COMPENDIUM

Assistance to States for Control of Animal Diseases (ASCAD) Training Course

on

Role of Veterinarians in Disaster Management, Food Safety and Control of Zoonotic Diseases

December 9-14, 2013

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Organized by
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Dr. P. H. Tank
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Foreword

The diseases and infections that are naturally transmissible between vertebrate animals and humans are collectively referred to as zoonoses. With nearly two-thirds of the human infections recognized as zoonoses, veterinarians have a huge role in protecting human health. Most Indian rural households stay in close contact with animals, increasing the risk of zoonotic disease transmission. Although the exact burden of foodborne diseases is unavailable, sporadic attempts have been made to document outbreaks. Unfortunately, the unreported cases far outnumber the reported ones with major losses in terms of lost man hours and treatment costs, a prominent factor that pushes forth the issue of food safety. The ever increasing human population has put stress on the agricultural produce for food and hence there is a shift towards animal products, which puts veterinarians at the centre of this food safety chain. India has a unique geo-climatic condition and is highly vulnerable to natural disasters. Nearly 30 million people were affected by disaster every year. The loss in term of human and livestock lives as well as the community and public assets is enormous. There have been attempts to address different kinds of natural and man-made disasters at different times. Introduction of these aspects to the field veterinarians will equip them better to deal with natural disasters and animal epidemics.

In this direction, the ASCAD training course on "***Role of Veterinarians in Disaster Management, Food Safety and Control of Zoonotic Diseases***" is organized by the College of Veterinary Science and Animal Husbandry, Junagadh Agricultural University, Junagadh with the aim of updating the knowledge of the field veterinarians on disaster management, food safety and control of zoonotic diseases.

I congratulate Dr. S.H. Sindhi, Course Coordinator and his team for taking this initiative and compiling the training manual which covers a range of topics covering aspects on disaster management, food safety and control of zoonotic diseases. I hope that this training course will be of immense help in improving knowledge and skills of veterinarians in these aspects.

I wish this training programme to be successful and rewarding to all concerned.

(P. H. Tank)
Course Director

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Dr. S. H. Sindhi
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Preface

The world is a 'global village' owing to reduced travel time and advances in communication. The increased tourism and trade have also contributed to the rapid spread of diseases. The diseases and infections do not recognize geographical or species borders. The emerging and re-emerging zoonotic and food borne diseases have a major socioeconomic and public health impact. In recent years disasters have assumed serious dimensions as they pose a greater threat to health, environment and national security. A wide spectrum of pandemics have engulfed our nation previously and continue to do so affecting both human and animal health. These situations pose new challenges to the skills and capacities of the veterinarian.

The training course on "***Role of Veterinarians in Disaster Management, Food Safety and Control of Zoonotic Diseases***" includes variety of information on the major zoonotic disease including foodborne diseases and their control measures. Further, the course covers various topics related to disaster management. The compendium has been meticulously compiled by the staff of the department which I hope, will be a useful document and guide for further reference to the field veterinarians.

I take this opportunity to extend my sincere thanks to Dr. N. C. Patel, Hon'ble Vice Chancellor, Junagadh Agricultural University, Junagadh. I extend my heartfelt thanks to Dr. A. J. Kachhia Patel, Director, Department of Animal Husbandry, Government of Gujarat. I am highly thankful to Dr. P. H. Tank, Principal and Dean, College of Veterinary Science and Animal Husbandry, JAU for the unabated support and encouragement in conducting this training. I also thank Dr. P. H. Vataliya, Professor and Head, Department of Animal Genetics and Breeding, College of Veterinary Science and Animal Husbandry, JAU for his valuable suggestions and guidelines in planning the training course. I acknowledge the all round efforts of Dr. Suman Kumar, Asst. Prof., Dept. of VPE. I also thank all my colleagues in the College who have contributed immensely in the formation of this manual by providing their valuable chapters.

S.H. Sindhi

(**S. H. Sindhi**)
Course Coordinator

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December 9-14, 2013

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ASCAD Training on
"Role of Veterinarians in Disaster Management, Food Safety and Control of Zoonotic Diseases" 9th-14th December, 2013

Training schedule

Sr. No.	Date	Time	Topic	Name of speaker
1.	9/12/2013	9.00 to 9.30	Registration and Inauguration	
		9.30 to 10.30	Leptospirosis in India: A veterinary perspective	Dr. S. H. Sindhi
		10.30 to 11.30	National scenario of zoonotic diseases: Threats and socio-economic impact	Dr. M. Suman Kumar
		11.30 to 12.30	Pet-borne Zoonoses: Do's and Don'ts	Dr. P. H. Vataliya
		Lunch Break		
		3.00 to 4.30	Emerging viral zoonoses in India with special reference to CCHF	Dr. B. S. Matapathi
		4.30 to 6.00	Bacterial zoonoses and approaches to their management	Dr. D. B. Barad
2.	10/12/2013	9.00 to 10.00	Parasitic zoonoses in India: An overview	Dr. Binod Kumar
		10.00 to 11.00	Zoonotic diseases and wildlife	Dr. D. T. Fefar
		11.00 to 12.00	Avian Influenza: Disease and public health importance	Dr. S. H. Sindhi
		Lunch Break		
		3.00 to 4.30	Rabies: Indian scenario and control strategies	Dr. A. R. Bhadania
		4.30 to 6.00	Biosecurity measures at poultry farms for prevention and control of zoonotic diseases	Dr. V. A. Kalaria
3.	11/12/2013	9.00 to 10.00	Role of extension education in control of zoonotic diseases	Dr. S. W. Sawarkar
		10.00 to 11.00	An overview on zoonotic diseases of equine	Dr. J. S. Patel
		11.00 to 12.00	Foodborne zoonoses and control strategies	Dr. Sagar Chand
		Lunch Break		
		3.00 to 4.30	Data Collection during Natural Disasters	Dr. G. S. Sonawane
		4.30 to 6.00	Zooanthropophillic ticks and their role in zoonotic disease transmission	Dr. Binod Kumar
4.	12/12/2013	9.00 to 10.00	Food safety in the era of globalization	Dr. D. D. Garg
		10.00 to 11.00	National and International Food Safety Standards	Dr. S. R. Badhe
		11.00 to 12.00	Efficient utilization of fallen Livestock	Dr. M. M. Pathan
		Lunch Break		
		3.00 to 4.30	Safety issues in meat production and processing	Dr. S. R. Badhe
		4.30 to 6.00	An update on techniques to detect food adulteration	Dr. M.V. Parakhia

5.	13/12/2103	9.00 to 10.00	Overview of Disaster Management	Dr. M. Suman Kumar
		10.00 to 11.00	Emergency preparedness in the face of zoonotic disease outbreak	Dr. B. S. Matapathi
		11.00 to 12.00	Brucellosis: An important occupational zoonoses	Dr. B. B. Javia
		Lunch Break		
		3.00 to 4.30	Pesticide residues in foods: Significance and impact on human health	Dr. U. D. Patel
		4.30 to 6.00	Risk assessment of antibiotic residues in foods of animal origin	Dr. H. B. Patel
6.	14/12/2013	9.00 to 10.00	Early warning system for Livestock and Zoonotic diseases	Dr. Amit Prasad
		10.00 to 11.00	Livestock Emergency Guidelines & Standards	Dr. Sagar Chand
		11.00 to 12.00	Animal evacuation and emergency shelter	Dr. T. K. Patbandha
		Lunch Break		
		3.00 to 4.00	Management of livestock during disasters	Dr. S. S. Patil
		4.00 to 5.00	Safe Disposal of Animal Carcasses	Dr. Vivek Singh
		5.00 to 6.00	Distribution of certificates and Valedictory function	

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Veterinary standard precautions to prevent pet-borne zoonotic infections

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A significant number of zoonotic diseases are transmitted by pets, making veterinarians vulnerable to numerous zoonotic diseases. Veterinary practices are unique environments that bring humans into close contact with many different species of animals. In the practice environment veterinary personnel are frequently exposed to the infectious pathogens, many of which are zoonotic. Education on the prevention of zoonotic diseases is a considerable part of the clinical practice of veterinarians. The 'One Health, One World' paradigm for global health recognizes that most new human infectious diseases will emerge from animal reservoirs. With the cats and dogs closely sharing domestic environment with humans, they have the potential to act as sources and sentinels of a wide spectrum of zoonotic diseases. Among the emerging human infections, nearly 75% of the diseases are likely to emerge from an animal reservoir. This fact reaffirms the significance of zoonotic disease prevention and control (Taylor *et al*., 2001). The factors contributing to the emerging infections include globalization of the economy; increased world tourisml; ecological changes such as agricultural shifts, migration, urbanization, deforestation, or dam construction; and increased contact with animals due to development and travel. These factors place more people at risk for these diseases as well as increase the spread and emergence of infectious diseases.

From a 'One Health' perspective, companion animals can serve as sources of zoonotic infections, as intermediate hosts between wildlife reservoirs and humans, or as sentinel or proxy species for emerging disease surveillance. The role of companion animals in the human domestic and peridomestic environment, the major companion animal zoonoses and the potential for emergence of new human infections transmitted from these species are discussed here.

Household pets as a source of zoonotic infections

Pets, particularly dogs and cats, play important roles in societies throughout the world. Many Indian households own a dog or cat commonly. Other pets include birds, monkeys, reptiles, and rodents. Pets are important companions in many of the households where they live and are often considered family members. Pets contribute to the physical, social, and emotional development of children and to the well-being of their owners, particularly elderly people. Although pets offer significant benefits to society, there are well-known health risks associated with owning a pet. While animal bites and allergies to pets are the most common health risks, over one hundred infectious agents can be transmitted either directly or indirectly to humans, some of which are listed in table 1. The most common modes of transmission include direct skin contact (e.g. fungal diseases and sarcoptic mange); bite and scratch wounds (e.g. Pasteurellosis and rabies); fecal-oral transmission (e.g. roundworms and toxoplasmosis), especially in infants and young children; and vector transmission.

Veterinary standard precautions

A. Personal Protective Actions and Equipment

1. Hand hygiene

Hand-washing is the single most important measure to reduce the risk of disease transmission. Hands should be washed between animal contacts and after contact with blood, body fluids, secretions, excretions, and equipment or articles contaminated by them. Hand-washing with plain soap and running water mechanically removes soil and reduces the number of transient organisms on the skin, whereas antimicrobial soap kills or inhibits growth of both transient and resident flora. All soaps also have the effect of dissolving the lipid envelope of enveloped viruses, and have cell wall effects that are bactericidal.

Alcohol-based gels are highly effective against bacteria and enveloped viruses and may be used if hands are not visibly soiled. Alcohol-based gels are not effective against some non-enveloped viruses (e.g., norovirus, rotavirus, parvovirus), bacterial spores (e.g., anthrax, *Clostridium difficile*), or protozoal parasites (e.g., cryptosporidia). Antimicrobial-impregnated wipes (i.e., towelettes), followed by alcohol-based gels, may be used when running water is not available. Used alone, wipes are not as effective as alcohol-based hand gels or washing hands with soap and running water.

2. Use of gloves and sleeves

Gloves reduce the risk of pathogen transmission by providing barrier protection. They should be worn when touching blood, body fluids, secretions, excretions, mucous membranes, and non-intact skin. However, wearing gloves (including sleeves) does not replace hand-washing. Gloves should be changed between examinations of individual animals or animal groups (e.g., litter of puppies/kittens, group of cattle) and between dirty and clean procedures on a single patient. Gloves come in a variety of materials. Choice of gloves depends on their intended use. If latex allergies are a concern, acceptable alternatives include nitrile or vinyl gloves.

3. Facial protection

Facial protection prevents exposure of mucous membranes of the eyes, nose and mouth to infectious materials. Facial protection should be used whenever exposures to splashes or sprays are likely to occur. Facial protection should include a mask worn with either goggles or a face shield. A surgical mask provides adequate protection during most veterinary procedures that generate potentially infectious aerosols. These include dentistry, nebulization, suctioning, bronchoscopy, lavage, flushing wounds and cleaning with high pressure sprayers.

4. Respiratory protection

Respiratory protection is designed to protect the respiratory tract from zoonotic infectious diseases transmitted through the air. The need for this type of protection is limited in veterinary medicine. However, it may be necessary in certain situations, such as when investigating abortion storms in small ruminants (Q fever), significant poultry mortality (avian influenza), ill psittacine birds (avian chlamydiosis) or other circumstances where there is concern about aerosol transmission. The N-95 rated disposable particulate respirator is a mask that is inexpensive, readily available, and easy to use.

5. Protective outerwear

Use of outerwear like lab coats, coveralls, gowns, footwear and head-covers provide a barrier between persons and infectious agents. Although use of these alone may not be the ultimate solution to prevent diseases, adjoining environment protection measures are also helpful in preventing zoonotic infections.

6. Bite and other animal-related injury prevention

According to a study the majority (61%-68%) of veterinarians suffer an animal-related injury resulting in hospitalization and/or significant lost work time during their careers. These are mainly dog and cat bites, kicks, cat scratches and crush injuries, and account for most occupational injuries among veterinarians. Veterinary personnel reliably interpret the behaviors associated with an animal's propensity to bite; their professional judgment should be relied upon to guide bite prevention practices. Approximately 3 to 18% of dog bites and 28 to 80% of cat bites become infected. Most clinically infected dog and cat bite wounds are mixed infections of aerobic and anaerobic bacteria.

Veterinary personnel should take all necessary precautions to prevent animal-related injuries in the clinic and in the field. These may include physical restraints, bite-resistant gloves, muzzles, sedation, or anesthesia, and relying on experienced veterinary personnel rather than owners to restrain animals. Practitioners should remain alert for changes in their patients' behavior. Veterinary personnel attending large animals should have an escape route in mind at all times. When bites and scratches occur, immediate and thorough washing of the wound with soap and water is critical. Prompt medical attention should be sought for puncture wounds and other serious injuries. The need for tetanus immunization, antibiotics or rabies post-exposure prophylaxis should be evaluated.

B. Protective actions during veterinary procedures

1. Intake of animals

Waiting rooms should be safe environment for clients, animals and employees. Aggressive or potentially infectious animals should be placed directly into an exam room. Animals with respiratory or gastrointestinal signs, or a history of exposure to a known infectious disease should be asked to enter through an alternative entrance to avoid traversing the reception area.

2. Examination of animals

All veterinary personnel must wash their hands between examinations of individual animals or animal groups (e.g., litter of puppies/kittens, herd of cattle). Hand hygiene is the most important measure to prevent transmission of zoonotic diseases while examining animals. Potentially infectious animals should be examined in a dedicated exam room and should remain there until initial diagnostic procedures and treatments have been performed.

3. Injections, venipuncture, and aspirations

a. Needlestick injury prevention

Needlestick injuries are among the most prevalent accidents in the veterinary workplace. The most common needlestick injury is inadvertent injection of a vaccine. In a survey of 701 veterinarians, 27% of respondents had accidentally self-inoculated rabies vaccine and 7% live Brucella vaccine.

The most important precaution is to avoid recapping needles. Recapping causes more injuries than it prevents. When it is absolutely necessary to recap needles as part of a medical procedure or protocol, a mechanical device such as forceps can be used to replace the cap on the needle.

Following most other veterinary procedures, the needle and syringe may be separated for disposal of the needle in the sharps container. This can be most safely accomplished by using the needle removal device on the sharps container, which allows the needle to drop directly into the container. Needles should never be removed from the syringe by hand. In addition, needle caps should not be removed by mouth. Sharps containers are safe and economical, and should be located in every area where animal care occurs.

b. Barrier Protection

Gloves should be worn during venipuncture on animals suspected of having an infectious disease and when performing soft tissue aspirations.

4. Dental procedures

Dental procedures create infectious aerosols and there is risk of exposure to splashes or sprays of saliva, blood, and infectious particles. There is also the potential for cuts and abrasions from dental equipment or teeth. It has been observed that irrigating the oral cavity with a 0.12% chlorohexidine solution significantly decreases bacterial aerosolization.

5. Resuscitations

Resuscitations are particularly hazardous because they may occur without warning and unrecognized/undiagnosed zoonotic infectious agents may be involved. For example, a dog that presents in respiratory failure after being hit by a car may have been in the road due to clinical rabies. Barrier precautions such as gloves, mask, and face shield or goggles should be worn at all times. Never blow into the nose/mouth of an animal or into an endotracheal tube to resuscitate an animal; instead, intubate the animal and use an anesthesia machine/respirator.

6. Obstetrics

Common zoonotic agents, including *Brucella* spp., *Coxiella burnetii*, and *Listeria monocytogenes* may be found in high concentrations in the birthing fluids of aborting or parturient animals, stillborn fetuses, and neonates. Gloves, sleeves, mask or respirator, face shield or goggles, and impermeable protective outerwear should be employed as needed to prevent exposures to potentially infectious materials. During resuscitation, do not blow into the nose or mouth of a non-respiring neonate.

7. Necropsy

Necropsy is a high risk procedure due to contact with infectious body fluids, aerosols, and contaminated sharps. Non-essential persons should not be present. Veterinary personnel involved in or present at necropsies should wear gloves, masks, face shields or goggles and impermeable protective outerwear as needed. In addition, cut-proof gloves should be used to prevent sharps injuries. Respiratory protection (including environmental controls and respirators) should be employed when band saws or other power equipment are used.

8. Diagnostic specimen handling

Feces, urine, aspirates, and swabs should be presumed to be infectious. Protective outerwear and disposable gloves should be worn when handling these specimens. Discard gloves and wash hands before touching clean items (e.g., microscopes, telephones, food). Although in veterinary practices animal blood specimens have not been a significant source of occupational infection, percutaneous and mucosal exposure to blood and blood products should be avoided. Eating and drinking must not be allowed in the laboratory.

C. Environmental infection control

1. Isolation of infectious animals

Patients with a contagious or zoonotic disease should be clearly identified so their infection status is obvious to everyone, including visitors allowed access to clinical areas. Prominent signage should indicate that the animal may be infectious and should outline any additional precautions that should be taken. Ideally, veterinary practices should utilize a single-purpose isolation room for caring for and housing contagious patients. Access to the isolation room should be limited and a sign-in sheet should be kept of all people having contact with a patient in isolation. A disinfectant should be use in the footbath just inside the door of the isolation area and used before departing the room.

2. Cleaning and disinfection of equipment and environmental surfaces

Proper cleaning of environmental surfaces, including work areas and equipment, prevents transmission of zoonotic pathogens. Environmental surfaces and equipment should be cleaned between uses or whenever visibly soiled. A recent report indicates that directed misting application of a peroxygen disinfectant for environmental decontamination is effective in veterinary settings. When cleaning, avoid generating dust that may contain pathogens by using central vacuum units, wet mopping, dust mopping, or electrostatic. Surfaces may be lightly sprayed with water prior to mopping or sweeping. Areas to be cleaned should be appropriately ventilated.

3. Decontamination and spill response

Spills and splashes of blood or other body fluids should be immediately sprayed with disinfectant and contained by dropping absorbent material (e.g., paper towels, sawdust, cat litter) on them. A staff person should wear gloves, a mask, and protective clothing (including shoe covers if the spill is on the floor and may be stepped in) before beginning the clean-up.

5. Veterinary medical waste

Veterinary medical waste is a potential source of zoonotic pathogens if not handled appropriately. Medical waste is defined and regulated at the state level by multiple agencies, but may include sharps, tissues, contaminated materials, and dead animals. The local and/or state health departments and municipal governments should be consulted for guidance.

6. Rodent and vector control

Many important zoonotic pathogens are transmitted by rodents or insect vectors. The principles of integrated pest management (IPM) are central to effective prevention and control. IPM practices include:

- Sealing entry and exit points into buildings. Common methods include the use of steel wool, or lath metal under doors and around pipes
- Storing food and garbage in metal or thick plastic containers with tight lids
- Disposing of food-waste promptly
- Eliminating potential rodent nesting sites (e.g., hay storage)
- Maintaining snap traps throughout the practice to trap rodents (check daily)
- Removing sources of standing water (empty cans, tires, etc.) from around the building to prevent breeding of mosquitoes
- Installing and maintaining window screens to prevent entry of insects into buildings

7. General hospital biosecurity guidelines

- Wash hands before and after each animal contact.
- Wear gloves when handling animals when zoonotic diseases are on the differential list of diagnoses.
- Minimize contact with hospital materials (instruments, records, door handles, etc.) while hands or gloves are contaminated.
- Change outer garments when soiled by faeces, secretions, or exudates.
- Clean and disinfect equipment (stethoscopes, thermometers, bandage scissors, etc.) with 0.5% chlorhexidine solution after each use.
- Clean and disinfect examination tables and cages after each use.
- Clean and disinfect litter boxes and dishes after each use.
- Place pets with suspected infectious diseases immediately into an examination room or an isolation area upon admission into the hospital.
- When possible, postpone until the end of the day any procedures using general hospital facilities like surgery and radiology.

D. General measures

1. Employee immunization policies

The veterinarian and supporting staff must be immunized prophylactically against some of the diseases and infections.

a. Rabies

Veterinary personnel who have contact with animals should be vaccinated against rabies. Pre-exposure rabies vaccination consists of three doses of a licensed human rabies vaccine administered on days 0, 7, and 21 or 28. In addition to pre-exposure rabies vaccination, the rabies antibody titer should be checked every two years for those in the frequent risk category, including veterinarians and their animal handling staff.

b. Tetanus

All staff should have an initial series of tetanus immunizations, followed by a booster vaccination every 10 years. In the event of a possible exposure to tetanus, such as a puncture wound, employees should be evaluated by their health care provider; a tetanus booster may be indicated.

c. Seasonal Influenza

Veterinary personnel are encouraged to receive the current seasonal influenza vaccine, unless contraindicated. This is intended to minimize the small possibility that dual infection of an individual with human and avian or swine influenza virus could result in a new hybrid strain of the virus.

2. Staff training and education

Staff training and education are essential components of an effective employee health program. All employees should receive education and training on injury prevention and infection control at the beginning of their employment and at least annually. Additional in-service training should be provided as recommendations change or if problems with infection control policies are identified. Training should emphasize the potential for zoonotic disease exposure and hazards associated with work duties, and include animal handling, restraint, and behavioral cue recognition. Staff participation in training should be documented.

Recommendation: education of higher risk individuals about zoonotic diseases

Education of pet owners at higher risk of infection is essential in helping to prevent the severe syndromes of zoonotic diseases that may occur in these individuals. It is critical that higher risk individuals are aware of the risks of owning a pet and are disposed to discussing their questions about zoonotic diseases with their veterinarian and physician. Educational materials aimed at higher risk clients or patients should be available at veterinarians' and physicians' offices to help encourage these individuals to discuss zoonotic diseases. Veterinarians should provide intake forms to clients inquiring about higher risk status of household members in addition to medical history of the pet.

Recommendation: collaboration between veterinarians, physicians, and public health agencies

It is also vital that regular communication and collaboration occur between veterinarians, physicians, and public health agencies. The three groups have necessary roles to play in education and prevention of zoonotic diseases but have contact with the public in different settings and for different reasons. Public health agencies could serve as a catalyst and a resource for the improvement of education and prevention of zoonotic diseases in their communities. Public health agencies should meet regularly with veterinarians and with physicians in the community to discuss ways in which they could better assist with zoonotic diseases and how to implement these ways. Public health agencies should also increase their involvement with both professions by providing educational materials.

Recommendation: education of veterinarians and physicians

Veterinarians and physicians must maintain a high level of knowledge about zoonotic diseases to be in a position to educate clients or patients and to be involved in prevention of zoonotic diseases. Continuing education courses on zoonotic diseases need to be regularly available and need to emphasize the importance of zoonotic diseases. Joint continuing education programs for veterinarians and physicians would provide excellent opportunities to establish communication formats between the two professions.

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The best doctor in the world is a Veterinarian. He can't ask his patients what is the matter -- he's got to just know

Will Rogers

Table 1: List of some commonly transmitted zoonotic pet-borne infections

Route of human exposure	Agent	Principal clinical syndromes
Bites, scratches, or contact with exudates	*Bartonella* spp.	**Cats** and **dogs**: subclinical fever, hyperglobulinemia, endocarditis, myocarditis, epistaxis, granulomatous rhinitis, uveitis, lymphadenopathy; **Humans**: fever, malaise, endocarditis, myocarditis, meningitis, encephalopathy, lymphadenopathy, pulmonary granulomata, neuroretinitis, bacillary angiomatosis, bacillary peliosis
	Capnocytophaga canimorsus	**Cats** and **dogs**: subclinical oral carriage; **Humans**: bacteremia
	Staphylococcus spp.	**Cats**, **dogs**, and **Humans**: subclinical cutaneous infections, bacteremia
	Yersinia pestis	**Cats** and **Humans**: bubonic, bacteremic, or pneumonic (depending on route of inoculation and success of initial therapy)
	Rabies	**Cats**, **dogs**, and **Humans**: progressive CNS disease
	Dermatophytes	**Cats** and **dogs**: superficial dermatologic disease; **Humans**: superficial dermatologic disease and deep tissue infections in immunocompromised patients
Contact with infected feces (ingestion unless otherwise indicated)	*Campylobacter jejuni, C. coli*	**Cats**, **dogs**, and **Humans**: diarrhea and vomiting
	Escherichia coli	**Cats**, **dogs**, and **Humans**: diarrhea and vomiting
	Salmonella spp.	**Cats**, **dogs**, and **Humans**: diarrhea and vomiting
	Helicobacter spp.	**Cats** and **dogs**: vomiting; **Humans**: reflux disease and vomiting
	Yersinia enterocolitica	**Cats** and **dogs**: subclinical infection or abdominal pain, vomiting and diarrhea; **Humans**: diarrhea and vomiting
	Ancylostoma caninum *Uncinaria stenocephala*	**Cats** and **dogs**: blood-loss anemia, diarrhea, unthrifty; **Humans**: cutaneous larva migrans, eosinophilic enteritis
	Toxocara canis and *T. cati*	**Cats** and **dogs**: vomiting, diarrhea, failure to thrive; **Humans**: ocular and visceral larva migrans
	Echinococcus multilocularis	**Cats** and **dogs**: subclinical infection; **Humans**: polysystemic hydatid disease
	Echinococcus granulosus	**Dogs**: subclinical infection; **Humans** polysystemic disease

	Cryptosporidium spp	**Cats**, **dogs**, and **Humans**: diarrhea and vomiting
	Toxoplasma gondii	**Cats**: rarely diarrhea, polysystemic disease; **dogs**: neuromuscular and rarely polysystemic disease; **Humans**: occular, CNS, and polysystemic disease
	Giardia spp.	**Cats**, **dogs**, and **Humans**: diarrhea and vomiting
Contact with infected respiratory or ocular secretions	*Bordetella bronchiseptica*	**Cats** and **dogs**: sneezing and coughing; **Humans**: pneumonia in immunosuppressed patients
	F. tularensis	**Cats**: septicemia, pneumonia; **Humans**: ulceroglandular, oculoglandular, glandular, pneumonic or typhoidal (depending on route of infection)
	Streptococcus group A	**Cats** and **dogs**: subclinical transient carrier; **Humans**: strep throat, septicemia
	Y. pestis	Same as entry under bites, scratches, or contact with exudates
	Influenza A virus	**Cats** and **dogs**: respiratory disease, systemic disease; **Humans**: respiratory disease
Contact with infected genital secretions	*Brucella canis*	**Dogs**: orchitis, epididymitis, abortion, stillbirth, vaginal discharge, uveitis, fever; **Humans**: fever, arthralgia, headache, fatigue, myalgia, weight loss, arthritis/spondylitis, meningitis or focal organ involvement (endocarditis, orchitis/epididymitis, hepatomegaly, splenomegaly)
	Coxiella burnetti	**Cats**: subclinical, abortion or stillbirth; **Humans**: fever, pneumonitis, lymphadenopathy, myalgia, arthritis
Contact with infected urine	*Leptospira* spp	**Dogs**: fever, vomiting, pulmonary hemorrhage, renal and hepatic dysfunction, encephalopathy, uveitis; **Humans**: fever, headache, myalgia, meningitis, pulmonary/hepatic and renal dysfunction, hemorrhagic complications
Flea-borne	*Bartonella* spp. and *Y. pestis*	Same as entry under bites, scratches, and contact with exudates
	Rickettsia felis	**Cats**: subclinical, fever; **Humans**: fever, CNS disease
	Rickettsia typhi	**Cats**: subclinical; **Humans**: fever, polysystemic disease
Tick-borne diseases	*Borrelia burgdorferi*	**Dogs**: subclinical infection, fever, polyarthritis, nephropathy; **Humans**: polyarthropathy, cardiac and CNS disease
	Ehrlichia spp.	**Dogs**: subclinical infection, fever, polysystemic disease; **Humans**: fever, polysystemic disease
	Rickettsia rickettsii	**Dogs**: subclinical infection, fever, polysystemic disease; **Humans**: fever, polysystemic disease

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National scenario of zoonotic diseases: Threats and socio-economic impact

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Zoonotic diseases are recognized as a major global threat to human health and sustainable development. They are a major concern to the national and international agencies affecting travel, trade and costing man hours. The 'golden era of antibiotics' between 1960s and 70s prompted expectations that the antibiotic and vaccines would relegate infectious diseases to footnotes of history, and in many countries communicable control systems were neglected (Keusch *et al.* 2009) but the frequent and often dramatic appearance of new infectious agents or the reappearance of well recognized zoonoses has changed perceptions. The infections or diseases that are naturally transmissible between animals and human beings are collectively referred to as "zoonoses". The term "zoonoses" comprises Greek words– '*zoon'* meaning -the animal and '*noses'* meaning– diseases. This term was used by Rudolf Virchow to define communicable diseases of animals transmissible to man under natural circumstances. Animals have been a source of infectious disease to man right from the time they were domesticated. Two-thirds of all infectious diseases of human beings are shared with the domestic, pet and wild animals.

A wide variety of animal species, domesticated, peri-domesticated and wild, can act as reservoirs for these pathogens, which may be viruses, bacteria, parasites or prions. Considering the wide variety of animal species involved and the often complex natural history of the pathogens concerned, effective surveillance, prevention and control of zoonotic diseases pose a real challenge to public health (WHO, 2004). No country has been able to anticipate the sudden and sometimes devastating impact of novel disease agents. Adding to the complexity is the fact that international trade and transport of people, animals and goods have ensured that we live in a global village which has ensured that wherever zoonoses emerge they have to be considered as a world issue.

Out of a total of 1405 infectious diseases that affect human beings, approximately 58% (817) are zoonotic in nature; and out of 177 infections that are emerging or re-emerging, about 73% (130) are zoonoses. The importance of zoonotic diseases can be gazed from the fact that 64% (14/22) of the major etiological agents for infectious diseases identified between 1973 and 1994 are zoonotic in nature (Taylor *et al*., 2001).

India is currently fighting a nagging war against Swine flu and Bird Flu. These two names have become synonymous to the terror the nature has unleashed recently, which has left the world community in a state of panic. The highly contagious swine flu virus (H5N1 strain of type 'A' influenza virus) has already infected over 41,450,671 humans, and about 200 crore people are likely to be infected in next 2 years. In our country, which has maximum tuberculosis patients in the world, the TB (particularly MDR strains of *M. tuberculosis*) claims one human life every minute, and in a deadly combination with AIDS; it is fast emerging as a major human killer. Japanese encephalitis had killed nearly 1016 children and left many crippled with permanent neuromuscular retardation in 2005 and now it has become endemic in the central-eastern parts of Uttar Pradesh and North-eastern region of the country. Every year following the floods in Maharashtra and Gujarat, the leptospirosis as an emerging and reemerging disease has claimed many human lives in the recent past.

Socio-economic conditions in India and spread of zoonoses

An analysis of recent emerging infectious diseases demonstrates the increased risk of emergence of zoonotic pathogens in the Indian subcontinent. Large parts of the country have been demonstrated to be global ''hot spots'' at high risk for emergence of pathogens from wildlife as well as domestic animals. It is suggested that human population density, human population growth, wildlife host species richness, and low latitude are predictors for the emergence of zoonotic diseases. With the world's second largest human population, two biodiversity hotspots, and one of the world's greatest densities of tropical livestock, India possesses a favourable environment for the transmission of both known and novel diseases between animals and people Available information in India suggests zoonotic diseases are responsible for a large burden on the public health, livestock economies, and wildlife of the country. For example, India is estimated to have the highest rabies burden in the world with more than 20,000 human deaths annually; outbreaks of anthrax contracted from wild and domestic animals have led to hundreds of reported deaths; the emergence of diseases from wildlife such as Nipah and Hendra viruses may be increasing; and many other endemic zoonoses have been documented, most of which disproportionately affect India's poor and marginal communities (Sekar *et al*., 2011).

In India, agriculture and animal husbandry workers such as farmers, livestock owners, animal handlers, veterinary extension workers and veterinarians have been found to commonly contact approx. 40 zoonotic diseases, whereas, people engaged in production and processing of livestock products such as personnel working in abattoir, dairy, poultry enterprises and piggery suffer frequently with about 22 zoonotic diseases. In many countries including India, especially in the rural settings, close contact between humans and cattle or dogs provides an unusual environment for zoonotic transmission of many infectious agents to humans. In rural areas in many developing countries, cattle are housed in the same premises as humans. The infants, young children and adults are responsible for feeding the cattle. It is not unusual to find humans and young bovine calves indulging in friendly sports in the animal dwellings. Stray dogs also provide constant contact between humans and canines. In many developing countries in Asia, monkeys are trained to create amusement to people on the streets. The tamed apes often share the human dwellings constituting a potential source of disease transmission. Furthermore, macaques can be very mischievous and grab edibles from passers-by in rural and urban areas.

In India, approx. 40 zoonotic diseases that have been commonly reported include Bird flu, Swine flu, Rabies, Japanese encephalitis, Brucellosis, Plague, Anthrax, Tuberculosis, Leptospirosis, Salmonellosis, Campylobacteriosis, Glanders, Chikungunya and Dengue. Of theses, zoonotic pathogens such as Brucella, Listeria, Campylobacter, Leptospira, *Coxiella burnetii* and Chlamydophilla spp. are not only important from reproduction and economical standpoint as these are associated with cases of infectious abortion, repeat breeding and infertility in animals but also potentially hazardous to human health.

Major zoonotic diseases in India and their threat perception:

All major zoonotic diseases, emerging, re-emerging or endemic, in addition to being direct public health problems by affecting the health and well-being of millions of people, also prevent the efficient production of food, particularly of much-needed proteins, and create obstacles to international trade in animals and animal products. These diseases, therefore, are an impediment to overall socio-economic development.

The status of major viral zoonotic diseases in India has been reviewed in recent times.

Swine flu: The recent pandemic of 'Swine Flu' caused by H1N1 strain has left the world community in a state of panic with more than 3917 deaths, that has forced the World Health Organization to declare it as a flu Pandemic in June, 2009-the first global pandemic in 41 years.

The present swine flu strain H1N1 originated from reassortment of swine influenza-A type, avian influenza and human influenza in swine which act as mixing vessel allowing reassortment of genetic material giving rise to new strains. The first case of H1N1 infection in India was reported on May 16, when a 23-yearold infected student arrived in Hyderabad from US. The first case of human-to-human transmission of swine flu in India was reported on 8th June, 2009 in Hyderabad. Till now, the swine flu death toll has reached 1,152 with more than 28,401 cases in India.

Bird Flu: Avian influenza is a viral disease of wild and domestic birds that occasionally affects other animal species such as pigs. The first documented human outbreak of H5N1 strain of Highly Pathogenic Avian Influenza (HPAI) occurred in Hong Kong in 1997. In India, the first outbreak of HPAI in poultry was confirmed in Navapur sub-district of western Maharashtra on 18 February, 2006; and subsequently from other places including Jalgaon (Maharashtra), Gujarat and MP in 2006; Imphal (Manipur) in July 2007, West Bengal, Assam and Tripura in 200. Reports of bird flu sent Indian poultry sales plunging by 80-90 percent and halted exports to neighbouring countries, the Middle East and Japan. Recent outbreak of bird flu on 14 January 2008 caused by HPAI in 15 districts of West Bengal has caused great losses to poultry industry, which has estimated at Rs. 500 crore owing to its very high virulence (1.5 lakh birds died, 38 lakh chickens culled and killed); and threat to public health due to its zoonotic nature, thereby, infecting 357 people and claiming more than 224 human lives across the world since the virus began affecting poultry stocks in Asia in 2003. With fresh reports of Bird flu cases in poultry in Sikkim in Jan., 2009, the concerned agencies are struggling to effectively control the bird flu in the country. Very recently, the bird flu has struck the country again in August 2013 at a government owned farm in Chattisgarh. Currently India is free of notifiable Avian Influenza.

Rabies: More than 99% of all human rabies deaths occur in developing world and half of the global human population lives in canine rabies endemic areas. An estimated number of 55,000 persons, mainly children, die of this disease in the world every year. Economic cost due to rabies in Asia is about US $563 million. In India, the disease has been estimated to claim about 20,500 human lives (36% of global cases) annually through the bites of dogs (whose number in the country has been estimated to be around 27 million, of which 75.2% are stray dogs) in more than 96% of cases. The remaining cases are due to bite of cats (1.7%) and other animals (2.1%) including monkey and raccoons. The total dog bite cases in India are 1.74 crore leading to 14 lakh human vaccinations. The human and animal rabies cases in the country cost an estimated Rs. 300 and Rs.100 crores, respectively.

Japanese Encephalitis (JE): Globally, JE is a leading cause of viral encephalitis with approx. 30–50,000 cases and 15,000 deaths annually; and has been estimated to cause economic losses to the tune of US$1 million/year. In India, it is a disease of rural areas and people of lower socio-economic group. The disease has been reported from 24 states/ union territories but remains endemic in northeastern region and east-central UP. Around 378 million populations are living at the risk of JE. In the last 20 years, JE has claimed more than 6,500 lives of children in the country inclusive of a major outbreak in 1978 which claimed 1,072 lives. In recent major outbreak of JE in 2005 (July - Nov) with around 6097 suspected cases, 1398 deaths with a CFR 22.9% were reported from central-eastern UP and Bihar. Of these, 5290 cases with 1332 death were from UP. In 2007, JE cases were reported from Assam (368), Goa (44), Tamil Nadu (17), Manipur (11), Karnataka (6), Haryana (6) and Kerala (1) (Anon, 2007. www.promedmail.org). Recently, the encephalitis toll has reached to 441 in UP. There is high mortality in piglets with a huge economic impact in swine market. In equines, there is 2% morbidity during outbreak and mortality is up to 5%.

Kyasanur Forest Disease (KFD): Earlier serological surveys showed antibodies to KFD virus or a related virus in Kutch and Saurashtra, and other parts of country. With increase in number of human cases (720) and deaths (6) recorded in2004-05, the disease has shown a re-emerging trend in the country. Recently Andaman and Nicobar Islands showed highest (22.4%) positivity in human population. Each year about 1000 human cases are being reported in India.

Nipah virus: Nipah virus (NiV), a zoonotic paramyxovirus, was implicated as the cause of a highly fatal febrile human encephalitis in Malaysia and Singapore in 1999 with CFR ranging from 38%-75% and later on in Bangladesh during the winters of 2001, 2003, and 2004. Also in India the disease has been reported from siliguri district of West Bengal in 2001. While In the Malaysian outbreak, NiV was introduced into the pig population through fruit bat which a natural reservoir of the virus and most of the human cases resulted from exposure to infected pigs. Also Human-to-human transmission of NiV has also been verified during the outbreak in Faridpur, Bangladesh.

Crimean-Congo Haemorrhagic Fever (CCHF): In India, the first ever case of this highly infectious tickborne haemorrhagic fever, which also spreads through the contact with the discharges of the infected person was confirmed in Ahmedabad in Jan, 2011 claiming three human life including the doctor and nurse who attended on the patient. The virus shows no signs in animals but kills about 20-40%humans who contract it. There is no vaccine available to give protection against it.

Pox viruses: Poxviruses include a group of important pathogens which are known to human being since old days. But, of them some are important as they are zoonotic in nature like Buffalo pox, monkey pox and cow pox. In India, Buffalo pox virus poses a great risk to farmers compromising their health and economic condition. Buffalo pox is endemic mainly in Andhra Pradesh, Karnataka and Maharashtra. Lesions of the disease include pox like local lesions on hands, forearms and forehead with fever, axillary lymphadenopathy and general malaise.

Chikungunya: Chikungunya is a disease of zoonotic importance affecting man characterized by arthralgia- joint pain of knee. Recently, the world has seen its outbreaks in Asia and Africa affecting large population. The disease has re-emerged after 2 long decades. In India, Chikungunya virus was first isolated from Calcutta, in 1963. The disease, first detected in the state in July, 2006 has affected about 100,000 people and India finally declared the current outbreak of Chikungunya, an epidemic. Five worst affected states since Dec, 2005 are Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu and Madhya Pradesh.

Dengue viral infection: Dengue is considered as one of the important arboviral zoonotic infection. Dengue infection in human is characterized by a spectrum of illness ranging from inapparent infection to moderate febrile illness (DF) and severe and fatal hemorrhagic conditions known as dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS).

Rota viruses: It is one of the major viral diseases responsible for infant diarrhoeal cases accounting 20-25% of diarrhoeal deaths.

Tuberculosis: With a total of 322,000 deaths annually, India is the highest TB burden country in the world, accounting for one fifth of the global incidence - an estimated 1.9 million cases annually (DGHS Report, 2009). It is estimated that about 1000 Indians die from TB per day i.e. one per min. TB costs more than Rs 13,000 crores in India/ year. 67% rural and 75% urban patients are in debts on account of treatment and loss of workdays. However, with the introduction of RNTCP, TB mortality in the country has reduced from an estimated 42/lakh population in 1990 to 628/lakh population in 2006 (DGHS Report, 2009).

Brucellosis: In India, brucellosis costs Rs. 350 million in the form of food animals and man days of labour. Moreover, there are losses due to abortion in the affected animal population, loss of progeny, reduced milk production. Human brucellosis is causing physical incapacity and loss of 3 million man days of labour annually

Salmonellosis: This disease is caused by a widely prevalent bacterium belonging genus- *Salmonella* having more than 2435 serovars identified so far. Salmonella infections are prevalent all over the world among various species of domestic as well as wild animals besides poultry, ducks, birds, amphibians, reptiles and rodents. In India, human salmonellosis is endemic and one of the most widespread zoonosis. The prevalence of Salmonella infection will probably continue unabated in the future because of the ubiquitous distribution of the organism in animal reservoirs and humans.

Leptospirosis: It is caused by a spirochaete- *Leptospira interogans*. The disease is contracted from infected rat's urine/ contaminated watercourses. Population at high risk includes farm workers, rice field workers, sugarcane cutters, cattle rearers, fishermen, slaughter house and sewer workers. Cases of Leptospirosis have been regularly reported from TN, Kerala, and Andaman over the last 2 decades due to farming and inadequate rodent control.

Anthrax: It is endemic in Tamil Nadu, Karnataka & Andhra Pradesh. In India, 205 human cases with majority of cutaneous anthrax have been documented. In endemic areas of India, it is a sporadic disease in cattle with 479 reported deaths in about 3 years span. A recent outbreak of anthrax in three districts of west Bengal has been reported to claim lives of 10 animals.

Plague: It is a disease of antiquity, and not only India but the whole world had seen major pandemics of plague. Case fatality rate is 100% in untreated cases, in septicaemic and pneumonic forms. Economic losses of more than US $1.5 billion have been estimated during Surat outbreak in India in 1994.

Glanders: It is primarily a highly contagious, acute or chronic, usually fatal disease of equines caused by *Burkholderia mallei*, and characterized by serial development of ulcerating nodules that are most commonly found in the upper respiratory tract, lungs, and skin. In India, sporadic cases of glanders had surfaced between 1985-86 and 1990-91 from the states of Haryana, Himachal Pradesh and Punjab. Subsequent to its reemergence in and around Pune and Panchgani area of Maharashtra in July-August, 2006, several cases have been reported in equines from different states viz., Andhra Pradesh, Uttar Pradesh, Uttarakhand and Punjab. Recently in the year 2006-07, 97 out of 4395 equine samples tested positive for glanders with isolation of *B. mallei* from 8 cases.

Listeriosis: In India, cases of human listeriosis, spontaneous abortions in women have been reported with seroprevalence of the disease varying from 2.8 to 7%. The pathogen has also been recovered from food of animal origin, repeat breeding, infertility and mastitis cases in animals.

Q-fever: It is caused by the bacterium *Coxiella burnetii*, which was earlier considered as a rickettsia. In India, the overall seroprevalence of Q fever in humans (2.7-26%), cattle (14.98%), sheep (6.2-14.41%), buffaloes (14.5-15.22%), goats (14.26-17.5%), equines (20.1%), swine (14.67%), dog (16%), and poultry (11.87%) has been reported, with most of the infectious cases from Punjab, Haryana, Rajasthan, UP, MP & Karnataka. The high excretion rate of pathogen particularly in milk observed in the study posses a potential public health threat from infected animals.

Colibacillosis: The causative agent Escherichia coli has over 200 recognized serotypes and are divided into 5 virulence groups (a) enteroaggregative (EAEC), (b) enterohaemorrhagic (EHEC), (c) enteroinvasive (EIEC), (d) enteropathogenic (EPEC), 8and (e) enterotoxigenic (ETEC). Of various groups, the EPEC and ETEC are important causes of acute enteritis whereas the EHEC has been implicated in a syndrome of diseases from mild diarrhoea to severe haemorrhagic colitis (HC) and haemolytic uraemic syndrome (HUS).

Toxoplasmosis: Toxoplasmosis is a common illness in both animals and man throughout the world and is caused by an obligate intracellular protozoan parasite, *Toxoplasma gondii*. Although the majority of human infections are mildly flu-like or asymptomatic, infection during pregnancy can cause abortion or congenital malformation. In animals, Toxoplasma is an important cause of ovine abortion, which may be controlled by management practices and vaccination. Pregnant women should avoid cleaning kitten litters and gardening as they may have heavy number of Toxoplasma oocyst.

Hydatid disease**:** The disease is caused by cysts formed by the cestode tapeworm Echinococcus granulosus in the tissues of an intermediate host. Man is an accidental intermediate host.

Cysticercosis/Taeniasis: The disease is worldwide including India. It is caused by *Taenia saginata* (beef tapeworm)-larval stage- *Cysticercus bovis* which occurs in cattle and *Taenia solium* (pork tapeworm) - larval stage- *Cysticercus cellulosae* which occurs in pig. There is ample evidence for the widespread occurrence of neurocysticercosis (NCC) caused by *T. solium* in India. The disease is wide spread in virtually all states anywhere between 26 and 50% of all Indian patients presenting with partial seizures are diagnosed with a SCG (solitary cysticercus granuloma-SCG) on the CT-scan. The other unusual feature of the disease is the low proportion of pork eaters amongst Indian patients with NCC. More than 95% of Indian patients with NCC are vegetarian or do not consume pork. Serologic assays revealed exposure to the disease in 21.5% of 107 neurological patients in Mumbai.

Ringworm: Ringworm infection are likely to be one of the most common zoonotic infections, reliable data are not available for the number of cases in humans. Ringworm is caused by a fungal infection, and there are a number of species of the fungus. The fungus causes a skin disease in both humans and animals which generally responds well to treatment or gradually disappears with time.

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Bacterial Zoonoses and approaches to their managemnet

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Zoonoses refer to those diseases and infections which are naturally transmitted between vertebrate animals and man. Worldwide, zoonotic diseases have a negative impact on commerce, travel and economies besides having severe public health implications. In the past when elementary rules of hygiene were not appropriately established and preventive measures were not discovered, bacterial zoonoses such as bubonic plague, bovine tuberculosis and brucellosis caused more human deaths than they ever will again. However, the burden of some bacterial zoonotic diseases appears to have been escalating over the last several decades and new bacterial zoonoses could arise. At present, 75% of emerging human pathogen has zoonotic origin and out of identified 1415 species of infectious organisms known to be pathogenic, 538 (38%) have bacterial origin (Taylor *et al*., 2001). Various elements are responsible for emergence of these pathogens including continuous increase in human and animal populations, reduction in travel time making it possible to circumnavigate the globe in less than the incubation period of most infectious bacterial agents and ecological changes caused by human activities like deforestation, urbanization and dam building.

Food producing animals and their products are the major sources for many of zoonotic organisms, which include *Salmonella* spp., *Campylobacter* spp., *L. monocytogenes*, *E. coli*, *Y. enterocolitica*, *Brucella* spp. and *Aeromonas* spp. These organisms can contaminate carcasses at slaughter or cross-contaminate other food items, leading to human illness and cause huge economic losses. Further, emergence of multi drug resistance in these pathogens has been documented worldwide. Studies have confirmed that antibiotic resistant *Campylobacter* and *Salmonella* Typhimurium DT104, have moved from animals to human through foods of animal origin (Smith *et al*., 1999; Ribot *et al*., 2002).

Table: Some of the important bacterial zoonotic diseases

Disease	Causative agent
Anthrax	*Bacillus anthracis*
Brucellosis	*Brucella* spp.
Campylobacteriosis	*Campylobacter* spp.
Cat Scratch disease	*Bartonella henselae*
Clostridial diseases	*Clostridium perfringens*
Colibacteriosis	*Escherichia coli* O157:H7
Erysipeloid	*Erysipelothrix rhusiopathiae*
Glanders	*Burkholderia mallei*
Leptospirosis	*Leptospira interrogans*
Listeriosis	*Listeria* spp.
Plague	*Yersinia pestis*
Q-fever	*Coxiella burnetii*
Salmonellosis	*Salmonella enterica*
Streptococcosis	*Streptococcus* spp.
Tetanus	*Clostridium tetani*
Tuberculosis	*Mycobacterium bovis, M. tuberculosis*
Tularemia	*Francisella tularensis*
Vibriosis	*Vibrio parahaemolyticus*

Others: Borreliosis, rat bite fever, melioidosis, *Aeromonas* infection and *Helicobacter* infection.

Anthrax

The incidence of human anthrax in the world is estimated to be 20,000 to 100,000 cases per annum, and there is considerable under reporting (Bacchil and Malik, 2004). The disease is characterised by outbreaks that usually involve a small number of animals, herbivores that are usually kept on pasture, but it can sometimes turn into an epidemic with potentially very serious consequences for humans (Fasanella *et al*., 2010). Vaccination of animals in endemic areas with single dose of Sterne vaccine is recommended. Human being acquires infection via three ways *viz* cutaneous that may be due to biting of infected fly or through implantation of spores on the wound in skin, through consumption of contaminated milk or meat of infected amimals, and through inhalation of spores. Cutaneous anthrax accounts for 95-99% of human cases throughout the world including India.

Brucellosis

Brucellosis is a widely prevalent and economically important bacterial disease. There are losses due to abortion in the affected animal population, loss of progeny and reduced milk production. Moreover, human brucellosis is causing physical incapacity and loss of millions man days of labour annually. Brucellosis affects primarily the livestock and transmitted to humans by ingestion, close contact, inhalation or accidental inoculations. Vaccination with *B. abortus* strains 19 and RB 51 is recommended for the prevention of bovine brucellosis and *B. melitensis* Rev 1 is recommended for prevention of *B. melitensis* infection in sheep and goats (WHO, 2006). The prevalence of brucellosis varies in different geographical areas with standards of personal and environmental hygiene, animal husbandry practices, species of the causative agent and methods of food processing.

Campylobacteriosis

C. jejuni is a leading cause of bacterial gastroenteritis worldwide (WHO, 2011). Meat becomes infected with *C. jejuni* mainly when processing procedures or equipment rupture an animal's intestinal tract and cause fecal matter to contaminate the raw flesh. Raw milk can become contaminated with *C. jejuni* either from feces that accidentally get into the milk or from infected cow udder. The most important source of infection for human population is contaminated poultry meat and it may contain very high (more than 10^7 cells per carcass) campylobacter contamination levels (Jorgensen *et al*., 2002). Temperatures below 32ºF (0ºC) or above 165ºF (74ºC) destroy *C. jejuni*.

***Eshcherichia coli* O157:H7**

E.coli serotype O157:H7 have been associated with hemolytic uremic syndrome (HUS) and hemorrhagic diarrhea. Beef is the most common vehicle for its transmission to human but unpasteurized milk, fruits, vegetables and water contaminated by bovine or infected human feces may also act as a source of infection (Su and Brandt, 1995). It causes no signs of illness in its natural host, cattle and sheep, but has a low infectious dose in humans where it causes haemorrhagic colitis and HUS. Human infection with *E. coli* O157:H7 is being reported from many countries worldwide with an increasing incidence, which is the reason for its inclusion in the list of emerging diseases (Dontoroua, 2004).

Glanders

Glanders primarily affects horses, mules and donkeys. Human beings contract the infection in most cases as an occupational exposure primarily among persons working in close association with the diseased horses, wound infection during autopsy or handling of meat of diseased animals and handling of cultures in laboratory. Four forms of glanders are seen in humans: the local cutaneous form, pulmonary form, septicemic form and the chronic form (farcy). No vaccine is available for the disease in both human and animals. The test-positive animals should be slaughtered immediately.

Leptospirosis

Leptospirosis is re-emerging as global public health problem. Its causative agent parasitizes kidneys and is excreted in rat urine. Man is incidental host and acquires infection by contact with water or soil contaminated with rat urine. The farm workers, sewer workers, fishermen and miners are at high risk of infection. Alkaline pH of the environment provides favorable conditions for the survival and multiplication of *Leptospira* spp. Although little can be done in wild animals, leptospirosis in domestic animals can be controlled through vaccination. Due to difficult laboratory diagnosis and a lack of awareness, the real magnitude of the disease remains unknown.

Listeriosis

Listeria monocytogenes accounts for approximately 98% of human and 85% of animal cases of listeriosis (McLauchlin, 1987). Listeriosis is characterized by meningoencephalitis, abortion, septicemia and sometimes enteritis. It occurs more frequently in immunocompromised or immunosuppresed people. *L. monocytogenes* is described as being a 'tough bug' because it is able to survive typical cooking temperatures and the effects of food processing much better than many microorganisms. It can even continue multiplying at refrigerator temperatures. However, temperatures of 0ºF (-18ºC) will stop it from multiplying and temperatures above 140ºF (60ºC) will kill it (Skinner, 1988).

Plague

Plague, an ancient disease, caused 3 pandemics since the 6th century but the global transmission has been low in recent years. It is transmitted between rodents and humans by the rat flea. In humans, plague is manifested in 3 forms: local lymphadenitis (bubonic plague), pneumonia (pneumonic plague) or septicemia (septicemic plague). Human to human transmission occurs in case of pneumonic plague, which is highly contagious.

Salmonellosis

Salmonellosis caused by non-typhoidal species has shown an increasing prevalence world over with majority of cases being caused by *S.* Enteritidis and *S.* Typhimurium. The bacteria are generally transmitted to humans through consumption of contaminated food of animal origin, mainly meat, poultry, eggs and milk. Even the World Health Organization (WHO) has also highlighted that the *Salmonella* food poisoning is one of the most common and widely distributed disease in the world (WHO, 2009), which leads to severe gastro-enteritis and can also cause life threatening illness which includes meningitis, hepatitis, pericarditis, and pneumonia.

Tuberculosis

Tuberculosis is one of the ancient diseases known to mankind and is now the leading cause of death in adults worldwide. According to WHO estimates, 8.7 million people fell ill with TB in the year 2011 and 1.4 million people died from it, (WHO, 2012). Clinically, *M. bovis* shows a high degree of virulence for both humans and cattle, in contrast to *M. tuberculosis* which is virulent for humans but not for cattle. In developing countries, increase of *M. bovis* infection in humans along with emergence of MDR has manifested into a grave public health problem.

Q-fever

Q fever is occupational zoonoses which is prevalent throughout the world. Farm animals and pets are the main reservoirs of infection and transmission to human beings is mainly accomplished through inhalation of contaminated aerosols besides consumption of contaminated milk and handling of infected animal's material like aborted fetus. Approximately half of the infected individuals exhibit no symptoms while disease in its course can lead to pneumonia and endocarditis also.

Prevention and control strategies

The control strategies for zoonotic diseases require proper surveillance of disease, control of disease in animals, vectors and humans by sanitary and prophylactic measures. Regular immunization schedule should be followed strictly in endemic zones. The inter-sectorial cooperation between professionals from Veterinary medicine, Human medicine and environmental science is the need of the hour. The essential tools of surveillance, clinical curiosity, general awareness, sound knowledge of modern epidemiological tools among veterinary public health personnel and related professionals is a *sine qua non* to meet the challenge of zoonoses, especially the emerging ones.

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Emerging Viral Zoonoses in India with special reference to CCHF

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An emerging disease as defined by Centre for disease control and prevention (CDC) is 'any infectious disease that has appeared in a population or host species for the first time, or that may have existed previously but is rapidly increasing in incidence or geographic range or host range'. Among all the infectious diseases, the infections which are shared by both human and animals are said to be zoonotic. Zoonotic diseases are a major global threat to human health. They have had a huge impact on sustainable development through economic loss in terms of treatment costs and loss of man hours. In the mid-twentieth century it was widely expected that the antibiotic and vaccine era would help in harnessing the infectious diseases and even wipe them off the globe. The frequent and often dramatic appearance of new infectious agents or the reappearance of well recognized zoonoses has turned to be an anti-climax to these thoughts.

While new diseases continue to be recognized, old diseases are emerging or re-emerging, and the most emergent pathogens are zoonotic viruses. The survey of human pathogens totals up to 1,407 human pathogen species, with 177 (13%) species regarded as emerging or reemerging. Among these pathogen species, 208 (14.7%) are viruses or prions, including 77 (37%) regarded as emerging or reemerging. Viral pathogens (especially RNA viruses) have been highlighted as a major threat, owing to their often high rates of nucleotide substitution, poor mutation error-correction ability and therefore higher capacity to adapt to new hosts, including humans (Taylor *et al*., 2001; Woolhouse and Gowtage-Sequeria, 2005).

The impact of viral zoonoses is palpable across the globe owing to its high morbidity and mortality in human beings and domestic animals. Viruses are mostly host-specific and are maintained in nature within the population of same or related species. In addition, there are certain viruses, which may have multiple hosts. These viruses may spread naturally between different species of vertebrate host. Some of the viral diseases involve vectors, mainly mosquitoes and ticks, which act as intermediate hosts. The climate anomalies that have been occurring in the past decade have led to a significant increase in number of vector-borne events. Many countries are plagued with the epidemics of viral diseases of zoonotic nature such as influenza, rabies and viral hemorrhagic fevers that are of major public health concern. Encroachment of wild life habitat, virus genetic variations, traveling of people across the globe and animal husbandry intensification are some of the factors responsible for emergence of viral zoonotic diseases (Ludwig *et al*., 2003).

Classification of viral zoonotic diseases:

I. Arthropod-borne viral (arboviral) diseases:

Hemorrhagic fevers	
Mosquito-borne: Yellow fever, Dengue Hemorrhagic Fever, Rift Valley Fever	***Tick-borne:*** Crimean-Congo Hemorrhagic fever, Kyasanur Forest Disease, Omsk Hemorrhagic Fever, Nairobi Sheep Disease, Banja Virus Infection

Non-hemorrhagic fevers	
Mosquito-borne: JE, St. Louis Encephalitis, West Nile fever, Murray valley Encephalitis, VEE, WEE, EEE, Chikungunya fever, Sindbis fever	***Tick-borne:*** Louping ill, Powassan Encephalitis, RSSE, Central European Tick-borne Encephalitis, Colorado Tick Fever

II. Non-arboviral diseases:

Influenza: Avian, Equine and Swine; Hendra and Nipah virus infection; Ebola and Marburg virus disease; Argentine hemorrhagic fever; Lassa fever; Lymphocytic choriomeningitis; Bolivian hemorrhagic fever; Brazilian hemorrhagic fever; Venezuelan hemorrhagic fever; Haemorrhagic fever with renal syndrome (HFRS); Rabies; Herpes infections; Pox viral infections: Buffalo pox, Camel pox, Cow pox, Monkey pox; Parapoxviruses: Orf, Bovine papular-stomatitis and Milker's nodule; Yaba and Tana pox; Rotavirus and Norovirus Enteritis.

Some of the important emerging and re-emerging viral zoonotic diseases

Japanese Encephalitis

Japanese encephalitis (JE) is a mosquito-borne zoonotic flaviviral disease. It affects the central nervous system, causing encephalitis in humans as well as in horses and may cause abortion in pigs**.** It is the most important cause of epidemic encephalitis and childhood mortality globally, with an estimated 50,000-67,900 cases and 10,000-20,000 deaths annually although official reports underestimate the true number of cases (Campbell *et al*., 2011). JEV is maintained in nature by complex cycle that involves Ardeid birds as reservoirs, mosquitoes as vector and pigs as amplifying host. Humans become infected only coincidently when bitten by an infected mosquito. Vaccination in children has helped in reducing the incidence in many countries.

Avian influenza

Avian influenza viruses are highly contagious, extremely variable viruses that are widespread in birds, particularly wild waterfowl and shorebirds. Most of these viruses, which are usually carried asymptomatically by wild birds, cause only mild disease in poultry. Others, like the high pathogenicity avian influenza (HPAI) viruses, can kill up to 90-100% of a poultry flock. The severity of zoonotic avian influenza varies with the subtype of the virus. Although many human infections are limited to conjunctivitis or mild respiratory disease, some viral strains cause severe disease and death. There are fears that an avian H5N1 virus could eventually become adapted to humans, resulting in a severe human pandemic. Controlling epidemics in poultry decreases the risk of exposure for humans. People working with infected birds should follow good hygiene practices and wear appropriate protective clothing. Outbreaks can be controlled by rapid depopulation of infected and exposed flocks, proper disposal of carcasses and contaminated materials and strict biosecurity measures.

Swine influenza

Swine influenza is caused by influenza A viruses of the *Orthomyxoviridae* family. Most of the swine influenza viruses (SIVs) do not cause disease in humans. However, some countries have reported cases of human infection with SIVs. The H1N1 virus that caused the influenza pandemic in 2009-2010, thought to have originated in swine, is an example of an SIV that was able to spread easily among people and also cause disease. Influenza viruses have a history of genetic re-assortment and as a consequence of such re-assortment, a influenza A (H1N1) virus emerged among humans in California and Mexico in April 2009, quickly spreading worldwide through human-to-human transmission, and generating the first influenza pandemic of the 21st century (Murphy, 2008). Pigs can become infected with influenza viruses from a variety of different hosts (such as birds and humans) and thus they can act as a 'mixing vessel', facilitating the reassortment of influenza genes from different viruses and creating a 'new' influenza virus.

Hendra and Nipah virus infection

Hendra virus and Nipah virus occur naturally among the fruit bats. They belong to the family *Paramyxoviridae*. Hendra virus can cause fatal respiratory and neurological disease in horses and can be transmitted to people from horses. Till now Hendra virus has been reported only from Australia while Nipah has been reported from Asian countries. Nipah virus (NiV) causes severe illness characterized by inflammation of the brain or respiratory diseases. It can be transmitted to humans from pigs and bats and can also be transmitted directly from human-to-human. Case fatality rate of NiV ranges from 40-70% although it has been as high as 100% in some outbreaks (WHO, 2009).

Ebola and Marburg virus infection

Ebola and Marburg viruses of family *Filoviridae* cause outbreaks of haemorrhagic fever. These fevers are characterized by person-to-person transmission and high case fatality rate. Humans acquire infection occasionally from contact with tissues of diseased nonhuman primates and perhaps herbivores. Although the source of filoviruses in nature has not been definitively identified, the cumulative evidence suggests that bats are involved. At first, nonhuman primates were suspected to be the reservoirs, but it is now evident that they, too, are simply targets.

Australian Bat Lyssavirus

Australian bat lyssavirus (ABLV) was first discovered in a black flying-fox bat in Australia that was displaying neurologic signs. The virus was found antigenically similar to classic rabies virus and was initially considered as a member of lyssavirus serotype 1. The genotyping studies revealed a distinguishable genetic sequence from the former and hence was ascribed a new genotype number - genotype 7. The first human case of ABLV infection occurred in 1996 when a 39-year-old animal handler, who had been bitten 5 weeks earlier by a yellow-bellied sheath-tailed bat, died of encephalitis. The second case, also manifested by fatal encephalitis, occurred in a 27-year-old woman who had been bitten by a flying fox more than 2 years previously. In both instances, the clinical signs were consistent with classic rabies infection (Mackenzie *et al*., 2001).

Crimean-Congo haemorrhagic fever (CCHF)

CCHF is a widespread disease caused by a tick-borne virus (*Nairovirus*) of the *Bunyaviridae* family. The CCHF virus causes severe viral haemorrhagic fever outbreaks, with a case fatality rate of 10–40%. CCHF is endemic in Africa, the Balkans, the Middle East and Asian countries. The hosts of the CCHF virus include a wide range of wild and domestic animals such as cattle, sheep and goats. The CCHF virus is transmitted to people either by tick bites or through contact with infected animal blood or tissues during and immediately after slaughter. The majority of cases have occurred in people involved in the livestock industry, such as agricultural workers, slaughterhouse workers and veterinarians (WHO, 2013). Vaccines are not available either man or animals.

India is considered as a hot spot for emerging infectious diseases. In the recent past many infectious diseases of emerging and re-emerging nature have entered this subcontinent and affected a large number of populations. A few examples are Nipah, Avian influenza, Pandemic influenza, severe acute respiratory syndrome corona virus and Chikungunya virus. These diseases have not only affected human and animal health but also economy of the country on a very large scale. During December 2010, National Institute of Virology, Pune detected Crimean-Congo hemorrhagic fever virus specific IgG antibodies in livestock serum samples from Gujarat and Rajasthan states. Subsequently, during January 2011 Crimean-Congo hemorrhagic fever virus was confirmed in a nosocomial outbreak, in Ahmadabad, Gujarat, India. Retrospective investigation of suspected human samples confirmed that the virus was present in Gujarat state, earlier to this outbreak. This disease has a case fatality rate ranging from 5 to 80 %. Earlier presence of hemagglutination inhibition antibodies have been detected in animal sera from Jammu and Kashmir, the western border districts, southern regions and Maharashtra state of India. The evidences of virus activity and antibodies were observed during and after the outbreak in human beings, ticks and domestic animals (buffalo, cattle, goat and sheep) from Gujarat State of India. During the year 2012, this virus was again reported in human beings and animals. Phylogenetic analysis showed that all the four isolates of 2011, as well as the S segment from specimen of 2010 and 2012 were highly conserved and clustered together in the Asian/Middle East genotype IV. The S segment of South-Asia 2 type was closest to a Tajikistan strain TADJ/HU8966 of 1990. The present scenario in India suggests the need to look seriously into various important aspects of this zoonotic disease, which includes diagnosis, intervention, patient management, control of laboratory acquired and nosocomial infection, tick control, livestock survey and this, should be done in priority before it further spreads to other states. Being a high risk group pathogen, diagnosis is a major concern in India where only a few Biosafety level 3 laboratories exist and it needs to be addressed immediately before this disease becomes endemic in India.

CCHF is caused by the CCHF virus (CCHFV, family *Bunyaviridae*, genus *Nairovirus*), with overall case fatality of 9-50%. The virus is maintained in nature predominantly in the Ixodid tick vectors, particularly ticks of the genus *Hyalomma*. The main natural hosts of the CCHF virus are hares and hedgehogs (hosts for immature ticks) and cattle, sheep, goats, horses, and swine (hosts for adult ticks). The periodic changes in the population of the tick vectors make for notable differences in the rates of infected animals. Domestic animals, hares, hedgehogs and possibly some other animals may serve as amplifiers of the virus and a food source for the ticks. Birds do not become infected, but they play an important role as a food source for immature ticks and as a vehicle for the long-distance dispersion of these vectors. The infection is asymptomatic or produces a mild illness, even though viremia has been confirmed in various animal species.

Inter-mediate hosts:

Ticks belonging mainly to the genera *Hyalomma*, *Dermacentor*, *Rhipicephalus*, and *Boophilus* are the vectors for this virus. Several species of *Hyalomma* play a prominent role as vectors and reservoirs of the CCHF virus. The multi host tick, *Hyalomma anatolicum*, is the commonest *Hyalomma* species in India and cattle serves as the main host of this species. They feed on large wild and domestic animals and are easily attracted to man. The Hyalomma ticks are three-host ticks and need about 9 weeks to complete their life-cycle. The period of maturity is lesser in warmer climate. The ticks are found in places like cowsheds next to houses in rural areas. Within the ticks virus propagates and survives through both trans-stadial (stage-to-stage) and trans-ovarial (infected female to eggs) transmission, thus ticks are not only vectors but also reservoirs, of this virus.

Vulnerable groups:

The human disease occurs in rural areas, and the most vulnerable occupational groups are agricultural and livestock workers. The veterinarians and supporting staff of animal health care are equally vulnerable. Animal handlers, butchers and others associated with slaughter houses are at high risk too.

Humans acquire the infection from the bite of an infected tick and can also become infected by crushing a tick with their hands where the virus happens to gain entry through a lesion on the skin. Humans may also be directly infected during the slaughter and skinning of viraemic animals. Person-to-person transmission among family members and hospital personnel occurs as a result of exposure to the hemorrhagic discharges of affected patients.

Diagnosis:

Virus isolation is the standard for CCHF diagnosis. As it has to be done in high-containment biosafety level 4 (BSL-4) facilities, the number of laboratories that can perform this technique is limited. Other methods include conventional and real-time quantitative reverse transcription PCR (RT-PCR and qRT-PCR) for detection of the viral genome and indirect immunofluorescence assays (IFAs) or ELISAs for detection of specific IgM and IgG antibodies. Microarrays have also been developed to detect the disease.

Treatment:

General supportive therapy is the vital component of patient management. The antiviral drug Ribavirin has been used in treatment of established CCHF infection with apparent benefits. Both oral and intravenous formulations seem to be effective. There is no protective vaccine as of now.

Prevention and control:

The mainstay of prevention and control of CCHF viral infection should target both at the community level and in the nosocomial set up. At the community level, care should be taken to prevent human contact with livestock and minimize the tick burden in these vertebrate hosts.

1) **Vector control**:

- The tick vectors are numerous and widespread and tick control with Acaricides is a realistic option for well-managed livestock production facilities.
- In endemic areas, a measure of tick control has been achieved by environmental sanitation of underbrush habitats.
- Acaricides may be useful on domestic animals to control CCHFV-infected ticks, if used 10 to 14 days prior to slaughter or export of animals from enzootic regions.
- The control of ticks is very effective when practiced 'on and off the animal'. Since ticks lay eggs in the cracks and crevices of animal sheds, the premises need to be cleaned and disinfected with suitable insecticides.
- Acaricides like Cypermethrin are very effective against Ixodid ticks. Cypermethrin is recommended as pour-on on the animal at 1% concentration. Although Deltamethrin was extensively used, high resistance has been recorded against it of late.

2) **Personal protection**:

- Persons living in endemic areas should use personal protective measures that include avoidance of areas where tick vectors are abundant.
- Regular examination of clothing and skin for ticks, and their removal should be undertaken. Use of repellents on the skin (e.g., DEET) and clothing (e.g., permethrin) is recommended.
- Wearing gloves or other protective clothing to prevent skin contact with infected tissue or blood reduces the risk of tick-bite.
- Other precautions include use of light-colored fully covered clothing wherein ticks can be easily identified.
- Protective clothing and gloves should be used whenever there is chance of contact with skin or mucous membranes of viraemic animals, particularly when blood and tissues are handled.
- Carcasses of affected animal are to be disposed off under safe burial practices including the use of liquid bleach solution as a disinfectant, and covering the body in polythene bags.
- The virus is destroyed by use of disinfectants like 1% hypochlorite and 2% glutaraldehyde and by heating at 56°C (133°F) for 30 min.

3) **Reduction of chances of nosocomial spread**:

- To reduce the risk of nosocomial spread of infection it is imperative that adequate infection control measures are practiced.
- Patients with suspected or confirmed CCHF should be isolated and cared for using barrier nursing techniques.
- Specimens of blood or tissues taken for diagnostic purposes should be collected and handled using universal precautions.
- Sharps (needles and other penetrating surgical instruments) and body wastes should be safely disposed of using appropriate decontamination procedures.
- Healthcare workers who have contact with tissue or blood from patients with suspected or confirmed CCHF should be followed up with daily temperature and symptom monitoring for at least 14 days after the putative exposure.

4) Vaccines: A suckling mouse brain, formalin-inactivated vaccine has been used in Bulgaria and other parts of Eastern Europe and the former Soviet Union. Initially two doses are to be given subcutaneously at an interval of four weeks. Re-vaccination is required at 1 year after the first vaccination and subsequently after every five years. Effective antibody response is initiated 14 days after the vaccination.

Since a relatively small target population of individuals is at risk of contracting CCHFV, the large-scale development and production of a CCHF vaccine by modern standards seems unlikely. Moreover, divergence had been seen among the viral stains found in European, Asian and African region making the efficacy of Bulgarian vaccine doubtful in our country.

Preparedness and Response

As CCHF has the potential to cause epidemics, timely and appropriate response is essential. Experiences gained from the previous outbreaks of similar viral hemorrhagic fevers (VHFs) and partnership at global level should be utilized for its control. Some of the measures include:

- A comprehensive epidemiological surveillance plan including the animal, entomological and human components.
- Cross-border sharing of information and establishing special community based laboratory surveillance programs for at-risk population groups.
- Establishing high level national inter-sectoral surveillance and response system,
- Strengthening laboratory capacity for timely diagnosis along with a regional network of accredited laboratories and building human capacity
- Infection control and vector control activities through integrated vector management
- Social mobilization for control and prevention in household, communities and health care settings and to inform culturally appropriate behavioural interventions and messages,
- Effective case management,
- Advocacy and health education for high-risk groups, i.e., veterinarians, farmers, workers in slaughter houses, and other high risk groups,
- Research for better understanding of the epidemiology and natural history of similar VHFs. There is a need for active surveillance not only for existing pathogens but also for those that pose future threat.

Conclusion

Since the last decade the threat of viral zoonotic diseases has been increased with several factors like genetic variation in viruses, increasing human population and climate changes being held responsible for it. To combat this challenge, clinical attentiveness, adequate laboratory facilities, new vaccines and comprehensive epidemiological surveillance systems need to be established. A network program on the surveillance and reporting of major viral diseases with provisions for real-time reporting and rapid response is the need of the hour. An understanding of the epidemiology of viral diseases in wild animals is vital in controlling or eliminating many viral diseases which have wildlife reservoirs. Research should focus on development of suitable diagnostics and prophylactics to mitigate many of these severe diseases.

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We can judge the heart of a man by his treatment of animals

Immanuel Kant

Parasitic Zoonoses in India: An overview

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According to WHO zoonosis is defined as 'diseases and infections that are naturally transmitted between vertebrate animals and humans'. Here, the infectious agent are the parasites (trematodes, cestodes, nematodes or protozooans) and are therefore referred to as parasitic zoonoses. Large number of parasites infecting the animals leads to production losses and death in animals. Production animals play a critical role in human nutrition and socio-economic development. Livestock products including meat, milk, eggs and offal are source of protein, energy, calcium and micronutrients, contributing around 13% of calories and 28% of protein worldwide (FAO, 2011). In lower-income countries like India, livestock do not only provide a regular supply of nutrients, but also serve as a direct source of income and employment, contribute to crop production through the provision of manure and traction power, and act as capital assets usable as future investment revenue.

The zoonotic parasites circulating in environment are a significant burden on human health and well being and there are multiple transmission pathways that place people at risk. Worldwide, zoonotic diseases make a significant contribution to the entrenchment of poverty in poor rural communities who derive income from livestock production. Developing countries including India are currently undergoing changes with respect to climate change, environmental degradation, deforestation and river basin management, socioeconomic development and the industrialisation of livestock production. These complex ecological changes have the potential to modify the interactions between hosts, vectors and parasites and these altered interactions impact on the distribution, prevalence and severity of disease.

Based upon mode of transmission of parasites, the parasitic zoonosis is classified as Food-borne parasitic zoonoses (Meat-borne, Fish-borne, Water-borne, Snail and crustacean-borne, Vegetable/Vegetation-borne) and Vector-borne zoonoses. In general, food-borne zoonotic parasites are helminths and protozoa. Amongst helminths, about 20 species of trematode, 12 species of cestode and at least 12 species of nematode are zoonotic importance. Amongst protozoa, about 20 species are recognized as zoonoses. The major factor which is contributing in transmission of zoonotic parasites between human and animals are:- lack of awareness and education, unhygienic living condition, lack of sense of self-hygiene, food habits, lack of clean water, encroachment in forest areas etc.

Meat-borne zoonoses

The traditional practice of consuming uncooked or partially cooked meat places many people at risk of acquiring food-borne parasitic zoonoses, particularly *Taenia solium* and members of the genus *Trichinella*. The *T. solium,* taeniasis and cysticercosis infection complex involves two distinct disease transmission processes and requires both humans and pigs to maintain the lifecycle. *T. solium* has public health significance because humans can also be inadvertently infected with cysticerci following the ingestion of eggs through poor hygiene or contaminated food and water. Human cysticercosis cases are not involved in perpetuating the lifecycle but are clinically important since cysticerci may form in the brain causing neurocysticercosis, leading to seizures, epilepsy, neurological sequelae or death. In India, incidence of *T. solium* infection in human is well established and has been recorded to very from 0.75 to 1.0 percent in certain communities particularly those who remain in contact with pig population especially in rural areas. The prevalence of metacestode of *T. solium, Cysticercus cellulosae*, in muscle of pig is much higher ranging from 2.0-28.8 percent in the country.

Trichinellosis is a direct zoonosis caused by infection with nematodes of the genus *Trichinella* and is one of the most widely distributed parasitic zoonoses worldwide. Infection occurs via the consumption of encysted larvae in the muscle of infected animals and involves an enteral phase associated with excystment, sexual maturation, reproduction and larval penetration of the intestinal wall and a parenteral phase associated with the migration of larvae, via lymphatic and blood vessels, to striated muscles where they encyst in a nurse cell complex. Clinical symptoms in humans are related to the number of viable larvae consumed and are typically associated with the parenteral phase. There are few stray reports of *T. spiralis* in some mammalian hosts in India e.g., cat and civet cat from Kolkata, *Bandicota bengalensis* and pigs from Mumbai. So far, there is no report of *Trichinella* infection from man in India.

Toxoplasma gondii is of great zoonotic importance with cats as the key definitive hosts with unusual wide range of intermediate hosts exceeding 200 species of animals including man. Man suffers from toxoplasmosis with a wide spectrum of pathological conditions particularly the congenitally infected children and immunosuppressed adults. Congenital infection occurs only when a woman has a primary infection during pregnancy. Infection can be acquired either through ingestion of raw or under-cooked meat containing tissue cyst or ingestion of sporulated oocysts contaminating food and water. Toxoplasmosis in human beings is widespread but its prevalence varies from place to place, it ranges from 0 to 90 percent. In India, antibodies to *T. gondii* have been demonstrated at significant levels in normal human population as well as in higher number in persons keeping contacts with animals. Seropositivity has been demonstrated both in the vegetarian and non-vegetarian population and *Toxoplasma* infection in human in country have been documented. Antibodies to *T. gondii* have been demonstrated in 9.7 to 33.7 percent case of sheep, goats, pigs, cattle, buffaloes, camels, horses, cat and dogs. Dubey (1987) reviewed toxoplasmosis in domestic animals in India and came up with the conclusion that clinical toxoplasmosis is not known in India. However, few case of abortion were seen in goats with antibody titre of 1:64 or above (IHA titre) and neonatal mortality was seen in goat born to dams with titres from 1:8 to 1:26 from Parbhani (Maharastra). Dubey *et al*. (1993) reported a high seroprevalence of *T. gondii* in goats from Kumaon region in India.

Fish-borne parasitic zoonoses

The World Health Organization (1995) has estimated that the number of people currently infected with fish-borne trematodes exceeds 18 million, but worldwide the number of people at risk, including those in developed countries, is more than half a billion. Though the list of potential fish-borne zoonoses that might be quite large, only fewer are very important like opisthorchiasis, intestinal trematodiasis, anisakiasis or diphyllobothriasis. Flukes belonged to Family: Opisthorchiidae (*Clonorchis sinensis, Opisthorchis viverrini, Metorchis conjunctus*), have long been known to cause serious disease in certain areas of the world. Cholangitis, choledocholithiasis, pancreatitis, and cholangiocarcinoma are the major clinical problems, associated with the long chronic pattern of these infections. A total of 17 million people around the world are estimated to be infected with these liver flukes. In India, infection with these flukes in human has been not reported.

This is the most important fish-borne zoonosis caused by a cestode (tapeworm) parasite. Species of the genus *Diphyllobothrium* are responsible for most reported cestode infections in humans. The zoonosis occurs most commonly in countries where it is a frequent practice to consume raw or marinated fish. At least 13 of about 50 species of *Diphyllobothrium* have been reported from humans. Because diphyllobothriasis is considered a mild illness, it is not normally reportable. The common symptoms include abdominal pain, diarrhoea, nausea, weakness, pernicious anaemia and some neurological symptoms. The zoonosis occurs most frequently in communities that have food preferences for wild-caught fish prepared in a variety of ways. From India, human infection has been not reported in recent years.

Sparganosis is an infection of man with larval stage of the species of genus *Spirometra* of dogs and cats. Man gets infection by eating raw or undercooked infected copepods acting as the first intermediate host. Amphibians, water snakes, fish, birds and some mammals act as second intermediate host. Man may also get the infection from these second intermediate hosts. Some years back, a case of human sparganosis was reported from Jodhpur, Rajasthan. Recently, *Spirometra* eggs from the faeces of dog have been identified at department of Veterinary Parasitology, Junagadh which was brought for treatment at Teaching Veterinary Clinical Complex, Veterinary College, Junagadh.

Gnathostoma spinigerum is a stomach worm of cats and dogs. Man is less frequent host for this parasite and is responsible for an aberrant infection with larvae of this worm. Man acquires infection from contact with meat of infected intermediate host like fish, amphibians and birds. The parasite has been reported from a cat in Madras, in dogs from Kerala and more frequently dogs from Assam. In 1945, subcutaneous infection of larvae of *G. spinigerum* in human has been reported from West Bengal.

Water-borne parasitic zoonoses

Cryptosporidial infections have been reported in faeces of many species of wild and domesticated animals from several countries. There is only one authentic report on the occurrence of *Cryptosporidium* infection in animals in India based on a brief investigation made in calves of zebu and buffalo around Izatnagar-Bareilly revealing cryptosporidial oocyst in faeces of four zebu and one buffalo calves. The oocyst detected appeared to be *C. parvum*. On the other hand, human case of cryptosporidiosis are on the record from Vellore, Kolkata, Varanasi, Mumbai, Kashmir, Madurai and Chandigarh associated with diarrhoea in children in India. It is not known how cryptosporidia cause disease in humans. *Cryptosporidium* infection has been described only in recent years. In early 1980s the onset of AIDS in the United States brought attention to the association of *Cryptosporidium* spp. with diarrhoea illness in 21 patients with AIDS.

Entamoeba histolytica is a primary cause of amoebosis disease in human beings. The disease is largely confined to man but it has zoonotic potential. Clinical amoebosis is a major health problem in India besides in other countries. Poor sanitary conditions, lack of self hygiene and socio-economic status are the factors responsible for the widespread transmission of *E. histolytica* infection from person to person. Man acquires infection by the ingestion of food and drinks contaminated with cyst of *E. histolytica*. A high prevalence (20-30 percent of the population) has been recorded in various states of the country.

Giardia intestinalis is a common intestinal falgellates cause diarrhoea and epigastric distress. The incidence has been reported to vary from 1 % to as high as 50 % in different parts of the worlds including India. The mode of transmission of infection is through ingestion of contaminated food and water with mature cysts. The cysts of this species can also cause infection in dogs, cats and beaver which are suggested to be potential reservoirs for transmission of this zoonotic infection to man.

Balantidium coli are the only ciliate pathogen causing diarrhoea, ulceration of intestine in man and pigs. The infective stage is the cystic stage of *B. coli* and infection to man occurs by ingestion of food and water contaminated by cysts of human origin usually. The parasite is of zoonotic importance and when transmission occurs from pigs to man by ingestion of food and water contaminated with cyst of pig origin. Balantidiosis in humans is more common who live in hot and humid climate and remain directly associated with pig colony.

Snail, crustacean and Vegetation-borne parasitic zoonoses

Fasciolopsis buski is a common intestinal flukes of pig and man. The species is widely prevalent in pigs in India, particularly in Assam, Orissa, Bihar, Utter Pradesh, foothills of Uttrakhand, Madhya Pradesh and tamil Nadu. On an average 33-60% of undescribed pig population carry *F. buski* infection. Human infection with *F. buski* occurs when the freshly taken out water caltrops and water chestnuts are peeled off by teeth without proper cleaning. This practise of eating raw water fruits results in ingestion of large number of matecercariae. The flukes cause inflammation, ulceration and some times abscess formation in duodenum and jejunum. Human infections with *F. buski* in India are on record.

Paragonimus westermanii infection occurs in lungs and rarely in the brain, spinal cord and other organs of pig, dog, cat, cattle, fox, and other wild carnivores and man. Human infection with *P. westermanii* flukes occurs through ingestion of raw or inadequately cooked fresh water crab or crayfish containing metacercaria of the fluke or ingestion of metacercaria with contaminated hand by handling the crabs or crayfish. Reports of human paragonimiosis were recorded from Asia and Africa. In India, isolated foci of paragonimiosis in human existed in Madras, West Bengal, Assam and Manipur. In recent past, 39 cases of young persons, in 11-30 years of age group, were reported from Manipur showing symptoms of recurrent haemoptysis having *P. westermanii* flukes. They had eaten raw crabs.

Gastrodiscoides hominis is the amphistomes, commonly found in the caecum of pig and rarely in large intestine of man. Man accidentally gets infection through ingestion of raw or under-cooked aquatic vegetation harbouring a large number of infective metacercariae. Depending upon severity of infection, inflammation of intestine and diarrhoea occur. The parasite is widespread in different part of India amongst pig population. There is no recent report of human infection in the country.

Fasciola hepatica and *F. gigantica* are the common flukes infecting the ruminants. Man rarely gets the infection through consumption of raw and uncleaned aquatic vegetations or drinking water of the ponds having metacercariae. Clinical manifestations of infection are abdominal pain, irregular fever, diarrhoea urticaria, anaemia and eosonophilia. Human infection was reported from some European and Latin American countries but there is no report in the recent past of human infection with *Fasciola* spp. in India.

Vector-borne zoonoses

Changing climate is not the only driver for alterations in the dynamic interaction between arthropod vectors of zoonotic parasites and their hosts, including humans. A suite of other factors ranging from urbanization and deforestation to changing demographics in both developing and developed countries, the impact of the recent economic crisis, increased global movement of people and animals and follow-on effects of major catastrophes. The following vector-borne parasites are implicated wtth zoonotic potential: Parasites of simian malaria (*Plasmodium knowlesi*), *Trypanosoma cruzi, Leishmania infentum, L. braziliensis, Babesia microti, B. divergence, B. duncani, B. venatorum, Thelazia callipaeda, Dirifilaria immitis, D. repens*. Since 2004, a simian malaria parasite, *Plasmodium knowlesi*, has been implicated in human disease. Specifically *P. knowlesi* has been confirmed in several human cases of malaria diagnosed from Malaysian Borneo, Thailand, Myanmar, and the Philippines. Certainly, reports of simian malaria in these neighbouring countries compel India to keep preparedness and knowledge about this parasite.

Soil-borne zoonoses

Zoonotic infections caused by dog and cat hookworm species, *Ancylostoma caninum, A. braziliense and A. tubaeforme* can also occur and the pathogenic nature of the infection is dependent on the migration of larvae to ectopic sites in the paratenic human host. Cutaneous larva migrans (CLM) is the most common disease described. Other clinical manifestations include eosinophilic enteritis, eosinophilic pneumonia, myositis, folliculitis, erythema multiforme or ophthalmological manifestations. Cutaneous larva migrans is predominantly associated with *A. braziliense*. Since *A. braziliense* is rarely reported in South-East Asia, with just a few reports from Malaysia, Indonesia and Laos, it is not clear what hookworm species were the cause of these CLM cases, possibly *A. ceylanicum* or *A. caninum*. *Ancylostoma ceylanicum* on the other hand is endemic in South-East Asia with a wide geographic range, encompassing Indonesia, Borneo, Malaysia, Philippines, Thailand and Laos. Many case reports have been published on cutenous larval migrants in human being in recent years from different parts of India.

Visceral larval migrans (VLM) in human beings is produced mainly by ingestion of food and water contaminated with the infective eggs of *Toxocara canis* and *T. cati* inhabiting the intestine of dogs and cats, respectively. As the worms can not complete their development in man, larvae undergo a prolonged migration through various tissues of the human host. Heavy infections occur particularly in children with a craving of eating dirt or frequently fondling with their pets infected with ascarid worms. This condition may lead to myocarditis, encephalitis, granulomas in liver, and lungs together with diffuse inflammations. In India many reports of VLM has been published in recent past.

Conclusion

Effective prevention and control of the zoonotic parasite infections discussed above have been and will be difficult to attain as it has strong link with socio-economic status and cultural background of people of India and world. Further, it is necessary to create awareness towards the hygienic practices, use of clean water and discourage the cultural taboos. The strategies to control the zoonoses, mass chemotherapy in endemic region can be practiced in both human and animals. Moreover, in future to facilitate the implementation of any control efforts the following points should be considered:

1. Improved diagnostic tools are badly needed, especially those that can differentiate the various species;
2. Guidelines for designing and implementing epidemiological studies are needed in order to obtain the impact data required by public health agencies in setting priorities;
3. The role of reservoir hosts in maintaining transmission in the absence of infected humans needs investigation in order to design sustainable control strategies;
4. Social/anthropological studies are needed to better understand the cultural and behavioral traits of people with regard to food choices in order to develop education strategies aimed at influencing risky behavior;
5. Development of improved aquaculture systems that can prevent or mitigate the transmission of trematodes; and
6. Long-term pilot control projects are needed to compare efforts targeted at multiple high risk factors identified in risk assessment studies with the current mass chemotherapy strategy.

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I hope to make people realize how totally helpless animals are, how dependent on us, trusting as a child must that we will be kind and take care of their needs... are an obligation put on us, a responsibility we have no right to neglect, nor to violate by cruelty.

James Herriot

Zoonotic diseases and wildlife

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Diseases of wildlife can cause significant illness and death to individual animals and can significantly affect wildlife populations. Wildlife species can also serve as natural hosts for certain diseases that affect humans (zoonoses). The disease agents or parasites that cause these zoonotic diseases can be contracted from wildlife directly by bites or contamination, or indirectly through the bite of arthropod vectors such as mosquitoes, ticks, fleas, and mites that have previously fed on an infected animal. These zoonotic diseases are primarily diseases acquired within a specific locality, and secondarily, diseases of occupation and avocation. Biologists, field assistants, hunters, and other individuals who work directly with wildlife have an increased risk of acquiring these diseases directly from animal hosts or their ectoparasites. Plague, tularemia, and leptospirosis have been acquired in the handling and skinning of rodents, rabbits, and carnivores. Humans have usually acquired diseases like Colorado tick fever, Rocky Mountain spotted fever, and Lyme disease because they have spent time in optimal habitats of disease vectors and hosts. Therefore, some general precautions should be taken to reduce risks of exposure and prevent infection.

General precautions

Use extreme caution when approaching or handling a wild animal that looks sick or abnormal to guard against those diseases contracted directly from wildlife. Procedures for basic personal hygiene and cleanliness of equipment are important for any activity but become a matter of major health concern when handling animals or their products that could be infected with disease agents. Some of the important precautions are:

- Wear protective clothing, particularly disposable rubber or plastic gloves, when dissecting or skinning wild animals.
- Scrub the work area, knives, other tools, and reusable gloves with soap or detergent followed by disinfection with diluted household bleach.
- Avoid eating and drinking while handling or skinning animals and wash hands thoroughly when finished.
- Safely dispose of carcasses and tissues as well as any contaminated disposable items like plastic gloves.
- Contact a physician if you become sick following exposure to a wild animal or its ectoparasites. Inform the physician of your possible exposure to a zoonotic disease.

Precautions against acquiring fungal diseases, especially histoplasmosis, should be taken when working in high-risk sites that contain contaminated soil or accumulations of animal feces; for example, under large bird roosts or in buildings or caves containing bat colonies. Wear protective masks to reduce or prevent the inhalation of fungal spores.

Protection from vector-borne diseases in high-risk areas involves personal measures such as using mosquito or tick repellents, wearing special clothing, or simply tucking pant cuffs into socks to increase the chance of finding crawling ticks before they attach. Additional preventive methods include checking your clothing and body and your pets for ticks and removing the ticks promptly after returning from infested sites. If possible, avoid tick-in-fested areas or locations with intense mosquito activity during the transmission season. Reduce outdoor exposure to mosquitoes especially in early evening hours to diminish the risk of infection with mosquito-borne diseases.

Equally important preventive measures are knowledge of the diseases present in the general area and the specific habitats and times of year that present the greatest risk of exposure. Knowledge of and recognition of the early symptoms of the diseases and the conditions of exposure are essential in preventing severe illness.

Also important are medical evaluation and treatment with proper antibiotics. For example, if you become ill following some field activity in a known plague-endemic area and you recognize the early symptoms of the disease, seeking medical care and informing the attending physician of your possible exposure to plague will aid in the correct treatment of your illness and reduce the risk of complications or even death.

In addition to taking personal precautions, risk of acquiring vector-borne diseases can be reduced in specific locations through area-wide applications of insecticides to control mosquito or flea vectors or acaricides to control tick vectors. Reduction in host populations (for example, rodents) and their ectoparasites (fleas or ticks) may be needed to control transmission of such diseases as plague or Lyme disease. Vaccination of wildlife hosts as a means of reducing zoonotic diseases is currently being investigated and may soon be available for diseases like rabies.

Directly Transmitted Diseases

Rabies

Rabies is an acute disease, caused by a virus (*Rhabdovirus*) that can infect all warm-blooded animals, and is usually fatal. Certain carnivorous mammals and bats are the usual animal hosts. Rabies occurs throughout most of the world; only Australia and Antarctica are free of it. Most human cases have been contracted from rabies-infected dogs. Most of the treatments are still due to dog and cat bites; however, these pet species have the lowest occurrence of reported rabies among all animal species tested.

Rabies is considered almost 100% fatal once clinical signs develop. The disease progresses rapidly following the appearance of clinical signs, and the animal dies within a few days. Although abnormal behavior is not diagnostic for rabies (other diseases, like distemper, cause similar behavioral changes), atypical behavior and signs develop following brain infection, and rabies should be suspected whenever wild animals display unusual behavior.

Infected animals usually display either "furious" or "dumb" rabies, although some animals progress through both stages. Skunks, raccoons, foxes, and other canids usually have furious rabies and are unduly aggressive before convulsions and paralysis set in. Some animals, however, have dumb rabies and proceed to tremors and convulsions without agitation or aggression. Other behavioral changes include friendliness or loss of fear, appearance in the daytime for some typically nocturnal species (skunks, bats), unprovoked attacks on anything that moves (including inanimate objects), bewilderment, and aimless wandering. Unusual barking, crying, and frothing at the mouth are additional signs, which are the result of paralysis of the throat muscles. Occasionally, rabid bats are encountered prostrate or fluttering on the ground, unable to fly; they should be handled with care because they can still bite and transmit rabies. Some rabid bats, particularly solitary species like the hoary bat, are aggressive and have been known to attack people. In domestic animals, rabies should be suspected if there is any change in normal habits, such as sudden change in disposition, failure to eat or drink, running into objects, or paralysis.

Rabies virus is transmitted primarily via the saliva during the bite of a rabid animal. However, other methods of transmission are possible. Accidental exposure of wounds or cuts to the saliva or tissues of infected animals can occur. The virus is also present in various body organs of infected animals, especially the brain and salivary glands, which poses a health hazard to persons who are field dressing or performing necropsies on these animals. In addition, aerosol exposure has occurred, although rarely, in caves containing very large populations of infected bats. Transmission between animals also occurs by ingestion of infected tissues and by transplacental passage to offspring.

Use caution when approaching a suspected rabid animal since many are still aggressive and can bite even if paralyzed. If the animal is still alive, it should be killed humanely without damaging the head. To confirm whether an animal is infected with rabies, the animal must be submitted to the local health department or state diagnostic laboratory for testing.

Avoid exposure to any sick or dead animals that are suspected to have rabies. Handle any dead animal with gloves or with a plastic bag that can be turned inside-out to cover and contain the animal. Avoid direct skin contact with the animal. For large animals such as skunks and raccoons, remove the head cautiously and seal it in a plastic bag, avoiding contact or aerosol exposure. Seal the whole animal or head inside an additional plastic bag (double) and keep it cool at all times. Do not freeze the specimen unless a delay of several days is anticipated before it is examined for rabies. Disinfect gloves or knives that were in contact with the animal with a strong detergent or bleach or dispose of them.

For transport to the laboratory, place the double-wrapped specimen in a leak-proof container with a coolant (not wet ice). Send the container by bus or other prearranged transportation. Include information about the specimen (species, date, geographic data and behavior) and the names, addresses, and telephone numbers of the person submitting the specimen and of anyone exposed to the animal.

To test for rabies, a fluorescent antibody test (FAT) is performed directly on brain tissue to distinguish rabies virus from other disease agents (like distemper virus) that could be present in the animal's brain. In some states, brain material is inoculated into mice to demonstrate virus for those specimens that resulted in human exposure.

If a person or pet is exposed to an animal suspected of having rabies but that has not been captured, record a description of the suspect animal (species, behavior) and provide the description to public health officials or the attending physician to determine possible treatment.

***Prevention and treatment*:**

The best treatment for rabies is prevention. Individuals at high risk of exposure to rabies, such as wildlife biologists, game wardens, animal control officers, animal handlers, and veterinarians should be vaccinated before potential exposure. Safe and highly effective vaccines are available through a physician or the local health department.

First aid should immediately be provided to a person who has been bitten by or had contact with a potentially rabid animal. Scrub the exposed site, including bite wounds, with soap and water or water alone and flush thoroughly. Then apply a strong first aid solution (iodine) or cream. First aid treatment is the most effective method of preventing infection by the rabies virus but should not preclude medical attention from a physician, hospital emergency room, or the local health department. Contact your physician or health department as soon as possible to determine dosage of rabies vaccine and whether antirabies serum is required. Inform the health care professionals about the rabid animal and the circumstances of the exposure (species of animal involved and its behavior, if the attack or bite from the animal was provoked, and what type of first aid was administered).

Tuberculosis

Tuberculosis (TB), considered an important emerging disease in humans and domesticate animal but now a days, it is also become important for wildlife. Although *Mycobacterium tuberculosis* is the most common infection in humans, *M. bovis* is responsible for an increasing proportion of human TB cases. *M. bovis* is widespread in domestic animals and has been extensively documented in both captive and free-ranging wildlife populations. A number of wildlife populations are endemically infected, for example, the European badger (Meles meles) in the United Kingdom, the African buffalo (*Syncerus caffer*) in South Africa, Spotted deer, Nilgai and other different species of deer and antelopes. These permanent reservoirs of infection pose a serious threat to public health and TB eradication programs. Necessary precautions need to be taken when there are possibilities of disease being found in the wildlife population.

Trichinosis

Trichinosis may result in diarrhea, sudden edema of the upper eyelids, photophobia, muscle soreness and pain, skin lesions, thirst, sweating, chills, and weakness. Other respiratory and neurological symptoms may appear if treatment is delayed. Trichinosis is contracted by eating infected meat which contains the encysted parasites. The parasites may remain infectious in meat which is raw or poorly cooked. Trichinosis is caused by a nematode parasite which produces the disease in humans and domestic and wild animals. Evidence indicates that nearly all mammals are susceptible to infections with this parasite, which encysts in the muscle of the host and is then transmitted through consumption of infected flesh. As would be expected, the disease is most common in wild carnivores and scavengers.

As with other wildlife diseases, trichinosis is difficult to control in nature. However, certain steps can be taken to decrease the problem. Carcasses of carnivores and other meat-eating species should not be discarded in the fields or woods, but should be made unavailable by burying or other means. These carcasses also should not be fed to swine, dogs, or other domestic animals. Open garbage dumps should be replaced by the landfill type or other methods of disposal where wildlife will not have access to meat scraps. If open garbage dumps cannot be eliminated, rodent control programs should be initiated and the areas fenced to prevent scavenging by larger animals such as foxes. These steps would markedly reduce the problem of trichinosis in wildlife in the United States.

If carnivorous or omnivorous wildlife such as bears, bobcats, opossums, raccoons, or feral pigs are consumed by humans, the meat should be properly prepared by cooking, freezing, or curing to destroy any viable trichinae. Cooking to an internal temperature of 137°F is deemed sufficient for pork, while freezing at 5°F for 20 days, -10°F for 10 days, or 20°F for 6 days will kill trichinae. Curing should follow approved government regulations.

Tick-borne Diseases:

Rocky Mountain spotted fever (Tick-borne Typhus)

Rocky Mountain spotted fever (RMSF) is a moderate to severe illness caused by a rickettsia (*Rickettsia rickettsii*). The disease is distinguished by a sudden onset of high fever, severe headache, muscle pain, and a red rash starting on the extremities about 3 to 6 days after onset of symptoms and extending to the palms of hands and soles of feet and then to the rest of the body. Delirium, coma, and death occur in about 1% to 2% of cases (15% to 20% in untreated cases). The disease is transmitted to humans in by several hard tick (Ixodidae) species; *D. andersoni* in the Rocky Mountain region, *D. variabilis* in the east and southeast, and *Amblyomma americanum* in the south-central states. The natural hosts for the rickettsia are a variety of wild rodents, although rabbits and wild and domestic carnivores are involved in some cases. The rickettsia survive the winter months in the tick vector and may be maintained by transovarial transmission from the female adult tick to its offspring.

Avoid tick-infested areas and use personal measures to protect against tick bites. No vaccine is presently licensed for public use, but antibiotic treatment is effective and should be initiated without waiting for laboratory confirmation of clinical diagnosis.

Lyme Disease

Lyme disease is caused by a spirochete bacterium (*Borrelia burgdorferi*) that is transmitted to humans by hard ticks. Early symptoms include a flu-like illness with headache, slight fever, muscle or joint pain, neck stiffness, swollen glands, jaw discomfort, and inflammation of the eye membranes. A diagnostic rash, erythema migrans (EM), occurs in 65% to 75% of the cases. The rapidly expanding red rash starts at the tick bite site and expands to a nearly circular lesion of about 1 to 8 inches (2 to 20 cm). It often has a bulls-eye appearance with central clearing and/or darkening around the edge. Additional smaller skin lesions may appear at other sites of the body and may last for days or weeks. Later symptoms, including heart, nervous system, and joint manifestations, may develop in untreated individuals. The joint pain and swelling usually occur one or more months after infection, may involve one or more joints, and may recur in different joints; the knee joint is most frequently affected. Domestic animals may be affected as well.

Flea-borne Diseases

Plague

Plague is an acute disease caused by the bacteria *Yersinia pestis*. Humans usually become infected by the bites of infected fleas but also directly from exposure to tissues or body fluids from diseased animals, especially when skinning animals. The disease is characterized by the sudden onset of fever and chills, followed by the development of swollen and painful lymph nodes (buboes) in the armpits, groin, and other areas 2 to 6 days following exposure. In addition to the bubonic form, septicemic infection may develop and involve other organs. Secondary infection of the lungs may lead to primary plague pneumonia, which then can be transmitted from person to person by aerosol. The disease may be only mild and short-lived but frequently progresses to a severe form, with 25% to 60% fatality in untreated cases. Plague is maintained in wild rodent populations in the western states by flea transmission between rodents. Sylvatic plague may persist in these animal populations with varying severity, depending on the species' resistance. Rabbits, hares, carnivores, and wild ungulates have also been infected occasionally. Use insect repellents on skin or treat field clothes with permethrin. Practice good sanitation procedures when handling animals. Seek medical care and treatment if sick.

Murine Typhus Fever

Murine typhus fever is caused by *Rickettsia typhi*, a rickettsial organism that occurs throughout the world. Rats are the reservoir animals from which the disease reaches many humans by way of rat fleas. The oriental rat flea, *Xenopsylla cheopis*, is considered the most important vector of the disease. The causative organism enters the bloodstream when feces of infected fleas are scratched or rubbed into a flea-bite wound or other breaks in the skin. Murine typhus is similar to epidemic or louse-borne typhus, but illness is much milder and the fatality rate in untreated cases is much lower.

Commensal Rodent-borne Diseases

Rats and mice are responsible for the spread of over 35 diseases, either directly, through contamination of human food with their urine or feces, or indirectly, by way of rodent fleas and mites. Following are brief descriptions of the more common of these diseases.

Rat-bite Fever

Rat-bite fever is caused by the bacteria *Streptobacillus moniliformis*, which is found on the teeth and gums of rats. It is transferred from rats to humans by the bite of the rat. The most frequently occurring rat-bite fever in the United States is called Haverhill fever. It is similar to the rat-bite fever of the Orient called sodoku (caused by *Spirillus minus*).

Leptospirosis (Weil's Disease)

Leptospirosis is a mild to severe infection that is seldom fatal. Human cases of the disease result from direct or indirect contact with infected urine of rodents and other animals. The spirochetes (Leptospira spp., primarily *L. icterohemorrhagiae*) are found in contaminated water or on food, and may enter humans through mucous membranes or minute cuts or abrasions of the skin. Thus, Weil's disease is often found in sailors, miners, sewer workers, and fish or poultry dealers.

Symptoms of leptospirosis infection range from none to severe, with acute fatalities. Many infections are characterized by diarrhea, chills, vomiting, myalgia, and kidney damage. Prevention is the most important means of dealing with this disease. Proper sanitation, rodent-proofing, and food storage and handling are essential. Medical attention is typically required.

Salmonellosis

The Salmonella group of bacteria exists nearly everywhere in the environment and, unfortunately, several serotypes are pathogenic to humans and other animals. Salmonellosis can lead to severe cases of gastroenteritis (food poisoning), enteric fever septicemia (blood poisoning), and death. Food poisoning, the most common malady, is characterized by a sudden onset of abdominal pain, diahrrea, nausea, and vomiting. Due to the severity of this disease, medical attention is typically required.

Salmonella bacteria recognize few host barriers and are transmitted in many ways. One common form of transmission is through food contaminated by rat or mouse feces that contain Salmonella (especially *S. typhimurium*) organisms. It may also be spread by birds, which contaminate food with their feces or bacteria carried on their feet.

As with leptospirosis, the most important means of reducing the potential of this disease is through proper sanitation, rodent-proofing, and food storage and handling. Rodent control through trapping and appropriate use of toxicants may also be necessary.

Bird-borne Diseases

Large roosting concentrations of birds can be noisy, and the associated droppings can be a nuisance because of the objectionable odor and mess. In addition, birds may carry and transmit diseases to livestock and humans. Collections of droppings may provide a medium for bacterial and fungal growth that could pose a potential public health problem. Birds should be dispersed or controlled when they form large concentrations near human habitations and are judged to pose a threat to public health or livestock. Concentrations of birds that do not threaten human health or agriculture are usually better left undisturbed.

Avian Influenza

Avian Influenza (AI) is a viral disease that affects the respiratory and digestive systems of most species of domestic and wild birds. AI is characterized into two basic forms: High Pathogenicity Avian Influenza (HPAI) – a rapidly fatal form of AI among birds, and Low Pathogenicity Avian Influenza (LPAI) - a mild, often undetected form of the disease that frequently occurs in wild bird populations. H5N1 Surface proteins on avian influenza viruses are classified as H – Hemagglutinin and N – Neuraminidase. There are 16 H and 9 N types affecting birds. The possible combinations of H & N surface proteins create the numerous strains of AI such as the Asian HPAI H5N1 currently affecting poultry, people and some wild birds in Europe, Africa and Asia. H5N1 is a form of HPAI, however, not all H5N1 avian viruses are HPAI. All birds are susceptible. Waterfowl, shorebirds, marine birds and upland game birds are known carriers of the LPAI form of avian influenza. AI is passed between birds through fecal material and body fluids such as saliva, nasal secretions and aerosol droplets. In Southeast Asia poultry may have spread HPAI to wild birds through contact with domestic chickens, ducks and geese raised outdoors. Avian Influenza has not been transmitted from wild birds to humans. The current outbreaks in Asia, Europe and Africa are between captive poultry and people. Since 2003 approximately 250 individuals have been affected with the Asian HPAI H5N1 strain of the influenza virus causing mortality in about half of these people. In the current outbreaks in Eurasia, human-to-human transmission has not been documented. Previous worldwide human pandemic flu outbreaks, such as the one in 1918 involved human-to-human transmission and killed millions of people.

Histoplasmosis

Histoplasmosis is a respiratory disease in humans caused by inhaling spores from the fungus *Histoplasma capsulatum*. Birds do not spread the disease directly — spores are spread by the wind and the disease is contracted by inhalation. Bird droppings enrich the soil and promote growth of the fungus. Notable sources for histoplasmosis infection include: (1) traditional bird roosts, (2) poultry farms, (3) enclosed buildings where birds or bats have roosted, and (4) natural or organic fertilizers. In addition, the fungus can grow in various natural soils, with or without droppings.

Infection by only a few spores generally produces a mild case in humans and people are often unaware that they have contracted the disease (unless it is detected later through a skin reactivity test or lung X ray that reveals healed lesions). A more severe infection may result in an acute respiratory illness with flu-like symptoms (in fact, histoplasmosis is often misdiagnosed as flu). The most serious infections, usually resulting from massive spore inhalation, may involve a dissemination of the fungus through the blood stream. Such cases may become chronic, recurring at later times, and affect organs other than the lungs. Treatment with an antifungal agent such as amphotericin B or imidazole ketoconazole may be prescribed in more severe cases.

Not all blackbird or starling roosts pose immediate public health problems related to histoplasmosis. The histoplasmosis fungus grows readily in the soil beneath bird roosts, but it cannot form spores under the acidic conditions of fresh droppings. An active, undisturbed roost may only give off a few spores. Old or abandoned roosts, however, can pose a significant threat to human health. After the droppings have dried out or been leached by the rain, the right conditions develop for spore release. If the soil is stirred up under dusty conditions, as may be the case in land clearing or bulldozing, massive amounts of spores may be released. Severe epidemics have occurred in association with bird roosts under such conditions.

Birds in large roosts can be dispersed by the use of various frightening devices or by roost thinning or clearing. Precautions should be taken when working around an old or abandoned roost site. It is wise to test for the presence of histoplasmosis before beginning any work. Wear a self-contained breathing apparatus or face mask with a dust filter (less than 2 microns) to prevent inhalation of the spores. Wear protective clothing, gloves, and boots that can be removed and disinfected with formalin and washed. If an area that was once a bird roost is going to be cleared or bulldozed, the area should be dampened with water or work should be done when the weather is wet or cold or both. Avoid working under dry, dusty conditions in late summer. A roost may be decontaminated by spraying it with a 3% to 5% solution of formaldehyde before clearing, but this option is very expensive.

Ornithosis (Psittacosis)

Ornithosis is an infectious respiratory disease caused by *Chlamydia psittaci*, a viruslike organism that affects humans, pets, and livestock. It usually leads to a mild pneumonia-or flu-like infection, but it can be a rapidly fatal disease (less than 1% of the cases reported in the United States). In humans many cases occur that are undetected or incorrectly diagnosed. Pigeons are most commonly associated with the transmission of ornithosis to humans. Birds have adapted to the disease and show no symptoms, but act as healthy carriers, shedding the organism in their feces, which later may become airborne as dust. The disease may also be contracted from parakeets, farm poultry, or waterfowl.

People working in dry, dusty areas where bird droppings are present, should wear face masks or respirators to avoid inhaling airborne avian fecal material. Spray work areas with water and/or disinfectants to minimize the potential for airborne infections particles. Medical attention, including antibiotic treatments are recommended for disease treatment.

Salmonellosis

The Salmonella group of bacteria can also be transmitted by birds. Refer to Commensal Rodent-borne Diseases (above) for additional information.

Other Bird-borne Diseases

Pigeons, starlings, sparrows, blackbirds, and other types of birds have been implicated in the transmission of various diseases of significance to humans or livestock. Starlings have been shown to be vectors of transmissible gastroenteritis (TGE) of swine. The virus can be carried in an infective state in the birds' intestines or on their feet for up to 30 hours. It is generally fatal to baby pigs and causes weight loss in adults. Starlings may also be involved in the transmission of hog cholera. Cryptococcosis is a fungal disease spread by pigeons and starlings that result in chronic, usually fatal, meningitis. Various species of birds may also play a part in the transmission of encephalitis, Newcastle disease, aspergillosis, toxoplasmosis, pseudotuberculosis, avian tuberculosis, and coccidiosis.

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Until one has loved an animal, a part of one's soul remains unawakened
Anatole France

Leptospirosis in India: A veterinary perspective

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Leptospirosis is an acute anthropo-zoonotic infection of worldwide significance caused by spirochaete *Leptospira interrogans* which has 23 serogroups and >200 serovars. Various factors influencing the animal activity, suitability of the environment for the survival of the organism and behavioral and occupational habits of human beings can be the determinants of incidence and prevalence of the disease. The disease was considered inconsequential till recently, but it is emerging as an important public health problem during the last decade or so due to sudden upsurge in the number of reported cases and outbreaks. It is a zoonotic disease that is spread primarily by rodents. It has become an important cause of acute febrile illness in children in India during the monsoon and immediate post-monsoon periods. In recent times, it has also become common to encounter cases of leptospirosis throughout the year in urban areas due to poor sanitation, water logging, overcrowding, and mushrooming of slums.

Etiology:

Order: *Spirochaetales*
Family: *Leptospiraceae*
Genus: *Leptospira*

The genus at present consists of two species: "*L. interrogans*" and "*L. biflexa*". The former species is pathogenic to man and animals while the latter is saprophytic and can be found in fresh water, tap water and salt water.

Transmission:

Leptospires may be transmitted to humans through the following routes:

- Direct contact with infected urine or animals (especially occupational). The usual portal of entry is through abrasions or cuts in the skin or via the conjunctiva.
- Indirectly via contaminated soil or water, especially in times of flood. Infection may take place via intact skin after prolonged immersion in water, but this usually occurs when abrasions are likely to occur and is thus difficult to substantiate.
- Ingestion of infected water. Water-borne transmission has been documented; point contamination of water supplies has resulted in several outbreaks of leptospirosis.
- Inhalation of water or aerosols also may result in infection via the mucous membranes of the respiratory tract.

Hosts involved:

Maintenance hosts: rats, pigs, cattle, bandicoots, dogs and cats.

Accidental (incidental) hosts: Humans and other animals.

The disease is maintained in nature by chronic infection of the renal tubules of maintenance hosts. A maintenance host is defined as a species in which infection is endemic and is usually transferred from animal to animal by direct contact. Infection is usually acquired at an early age, and the prevalence of chronic excretion in the urine increases with the age of the animal. Other animals (such as humans) may become infected by indirect contact with the maintenance host. Animals may be maintenance hosts of some serovars but incidental hosts of others, infection with which may cause severe or fatal disease. The most important maintenance hosts are small mammals, which may transfer infection to domestic farm animals, dogs, and humans. The extent to which infection is transmitted depends on many factors, including climate, population density, and the degree of contact between maintenance and accidental hosts.

Domestic animals are also maintenance hosts; dairy cattle may harbor serovars *hardjo, pomona,* and *grippotyphosa*; pigs may harbor *pomona, tarassovi or bratislava*; sheep may harbour *hardjo* and *pomona*; and dogs may harbour canicola. Distinct variations in maintenance hosts and the serovars they carry occur throughout the world. Human infections may be acquired through occupational, recreational, or vocational exposures. Occupation is a significant risk factor for humans. Direct contact with infected animals accounts for most infections in farmers, veterinarians, abattoir workers, meat inspectors, rodent control workers, and other occupations which require contact with animals. Indirect contact is important for sewer workers, miners, soldiers, septic tank cleaners, fish farmers, gamekeepers, canal workers, rice field workers, taro farmers, banana farmers, and sugar cane cutters.

There is a significant risk associated with recreational exposures occurring in water sports, including swimming, canoeing, white water rafting, fresh water fishing, and other sports where exposure is common, such as potholing and caving. The potential for exposure of large numbers of individuals occurs during competitive events. Several outbreaks of leptospirosis associated with water have been reported. Many of these outbreaks have followed extended periods of hot, dry weather, when pathogenic leptospires presumably have multiplied in freshwater ponds or rivers. Cases of leptospirosis also follow extensive flooding.

Epidemiology:

Leptospirosis is presumed to be the most widespread zoonoses in the world. The incidence is significantly higher in warm-climate countries than in temperate regions; this is due mainly to longer survival of leptospires in the environment in warm, humid conditions. However, most tropical countries are also developing countries, and there are greater opportunities for exposure of the human population to infected animals, whether livestock, domestic pets, or wild or feral animals. The disease is seasonal, with peak incidence occurring in summer or fall in temperate regions, where temperature is the limiting factor in survival of leptospires, and during rainy seasons in warm-climate regions, where rapid desiccation would otherwise prevent survival.

Three epidemiological patterns of leptospirosis were defined by Faine.

- The first occurs in temperate climates where few serovars are involved and human infection almost invariably occurs by direct contact with infected animals though farming of cattle and pigs. Control by immunization of animals and/or humans are potentially possible.
- The second occurs in tropical wet areas, within which there are many, more serovars infecting humans and animals and larger numbers of reservoir species, including rodents, farm animals, and dogs. Human exposure is not limited by occupation but results more often from the widespread environmental contamination, particularly during the rainy season. Control of rodent populations, drainage of wet areas, and occupational hygiene are all necessary for prevention of human leptospirosis. These are also the areas where large outbreaks of leptospirosis are most likely to occur following floods, hurricanes, or other disasters.
- The third pattern comprises rodent-borne infection in the urban environment. While this is of lesser significance throughout most of the world, it is potentially more important when the urban infrastructure is disrupted by war or by natural disasters.

In India, the disease has been found more commonly associated with natural disasters especially during the monsoon period at which times acute epidemics may eventuate. A multi-centric study in India showed that leptospirosis accounts for about 12.7% of cases of acute febrile illness responsible for attendance at hospitals. Carrier animals include rats, pigs, cattle, bandicoots and dogs. The predominant serovars are *copenhageni, autumnalis, pyrogenes, grippotyphosa, canicola, australis, javanica, sejroe, louisiana, and pomona*. Outbreaks of leptospirosis have increasingly been reported from Kerala, Gujarat, Tamil Nadu and Karnataka and sporadic cases have been reported from Goa, Andhra Pradesh and Assam.

Clinical features of Leptospirosis:

According to information provided by the World Health Organization, the disease can present in one of four ways:

i. As a mild influenza-like illness
ii. As Weil's syndrome, characterized by jaundice, renal failure, hemorrhage, and myocarditis with arrhythmias
iii. As meningitis/meningoencephalitis
iv. As pulmonary hemorrhage with respiratory failure

Most patients have subclinical or very mild illness. The exact ratio of asymptomatic to symptomatic leptospirosis in children (from India) is not available as most of the infections are either subclinical or have nonspecific manifestations, indistinguishable from that of other common febrile illnesses. In a study from the Andaman and Nicobar islands (India), 90% of school children had subclinical or unnoticed infections. It was also seen that children who had had the infection earlier (i.e., were previously seropositive) suffered less morbidity and mortality in subsequent outbreaks. The clinical presentation of leptospirosis varies widely; it can range from an acute febrile illness to a severe syndrome of multiorgan dysfunction and therefore the diagnosis may be missed unless the physician has a high index of suspicion for the disease. Symptomatic infection presents as a sudden-onset febrile illness with nonspecific signs and symptoms (70%) or as aseptic meningitis (20%) or hepatorenal dysfunction (10%). Both anicteric (90% or more cases) and icteric leptospirosis are known to occur. The more common, mild, anicteric form of the disease is characterized by nonspecific symptoms such as fever, headache, chills, myalgia, nausea, and abdominal pain, while the severe, potentially fatal, icteric form of leptospirosis (Weil's syndrome) is characterized by renal, hepatic, and vascular complications.

Diagnosis:

General clinical laboratory findings

In anicteric disease, the erythrocyte sedimentation rate is elevated, and white cell counts range from below normal to moderately elevated. Liver function tests show a slight elevation in aminotransferases, bilirubin, and alkaline phosphatase in the absence of jaundice. Urinalysis shows proteinuria, pyuria, and often microscopic hematuria. Hyaline and granular casts may also be present during the first week of illness.Lumbar puncture will usually reveal a normal or slightly elevated CSF pressure and may serve to reduce the intensity of headache. CSF examination may initially show a predominance of polymorphs or lymphocytes, but later examination almost invariably shows that lymphocytes predominate. CSF protein may be normal or elevated, while CSF glucose is usually normal. In patients with severe jaundice, xanthochromia may occur. CSF abnormalities are common in the second week of illness, and CSF pleocytosis can persist for weeks.

In severe leptospirosis, a peripheral leukocytosis occurs with a shift to the left, whereas in dengue, atypical lymphocytes are commonly observed. Thrombocytopenia is common and may be marked. Renal function impairment is indicated by raised plasma creatinine levels. The degree of azotemia varies with severity of illness. In icteric leptospirosis, liver function tests generally show a significant rise in bilirubin, with lesser increases in transaminases and marginal increases in alkaline phosphatase levels. The increase in bilirubin is generally out of proportion to the other liver function test values. Similar findings were reported for serum creatinine phophokinase levels. Serum amylase may also be elevated, particularly in patients with ARF.

Microscopic demonstration

Leptospires may be visualized in clinical material by dark-field microscopy or by immunofluorescence or light microscopy after appropriate staining. Dark-field microscopic examination of body fluids such as blood, urine, CSF, and dialysate fluid has been used but is both insensitive and lacking specificity. Approximately 10^4 leptospires/ml are necessary for one cell per field to be visible by dark-field microscopy. A quantitative Buffy coat method was recently shown to have a sensitivity of approximately 10^3 leptospires/ml. A method which involved repeated microscopic examination of double-centrifuged anticoagulated blood demonstrated leptospires in 32% of patients whose leptospirosis was confirmed by animal inoculation.Microscopy of blood is of value only during the first few days of the acute illness, while leptospiremia occurs. In volunteers infected with serovar *grippotyphosa*, leptospires were detected as early as 4 days prior to the development of symptoms. Most authorities agree that there are too few leptospires in CSF for detection by dark-field microscopy. Direct dark-field microscopy of blood is also subject to misinterpretation of fibrin or protein threads, which may show Brownian motion.

Staining methods

These methods have been applied to increase the sensitivity of direct microscopic examination. These have included immunofluorescence staining of bovine urine, water, and soil and immunoperoxidase staining of blood and urine. A variety of histopathological stains have been applied to the detection of leptospires in tissues. Leptospires were first visualized by silver staining, and the Warthin-Starry stain is widely used for histological examination. Immunofluorescence microscopy is used extensively to demonstrate leptospires in veterinary specimens. More recently, immunohistochemical methods have been applied.

Antigen detection

Detection of leptospiral antigens in clinical material would offer greater specificity than dark-field microscopy while having the potential for greater sensitivity. An evaluation of several methods concluded that radioimmunoassay (RIA) could detect 10^4 to 10^5 leptospires/ml and an enzyme-linked immunosorbent assay (ELISA) method could detect 10^5 leptospires/ml, but countercurrent immunoelectrophoresis and staphylococcal coagglutination were much less sensitive. RIA was more sensitive than dark-field microscopy but less sensitive than culture when applied to porcine urine. A double-sandwich ELISA could detect 10^4 leptospires of serovar *hardjo* but was less sensitive for other serovars. A chemiluminescent immunoassay was applied to human blood and urine but was no more sensitive than earlier ELISA. More recently, immunomagnetic antigen capture was combined with fluoroimmunoassay to detect as few as 10^2 leptospires/ml in urine of cattle infected with serovar *hardjo*. Inhibitory substances have been reported in urine, indicating the need for treatment of urine prior to testing.

Isolation of leptospires

Leptospiremia occurs during the first stage of the disease, beginning before the onset of symptoms, and has usually finished by the end of the first week of the acute illness. Therefore, blood cultures should be taken as soon as possible after the patient's presentation. One or two drops of blood are inoculated into 10 ml of semisolid medium containing **5-**fluorouracil at the patient's bedside. For the greatest recovery rate, multiple cultures should be performed, but this is rarely possible. Inoculation of media with dilutions of blood samples may increase recovery. Rapid detection of leptospires by radiometric methods has been described. Leptospires survive in conventional blood culture media for a number of days. Rarely, leptospires have been isolated from blood weeks after the onset of symptoms.

Table: Some media used for the isolation of *Leptospira* isolation

Nature of the media	Serum enriched	Serum replaced by albumin and tween	Chemically defined medium
Liquid	Korthof's Stuart's Vervoort's	EMJH, PLM-5, Leptospira 5x, Protein free media	Shenberg's, Vogel and Hunter
Semisolid	Fletcher's Noguchi's	Semisolid EMJH	
Solid	Cox's Korthof'		

Other samples that may be cultured during the first week of illness include CSF and dialysate. Urine can be cultured from the beginning of the second week of symptomatic illness. The duration of urinary excretion varies but may last for several weeks. Survival of leptospires in voided human urine is limited, so urine should be processed immediately by centrifugation, followed by resuspending the sediment in phosphate-buffered saline (to neutralize the pH) and inoculating into semisolid medium containing 5-fluorouracil.Cultures are incubated at 28 to 30°C and examined weekly by dark-field microscopy for up to 13 weeks before being discarded. Contaminated cultures may be passed through a 0.2-µm or 0.45-µm filter before subculture into fresh medium.

Identification of leptospiral isolates

Isolated leptospires are identified either by serological methods or, more recently, by molecular techniques. Traditional methods relied on cross-agglutinin absorption. The number of laboratories which can perform these identification methods is very small. The use of panels of monoclonal antibodies allows laboratories which can perform the microscopic agglutination test to identify isolates with relative rapidity. Molecular methods have become more widely used and are discussed below.

Other serological tests

Because of the complexity of the MAT, rapid screening tests for leptospiral antibodies in acute infection have been developed. Complement fixation (CF) was widely used, but methods were not standardized. CF was applied to veterinary diagnosis, but species-specific differences were noted. CF tests have generally been replaced by ELISA methods. IgM antibodies become detectable during the first week of illness, allowing the diagnosis to be confirmed and treatment initiated while it is likely to be most effective. IgM detection has repeatedly been shown to be more sensitive than MAT when the first specimen is taken early in the acute phase of the illness.IgM antibodies have been detected by ELISA in CSF from patients with icteric leptospirosis. In patients with meningitis without a proven etiology, IgM was detected in the CSF in 15%. IgM has been detected in saliva, and a dot-ELISA using polyester fiber was developed to facilitate collection of saliva directly onto the support material.

ELISA methods have been applied in a number of modifications. An IgM-specific dot-ELISA was developed in which polyvalent leptospiral antigen was dotted onto nitrocellulose filter disks in microtitre tray wells, allowing the use of smaller volumes of reagents. Further modifications of this approach have been used to detect IgG and IgA in addition to IgM and have employed an immunodominant antigen and a polyester fabric-resin support in place of nitrocellulose. A commercial IgM dot-ELISA dipstick has been shown to be as sensitive as a microtiter plate IgM-ELISA. Another dipstick assay has been extensively evaluated in several populations. A dot immunoblot assay using colloidal gold conjugate allowed completion of the assay within 30 min.

Molecular diagnosis

Leptospiral DNA has been detected in clinical material by dot-blotting and in situ hybridization. A recombinant probe specific for pathogenic serovars was prepared from serovar *lai*. Probes specific for serovar *hardjo*bovis were developed and applied to the detection of leptospires in bovine urine. However, the sensitivity of ^{32}P-labeled probes was approximately 10^3 leptospires, much lower than the sensitivity of PCR, and probes have not been used extensively for diagnosis since PCR became available.

Treatment:

Treatment of leptospirosis differs depending on the severity and duration of symptoms at the time of presentation. Patients with mild, flu-like symptoms require only symptomatic treatment but should be cautioned to seek further medical help if they develop jaundice. Specific antibiotic treatment was reported soon after penicillin became available, with mixed results. Oxytetracycline was also used. Few well-designed and well-controlled studies of antibiotic treatment have been reported. A major difficulty in assessing the efficacy of antibiotic treatment results from the late presentation of many patients with severe disease, after the leptospires have localized in the tissues. Doxycycline (100 mg twice a day for 7 days) was shown to reduce the duration and severity of illness in anicteric leptospirosis by an average of 2 days. Parenteral penicillin G (6-8 million U/m ^{2} /day given intravenously in divided doses every 4 hours for 7 days) is the drug of choice. Tetracycline (10-20 mg/kg/day given orally or intravenously in divided doses every 6 hours for 7 days) can be used in those allergic to penicillin. Doxycycline has been successfully used in adults. Oral amoxicillin (25-50 mg/kg/day in two or three divided doses) is an alternative therapy for children < 9 years of age. Although ciprofloxacin has been occasionally used for treatment (especially in patients with uveitis), there is a need for more trials to evaluate its efficacy in both adults and children.

Prevention and control:

- Important measures for prevention are rodent control and avoidance of contact with contaminated water and soil.
- Parents should instruct children not to wade through flood waters or play in puddles/stagnant water.
- Vaccination:
  - On-going research into numerous vaccine preparations for humans and animals is well documented. This includes the use of inactivated and attenuated vaccines, recombinant protein or lipoprotein vaccines, LPS vaccines and DNA vaccines.
  - Immunization of livestock (cattle, sheep, pigs, and horses) and family pets (cats and dogs) has been recommended as a means of eliminating some of the animal reservoirs.
- Social control measures:
  - Effective risk communication strategies such as awareness, health promotion and health education, advocacy and capacity building. Leptospirosis has typically been considered an occupational disease and thus social control measures directed towards agriculture and other at-risk workers are critical.
  - Improvement in sanitation and living conditions, and rodent control
  - The use of rodenticides, entrapment of animals, and improved sanitation have been shown to successfully diminish the risk of leptospirosis transmission. In India, the timing of rodent control was shown to be a vital consideration in the prevention of disease transmission. The rodent breeding period starts with the southwest monsoon, suggesting that rodent control measures in the pre-monsoon period would bring better vector control.

- Prophylactic and therapeutic medical and veterinary interventions:
    - Doxycycline (200 mg orally once a week) is used as prophylaxis in adults traveling to a highly endemic area for a limited period of time and also during outbreaks, but its use in children has not been studied.
- Surveillance systems:
    - A functional disease surveillance system, for both humans and animals, is essential for the effective control of leptospirosis. In addition to a number of research institutions, there are three WHO collaborating centers for leptospirosis in the region: the WHO/FAO/OIE Collaborating Centre for Reference and Research on Leptospirosis, Australia and Western Pacific Region based in Brisbane, Australia, and the Regional Medical Research Center in Port Blair, India.

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Avian Influenza: Disease and Public Health Importance

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The largest, most devastating outbreak of an infectious disease in modern history occurred in 1918, when a highly virulent influenza A (H1N1) virus spread throughout the world and killed between 20million and 40 million people. Additional epidemics occurred in 1957 (H2N2) and 1968 (H3N2), both originating in Asia and each killing approximately 1 million people. These haunting memories have led to widespread concern about the ongoing outbreak of avian H5N1 influenza in Asia. Avian influenza (AI) is caused by viruses of the genus Influenzavirus A which is placed under the family *Orthomyxoviridae*. There are three influenza genera – A, B and C; only influenza A viruses are known to infect birds. The virus of this genus has the potential to cause pandemics. The domesticated birds are mainly affected with very high flock mortality. Free flying and aquatic birds are believed to be important reservoirs for the virus where usually it does not cause disease. The present AI virus is the H5N1 subtype, which has spread to migratory birds also and has emerged in mammals and among the human population too. This subtype, having a significant zoonotic potential, has caused several disease outbreaks in poultry in many Asian, European and African countries leading to culling or death of more than 400 million birds and an estimated loss of US$20 billion. At its peak in 2006 the H5N1 strain was spread across 63 countries before it was eliminated from most of them. The H5N1 HPAI virus remains endemic in six nations across South-East Asia and Africa (EMPRES, 2012).

Avian influenza virus (AIV) is generally limited to poultry but an unprecedented epizootic of avian influenza A (H5N1) that is highly pathogenic has crossed the species barrier in Asia to cause many human fatalities and has an increasing pandemic threat. Zoonotic potential of AI virus was first recorded in 1997 with hospitalization of 18 people (six died) following the infection with HPAI H5N1 in Hong Kong (Lupiani and Reddy, 2009). This provided the evidence that HPAI strains of chicken can adapt, multiply and even cause death in affected individuals. The first outbreak in India was recorded in February 2006. The Government of India initiated active control and containment measures immediately and in most of the states the disease was successfully controlled. Sporadic outbreaks continue to occur in India especially in the eastern and northern part of the country which shares a porous border with Bangladesh and Nepal. The most recent outbreaks were recorded in turkeys in a farm near Bangalore in October 2012 and in poultry in Chattisgarh in August 2013. A total of 97 outbreaks have been reported from India (OIE, 2013) resulting in the death and culling of more than 75 lakh birds throughout the country.

Aetiology and threat potential

Influenza A viruses are classified into subtypes on the basis of their haemagglutinin (HA) and neuraminidase (NA) antigens. At present, 16 H subtypes (H1–H16) and 9 N subtypes (N1–N9) are recognized. The HA glycoprotein is responsible for the hemagglutinating activity and attachment of the virus to the host cells and is also responsible for producing protective antibodies in the host. NA glycoprotein aids in the spread of infection. AIV undergo antigenic variations by drift (point mutations), which favor the emergence of more pathogenic biovars. In addition, genetic reassortment (shift) can occur in reservoir hosts including migratory and free living birds apart from a large population of domestic poultry. With infection of two strains there is a possibility of production of 256 (2^8) genetically different progeny viruses due to antigenic shift. Pigs act as 'mixing vessel' for genetic reassortment, resulting in emergence of an AI virus with the necessary gene from the virus of human origin that allows its replication and spread in the human population. A slight change in the arrangement of the virus molecules can allow it to transform quickly from a relatively harmless state to become a dangerous killer.

On the basis of pathogenicity the disease is categorized into highly pathogenic avian influenza (HPAI) and low pathogenicity avian influenza (LPAI). The HPAI strains are further classified as highly pathogenic notifiable avian influenza (HPNAI) and low pathogenicity notifiable avian influenza (LPNAI) varieties. Any highly pathogenic avian influenza isolate is classified as notifiable avian influenza (NAI) virus.

Threat perception in Indian context

India is the fifth largest producer of eggs and ninth largest producer of poultry meat in the world, producing over 59 billion eggs and about 2.1 million metric tons of poultry meat in 2010-2011 (AHS, 2012). Several breakthroughs in poultry science and technology have led to the development of genetically superior breeds capable of higher production, even under adverse climatic conditions. India's broiler meat consumption has risen from 2.23 million metric tons in 2007 to a projected 2.75 million in 2012-13. The slight short fall in production is managed by way of importing meat.

India's first H5N1 outbreak was reported in January of 2006 in the Navapur District, Maharashtra, India. Since then H5N1 has been reported in 10 different states with 90% of the outbreaks concentrated in the Eastern, North-eastern and Western parts of India. West Bengal alone reported 55 H5N1 outbreaks in poultry, making it the state with highest incidence in India. Very few studies have been conducted about the epidemiology of H5N1 outbreaks in our country. To date, H5N1 outbreaks are restricted to poultry except for an outbreak in jungle crow that took place at Jharkhand in February 2012.

- Molecular Phylogeny of the Indian isolates:

All the Indian isolates from outbreaks in 2006 belonged to clade of virus similar to that of the Qinghai lake outbreak in China. The 2006, 2007 and 2008 viruses grouped into distinct sub-lineages related to those from Russia, Iran, Italy, Afghanistan & Pakistan. The 2007 outbreak strains grouped with the guinea fowl isolate from China. The strains isolated in 2008 & 2009 grouped with the isolates from Bangladesh and Kuwait indicating epidemiological link between the viruses (Nagarajan *et al*., 2012). This proves beyond fact that the origin of the virus is the migratory birds and illegal trade with neighbouring nations. India shares a lengthy border with Bangladesh which has recorded 1084 outbreaks to date. There have been a total of 1350 outbreaks in the Indian sub-continent in the past decade (OIE, 2013). With illegal cross-border trade the chances of disease outbreak increase in all these nations.

Migratory birds which escape the severe winter of their native habitat fly to the Asian continent bringing with them the virus. A typical example is the outbreak in Orissa near the Chilka Lake which houses one of the top most winter homes for migratory birds in the country. Though HPAI viruses infrequently causes disease in wild/migratory birds, only very recently, it has been observed that re-emerging AIV H5N1 appeared to be lethal in these birds. Therefore, surveillance and tracking of migratory and resident wild birds should be strengthened. Global Livestock Early Warning and Response System (GLEWS), Global Avian Influenza Network for Surveillance (GAINS) and satellite-based tracking systems need to be exploited to their full potential (Dhama *et al*., 2010).

- Impact of Avian Influenza on Indian economy

Indian poultry sector has been growing at the rate of 10-15% every year. Of late, the outbreak of AI in different states of the country in the last few years has become a major deterrent for the growth of this crucial sector. Various media reports mentioned that Maharashtra, West Bengal and Tripura have culled about 15, 33 and 2 lakh birds, respectively in 2006-07, which threw this occupation into turmoil following the outbreaks. A study by National Centre for Agricultural Economics and Policy Research, New Delhi in Manipur in July 2007 revealed that about 3.39 lakh birds were culled and 24 tonnes of poultry feed destroyed post-flu, causing a total loss of about Rs. 2455 lakh, which amounts to 14% of total value of livestock outputs and 0.5% of gross state domestic product of Manipur (Ganesh Kumar and Datta, 2008).

Market shocks associated with largely misplaced, but understandable public fears, fuelled in part by the media, regarding safety of poultry products due to avian influenza outbreak used to have a devastating impact on traders. In addition, economic losses would also occur in other industries "downstream" from the poultry industry that provides inputs to the poultry industry like bird feed, transportation and marketing up to the point where the product reaches the consumer. There may also be negative spillovers on the tourism industry (IDA, 2007).

Indian poultry meat market is dominated by live bird sales. Around 95% of total demand for poultry meat is in terms of live birds; only 5% of poultry meat is actually processed. Because of this feature of Indian poultry meat market, there is a real danger of the avian flu spreading to different locations unless strong measures are taken to contain it.

Diagnosis

Highly pathogenic avian influenza (HPAI) is classified as a select agent and the diagnostic techniques should only be performed in referral laboratories equipped with trained scientific manpower and minimum level 3 biosecurity (BSL-3) measures. Virus isolation remains the gold standard of diagnosis. Rapid laboratory confirmation of suspected influenza is usually performed by immunochromatographic or immunofluorescent detection of influenza viral antigens or RT-PCR detection of viral nucleic acids. In addition serum antibodies are detected by agar gel immunodiffusion test (AGID) and haemagglutination inhibition (HI) tests. Rapid diagnostic tests based on antigen capture enzyme immunoassay are also commercially available. Subtyping of AIVs can also be made by RT-PCR and PCR-ELISA.

1. Identification of the agent

It is the prescribed test for international trade. The samples taken from dead birds include faeces or cloacal swabs and oropharyngeal swabs. Samples from trachea, lungs, air sacs, intestine,spleen, kidney, brain, liver and heart should also be collected and processed either separately or as a pool. The samples should be placed in isotonic phosphate-buffered saline (PBS), pH 7.0–7.4 with antibiotics or a solution containing protein and antibiotics. The presence of protein stabilizes the virus. Suspensions should be processed as soon as possible after incubation for 1–2 hours at room temperature. When immediate processing is impracticable, samples may be stored at 4°C for up to 4 days. For prolonged storage, diagnostic samples and isolates should be kept at –80°C. The preferred method of growing AIV is by the inoculation of embryonated chicken eggs. The supernatant fluids of faeces or tissue suspensions are inoculated into the allantoic sac of three to five embryonated chicken eggs of 9–11 days' incubation. The eggs are incubated at 37°C (range 35–39°C) for 2–7 days. The allantoic fluids is recovered and tested with a screening test like haemagglutination test, agar gel immunodiffusion test or antigen-capture enzyme-linked immunosorbent assays or molecular tests like real-time reverse transcriptase polymerase chain reaction (OIE terrestrial Manual, 2012).

2. Assessment of pathogenicity

As listed earlier the AIV fall under the main categories of HPAI and LPAI. The following criteria have been adopted by the OIE for classifying an AIV as HPAI. One of the two following methods to determine pathogenicity in chickens is used.

A HPAI virus is: i) Any influenza virus that is lethal for six, seven or eight of eight 4 to 8 week-old susceptible chickens within 10 days following intravenous inoculation with 0.2 ml of a 1/10 dilution of a bacteria-free, infective allantoic fluid.
ii) Any virus that has an intravenous pathogenicity index (IVPI) greater than 1.2.
All AI isolates that meet the above criteria are designated as HPAI. This class is further divided into HPNAI and LPNAI. The non-H5 or non-H7 AI isolates that are not virulent for chickens are designated as LPAI.

Another approach to determine the virulence is to sequence the nucleotides at the portion of the HA gene coding for the cleavage site region of the haemagglutinin of H5 and H7 subtypes of avian influenza, thus enabling the amino acids there to be deduced. This is a rapid method and the exact genome sequence can be obtained.

3. **Serological tests**

a) Agar gel immunodiffusion (AGID) test

It is considered as an alternative test for international trade. Since all influenza A viruses have antigenically similar nucleocapsid and antigenically similar matrix antigens, the AGID tests are able to detect the presence or absence of antibodies to any influenza A virus. This test has been widely and routinely used to detect specific antibodies in chicken and turkey flocks as an indication of infection but is less reliable at detecting antibodies following infection with influenza A viruses in other avian species. Tests are usually carried out using gels of 1% agarose. Each suspect serum is to be placed adjacent to a known positive serum and antigen. The test takes around 24-48 hours depending on the concentrations of the antibody and the antigen.

b) Haemagglutination and haemagglutination inhibition tests (HA and HI)

Hemagglutination (HA) Test: A two-fold serial dilution of amnio-allantoic fluid is prepared with PBS and chicken RBCs are added to it. The plate is incubated 30 min at the room temperature (20-25^{o}C). The HA titer is determined by observing the presence or absence of tear shaped streaming of the RBCs against the RBC control. The reciprocal of the highest dilution giving complete HA is taken as HA titer.

Hemagglutination (HA) Inhibition Test: A two-fold serial dilution of amnio-allantoic fluid is prepared in PBS followed by addition of 4 HAU of virus into each well. The plate is incubated at room temperature for 30 min. The next step is addition of chicken RBCs followed by incubation at room temperature for further 30 min. The HI titer is the highest dilution of serum causing complete inhibition of 4 HAU of antigen.

c) Enzyme-linked immunoassay (ELISA)

Commercial ELISA kits that detect antibodies against the nucleocapsid protein are available. Kits with an indirect and competitive format have been developed and are now being used to detect AIV-specific antibodies. The kits should be validated for the specific species of interest and for the specific purpose(s) for which they are to be used. Several different test and antigen preparation methods are used. Such tests have usually been evaluated and validated by the manufacturer, and it is therefore important that the instructions specified for their use be followed carefully.

4. Antigen capture and molecular techniques

At present, the conventional virus isolation and characterization techniques for the diagnosis of AI remain the methods of choice, for at least the initial diagnosis of AI infections. However, conventional methods tend to be costly, labour intensive and slow. There have been enormous developments and improvements in molecular and other diagnostic techniques, many of which have been applied to the diagnosis of AI infections.

a) Antigen detection

Several commercially available antigen capture-ELISA kits that can detect the presence of influenza A viruses in poultry are available. The main advantage of these tests is that they can demonstrate the presence of AI within 15 minutes. The disadvantages are that they may lack sensitivity, they may not have been validated for different species of birds, subtype identification is not achieved and the kits are expensive. The tests should only be interpreted on a flock basis and not as an individual bird test.

b) Direct RNA detection

Development of diagnostic methods based on reverse transcription polymerase chain reaction (RT-PCR), real-time RT-PCR, nucleic acid sequence-based amplification and loop-mediated isothermal amplification (LAMP) has made the rapid detection of group A influenza and H5 and H7 subtype viruses possible (Pasick, 2008). These tests are rapid and save much time and economy. Molecular tests can then be applied to rapidly identify subsequently infected flocks. Perhaps the greatest application of molecular diagnostic techniques will be in high throughput endeavours like the characterization of influenza A viruses circulating in free-living bird populations, or monitoring for genomic changes, which could signal changes in pathogenicity or host specificity. These methods are particularly useful in surveillance and outbreak situations where flock status needs to be determined rapidly.

AI diagnostic labs in India

Two National Reference Laboratories have been established in the country. For veterinary samples - HSADL, Bhopal is the OIE reference lab while for human samples NIV, Pune is the WHO referral lab. Additionally, five regional diagnostic labs (RDDLs) located at Kolkata, Jalandhar, Bangalore, Pune and Guwahati are involved in screening samples. The Govt. of India has brought out 'Action plan for avian influenza'. Veterinary workforce has been trained in handling bird flu related emergencies and guidelines have been laid down to constitute a rapid response team immediately after the outbreak. A weekly reporting system has been devised and is updated on the website of Department of Animal Husbandry, Dairying and Fisheries (DAHDF), GOI. Only the DAHDF is authorized to declare an outbreak and any communication regarding AI reporting is to be routed through the Department.

Conclusion

Strict biosecurity measures, disease surveillance and judicious vaccination strategies are of paramount importance in preventing the disease in birds and limiting its epidemic potential and. Some of the critical factors determining the effectiveness of India's AI preparedness and responsiveness appear to lie particularly in the segments like:

(i) More refined and precise surveillance;
(ii) Faster laboratory testing response times;
(iii) Improved on-farm bio-security;
(iv) Better understanding of underlying causes and spread of the virus; and
(v) Effective partnerships with relevant stakeholders.

This could prevent the financial losses to the poultry industry as well as save the precious lives of millions of people having put under a possible pandemic threat. Veterinarians, public health physicians and researchers make a good line of defense against this kind of important zoonotic disease by creating public awareness and devising effective and timely prevention and control strategies. Emphasis need to be given on education of the poultry industry, bird-rearers and veterinary professionals regarding the disease, modes of spread, essential biosecurity principles, disinfection, hygiene and safety measures.

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> *You can't tell the story of human health separate from animal health or environmental health*
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> *William Foege*

Rabies: Indian Scenario and Control Strategies

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Rabies is one of the fatal viral diseases of central nervous system (CNS) causing non suppurative encephalitis. The rabies virus is usually introduced into the body through bite, although penetration can occur through intact mucous membranes and the digestive tract, but not through intact skin. The disease is characterized by varying degree of mild to severe neurological signs of abnormal behavior (psychic and motor aspects like dullness, lethargy, irritability, aggression, polyphagia, pica, hypersexuality, dementia, etc.), described as furious and dumb forms, depending upon the susceptibility of species, specific regions of the brain damaged and virus type involved followed by paralysis, coma and death. It is a major zoonotic disease of worldwide occurrence and only few countries are free of rabies mainly the islands like Australia, New Zealand and Scandinavian countries, it is because of their geographical distribution and by strict application of stringent legislation. The disease affects all warm-blooded animals, including man. More than 99% of all human deaths from rabies occur in the developing countries and is still a great public health problem in Asia, Africa and Latin America. It is responsible for more than 60,000 human deaths annually worldwide, making it the tenth most common deadly infectious disease (Dietzschold *et al*., 2005). In India alone, the disease causes more than 20,000 human deaths in a year (Anon, 2003). In India and other developing countries, dogs play a major role as the reservoir and transmitter of the virus to humans and domestic animals.

Etiology:

It is caused by *Lyssa* virus, a RNA virus of the family *Rhabdoviridae*. The virus has bullet shaped morphology and is neurotropic in nature. The virus is highly fragile and susceptible to standard disinfectants. Sunlight and moderate heat destroy the virus.

Epidemiology:

Rabies is usually maintained and transmitted by particular mammalian reservoir hosts. Two epidemiologically important infectious cycles are recognized, urban rabies in dogs and sylvatic rabies in wildlife. More than 95% of human cases are the result of bites from rabid dogs. Racoons, skunks, foxes and bats are important reservoirs of rabies virus in North America. Rabies is endemic in India and considered serious concern for veterinary and medical fraternity. In India, about 15 million people are bitten by animals, mostly dogs, and estimates put the number of deaths in India at 25,000 - 30,000 annually. In the Indian sub-continent, dogs are mainly responsible for maintaining the virus in urban areas while jackals, wolves and foxes, etc. maintain the virus in sylvatic areas. In developed countries, the control of stray dogs and vaccination programmes has reduced the prevalence of urban rabies and the focus is now on wildlife reservoirs.

Transmission:

A very high concentration of virus is released from the salivary gland secretions before the onset of clinical signs. Virus in fresh saliva is transmitted via bite, scratch or abrasion by an rabid animal (rabid dogs shed virus in saliva 5-7 days before showing signs and cat does so for only 3 days before signs). Contamination of skin wounds by fresh saliva from infected animals. Aerosol transmission has been documented in the laboratory and in caves where bats inhabit (requires a high concentration of suspended viral particles).

Pathogenesis:

There is long and variable incubation period in animal and human rabies, usually lasting 20 to 90 days, but sometimes it lasts longer than one year (Smith *et. al*., 1991). The infection of muscle fibers at the site of bite may be a critical pathogenetic step for the virus to gain access to peripheral nervous system. RV binds to nicotinic acetyl choline receptors at the neuromuscular junction (NMJ) and NMJ is the major site of entry into neurons. Two other RV receptors which were found out recently are neural cell adhesion molecule (Thoulouze *et al.,* 1998) and p75 neurotropic receptor (Tuffereau *et al*., 1998). The final death of the neurons and the cells in the central nervous system are due to the process of apoptosis, which is said to be undergoing in these cells (Graffin and Hardwick, 1999).

The RV is transported to the CNS by retrograde transportation, possibly by binding to axoplasmic dynein. The phosphoprotein of rabies virus binds to dynein light chain for the transportation to the CNS (Raux *et al.,* 2000). CD56 neural cell associated molecule (NCAM) is expressed on neurons, astrocytes, myoblasts, myotubes, activated T cells and NK cells. The NCAM is expressed in three major isoforms and expression occurs in adult muscle and at the neuromuscular junction. RV propagates and spreads from sites of peripheral inoculation to CNS by fast axonal transport at the rate of 12 to 100 mm per day in retrograde direction. Glycoprotein is important for the trans-synaptic spread of rabies virus between neurons. Glycoprotein also exerts a very important influence on distribution of RV infection in CNS. Despite of dramatic and severe clinical neurological signs in rabies, the neuropathological findings under natural conditions are relatively mild and degenerative neuronal changes are not prominent. Now it is said that the clinical signs in rabies are due to neuronal dysfunction and not due to neuronal death, which was the earlier hypothesis. This neuronal dysfunction is either due to action of acetylcholine receptors, or due to action of nitric oxide or due to apoptosis or necrosis.

Oxidative or reductive status of NO is responsible for its neurotoxic or neuroprotective actions. The oxidative state (NO^+) is proposed to mediate neuroprotective effects through S-nitrosylation of thiol groups. The reductive state, NO^-, reacts with superoxide (O_2^-) to form peroxynitrate, a highly reactive molecule that can initiate non-specific protein and lipid peroxidation. It is possible that the reduced state of NO is dominant in rabies virus infected brains (Ubol *et al.,* 2001). Both innate and acquired immunity play a vital role in rabies virus infection, but it is the innate immunity which plays major role, since there are few MHC molecules for adaptive immunity to play in the central nervous system. Innate immunity is the first line of defense, activated by interferon pathways which are released from virus infected cells in CNS. Macrophages (Microglia cells) and the NK cells are mainly responsible for the production of nitric oxide in brain.

The incubation period may last from two weeks to six months. Incubation period is variable and depends upon site of bite (distance from brain), the amount of virus introduced, age and immune status of the victim.

Clinical Symptoms:

Animal Rabies: Rabies is infectious to mammals. Three stages of rabies are recognized in dogs and other animals. The first stage is a one to three day period characterized by behavioral changes and is known as the prodromal stage. The second stage is the excitative stage, which lasts about three to four days. This stage is often known as furious rabies due to tendency of the affected dog to be hyper reactive to external stimuli and bite at anything near, wander here and there, furiously attacking other dogs and animals. The third stage is the paralytic stage and is caused by damage to motor neurons. Incoordination is seen owing to rear limb paralysis and drooling of saliva and difficulty in swallowing is caused by paralysis of facial and throat muscles. Death is usually caused by respiratory arrest. Wild animals may be abnormally tame or appear sick- beware of approaching or picking up such an animal ("dumb rabies").

***Cattle/Buffalo**:* Drooling of saliva, bellowing, swaying of hind quarters while walking, anorexia, frequent micturition, paralysis of penis and death occur usually 48 hours after recumbency or after a course of 6-7 days in dumb form. In furious rabies tense, alert appearance, hyper-sensitive, violently attack other animals or inanimate objects, loud bellowing, sexual excitement and death is often sudden.

Human Rabies

A) Furious rabies: When the virus reaches the CNS, the patient presents prodromal stage with headache, fever, irritability, restlessness and anxiety. This may progress to muscle pain, salivation and vomiting. After a few days to a week the patient may experience a stage of excitement and be wracked with painful muscle spasms, triggered sometimes by swallowing of saliva or water. Hence they drool and learn to fear water (hydrophobia). The patients are also excessively sensitive to air blown on the face. The stage of excitement lasts only a few days (2-7 days) before the patient lapses into paralysis, coma and death. Once clinical disease manifests, there is a rapid, relentless progression to invariable death, despite all treatment.

B) Dumb rabies: Starts in the same way, but instead of progressing into excitement, the subject retreats steadily and quietly downhill, with some paralysis to death. In this form, diagnosis may easily be missed.

Diagnosis:

A. By assessment of:

1. **Bite**: Geographical area, type of animal, severity and site of bite.
2. **Animal**:
   - **Live** - observe in cage: If survives > 8 days, then probably NOT rabies.
   - **Dead** - brain sample sent to laboratory: impression smear and histopathology
3. **Man:**
   - **Live** - difficult diagnosis: clinical picture, skin biopsy, corneal impression.
   - **Dead** - "Negri bodies" in cytoplasm of brain cells, immune-fluorescence, virus isolation

B. Diagnostic Techniques:

1. Identification of the agent: Clinical observation may only lead to a suspicion of rabies because signs of the disease are not characteristic and may vary greatly from one animal to another. The only way to undertake a reliable diagnosis of rabies is to identify the virus or some of its specific components using laboratory tests. As rabies virus is rapidly inactivated, refrigerated diagnostic specimens should be sent to the laboratory by the fastest means available.

Precautions should be taken when handling central nervous system tissues from suspected rabies cases. Gloves should always be worn and precautions must be taken to prevent aerosols. Cutting tools, scissors and scalpels, should be used with care to prevent injury and contamination.

a) Collection of brain samples

Usually the brain is collected following the opening of the skull in a necropsy room, and the appropriate samples collected are Ammon's horn, thalamus, cerebral cortex and medulla oblongata. Under some conditions (e.g. in the field or when sampling for large epidemiological studies, this step may be impractical. In such cases, there are two possible methods of collecting some brain samples without opening the skull.

Occipital foramen route for brain sampling: A 5 mm drinking straw or a 2 ml disposable plastic pipette is introduced into the occipital foramen in the direction of an eye. Samples can be collected from the rachidian bulb, the base of the cerebellum, hippocampus, cortex, and medulla oblongata. Brain specimens from cattle can also be sampled using the 'brain scoop or tool'.

Retro-orbital route for brain sampling: In this technique (Montano Hirose *et al.*, 1991), a trocar is used to make a hole in the posterior wall of the eye socket, and a plastic pipette or straw is then introduced through this hole. The sampled parts of the brain are the same as in the former technique, but they are taken in the opposite direction.

b) Shipment of samples: Samples in 50% glycerol/PBS mixture should be kept refrigerated. As the virus is not inactivated by glycerol/PBS, all laboratory tests can be used on these samples. When it is not possible to send refrigerated samples, other preservation techniques may be used. The choice of the preservative is dependent on the tests to be used for diagnosis.

Formalin inactivates the virus, thus virus isolation tests cannot be used and diagnosis depends on using a modified direct fluorescent antibody test (FAT), polymerase chain reaction (PCR), (less sensitive than these tests on fresh tissue), immunohistochemistry or histology (Warner *et al.*, 1997).

An alternative for the transport of samples for molecular techniques is the use of FTA Gene Guard system (Picard-Meyer *et al.*, 2007). The FTA paper preserves rabies virus RNA within the fiber matrix allowing the transport of samples at ambient temperature without specific biohazard precautions for further characterization of rabies strains.

c) Laboratory tests

i) Immunochemical identification of rabies virus antigen

Fluorescent antibody test (FAT): The most widely used test for rabies diagnosis is the FAT, which is recommended by both WHO and OIE. This 'gold-standard' test may be used directly on a smear, and can also be used to confirm the presence of rabies antigen in cell culture or in brain tissue of mice that have been inoculated for diagnosis. The FAT gives reliable results on fresh specimens within a few hours in more than 95-99% of cases. The FAT is sensitive, specific and cheap. Aggregates of nucleocapsid protein are identified by specific fluorescence of bound conjugate.

Immunochemical tests: Immunoperoxidase methods can be used as an alternative to FAT with the same sensitivity (Lembo *et al.,* 2006), but attention should be paid to the risk of nonspecific false-positive results. Peroxidase conjugate may also be used on fresh brain tissue or sections of formalin-fixed tissue for immunohistochemical tests.

Enzyme-linked immunosorbent assay (ELISA): An ELISA that detects rabies antigen is a variation of the immunochemical test. It is useful for large epidemiological surveys (Xu *et al.,* 2007). The specificity and sensitivity of such tests for locally predominant virus variants should be checked before use. In case of human contact, these tests should be used in combination with confirmatory tests such as FAT or virus isolation.

Rapid immunodiagnostic test (RIDT): A rapid immunodiagnostic test was developed recently (Kang *et al.,* 2007). This simple test can be used under field conditions and in developing countries with limited diagnostic resources. Generally, tests other than the gold standard FAT should only be used after validation in multiple laboratories.

ii) Detection of the replication of rabies virus after inoculation: These tests detect the infectivity of a tissue suspension in cell cultures or in laboratory animals. They should be used if the FAT gives an uncertain result or when the FAT is negative in the case of known human exposure. Wherever possible, virus isolation on cell culture should be considered in preference to the mouse inoculation test (MIT). Cell culture tests are as sensitive as MIT (Rudd & Trimarchi, 1989) but are less expensive, give more rapid results and avoid the use of animals.

iii) Molecular techniques: Various molecular diagnostic tests, e.g. detection of viral RNA by reverse transcription PCR (RT-PCR), PCR-ELISA, hybridization *in situ* and real-time PCR are used as rapid and sensitive additional techniques for rabies diagnosis (Fooks *et al.,* 2009). The principle of *Lyssa* virus-specific PCRs is a reverse transcription of the target RNA (usually parts of the N gene) into complementary DNA followed by the amplification of the cDNA by PCR. Although those molecular tests have the highest level of sensitivity, their use is currently not recommended for routine post-mortem diagnosis of rabies (WHO Expert Committee on Rabies, 2005) due to high levels of false positive or false negative results without standardization and very stringent quality control. Nevertheless, they are useful for confirmatory diagnosis, as a first step in virus typing.

iv) Histological identification of characteristic cell lesions: Negri bodies correspond to the aggregation of viral proteins, but the classical staining techniques detect only an affinity of these structures for acidophilic stains. Techniques that stain sections of paraffin embedded brain tissues (e.g. Mann's technique) are time consuming, less sensitive and more expensive than FAT.

Seller's method on unfixed tissue smears has a very low sensitivity and is only suitable for perfectly fresh specimens. These methods are no longer recommended for routine diagnosis. Immunohistochemical tests are the only histological methods specific to rabies.

d) Other identification tests: The tests above describe methods to accurately diagnose rabies and to isolate and identify the virus. Typing of the virus can provide useful epidemiological information and should be undertaken in specialized laboratories (such as OIE or WHO Reference Laboratories). These techniques would include the use of MAbs, nucleic acid probes, or the PCR, followed by DNA sequencing of genomic areas for typing the virus (Bourhy *et al.,* 1993). These characterizations enable, for instance, a distinction to be made between vaccine virus and a field strain of virus, and possibly identify the geographical origin of the latter.

2. Serological tests: The main application of serology for classical rabies is to determine responses to vaccination, either in domestic animals prior to international travel, or in wildlife populations following oral immunization. In accordance with the WHO recommendations 0.5 IU per ml of rabies antibodies is the minimum measurable antibody titer considered to represent a level of immunity in humans that correlates with the ability to protect against rabies infection. The same measure is used in dogs and cats to confirm a satisfactory response to vaccination. As neutralizing antibodies are considered a key component of the adaptive immune response against rabies virus (Hooper *et al.*, 1998) the gold standard tests are virus neutralization (VN) tests. However, indirect ELISAs have been developed that do not require high-containment facilities and produce rapid results.

Treatment:

No specific drug is available. thorough washing of bite wound with soap and water, local application of 1% cetrimonium bromide, carbolic acid, silver nitrate and tincture of iodine, avoid suture of wound; muscle relaxant (scopalamide hydrobriomide), high doses of vitamin C, administration of rabies immunoglobulin and antirabies vaccine are helpful in the management of rabies.

Rabies Vaccine:

Human Vaccine: A good but expensive killed virus vaccine (Human Diploid Cell Vaccine, HDCV) grown in human fibroblasts or purified chick embryo cell vaccine (PCECV) is available for safe use in man. The unusually long incubation period of the virus permits the effective use of active immunization with vaccine post-exposure (0, 3, 7, 14, 28 and 90th day). When used, vaccine has dramatically cut the rabies death rate.

Prophylaxis: High-risk persons, eg. Veterinarians may be immunized before exposure and then merely require one or two booster doses if they may be exposed to suspected cases of rabies.

Animal Vaccines: A range of live and killed virus vaccines are available for domestic animals farm animals, cats and dogs). In dog and cat, first vaccine is given at 3 months, the booster after 3 weeks followed by annual vaccination.

For animals, live and recombinant vaccines are effective by the oral route and can be distributed in baits in order to immunize wild (or domestic) animals.

Prevention & Control

1. Immediate treatment of wound caused by a scratch or bite of a rabid animal or wild animal.
2. Compulsory registration and licensing of all pet dogs.
3. Collection and destruction of stray or unwanted dogs as it is the main reservoir in India.
4. Destruction of unvaccinated dogs bitten by known rabid animal.
5. Keep on leash on dogs in congested areas.
6. Preventive vaccination of all dogs with Raksharab (Indian Immunological) or Rabisan (Serum Institute.)
7. Imported dogs should have vaccination certificate and in the absence of which keep the animal under quarantine for six months.
8. Free of subsidized vaccination of all dog population.
9. Oral immunization of wildlife against rabies.
10. Provide free post bite vaccination to man and animals.
11. Prophylaxis vaccination of high risk groups like kennel staff. Veterinarian, dog catcher, cave explorer, hunter, animal handler and laboratory worker.
12. Submission of intact head of suspected rabid animal under refrigeration to a laboratory for the confirmation of rabies.
13. Person with skin lesions should not attend the rabies patient.
14. Keep the animal (who has bitten a man) under observation for 7-10 days.
15. Person should wear protective clothings (rubber glove, apron, gum boots) while attending a sick animal or cleaning saliva of the patient.
16. Intensification of mass education about the mode of transmission and prevention through media of radio, television, newspaper, and poster etc.
17. Reporting of rabies cases both in man and animals.
18. Close collaboration and coordination between veterinary and medical authorities at all level i.e. local, state and central.

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I care not much for a man's religion whose dog and cat are not the better for it

Abraham Lincoln

Brucellosis: An important occupational zoonoses

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Brucellosis is an ancient disease and is one of world's major zoonoses accounting for enormous economic losses and significant human morbidity in endemic areas. Clinical conditions similar to brucellosis have been described since the time of Hippocrates in 450 BC. In the 19th century J. A. Marston was the first to describe brucellosis as Mediterranean gastric remittent fever in 1861 from his base in Malta (Marston, 1861). Sir David Bruce described the cause of the disease in 1887 and reported numerous small coccal organisms in stained sections of spleen from a fatally infected soldier. He isolated and identified the organism in culture from spleen tissue of British soldiers stationed at Malta and named it *Micrococcus melitensis* (Bruce 1887). Later, it was renamed *Brucella melitensis* in his honor. The relationship between contagious bovine brucellosis and human brucellosis was confirmed by Meyer and Shaw in 1920. In India, the presence of brucellosis was first established early in the previous century and since then reported from almost all states (Renukaradhya *et al*. 2002).

Occurrence and transmission

Animal brucellosis is endemic worldwide and bovine brucellosis, caused by *B. abortus*, remains the most widespread form in animals. Brucellosis causes considerable economic losses through reduced productivity, abortions and weak offspring of livestock, which is a major hurdle for trade and export. Human brucellosis is mainly caused by *B. melitensis, B. abortus, B. suis* and *B. canis*. Although *B. ovis* is widespread in sheep, it has not been identified in humans. *B. melitensis* is the principal cause of human brucellosis worldwide and may account for up to 90% of all brucellosis cases with *B. melitensis* type 1 predominating in India (Mantur *et al*. 2006). The infective dose of *B. melitensis* is very low (10 organisms). Human brucellosis is traditionally described as a disease of variable manifestations. It is a severely debilitating disease manifesting numerous complications that require prolonged treatment with a combination of antibiotics leading to considerable medical expenses in addition to loss of income due to loss of working hours.

Consumption of unpasteurized milk and their products especially soft cheese, yoghurts and ice-cream, undercooked traditional delicacies such as liver and spleen are mainly responsible for human brucellosis (Malik 1997). Camel milk is considered to be the most important source of infection in Middle East countries and Mongolia. Though rare, occasionally human-to-human transmission takes place through tissue transplantation or sexual contact. Also, contact with vaginal discharge, urine, feces and blood of infected animals through broken skin and mucous membrane of conjunctiva and inhalation of the organism can cause the disease. The disease is an occupational hazard for livestock owners, abattoir workers, dairy workers, shepherds, farmers, veterinarians and laboratory workers. Brucellosis is one of the most common laboratory acquired infections. With the increase in global tourism, brucellosis is emerging as a common imported disease in the developed world (Memish and Balkhy, 2004).

Among non-human animals, the predominant route of exposure for smooth strains of Brucella is through ingestion or inhalation of organisms that are present in fetal fluids or other birth products; herds are typically exposed following the introduction of an infected animal that subsequently gives birth or aborts a fetus, whereupon pasture or water become contaminated by excretions. Transient disease (e.g. abortions) can also develop following administration of a live Brucella vaccine, particularly the *B. abortus* vaccine strain. Among dogs and sheep, transmission of rough strains of Brucella may be more common via the venereal route, although supporting data are limited. Among dogs, the urine of males and vaginal secretions of females are the main sources of infection via the venereal, oral, nasal, or conjunctival routes (Hollett, 2006). The greatest impact of brucellosis is evident in breeding facilities, where chronic infections can become established and leave considerable effect on breeding success. Unlike other rough strains, *B. canis* is capable of causing human illness; however, *B. canis* associated illness is of decreased severity and frequency, compared with illness caused by the smooth Brucella strains.

B. suis was among the earliest agents investigated and developed as a bioterrorism weapon in the United States offensive bioterrorism program in the 1950s (Christopher *et al*. 2005) The zoonotic pathogens *B. abortus, B. melitensis* and *B. suis* have been identified as Category B bioterrorism agents (Rotz *et al*. 2002) because they are easily capable of causing considerable morbidity and low numbers of deaths if used in a mass event. These three *Brucella* spp. are also designated as select agents by the US Government (CDC, 2005). They are under joint regulation between the CDC and the USDA as pathogens capable of causing substantial morbidity and death rates among domestic animals, with resultant effects on food supply. Therefore, any research or other work with these pathogens and any interstate transportation of isolates must be registered with these regulating agencies and be accompanied by the appropriate permits.

An estimated 500,000 human infections per year still occur worldwide. The reported incidence in endemic areas varies from <1/100,000 population in UK, USA and Australia, to >20-30/100,000 in southern European countries such as Greece and Spain and up to >70/100,000 in Middle Eastern countries like Kuwait and Saudi Arabia.

Worldwide prevalence

Brucellosis is major health problem in Mediterranean, Middle East, India, Latin America, Africa, parts of Mexico and parts of Asia. Syria has the highest annual incidence worldwide, reaching an alarming 1603 cases per million per year (OIE, 2005). Rate of human infection is high in Peru, Kuwait and Saudi Arabia as compared to sub-Saharan Africa, where the rate is relatively low which may be due to under reporting and low levels of surveillance.

Only 17 countries claim to be free of brucellosis. Though it has been eradicated from almost all of Europe, reports still indicate presence of human brucellosis in Greece, Spain and Turkey. Brucellosis-free status has been granted by the European Union (EU) to Sweden, Denmark, Finland, Germany, the UK (excluding Northern Ireland), Austria, Netherlands, Belgium, and Luxembourg (European Commission 2005). Norway and Switzerland are also considered brucellosis-free countries. France is an example of successful eradication. An increase in annual number of reported cases in Turkey has been observed, exceeding 15000 cases in 2004 (OIE, 2005) whereas situation in Iran is improving with the annual incidence falling from 1000 cases to 238.6 cases per million in 2003 (OIE, 2005). Iraq shows high endemicity with the annual incidence of 278.4 cases per million of population (OIE, 2005). Serological evidence of brucellosis was reported in chicken using conventional and non-conventional serological tests (Junaidu *et al*. 2006).

In US, the disease is usually present in Hispanic populations due to illegal importation of unpasteurized dairy products from neighboring Mexico, where the disease is endemic (Chang *et al*. 2003). The incidence is approximately 200 per year or 0.04 per 100,000. Patients in the United States are primarily found in Texas, California, Virginia, and Florida.

The occurrence of bovine brucellosis has been reported by 93 countries. The concept of host restriction of different *Brucella* species is gradually eluding as reports from Brazil and Columbia show that *B. suis* biovar 1 has become established in cattle, thus, becoming a more important reservoir than pigs. *B. suis* has the widest host range, with established host-pathogen relationships in reindeer and hares in addition to swine. However, almost all *Brucella* spp can infect mammalian species other than their preferred host; for example, both *B. melitensis* and *B. suis* are capable of colonizing bovine udders and, therefore, contaminating cows' milk (Refai 2002).

Prevalence in India

The true incidence of human brucellosis in India is not known. It has been estimated that the true incidence may be 25 times higher than the reported incidence due to misdiagnosis and underreporting. Mantur *et al*. (2004) showed a seroprevalence of 1.6% by SAT and confirmed by isolating *B. melitensis* in 43 of the 93 children referred to the microbiology laboratory of the Patil Medical College in Bijapur, Karnataka during a period of 13 years. Most of them were shepherds and had the habit of consuming fresh goat milk. They also reported brucellosis in 495 adults with a prevalence rate of 1.8% by testing blood samples of 26,948 adults in Bijapur during a period of 16 years from 1988 to 2004 and isolated *B. melitensis* from 191 cases (Mantur *et al*. 2006). Mathur (1964) reported 8.5% seroprevalence of brucellosis among dairy personnel in contact with infected animals and isolated Brucella from 7 cases. In Gujarat, 8.5% prevalence of Brucella agglutinins was recorded in human cases (Panjarathinam and Jhala 1986). In Haryana, 34% prevalence of human brucellosis was recorded among veterinarians, attendants and compounders in contact with animals (Chauhan 1999). Thakur and Thapliyal (2002) observed a prevalence rate of 4.97% in samples obtained from persons exposed to animals with a markedly higher prevalence of 17.39% among field veterinarians. Hemashettar and Patil (1994) found that 24 (8.2%) veterinary workers showed Brucella specific antibodies in significant titres. High seroprevalence rate was also noted in specific risk groups such as abattoir workers (Chadda *et al*. 2004). Kadri *et al*. (2000) identified 28 (0.8%) seropositive cases in a group of 3,532 patients with FUO. Mudaliar *et al*. (2003) showed the presence of Brucella antibodies in 5.33 % of animal handlers of which 4.51 % were dairy farm workers and 14.63 % were veterinary doctors. Rana *et al*. (1985) showed a seropositivity of 27.7 % among veterinarians in Delhi. Agasthya *et al*. (2007) reported brucellosis in high risk group individuals with disease prevalence at 41.23 % in veterinary inspectors, 30.92 % in veterinary assistants, 12.37 % in veterinary officers, 6.18 % in veterinary supervisors, 6.18 % in group- D workers, 2.06 % in shepherds and 1.03 % in butchers.

Economic impact

The impact of the disease on national economy due to brucellosis in cattle and buffalo was to the tune of Rs 240 million every year (Schwabe 1984). This amounts to more than half % of total value of all meat and milk products produced in the country. The annual loss due to human brucellosis was estimated to be 30 million man-days. Earlier to this, the economic loss due to brucellosis among bovines was estimated at Rs 311.47 million (Mathur and Sharma 1974). Kunen (1994) estimated that the losses due to brucellosis cost India at least Rs 350 million annually in terms of food animals and man-days of labour lost. Human brucellosis causing physical incapacity and loss of 3 million man days of labour annually and it is estimated that 5 lakhs new human cases are affected annually in the world.

Prevention and control

Prevention of human brucellosis is dependent primarily on eradication or control of animal brucellosis by vaccination or culling, practice of hygienic measures by those at occupational risk and pasteurization or proper heating of milk produce before consumption.

Control of animal brucellosis is dependent on two main principles:

(a) *Prevention of exposure of animals* to infection by preventing free grazing and movement along with frequent mixing of flocks of sheep and goats, unrestricted trade, use of local cattle yards and fairs for trading, sending dry animals back to villages for maintenance, use of semen from unscreened bulls for artificial insemination and poor farm hygiene which contribute to the high prevalence and wide distribution of brucellosis in animals in India.

(b) *Elimination of infected animals from the herd.*

Detection of truly infected animals assumes paramount importance in any brucellosis control programme. The campaign is easy to operate with high success in small farms with control over movement of animals. A test and slaughter of infected animals or extensive vaccination with approved vaccine, depending on the situation, may be used. This requires a quick, cheap and reasonably sensitive screening test besides a good confirmatory test. In cattle, RBPT is used as screen test followed by testing positive sera with CFT for confirmation. The milk ring test (MRT) could be used for identifying infected dairy herd with good results followed by sero-testing individual animals. Its major drawbacks are that this cannot be used on dry animals and its efficacy is doubtful in sheep and goats.

Mass immunization in cattle: At present, mass immunization with recommended doses of approved vaccines is the only way to bring down the incidence of brucellosis in areas with high prevalence. For cattle, B. abortus S-19, a live attenuated vaccine, given at the age of 3 to 6 months (in certain cases up to 8 months) is recommended. In spite of certain drawbacks, it is used 80% of cases with satisfactory results. When used routinely to attain coverage of population, there is a gradual decline in incidence leading to herd immunity. Where eradication is the aim, vaccination should be stopped once the incidence falls below 0.2% and the infected animals must be eliminated.

Control in sheep and goat: The epidemiology and planning for prevention and control of brucellosis in sheep and goats are similar to that of cattle with minor adjustments. A live attenuated Brucella vaccine based on a smooth variant of *B. melitensis* Rev-1 appears to be highly effective and is widely used to vaccinate small ruminants in parts of the world where *B. melitensis* is enzootic. Immunization of young recently weaned rams (weaner rams) with the *B. melitensis* Rev-1 vaccine is also recommended for control of *B. ovis* in some countries. Like the strain 19 vaccine, this vaccine, too, causes abortions in pregnant animals and short-term shedding of the Rev-1 strain in milk leading to human infections with *B. melitensis* Rev-1. The probability of success in flocks where contact with other flocks is frequent remains poor. Under such circumstances, all the animals coming in contact should be tested.

Control in swine: In swine, control of brucellosis poses difficulty because there is neither a satisfactory test to identify infected individual animal nor a satisfactory vaccine. It is, therefore, advisable to slaughter the herd.

Control in wild animals: Control of brucellosis in wildlife animals has proved more challenging, which has been much complicated by the movement to protect animal biodiversity. In USA, brucellosis control in elk and bison in the Greater Yellowstone Area currently calls for surveillance and removal of seropositive animals from some populations as well as management actions to limit contact between bison and cattle in selected locations. Because transmission is increased among populations that access elk in winter feeding areas, some authorities have proposed discontinuation of winter feeding programs. Experimental vaccination did not prove effective in feral swine or elk (Olsen *et al*. 2006) with variable results in bison. A bigger challenge for brucellosis control in wildlife and feral domestic animals, even an effective vaccine is developed, could be effective vaccine delivery systems for these animals.

Although advances in vaccine safety have been made, even the current animal vaccines possess certain drawbacks such as these are capable of causing both abortion among pregnant vaccinates and persistent infection among vaccinates with the vaccine strain. Thus, development of new vaccine(s) or improvements in existing vaccines, including expansion for use in more animal species, and efficacy against more of the pathogenic *Brucella* spp. are needed.

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Role of extension education in control of zoonotic diseases

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Extension education is non-formal type of education in which the educational efforts are made beyond the limit of four walls with the aim to change the skill, knowledge and attitude of farmers and public. Those infections and diseases that are transmitted between vertebrate animals and humans are called zoonotic disease. In veterinary science, extension education play vital role in many ways for control of zoonotic diseases as explained below.

Participation in disease surveillance: In control of zoonotic diseases like Rabies, Listeriosis, Tuberculosis, Brucellosis etc. extension education can play indirect role in observation and collection of baseline information from zoonotic disease affected areas. The zoonotic disease related preliminary information could be collected by extension personnel from a particular area through various social groups, organizations, leaders, etc. After collection of first hand information on the basis of samples and disease symptoms, extension wing has to confirm from diagnostic labs regarding kind of zoonotic disease occurred which help in performing extension efforts in disaster management. During extension work, social communication with community leaders, progressive farmers, working organizations or any other interested social groups should be extended to get their support. The credibility of extension wing also depends upon type of inter-mediatory role played in reverse communication from laboratory to field. Zoonotic disease surveillance management could be correlated with proper planning and implementation of zoonotic disease control programme through extension education.

Diseases record management: In disease record management process, extension wing should maintain record of zoonotic disease incidences in local area and presented in a graphical and numerical form which could be easy for observers, readers and administrators. The data base system could be utilized for prediction of disease prevalence in the particular areas for advance communication of govt. as well as media and public. Computerized disease record management system helps to link disease monitoring and surveillance programme implemented at state or national level.

Reporting system: While executing extension work for control of zoonotic diseases, it is need to update higher office with documentary proofs. Reporting system enhances the sharing of responsibility which initiates from higher office in terms of planning of extension programmes for particular area. Administrative communication also helps to make disaster management efforts in critical situations. After diagnostically confirmation of zoonotic disease incidences with the help of pathology laboratory reports, it is essential to make administrative communication in terms of advisory and circular letters to stakeholders regarding the consequences of impact of diseases and need of adoption of control practices by them. During extension education work, documentation is very important at grass root level.

Experts' counseling: The counseling of technical experts in veterinary public health and in allied subjects play a key role in identifying cause public health diseases. Expert's counseling to public, farmers, management bodies, govt. officials, policy makers and leaders may have better results in programme planning for control of zoonotic diseases in multitier system in panchayat raj. Expert's counseling creates multi-dimensional approach for its better co-ordination with allied branches to minimize various consequences of zoonotic diseases. Expert's counseling helps for better interaction with stakeholders through advance communication to all concerned.

Organizing extension education programmes: At local level, the extension educational programmes on zoonotic disease control should be organized for better communication of public and farmers. While organizing such kind of programmes, it should be properly planned for achieving its objectives of programme. In planned extension programme for control of zoonotic diseases, collection of facts, figures and analysis of existing situation, problem identification and deciding objectives are important parts of programme. Whereas, proper execution of programme, monitoring and evaluation during work and reconsideration are crucial parts included in implementation process of extension programme planning awareness rallies, awareness week, community based educational programmes, disease testing camps, treatment camps, food safety programmes, environmental health programmes could be useful in organizing extension programmes for zoonotic disease control.

Extension approaches for public participation: Extension programme having participation of public creates more impact on control of zoonotic diseases. To increase participation of people, the extension approach should be applied from the initial stages of involvement of extension workers in extension educational work. Rapid Rural Appraisal and Participatory Rural Appraisal like approaches should be used for collection of facts from the field as well as to create linkages in the field for continuing further extension programmes. Participation of people in extension programme shows impact of inputs given in extension educational programme. Community based Focused Group discussions are better way for participation public in extension programme. Participation of people could be increased by identifying leaders in social groups.

Public communication networking: Communication networking is vital part of extension system. If public communication networking works properly for delivering messages, then it may reduce the public panic in disaster conditions especially in animal health. Public communication networking could be made through personal, group and mass contacts like television, radio, mobiles, internet, distance learning and mass meetings etc. Public communications have more importance of seasonal change and disaster time. While preparation of message for the communication of control of zoonotic diseases, it should prepared with positive attitude. The ambiguous words in messages could be avoided. The communication media should be used according to socio-economic-education situational background of public.

Preparation of communication materials: Literatures comprise of written messages having reliability and authenticity in reference to subject and organization from where it is produced. Literatures could be served with certain message at any time in absence of expert also. The clear understandable messages in literature itself speak with readers just like a speaker. If literatures are distributed in the meetings or workshops in the presence of expert, then it has more credibility for communication. In extension, literatures are mainly used as leaflet, folder, pamphlet etc. Leaflet is a single sheet of paper printed on one or both the side. The information is presented on only one topic in a concise manner with simple language. For campaigning, illustration of prominent disease symptom may have better impact in communication. Folder is a single sheet of paper folded once or twice when it is opened the message is presented in sequence. Folder can be made attractive by inserting photographs and preparing small meaningful sentences. It is having more credibility in group meetings. Pamphlet contains 2-12 pages and first cover page is printed in multicolor with some action picture. Circular and advisory letters are also more important literatures used in extension work to communicate people before organizing any extension campaign. Circular letter is quick and cheap in communication of information to more number of people within short period of time. These literatures are used Advisory letters are generally written to advice farmers and public which contain preliminary information on any aspects like prevention and control practices of zoonotic diseases. Advisory letter has prime importance of season and time. Audio-visual productions like CDs are important tool to disseminate messages for public awareness.

Training of local grass root level organizations: Extension education is non-formal type of education which is to be carried beyond the limit of four walls. Grass root level organizations like social organizations (NGOs), co-operative organizations, youth clubs, mahila mandals and SHGs are functional and closely attached to local public and farmers, having potential human resources in terms of delivering the messages for the local public and control over their sentiments. Hence, it is essential to select important human resources of the various grass root level organizations for training on prevention and control of zoonotic diseases by adopting hygiene management practices, quarantine and isolation practices, bio-security management etc.

Training of extension workers: In the livestock sector, Veterinary Officers and para-vets are important human resources to carry information to public and work in the areas of control of zoonotic diseases. Due to advance research and development of new technologies in the field of veterinary sciences, this manpower should remain update for effective handling of field problems. This manpower is very important in disaster management to control public health diseases and its panic in public. Training of extension workers from the experts of veterinary public health or related subjects could be more beneficial to refresh skill and knowledge as well as to gain need based information. The training should be facilitated by distributing literatures on the concerned topics on hygiene management practices, quarantine and isolation practices, bio-security management and use of inexpensive vaccines, improvement in diagnostic skills etc.

Organizing scientific gathering: The scientific gatherings like conferences and workshops on control of zoonotic diseases should be organized for communication of scientists and other related stakeholders in livestock sector. These gatherings have importance of discussing the problems related issues for its better solution. While organizing scientific gatherings, the proceedings of meetings should be maintained properly and important decisions should be communicated to higher authorities or govt. officials.

Monitoring and evaluation: During zoonotic disease outbreaks, monitoring of farms, abattoirs, dairies, butcheries, homes, livestock trade areas etc. are important for investigation of epidemiological disease incidences for its control. In another way, monitoring and evaluation are the prime steps in programme implementation process while organizing extension campaign. The evaluation is made weekly, fortnightly, monthly or depends upon the planned schedule of various activities of programme. Monitoring and evaluation of human, financial, administrative, communication resources applied in the workable plan help to minimize the gap between what is present and what is to be done in reference to framed objectives. Monitoring and evaluation requires various skills to collect the data of first hand information from field which should have more reliability and validity for drawing proper conclusion at particular situation.

Zoonotic diseases could be better controlled by use of effective extension educational methods with proper planning in organizing extension programmes in the field with multidisciplinary extension approach.

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Zooanthropophillic ticks and their role in zoonotic disease transmission

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Ticks are obligate hematophagous arthropods that parasitize every class of vertebrates including human beings in almost every region of the world. On a Global basis, ticks are second to mosquitoes as vector of infectious pathogen to human and they form the most important group of arthropods to transfer pathogens from one animal to another (Jongejan and Uilenberg, 2004). Tick transmits numerous protozoan, viral, bacterial including rickettsiale, fungal and even filarial pathogens. Moreover, ticks can cause severe toxic conditions leading to irritation and allergy and paralysis in the host. Tick and tick-borne disease (TTBD) are ranked high in term of their impact on livelihood resources of poor farming communities in developing countries including India. As per the estimates of FAO/OIE/WHO (1994) about 80% of the world cattle population are at the risk of TTBDs and both of which can decrease the economic performances of the livestock significantly (Jongejan and Uilenberg, 2004) by reducing weight gain, milk yield and fertility besides diminishing the value of skin and hides by 20-30%.

Ticks belong to the class Arachnids, subclass *Acari* and suborder *Ixodida*. The Ixodida was further classified into two major families of ticks, the *Argasidae* (soft ticks) and the *Ixodidae* (hard ticks). *Nuttalliellidae*, a third family of ticks, also exists, but consists of just one species. There are 683 recognized species of hard ticks representing nearly 80% of all tick species (Mullen and Durden, 2009).

Ticks of Medical-Veterinary importance

In general, ticks are not very much host-specific although some species or certain instars of a species show a particular preference for certain host species or there may be a definite adaptation to certain hosts (Soulsby, 1982).

Ticks are of public health significance mainly because of the zoonotic disease agents transmitted by them, which include an array of bacterial, viral, protozoan disease agents (Table 1). They also are important because their attachment can cause various kinds of dermatoses or skin disorders such as inflammation, pain and swelling. Certain species of ticks may cause a flaccid ascending and sometime fatal paralysis known as tick paralysis. Individuals bitten repeatedly by some ticks may develop allergic or even anaphylactic reaction. Some of the ticks which are important for both medical and veterinary point of view are described here.

Rhipicephalus sanguineus is also known as brown dog tick. Though, the primary host of this tick is dog, many a times it feeds on wide range of wildlife and also attacks human beings. In human, this species is acts as the vector of *Rickettsia conorii* (cause Boutonneuse fever) and recently also implicated as the vector of *R. rickettsii.* In animals, this tick is a vector for the agents of canine ehrlichiosis (*Ehrlichia canis*) and canine babesiosis (*Babesia canis vogeli* and *B. gibsoni*).

Haemaphysalis contains numerous species that attacks mammals and birds. In India, an important species of this genus is *H. spinigera*, which occur in dense forest habitat. Larvae feed on small mammals and ground-feeding birds, but nymphs and adults attack larger animals including monkeys, cattle and even humans. This tick is the principal vector for the virus that causes Kyasanur Forest disease (KFD). Kyasanur Forest disease (KFD), a tick-borne viral disease, was first recognized in 1957 in Shimoga District, India, when an outbreak in monkeys in Kyasanur Forest was followed by an outbreak of hemorrhagic febrile illness in humans. KFD is unique to 5 districts (Shimoga, Chikkamagalore, Uttara Kannada, Dakshina Kannada, and Udupi) of Karnataka State and occurs as seasonal outbreaks since then (Kasabi *et al*., 2013).

Table: Tick and Tick-borne diseases of zoonotic importance

S.No.	Primary Tick Vector	Pathogenic agents	Name of disease in humans	Hosts affected, besides human
1.	*Ixodes scapularis*, *I. ricinus*	*Babesia microti*, *B. divergens*, *B. duncani*, *B. venatorum*	Human babesiosis	Mice, Cattle
2.	*I. ricinus*, *I. persulcatus*	*Flavivirus*	Tick-borne encephalitis	Rodents, Insectivores, Carnivorous
3.	*I. scapularis*, *I. pacificus*, *I. ricinus*, *I. persulcatus and others*	*Anaplasma phagocytophilum*, *Borrelia burgdorferi*, *B. afzelii*, *B. garinii*	Human Anaplasmosis and Lyme disease	Rodents deer, dogs, Mammals and Birds
4.	*I. holocyclus*, *I.rubicundus*, *Dermacentor variabilis*, *D. andersoni*	Tick protein	Tick paralysis	Cattle, Sheep, dogs, birds and other mammals
5.	*Ixodes*, *Dermacentor* and *Haemaphysalis spp.*	*Flavivirus*	Powassan encephalitis	Rodents, carnivores hares,
6.	*Haemaphysalis spinigera*	*Flavivirus*	Kyasanur Forest disease (KFD)	Monkey, small mammals, carnivores, birds, cattle
7.	*Demacentor andersoni*	*Coltivirus*	Colorado tick fever	rodents, carnivores
8.	*Hyalomma maginatum marginatum*, *H. m. rufipes*	*Nairovirus*	CCHF	Hares, hedgehogs, small mammals
9.	*Dermacentor variabilis*, *D. andersoni*	*Rickettsia rickettsii*	Rocky Mountain spotted fever	Small mammals, carnivores
10.	*Rhipicephalus sanguineus*, *Dermacentor marginatum*, *D. reticulatus*	*Rickettsia conorii*	Boutonneuse fever	Small mammals, hedgehogs, dogs
11.	*Amblyomma* spp.	*Rickettsia africae*	African tick bite fever	Small and large mammals
12.	*Amblyomma americanum*	*Ehrlichia chaffensis*, *E. ewingii*	Human ehrlichiosis	Deer, dogs
13.	Many tick spp.	*Coxiella burnetii*	Q fever	Livestock
14.	*Ornithodoros* spp.	*Borrelia* spp.	Tick-borne relapsing fever	Various mammals

15.	Many tick spp.	*Francisella tularensis*	Tularemia	Lagomorphs, rodents, carnivores
16.	*Argas reflexus, Ornithodoros coriaceus, Ixodes pacificus,* others	Tick protein	Tick-bite allergies	Mammals

Dermacentor viriabilis (American dog tick) is a major pest of people and domestic animals in much of United States (US) and some part of Canada. Larvae and nymphs feed on small mammals but adult attacks dogs, livestock, other medium size mammals and humans. This tick is major vector of *Rickettsis rickttsii* in US cause Rocky Mountain spotted fever. It also transmits the agent of tularaemia and anaplasmosis and cause tick paralysis in dogs and humans.

Dermacentor andersoni is another important pest attacking humans, livestock and wildlife in US. Adults and nymphs attacks to medium to large size mammals, whereas larvae attack small mammals. This acts as the vector of *R. rickettsii* and Colorado tick fever virus. It also transmits *Anaplasma marginale* in domestic animals. It is also a causative agent for tick paralysis in both human and animals.

Ixodes scapularis (Black legged tick) is distributed throughout US. The immature stages usually feed on small mammals, lizards and birds whereas adults are most common on white tailed deer. All stages of *I. scapularis* will bite humans. It is the primary vector of Lyme disease spirochete *Borrelia burgdorferi*, the protozoan *Babesis microti* that cause human babesiosis and *Anaplasma phagocytophilum* the agent of human granulocytic anaplasmosis.

I. pacificus is another *Ixodes* species who feeds on human and transmit *Borrelia burgdorferi* and *A. phagocytophilum*. Like, *I. scapularis*, nymphal ticks are most apt to transmit *B. burgdorferi* to people. Human bitten repeatedly by this tick may develop severe allergic hypersensitivity reaction.

In Europe, *I. ricinus* is a major pest of livestock and humans. Larvae and nymphs attack mostly small mammals, insectivores, birds and lizards. Adults are found most commonly on sheep, other domestic ruminants and deer. However this tick may attack virtually any vertebrate including humans. In human it acts as a vector of *Borrelia burgdorferi, B. garinii, B. afzelius* (Lyme disease), Tick-borne Encephalitis virus, *A. phagocytophilum* and *Babesia divergence*.

Ixodes persulcatus is another major vector of human pathogens including borreliae, *A. phagocytophilum* and Tick-borne Encephalitis virus. Here, the adult female, not the nymph, serves as the primary vector of zoonotic pathogens to people.

In Australia *I. holocyclus* is prevalent species which feed on most wild mammals, domestic animals and humans. *I. holocyclus* causes tick paralysis which may be fatal.

Hyalomma genus having many species of ticks which transmit disease to human and animals. *Hyalomma anatolicum anatolicum* is the important tick vector in India, who transmits *Theileria annulata* (tropical bovine theileriosis) in livestock. This tick also bites to human especially to livestock owner and farm workers where prevalence of the species is very high (author personal experience). Another tick species is *Hyalomma marginatum* found mainly in Mediterranean basin and part of former USSR. Adults tick attack larger mammals including humans. This tick is implicated as most important vectors of Crimean-Congo haemorrhagic Fever (CCHF) virus which cause no clinical symptoms in animals but fatal disease in human beings. In India, the outbreak of this disease occurs recently in people of Gujarat sates (Mourya *et al*., 2012; Mishra *et al*., 2011).

Amblyomma americanum (Lone star tick) is the most notorious pest species in US. *A. americanum* larvae, nymphs and adults readily attack humans, companion animals and livestock as well as wildlife. It has been implicated as a vector of the agents that cause human ehrlichiosis (*Ehrlichia chaffeensis* and *E. ewingii*) and tularaemia (*Francisella tularensis*). *A. maculatum* is the species who accidentally feeds on humans and transmit *Reckettsia parkeri*. Other species like *A. hebraeum* and *A. variegatum* found in Africa, bite to human and transmits *Reckettsia africae* (African tick bite fever).

Among the Argasidae (soft tick), *Argas persicus* which is mainly feeds on poultry, accidentally attacks humans too. *Ornithodoros moubata* bits to human. It is the major vector for relapsing fever spirochete *Borrelia duttonii*. *O. savignyi* is a major pest of camels, other domestic animals and humans. Its bite is very painful and cause itching which remains for long periods. *Otobius megnini*, also found in India, frequently infest livestock, other domestic animals, wild ruminants and even humans.

Carios kelleyi is the bat ticks found in US, has been shown to feed occasionally on humans in bat infested house. An erythematous skin rash, presumably due to a reaction to bite may occur (Gill *et al*., 2004).

Prevention and Control

Historically, control of ticks and tick-borne diseases almost always was accomplished with pesticides to kill the ticks and drugs to kill the infectious agents. Treatment with acaricides still provides the most widely used means to control/prevent tick attack. Promising alternatives such as vaccines or pheromone-acaricidal treatments are under investigation.

Personal protection

Preventive measures are the most effective means for protecting persons who enter tick-infested habitats.

- People should wear boots, socks, long trousers and light coloured clothing.
- Trousers should be tucked into the boots, socks drawn over trousers and socks taped to form a light seal.
- The clothing should be treated with a repellent or acaricides. It is now possible to obtain clothing permanently impregnated with permethrin that remains efficacious for the life of the garments despite repeated washing (Faulde and Uedelhoven 2006). A recent study showed that wearing protective clothing was 40% effective in preventing Lyme disease.
- Exposed skin should be treated with repellents or acaricides suitable for use on humans.
- Each person should conduct self-examination for ticks during and after exposure to tick infested areas. Ticks should be removed by grasping the capitulum as close to the skin as possible with a pair of fine forceps and gently pulling the tick with a slow steady force until it mouth parts release their hold. Turning or twisting the tick should be avoided to prevent the hypostome breaking off in the wounds.

Note: Most widely used repellent DEET available as a lotion or a spray. Permethrin should not apply to bare skin. Repeated application of tick repellents/acaricides in child may cause adverse reaction. Picaridin and Oil of eucalyptus are also used as tick repellents.

Other methods which are used to control the tick populations on animals and its habitats:

1. Acaricides
2. Pheramone-assisted control
3. Passive treatment by self-treating device
4. Hormone-assisted control
5. Vaccines
6. Management –integrated pest management.

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The greatness of a nation and its moral progress can be judged by the way its animals are treated

Mahatma Gandhi

An overview on zoonotic diseases of equine

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Relationship among men and equines exists since antiquity and is evident from variety of roles equines play in the mechanized world, including agriculture. In India, it is significant in mountainous and arid terrains, where approach through roads is not possible. Because of intricate co-existence, zoonoses find a position in India, which has a paradoxical situation to deal with. On one hand, age-old diseases affect indigenous equines and may act as a potential source of infection to elite horses while on the other hand, germplasm of exotic origin pose the danger of the ingress of exotic diseases to indigenous equids. This situation is not known in any developed part of the world. Further, army is maintaining equines for transport of logistics especially in difficult hilly terrain and a perceptible threat is always there for its eruption in indigenous population.

Zoonoses are those diseases and infections which are naturally transmitted between vertebrate animals and man. The basic assumptions in this definition include (i) the diseases are shared by man and animals, (ii) the sharing is bi-directional and (iii) the sharing occurs under natural conditions and is not based on experimental evidence. The 'One Health' concept involving a convergence of animal, human and environment is gaining momentum now-a-days, wherein management of zoonoses and cross-species diseases has assumed central position.

Over the last several decades, there is one new emerging disease every year on an average of which approximately 75% are zoonotic in nature (Manojkumar and Mrudula, 2006). The emergence and re-emergence of zoonotic diseases poses a great threat to veterinarians, public health professionals and general public. Certain individuals are at higher risk of zoonotic diseases including pregnant women, infants and children, immune compromised persons, elderly persons, individuals under stress of antibiotic therapy, veterinarians, animal handlers and animal health workers. To safeguard the public health from pathogens of zoonotic infections, application of skills, knowledge and resources of veterinary public health is essential.

Table: List of some important equine related zoonoses

Disease	Etiological agent	Reservoir	Zoonosis type/ transmission	Symptoms	Distribution
Japanese encephalitis	Flavivirus	Cattle, horse, swine, birds	Meta/ mosquito bite	Horses: No apparent disease, death Human: encephalitis	Asia, Australia
Equine encephalitis virus complex (EEE, VEE)	Togavirus	Horses, mules, donkeys, wild birds, fowl	Meta/ mosquito bite	Horses: No apparent disease, encephalitis, death Human: encephalitis, encephalomyelitis	USA, Carribean island
Rabies	Rhabdovirus	Mammals	Direct/ animal bite	Horses: paralytic or dumb form Human: excitation, paralysis, death	Worldwide

Hendravirus	Paramyxo virus	Fruit bats	Direct/ ingestion	Horses: Acute respiratory syndrome, death in 1-3 days Human: flu like symptoms progressing to pneumonitis, renal failure and cardiac arrest in acute form and meningoencephalitis in chronic form	Australia
Glanders	*Burkholderia mallei*	Horses, mules, donkeys	Direct/ contact/ ingestion/ inhalation	Horses: pulmonary, nasal, cutaneous or mixed form Human: Granulomatous to pustular lesions, septicemia	Asia, Mediterranean
Salmonellosis	Salmonellae (non-typhoidal)	Fowl, swine, sheep horses, dogs, cats, rodents, reptiles, birds, cattle	Direct/ ingestion	Horses: enteritis, septicemia Human: gastroenteritis, focal infection, septicemia	Worldwide
CDAD	*Clostridium difficile*	Multiple species	Direct/ ingestion	Horses: colitis, diarrhoea Human: Acute diarrhoea	Widespread
Leptospirosis	*Leptospira interrogans*	Cattle, buffalo, horse, dog, swine, rodents, sheep, goat, wild animals	Direct/ ingestion	Horses: Fever, icterus, conjunctivitis, recurrent uveitis, abortions, stillbirths Human: headache, muscular pain, vomiting; neurologic, respiratory, cardiac, gastrointestinal manifestations	Widespread
Anthrax	*Bacillus anthracis*	Cattle, sheep, other animals	Direct/ ingestion/ inhalation/insect bite	Horses: fever, colic, dyspnea, subcutaneous oedema, sudden death. Human: cutaneous, pulmonary, gastrointestinal forms.	Worldwide
Rhodococcosis	*Rhodococcus equi*	Horses	Direct/ ingestion/ inhalation	Horses: Bronchopneumonia, enteritis, arthritis, death in young foals Human: Pneumonia	Widespread
Brucellosis	*Brucella* spp	Goats, cattle, pigs, seal	Direct/ ingestion/ inhalation/insect bite	Horses: fistulous withers, poll evil Human: non-specific to undulant fever, malaise, arthritis, bacterimia, orchiepididymitis	Worldwide
Dermatophytosis (ringworm)	*Microsporum, Trichophyton* spp	Cattle, sheep, goat, dog,	Direct/ contact	Horses: Mild to severe mimicking pemphigus foliaceus	Widespread

		cat, birds, horses		Human: Ring form skin lesions	
Cryptococcosis	*Cryptococcus neoformans*	Cattle, horses, sheep, goats, cat, pigeon, other animals	Sapro/ inhalation	Mainly respiratory but may be variable	Widesprea d
Cryptosporidio -sis	*Cryptosporidi um parvum*	Calves, lambs, foals, birds	Direct/ ingestion	Horses: enteritis, diarrhoea Human: Profuse watery diarrhoea	Widesprea d

Bacterial Zoonoses

Glanders

Glanders is a fatal infectious disease of horses, donkeys, and mules caused by *Burkholderia mallei.* In last two decades, the occurrence of outbreaks amongst equines is steadily increasing and thus is currently considered as a re-emerging disease (Wittig *et al*., 2006). In India, the disease has re-emerged in several parts of the country during recent years (Malik *et al*., 2009). Glanders is commonly manifested in three forms namely pulmonary, nasal and cutaneous glanders or Farcy. These forms are not clearly distinct in most outbreaks, and may occur simultaneously. Chronic forms are more common though, the acute form typically progresses to death within about a week. The acute form is more common in donkeys and mules than in horses. Many cases of glanders are latent and clinically asymptomatic.

Respiratory tract discharges and skin are potent source of disease transmission. Animals to animals and animals to man transmission are by inhalation, ingestion of contaminated material or through skin abrasions. It is easily transmitted to humans, with 95% case fatality. All infected infected material must be handled in the laboratory under conditions of strict biocontainment. Glanders has been eradicated from many countries by statutory testing, elimination of infected animals, and import restrictions. The disease is still prevalent in Eastern European, Asian and African countries (Al-Ani and Robertson, 2007).

Organisms are Gram-negative nonsporulating, nonencapsulated, nonmotile,aerobic rods. Media containing glycerol augment their growth. Guinea-pigs are highly susceptible, and are used for testing of infected material. Intraperitoneal injections are given to attempt to elicit the Strauss reaction.

The mallein test is a sensitive and specific clinical test for diagnosis of glanders, where mullein PPD is inoculated intradermopalpebrally and a delayed hypersensitivity reaction is indicative of the presence of the disease. The complement fixation test is the most accurate and reliable laboratory test available. Many other tests are now being used including ELISA and PCR. The close genetic relationship between *B. mallei* and *B. pseudomallei*, together with the high genetic variability of *B. pseudomallei*, complicates the differentiation of these organisms by either serological or molecular tools (Godoy *et al*., 2003). No suitable vaccine is available at present (Wagg *et al*., 2006).

Anthrax

Anthrax is an acute disease of mammals, caused by a spores of *Bacillus anthracis.* This is a fatal infection which has been used as a biological weapon extensively owing to its highly pathogenic nature and efficiency of transmission. Horses are considered to be less susceptible and may show pyrexia, colic, dyspnea and subcutaneous oedema, or sudden death. In human beings, a variety of clinical forms including cutaneous, pulmonary and gastrointestinal are reported. Transmission of anthrax is through inhalation, ingestion, or contact of infective spores with abrasions (Weese, 2002). Transmission of anthrax is through spore forms. Spores are formed on exposure of vegetative form to air. Therefore the carcasses should not be opened. Dixon *et al*. (1999) have reported 95% of human beings having cutaneous form of anthrax often accompanied with a history of contact with animals or animal products. Cutaneous form of anthrax can be cured if diagnosed early and treated properly.

The handling of living organism requires physical containment and tedious in nature, thus it is essential to rely heavily on molecular tools. Standard PCR targeting *pag* and *cap* genes residing on pOX1 and pOX2 plasmids, respectively have been in use (Inoue *et al*. 2004). Daffonchio *et al*. (1999) reported that a RAPD marker specific for the *B. cereus* group was identified and the restriction enzyme analysis of this RAPD specific fragment with *Alu*I distinguished *B. anthracis* from other species of the *B. cereus* group. Ellerbrok *et al*. (2002) described that rapid and sensitive identification of pathogenic and apathogenic *B. anthracis* was carried out by real-time PCR, thus allowing confirmation or exclusion of potential attacks approximately 2-3 h after the material had arrived in the laboratory. A rapid detection protocol suitable for use by first-responders to detect anthrax spores using a low-cost, battery-powered, portable Raman spectrometer has been developed (Zhang *et al*. 2005), using surface-enhanced Raman spectroscopy (SERS) on silver film over nanosphere (AgFON) substrates.

Leptospirosis

Leptospirosis is a disease of worldwide significance that infects many domestic and wildlife animal species and humans. Leptospirosis is caused by serovars of *Leptospira interrogans*. *L. interrogans* is considered to be the most widespread zoonosis in the world.
Disease can spread between animals through contact with infected urine, contaminated water sources, food, bedding or human hands, venereal or placental transfer or bite wounds. *Leptospira* can survive in manure up to 2 months. Stagnant or slow moving water provides a suitable habitat. The organism can survive up to 20 days in water. That is why outbreaks increase during periods of flooding. Fever, shivering and muscle tenderness are among the first signs of acute infection. Rapid dehydration may develop subsequently. In subacute infections, the animal usually develops a fever, anorexia, dehydration, and increased thirst. Animals with liver involvement may develop icterus. Conjunctivitis may occur in chronic infections. Mortality in neonates and renal dysfunction in a stallion have also been encountered.

Veterinarians may contract infection through contact of mucous membranes or skin lesions with urine or tissues from an infected animal. Human leptospirosis is highly variable, ranging from asymptomatic infection to sepsis and death, though rare (Ellis, 1998). Headache, muscular pain, nausea, and vomiting are common symptoms; however, neurologic, respiratory, cardiac, ocular, and gastrointestinal manifestations can occur. Prevention involves early diagnosis, reducing contact with affected animals and the use of protective accessories (Ellis, 1998). Diagnosis of leptospirosis can be difficult and may involve antigen detection (PCR), serological evaluation, histopathological examination, culture, and dark field microscopy (Ellis, 1998).

Methicillin-Resistant *Staphylococcus aureus*

Hospital originated methicillin-resistant strains of *Staphylococcus aureus* (MRSA) are pathogens of serious concern in human and equine hospitals because of the high degree of antimicrobial resistance (Seguin *et al*., 1999) and transmission between infected horses and veterinary personnel. Although health care personnel may remain asymptomatic and transmit the organism to susceptible patients, clinical MRSA cases in human health care professionals have been reported. Personal hygiene and judicious use of antimicrobial drugs decrease the chances of acquisition of MRSA by equine veterinarians.

Diarrhoeal Diseases

Diarrhoea in horses can be of multietiologic origin including some pathogens having zoonotic potential. The identification of etiological agent is possible only in less than 50% of cases even with very sophisticated and advanced diagnostic procedures. However undiagnosed cases may be infectious and zoonotic.

Salmonellosis

Salmonellosis is one of the leading causes of bacterial enteric diseases and are associated with the consumption of animal products and fresh produce contaminated with *Salmonella* (**Foley *et al.*, 2008)**. Salmonellosis, caused by serotypes of *Salmonella enterica* sp *enterica*, affects humans, horses, most mammals and birds. Infection with a virulent, multi drug resistant strain of *S.* Typhimurium, DT104, was reported in horses (Weese *et al*., 2001), which causes high mortality in human beings. Acute toxic enterocolitis, chronic diarrhoea, pyrexia of unknown origin and septicemia may be exhibited. It occurs due to stresses like excessive traveling, shipping, training, hospitalization or antimicrobial therapy. Diagnosis is based on isolation of bacteria from faecal samples. Affected animals are considered potentially infectious since *Salmonella* are shed intermittently and therefore, repetitive negative culture testing is necessary. Faecal-oral route leads to zoonotic transmission of salmonellosis. Although relatively high number of organisms is required to cause clinical disease, antibiotic use, immunosupression or any associated disease may significantly lower the number of organisms required for causing clinical disease. Following strict personal hygiene, adopting protective measures and disinfection significantly reduces the probability of zoonotic transmission. *Salmonella* survives in environment for a long period but is susceptible to most of the common disinfectants.

***Clostridium difficile* associated diarrhea (CDAD)**

C. difficile is an anaerobic bacterium that causes colitis in horses human beings and other animals. Infection in neonatal foals is associated with necrotizing enterocolitis and horse, with typhlocolitis (Perrin *et al*., 1993). The organism is a common nosocomial pathogen in human patients and causes pseudomembranous colitis associated with antibiotic therapy.

Equine CDAD ranges from mild to per acute disease which may prove to be fatal and affects all age groups. Diagnosis of *C. difficile* is based on identification of bacterial toxins in faecal samples. *C. difficile* is an important human pathogen resulting in disease following antibiotic therapy, hospitalization or other stressful conditions. Sporicidal agents like 5-10 % bleach solution can effectively clean the contaminated areas and equipments.

Brucellosis

Brucellosis is a zoonotic disease having economic significance. Though it has been eradicated from Europe, Australia, Canada, Israel, Japan and New Zealand, yet it remains an uncontrolled problem in regions of high endemicity such as the Africa, Mediterranean, Middle East, parts of Asia and Latin America. Brucellosis organisms are small, non-motile, aerobic, facultative intracellular, Gram-negative coccobacilli.

All domestic species can be affected with brucellosis except cats which are resistant to *Brucella* infection. Horses are relatively resistant to infection; however, disease can occur and brucellosis can be transmitted from horses to humans. Considering the damage done by the infection in animals in terms of decreased milk production, abortions, weak offsprings, weight loss, infertility and lameness, it is one of the most serious and economically significant diseases of livestock. It is also a major impediment for the trade. Death may occur as a result of acute metritis, followed by retained fetal membranes.

Equine disease is commonly seen as fistulous withers and poll evil. Diagnosis is based on seropositivity because *B. abortus* is difficult to isolate. Human brucellosis is considered to be an occupational disease that mainly affects slaughterhouse workers, butchers, and veterinarians.

Transmission occurs through contact of infected animals or materials with skin abrasions. Human brucellosis can be highly variable, ranging from non-specific, flu-like symptoms to undulant fever, arthritis, and orchiepididymitis in males. The chronic form can result in fatigue, depression, and arthritis. Serologic and cultural testing should be performed in all horses with fistulous withers. Sero-conversion takes approximately 2 weeks, so repeated serologic testing of acute lesions is required. Prevention of infection involves early diagnosis, barrier precautions and careful handling of laboratory materials.

The disease is conventionally diagnosed by plate and tube agglutination tests serologically. However for rapid diagnosis several molecular tools are being applied. A Light Cycler-based real-time PCR (LC-PCR) assay has been developed by Qeipo-ortuno (2005) to evaluate its diagnostic use for the detection of Brucella DNA in serum samples.

***Rhodococcus equi* infection**

Rhodococcus equi is recognized as a pathogen in people infected with the human immunodeficiency virus (Capdevila *et al*., 1997). The role, that contact with horses plays in these cases, is not very clear.

R. equi appears to be most important among all cases of bacterial foal pneumonia between one to six months of age. *R. equi* is a pleomorphic gram positive coccobacillus ,a pathogen of macrophages. Pathology caused by *R. equi* is chronic pyogranulomatous pneumonia, foals may be presented as acute cases because the initial phase of disease often goes unnoticed. Other extrapulmonary involvements may be polysynovitis, septic arthritis, uveitis, subcutaneous abscesses, ulcerative lymphangitis, nephritis, hepatic or renal abscession. *R. equi* is found in the soil of most farms and equines can acquire the infection through inhalation. Amongst equines, morbidity rates of 5-17% with mortality rates of 40-80% was reported by Elissalde *et al*. (1980).

Farms that have endemic problems with *R. equi* are usually contaminated with a higher proportion of virulent strains (Takai *et al*.,1991). A 85 Kb plasmid was shown to be essential for virulence and containing genes for virulence associated proteins (Vap) A through H. Vap A has been proposed as a target for antibodies in diagnostic tests, besides conventional agent isolation and identification.

Viral zoonoses

Rabies

It is fatal viral disease caused by a *Lyssavirus*, causing encephalomyelitis in virtually all the warm-blooded animals, including man. The rabies in equines is difficult to diagnose because of variable clinical signs. The furious form, common in several animal species, is not common in horses. The paralytic and dumb forms are most common in horses (Green, 1997). During initial stages intense rubbing or biting of inoculation site as a result of paresthesia is seen. Other signs encountered during initial stages are lameness and colic (Green *et al*., 1992). Since rabies shows an array of symptoms in horses, this should be suspected in cases of acute encephalitis or neurological disease. Affected animal usually dies within 2-5 days after the onset of clinical signs, however it may take a longer period of up to 2 weeks in some instances.

Rabies may be ruled out during initial stages based on history, diagnostic tests for other diseases and the progression of the disease. However initially rabies must be considered and all requisite precautions must be taken. Tissues of rabies infected animal have the potential to infect with higher concentrations in the central nervous system, saliva and salivary glands. Rabies virus is most commonly transmitted through contact of saliva with broken or abraded skin and mucous membranes. Veterinarians in equine practice are less likely to suffer from this disease in comparison to those in small animal or wildlife practice.

Arboviral Encephalitidis

Several mosquito-borne arboviruses cause encephalitis in equines, which is one of the most important viral zoonosis. These are eastern (EEEV), western (WEEV) and Venezuelan equine encephalitis virus (VEEV) (Weaver *et al*, 1999). Arboviral encephalitides exhibit an array of highly variable clinical signs which simulate other causes of encephalomyelitis. Disease may be very mild or inapparent to peracute encephalomyelitis with sudden death. Human form of the disease is characterized by fever, drowsiness, paralysis, convulsions and comma. The patients recovered from the disease may suffer from mental retardation, epilepsy and blindness. WEE is relatively less severe in man. VEE causes a systemic febrile illness in man and a small proportion may develop encephalitis. VEE virus may cause abortion in pregnant women.

None of the arboviruses are directly transmissible from horses to human beings as high level of viraemia is not produced to infect mosquitoes and disseminate disease. In fact, both horses and humans are considered as dead end accidental hosts. Handling of infected carcasses may pose a risk, however, there is only a limited evidence of acquiring infection by handlers.

Hendravirus (morbillivirus) pneumonia

First report of Hendra virus (equine morbillivirus) pneumonia from Australia causing death of 14 horses and their trainer by Murray *et al*., 1995 added this dreaded infection in yet another emerging zoonosis of equine origin. Presence of antibodies in a significant percentage of fruit bats suggested that they act as reservoir hosts. It is suspected that infected urine or reproductive fluids of bats are involved in transmission, although the virus is not highly contagious.

In horses, the disease presents acute form; period from onset of signs to death is only 1–3 days. Fever, anorexia, and depression are the initial signs after an incubation period of 8–11 days with maximum of 16 days (Barclay and Paton, 2000). Signs of respiratory illness progress and thick frothy yellow nasal discharge are common characteristics in terminal stages. Differential diagnoses should be done with shipping fever, acute circulatory catastrophes, poisoning, acute bacterial infections, and intoxications such as anthrax. Serious influenza like signs predominate in human beings. Close contact between naturally affected horses is essential for transmission of disease.

Protozoal zoonoses

Cryptosporidiosis

Cryptosporidium parvum is an enteric protozoal pathogen that causes enteric disease in animals and human beings. Equine cryptosporidiosis is associated with immunodeficient animals and foals (Netherwood *et al*., 1996). *Cryptosporidium* are shed from asymptomatic horses. Infected animals shed infective oocysts. The symptom in human beings is profuse watery diarrhoea. A prolonged and potentially fatal disease may occur in immunocompromised people. Diarrheic animals are responsible for zoonotic disease because of higher rate of shedding. oocysts are susceptible to high and low temperatures but are mostly resistant to conventional disinfectants.

Giardiasis

An important intestinal protozoal disease of human beings caused by *Giardia intestinalis.* Twenty five per cent of adult horses may shed *Giardia*. In human beings the main clinical sign is varying degree of diarrhoea. Zoonotic transmission occurs by faecal-oral route.

Fungal zoonosis

Dermatophytosis

Dermatophytosis (ringworm) is a fungal skin disease caused by *Microsporum* or *Trichophyton* species. In horses, *T. equinum* is the common cause of dermatophytosis. Disease in horses can mimick pemphigus foliaceus, an autoimmune skin disorder (Stannard and White, 2002). It also affects human beings and can be transmitted through direct and indirect routes.

Ringworm infection was the most common zoonotic disease among veterinarians in Britain. Recognition and quarantine of infected animals, personal hygiene, and environmental disinfection are important for prevention of zoonotic transmission of disease. Contaminated areas or instruments should be cleaned thrice with stabilized chlorine dioxide disinfectants or a 10% bleach solution. Blankets, equipment, brushes, and other items should also be disinfected or discarded.

Parasitic zoonosis

Mange

Mange is characterized by pruritus, caused by *Sarcoptes equi*, *Psoroptes equi* and *Chorioptes bovis* var. *equi* in equines. Pruritus, raised skin tips, hairleass patches with skin folds, grey scabs and crusts, fetlock eczema and/or verrucose dermatitis are typical signs of these diseases. Eczema of fetlocks result in scab formation, skin hypertrophy and superimposed grey deposits. Human may be infected by direct contact during animal handling like grooming.

Veterinarians can play a key role in detection of emerging zoonotic diseases because of their close contact with both animals and owners. Considering the increasing concern about the use of zoonotic pathogens as bio-weapons, veterinarians may play important role in early detection of bioterrorism-associated outbreaks of zoonoses.

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Food-borne zoonoses and control strategies

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Estimates suggest that almost half of the population of the world is affected by water-borne and food-borne infections. Food-borne zoonoses are defined as 'those diseases contracted from eating foods of animal origin' such as milk, meat and eggs. This is a broad definition and covers a wide spectrum of pathogens such as bacteria, viruses, and parasites, although the most important on a day-to-day basis are mainly bacteria. Food-borne zoonoses are an important food safety issue worldwide and have also become an important cause of decreased economic productivity in both developed as well as developing countries. Rapid industrialization, change in food preferences and food habits, mass food processing and lack of effective food quality control system has led to the emergence of many food-borne pathogens. More than 250 known diseases are transmitted to humans through food.

Food producing animals (cattle, sheep, goats, pigs, chickens and turkeys) and their products are the major sources for many of zoonotic organisms, which include *Salmonella* spp., *Campylobacter* spp., *Listeria monocytogenes*, *Escherichia coli*, *Yersinia enterocolitica*, *Clostridium* spp., *Brucella* spp., *Staphylococcus aureus*, *Vibrio* spp., *Aeromonas* spp., etc. as well as food-borne viruses namely Norwalk and rotaviruses along with some food-borne parasites such as Toxoplasma, Sarcocystis, Cryptosporidium, Trichinella, Taenia, Diphylobothrium etc. These organisms can contaminate animal/poultry carcasses at slaughter or cross-contaminate other food items, leading to human illness and cause huge economic losses.

Typical transmission pathway

An animal suffering from a disease, which may not be apparent, creates a product of either milk or body tissue in which the causative organism is present. This product is either further processed or directly passed to a final consumer who then either with or without cooking eats the contaminated item, and in susceptible cases develops the disease after a variable incubation period.

Some of the important food-borne bacterial zoonoses

In many countries of the world, bacterial food-borne zoonotic infections are the most common cause of human intestinal disease. *Salmonella* and *Campylobacter* account for over 90 % of all reported cases of bacteria-related food poisoning world-wide. Poultry and poultry products have been incriminated in the majority of traceable food-borne illnesses caused by these bacteria, although all domestic livestock are reservoirs of infection. Other important bacterial zoonoses are cause by *Listeria monocytogenes*, *Escherichia coli*, *Yersinia enterocolitica*, *Clostridium* spp., *Brucella* spp., *Myocobactreium spp.,* etc. Some of these important food-borne bacterial zoonoses are described as follows:

Salmonella

Salmonella infections are prevalent all over the world among various species of domestic as well as wild animals besides poultry, ducks, birds, amphibians, reptiles and rodents. More than 2541 serovars of *Salmonella* are identified so far. Salmonellosis caused by non-typhoidal species is not only more prevalent but has also shown an increasing trend world over with majority of cases being caused by *S. Enteritidis* and *S. Typhimurium*. In India, human salmonellosis is endemic and one of the most widespread zoonosis. *Salmonella* organism has been isolated from a variety of foods including pork and pork products, beef, chevon, mutton, fish, milk and its products, fruit juice, fruits and vegetables and egg shells. Animals may be asymptomatic carriers of Salmonella. They may also suffer clinical disease with intestinal disturbance, septicaemia and death. Transmission usually follows ingestion of infected food, or direct or indirect contact with animal faecal material. In humans symptoms include sickness, diarrhoea, abdominal pain and fever. The most significant serotype in terms of mortality is *S. typhimurium* DT104, which shows a 3% mortality rate, being multi-drug resistant to many of the antibiotics.

Campylobacter

Campylobacter are a major cause of gastroenteritis throughout the world. This particular pathogen is widespread and present in many farm animals. In particular, poultry are very susceptible to heavy bacterial loading. Under normal circumstances, the animals show no sign of disease, although there have been cases of abortion in sheep being linked to *C. jejuni*. The bacterium has been isolated from pigs, birds, cattle, dogs, cats, unpasteurized milk and water supplies. Infection occurs mainly following consumption of faecal contaminated undercooked carcasses especially poultry, or of milk. The organism is capable of surviving freezing and has been shown to survive for several months in frozen poultry, minced meat and certain chilled foods. The most common symptoms of *Campylobacter* infection include diarrhoea, abdominal pain, fever, headache, nausea and vomiting. Symptoms usually start 2–5 days after infection, and last for 3–6 days. Severe complications, such as Guillain-Barre syndrome, may follow *Campylobacter* infection.

Listeria

L. monocytogenes is considered emerging because the role of food in its transmission has only recently been recognized. The disease is most often associated with consumption of foods such as soft cheese and processed meat products that are kept refrigerated for a long time because *Listeria* can grow at low temperatures. Outbreaks of listeriosis have been reported from many countries. Several outbreaks of listeriosis associated with consumption of milk and dairy products have occurred in India. It has been isolated from the milk of cow, buffalo and goat in India. It has also been reported from Seafood, beef, raw milk, vegetables and fresh raw fish. Animals can carry the bacterium without appearing ill and can contaminate foods of animal origin, such as meats and dairy products. Unpasteurised (raw) milk or milk products made from unpasteurized milk may contain the bacterium. In most cases, infection occurs following ingestion of contaminated foodstuffs. Clinical onset usually follows fever, headache, nausea and vomiting, and symptoms similar to a severe chill. Abdominal cramps, stiffness of the neck and photophobia may also be present. The condition may progress with organ involvement, including endocarditis, internal lesions, metritis, septicaemia and meningitis. Focal necrosis in the placenta may occur with spontaneous abortion, premature birth or infective transfer to the baby at birth. A fatality rate of higher than 20% of clinical cases has been seen when treatment is not made, or is not started quickly.

Escherichia coli

E. coli forms a part of most mammalian bacterial gut flora. It has a vast array of serotypes: some are benign, whereas others are dramatically pathogenic. This can vary from species to species; a benign form in one animal may be a deadly organism in another. The particular serotype of major concern is O157:H7, which was first identified as a major cause of serious outbreaks of food poisoning. This serotype is variously known as entero-haemorrhagic E. coli (EHEC), shiga toxin-producing E. coli (STEC) or verocytotoxin-producing E. coli (VTEC) O157. Many outbreaks and sporadic cases have been reported due to STEC in developed as well as developing countries. It is transmitted to humans primarily through consumption of contaminated foods, such as raw or undercooked ground meat products and raw milk. Symptoms of the diseases caused by EHEC include abdominal cramps, haemorrhagic colitis, haemolytic uraemic syndrome etc. The National *Salmonella* and *Escherichia* Centre, Kasauli conducted an epidemiological survey of *E. coli* O157 in different regions of India during the 10-year period (Seghal *et al*., 2008), in which a significantly high percentage of *E. coli* O157 was isolated from meat, milk and milk products, seafood and water.

Yersinia enterocolitica

Of the same bacterial genus as plague, it is transmitted to humans by ingestion of foods as diverse as meat (pork, beef and lamb), oysters, fish and raw milk. It causes acute-onset of gastroenteritis with diarrhoea and vomiting, marked fever and abdominal pain. The pain can be so severe that it mimics appendicitis and has also led to misdiagnosis of Crohn's disease. It is capable of producing clinical complications which include septic arthritis, colonisation of existing wounds, bacteraemia and urinary tract infections. Luckily it is rarely fatal.

Clostridium spp.

Clostridium perfringens, the causative anaerobic bacterium of many cases of gas gangrene, may also cause a food-borne disease. Widespread in the environment, and an inhabitant of the gastrointestinal tracts of humans and animals, it is often found in foodstuffs as a result of faecal contamination. As with other forms of clostridial diseases, it is the production of exotoxins by the pathogen that causes the main damage, especially where the ingested food carries a large inoculum, or heavy toxin load. The usual pattern of disease is linked to the ingestion of a number of viable *C. perfringens* organisms that may produce clinical symptoms of abdominal cramps, diarrhoea and fever.

Botulism as a complex of disease state arises from contact with *C. botulinum* or its associated neurotoxin. There are seven types of botulism toxin associated with the bacteria, designated by the letters A–G. Only the A, B, E and F toxins are known to cause illness in humans. Often associated with ducks, geese and some other types of poultry, it can also be found in cattle and horses, which can act as hosts and amplifiers for some strains. The disease usually begins 18–36 hours after the ingestion of the toxin. Early signs include gait difficulties, dysphagia and impaired vision. Respiratory distress, muscle weakness, and abdominal distension and constipation may appear progressively.

Brucella

Brucellosis is a widely prevalent and economically very important bacterial disease caused by *Brucella* species, of which *B. abortus* and *B. melitensis* are the main causes of occupational zoonosis in farmers, veterinarians and workers in meat industry. It is common in organized herds and in areas with high rainfall and humidity. Source of infection in human is through the drinking of infected raw milk or unpasteurized milk, handling of aborted foetus, fluids and foetal membranes, slaughter house workers and butchers contract infection while handling foetuses, after births or by contact with vaginal secretions, veterinarian gets infection during rectal examination without wearing gloves and while conducting post mortem examination, through skin abrasions and conjunctiva. There are losses due to abortion in the affected animal population, loss of progeny and reduced milk production. In humans disease is clinically characterized by chills, profuse sweating, weakness and fatigue, insomnia, sexual impotence, headache, arthralgia and generalized malaise, which last for weeks and months; commonly shows remissions (hence also known as undulant fever).

Mycobacterium

Tuberculosis caused by *Mycobacterium bovis* needs no introduction. Human-to-human spread of resistant serotypes of *M. tuberculosisis* now more significant than the bovine form acquired from dairy products. Ingestion and inhalation are the most common mode of transmission. Consumption of infected milk and milk products is the mode by which food borne zoonoses occur. It is a chronic disease of man and animals causing development of tubercle in vital organs. The pulmonary tuberculosis is the most common form, characterized by cough, fever, fatigue, weight loss, chest pain and night sweat in human beings.

Some of the important food-borne viral zoonoses

Numerous viruses can be found in the nature, but only a few are commonly recognised as important food borne pathogens. These can be classified into three main groups, according to the type of illness they produce:

- Viruses that cause gastroenteritis such as Norovirus, Enteric adenovirus (types 40/41), Rotavirus (group A – C), Sapovirus, Astrovirus, Coronavirus.
- Enterically transmitted hepatitis viruses (Hepatitis A and E); and
- A third group of viruses that replicate in the human intestine but cause illness after they migrate to other organs, such as the central nervous system or the liver such as Enteroviruses.

Food borne illness has been documented for most of these viruses, but recent studies show that the Noroviruses (NoV) and hepatitis A virus (HAV) are by far the most common cause of illness by this mode of transmission. Some large food borne outbreaks have occurred with group B and C, rotaviruses, and waterborne outbreaks have occurred with hepatitis E virus. These viruses are spread by the faecal-oral route, cross-contamination and infected food handlers. Rotaviruses, classified in the reoviridae family, are ubiquitous and have been isolated from a variety of mammalian species. Rotavirus has been recognized as one of the most common cause of severe gastroenteritis in a wide variety of animal species including children, calves and piglets worldwide.

Outbreaks of rotaviral gastroenteritis are frequently observed in institutional settings such as hospitals, nursing homes, day-care centers, and schools. The incidence is higher during winter season in temperate climate whereas, no seasonal variations for tropical countries. However, certain studies reported higher incidence during rainy season. In developing countries, Norwalk viruses are so common that a very high percentage of children develop immunity at an early age. Generally the illness that results from Norwalk viruses is mild and brief. Foods are contaminated with Norwalk viruses via the faecal-oral route and contaminated water. Salads, insufficiently cooked clams and oysters, ice and water are the most commonly implicated foods. Common symptoms in viral food borne zoonoses include nausea, vomiting, diarrhea, abdominal cramps, headache, fever/chills, muscle aches. Symptoms usually last 1 or 2 days. However, during that brief period, people can feel very ill and vomit, often violently and without warning, many times a day.

Some of the important food-borne parasitic zoonoses

Food-borne parasitic zoonoses cause death and serious diseases in humans and animals worldwide, and are of both public health significance and socioeconomic importance. Food borne parasitic infections have been recently identified as an important public health problem having considerable economic impact in terms of morbidity, loss of productivity and health care costs. Poor sanitation and traditional methods of food preparation accelerated the spread of food borne parasitic infections. Some of the important food-borne parasitic zoonoses are described as follows:

Toxoplasmosis

Toxoplasma gondii is possibly the most wide spread and prevalent protozoan parasite on earth, infecting approximately half a billion people. *Toxoplasma gondii* is a parasite of domestic and wild cats that potentially is capable of infecting all vertebrates. Toxoplasmosis can be transmitted to humans via several routes. Although a major source of infection is thought to result from contamination of the environment with oocysts shed in cat faeces. Transmission of *T.gondii* by ingestion of tissue cysts in raw or under cooked meat from a variety of livestock and game animals has been documented as another major source of human infection. It is characterized by retinochoroiditis and encephalitis, and abortion in pregnant women (especially at first trimester). In animals, it causes abortion especially in sheep.

Sarcocystosis

Sarcocystis spp., like *T .gondii,* is coccidian protozoan which have a global distribution. Humans acquire *S. hominis* by consumption of uncooked beef containing zoitocysts. *Sarcocystis hominis* is only mildly pathogenic in humans, causing stomach pains, nausea and diarrhoea; Sporocysts begin to be passed in the faeces after 14 to 18 days (11 to 13 days after infection with *S. suihominis*). *Sarcocystis suihominis* is acquired by eating zoitocysts in under cooked pork. *Sarcocystis suihominis* is more pathogenic than *S. hominis*, causing stomach pains, nausea, diarrhoea and dyspnoea within 24 hours of infection.

Cryptosporidiosis

Cryptosporidium spp. are spore-forming parasitic protozoans found widely in the environment in an extensive variety of foodstuffs, including salad and vegetables, raw meat and meat products, offal and milk, usually associated with contamination arising from animal faecal matter. *Cryptosporidium parvum* is considered to be a particularly significant pathogen. Calves, lambs and deer have been identified as asymptomatic animal reservoirs, capable of shedding viable organisms in their faeces. Human infection follows either direct contact with animal faeces or consumption of inadequately cleaned or cooked products. Following a pre-patent period of between 2 and 14 days and in individuals with no underlying risk factors, there is profuse self-limiting watery diarrhoea, with abdominal pain and cramps, and a low fever that may last up to 7 days.

Taeniosis or Cysticercosis

Taenia solium (tapeworm of pigs) and *T. Saginata* (tapeworm of cattle) have cosmopolitan distributions with the former being more widespread in the rural areas of Latin America, Africa and Asia. Cysticercisis is caused by the intermediate stages of the tape worms *Taenia solium* and *Taenia saginata*. It is clinically characterized by abdominal pain, anorexia, nausea, diarrhoea and constipation, loss of body weight and debility. Nervousness and insomnia may also occur. Human beings are universally susceptible to taeniosis. Infection is more common in low socio-economic group of the people. Larvae (*Cysticercus cellulosae* – measly pork) and (*Cysticercus bovis* – measly beef) fully develop in the different predilection sites, such as heart, diaphragm, internal masseter, tongue, neck, intercostals and abdominal muscles, less commonly brain, liver, lung, kidney and eye after reaching to the blood by penetrating the intestinal wall when infected eggs are consumed. This is the infective stage for human beings. Man gets infection by ingesting measly beef or pork undercooked. Cysticercosis is more serious than taeniosis in humans. It recognized as:

- **Myocysticercosis:** Muscular cramps, pain and muscle fatigue.
- **Ocular cysticercosis:** Presence of cysticerci in vitreous humor and anterior chamber of eyes leads to uveitis, iritis, retinitis and palbebral conjunctivitis.
- **Neurocysticercosis:** Signs depend on the location of the cyst found on the brain. Usually it found in the meninges, cerebral cortex and ventricles. So, symptoms of meningitis, epileptic encephalitis, headache, ataxia, nausea, vomiting and visual disturbances may be observed.

Trichinellosis

It is a type of food-borne helminthosis, caused by *Trichinella spiralis*. Trichinellosis can occur where humans eat raw or improperly cooked meat or meat products from infected pigs, wild boars, horses, walruses, dogs and many other domestic or wild mammals. Number of larvae ingested by humans determines the clinical disease. Usually 10 to 100 parasites per gram of muscle cause clinical signs. It is clinically characterized muscle soreness and pain due to irritation, enteritis, edema of upper eyelids, thirst, profuse sweating, chills and eosinophilia, and eventually, death due to myocardial and respiratory failure may occur.

Control strategies

Control of food borne disease is a multifaceted process, as there are no vaccines available for most food borne pathogens. The prevention of infection requires control measures at all stages of the food chain, from agricultural production on the farm to processing, manufacturing and preparation of foods in both commercial establishments and the domestic environment. The general strategy of control is to understand the mechanisms by which contamination and disease transmission can occur well enough to interrupt them. Increasing liberalization of trade, and increasing competition in the international market place, have meant that live animals, animal feed, food ingredients and products are now sourced on a global stage, affording the opportunity for zoonotic pathogens to be disseminated widely. The public health veterinarian needs to be proficient in setting up surveillance systems to monitor trends, establish priorities, inform policy-makers and control interventions. Understanding the likely routes of infection and the life cycle of the pathogen allows selective measures to be applied in a focused way, breaking the transmission route at its weakest point. Different basic steps to prevent the occurrence of these food borne infections are discussed below.

Step 1: Control the disease in the animals

The effective control in the food chain requires the incidence of infection in animals to be reduced. The health of consumers is inextricably linked to the health of food producing animals and the importance of herd and flock health cannot be underestimated. The incidence of zoonotic disease in animals may be reduced by the use of vaccination, clean foodstuffs and water, and good housing and husbandry practices. Overcrowded or unsanitary conditions can often lead to overt disease or unthrifty animals, requiring more therapeutic support for them to maintain sufficient health to attain slaughter weight or to continue to be productive. A reduction in infection rates has a dramatic effect on the incidence of infection further down the food or product chain. The associated lower levels of contamination produce a lower likelihood of illness.

Step 2: Reduce contamination at harvesting

When eggs are picked out, or cows milked, the application of sensible hygiene precautions is essential. Eggs should be free of droppings and cleaned and date marked. In dairies, the udder of the cow and the milking machinery should be as clean and hygienic as possible, with subsequent disinfection after each milking. Pipe work and items such as clusters should be maintained and replaced as necessary to maintain adequate operating parameters. Milk should pass to a bulk tank and be subsequently chilled rapidly for later transport and pasteurization. At abattoirs, tight veterinary inspection both pre- and post-slaughter must be practiced. Animals that display heavy faecal contamination should be cleaned or rejected. Slaughterhouse controls should prevent or reduce onward transmission into the food chain, with rejection of suspect carcasses. Prompt refrigeration of meat and careful cleaning of the carcass can reduce bacterial contamination drastically.

Step 3: Retailing controls

Disinfection of working tools and areas, along with personal and premises hygiene procedures protect consumers and workers from zoonotic infection. Sourcing products from assured suppliers, temperature and environmental monitoring, and the separation of cooked and raw products reduce the possibility of amplification and transmission of infection. The tight control of 'use-by' and 'sell-by' dates is mandatory, as is periodic inspection by public health officials, and the implementation of monitoring of refrigeration and freezer plants.

Step 4: Domestic precautions

In the home, consumers should use common-sense measures, including disinfection of surfaces and equipment, personal hygiene procedures and thorough appropriate cooking techniques. Using a refrigerator correctly and observing sell-by dates would prevent many cases of food poisoning.

There are several factors that continually contribute to the occurrence of outbreaks of food-borne disease and often several of these occur simultaneously, thus amplifying outbreaks. These factors include: contaminated raw ingredients (including water), inadequate refrigeration or storage, insufficient cooking, cross-contamination between raw and cooked food, poor personal hygiene of staff, poor general hygiene on premises, and untrained staff. Robust food safety management systems with adequate process controls are essential with good manufacturing practice and hazard analysis and critical control points (HACCP). Prior to establishing HACCP, good food hygiene standards must already be in place, particularly in the following areas:

- Infrastructural and equipment requirements.
- Food safety specifications for raw materials.
- The safe handling of food (including packaging and transport).
- Sanitation (cleaning and disinfection).
- Water quality.
- Maintenance of the cold chain.
- The health of staff.
- Personal hygiene.
- Training.
- Food waste handling.
- Pest control.

These standards are designed to control hazards in a general way and they are clearly prescribed in the Codex Alimentarius.

Conclusions

Food-borne zoonotic diseases are caused by consuming food or drinking water contaminated by pathogenic (disease-causing) micro-organisms such as bacteria and their toxins, viruses and parasites. They enter the body through the gastrointestinal tract where the first symptoms often occur. The risks of contamination are present from farm to fork and require prevention and control throughout the food chain. To protect consumers from these food-borne zoonoses, an integrated approach to food safety from the farm to the fork is needed to be adopted.

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Love of animals is a universal impulse, a common ground on which all of us may meet. By loving and understanding animals, perhaps we humans shall come to understand each other.

Dr. Louis J.Camuti

Safety issues in meat production and processing

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The present production of meat is estimated at 6.27 million tons in 2010 (FAO, 2012), which is 2.21% of the world's meat production. The contribution of meat from buffalo is about 23.33%, while cattle contributes about 17.34%, sheep 4.61%, goat 9.36%, pig 5.31%, poultry 36.68% and other species 3.37% (Thota, 2013). The meat production has increased from 764,000 tonnes in 1970-71 to 6.27 million tons in 2010. The compounded average growth rate (CAGR) during the last two decades works out to be 4.5%. It is noticed that about 10.6% cattle, 10.6% buffaloes, 24.1% sheep, 58.7% goats, 95.0% pigs and 190.0% chicken are slaughtered each year. The value of meat and by-products is Rs 79,889 crore including skin and hides, while the export value of meat and meat products work outs to be more than Rs 6,000 crore in the year 2009-10. The contribution of buffalo meat accounts for more than 75% of total exports/foreign earnings. The poultry has gaining the widely acceptance by consumers and growing 10-15% annually (B. G. Mane, 2012).

In India, there are about 4,000 registered slaughter houses with the local bodies and more than 25,000 unregistered premises, where animals are slaughtered to fulfil the demands of domestic consumers. There are about 20 integrated abattoirs-cum-meat processing plants with state-of-the-art facilities for hygienic meat production to meet the export demands (Mane, 2012).

In spite of big potential, the Indian meat industry has not taken its due share. The major constraints for the meat industry are lack of scientific approach to rearing of meat animals, unorganised nature of meat production and marketing, socio-economic taboos associated with meat eating, inadequate infrastructure facilities and poor post-harvest management. The situation is further compounded by insistence of domestic consumers to buy freshly cut meat from the wet market, rather than processed or frozen. A majority of these abattoirs have outdated, primitive slaughtering facilities, use unhygienic practices and lack of basic facilities for the production of wholesome and safe meat for domestic consumers. Further, most of the meat for domestic consumption comes from poultry, sheep and goat that are slaughtered in unorganised/unregistered premises/meat shops. Livestock development is not in coherence with the requirements of meat consumption and meat business. Productivity of meat breeds has not tapped adequately. Livestock farmers are unaware of the potential of meat business. Many middle men are involved in livestock marketing. Livestock marketing is not well organised. There is no integration of animal farming, meat producers, processors and marketing. Potentially male buffalo for meat production is not realized.

Everyone in the food production chain, 'from the stable to the table', or from pre-harvest to post-harvest, has a role and responsibility in ensuring the safety of the food supply. Producers around the world recognise that food safety begins with them and take this responsibility seriously. Regulations on food safety may not be as obvious on the farm or ranch as they are in processing plants, stores or eating establishments, but they already exist in many areas (. Joint FAO/WHO, 2003; FDA, 2004). While regulations address food safety issues by enforcing standards, producers are, in many cases, taking active steps to ensure food safety by establishing species specific programmes to deal effectively with potential concerns. The standards that govern international trade are also concerned with food safety and affect the actions of producers and food processors (Butler, 2003; Filipic, 2003; Johnson, 2001).

Existing condition of slaughter house

The existing condition in the majority of the traditionally slaughter-houses is far from satisfactory. Most of the slaughter-houses are lacking basic facilities like water, electricity, ventilation, drainage, ceramic flooring, overhead rails and waste disposal. Animals are slaughtered in traditional ways on the open ground with/without further processing or dressing on the floor/rails are the common practices in a majority of the slaughter-houses. Carcasses are exposed to heavy contamination from dung and soil. Situation is further aggravated by inadequate ante- mortem and post-mortem inspection practices. The quality of meat produced in these existing slaughterhouses is unhygienic and carries high levels of microbial contamination. Though cooking may kill many of the microorganisms in meat, cross-contamination of the products eventually occurs under the prevailing conditions of meat-handling. Enormous quantities of by-products are not utilised efficiently and economically. These existing slaughter houses are mostly under the local governmental authority and no one is bother about their 'up-gradation' and consumer/public health point of view. There is urgent need to upgrade these slaughter-houses with minimum basic facilities.

Animal welfare

The production of carcasses of high hygienic standards, safe and wholesome demands sound husbandry methods, which pay close attention to animal health as well as cleanliness in the final stages of fattening in the farm. Transport of livestock is undoubtedly the most stressful and injurious stage in the chain of operations between farm and slaughterhouse and contributes significantly to poor animal welfare, produce unhygienic meat and loss of production. It is of equal importance to keep them free from injury, stress, loss of weight and disease during the journey. For all these reasons it is essential that livestock be slaughtered as near to the point of production in order to avoid long journey. or provide sufficient rest so that the animal is physiologically settled.

However, in general a *minimum of six hours* rest for normal animal and *maximum of 24 hrs* rest for tired & agitated animals is considered ample, but it should not exceed 36 hrs. Certain animals such as young bulls and young lambs in good condition require quick slaughter particularly in cold weather on account of Hypomagnesaemic tetany and carryout ante-mortem examination of animal before slaughter. (Meat hygiene, 2009)

Slaughter Hall

All working stations in the slaughter hall should be provided with natural/artificial light of the intensity of 220 lux candles. However at the inspection point the light intensity should not be less than 540 lux. All floors in slaughter hall, work rooms and hanging rooms should be of non-slip material and the floors must have *a fall of not less than 10cms in every 6m*. A routine post mortem inspection should be carried out as soon as possible after carcass dressing is completed since the carcass sets rapidly. If the inspection is delayed the examination of carcass lymph nodes becomes difficult. Slaughter house must be provided with detained meat room and condemned meat room. Fresh meat (carcass/offal) must be chilled immediately after PM examination and kept at a constant temperature of not more than 7^oC for carcass and cuts and 3^oC for offal. The carcass must be hung in such a way so as to allow free movement of cold air around them. Continuous monitoring and recording of chillier temperature is essential. Chill doors should be made of durable, high impact material such as SS, aluminium or reinforced concrete/plastic. They may be sliding or single or double hinged and if hinged they should open outwards. Internal finishes should be durable and impervious with good insulation and floor drainages. Areas of wall where contact with carcass occurs during loading should be covered with SS or galvanized steel or Aluminium sheeting. Chillier/ freezer doors must be provided with an internal opening device to avoid personnel being closed in the room, accidentally. The fresh meat dispatch area must be sited away from the dirty part. It must be accessible to vehicles associated with transportation of meat and offal for Human Consumption (BD Sharma, 2003).

Veterinary laboratory

In the large facilities, a well-equipped lab is essential, not only for preliminary disease diagnosis of animal diseases, water analysis and antibiotic and pesticide residues but also to maintain the overall hygienic standards. These premises are often used for training of meat inspectors and other employees. (User's Manual on Codex)

Pest control

Ensuring cleanliness, absence of food scraps and the use of specialist pest control measures can control pests. For effective control of rats and mice, different bait points types are useful. Pre-digested food such as excreta and warmth attract the insects. Breeding grounds viz waste bins, stagnant ponds and sewage wastes may advent flies. Hence, plant location and design are important factors in fly control.

Personal & Personnel Hygiene

Plant layout, design and facilities in the abattoir must combine with a high standard of personal hygiene and responsibility towards cleanliness in the employees themselves.

- ➢ Periodical medical check-up of abattoir employees for certain communicable diseases which might be responsible for food poisoning / outbreaks is compulsory.
- ➢ The responsibility of meat hygiene in an abattoir rests with top management.
- ➢ All managers need to be fully familiar with current meat hygiene legislations and must be up-to-date with techniques concerned with sanitation

In this regard timely training to different level of staff members are beneficial. For operatives, training in various techniques associated with meat plant operation is essential for efficient, humane treatment of animals and for carcass meat of high quality. Besides these other training includes:

- ➢ Basis training in hygiene for freshers – include nature of hygiene, how it affects the operatives, customers and hygiene practice and regulations.
- ➢ On the job training: It can deal with use of equipment's and tools, their sterilization, protective clothing, good housekeeping, use of dressing and first aid room etc.,
- ➢ On-going Training – Creating awareness about good hygiene practices by way of posters, lectures and personal approach etc. (Public Health Training of Trainers Manual, 2012)

Important point to be consider for safe meat production

- ✓ Lairage hygiene
- ✓ Strength and time of electric current during stunning
- ✓ Stunning operation
- ✓ Temperature of knife sterilization must be 83ºC
- ✓ Efficient bleeding
- ✓ Dressed carcass must not contaminate with intestinal content
- ✓ Light intensity at inspection point, working area and other area must be maintained
- ✓ Chillier temperature must be 0.5 to 1ºC
- ✓ Carcass temperature <7ºC
- ✓ Deboning hall temperature<16ºC
- ✓ Blast freezer temperature must be upto 40ºC
- ✓ Core temperature of products must be 18ºC
- ✓ Chlorinated potable water must be used for carcass wash, hand wash and footbath.
- ✓ Cleaning of abattoir must be continuous process
- ✓ Tube light must be cover with acrylic sheath

- ✓ Use of personal protective equipment
- ✓ Implementation of food safety & HACCP system, quality management system and environmental management system.

This information makes it possible to carry out risk-based inspections, which will gradually replace traditional procedures. Emerging biological, physical and chemical hazards, as well as new technologies, mean that we cannot become complacent about inspection procedures but must continue to be alert and to keep pace with the constant changes in food safety sciences. Another new trend is the active participation of operators, who must shoulder primary responsibility in upholding the safety of the food they produce. Official veterinary inspection in the slaughterhouse plays several roles: the detection of animal diseases, the inspection of meat and meat products and the verification of audits carried out by the private sector. In recent years, the bovine spongiform encephalopathy crisis and cases of dioxin poisoning have highlighted the need for traceability of foodstuffs, i.e. giving consumers the opportunity to obtain information about the origin of their food and the different stages of its production (commonly referred to as the 'farm to fork' chain) (A. Schnöller, 2006). Finally, the slaughterhouse veterinarian, as a professional devoted to providing care to animals, is also responsible for ensuring animal welfare his is an inherent part of his professional ethics.

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Pesticide residues in foods: Significance and impact on human health

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Food is essential for life. For most Indians, the concern is not one of quality but of quantity. Because most Indians do not have enough food available to meet their needs, they can't consider a variety of factors in their food selection. These include cost, preferences, ease of preparation, time for preparation, nutrient content, and appearance. In the past, people identified risks associated with foods as a factor in selection. Recently, increased attention has been focused on chemical residues in food. The presence of minute residues of pesticides in food has caused some people to ask, "Is our food supply safe?" Current evidence strongly indicates that our food is not safe. Food and Drug Administration (FDA) officials recently stated that "pesticide residues occurring in foods".

Use of pesticides in India began in 1948 when DDT was imported for malaria control and BHC for locust control. Since then various synthetic pesticides are used for protection of crops and public health. The persistence nature of some of these pesticides led to their accumulation in animal tissues and subsequently causes human dietary exposure to these pesticides through consumption of animal products viz. meat, milk, eggs and seafoods. Scientific evidence suggest that even such low dose but long term exposure can cause serious health hazards to human health and environment as well. The reports on occurrence of pesticides residues in animal products manufactured in India are fragmentary, but provide confirmation to the fact Indian consumers do get dietary exposure to these pesticides.

Pesticides – classification by use

There is a large variety of pesticides designed to kill specific pests – those most widely used are listed below.

•**Insecticides** (for killing insects) such as organochlorines, organophosphates and carbamates. This category also includes insect repellents such as diethyltoluamide (DEET) and citronella (of natural origin).

•**Herbicides** or weedkillers (e.g. paraquat, glyphosate and propanil).

•**Fungicides** (to kill mould or fungi): when applied to wood, they are called wood preservatives.

•**Rodenticides** (to kill mice, rats, moles and other rodents).

•**Fumigants** are pesticides that exist as a gas or a vapour at room temperature and may be used as insecticides, fungicides or rodenticides, especially in closed storage places – as they kill every living organism. They are extremely toxic, due to their physical properties, rapid environmental dissemination and human or animal absorption (examples include cyanide, aluminium phosphate and methyl bromide).

•**Other pesticides** include algaecides (to kill algae), miticides (to kill moths) and acaricides (to kill ticks).

Pesticide residues

1. Insecticides may persist in house dust, in soil tracked in from outdoors, in carpets, toys, food and furniture.
2. High levels of insecticides have been measured for weeks after professional application.
3. Residues of organophosphorus insecticides sprayed in indoor environments have been reported to occur on floors, carpets, children's toys, furniture, bed covers and in dust.
4. Poor hygiene habits or houses that are difficult to clean increase the risk of exposure.

5. Playgrounds, playing fields, lawns and gardens may be routinely sprayed in order to keep insects away.
6. Pesticides are found in recreational waters (lakes, rivers and in pools (algaecides)).
7. Persistent wood preservatives such as arsenic/copper/chromium mixtures have been used on play structures.

Causes and concerns of pesticide residues

The principal sources of pesticide residues in crops, food animals, soil, water and almost all food commodities are given below (Mukherjee and Gopal, 1996):

1. Carry-over from insecticide application to soil or to growing crops
2. Leaching of pesticides (herbicides) or insecticides into ground water
3. Drift of the pesticides from adjacent field
4. Translocation of soil applied pesticide into growing crops
5. Disposal of pesticides in streams, rivers and lakes
6. Effluents of pesticide industry in rivers and streams, and into soil which may be translocated in crops

How Are Pesticides Regulated?

Any pesticide that might leave residues in a food is regulated by the Food, Drug and Cosmetic Act. Environmental Protection Agency (EPA) is acting to determine safe amounts (i.e., maximum allowable amount or tolerance) of pesticides that can remain on raw agricultural products used as food. These procedures involve the collection of scientific data to determine if any risks to human health could result from residues in the food. The potential public health and economic benefits from use of the pesticide are also determined. The benefits are weighed against the risks. When the benefits outweigh the risks, pesticide use is approved at application rates that will not create unsafe residues. When the risks outweigh the benefits, use of the pesticide is either banned or cancelled. Pesticides from raw products that carry over into processed food are considered food additives and are regulated by the 1958 Food Additives Amendment. This amendment differs from that used to regulate pesticides on raw products in that benefits are not considered if a possible risk of cancer is detected. According to the "Delaney Clause" of this amendment, no additive shall be deemed to be safe if it is found to induce cancer when ingested by man or animal, or if it is found, after tests which are appropriate for the evaluation of safety of food additives, to induce cancer in man or animals.

How Do We Know the Pesticide Residues on Food Are Below the Set Tolerance?

The FDA routinely conducts market-basket surveys nationwide. A five-year summary of the surveys, with over 88,000 food samples from supermarkets, showed that less than 1 percent of domestic produce contained illegal residues. Remember that a residue is illegal if it is over the tolerance level or is not registered for that crop. Tolerances are set well below any health effect level. The survey of 5,500 food samples in U.S. including fruits and vegetables showed that nearly 85 percent had no detectable residues whatsoever. In addition, 12 percent of the samples contained residues at less than 50 percent of the established tolerance levels. Less than 2 percent of the samples taken contained illegal residues. Serious problems can occur when pesticides are misused. Illnesses, which fortunately lasted only a short time, were reported by several people. Incidents like these, although rare, show the critical importance for users of pesticides to follow directions on the pesticide label to the letter.

FAO/WHO sets maximum residue limits (MRL's) for each pesticide. In order to achieve this there are supervised trials involving approved pesticides using "good agricultural practice" principles and data are collected on the residues. This data is then used to set MRLs. MRLs must be toxicologically acceptable in terms of estimated pesticide intake by consumers.

Mechanisms of Toxicity

Several mechanisms of toxicity have been described and these differ according to the specific properties of the pesticide.

1. Irritation is a local effect due to contact of the pesticide with the skin, eyes or other mucosa.
    i. The effects are usually redness and pain.
    ii. Respiratory irritation can produce nasal, laryngeal or pulmonary effects.
    iii. Most herbicides and fungicides are strong irritants.
2. Allergic sensitization is a common effect of pesticides, especially fungicides.
3. Enzyme inhibition (e.g. cholinesterase activity is decreased by exposure to organophosphorus compounds and carbamates).
4. Oxidative damage (e.g. paraquat is a promoter of superoxide radicals).
5. Inhibition of neurotransmission (organochlorines inhibit the GABA system and cause alteration of calcium homeostasis.
6. Uncoupling of oxidative phosphorylation (e.g. glyphosate).

Harmful effects of pesticide residues on health

Signs and symptoms are:

1. Dermal and ocular irritation (or allergic response)
2. Upper and lower respiratory tract irritation
3. Allergic responses and asthma
4. Gastrointestinal symptoms: usually vomiting, diarrhoea and abdominal pain
5. Neurological symptoms: excitatory signs in the case of exposure to organochlorines, lethargy and coma; also polyneuritis
6. Specific syndromes:
    - Cholinergic crisis (organophosphorus pesticides)
    - Bleeding (warfarin-based rodenticides)
    - Caustic lesions and pulmonary fibrosis (paraquat)

Low-Level Chronic Exposure

1. Abnormal growth and development
2. Impaired neurobehavioral development / functions
3. Cancer
4. Increased susceptibility to infections

Prenatal exposure and neurodevelopmental effects

Permanent effects on:

1. Brain structure and function
2. Neuronal and axonal differentiation
3. Serotoninergic system
4. Synaptogenesis
5. Programming of synaptic function

Neurological effects

Neurotoxins and other chemicals that originate from pesticides pose the biggest threat to the developing human brain and nervous system. This is especially dangerous for kids who may be at their critical developmental stages. Studies have been conducted using urine samples and pesticide metabolites found is implicated in the cause of certain disorders children may have. These include attention deficit hyperactivity disorder (ADHD), autism, behavioral and emotional problems, and delays in development. Epidemiological studies provide evidence for an association between Parkinson's disease and past exposure to pesticides and other putative neurotoxins depends on variability in exposure to environmental agents including pesticides.

Hormonal Disruption

The European Union has suggested that there are a number of pesticide residues found in food that can most likely cause hormone disruption in the human body. The effects of these are linked in affecting brain development as stated before as well as the development of reproductive organs.

1. Infertility
2. Low sperm count
3. Early puberty
4. Hormone-dependent cancers (testicular, breast, prostate)
5. Altered sex ratio

Immunotoxic effect

Children contaminated with chlordane and heptachlor had cytokine panel abnormalities. Infants exposed *in utero* and to breast milk contaminated with *p,p′*-DDE, hexachlorobenzene and dieldrin had an elevated risk of otitis media.

Reproductive Toxicity

Exposure to pesticides with endocrine disrupting potential raises a particular concern for male fertility because of the possible occurrence of effects at low concentrations and additive interactions with other environmental risk factors. Epidemiological studies have confirmed an increased risk of delayed conception associated with exposure to pesticides. Moreover, an increased risk of spontaneous abortion has been noted among wives of exposed workers (Petrelli & Mantovani, 2002). Birth abnormalities were reported in the offspring of registered users of pesticide as well as the general population living around agricultural areas (Garry, 1996). Studies show a stronger association between fetal death due to Health Perspective of Pesticide Exposure and Dietary Management congenital abnormalities and residential proximity to applications of pyrethroid and observed elevated risk when the exposure occurred during the third – eighth week of pregnancy (Bell *et al*., 2001).

Cytotoxic defects

The potential genetic hazard of pesticides to human beings is of great concern. Results from the biological monitoring or cytogenetic methods for the detection of health risks to pesticides have showed DNA damage in peripheral lymphocytes among workers employed in municipality. The observed DNA damage was found to be significantly lower in workers taking some of the necessary safety precautions during their work (Undeger & Basaran 2002). Malaoxon is the first and main metabolite that is more toxic than the parental compound, Malathion. Malaoxon can damage DNA in human lymphocyte, by various mechanisms including oxidative damage. Hydrogen peroxide and reactive oxygen species may be involved in the formation of DNA lesions induced by Malaoxon. Malaoxon can also methylate DNA bases. Increased chromatid breaks and chromosomal aberrations in human lymphocytes were observed in workers occupationally exposed to pesticides. Bolognesi *et al*. (2002) observed micronuclei frequency in peripheral blood lymphocytes among the farm workers, which was more evident among workers who avoided protective measures.

Diagnosis of exposure

The diagnosis is based upon the history of exposure (e.g. pesticides are available in the home, recently applied, or child was found playing with containers), signs and symptoms of exposure (see next slides) and laboratory measurements. Diagnosis also requires a high index of suspicion. Even after acute exposures, pesticide poisoning may be misdiagnosed as a viral illness (e.g. infectious diarrhoea rather than organophosphate poisoning) resulting in inadequate treatment and potentially returning children to a setting where exposure will be ongoing or recur. Pesticides and/or their metabolites can be measured in samples of blood, urine, breast milk, amniotic fluid or meconium. This can confirm the diagnosis. Laboratory tests are available to assess exposure to organophosphates, organochlorine, dicarboximide fungicides, carbamates, dipyridyl herbicides (e.g. paraquat) and pyrethroids.

Can Consumers Protect Themselves?

The best that we can hope for is to assure that a product causes no harm in every reasonable use situation. The goal of EPA is to set tolerances to limit the amount of pesticide residues that can remain in our food. Prediction of absolute exposure to pesticides and therefore potential risk is impossible, since amounts may be altered dramatically by various factors associated with storage, processing, and handling of food. Our actual exposure generally is much lower than legal safety levels or tolerances, since pesticide residues tend to break down over time and with processing and cooking. Consumers can take the following steps to reduce their potential exposure to pesticide residues in food:

1. Store in original containers with child-proof seals, out of reach, in a locked cabinet
2. Cultivating your own crops without the use or little use of pesticides or what we term organic farming.
3. Choose a variety of foods rather than a diet cantered on only a small number of foods.
4. Rinse all fruits and vegetables thoroughly in water. This surface cleaning will not remove pesticide residues taken up by the growing plant, but it will remove residues on the surface as well as any in dirt on the product. (USDA and FDA do not recommend using soap to wash food)
5. Trim the fat from meat and poultry and discard the fat in broths and pan drippings. This eliminates most residues that might concentrate in the fat.
6. Avoid fish and game from areas where pesticides have been misused or areas that are known to be contaminated.
7. Use least hazardous chemicals, least dangerous mode of application
8. Follow manufacturer's instructions
9. Use protective equipment

Toxicologists tell that pesticide residues, as a hazard in food supply, would rank lower than the following: (1) food-borne disease caused by the way food is handled or stored, (2) poor nutrition due to improper food choices, (3) environmental contaminants, and (4) naturally occurring toxicants in food. The best approach for assuring safe food is to choose a varied and balanced diet and to handle the food properly.

Many organizations (especially FAO and WHO) promote alternative non-chemical forms of pest-control and there is increasing engagement in non-pesticide dependent agriculture and integrated pest management (IPM). A variety of local initiatives involving the community can help to create an environment that promotes decreased dependence on pesticides in homes, schools, public areas, health facilities and parks.

Examples of community activities include:

1. Community campaigns and school activities
2. Local awards or contests
3. Pesticide-free "zones"
4. Support for organic farming
5. Education campaigns aimed at pesticide users, general
6. population and children
7. Restrict availability or limit use
8. Establish and monitor maximum residue limits
9. Surveillance and epidemiological vigilance for acute and Chronic related illness

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Our task must be to free ourselves...by widening our circle of compassion to embrace all living creatures and the whole of nature and its beauty.

Albert Einstein

Food safety in the era of globalisation

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The slogan "Healthy Animal, Healthy Humans" is used by the various food safety agencies in order to demonstrate the clear relationship exists between the health status of animals and that of human beings. Nutritional quality of feed and fodder is important points for a common policy in the feed industry and is the main concern for the food safety. Safety of feed is not only the element that is responsible for safety of food from animal origin, but also use of several feed supplements and additives like growth promoters, pre & probiotics, minerals, vitamins etc including drug residue.

Animal feed is a critical component of human food chain that has a direct impact on animal health, welfare and food safety. The safety of food from animal origin starts with safe animal feed. Therefore feed manufacturers, farmers, food operators and nutritionist have primary responsibility for food safety. Quality assurance and feed-food safety are therefore of paramount importance to all chance involved in the production chain.

India has the largest livestock population in the world comprising of 199, 105, 71, 140, 648 and 96 million of cattle, buffaloes, sheep, goats, poultry and broilers, respectively (DAHD, GOI, 2007), (Table 1). The efficient utilization of feed resources in the livestock and poultry and development of feed industry in the country is depending on the quality of feed and fodder. In India, livestock is primarily depending on the crop residue and agro-industrial by products i.e. crop residue forms the basal feed for cattle and buffalo.

Over the years problems such as salmonellae and other pathogenic micro-organisms in feed; aflatoxin contamination in feed affecting poultry and trout and other mycotoxin problems; contamination of feeds with pesticide residues, heavy metals, and industrial chemicals have created concern at national and international levels. Such problems can pose risks to human health and significant difficulties to trade in feed and in food derived from animals. In the past many feed components have been handled in ways that were not designed to assure the quality and safety of the final feed. Most recently the link that has been drawn between bovine spongiform encephalopathy (BSE) and feed ingredients has given additional impetus towards devising and enforcing strict quality and safety control procedures in all steps of producing, processing and utilization of feeds.

Animal feed quality comprises of two distinct components- wholesomeness and safety. Food safety, moreover, is the latest flash point on the global agenda. People in a great many countries are worried about transgenic foods, or GMOs. They worry about food additives that may be carcinogenic and about pesticide residues on fruit .Feed/food safety means a minimum or the lowest practical relevant content of undesirable /anti-nutritive substances so that it does not create health hazard to animal or to human on consuming these animal products. For, animal nutritionist, maximizing the animal production with minimum inputs remains important criterion, but now there is also a need to achieve a satisfactory balance between inputs, production, food safety and customer satisfaction.

Common adulterants in feeds and fodders:

Adulteration is defined as the admixture of a pure substance with some cheaper and low quality substance. It is done intentionally usually to get extra profit. In costly feed ingredients like oil seed cakes and feed from animal origin like fish meal, adulteration is done by spraying urea in order to raise protein content. The common contaminants of adulterant are husk, sand/ silica, dirt and saw dust. The common methods to detect these adulterants are sieving, winnowing and soaking in water. The amount of Acid Insoluble Ash is the good guide to the amount of sand or other dirt which may be present. Determination of peroxide content and free fatty acid in oily materials is indicative of rancidity and duration of storage, respectively.

Table 1: Common adulterants of different feed ingredients

Feed Ingredient	Adulterant
Groundnut cake	Groundnut husk, urea, non-edible oil cake
Mustard cake	*Argimona maxicana* seeds, urea
Soybean meal	Urea, hulls, saw dust
Deoiled rice bran, wheat bran	Ground rice husk, saw husk
Fish meal	Common salt, urea, crustaceans, feather meal, sand
Mineral mixture	Common salt, marble powder, sand, lime stone
Meat and bone meal	Sand, leather meal, blood meal, rock phosphate
Shell grit	Sand, dust
Molasses	Water
Rice broken/kani	Marble, grit
Dicalcium phosphate	Calcite powder, rock phosphate

Certain spot test can be done to identify the presence of undesirable and incriminating factors and quality of feedstuffs (Table 2). Application of spot test in feed ingredients and mixed feeds is rapid compared to elaborate chemical tests.

Table 2: Most commonly used spot test

Constituent	Test	Remarks
Thiram (pesticide in maize)	100g sample+50ml $CHCl_3$ % shake (5min.) Filter the content with Whatman filter paper1. Add few crystals of cuprous iodide to filtrate and shake.	Filtered chloroform extract turns amber to brown colour with 1-2min- indicative of thiram.
HCN in feeds	Dip filter paper into 1% picric acid solution & dry. Than dip 10% sodium carbonate solution & dry and preserve in stoppered bottle. Take test material in test tube and add few drops of $CHCl_3$ & stopper tube tightly.	The sodium picrate paper turns orange & brick red if positive for HCN.
Argimona seeds	Prepare water extract of test feed and add concentrate nitric acid	Appearance of brown-reddish colour indicates presence of Argimona seeds.
Mahua cake	To water extract of test feed add conc. H_2SO_4	Violet or pink colour- presence of Mahua cake.
Linseed meal	Test feed is treated with 1-2 drops or more of dilute H_2SO_4 in micro test tube. The mouth of test tube is covered with a disk of filter paper moistened with a drop of reagent.	Depending upon the amount of HCN produced a more or less intense blue colour appears.
Common salt	To 1g sample, add 10oml distill water, stir & filter. Add 8ml HNO_3 to filtrate	White turbidity indicates presence of salts
Leather meal	Pick up brown to black particles from sample and place on Petridish, add 3-5 drops of ammonium molybdate, stand for 5-10min.	No colour change- Leather meal; Greenish yellow colour- Meat & bone meal.
Fish meal quality (presence of NPN)	Put 2-3g of test sample in a 100ml beaker and add 10-15ml distill water & stir. After 2-3min, add 3-5frops of test extract on white porcelain plate and add 2-3 drops of mercuric-potassium iodide alkaline solution.	Heavy or orange colour indicates presence of NPN. Intensity of orange colour of precipitate depends on amount of NPN.

Decomposition test (animal & marine product)	5g test sample in 250ml flask. Prepare cork to fit 2.25" of filter paper strip pinned to bottom & moistened with saturated lead acetate. Add 50ml dilute H2SO4 (5ml acid+45ml distill water) & insert cork. Stand for 16h.	Test paper darkens quickly, if sample is badly decomposed.
Hoof or horn	Place 2-3 particles of amber colour test sample into evaporating dish, add 5ml glacial acetic acid, stand for 60min.	Test particles if hard & tough- hoof & horn; soft & swollen – gelatin.
Urease activity in soybean meal	Spread the sample uniformly on petrydish, glazed paper with white background. Spray cresol red (0.1% solution) & thymol blue(0.1% alcoholic solution) reagent mixture (80ml cresol red, 20ml glycerol/ sorbitol, 2g urea & few drops of thymol blue) & examine for colour.	Inadequate heat treatment- particles (<10%) slowly develop red colouration. Excessive heat treatment- No particles show red colouration.
Urea	Mix 10ml of indicator solution (rub 0.15g Bromothymol blue powder with 0.1N NaOH solution, make 50ml with distills water) with 10ml urease solution (0.2g urease in 10ml water) in a watch glass. Using clean tweezers, dip pieces of filter paper (No.5) in solution (to avoid uneven distribution of indicator and enzyme, wet entire paper at one time by lying in surface of solution). Allow paper to dry in place free from ammonia, strong air currents, heat. Paper should be orange when dry.	Moisten urea test paper with few drops of distill water. Sprinkle feed evenly over the paper. A dark blue colour will develop is urea is present.

Feed microscopy:

Feed microscopy is commonly used for confirming the adulteration and identifying the adulterants (AOAC, 1980) apart from physical evaluation and spot test for quick evaluation of feed quality. Feed ingredients, adulterants and contaminants must be studied under low and high magnification for distinguishing feature whether coarsely or finely ground. Physical characteristic such as shape, colour and particle size, softness, hardness and texture of the feed are examined at low magnification of 8x to 50x. It is useful method to identify impurities/ contaminants and evaluating the quality of feed ingredients. It also serves as a useful method for identifying missing ingredients in finished feed.

Feed quality either be quantity or qualitative. Qualitative feed microscopy identifies and evaluates ingredients and foreign materials, either alone or in mixtures, via surface features (stereomicroscopy) or via cellular or internal particle characteristics (compound microscopy). Quantitative microscopy is proportioned measurement of each ingredient in finished feeds or of contaminants and adulterants in ingredients. Acceptance or rejections decisions of incoming ingredients can ne dine based on microscopy. The basic equipment for feed microscopy is stereomicroscope with wide field eyepiece (magnification range 7-45 x) and zoom objective.

Animal feed safety and risk assessments:

It is important to establish guidelines that are broad enough to cover the requirements of all ingredients and are flexible enough to allow for differences in ingredient types. Safety assessments are often multifaceted.

The integrity of safe feed production chain can be threatens by wide range of substance like,

- ✓ Biological: All food pathogens like Salmonella, Clostridium, Botulism, Prions etc. (Table 5)
- ✓ Non-Biological:
  - o Chemical: Pesticide & drug residue, heavy metals, plant toxins, feed additives etc.
  - o Physical: Glass, wood, stone, plastic, metallic objects, radionuclide's etc
  - o Miscellaneous: Genetic modified crops, novel and functional foods, etc.

Table 3: Principal biological agents transmitted through animal feed

Category	Feed/ Feed ingredient	Dried/fermented forage	Pasture or grazing land	Waste food/ garbage
Infectious agents transmissible to humans from farm animals i.e., zoonoses	*Bacillus anthracis spiralis, BSE, Salmonella, E.coli, ND virus*	Toxoplasma	*Bacillus anthracis spiralis spores; Mycobacterium spp. From wild life sources; E.coli; eggs of cysticercus*	Trichinella
Infectious agent or their products which cause disease in both farm animals & humans		*Clostrodium botulinum* toxin, *Listeria monocytogens*		
Non-zoonotic infectious agents causing epidemic diseases in farm animals which may result in human hardship.	Viruses of African swine fever, foot & mouth disease & swine fever			Viruses of African swine fever, FMD & swine fever
Non- infectious agents which cause disease from farm animals & humans.	Fungal hyphae & spores causing allergic diseases	Fungal hyphae & spores causing allergic diseases		
Products of non- infectious agents which cause disease from farm animals & humans.	Mycotoxins	Mycotoxins	Mycotoxins	

(Adapted from Hinton, 2000; D'Mello, 2004)

Toxins in animal feed:

The various feed ingredients should be analyzed for the toxins present in them, which are otherwise injurious to the health of animals. The examples of toxins in the various feed and fodder are given in Table 4.

Table 4: Anti-nutritional factors in agro-industrial by product feeds

Feedstuff	Inhibitors toxin	Deactivation process
Cottonseed meal	Gossypol cyclopropene fatty acids	Adding iron salts; rupturing pigment gland
Soybean meal	Trypsin inhibitors an unidentified factor, Hemagglutinins, Goitrin	Heat; autoclaving
Linseed meal	Cyanogens, Anti-B6, Linamarin, Linatin,	Water treatment
Raw fish	Thiaminase	Heat
Lucerne meal	Saponins: pectin methyl esterase	Limit amount feed
Rapeseed and Mustard	Isothiocyanate, Thioglucoside, Goitrin Thyroactive materials	--------
Groundnut meal	Aflatoxin	Treatment with ammonia or ammonium hydroxide
Castor seed meal	Ricin, Heamagglutinin	
Peanut meal	Aflatoxin, goitrogen, Protease inhibitors, saponins	
Guar meal	Protease inhibitors	
Beet pulp	Saponins	

Sesame meal	Mineral binders	
Sunflower meal	Chlorogenic acid, tannins	Supplementing with Methyl donors (Methinine & Choline)
Safflower meal	Oxalates, Phytate in hull fraction	
Mango seed kernel	Tannins	

(Source: Benerjee, 1993)

Pesticide residue and their Effects:

Pesticides are very essential and invaluable input in modern day agriculture due to fact that pests, diseases and weed destroying 1/3rd of the crop or commodity during growth, harvesting and storage e.g. insecticides, rodenticides, herbicides and fungicides. Most of the pesticide molecule or their metabolites are xenobiotics and are reported to have toxicity related health problems like *carcinogencity, teratogenicity, mutagenicity, genotoxicity, neurotoxicity* and many other adverse effects.

The occurrence of pesticide residue in ecosystem may have a threefold impact on man, by reducing the reproductive capacity of his environment or by contamination of either his food or work environment. Man and animals are exposed to low level of pesticide residues in air, water and food chain for a prolonged period of time. *Man is the ultimate consumer of pesticide*.
Pesticides enter into the Animal Body through contaminated feed and water and skin pores when sprayed on animal body surface for killing ecto parasites.
Pesticides can be divided into three major classes.

1. Compound rapidly metabolized and excreted e.g. endosulfan, methoxychlor, chlorpyrifos, 2,4-Dichlofophenoxyacetic acid, deltamethrin, diazinon etc. The risk of residue in animal product is considered to be quite limited.
2. Compounds with detectable accumulation in the animal e.g. Chlordane, alpha hexachlorocyclohexane, lindane etc. These compounds can be found for some weeks after exposure of the animals.
3. Compounds with high accumulation e.g. DDT, dieldrin/ aldrin, endrin, hexachlorobenzene, beta hexachlorocyclohexane, heptachlor etc. These compounds can be found in animal products for weeks or months after exposure of the animals.

The risk managements for these compounds should consist of regular checking of feed ingredients from those areas in the world where these compounds are still in use.

Veterinary drugs/ feed additives:

- ⇨ Now-a-days extensive utilization of medicine in veterinary practices due to increasing intensification of animal production, the prophylactic use of drugs as a precaution against diseases, hormonal drugs to maintain reproduction, tranquillizers to reduce stress and growth promoters is increasing.
- ⇨ Typically three kinds of risks are associated with the use of antibiotics /similar compounds viz. toxicological risk of human being, allergenicity to particular drug and risk of development of resistant strain of bacteria.
- ⇨ Residues of veterinary drugs can be present in feed when ingredient of animal origin (terrestrial and aquatic) is used, but this is not very significant route of exposure.
- ⇨ It also important to take into account then illegal use of drugs in animal feed which may result in unsafe residue in meat, milk or eggs e.g. chloramphenicol/ nitrofurans in shrimps and chloramphenicol in milk powder.

- ⇨ The excessive dosages and inappropriate use of drugs and additives can pose a serious risk to public health through the development of resistances to certain antibiotics and intrinsic toxicity of certain products.
- ⇨ To check for carryover of antibiotic veterinary drugs and coccidiostats, at industry level, HPLC methods are frequently applied for their detection.

Mycotoxin residues in animal products- impact on human health:

Mycotoxins are ubiquitous and wide spread at all levels of food chain. Feedstuffs could simultaneously contain various mycotoxins from different sources of molds (Table 5) and maximum limits of aflatoxin level in foods and feeds (Table 6).

Table 5: Mycotoxins commonly identified in feed ingredients and their effect on animals

Major class of Mycotoxins	Mold	Nature of toxin & effects
Aflatoxinn (b1,l B2, G1, G2, M1, M2)	*Aspergillus flavus; A. parasiticus.*	Hepatotoxin, Immunosuppresion, carcinogenic, teratogenic; reduced feed intake, Reduced production,
Trichothecenes (3-or 15-acety-deoxynivalenol, Deoxynivalenol, nivalenol, fusarenon X (type- B trichothecenes), T-2 tosin, HT- 2 toxin	*Fusarium sp.*	Dermatoxins, immunologic effects, hematological changes & digestive disorders, weight loss, reduced milk production.
Zearalenone (ZEA)	*Fusarium graminearum*	Estrogenic (vulvovaginitis, enlargement of uterus) & reproductive disorders (low birth weight, reduced litter size, abortion, swollen vents, reduced egg production.
Ochratoxin (OTA)	*A. ochraceus Penicillium spp.*	Nephrotoxins (nephropathy, kidney dysfunction, gout), immune-suppression; Retarded growth, feed refusal, mortality.
Fumonisin (B1, B2, B3)	*Fusarium moniloforme F. proliferatum*	Neurological disorders, leukoencphalomalacia, blindness, head butting & pressing, incordination, liver damage, pulmonary edema, pancreatic lesion.
Eargot alkaloids (Ergometrine, ergosine, ergotamine, clavines)	*Claviceps purpurea, C. paspaspali, C. fusiformis*	Nervous or gangrenous syndrome.

Table 6: Maximum limits of aflatoxin level in food and feeds: in U.S., & India

Countries	Product	Species
United States (ppb)		
0.5	Milk	Human
20	Any food, except milk	Human
20	Animal feed	All species
India (ppb)		
50	Animal feed	Poultry and livestock

Control of mycotoxins:

The current emphasis is on reducing the deleterious effects of the pe-formed mycotoxins and thereby enhancing production. Strategies to reduce the impact of mycotoxins include

- Plant breeding for mould resistance
- Efficient harvesting
- Storage practices to minimize contamination
- The development of potential commercially applicably techniques for decontaminating such commodities
- The most effective methods of neutralizing mycotoxins in feed by binding them to an inert compound before they can be absorbed from the intestine

Genetically Modified Organisms (GMO) and novel foods

Modern biotechnology, i.e *genetic engineering* or *genetic manipulation*, can now transfer the hereditary material across species boundaries. This can broaden the range of genetic changes that can be made to food and can expand the spectrum of possible food sources. The accelerating pace of developments in modern biotechnology has opened a new era in food production and this may have a tremendous impact on world food supply systems. However, there are considerable differences of opinion among scientists about the safety, nutritional value and environmental effects of such foods.

Overall, it is argued that the consequences of some gene transfer methods are less predictable when compared to those of traditional plant breeding methods and considerable scientific evidence will be needed to clear these foods from points of view of nutrition, food safety and impact on the environment. GM crops encompass many real and feared health risk, rigorous safety assessment is needed before these crops are permitted for use.

Urbanization, nutrition and food security

In 2020, the world population is projected to reach 7.6 billion, an increase of 31% over the mid-1996 population of 5.8 billion. Approximately 98% of the population growth occurring during this period will take place in developing countries. While urbanization is a global phenomenon, it has been estimated that between the years 1995 and 2020 the developing world's urban population will double, reaching 3.4 billion. Such population growth poses great challenges to world food security and food systems. Further extension of improved agriculture and animal husbandry practices; use of measures to prevent and control pre- and post-harvest losses; more efficient food processing and distribution systems; introduction of new technologies including the application of biotechnology, and others will have to be exploited to increase food availability to meet the needs of growing populations. Growing urbanization and associated changes in the way food is produced and marketed have led to a lengthening of the food chain and potential for introducing or exacerbating food borne hazards

Animal feed safety system

The FAO /WHO 2000 report that the criteria for safety assessments should be made explicit and objective and that differences in the application of the principle of substantial equivalence. The animal feed safety system is to develop and implement a comprehensive, risk based preventive animal feed safety system that minimizes, reduces or eliminates the risks to animal and human health that can arise from animal feed. The regulatory body as mentioned beliow needs to certify for an innovative or new food or food product prior to its release for human or animal consumption.

Codex Alimentarius Commission (CAC)

Since 1962, CAC has been responsible for implementing the joint FAO/WHO food standards program.

Codex committee on food hygiene (CCFH)

This committee has overall responsibility for all provisions of food hygiene prepared by codex commodity committee and develop general principles, codes of practice, guidelines for food hygiene and microbiological criteria.

Legal Aspect for Feed Safety:

In India the quality control is regulated by to a statuary body Bureau of Indian Standards (BIS). It was established under BIS Act, 1986. Bureau has set up subcommittees for animal feeds called Animal Feeds Sectional Committee, which has been specifically set up to check the quality of animal feeds and feed ingredients. The members of animal feeds sectional committee are the eminent nutritionist taken from the :

- Indian Council of Agricultural Research (ICAR) institutes
- State Agricultural Universities
- Feed Industry
- Government departments having specialization in Animal Nutrition
- Feed Technologist concerned with Animal Husbandry Activities.

Conclusion

Food safety is a matter of major concern around the world in the new era as there is challenge before feed manufacturers, farmers, food operators and nutritionist to meet the increasing demand of human food as well as animal feed. Agricultural scientists are making efforts to find new feed resources, developing improved varieties of crops with higher production and supply more nutrients, developing GM crops etc. To ensure that the materials are safe to use require both long term and short term approaches. Still there is need to develop procedures for safe processing and treatment and the feed users and regulating agencies need to understand the origins and methods of processing the materials so that monitoring systems can be established to confirm the levels and presence of any unsafe materials.

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Medicine to produce health, has to examine disease, and music, to create harmony, must investigarte discord

Plutarch

Risk assessment of antibiotic residues in foods of animal origin

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Public confidence in the safety of the food supply has been shaken by incidents involving chemical contaminants. The 1962 publication of the book Silent spring by Rachel Carson drew public attention to the dangers of pesticides in the environment and in food. The association of diethylstilbestrol (DES) with cancer in the daughters of women treated with this hormone raised questions about the safety of using DES as a growth promoter in animals. The banning of several artificial sweeteners in the 1970s due to evidence of carcinogenicity demonstrated in laboratory animal experiments raised questions about the safety of food additives and about the role of laboratory animal testing for food safety evaluation. In addition, there have been incidents of illegal use of hormones in animal production, reports of drug residues in milk, and considerable public debate about bovine somatotropin (BST) use in dairy cattle. Until very recently, the principal food safety issue in the mind of the public was chemical residue contamination and food additives, although concerns over microbial contaminants have superseded this in some countries. Notwithstanding the evidence from food borne disease surveillance programmes showing that microbial contamination of foods is a much greater food safety problem than chemical residues.

Introduction:

Much has been written about the theory, importance and practice of risk analysis (including risk assessment, risk management and risk communication) for food safety. Risk assessment principles were first applied explicitly to food safety in the context of chemical residues. Risk assessment is a process which has evolved over the last two decades to assist in the characterization of risks due to low-level exposure to environmental contaminants and other hazards. Used in this context, the term 'risk' connotes both the probability of occurrence and the magnitude (or impact) of the negative health outcome from exposure to the chemical residue in food. The impact may also involve outcomes other than health, such as lost sales or international trade, or loss in public confidence. These determinations have been based on evidence from case reports or epidemiological studies in people, when such data are available. More often, the results of animal bioassays have been used to identify both the outcomes and threshold doses or 'no observed adverse effect levels'. It is well established that agricultural use of antibiotics results in increased prevalence of antibiotic resistant bacteria in farm environments, thus contributing to the global pool of resistant organisms. There are several confounding factors that make the assessment of the risk posed by agricultural use of antibiotics difficult. A primary difficulty is that a large number of the antibiotics used in livestock production are also used in human and pet medicines, thus presenting difficulties in determining the initial sources or reservoirs for the resistant populations. For example, it would be difficult to assign blame for the increase in sulfonamide resistance to use of sulfa drugs in livestock, when sulfonamides have been used extensively in humans for prevention of acne, urinary tract infections, and diarrhea, among other common uses. Cross resistance within and across families of antibiotics is also a confounding factor, as some antibiotics used solely in human medicine can select for resistance to other drugs which may be used primarily in livestock, and vice versa. Elimination of the veterinary use of some antimicrobial products may not translate into reductions of some resistance patterns in bacteria of concern. For those antibiotics that are critical for human use, resistance is of particular concern, whereas resistance to antibiotics of a lesser role in human medicine may not carry the same importance. For example, the importance of fluoroquinolones as one of the last lines of defense in treating MDR human pathogens dictates that resistance to that drug family carries a high importance than resistance to a drug family, such as tetracyclines. Some efforts have been undertaken to model antimicrobial resistance and assess risk quantitatively or semi quantitatively associated with agricultural use of antibiotics. The discipline of risk analysis is evolving and maturing in many of its applications, which include environmental chemicals, food microbiology and animal health. The available empirical evidence from food borne disease surveillance programmes suggests that risk assessment and risk management have protected public health in the area of food contaminants.

USE of antibiotics in animals:

- Antibiotics as growth promoter
- Antibiotics in therapeutics
- Antibiotics in prophylaxis

Factors predisposing to contamination of animal source food with antibiotic drug residues:

- Not adherence to withdrawal requirements of antibiotics by farmers and
- Injudicious use of antibiotics by paravets and farmers
- Lack of knowledge of withdrawal requirements of drugs by farmers
- Lack of knowledge of possible health risk associated with drugs in animal source food

Pathological Effects produced by Antibiotic Residues in Food

- Transfer of antibiotic resistant bacteria to the human.
- Immunopathological effects Autoimmunity
- Carcinogenicity (Sulphamethazine, Oxytetracycline, Furazolidone)
- Mutagenicity
- Nephropathy (Gentamicin)
- Hepatotoxicity
- Reproductive disorders
- Bone marrow toxicity (Chloramphenicol)
- Allergy (Penicillin)

Technological effects:

- Interfere with starter metabolism
- Inhibition of lactic acid production.
- Off flavours
- Poor quality product
- Economic loss

Why addressing/checking the Use of Antimicrobials in Food Animals?

No Action Today, No Cure Tomorrow

- Emergence & spread of resistant bacteria
- Genes coding for AMR resistance in animals can be transferred to microbes in humans
- Cosmopolitan spread of AMR through food animals and foods of animal origin
- Small percentage of people is violently allergic to antibiotics. Extremely small doses can be fatal. Other people are sensitive to low drug concentrations that cause mild reactions that can be uncomfortable.
- Antibiotics interfere with growth of starter cultures used in making yogurt and cottage or other cheeses.

Techniques used for Detection and Analysis of Drug Residues

- ELISA

- HPLC
- Liquid chromatography
- Gas chromatography
- Paper chromatography.

Laboratory analytical methods

There are several methods available for screening of raw milk for the presence of antibiotic residues. A control program for antibiotic residues in milk is usually performed in two steps where a microbial, enzymatic or receptor-based method is used for initial screening (IDF, 1995). The samples found positive are usually confirmed by a confirmatory method has to be able to identify the molecule present in the sample and to quantitate it. High-pressure liquid chromatography coupled with UV detector (HPLC-UV) is the technique often adopted as a confirmatory method for antibiotic residues. This technique has some limitations in a low sensitivity and selectivity; therefore many purification steps are needed. Other techniques used for confirmation of residues include, spectrophotometric, thin-layer chromatographic and gas chromatographic, mass spectrometric, and immunochemical methods.

Microbiological:

Briefly, the test procedure is described as follows: using Bacillus subtilis BGA strain or Bacillus stearothermophilus variety calidolactis as the test organism, a 0.5% McFarland's standard suspension of the organism was prepared. This was used to inoculate the surface of Mueller-Hinton agar plates prepared at pH¼ 7.0 and containing 0.2 mg/ml of trimethoprim. A sterile 8 mm diameter cork borer was used to create disc shaped meat samples of 2 mm thickness, which were applied to the surface of the agar medium. Positive controls were set up with 1 mg/ml of ciprofloxacin, chloramphenicol and tetracycline, while negative controls were set up with distilled water. The agar plates were incubated at 37°C for 18-24h. After incubation a zone of inhibition of 1 cm or more was considered a positive case of the meat sample containing drug residues. Positive controls were expected to have zones of inhibition while the negative control was not expected to have any zone of inhibition.

Immuno-enzymatic:

Quantitative confirmation of the antibiotic residues was performed using a competitive immunoassay tests method. For the analysis of the antibiotic residues in dairy products was initially used the semi-quantitative test to identify positive samples, these being quantitatively confirmed lately by the method of competitive enzyme immunoassay tests.

Risks determination:

Threshold doses have been used to establish acceptable daily intakes (ADIs) of chemical residues in foods over a lifetime. Knowledge of routes of exposure and the estimated consumption quantities of various foods which may contain the contaminants may enable the setting of maximum residue limits (MRLs) in various foods (e.g., milk, muscle or organ tissue). In the case of veterinary drugs, the ADI and MRL estimates can be used to establish milk and meat withholding times for animals treated with these compounds, which are intended to ensure that harmful residues do not appear in edible products, provided that the compounds are used in accordance with approved label instructions and good agricultural practice. The World Health Organisation (WHO) , through the Joint Food and Agriculture Organisation/WHO Expert Committee on Food Additives, contributes significantly in this area by carrying out some of the elements of risk analysis (especially hazard identification and hazard characterisation components of risk assessment) pertaining to chemical contaminants in foods and for establishing ADI and MRL guidelines which are useful in managing risks. Exposure assessment is sometimes achieved by measuring the quantities of residues within people (e.g., measurements of organochlorines in blood or body fat), or by measuring residue levels in foods and then estimating the amounts of food eaten by people in society. In many cases, qualitative or semi-quantitative estimates of risk (i.e., the probability and impact of adverse health effects) posed by various chemical residues have been used to rank contaminants in a priority list for risk management action.

Maximum Residue Limits

Regulatory levels have been established for drug residues in foods in the form of maximum residue limits MRLs (Lee *et al*., 2000). MRLs for veterinary drugs refer to the maximum concentration of a residue (resulting from the use of a veterinary drug) that is acceptable in food (CAC, 1995). Sampling and testing protocols are based on standards set by CAC and Table 3 gives some examples of those, which have been set for milk from veterinary cows.The MRL is based on the Acceptable Daily Intake (ADI) for a given compound, which is the amount of a substance that can be ingested daily over a life time without appreciable health risk. MRLs are fixed on the basis of relevant toxicological data including information on absorption, distribution, metabolism and excretion

Table. - 1. Maximum Residues Limit (MRL) (ug/kg) for veterinary drug residues.

Antibiotic	MRL (ug/kg)	Antibiotic	MRL (ug/kg)
Benzyl penicillin & Ampicillin	4	Neomycin	100
Amoxycillin	4	Sulphonamides	100
Oxacillin	30	Trimethoprime	50
Cloxacillin	30	Spiramycin	200
Dicloxacillin	30	Tylosine	50
Tetracycline	100	Erythromycine	40
Oxytetracycline	100	Quinalones	75
Chlortetracycline	100	Polymyxine	50
Streptomycin	200	Ceftiofur	100
Dihydrostreptomycine	200	Cefquinome	20
Gentamicine	200		

Table. 2: Drug withdrawl period to prevent veterinary drug residues.

Antibiotic in Lactating cattle	Route of Administration	Withdrawal time	
		Milk(hR)	Meat(D)
Amoxicillin	Intramammary	60	12
	Injectable	96	25
Ampicillin	Injectable	48	6
Cefapirin	Intramammary	96	4
Cloxacillin	Intramammary	48	10
Erythromycin	Injectable		14
	Intra mammary	36	14
Novobiocin	Intra mammary	72	15
Penicillin-G	Intra mammary	72	15
	Injectable	48	10

Current scenario in India

Availability of almost all antibiotics 'OTC'

Current regulations or guidelines in India

- Manufacture of antibiotic drugs for humans and veterinary purpose
- CDSCO –Drug & Cosmetics Act-1940
- FSSAI-main regulatory authority
- Food Safety and Standards Act-2006 (MoH&FW)
- GMP, GHP, HACCP

- The various provisions which have direct or indirect implication for AGPs include

FSSA, 2006-Section 16(2)(b)

The Food Authority specify the limits for use of food additives, crop contaminants, pesticide residues, residues of veterinary drugs, heavy metals, processing aids, mycotoxins, antibiotics drugs, heavy metals, processing aids, mycotoxins, antibiotics and Pharmacological active substances and Irradiation of food

FSSA, 2006-Section 16(3)(b)

The Food Authority shall also search, collect, collate, analyze and summarize relevant scientific and technical data particularly relating to incidence and prevalence of biological risk, residues of various contaminants, biological risk, residues of various contaminants, identification of emerging risks among many others also.

FSSA, 2006-Section 21(1)

No article of food shall contain insecticides or pesticides residues, Veterinary drugs residues, antibiotic residues, solvent residues, pharmacological active substances and micro-solvent residues, pharmacological active substances and micro- biological counts in excess of such tolerance limit as may be specified by regulations.

Export Inspection Council MoC & I (Ministry of Commerce & Industry)

- Antibiotics and AGPs banned for use
- Total residual antibiotics (Beta lactam), Anthelmintics
- Specifies maximum residual limits
  Antibiotics, Anthelmintics
- Checks raw/finished products
  Antibiotics, Bacterial Inhibitors

Drug and Cosmetics Rules, 1945

Rule97

Container of a medicine for treatment for food producing animals shall be labeled with the withdrawal period of the drug for the shall be labeled with the withdrawal period of the drug for the species on which it is intended to be used. Specific withdrawal period shall not be less than seven days for eggs or milk, twenty eight days for meat from poultry and mammals including fat and offal, five hundred degree days for fish meat.

Ways to control residues:

- Read the label and administer the drug properly.
- Pay attention to withdrawal times
- Prevent extra-label drug use
- Mark and identify all treated cows.
- Keep a written record of all treatments, including date of treatment, diagnosis
- Discard milk from all four quarters of a treated cow.
- Do not exceed recommended dose levels
- Do not combine several antibiotics.
- Prevent careless use of pesticides and insecticides, as well as cleansing and sanitizing agents.
- Make individuals and organizations aware of the problem through education by veterinary personnel, organizations, and literatures and governmental agencies.
- Rapid screening procedures for the analysis of antibiotic residues and instant grading and prohibition of food containing antibiotics more than MRL.
- Processing of milk help for the inactivation of antibiotics.

- Refrigeration causes disappearance of penicillin. In pasteurization most of antibiotics will lose activity.
- Irrational use of antibiotics in field veterinary practices should be avoided.
- Development of simple and economic field test to identify drug residue in edible animal products.
- Ethno-veterinary practices may be promoted.

Future Challenges

- Studies to understand the emergence and pattern of spread of antimicrobial resistance and the factors influencing it in Livestock.
- Promotion of discovery of newer and effective livestock antimicrobials based on current knowledge of resistance mechanisms.
- Rapid and accurate diagnosis of livestock infections and infectious diseases.
- To establish a nationwide well coordinated antimicrobial programme with well defined and interlinked responsibilities and functions of different arms of the programme.

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Compassion for animals is intimately connected with goodness of character; and it may be confidently asserted that he who is cruel to animals cannot be a good man.

Arthur Schopenhauer

National and International food safety standards

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Food safety is an issue of increasing concern worldwide and prioritisation of food safety as an essential public health function was advocated recently by the World Health Assembly. Better monitoring and surveillance demonstrates that the main burden of food-borne disease is due to microbiological pathogens of animal origin and this has important implications for the veterinary profession at both the international and the national level. The possibility of chemical residues in food is also causing growing anxiety amongst consumers (OIE, 2002).

The Food Safety and Standards Authority of India (FSSAI) has been established under Food Safety and Standards Act, 2006 which consolidates various acts & orders that have hitherto handled food related issues in various Ministries and Departments. FSSAI has been created for laying down science based standards for articles of food and to regulate their manufacture, storage, distribution, sale and import to ensure availability of safe and wholesome food for human consumption. Various central Acts like Prevention of Food Adulteration Act 1954; Fruit Products Order 1955; Meat Food Products Order 1973; Vegetable Oil Products (Control) Order, 1947; Edible Oils Packaging (Regulation)Order 1988; Solvent Extracted Oil, De- Oiled Meal and Edible Flour (Control) Order, 1967; Milk and Milk Products Order, 1992 etc. will be repealed after commencement of FSS act, 2006. (Food Safety Act, 2006)

Food recalls are an everyday event. Three million people die each year from food and water borne illness. Each year, in the United States alone 48 million people get sick; 128,000 are hospitalized and 3,000 die from food borne illness (Matthew Turner, 2013). Because of these facts the U.S. food and drug administration (FDA) food safety modernization act (FSMA) was signed into law by President Barak Obama on January 4, 2011.

The World Organization for Animal Health (OIE) has a SPS responsibility for elaborating standards and related texts for the prevention, control and eradication of animal diseases and zoonoses, while the Codex Alimentarius Commission (CAC) elaborates standards and related texts for both safety and suitability aspects of food control. CAC and the OIE have strategies and mechanisms in place to co-ordinate and integrate food safety activities across the production to consumption continuum and so enhance the safety of foods of animal origin on a world-wide basis. A part of OIE's strategy was the setting up of a permanent Working Group on Animal Production Food Safety to review, develop and/or contribute to international food safety standards and guidelines, incorporating good animal production practice (including veterinary aspects) as it relates to food safety and taking into account a risk-based 'production to consumption' approach. With regard to strategies and mechanisms to integrate and implement food safety activities and develop good animal production practices, the OIE and the CAC work in close collaboration and with the support of the specialised services in FAO and WHO.

National laws

Prevention of Food Adulteration Act, 1954

The Act was promulgated by Parliament in 1954 to make provision for the prevention of adulteration of food, along with the Prevention of Food Adulteration Rules, 1955 which was incorporated in 1955 as an extension to the Act. Broadly, the PFA Act covers food standards, general procedures for sampling, analysis of food, powers of authorized officers, nature of penalties and other parameters related to food. It deals with parameters relating to food additives,

preservative, colouring matters, packing & labelling of foods, prohibition & regulations of sales etc. Like FPO, amendment in PFA rules are incorporated with the recommendation made by the Central Committee of Food Standards (CCFS) which has been setup by Central Government under the Ministry of Health and Family Welfare comprising members from different regions of the country. The provisions of PFA Act and Rules are implemented by State Government and local bodies as provided in the rules.
Prevention of Food Adulteration Act, 1954 will be repealed from the date to be notified by the Central Government as per the Food Safety and Standards Act, 2006. Till that date new standards are specified, the requirement and other provisions of the PFA Act, 1954 and Rules, 1955 shall continue to be in force as a transitory provision for food standards.

Meat food products order, 1973

Meat & Meat Products are highly perishable in nature and can transmit diseases from animals to human-beings. Processing of meat products is licensed under Meat Food Products Order,(MFPO) 1973 which was hitherto being implemented by Ministry of food Processing industries w.e.f. 19.03.2004 on being transferred from the Directorate of Marketing Inspection, Ministry of Agriculture. The main objectives of the MFPO, 1973 are to regulate production and sale of meat food products through licensing of manufacturers, enforce sanitary and hygienic conditions prescribed for production of wholesome meat food products, exercise strict quality control at all stages of production of meat food products, fish products including chilled poultry etc. Under the provision of MFPO all manufacturers of meat food products engaged in the business of manufacturing, packing, repacking, relabeling meat food products meant for sale are licensed but excluding those manufacturers who manufactures such products for consumption on the spot like a restaurant, hotel, boarding house, snack bar, eating house or any other similar establishment. Depending on the source of meat the manufacturers are licensed under category A, B & C. Presently, 279 units are licensed under MFPO as on 01.04.09.

Milk & Milk Product Amendment Regulations - 2009 (MMPR-09) division (MMPO, 1992 has been renamed as MMPR, 2009)

Consequent upon de-licensing of Dairy Sector in 1991 under Industrial Development & Regulation Act, the Department of AH and Dairying & Fisheries had promulgated the Milk and Milk Product Order (MMPO) 1992 on 9/6/92 under section 3 of the Essential Commodities Act 1955. The objective of the order is to maintain and increase the supply of liquid milk of desired quality in the interest of the general public and also for regulating the production, processing and distribution of milk and milk products. As per the provisions of this order, any person/dairy plant handling more than 10,000 liters per day of milk or 500 MT of milk solids per annum needs to be registered with the Registering Authority appointed by the Central Government.

There is no restriction on setting up of new dairy units and expansion in the milk processing capacity, while noting the requirement of registration is for enforcing the prescribed Sanitary and Hygienic Conditions, Quality and Food Safety Measures as specified in Vth Schedule of MMPO-1992. In order to comply the provisions of Para 5 (5) (B) of MMPO-92, two inspection agencies i.e. National Productivity Council (NPC) and Export Inspection Council (EIC) of India have been notified for annual inspection of registered dairy units on rotation basis. Now it has been subsumed as milk and milk products regulations under Section-99 of the Food Safety& Standards Act-2006.

Food Safety Standards Act-2006

It is almost six decades since the food regulation was made in independent India. Tremendous progress made in agriculture, food processing and changing food habits in population coupled with long pending demand from stakeholders for integrated food laws as well as obligation under WTO have necessitated the birth of new food safety and standards act 2006 and is in operation from august 2011. The salient feature of this act: (1) multi-level, multi-departmental control to integrated line of command; (2) integrated response to strategic issue like novel/genetically modified foods and international trade; (3)power to licensing for manufacture of foods to the commissioner of food safety and designated officers (4) single reference point for all matters relating food safety standards regulation and enforcements; (5) regulatory regime to self-compliance through management system;(6)graded penalties depending on the gravity of offence. (V. Sudarshan Rao, 2013)

An Act to consolidate the laws relating to food and to establish the Food Safety and Standards Authority of India for laying down science based standards for articles of food and to regulate their manufacture, storage, distribution, sale and import, to ensure availability of safe and wholesome food for human consumption and for matters connected therewith or incidental thereto.

International food safety Standards

Globalization is a process that includes removal of trade barriers and growing financial and economic integration between nations. And globalization brought countries together mainly in trade. Our country also countersigner on agreement, namely sanitary and phyto sanitary (SPS) and technical barrier to trade (TBT) etc. which prescribe number of quality requirements. The SPS agreement necessitates maintenance of standard guide line and recommendation formulated by Codex Alimentarions commission (CAC). And world organization for animal health (OIE) reference for food safety and animal health respectively in global trade. Some of the countries restricted import of meat, milk and other animal products from India for absence of appropriate standards for conformity with OIE requirements. (R. N. S. Gowda, 2008, Dr. G Srinivasan, 2008)

There is absence of much required HACCP system in many of the organizations or institution associated with import/export certifications towards fulfilment of OIE requirements concerning animal environmental conditions. Safe food for humans in ways is dependent on safe feed to animals. If the animals are not given safe feed they remain as potent toxic meat and animal products. The FAO, in its conference in Porto where the theme for meeting was "Food Safety and Quality" as affected by animal feed stuff has drawn up worry list in which many challenges for professionals worldwide are veterinary drugs, mycotoxins, infectious agents, chemicals and genetically modified organisms.

WHO in May 2000 highlighted animal feed that some of the food poisoning out breaks in human were related to as a source of contamination causing public health concern like BSE, dioxins, pesticides residues, antibiotics and mycotoxins etc. as a results some of the coutries are imposing ban on certain feed ingredients/ feed additives to ensure safe food from safe feed (R. N. S. Gowda, 2008).

Conclusion

Consumers expect food to be always safe. However despite great advances in technology, production of safe food is a public health problem worldwide. National and international food safety standards are the way to manage future safe food production. Science based and systematic, food safety management systems are tool to assess hazards and established control systems that emphasize on prevention of food quality deterioration at every stage of processing. Adoption of proper food safety standards will provide Indian food industries greater potentiality in the international market.

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Veterinary medicine and human medicine complement each other and should be considered as one medicine.

William Osler

An update on techniques to detect food adulteration

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Food is essential for every organism. The evolution of organism has been remained related to the source, type and utilization of food substances. The scriptures ans science advocates for the pios and balanced food. In Bhagavad Geeta, Sri Krishna says: Yuktahar Viharasya… means "take appropriate food…". There is vast diversity exists in rituals and types of foods. Food accounts for a large part of the family budget. People of India now a day's becoming more aware about the quality of food they consume.

Every consumer wants to get the maximum quantity of a commodity for as low a price as possible. This attitude of the consumers being coupled with the intention of the traders as well as the manufacturer to increase the margin of a profit as high as the variable market demand permits generates a vicious circle where the quality of the commodity gets reduced through addition of baser substances and / or removal of vital elements, and the process is defined as

Adulteration

What Is Food Adulteration?

Any article of food is adulterated if:

- If any inferior or cheaper substance has been substituted wholly or in part,
- If any constituent of the article has been wholly or in part abstracted
- If the article has been prepared, packed or kept under insanitary conditions
- If the article consists in part filthy, rotten, decomposed or diseased animal or vegetable or is infested with insects
- If the article is obtained from diseased animal
- If the article contains any poisonous ingredient
- If the article has unprescribed colouring substance or the colouring substance is in excess of the prescribed limits.

The consumer should be able to detect the adulteration in food. There are many sources of information available in print and in soft form. The method of detection may require simple materials.

Milk

Impure water:

The lactometer reading shall not ordinarily be less than 26.

Water:

- The presence of water can be detected by putting a drop of milk on a polished slanting surface, the drop of pure milk either stops or flows slowly leaving a white trail behind it. Whereas milk adulterated with water will flow immediately without leaving a mark.
- Take 10 ml milk, add 1 ml 10% Acetic acid, filter it and add 2 drops of Diphenyl amine. Dark violet/purple colour indicates addition of water.

Hydrogen peroxide:

- Take 10 ml milk, add 2 drops of 1% Paraphenyle diamine. Violet color indicates addition of Hydrogen peroxide.

Sodium bicarbonate:

- Take 3 ml of the milk in a test tube. Add 10 drops of rosalic acid solution. The rosy colouration indicates the presence of sodium bicarbonate in the milk.

Glucose:

- Take a teaspoonful of the milk in a test tube. Dip a strip of diastix in it for 30 seconds. A change in colouration from blue to green indicates the presence of glucose in the milk.

Sugar:

- Take 3 ml of the milk in a test tube. Add 2 ml of concentrated hydrochloric acid or Muratic acid in it. Heat the test tube after adding 50 mg of resorcinol. The red colouration indicates the use of sugar in the milk.
- The detection may also be made by a different test. Take a teaspoonful of milk in a test tube. Add 1 mg of invertase enzyme. After 5 minutes, dip a strip of diastix in it. Take out the strip after 30 seconds. A change in colour from blue to green indicates the use of sugar in the milk.

Formaldehyde:

- Take 5 ml milk; add 5 ml 5% Ferric chloride and Hydrochloric acid. Light purple colour indicates adulteration of formaldehyde.

Cereal starch:

- Take 3 ml of the milk in a test tube. Add 1 drop of 1% aqueous solution of iodine. The blue of deep blue coloration indicates the presence of cereal starch in the milk.

Urea:

- Take a teaspoonful of milk in a test tube. Add a ½ teaspoon of soybean or arhar powder. Mix up the contents thoroughly by shaking the test tube. After 5 minutes, dip a red litmus paper in it. Remove the paper after half a minute. A change in colour from red to blue, indicates the presence of urea in the milk.
- Take 5 ml of milk in a test tube and add 2 drops of 1% bromothymol blue solution development of blue colour after 10 minutes indicates the presence of urea in milk.
- Take 5 ml milk. Add 5ml 24% acetic acid, filter it. Take 1 ml filtrate; add 1 ml 2% Caustic soda and 0.5 ml Phenol reagent. Violet or green colour indicates presence of urea.

Neutralizer washing soda/baking soda alkaline detergent:

- Take 5 ml of milk in a test tube and 2 drops of bromocresol purple solution. Development of violet colour after 10 minutes indicates the presence of Neutralizer or alkaline detergent in milk.

Boric acid:

- Take 3 ml of milk in a test tube. Add 20 drops of hydrochloric acid and shake the test tube to mix up the contents thoroughly. Dip a yellow paper-strip, and remove the same after 1 minute. A change in the colour from the yellow to red, followed by the change from the red to green, by addition of ammonia-drop solution, indicates that the boric acid is present in the milk (to prepare the yellow paper-strips, dip strips of filter paper in an aqueous solution of the turmeric, and dry it up).

Hydrogenated oil "vegetable ghee":

- Take 3 ml of milk in a test tube. Add 10 drops of hydrochloric acid or Muriatic acid. Mix up one teaspoonful of sugar. After 5 minutes, examine the mixture. The red coloration indicates the presence of Hydrogenated oil "vegetable ghee" in the milk.

Removal of fat:

- The Lactometer reading will go above 26 while the milk apparently remains thick.

Synthetic milk:

a) Test for protein

- The milk can easily be tested by Urease strips (available in the Medical stores) because synthetic milk is devoid of protein.

b) Test for Glucose/ inverted sugar, Sugar syrup

- Milk does not contain glucose /invert sugar, if test for glucose with urease strip found positive. It means milk is adulterated.

Rabri

Blotting paper:

- Take 1 teaspoonful of rabri in a test tube. Add 3 ml of hydrochloric acid or muratic acid and 3 ml of distilled water. Stir the contents with a glass rod. Remove the rod and examine. Presence of finer fibres to the glass rod, will indicate the presence of blotting paper in rabri.

Sweet Card

Hydrogenated oil "vegetable ghee":

- Take 1 teaspoonful of sweet card in the test tube. Add 10 drops of hydrochloric acid or muratic acid. Mix up the contents shaking the test tube gently. After 5 minutes, examine the mixture. The red colouration indicates the use Hydrogenated oil "vegetable ghee" in the sweet card.

Paneer

Starch:

- Boil a small quantity of sample with some water, cool and add a few drops of iodine solution. Formation of blue colour indicates the presences of starch.

Ghee

Hydrogenated oil "vegetable ghee":

- Take 3 ml of ghee in a test tube. Add 10 drops of hydrochloric acid or muratic acid, and 1/4th of teaspoon of sugar. Shake the tube to mix up the contents thoroughly. Examine the test tube after 5 minutes. The red colouration will indicate the presence of Hydrogenated oil "vegetable ghee" in the ghee.
- Take about one tea spoon full of method sample of ghee with equal quantity of concentrated Hydrochloric acid in a stopered test tube and add to it a pinch of sugar. Shake well for one minute and let it stand for five minutes. Appearance of crimson colour (violet pink) in lower (acid) layer shows presence of Vanaspati or Margarine.

Cottonseed oil (Halfans test):

- Take 5 ml Ghee and add 5 ml Amyl alcohol and 5 ml 1% Sulphur in Carbon disulphide, keep it for 30 min hot water. Crimson colour indicates presence of cottonseed oil in ghee.

[If animal is given cotton seed cake, test also shows positive]

Mashed potatoes, other starches:

- The presence of mashed potatoes and sweet patotatoes in a sample of Ghee can easily be detected by adding a few drops of iodine, when iodine, which is brownish in colour turns to blue then mashed potatoes /sweet potatoes/other starches are presents.The colour disappears on boiling and reappears on cooling.

Butter

Vanaspati or Margraine:

- Take about one tea spoon full of melted sample of butter with equal quantity of concentrated Hydrochloric acid in a stoppered test tube and add to a pinch of sugar.

Shake well for one minute Appearance of crimson colour is lower (acid) layer shows presence of Vanaspati or Margarine.

Mashed potatoes sweet potatoes and other starches:

- The presence of mashed potatoes and sweet potatoes in a sample of butter can easily be detected by adding a few drops of iodine.When iodine (which is brownish in colour) turns to blue if mashed potatoes/sweet potatoes/other starches are present.

Honey

- A cotton wick dipped in pure honey when lighten with a match stick burns and shows the purity of honey. If adulterated, the presence of water will not allow the honey to burn. It does, it will produce a cracking sond.

Sugar/ Jaggery:

- Fiehe's Test: Add 5 ml of solvent ether to 5 ml of honey. Shake well and decant the ether layer in a petridish. Evaporate completely by blowing the ether layer. Add 2 to 3 ml. of resorcinol (1 gm of resorcinol resublimed in 5 ml of concentrated HCl.) Appearance of cherry red colour indicates presence of sugar/jaggery.
- Aniline Chloride Test: Take 5 ml of honey in a porcelain dish. Add Aniline Chloride solution (3 ml of Aniline and 7 ml. of 1:3 HCl:water) and stir well. Orange red colour indicates presence of sugar.

Jaggery

Sodium bicarbonate:

- Take 1/4th of a teaspoon of the jaggery in a test tube. Add 3 ml of Muriatic Acid. The presence of Sodium Carbonate effects effervescence.

Oils and Fats

Argemone oil:

- Take about 3 ml of the oil in a test tube. Add 20 drops of nitric acid. Shake carefully. Red to reddish brown colour in lower (acid) layer would indicate the presence of Argemone oil. Or heat the tube for 3 minutes on the flame of a spirit lamp. A red colouration indicates the presence of Argemone oil.

Mineral oil:

- Take 2 ml of the oil sample and add equal quantity of 0.5N alcoholic potash. Heat in boiling water bath(dip in boiling water) for about 15 minute or till it becomes clear and add 10 ml of hot water. Any turbidity shows presence of mineral oil.

Cotton seed oil:

- Take about 3 ml of the oil in a test tube. Add 2 ml of amyl alcohol in it and 1 ml of carbon disulphide and a little amount of sulpher. Plug the mouth of the test tube and heat it on the flame of a spirit lamp for 3 minutes. A red colouration indicates the presence of cotton seed oil in the oil.

Castor oil:

- Take about one ml of the oil. Add 10 ml of acidified petroleum ether and mix well. And a few drops of ammonium molybdate regent. Immediate appearance of white turbidity indicates the presence of castor oil.
- Take about 3 ml of the oil in a test tube. Add 2 ml of petroleum ether. Shake the test tube and mix up the contents thoroughly. Keep the tube immersed in the salt-ice mixture, or in a pot of cold saline water. Examine the test tube after 5 minutes. The appearance of turbidity in the mixture indicates the presence of castor oil . Similar test may also be made to detect adulteration of mustard oil with coconut oil, or Hydrogenated oil "vegetable ghee" (vanaspati).

Cyanide:

- Take 3 ml of the edible oil in a test tube. Add 10 drops of alcoholic potash, and heat the tube on the flame of a spirit lamp. Make an addition of a little amount of each of ferrous sulphate and ferric chloride in the test tube, and shake it to mix up the contents thoroughly. Add 3 ml hydrochloric acid. The blue colouration indicates the presence of hydrocyanic acid, which get produced due to presence of cyanide in edible oil.

Rancidity:

- Take 3 ml of the edible oil in a test tube. Add 3 ml of hydrochloric acid, in it. Close the mouth of the test tube. Mix up the contents thoroughly by shaking. Add 3 ml of 0.1% phloroglucinol solution in it. Shake the test tube vigorously for 2 minutes and keep it aside. Examine the test tube after 30 minutes. A pink or red colouration in acid layer indicates that, the oil sample is rancid.

Processed Food, Sweet or Syrup

Rhodamine B colour:

- If this chemical colour is present in the food, it is very easy to detect. Because it shines very brightly under the sun. Also it can be detected by a more precise method. Take ½ teaspoon of the sample in a test tube. Pour 3 ml of Carbon Tetrachloride and shake the test tube to mix up the contents thoroughly. The mixture turns colourless and addition of a drop of Hydrochloric Acid brings the colour back, when food contains Rhodamine B colour.

Lemonade soda:

Mineral acid

- Pour 2 drops of the lemonade soda on a Metanil yellow paper-strip. A violet coloration indicates the presence of mineral acid in aerated water. The colour impression gets retained even after drying the paper (you can prepare Metanil yellow paper-strips by soaking filter paper-strips in 0.1% aqueous solution, and then drying the paper-strips)

Meat

Adulteration and authenticity of meat products have been making the headlines with horse and pig meat found in UK and Irish beef products and now in several other countries. The EU Commission initiated an EU-wide program of control measures including random control of processed beef products for foreign DNA as well as analysis of residues of the veterinary drug phenylbutazone ("bute"). Horses that have been treated with the drug phenylbutazone are not allowed to enter the food chain.

Eurofins has been pioneering DNA-based analytical technologies for meat testing using innovative protocols to improve the safety and authenticity of our clients' food products for over 10 years.

Meat species testing:

- Semi-quantitative DNA species testing by means of Real-Time PCR, and confirmation by DNA sequencing
- 1% Threshold Testing according to the method published by the European Union Reference Laboratory for Animal Proteins (EURL-AP) in feeding stuffs
- Qualitative DNA species testing by means of Real-Time PCR
- ELISA tests - screening test that may not be suitable for all matrices and processing levels.

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Overview of Disaster Management

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Disaster management refers to a proactive approach which aims to reduce the negative impact or consequences of adverse events and is not merely response and relief. The term 'reduce' is used here since disasters cannot always be prevented, but the adverse effects can be minimized. It is a multi-system process based on the key principles of planning, organizing, and leading in addition to coordinating and controlling.

Because of its large geographical size, India often faces natural calamities like earthquakes, floods, cyclones, drought and landslides occurring frequently in different parts of the country. Natural disasters in India are recurrent phenomena. About 60% of the landmass is prone to earthquakes of various intensities; over 40 million hectares is prone to floods; about 8% of the total area is prone to cyclones and 68% of the area is susceptible to drought (NDMA, 2008). Natural disasters cannot be prevented, but their impact on people's and animals' lives can be reduced to a considerable extent. A lack of well-developed disaster management plan results in a severe loss of human and animal life and property. Most disasters can be predicted (flood, cyclone, drought) and some are unpredictable which strike suddenly (earthquake) and disrupt socio-economic life. It is quite often a panicky situation where all services are disrupted. Longer the period of external rescue and relief operations, more is the suffering of the affected communities. Animal are abandoned by the owners, dying and lying wherever they are, unattended, rotting, giving scope for epidemics.

Emergency *vs.* disaster situation

An emergency and a disaster are two different situations: Emergency refers to a situation in which the community is capable of coping. It is a situation generated by the real or imminent occurrence of an event that requires immediate attention of emergency resources.

On the other hand, a disaster is a situation in which the community is incapable of coping. It is a natural or human-caused event which causes intense negative impacts on people, goods, services and/or the environment, exceeding the affected community's capability to respond; therefore the community seeks the assistance of government and international agencies.

Types of disasters

Disasters are often classified according to their causes as either natural or man-made and based on the speed of onset as sudden or slow.

Classification based on cause:

I. Natural Disasters - These types of disaster naturally occur in proximity to people, structures or economic assets and pose a threat to life and assets. They are caused by biological, geological, seismic, hydrologic, or meteorological conditions or processes in the natural environment.

1. Cyclones, Hurricanes or Typhoons

Cyclones develop when a warm ocean gives rise to hot air, which in turn creates convectional air currents. Cyclones occur when these conventional air currents are being displaced. The term hurricane/typhoon is a regionally specific name for a "tropical cyclone". In Asia they are called 'typhoons'; in the Indian and Pacific Oceans they are called 'cyclones'; and over the North Atlantic and Caribbean Basin, they are called 'hurricanes'.

2. Earthquakes

An earthquake is a trembling or shaking movement of the earth's surface, resulting from plate movements along a fault-plane or as a result of volcanic activity. Earthquakes can strike suddenly, violently, and without warning at any time of the day or night.

3. Tsunami

A tsunami is a series of water waves generated by a submarine earthquake, volcano or underwater explosions, meteorite impacts or other disturbances above or below the water surface have the potential to generate tsunamis. The infamous 2004 Indian Ocean tsunami is the deadliest of natural disasters killing nearly 230,000 in 14 nations bordering the Indian Ocean. The deadly potential of tsunamis is potentiated by the fact that the intensity of a tsunami is very tough to predict even when the location and scale of the earthquake is known.

4. Floods

This phenomenon occurs when water covers previously dry areas, i.e., when large amounts of water flow from a source such as a river onto a previously dry area, or when water overflows banks or barriers.

5. Landslides

The term landslide refers to the downward movement of masses of rock and soil. Landslides are caused by one or a combination of factors like change in slope gradient, increasing the load on the land, shocks and vibrations, change in water content, ground water movement, and removal or changing the type of vegetation covering slopes, rains, floods, earthquakes, etc.

II. Man-made Disasters -These are disasters or emergency situations of which the principal, direct causes are identifiable human actions, deliberate or otherwise. Apart from "technological disasters" this mainly involves situations in which civilian populations suffer casualties, losses of property, basic services and means of livelihood as a result of war, civil strife or other conflicts, or policy implementation. In many cases, people are forced to leave their homes, giving rise to congregations of refugees or externally and/or internally displaced persons as a result of civil strife, an airplane crash, a major fire, oil spill, epidemic, terrorism, etc.

Classification based on speed of onset:

1. **Sudden onset**: Little or no warning, minimal time to prepare. For example, an earthquake, tsunami, cyclone, volcano, etc.
2. **Slow onset**: Adverse event slow to develop; first the situation develops; the second level is an emergency; the third level is a disaster. For example, drought, civil strife, epidemic, etc.

Disaster Management Cycle

Disaster management is a cyclical process: the end of one phase is the beginning of another, although one phase of the cycle does not necessarily have to be completed in order for the next to take place. Often several phases take place concurrently. Timely decision making during each phase results in greater preparedness, better warnings, reduced vulnerability and/or the prevention of future disasters. The complete disaster management cycle includes:

1. ***Mitigation*** (preventing or minimizing the effects of future emergencies): This phase includes activities that prevent an emergency, reduce the likelihood of occurrence, or reduce the damaging effects of unavoidable hazards. Mitigation activities should be considered long before an emergency.

2***. Preparedness*** (preparing to handle an emergency): This phase includes developing plans for what to do, where to go, or who to call for help before an event occurs; actions that will improve your chances of successfully dealing with an emergency. For instance, posting emergency telephone numbers, holding disaster drills, and installing tsunami warning system are all preparedness measures.

3. ***Response*** (responding safely to an emergency): It includes actions taken to save lives and prevent further property damage in an emergency situation. Response is executing the preparedness plans into action. Seeking shelter from a cyclone or leaving out of the buildings at earthquake are both response activities.

4. ***Recovery*** (recovering from an emergency): It includes actions taken to return to a normal or an even safer situation following an emergency. Recovery includes getting financial assistance for the repairs.

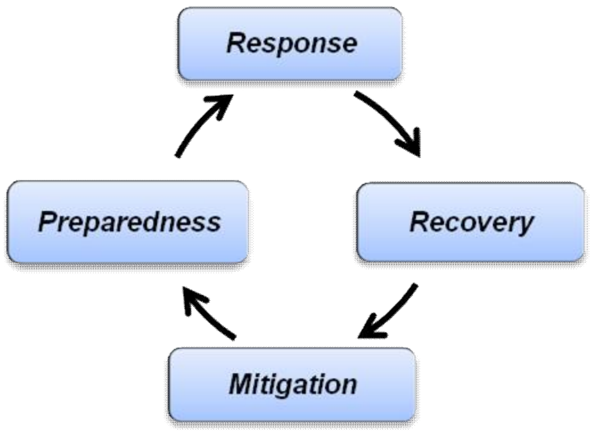

Fig.: Disaster management cycle

Disaster management in animals

With increasing globalization, the persistence of Trans-boundary Animal Diseases (TADs) anywhere in the world poses a serious risk to the world's animal, agriculture and food security and jeopardizes international trade. Recent animal health emergencies, including Foot and Mouth Disease (FMD) and bird flu have highlighted the vulnerability of the livestock sector to serious damage by epidemic diseases and its reliance on efficient animal health services and practices at all levels. The significance of animal diseases (including zoonoses) on human health and welfare is also being increasingly recognized.

Epidemics, epizootics, respiratory diseases, parasites (internal and external), other bacterial and vector-borne diseases occur after most of disasters. Usually post-disaster relief measures are focused on the human beings as first priority. Due to many reasons, livestock get little or no attention. This makes animals more vulnerable to disasters than human beings and the resulting impact of disasters on animals is high and long lasting. Under disaster situations, due to extreme stress, immunity goes down, coupled with starvation, the animals as well as human beings become more susceptible to infections, diseases with the associated risk of spread in the form of epidemic. The role of veterinary departments and veterinarians becomes crucial in such a situation.

The risk of epidemics increases after natural disasters because of exposure to many kinds of disease causing bacteria, viruses, fungi and parasites spread by flood waters, debris and stress that lowers the immunity combined with animal housing in emergency animal shelters where communicable disease agents build up in the environment and pass to others.

Table 1: Some common diseases encountered post disaster

Rabies, leptospirosis, E. coli, plague, Lyme disease, Rocky mountain spotted fever, ringworm internal parasites (*Toxocara, Ancylostoma, Giardia*), external parasites (fleas, scabies, mites)
Most common diseases during flood are: Poultry: Avian Influenza and Newcastle disease, brooders pneumonia Pig: Classical swine fever, foot and mouth disease (FMD), Japanese encephalitis. Sheep and Goat: PPR, pasteurellosis, flea, scabies and mite infestation, etc. Cattle: PPR, FMD, HS, anthrax, malignant edema, tetanus (Lockjaw), botulism, foot rot and mastitis

These diseases should be monitored and where appropriate, animal disease control procedures should be implemented to prevent the spread of diseases. In specific instances, restocking should be considered after going through the necessary quarantine period. Vaccination against those epidemics and anthelmintics and treatment campaigns should be made.

Disasters that could lead to an emergency situation in the animal husbandry sector:

Emergency situations in animals may arise primarily due to the following four categories of risks:

(A) Natural Disasters – As mentioned earlier India is vulnerable to most types of natural disasters and its vulnerability varies from region to region and a large part of the country is exposed to these natural hazards which often turn into disasters, causing a significant disruption of the social and economic life of communities arising from the loss of life and property, including livestock.

(B) Infectious Diseases - Emergency animal diseases are not always the same as exotic or foreign animal diseases. Outbreaks of infectious diseases are of many types:

i) Any unusual outbreak of an endemic disease in exponential frequency causing significant change in the epidemiological pattern of that particular disease.

ii) The appearance of a previously unknown disease in a particular region.

iii) Animal health emergencies caused due to non-disease events, for example, a major chemical residue problem in livestock or a food safety problem such as hemorrhagic uraemic syndrome in humans caused by the contamination of animal products by verotoxic strains of *E. coli*.

iv) Deliberate introduction of exotic microorganisms in a targeted region.

(C) Fodder Poisoning - Accumulation in chemicals in plants leads to poisoning which is a potential danger to grazing animals. In order to keep a check on such cases, awareness among the local community must be created so that they take proper care of their animals and prevent them from eating poisonous toxic materials. Based on the above approach, the following activities should be undertaken:

i) Listing of the various poisonous materials, including braken fern, *Lantana camara*, parthenium, rati (*Abrus prectorus*), dhatura (thorn apple), kaner (oleandar); cyanogenic plants like immature maize, sorghum banchari, cereal affected with egrot, India pea; nitrate and nitrite containing plants, etc.; and the measures to prevent the availability of such materials to livestock.

ii) Exotic/cross breeds are more susceptible to damage under drought conditions than indigenous breeds. Livestock owners will be made aware of how to take proper care of these exotic/cross breeds.

iii) Certain areas will be demarcated for fodder production. Pastures should also be developed for migratory sheep and goat and clean grain made available for pigs and poultry.

(D) Trans-boundary Animal Diseases

TADs are a major cause of economic losses to the livestock industry and are those infectious diseases which could spread fast and have the potential to cause considerable mortality or losses in productivity. TADs have the capability to seriously affect earnings from export of livestock or its products.

A TAD epidemic such as avian influenza (bird flu) or FMD has the same characteristics as other natural disasters—it is often a sudden and unexpected event, has the potential to cause major socio-economic consequences of national dimensions and even threaten food security, may endanger human life, and requires a rapid national level response. Some very important diseases of animal husbandry and public health perspectives include: i) Non-zoonotic diseases – FMD, PPR, RP, CSF, CBPP, etc. ii) Diseases with known zoonotic potential – Anthrax, BSE, Brucellosis, CCHF, Ebola virus, Food-borne diseases, HPAI, JE, Q fever, Rabies, etc.

(E) Miscellaneous Causes - India may have remained blissfully unaware of the losses in livestock due to the Bhopal gas tragedy or the consequences of arsenic or other toxic elements that may not only cause acute loss of livestock but are also potentially hazardous for public health as livestock produce is directly related to the human food chain. The impact of major accident hazard units such as nuclear reactors and hazardous waste dumping sites are examples of slow and impending livestock disaster situations.

Role of veterinarians and veterinary service in disasters

During disasters, the role of veterinarians is to ensure high standards of animal health and to reduce mortality among animals. Veterinarians can play a major role in promoting local pre-disaster planning at community level which places a high priority on facilitating livestock and pet evacuation (Heath, 1999). Veterinarians have a role to play in all stages of disaster mitigation and management, but it is during relief efforts that they can play a crucial role in increasing the survivability of animals that are victims and of those that are deployed in rescue teams. Veterinarians can also instruct their clients on first aid for horses and livestock and advice on the contents and appropriate use of first aid kits. The basic needs in a standard kit are listed in table 2.

It is not possible to react effectively and efficiently to a disaster unless the response has been planned well in advance on the basis of a comprehensive risk assessment and unless the measures to be taken by the organizations, institutions and government bodies involved have been co-coordinated and carefully rehearsed. Three operational sectors are essential to be monitored: (i) Animal health, (ii) Hygiene for food processing and sales and (iii) Farm hygiene. These sectors, together with the Veterinary health service personal, are responsible for

a) Disinfection and disinfestations
b) Capture and care of stray animals including housing and feeding
c) Health care of animals
d) Disposal of animal waste and dead carcasses
e) Intervention in the case of epizootics
f) Storage and preservation of food of animal origin
h) Training and up-dating personnel.

Although many natural disasters can be predicted with a great degree of accuracy, salvaging cattle has never been a priority. Nevertheless, disaster management should consider making animal shelters in such areas in safe zones to house cattle. These animal shelters could also have provision for stocking fodder, medicines and drinking water. Endemic disease and chronic conditions like worm infestation or ticks require special attention.

Table 2: Minimum requirements for a standard kit - List of basic needs

Maps, stationery	Medical disaster kit: oxygen airway, intubation set, ventilation bag, suction device, chest tube set, tracheotomy set, etc.
Means for communication and transportation	IV fluids, drugs for shock, tourniquet
Area lighting, flashlights	Dressing/splint kit: compresses, gloves antiseptics, suture set, splints
Identification devices for area, staff and victims: flags, arm bands, triage tags	Blood pressure cuff, stethoscope
Stretchers, boards, blankets. Protective devices: gloves, masks, etc.	Scissors, adhesive tape

Prevention and Preparedness of disasters in livestock: National Scenario

Veterinary services in India:

Animal husbandry and veterinary services is a state subject and falls within the purview of the state government. As a consequence each state government and UT has its own department of animal husbandry and veterinary services. Subjects such as animal quarantine, prevention of inter-state transmission of diseases, regulatory measures for quality of biologicals and drugs, import of biologicals, livestock, livestock products and control of diseases of national importance are the responsibilities of the central government.

The Dept. of Animal Husbandry Dairying and Fisheries (DADF) of the Ministry of Agriculture handles the central animal health services. India has about 47,000 registered veterinary practitioners engaged in different activities. More than 70% of the registered veterinary practitioners are in the state government services. The country has 8,720 veterinary hospitals and polyclinics, 17,820 veterinary dispensaries, and 25,433 Veterinary Aid Centres (VACs) and mobile veterinary clinics totaling 51,973 centres. In addition, there are border posts which besides their border duties also work as disease reporting posts. Thus the total number of disease reporting posts is 52,390. These disease reporting units form the backbone of the disease surveillance system and have an effective coverage.

National Animal Disease Emergency Committee

The central government has a special responsibility for safeguarding against any new disease threatening to enter the country. In the event of an emergency in the livestock sector, the DADF activates its National Animal Disease Emergency Committee (NADEC) to monitor, evaluate and issue necessary guidelines to handle the emergency. At the state level, a similar committee, i.e., the state animal disease emergency committee is activated. The committee holds importance in case of Bird flu outbreaks wherein immediate help and support to the farms, poultry breeders and farmers is provided by the State authority through the emergency responsive system as per exigencies under intimation to the Chairman, NADEC. The freedom from Rinderpest was another achievement through the successful implementation of NADEC. All important stakeholders, including specialists in the subject are members of these committees. The concept is put forth by FAO.

Disease investigation laboratories in India

There are 250 disease investigation laboratories in India for providing disease diagnostics services. Many states have disease investigation laboratories at the district level. Each state has a state-level laboratory which is well equipped and has specialist staff in various disciplines of animal health. Beside the state disease investigation laboratories there is one central and five referral regional disease diagnostics laboratories funded by the DADF. Each state agriculture university/veterinary college also has disease diagnostic facilities. At the national level, the IVRI, and specially its Centre for Animal Disease Research and Diagnostics based at Izatnagar (Bareilly) and the Disease Diagnostic Laboratory of the National Dairy Development Board (NDDB) at Anand, Gujarat, are highly specialized laboratories providing disease diagnostic services. In order to monitor ingress of exotic diseases, a state-of-the-art laboratory exists at HSADL, Bhopal with BSL-4 standards.

Livestock management during disasters

The following preparations are essential for management of animals during disasters:

i) Development of flood, cyclone and other natural calamity warning systems. In principle, an early warning system (EWS) would make it possible to avoid many adverse economic and human costs that arise due to the destruction of livestock resources every year. Reliable forecasting would also allow state governments to undertake more efficient relief interventions. Other tools that may provide early warning signals include field monitoring and remote sensing systems. Remote sensing, which relies on imagery satellites, is a valuable tool when used in conjunction with field monitoring.

ii) Establishment of fodder banks at the village level for storage of fodder in the form of bales and blocks for feeding animals during drought and other natural calamities is an integral part of disaster mitigation. The fodder bank must be established at a secure highland that may not be easily affected by a natural calamity. A few fodder banks will be developed as closed facilities to prevent them from getting contaminated.

iii) Supply of feed ingredients at nominal cost from the Food Corporation of India: Most grain rations for cattle and sheep provide enough protein to maintain a satisfactory 10–12% level. But when we feed livestock in emergency situations—mostly low-protein materials such as ground ear corn, grain straws or grass straws—a protein supplement is needed. Adequate reserves as per the availability of resources will be developed.

iv) Conservation of monsoon grasses in the form of hay and silage during the flush season greatly help in supplementing shortage of fodder during emergencies such as drought or flood.

v) Development of existing degraded grazing lands by perennial grasses and legumes.

vi) Provision of free movement of animals for grazing from affected states to the unaffected reduces pressure on pastures and also facilitates early rehabilitation of the affected livestock. In emergency situations, the presence of livestock can exacerbate conflict when refugees with animals compete for reduced forage and water resources. To prevent this, what is technically known as emergency destocking programme, will be instituted. This programme provides for the intentional removal of animals from a region before they die.

viii) Treatment and vaccination of animals against contagious diseases in flood affected areas. Routine prophylactic vaccination of livestock in flood-prone area significantly reduces the severity of the post-disaster outbreak of any endemic diseases.

ix) Provision of compensation on account of distressed sale of animals and economic losses to farmers due to death or injury of livestock. A legislation that provides the power to destroy livestock and property, and the process by which compensation is to be paid has to be enacted and implemented by the respective legislative bodies.

Some of the common problems in early warning systems for serious epidemic livestock diseases after disaster include:

- Lack of farmer awareness programmes on high threat epidemic livestock diseases and generally inadequate contact between field veterinary staff and farmers.
- Disease reporting systems which are based primarily on passive reporting of outbreaks rather than active disease surveillance.
- Inadequate training of veterinary and paraveterinary staff in the clinical and gross pathological recognition of epidemic diseases, which may be either unusual or exotic for the country, the implications of delayed action, and the collection and transportation of appropriate diagnostic specimens.
- Poor coordination of field and laboratory veterinary services.
- Lengthy and over-complicated routine disease reporting chains and failure to institute an emergency reporting system for serious disease outbreaks.
- Failure to establish confirmatory diagnostic capabilities for the target diseases within national laboratories.
- Inadequate liaison with international reference laboratories and failure to send new virus strains from outbreaks to these laboratories on a regular basis for specialized antigenic and epidemiological analysis.

- Lack of an epidemiology unit and expertise to analyze new disease outbreaks, including trace back and trace forward activities.
- Failure to report new disease occurrences to appropriate international organizations, e.g. OIE, within an acceptable time.
- Lack of contingency planning and other emergency preparedness for epidemic diseases.

Existing international disease reporting mechanisms

The Office International des Epizooties (OIE) is the main international animal health organization responsible for international disease reporting. There is a well established system for emergency reporting of important diseases or diseases newly found in a country and a more routine reporting system for other defined diseases. There are a number of other international disease reporting structures, which operate on a regional or global basis either for specific diseases or of a more general nature. These include WHO, European FMD Commission, etc.

Nodal agencies for disaster management in India:

Various departments handle disaster management responses in India as listed under. The livestock disasters are handled by the DADF, MoA. The National Disaster Management Authority (NDMA) has been set up as the apex body for Disaster Management in India, with the Prime Minister as its Chairman. Disaster Management Authorities will be set up at the State and District Levels to be headed by the Chief Ministers and Collectors/Zilla Parishad Chairmen respectively. A National Disaster Mitigation Fund will be administered by NDMA. States and districts will administer mitigation funds. A National Disaster Response Fund will be administerd by NDMA through the National Executive Committee. States and Districts will administer state Disaster Response Fund and Disaster Response Fund respectively.

Table 3: Nodal agencies for disaster management in India

Floods	Ministry of Water Resources, CWC
Cyclones	Indian Meteorological Department
Earthquakes	Indian Meteorological Department
Epidemics	Ministry of Health and Family Welfare
Avian Flu	Ministry of Health, Ministry of Environment, Ministry of Agriculture and Animal Husbandry
Chemical Disasters	Ministry of Environment and Forests
Rail Accidents	Ministry of Railways
Air Accidents	Ministry of Civil Aviation
Fire	Ministry of Home Affairs
Nuclear Incidents	Department of Atomic Energy
Mine Disasters	Department of Mines
Livestock disasters	Department of Animal Husbandry Dairying and Fisheries

Steps for Prevention, Mitigation and Preparedness

DM plans at all levels will include the following important measures:

i) Public awareness about natural disasters that different regions and the country are most likely to experience and their consequences on the livestock sector.

ii) Provisions to establish adequate facilities to predict and warn about the disasters periodically, including forecasting disease outbreaks. This could only be achieved by a well networked surveillance mechanism that proactively monitors emerging infections and epidemics.

iii) Development and implementation of relevant policies, procedures and legislation for management of disasters in the animal husbandry sector. The livestock health infrastructure in India, modeled to provide routine veterinary cover, needs reorganization in view of emerging epidemics/challenges. The existing animal husbandry policies will be revisited and if required, modified to cater to changing realities.

iv) Mobilize the necessary resources, e.g., access to feed, water, health care, sanitation and shelter, which are all short-term measures. In the long term, resettlement programmes, psycho-social, economic and legal needs (e.g., counselling, documentation, insurance) are required to be undertaken.

v) Another long-term strategy is required to readjust the livestock production system in the country from a biosecurity point of view so that in the event of the entry of any new, dangerous pathogen, the losses could be minimised by segregation.

vi) Initiation of PPP in livestock emergency management, especially in the field of vaccine production, will go a long way in combating animal health emergencies of infectious origin. Similar partnership in feed manufacturing as well as livestock production will minimize the losses due to other livestock emergencies.

vii) Commissioning of risk assessments on high-priority disease threats and subsequent identification of those diseases whose occurrence would constitute a national emergency.

viii) Appointment of drafting teams for the preparation, monitoring and approval of contingency plans. Implementation of simulation exercises to test and modify animal health emergency plans and preparedness are also necessary.

ix) Assessment of resource needs and planning for their provision during animal health emergencies.

x) Central/state governments will develop/ establish an adequate number of R&D and biosafety laboratories in a phased manner for dealing with animal pathogens.

xi) A dedicated establishment, preferably under DADF, may be entrusted with the overall monitoring of the national state of preparedness for animal health emergencies.

xii) Development of active disease surveillance and epidemiological analysis capabilities and emergency reporting systems.

xiii) A computer-based national grid of surveillance and disease reporting should be developed for timely detection and containment of any emergent epidemic.

xiv) An intelligence cell—Central Bureau of Health Intelligence under DGHS should be raised to assist the proposed National Animal Disaster Emergency Planning Committee (NADEPC).

xv) Immunization of all persons who are likely to handle diseased animals such as anthrax infected cattle and animals.

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Emergency preparedness in the face of zoonotic disease outbreak

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Outbreaks of serious zoonotic disease, whether new, emerging or re-emerging, constitute emergencies and disasters for the communities and countries in which they occur and should be prepared for and managed accordingly; however this is not always immediately recognised. Zoonotic disease emergencies may occur due to: Emergence of new diseases with unknown but potentially severe epidemic potential; Incursions of known zoonotic diseases into countries or districts which had been historically free or had previously eradicated the disease; or, Epidemics of known endemic zoonotic diseases, due to either inadequate preventive or control measures, or unknown but rare ecological events.

Serious zoonotic diseases are emerging or re-emerging around the world, with increased human and livestock population, and increased travel and trade. Recent experience with SARS and HPAI particularly has sensitized international organizations and led to the incorporation of emerging infectious diseases (EID) into wider global disaster risk reduction frameworks and strategies. This in turn has led to Increased global commitment and availability of improved emergency preparedness and response frameworks, new technologies, innovative community engagement models and international funding sources, to tackle previously neglected zoonoses which otherwise can cause disastrous outbreaks. However, inclusion of zoonotic disease outbreaks / incursions in an emergency preparedness and response framework is a major challenge for developing countries, when considered against their many pressing development needs. Although outbreaks of serious zoonotic disease, whether new, emerging or re-emerging, constitute emergencies and disasters for the communities in which they occur and should be prepared for and managed accordingly, this is not always immediately apparent to resource-poor governments. The disaster of a zoonotic outbreak may occur at several levels, e.g. the damage caused by the disease to human and / or animal health, loss of smallholder income as a result of livestock market disruption, or damage and loss caused by the disease control program. In some cases smallholders will ignore the presence or impact of the disease, but will find the control program a disaster if it means killing their livestock (especially without compensation). Some zoonoses, with known or observed pandemic, bioterrorism or transboundary potential, are easily assimilated into recognized disaster risk reduction frameworks, and also attract global and national attention. However, because of the insidious manner in which other zoonoses emerge, they may not be recognized as emergencies or disasters until they have spread extensively, compounding the misery and costs of control they eventually cause.

Action Plan

Drivers for strengthening national frameworks for emergency zoonoses preparedness include:

- Increasing risks of zoonotic disease emergence or re-emergence with increased human and livestock population and increased travel and trade; and

- Increased global commitment and availability of improved emergency preparedness and response frameworks, new technologies, innovative community engagement models and international funding sources to tackle both newly emerging and previously neglected zoonoses which otherwise can cause disastrous outbreaks.
- The policies, institutions and stakeholders engaged in preparedness for and response to zoonotic disease emergencies are critical to their effective management. These will determine the success or otherwise of management and control efforts at least as much as, if not more than, detailed technical understanding of the disease.
- International disaster management frameworks should and are being applied at the national level in many countries. Effective and implementable national emergency preparedness plans are the key to managing emergency zoonotic disease risks.
- Operational and systems research into adequacy of zoonotic emergency preparedness in different countries can facilitate investments which will increase their long term resilience in the face of future zoonotic threats.

International frameworks

International efforts in disaster risk reduction have been crystallized as the "Hyogo Framework for Action: (HFA) Building the resilience of nations and communities to disasters". This framework applies to natural disasters such as earthquakes and tsunamis and also directly applies to human disease epidemics.

The International Strategy for Disaster Risk Reduction (ISDR) includes epidemics of human diseases within this framework, however ISDR staff may neglect this aspect to concentrate on natural events, despite data on UN ISDR Prevention web which show that epidemics are among disasters with high mortality. Significantly the economic costs of epidemics are often not calculated.

At the regional level, ASEAN has created the first legally binding HFA-related instrument with their ASEAN Agreement on Disaster Management and Emergency Response (AADMER). AADMER is a proactive regional framework for cooperation, coordination, technical assistance, and resource mobilization in all aspects of disaster management, including emerging infectious diseases (EID). The AADMER gives priority to disaster risk reduction and proposes the inclusion of all stakeholders such as NGOs, private sector, and local communities as a key to effective disaster management.

From the HFA, global organizations have developed supporting sectoral plans, e.g. the FAO/WHO framework for developing national food safety emergency response plans(WHO 2010), which contains excellent broad principles highly relevant to zoonotic disease emergencies, and the WHO strategy on health sector risk reduction and emergency preparedness (WHO 2007).

National frameworks

A strong framework of national preparedness is the key to managing known disease risks and there are many models around the world. While broad international frameworks have been developed, effective response involves preparedness at national and lower levels. There is also a need for sectoral plans at international and national levels e.g. the UN Medical Directors'

Influenza Pandemic Guidelines (UN 2011), and Australia's Emergency Animal Disease (EAD) framework.

Research on policies, institutions and stakeholders involved in zoonotic emergency management

Comparative research is needed to determine the applicability of successful emergency management frameworks to the management of zoonotic disease outbreaks In individual developing countries, and associated gaps in national arrangements and opportunities for integration of action between agencies. Examples of some web-available emergency zoonoses preparedness plans and policies developed in south-east Asian countries and sub-Saharan Africa, and demonstrate the relative lack of inter-sectoral planning in some areas are freely accessible.

Research on **decision making in the face of zoonotic emergencies** is particularly useful for improving risk management and risk communication procedures. Austin *et al* (2012) point out that:

"the criteria and timing for policy response and the resulting management decisions are often altered when a disease outbreak occurs and captures full media attention. ..... Political and media influences are powerful drivers of management decisions if fuelled by high profile outbreaks. Furthermore, the strength of the scientific evidence is often constrained by uncertainties in the data, and in the way knowledge is translated between policy levels during established risk management procedures.."

Research on preparedness and response to different types of zoonotic emergencies

I. Emergence of a new zoonosis with severe epidemic potential

In recent years, a number of previously unknown viruses or new recombinant strains of known viral pathogens have emerged and caused major disruption due to their potential to cause global pandemics. Some key examples are SARS, Nipah virus and H5N1 HPAI. Each of these has required both pre-existing and newly developed policies and procedures, and linking mechanisms for institutions and stakeholders, to develop and implement responses, at the local sub-national, national and international levels. Research on the effectiveness of these responses from the perspectives of different stakeholders can yield valuable lessons for future preparedness.

If a previously unknown disease is seen to be causing significant human mortality or morbidity, very stringent medical policies and procedures may need to be applied in the absence of complete or any information about the pathogenicity and epidemiology of the disease.

- Measures to prevent person-to-person spread may require sound medical and hospital barrier nursing procedures as close to the outbreak location(s) as possible. Prior education of frontline medical staff and availability of PPE and appropriate biocontainment facilities are highly desirable.
- Legal powers should be available and implementable to prevent people moving to or from quarantine areas. Medical authorities may require support from police.
- Governments and politicians must be helped to understand the necessity for such measures, and for how long they may be required.
- Risk communication to the affected and potentially affected communities is needed to support societal response and reduce panic, with attention to social and cultural contexts.

- Global or regional trans-national risk management and reporting measures may be required according to the International Health Regulations (WHO 2007) and the OIE Animal Health Act.

Adequate technical response must also be developed including measures such as:

- Diagnostic criteria and tests.
- Urgent surveillance and applied research to determine the source and extent of the infection.
- Vaccine development and registration if appropriate or feasible.
- Mechanisms to tap into global expertise quickly and efficiently.

When an animal reservoir is suspected and/ or confirmed, or if the main expression of disease is in animals, appropriate short and long term control or eradication measures need to be developed and implemented. Operational and systems research may be needed in the following areas.

- Discovery of livestock and / or wildlife reservoirs creates different implications for action and for involvement of different institutions and stakeholders.
- Policies of stamping out or short or long term movement controls for infected or highly at risk livestock populations may in some situations be technically sound but unfeasible due to market pressures and other issues including:-
    - lack of legally empowered, trained, equipped and supervised field staff;
    - lack of adequate compensation policies or the funds and practical means to implement them; or
    - Impact of loss of livestock on smallholders' livelihoods and / or cultural practices.
- Value chain analysis of movements of livestock and livestock products, coupled with a disease risk analysis framework and cost benefit analysis of proposed controls and disease impacts, may be urgently needed to devise control programs which do not impose unnecessary burdens on smallholder farmers and others in the value chain, leading inter alia to non-compliance with poorly devised programs;
- Cultural and social implications and acceptability of disease control actions in different livestock sectors may need careful examination at many local and sub-national levels;
- Involvement of wildlife in the disease epidemiology will raise a wide range of ecological and sometimes social issues depending on the species and environments involved. Prospects for compartmentalization and reduction of risky contact between wildlife reservoirs and people and/or susceptible livestock will need assessment.

II. Incursion of a known zoonotic disease into a country or part thereof which is historically free or has previously eradicated or effectively controlled the disease

Some zoonotic diseases e.g. rabies, are so feared that they have been well controlled or eliminated from their host animal species in most developed countries, and programs of varying effectiveness operate in many developing countries. Without global eradication, however, risks of incursion and re-establishment remain and may intensify as global trade and travel increase. These incursions may not appear as emergencies at first and hence spread to the point where they become major disasters, diverting scarce medical and veterinary resources from other programs.

Early detection of new incursions of serious zoonotic diseases is the key to their effective control before they cause too much damage and spread too far to be easily and economically containable. Research is needed into novel and cost -effective ways to deliver early detection (e.g. Desktop Flutracker for community based surveillance, "a tool that allows users to conveniently and accurately track the appearance and spread of flu in any community in the continental United States http://www.tamiflu.com/flutracker/) and the availability of :

- Health and veterinary / agriculture services which are aware of potential major disease risks and ideally have some surveillance programs for them.
- Community capacity building and education about key disease risks and reporting mechanisms.
- Field staff or community members who can respond to community concerns or observations , and either report to health / veterinary services or collect adequate specimens and transport them to be tested.
- Diagnostic facilities with equipment, reagents, trained staff and quality assurance procedures.

Once a serious zoonotic incursion has been diagnosed, application of appropriate technical measures is desirable as quickly as possible, to contain and if possible eliminate the disease from the recently infected area. A number of key non technical elements are also needed, namely:-

- Appropriate legal powers, instruments and policies to implement them, based on contingency / preparedness plans for dealing with such incursions, ideally agreed jointly by senior government agencies and other relevant stakeholders.
- Mechanisms for providing emergency funding, including cost-sharing arrangements between key stakeholders, to address such incursions adequately and in a timely manner.
- Mechanisms / policy framework to ensure high level commitment and coordination of government and other stakeholders to support decision making and funding of economically and technically preferred control / eradication options.
- Arrangements for organization of emergency response which are easily understood / grafted onto existing government structures.
- Trained staff in relevant agencies who can initiate / manage the response.
- Economic expertise to conduct prospective / retrospective cost:benefit analysis.
- Planning and project management expertise and authority to develop and implement agreed long term disease control measures /programs.
- Budgets to assist in control, and compensation to animal owners where culling occurs.

Prospective research into the availability of these elements and their customization to local conditions, particularly at the national and sub-national levels, is highly desirable.

III. Epidemics of known endemic zoonotic disease, due to either inadequate preventive or control measures, or unknown but rare ecological events.

Some endemic and effectively ineradicable zoonotic diseases such as anthrax periodically cause unexpected outbreaks in areas not suspected of being infected, which should if possible be handled as emergencies to reduce risks. Likewise the possibility exists of future emergence of rare but known diseases such as SARS in new ecological niches. These outbreaks ideally require:-

- Rapid response based on contingency plans, sound policy, adequate funding and stakeholder commitment;
- Retrospective risk analysis of why the epidemic(s) occurred including the impact of ecological, social and cultural factors;
- Development and implementation of new policies and procedures customized to the local situation and then generalized to prevent or promptly respond to further epidemics in future over as wide an area as possible; and
- Capacity building particularly in at risk communities and the professionals and agencies which serve them.

Prospective research on the adequacy of national and sub-national preparedness and the capacity of smallholder communities to respond to such outbreaks is highly desirable. A case study of the emergence of Nipah virus and different responses in Malaysia and parts of South Asia illustrates the complexity of the policy responses, institutional involvement and stakeholder engagement required to a previously unknown zoonotic disease in different ecosystems. A case study of management of several rabies incursions in Indonesia and Africa, nested in a wider background of rabies management in Africa, illustrates the impact of different dog : human ecosystems on drivers for rabies spread and persistence, the difficulty of mounting timely responses to incursions and particularly of amassing sufficient resources to mount effective rabies control programs.

IV. Key researchable areas for management of zoonotic disease emergencies

Operational and systems research is needed on many issues including:-

- Application of international disaster risk reduction frameworks in regional, national and sub-national plans for severe zoonotic outbreaks
- Sectoral and intersectoral awareness of zoonotic potential to cause disasters and multi-stakeholder involvement in policy formulation for prospective outbreaks
- Risk assessments allowing prioritisation of zoonotic emergency disease threats
- Availability of disease outbreak preparedness plans and policies which have been agreed by all relevant agencies
- Availability of agreed emergency funding and decision making arrangements to allow outbreak response plans to be implemented
- Capacity of national and local staff, value chain participants, livestock owners and communities to respond effectively
- Evaluation of mechanisms and implementation procedures for compensating owners for livestock destroyed in stamping out programs
- Availability and application of vaccines etc to combat specific diseases

V. Challenges and opportunities for zoonotic emergency management

Challenges	Opportunities
Developing rapid response systems which can work at national and sub-national levels	Assessing the applicability of proven rapid response models in different developing country contexts
Customising zoonoses emergency control policies to suit local conditions	Assessing the economic, social and cultural implications of proposed or existing policies

Including zoonotic emergencies in national disaster risk reduction plans	Assessing the economic, social and cultural impacts of zoonotic epidemics and mechanisms for inclusion in disaster reduction frameworks
Finding mechanisms for rapid resourcing of zoonotic emergency responses	Assessing cost-sharing arrangements between international and national agencies which will support timely control and eradication programs for zoonotic emergencies
Giving legal authority for necessary rapid control action for zoonotic emergencies which are appropriate for developing countries	Determining successful legal arrangements in place around the world and sharing lessons learned
Evidence-based decision making in the face of uncertainties	Research on effective rapid decision making by relevant local, national and international institutions
Capacity building at all levels for emergency preparedness and response	Research on best and most cost effective systems and impacts of past activities

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By ethical conduct toward all creatures, we enter into a spiritual relationship with the universe.

A. Schweitzer

Biosecurity measures at poultry farms for prevention and control of zoonotic disease

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During the past two decades, primary breeders of broiler, egg and laying strains have eliminated vertically-transmitted diseases from their elite and great-grandparent generations. Unfortunately, infection of grandparent and parent flocks occurs in many developing countries resulting in dissemination of diseases including mycoplasmosis, salmonellosis and reoviral infection. Improved biosecurity and an awareness of the need for appropriate vaccination programs, reduces the potential losses caused by both catastrophic and erosive infections on commercial-scale farms, village cooperatives and in integrated operations.

Angara disease, virulent infectious bursal disease, highly pathogenic influenza, reoviral stunting syndrome and swollen head syndrome are examples of emerging diseases affecting flocks in Asia, Africa, and Latin America. In addition, chronic, low-intensity infections such as coryza, pasteurellosis, and salmonellosis continue to erode profit margins. Prevention of disease depends on a comprehensive program incorporating a sequence of planning, implementing and control in a repetitive cycle. Strategies to prevent infection are based on the purchase of breeding stock free of vertically-transmitted disease. Vaccination of parent flocks and progeny and appropriate levels of biosecurity represent the components of disease prevention subject to direct managemental control. The relative importance and contribution of these strategies can be calculated using simulation studies. These should incorporate projections of risk of infection and compare the production parameters and costs for diseased and healthy flocks.

Objectives of bio-security:

- To keep highly contagious diseases like IBD, ND out of the poultry farm.
- To reduce common pathogens like E. coli and Salmonella.
- To reduce or eliminate background immunosuppressive agent such as MD & IBD virus.
- To reduce contamination by pathogens important to public health safety like Salmonella, Campylobacter.

The components of biosecurity comprise a hierarchy with each of 3 levels influencing the cost and effectiveness of the entire program.

Conceptual Biosecurity:

The primary level represents the basis of all programs to prevent disease. Conceptual biosecurity includes selecting the location of a complex or operation in a specific area to separate different types of poultry, reduce biodensity, and avoid contact with free-living birds. Siting of farms in relation to public roads and service facilities such as hatcheries, feed mills, and processing plants has a profound impact on the effectiveness of a program to maintain optimal standards of production. Decisions concerning conceptual biosecurity influence all subsequent activities relating to prevention and control of disease. Generally, defects in conceptual biosecurity cannot be changed in response to the emergence of new diseases which may result in severe losses or even failure of an enterprise.

Structural Biosecurity:

The second level of biosecurity includes considerations such as the layout of farms, erection of fences, construction of drainage, allweather roads, equipment for decontamination, bulk feed installations, change rooms, exclusion of rodents and wild birds, and the interior finishes in houses. Structural biosecurity can be enhanced in the intermediate term with appropriate capital investment. Remedial action may often be too late to respond to the emergence of a new disease or an epornitic of a catastrophic infection such as highly pathogenic avian influenza.

Major steps:

- Fencing of farm perimeter to prevent unwanted visitors restricting the entry of outside
- visitors & human beings.
- Test the water source for mineral, bacterial, chemical contamination and pathogen load.
- Disinfectant spray with suitable water and power supply for sanitization of vehicles.
- Suitable location for storage of bagged feed.
- Good roads within the farm to ease cleaning and to prevent spreading of microbes by vehicles and footwear.
- Facilities for scientific disposal of dead birds.
- Safe housing with suitable wild bird and rodent proofing.
- Feed, litter and equipment should be stored in section separated from the live bird area to prevent contamination.
- A 3 meter boundary of land around buildings must be kept free of all vegetation to inhibit rodent and wildlife activity.

Operational Biosecurity:

The third level comprises routine managemental procedures intended to prevent introduction and spread of infection within a complex or enterprise. These activities can be modified at short notice to respond to disease emergencies. Constant review of procedures, participation by all levels of management and labor and appropriate monitoring of the health status and immunity of flocks contributes to effective operational biosecurity.

Major steps:

- Operational manuals incorporating emergency plans should be developed for day to day activities carried out in feed mills, hatcheries, breeding and grow out facilities.
- Proper decontamination and disinfection of equipment, houses, etc. following depletion of flocks.
- In breeder farms, all workers and visitors should shower and use clean farm cloths to prevent cross contamination between facilities.
- Marinating a record of visitors, including name, comp[any purpose of visit previous farm visited and next farm to be visited.
- In case of breeders, no vehicles, or equipments should be allowed within the farm area from the time of delivery of flock until depletion.
- In commercial broilers units a minimum inter flock interval of 2 weeks is recommended.
- Effective pest management programme through biological, mechanical and chemical means.
- Appropriate disease detection and proper vaccination schedules should be implemented.
- In case of small-scale egg production units, follow all-in-all-out, If this is not possible, pullets should obtain from a source fee of vertically transmitted diseases.
- Recycled egg packing material, plastic egg trays. etc. Should be decontaminated at the point of entry to the farm.
- Routine disease monitoring procedures like post mortem examination of dead birds and periodic serum antibody assays to determine the immune status of flocks is necessary.

General biosecurity measures:

The following managerial factors help to reduce the spread of disease and stress to the birds.

1. Isolation

- Isolation of poultry farm from other poultry reduces the risk of infection
- Cross infection between farms is reduced at least up to 50% if a barrier of 5km is there.(Practically, isolation is more difficult because of the cost of transportation, feed, egg, bird and supply labour).

2. Security fencing

- Fencing of farm is very important in restriction of entry of natural predators like jackel, fox, and wolf for security and to protect from theft.
- Foot bath at the point of entry into each poultry farm will help in disinfection to a great extent.
- Showering in and showering out, that is staff, visitors and vehicles have no other entry to farm other than the shower system.

3. Farm and shed

- Batch interval before introduction of new flock (15 days to 1 month)
- Concrete floor for proper and easy cleaning.
- Clean thoroughly disinfect with a suitable detergent and disinfectant
- Proper curtains to protect the flock from extreme climatic conditions and rain water entry with adequate ventilation
- Knowledge of prevention of disease and to check bacterial load from microbiology laboratory
- Plant trees not fruit trees and do not allow grasses or weeds to grow around shed put gravel in between sheds.
- Distance between 2 different sheds of same type is 30 feet and different type is 100 ft and poultry house to hatchery is 500 feet.
- Construct proper drainage system

4. Human traffic

- Control of human traffic including regular workers, visiting service man particularly weekend veterinarian, who may visit several site in successive.
- Do not allow any visitor except on special circumstances like veterinarian.
- If possible the visitor should be covering all even boots ;supplied by the farm and disinfected after use.
- Record of all visitors to site with name, date of visit, nature of business is must.
- Staff and visitors having no other entry to the farm other than shower system
- Keep visitors to a minimum

  Human transportation of disease-causing organisms is one of the more serious threats to biosecurity.
- Post signs at the entrance to the farm indicating that entry to the farm and facilities are restricted.
- Lock buildings
- Do not be afraid to ask any visitors where they have been. They should not have been on a poultry farm within 48 hours before visiting yours.
- Owner should restrict visitors and make sure that any visitor to their farm has a good reason to be there. Visitors should never enter poultry houses unless approved by the farm personnel.
- Protective covering such as boots, coveralls, and headgear to any visitors that work with, or have had recent contact with poultry.
- Traffic through poultry houses should always flow from younger to older birds.

- Keep records of visitors that have been on the farm. If a problem arises, knowing who was there will help in limiting additional flock infections.

5. Restricting movement of vehicles

- Transport vehicles enter various farms regularly and are at great risk of infections. So, allow vehicles only when necessary.
- Avoid the entry of feed truck in premises by holding feed tank at the farm and then distribute to individual houses.
- Use of detergent and disinfectant outside and inside the drivers' compartment. Sanitizing the trucks as they enter the farm by disinfectants.

6. Rodent and wild bird control

- Rats and rodents are great disease spreaders and have to be controlled and eradicated
- Make the shed rodent proof.
- Wild birds have potential of carrying infectious organisms restrict their entry to farm.
- Do not throw away organic material like dead birds, meat used food, feed etc around the shed which attracts crows etc.
- No litter should be around the shed and should be transported away from shed.
- Control movement of all animals in the farm including dogs.

7. Equipments:

- Entry of equipments from farm to farm only after they are disinfected.
- Egg flats from farm to hatchery must be sanitized at hatchery.
- Entry and exist of egg flats into the farm and outside farm must be restricted.
- Disinfect the feeder and waterer

8. Water:

- Poultry farmers often fail to provide the birds with good quality water.
- Both the microbial and chemical quality of the water need to be tested before establishing a poultry farm in a given area.
- Microbial contamination of water may happen at the source, for instance in ponds, rivers, open wells and the public water supply system, or during transportation and storage, as well as in the overhead tank or bins. Unhygienic practices on the farm result in the spread of disease.
- The microbial load shoots up during flood conditions.
- Faecal contamination of water will add to the presence of coliform organisms.
- Mineral levels in water depend on soil conditions, and show only minor fluctuations based on the season and the water table.
- They lead to hardness in water and affect the taste and palatability.

Quality guidelines for drinking water on poultry farms

The desirable quality guidelines for drinking water on poultry farms are as follows:

- Total hardness : 60-180
- pH : 6.8-7.5
- Nitrate : 10 mg/litre
- Nitrite : 0.4 mg/litre
- Total bacterial count : 0/ml
- Coliform count : 0/ml
- Calcium chloride : 60 mg/litre
- Sodium : 50 mg/litre
- Sulphate : 125 mg/litre

9. Feed:

- Feed acts as a vector for micro-organisms
- Storage of excess feed must be avoided.
- Store in feed room above the ground and away from walls.
- Lumps in feeds must be discarded.
- Feed tanks must be swept every month, disinfected twice in month and fumigated at end of each crop of birds to reduce bacterial count and mold growth. Mould inhibitors can be used.
- Check feed for toxins such as aflatoxins etc.Heat treatment is helpful as it does not affect the nutritional quality.

10. Health monitoring:

10.1) *Recognizing sick birds*:

It is important to recognize sick birds. It is simple to check flock for dead birds but it requires skill to recognize sick birds. When walking through a flock, take time to scan the birds and spot individuals showing signs of illness, such as:

- Lethargy, lack of energy, drooping wings
- Loss of appetite
- Swelling of the head, eyes, comb, wattles and hocks
- Purple discoloration of the wattles, combs and legs
- Nasal discharge
- Coughing, wheezing, or sneezing
- Lack of coordination or complete paralysis
- Muscle tremors or twisted necks
- Diarrhea
- Sudden or excessive mortality without clinical signs
- Decreased egg production, soft-shelled or misshapen eggs for broiler.
- Abnormal respiratory sounds, of called a 'snick' can be heard. These sounds may have a variety of characteristics such as a high-pitched 'squeak', a sudden' chuck' sound, like a cough, or a gurgling or rattling sound.

10.2) *Vaccination*

10.3) *Maintain records*:

a) Flock mortality records will alert the producer of a potential problem, which should trigger the appropriate response and the first of which will be to find the cause of the problem.

b) Production records

A producer keep daily feed and production record which helps to check for drop in egg production or feed consumption, or a rise or fall in water consumption and it aware the producer to a potential problem. A drop in feed or water consumption can be a sign of an infectious disease.

A significant drop in consumption must be checked and specific diagnostic actions taken. It included investigations of the watering or feeding system to make sure that a failure in the supply has not resulted in the consumption drop. In absence of physical reason diagnostic procedures should be followed such as collection of feed and water samples.

A drop in egg production or fertility may be an indication of infectious disease. Such drops should be investigated and diagnostic. Veterinarian advice is must.

11. Method of rearing:

- All in all out system: Only one age group of birds on a farm and farm is populated at one single time.
- Depopulating the farm reduces the major disease threat.

12. Cleaning and disinfection:

- Disinfection is the process or act of destroying pathogenic microorganisms.
- A disinfectant is an agent that destroys pathogenic organisms, and that can be applied on inanimate objects or used as a footbath.
- Phenol, cresol, chlorine compounds and iodophors can be used for disinfecting surfaces as well as the egg room, feeders, drinkers, buildings and footwear; liquid formalin at 5 percent level, or formaldehyde gas by fumigation, will also serve as an effective disinfectant.
- Sun-drying may be practised for washed equipment; for cement surfaces-dry heat in the form of flame is recommended.
- Copper sulphate as a 0.5 percent solution is effective against fungi.
- Quarternary ammonium compounds are good disinfectants when used according to directions. However, they are not effective in hard water.
- They can be used for disinfecting surfaces, washing egg rooms, feeders and drinkers and other equipment.

13. Insect control:

- Counter measures against insects are part of maintaining a sanitary environment, as insects play a significant role in transmitting disease-producing micro-organisms, tape worms, etc.
- Flies sit on the birds, irritate them, prevent them from taking water and feeding normally, causing stress which results in reduced egg production especially where cage rearing is practised. Insect or fly control measures include:
  - ✓ Avoiding stagnation of water in and around the farm premises.
  - ✓ Provision of proper drainage facilities, attending immediately to leaky drinkers, water lines, etc.
  - ✓ Use of insecticide sprays or dusting at required intervals,
  - ✓ Treating the birds and checking the feed and water quality to avoid watery droppings.

Keep the surroundings clean by covering the area with treated soil devoid of vegetation or by growing grass lawns.

14. Dead bird disposal:

The main principle involved in the prevention and control of current and emerging diseases is the scientific disposal of dead birds.

- Mortality is inevitable on every poultry farm, and it varies with the prevailing disease and sanitary conditions on the farm.
- When birds die, their carcasses remain as a source of infection for pen-mates and other birds on the farm (or other farms).
- All carcasses should be removed from the pen as soon as possible.
- Diseased and ill birds also discharge infectious material into the environment and act as reservoirs for disease-producing organisms.
- It is essential to eliminate ailing birds from the flock rather than jeopardize the health of the remainder of the flock.

- The habit of throwing dead birds on to the nearest manure pile or into an open field is dangerous and unscientific for the following reasons:
- The smell of the carcasses attracts street dogs and cats, which consume the infected carcasses and harbour the enteric organisms infectious to poultry. Because of their free movement, these animals are capable of carrying contaminated material or a portion of a carcass to neighbouring farms, with disastrous results;
- Vultures and other wild birds invade the carcasses and become potential carriers of the disease-causing agents from one farm to another or even from one country to another country if they migrate;
- The carcasses lure insects and flies, which act as transmitters of infectious agents;
- The disease agents carried by rain water contaminate other water sources;
- The surrounding area of the farm is contaminated with feathers and bones, causing soil pollution; On decomposition, the carcasses may emit a foul smell and cause air pollution.
- The disposal of carcasses of birds dying from known or unknown causes, should be carefully attended to.
- There are many methods for the efficient disposal of carcasses such as burying, pit disposal, incineration, septic tank disposal, or composting.
- In general, the following points should be observed while disposing the carcasses:
- Remove the dead birds from the flock as soon as possible;
- Do not deposit carcasses in or near a flowing stream;
- Take the necessary precautions to prevent spillage of infectious material from the carcasses during transportation from the farm or post-mortem room to the disposal site;
- Take sound bio-security measures at the disposal sites to prevent disease transmission.
- Moreover, with the present concern for the environment, the poultry industry needs to pursue efforts to protect the environment.

Therefore, all methods that allow for environmentally safe and scientific ways of disposing of carcasses should be considered.

15. Litter removal

- After the pen is emptied, deep litter and caged layer droppings should be removed to a field far from the poultry shed, and spread to dry in the sun.
- It should be disposed off as soon as possible for manure or other purposes and not allowed to remain accumulating for a long period.
- Composting is better, since the heat produced will destroy the pathogens.

16. Personal hygiene of worker

- Use of clean and separate clothing meant for farm premises only.
- Hand sanitizers and cleaning tubs must all time be available in the shed.
- Separate workers for different age groups and different farms are must.
- Sick persons kept away from the farm.

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Animal evacuation and emergency shelter during disasters

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A disaster is a natural or man-made catastrophe resulting in significant physical damage or destruction or loss of life both human beings and animals. Disaster disrupts and affects everything in its path, including pets, livestock, and wildlife. Disaster negatively affects the weaker sections of the community particularly landless or small holder farmers who depend on animals for livelihood. Though, animals act as primary source of livelihood to the poorest of the poor, but disaster management of animals do not figure anywhere in preparedness, mitigation or rehabilitation. However, livestock play a key role in all the components of disaster management. Dogs are used for search and rescue operations, other animals like horse, mule, draft cattle etc. are the primary means of transport of injured and invalid people during disaster when no other transport is possible and pigs are also used for clearance of debris in disaster affected inaccessible areas. Therefore it is needed to evacuate the animals both companion animals and livestock and the provision of emergency shelter for animal along with the human being during disaster.

Why talk about animal evacuation?

In India at any time of the year, at any time of the day or night, a disaster or threat of a disaster could force people to leave their homes or even the community in which they live. However, while talking animal evacuation and sheltering there is little interest because the value of animal is less. Moreover, in transit camps or in rehabilitated dwellings too the animals can be utilised for milk, manure, transport, fuel (dung cakes). During emergency, animals are also sometimes used for fetching or lifting of water from the water sources, where machine or man power are not available or can't be used. Animals during disaster can be managed by partially damaged crops and grains those are unfit for human consumption.

Preparing before an emergency by learning about the community warning systems and evacuation routes and by making evacuation plans and discussing them with household members is the best way to be ready in case an evacuation is necessary. Making plans at the last minute can be upsetting, create confusion, and cost precious time.

Why talk about animal sheltering?

Sometimes, a disaster or threat of disaster mandates that farmers should shelter their animals in their home. The shelter should be safe for the animals depending on the disaster. The farmers should know the places where to shelter the animals and what to do for safe stay of animals. However, sometimes during cyclone or flood, farmers are forced to evacuate their animals from the immediate area, or even the entire region, and to shelter at public facilities. Knowing in advance, what to expect and preparing for all sheltering scenarios will make sheltering experiences safer and more secure and comfortable to the animals.

Evacuation

If evacuation of the animals is being considered to avoid the hazard, be sure to prepare before a disaster. Preparatory meeting should be organized in disaster prone areas by the Veterinarians/Para-vets to discuss the steps to be taken in this regard by the livestock keepers and others. The livestock holders of large and small animals and poultry should be trained regarding shifting of animals/ birds before disaster. The owner should plan the evacuation procedures, places, and routes. The following points should be considered for emergency evacuation:

1. First the safe place out of the area in danger should be located either with family, friends or government personnels and arrangements should be made with the owners of these places to accept the animals.
2. If it is not possible to evacuate all animals then owners should decide ahead of time that which animals are the most important to save. For the selection of animal to be evacuated with priority should be decided based on various decision criteria such as sale value, breeding quality, stage of pregnancy, stage of production, or simply sentimental preference.
3. Farmer should maintain a farm inventory. List of all animals on the farm should be kept and their location and any records of vaccinations or testing should also be mentioned.
4. After selection of animal to be evacuated, all animals should have some form of identification.
    a. Animals should be identified ahead of time and a written list be kept, so that in absence of the owner during disaster threatens, others could then know which animals to save.
    b. The animals should be photographed and permanently identified by metal/plastic ear tag, tattoo, brand or registration papers.
    c. A permanent record of the identification must be kept which will be useful to resolve arguments of ownership in case of animal loss or displacement.
    d. Papers documenting the identification should be kept with other important papers.
5. Primary and secondary routes should be mapped out in advance to avoid interfere with human evacuation routes. Alternate routes should be found in case the planned route is not accessible.
6. In advance, an evacuation kit should be prepared, it includes:
    a. Handling equipment like halters, nose leads,
    b. Water, feed, and buckets
    c. Medications,
    d. Tools and supplies needed for sanitation
    e. Cell phone, flashlights, portable radios, and batteries
    f. Basic first aid kit
    g. Safety and emergency items for your vehicles and trailers and
    h. Gas powered generators etc.
7. Restraint equipment, food and water supplies should be available to use and move with the animals or evacuation destinations should be prepared with, or ready to obtain, food, water, veterinary care, and handling equipment.
8. Truck, trailers and other vehicles needed for transporting and supporting each type of animal should be available along with experienced handlers and drivers in advanced. It is best to allow animals a chance to become accustomed to vehicular travel so they are less frightened and easier to move. Sufficient people should be on hand to help during moving the animals.
9. Ultimately the decision to evacuate will depend on the distance to be travelled, the amount of time available before the disaster is due to impact on the farm, and whether there is any advantage of moving the animals to the place selected.
10. In case evacuation is not possible, animal owners must decide whether to move large animals to shelter or turn them outside. This decision should be based on the disaster type, quality and location of shelter and the risks of turning them outside.

11. In earthquake prone area, animal should be always tied outside or in thatched shed, in flood prone area animal should not be tied during flood/cyclone alert as animals are natural swimmer,
12. Sometimes, evacuation may be done after the disaster when the roads are travelable, and the equipment needed for travel usable. If this is the case, the accepting location must be contacted to find out its condition.

Sheltering

During disaster alert temporary sheds are arranged with the help of District Collectors/ NGOs/ Society for the Prevention of Cruelty to Animals (SPCA)/ Animal Welfare Organizations working on disaster management for housing of destitute animals. Separate arrangements are made to house cattle, buffalo, sheep, goat, pig and poultry in order to maintain peck order and to avoid unnecessary competition for survival. The type of shelter depends on the type of disaster and the resources available. The most common type of emergency animal shelter is the one located close to the human shelter. Planning for these activities should take place prior to disaster e.g. prior to flood or cyclone at village level. The following points should be considered for sheltering of animal prior to or after disaster:

1. The decision whether to move farm animals to shelter or leave them outside will depend on the integrity and location of the shelter being used and the type of disaster.
2. Farmers should establish a safe environment for animals;
    a. Assess the stability and safety of barns and other structures,
    b. Remove uprooted and scattered branches of trees or other debris in fields or animal holding locations,
    c. Remove or secure any loose equipment or materials, such as feed troughs, water troughs etc.
    d. Make sure wiring for heat lamps or other electrical machinery is safe and away from flammable debris.
3. During disaster alert, the animals should not be tied otherwise their chance of escape are minimised. Some shelters don't withstand high winds or rain or earthquake and cause death of tied animals. Another reason for possibly leaving animals unsheltered is because flood waters that overflow around a barn could trap animals inside causing their drowning.
4. During severe winter weather, shelter animals from icy wind, rain, and snow. Generally, if the structure is sound, the animal should be placed indoors. Once they are inside, secure all openings to the outside.
5. As mentioned previously, the sheltering should be ordered and completed before similar action is taken for humans.
6. If a farmer is unable to evacuate with own livestock in any disaster situation, open gates, stalls and pens to allow animals a chance to find safer ground.
7. Remember that disasters often displace animals left behind so you should have a way to identify your animal. Ear tags, brands, contact information attached to halters, and pictures of you with your animal are good ways to prove ownership after a disaster.
8. Animals that are deemed dangerous to other animals or shelter personnel either because of aggressiveness or disease may be euthanized by permission of State Veterinarians or other competent authority.

When to open the shelter: pre-event or post-event?

Emergency animal sheltering should be done immediately after fast-onset disaster like flash flood, earthquake etc. However, certain disaster like flood, cyclone etc. are considered as slow-onset disaster, in such cases accurate predictions of disaster can be made and a reasonable time-frame be established for orderly evacuation of animal. In such slow onset disaster shelter can be opened before reaching of disaster to the target place. Here the shelters are arranged outside the predictable disaster zone, in a safe and accessible location well-advertised to the public.

After disaster it is important to keep the animals inside the shelter until informed by the authorities that it is safe to go out. Downed power lines and debris can often injure animals, therefore it is advised to keep animals confined until all fences and shelter areas are checked. This will also allow the animals to get reacquainted to their surroundings and farmers will get time to make any repairs or clean-up damage caused by the storm.

Conclusion

In those parts of India which are prone to different natural calamities like flood, cyclone, earthquake, land slide etc., at right time evacuation of animal and emergency shelter will reduce their impact. Under Ministry of Agriculture, nodal agency responsible in charge of disaster management should have a separate cell and should organise training regarding evacuation and sheltering of livestock during disaster. This cell should have information regarding disaster prone areas of India and the population dynamics of those areas. In cyclone prone areas, there should be provision of cyclone shelter, in flood areas the shelter areas should be constructed in high level from the ground. Agencies like Goshalas, dairies, NGO's etc. should be organised in such a manner that their services can also be utilised at short notice for disaster management. State Government should organise a disaster management group in the department dealing with Animal Husbandry and Veterinary service with specially trained staff regarding evacuation and sheltering of animals and all types of arrangement facilities needed during evacuation and at the shelter. All these activities will together reduce the impact of disaster on animals and will improve the livelihood of the poor in the country.

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…there is no difference of paradigm between human and veterinary medicine , and is extension of notions of comparative medicine. Both sciences share, as a general medicine, a common body of knowledge in anatomy, physiology, pathology and the origin of diseases in all species.

Calvin W Schwabe

Management of livestock during disasters

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According to the United Nations "A disaster is an event that is concentrated in space and time and that subject a society to severe danger and such serious losses of human life or major material damage that leads to break down of local social structure and the society is unable to perform any or some of its key functions. India is the worst-affected country of disaster in the South Asian region. Drought, floods, earthquakes and cyclones devastate the country with grim regularity with worst affected are the poor and marginalized sections of the India. Unfortunately, poverty is most widespread in areas that are more vulnerable to natural disasters - the flood-prone regions of North Bihar, East Uttar Pradesh, North Bengal and North-Eastern region etc. Small, marginal and landless farmers own 70% of the total livestock which produce 62% of total milk production in India. These are the most affected population during natural disasters. Natural disasters cause scarcity of feeds, fodders and scenario becomes again worse due to inaccessibility and transportation difficulties of feeds and fodders.

Natural disasters in India

Floods

Nearly 75% of the total rainfall is concentrated over a short monsoon season of four months (June-September). As a result the rivers witness a heavy discharge during these months, leading to widespread floods. The most flood-prone areas are the Brahmaputra and Gangetic basins in the Indo-Gangetic plains. The other flood-prone areas are the north-west region with the rivers Narmada and Tapti, Central India and the Deccan region with rivers like the Mahanadi, Krishna and Kauveri. While the area liable to floods is 40 million hectares, the average area affected by floods annually is about 8 million hectares. The annual average cropped area affected is approximately 3.7 million hectares.

Table 1. Average annual loss due to Floods

Sr. No.	Items	Loss
1.	Area affected	7.35 million hec.
2.	Population affected	40.97 million
3.	Human lives lost	1793 number
4.	Cattle lost	85599 number
5.	Houses damaged	1452904 number
6.	Houses damaged	370.61 crore
7.	Crop area damaged	3.73 million hectare
8.	Crop damaged	1095.13 crore
9.	Public Utilities damaged	1186.47 crore
	Total Losses	2706.24 crore

Source: Central Water Commission, Ministry of Water Resources, Government of India.

Drought

The heavy deliberation of rainfall within a span of three months in most areas causes heavy run-off and heavy flooding. On the other hand dry conditions prevailing during the rest of the year, particularly in the arid and semi-arid regions, renders 68% of the total landmass at risk to drought. The drought impacted 56% of the land mass and threatened the livelihoods of 300 million people across 18 states.

Cyclones

The states most exposed to cyclone-related hazards, including strong winds, floods and storm surges, are West Bengal, Orissa, Andhra Pradesh and Tamil Nadu along the Bay of Bengal. Along the Arabian Sea on the west coast, the Gujarat and Maharashtra coasts are most vulnerable. On an average, about five to six tropical cyclones form in the Bay of Bengal and Arabian Sea every year, of which two to three may be severe. Cyclones are most deadly when crossing the coastal areas of Andhra Pradesh, Orissa, West Bengal and Bangladesh, mainly because of the serious storm surge problem in this area. The impact of these cyclones is confined to the coastal districts, the maximum destruction being within 100 km from the centre of the cyclone and on either side of the storm track.

Earthquakes

Fifty-six per cent of India is prone to seismic activity. During the International Decade of Natural Disaster Reduction (IDNDR), India suffered the adverse impact of several earthquakes, north-eastern states, the Kutch region of Gujarat and Uttaranchal are the most vulnerable regions.

Tsunami

One of the most devastating disasters of the 21st century was the Asian tsunami that wreaked havoc in 11 countries on December 26, 2004. A tsunami is a series of ocean waves generated by sudden disturbances in the sea floor, landslides, or volcanic activity. In the ocean, the tsunami wave may only be a few inches high (typically 30-60 cm) but as they race onto shallow water regions their speed diminishes which results in increase in the height of the wave. Typical speeds in the open ocean are of the order of 600 to 800 km/hr.

Difficulties and actions for disaster management in livestock:

1. ***Animal reactions when under duress.***

Disasters that stimulate nervous reactions, such as flash flood, wildfire and tornadoes, animal owners may see a behavioural pattern from their livestock that they are both unprepared and unable to handle. This is one reason why emergency disaster management directors limit how much time owners can have to address livestock. This delay may imperil the residents and secondarily first responders. The local emergency system may have an organized predetermined group of volunteers who are trained, equipped and coordinated to move into disaster areas to deal with livestock evacuation.

2. ***Access and transportation difficulties.***

Traditionally, livestock producers have the equipment, resources, experience and practice to move livestock under a variety of conditions. Newer rural residents may lack livestock movement equipment, or enough equipment to handle their livestock population. This often stems from an operational philosophy. Producers expect the need to move large animals between forage sites and then off site to a market on a regular basis. Animal evacuation from a disaster area must occur in a coordinated manner under the direction of the incident command team to allow success without impeding handling of the disaster and while protecting public safety.

3. ***Equipment and facility design risks.***

Any livestock handler will tell you that when stress and an emergency combine while moving livestock is when you will find every hole in the fence, every sharp edge on the equipment and every loose board on the trailer. Having properly designed and effectively maintained equipment and facilities are critical during disasters. Remember, you will be handling agitated livestock with an extremely limited time frame.

4. ***Losing focus on the disaster event.***

The large amounts of stimuli and tension generated during disasters affect both humans and animals. Because people get so focused on 1 to 3 objectives they often fail to look around and notice the other things that are going on around them. Emergency responders get better at avoiding this problem with experience and training. Usually they follow a response guideline that reminds them to take in all the other factors. Although it's not desirable for livestock owners to face so many disasters that they also develop this broad focus, there is one key approach that helps enhance safety in tense situations—teamwork. Take help and designate one person to keep watching for additional oncoming hazards.

Feeding management strategies during natural disaster

We have to use different approaches by taking into consideration following two objectives,

1)Primary objective: Feeding and management of livestock for their survival.

2)Secondary objective: Ensuring minimum level of production and growth especially during later phases of flood.

Water management

Animals can survive for many days without food but cannot survive for more than 3 to 4 days without water. In draught scenario is again worsened by unavailability of clean safe drinking water due to contamination by different natural and spoiled sources. So one should take into consideration following
points intended for water management

1) Providing clean and safe water to the livestock
2) Priority should be given to lactating and pregnant animals over nonproductive stocks,
3) Water should be provided in small quantity and more frequently
4) Salt intake of the animal should be restricted.

Priority of feeding and watering

The priority of animals with different feeds and fodders should be in descending order as first suckling animals, then suckling with mother, producing and working animals, sick and old animals, and at last adult non producing animals.

Feeds and feeding technologies to be used during disaster

1. Concentrate mixture supplement

Concentrate mixture as high energy sources have capacity to balance the ration. It is easy to procure less bulk material like concentrate from unaffected area which permits easy transportation and distribution among farmers.

2. Treatment of Straws

After harvesting the grain from the crop, the left portion is known as straw. Paddy straw constitutes the basal roughage of cattle and buffaloes in India. To minimize spoilage in the heavy rainfall areas of flood it can be stored on wooden or bamboo platform raised over the ground. The straws soaked in flood water may be fed when fresh after receding of flood water. However, to prevent its spoilage due to growth of moulds and fungi, it should be processed and preserved properly. The following methods can be used for the preservation and improvement of flood soaked straws.

a***) Preservation:*** Common salt can be mixed at a rate of 0.5 to 1.0% in soaked straw after squeezing the water. This prevents substantially the growth of moulds and fungi, and helps in the preservation of soaked straw for sometimes.

b) *Sun drying:* In bright sun light soaked straw should be spread in thin layer and turned out with rakes. The drying can be done on dry ground or abandoned roads of flood affected areas and collected for storage when moisture content reduces to less than 15 %.

c) *Ensiling:* Straw can be ensiled with other ingredients in *kuchha* or *pucca* silos, depending upon the availability of other ingredients. Straw may be either ensiled with (a) chaffed green fodder; (tree leaves/grasses/aquatic plants) and molasses with urea or (b) poultry litter, a little green fodders and molasses, (c) pig excreta, green fodders and molasses etc.

d) *Urea treatment*: It is a very simple and effective technique to improve the utilization of poor quality roughages. Feeding of urea treated straw can meet the maintenance requirement without any concentrate supplement. Around 4.0 kg farm grade urea can be dissolved in 35-50 L water and this solution should sprinkle over 100kg straw. Tightly pack the urea treated straw with plastic sheets and kept for 7 days in summer and 15 days in winter and fed to animals by incorporating in animal's diet gradually. It can be fed to animals @ 1 % of whole ration.

3. Sugarcane crop residue

Around 383 MMT of sugarcane bagasse produced annually in India. It contains CP < 3%, CF >45%, Total ash 4%, Digestibility 30%. The palatability and nutritional value of bagasse for the livestock (cattle and buffaloes) are much better than the rice hull.

Feed formulations tried during the droughts of 1972-73 in Maharashtra

The cattle relief camps were set up around the sugarcane factories located in the drought affected zones. Large scale feeding of bagasse, molasses in combination with urea and mineral supplements was adopted. The feed formulations developed through experimentation were tried on nearly 40,000 cattle without any detrimental effects.

Ingredients	Adult non producing		Growing animals	
	I	I I	I	I I
Bagasse kg	2.0	3.0	2.0	3.0
Molasses kg	0.4	0.5	0.8	0.8
Sugarcane tops chopped (kg)	8.0	nil	3.0	--
Urea (g)	22	25	40	40
Common salt (g)	30	30	20	20
Mineral mix (g)	50	50	25	25
Vitamin A (IU)	--	8000	--	8000

4.Compressed Complete Feed Block (CCFB)

CCFB has decreased bulk density (65Kg Vs 400Kg/m3) as compare to normally stacked feeds makes its handling, storage and transportation easy and economical having potential as a part of feed bank. CCFB can be made for different types of animals such as maintenance, growth and lactation to economize the purpose.

5. UMMB and UMLD

Compact blocks of UMMB can easily be stored, transported and distributed. The aim of UMLD is survival of animal by using low cost and simple method of feeding. Revival feeding after restricted feeding showed improved nutrient intake and body weight gain.

Composition of UMMB and UMLD

UMMB		*UMLD*	
Ingredient	***%***	***Ingredient***	***%***
Molasses	38	Molasses	84
Urea	10	Concentrate	10
Portland Cement	10	Urea	3

Wheat bran	40	Mineral Mixture	2
Salt	1	Phosphoric Acid	2
Mineral Mixture	1	Vitablend AD3	0.02
Vitablend AD3	1g/qt		

6. Forest by products

Besides common fodder, shrubs and herbs like pipal, neem, saura, tara, mango, kathal, etc. other non-toxic tree leaves may also be fed to farm animals to supply part of their nutritional requirements. The availability of digestible protein for most of the green tree leaves is limited to 1-2% and energy equivalent to 10-15% of total digestible nutrients, on fresh basis containing about 15% dry matter. They are potential sources of much needed carotene, the source of Vit. A activity.

7. Aquatic plants

Several types of aquatic plants ate available in river, pond and other water logging areas may be used for the feeding of farm animals. Although the palatability of most of the aquatic plants is not good but the voluntary intake often exceeds 1 kg dry matter per 100 kg body weight in cattle and buffaloes. Besides supplying protein and energy they are rich sources of carotenes. So far the common aquatic plants tested for the feeding of farm animals are water hyacinth, aquatic spinach, stalks and leaves of lotus plant (Nymphacae sp. and Neumbiull sp.), hydrilla, pistia, aquatic weeds and jugaIi paddy etc. They are available readily at moat of the places during floods.

8. Unconventional cakes and seeds

The utilisation of deoiled salseed meal, treated neem seed cake, nahar seed meal, tapioca waste, extracted tea leaves have already been tested. These feeds may be incorporated to supply about 10-30% dry matter requirement of farm animals. These unconventional feeds can also be used for the feeding of simple stomached pig and poultry during scarcity of costlier conventional feeds replacing limited proportion of conventional ingredients.

9. Fruit factory waste

The waste materials like pine apple wastes, orange peel, tomato pomace are found to be abundantly available which are wasted due to lack of proper utilization as animal feed. These can form a part of the diet of livestock after processing through ensiling.

10. Animal organic wastes

The north eastern region has a large potential of animal organic wastes contributed by excreta of farm animals and poultry, waste materials from slaughter houses, dead animal carcasses etc. The animal excreta are richer in crude protein content. But their use is limited due to the presence of pathogenic micro-organisms and ova of different parasites. So these can only be used through suitable methods. The recent proliferation of gobar gas plants and its projected expansion would be capable of utilizing huge quantity of animal organic wastes and other carbon wastes for the production of biogas. The residual slurry available regularly after 3-5 weeks of anaerobic fermentation has been found to be a moderately good source of microbial protein (Kamra and Pathak, 1980). The feeding of digested slurry in the diets of ruminants and pigs has already been demonstrated as a potential source of feed at Indian Veterinary Research Institute (Pathak *et al.* 1981).

Feeds not to be fed exclusively during such calamities

In the scarcity conditions animals do not get enough feeds for eating and they mostly pass through under fed conditions due to non-availability and scarce supply of feed-stuffs. At the end of such scarcity period, animals usually develop craving for food and uncontrolled eating behaviour. Thus, it is desired to be careful in feeding the farm animals after the flood water has receded.

*1. **Nitrate Poisoning***

Newly growing grasses contain high concentration of nitrite and nitrate and they should be fed in small quantity mixed with dry roughages like paddy straw and wheat straw.

*2. **HCN Poisoning*** It may result when sorghum its crosses are used at too immature stage or are severely stressed as by drought. New tree leaves contain high level of hydrocyanic acid. Due to its softness animals eat larger quantity and occasionally suffer from toxicity. Such tree leaves should not be fed as a sole ration and should be incorporated in straws for partial supply of nutrients.

Requirements of a Relief Camp

The estimated amounts of various feed stuffs required for the feeding of 1000 heads of cattle and buffaloes for one month period have been worked out for guidance:

(A) Ration based on unconventional feeds and fodders etc.

The estimated requirement of feed stuff for a relief camp housing 40% adult male, 40% adult female and 20% young stock has been given below:

Paddy straw/wheat straw/Bagasse	40 ton
Molasses	1 ton
Rice Polish	6 tons
Wheat bran	6 tons
Oil cakes	5 tons
Damaged grains/cheap concentrate or grains	4 tons
Mineral mixture	0.4 tons
Common salt	0.2 tons
Any green fodder/aquatic weeds/tree leaves	30 tons

Feed and fodder bank

Creation of feed and fodder bank is a basic requisite for predisaster management. It includes,

1. Pasture improvement
2. Application of fodder conservation techniques
3. Management of stocking rates Promotion of seeds that flourish from the first irrigation
4. Introduction of drought-resistant and water logging tolerant plants varieties,
5. Crop residues from major cereals like rice & wheat straws, Coarse cereals, legumes, haulms, left after removing grains, grasses from periphery of forest area wastelands and farmlands may be harvested and stored as hay,
6. Gramin Feed and Fodder Bhandaran Yojna: Ministry of Agriculture and Cooperation.

Conclusion

Management of disaster to date has been reactionary rather than proactive and preventative and not sufficient to meet the challenge. Along with disease and epidemic management feeding technology applications like Conc. mix, urea treatment, UMLD, UMMB, CCFB are some of the alternatives to meet the challenges. Unconventional feeds and wastes also have capacity to mitigate the challenge. In this regard, integration of work among veterinarians with state and central local bodies is necessary.

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Early warning system for livestock and zoonotic diseases

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Early warning of outbreaks and the capacity for prediction of spread to new areas is an essential pre-requisite for the effective containment and control of epidemic animal diseases, including zoonoses. As experienced throughout much of the globe, weaknesses of disease surveillance systems and the inability to control major diseases at their source have contributed to the spread across geographical borders of diseases confined to livestock, such as foot-and-mouth disease, as well as diseases with a zoonotic potential, e.g. BSE and avian influenza.

Early Warning and Response is based on the concept that dealing with a disease epidemic in its early stages is easier and more economical than having to deal with it once it is widespread. From a public health perspective, early warning of outbreaks with a known zoonotic potential will enable control measures that can prevent human morbidity and mortality. Also, new previously unknown human infectious diseases have emerged and will continue to emerge from the animal reservoir.

Several initiatives, at national and regional level have already been developed in the field of early warning. At the international level FAO, OIE and WHO have each developed Early Warning and Response Systems that systematically collect, verify, analyse and respond to information from a variety of sources, including unofficial media reports and informal networks. In addition, the OIE and WHO mandates include official notification of disease or infection outbreaks to the international community within conditions determined by their Member Countries. FAO has a broad mandate to disseminate information, including all agricultural statistics, to Member Countries.

The Global Early Warning and Response System for Major Animal Diseases, including Zoonoses (GLEWS), build on the added value of combining the alert and response mechanisms of the different organizations, enhancing the Early Warning and Response capacity for the benefit of the international community. Through sharing of information on disease alerts, unjustified duplication of efforts will be avoided and the verification processes of the three organizations will be combined and coordinated. For zoonotic events, alerts of animal outbreaks can provide direct early warning so that human surveillance could be enhanced and preventive action taken. Similarly, there may be cases where human surveillance is more sensitive and alerts of human cases precede known animal occurrence of disease. On the other hand, sharing assessments of an ongoing outbreak will enable a joint and comprehensive analysis of the event and its possible consequences. Joint dissemination will furthermore allow harmonized communication by the three organizations regarding disease control strategies.

Regarding the joint response to disease emergencies, the three organizations will be able to respond to a larger number and cover a wider range of outbreaks or exceptional epidemiological events with the provision of a wider range of expertise. This will improve international preparedness for epidemics and provide rapid, efficient and coordinated assistance to countries experiencing them. GLEWS is based on the notion that infection does not recognize geographical nor species borders. For its zoonotic component it takes a stand in the shift in paradigm from independence to interdependence of agencies and professions involved in zoonotic control.

1. Existing Early Warning and Response Systems within the three Organizations

2.1 Legal framework of existing Early Warning and Response Systems

2.1.1 The International Health Regulations

The revised International Health Regulations adopted by the World Health Assembly in 2005 (IHR (2005)) are an international legal instrument that will come into force on 15 June 2007, replacing the current IHR. The purpose and scope of the IHR (2005) are to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks, and which avoid unnecessary interference with international traffic and trade. IHR(2005) is legally binding on all WHO Member States who have not rejected them and on all non-Member States of WHO that have agreed to be bound by them.

The IHR (2005) require States to notify WHO of all events that may constitute a public health emergency of international concern and to respond to requests for verification of information regarding such events. National IHR Focal Points will provide to and receive information from WHO on a 24 hour a day basis, seven days a week. This will enable WHO to ensure appropriate technical collaboration for effective protection of such emergencies and, under certain defined circumstances, inform other States of the public health risks that merit action on their part.

The IHR (2005) require WHO to cooperate with other competent intergovernmental organizations or international bodies in the implementation of the Regulations, including FAO and OIE.

2.2 Existing Early Warning Systems

OIE has set up an animal health information search and verification system for non-official information from various sources on the existence of outbreaks of diseases or exceptional epidemiological events that have not yet been officially notified to the OIE. It then relies on the capacity of its Member Countries and on their capabilities to verify the outbreak information. OIE operates an early warning system to warn the International Community of exceptional epidemiological events in its Member Countries. This alert system is aimed at the decision makers, enabling them to take any necessary protective measures as quickly as possible.

FAO, through its special EMPRES priority programme established in 1994, developed an early warning and response system. The system benefits from the official information furnished by the OIE and combines other sources of information such as those generated by technical projects, consultancy missions or personal contacts and provides an analysis of the situation through bulletins, electronic messages and reports for better disease containment and control. In addition, FAO has also developed information search and verification systems of information from various sources (so-called data mining).

WHO systematically gathers official reports and rumors of suspected outbreaks from a wide range of formal and informal sources. Reports of suspected outbreaks are received from ministries of health, national institutes of public health, WHO Regional and Country offices, WHO collaborating centres, civilian and military laboratories, academic institutes, and nongovernmental organizations (NGOs). With the advent of modern communication technologies, many initial outbreak reports now originate in the electronic media and electronic discussion groups.

2.3 Existing Response systems

The Global Framework for Transboundary Animal Diseases (GF-TADs) launched by **FAO** and **OIE** initiates and supports strategic regional and national cooperation for the control of TADs. The Framework is designed to empower countries and regional alliances in the fight against TADs, to provide capacity building and to assist in the establishment of programmes for the targeted control of certain TADs based on their regional priorities. It contributes to the strengthening of national disease reporting structures and mechanisms to fulfil international animal health monitoring functions effectively. The GLEWS initiative is a major contributor to this Framework.

The Technical Cooperation Programme (TCP) is an instrument that enables **FAO** to respond rapidly to urgent needs for technical and emergency assistance in member countries and to contribute to their capacity building. The programme does not operate in isolation, but is closely associated with other normative and field activities of the organization.

In addition, **FAO** has launched the Emergency Centre for Transboundary Animal Diseases Operations (ECTAD) within its EMPRES programme in November 2004, to operate as the corporate centre for the design and delivery of FAOís services as the Chief Veterinary Officer of the organization. ECTAD is primary aim is to implement a clear, simple chain of command between AGAH/EMPRES and the field to deal efficiently with the emergency at hand and to ensure an integrated approach of the relevant groups and services involved in the response.

WHO offers assistance to affected countries in the form of technical advice, supplies and by mounting coordinated international investigations The Global Outbreak Alert and Response Network (GOARN) is building on new and existing partnerships of national and international institutions and networks, to deal with the global threats of epidemic-prone and emerging diseases in humans and to prepare for rapid deployment and coordination of international resources in response to an outbreak of international importance. GOARN aims at ensuring appropriate technical support to affected human populations quickly, assessing risks of rapidly emerging epidemic disease threats and sustaining containment and control of outbreaks by contributing to national outbreak preparedness.

OIE has emergency funds that can be rapidly mobilized for sending experts from OIE Reference Laboratories to assess the epidemiological situation in a country and define the actions required.

2.4 Existing systems for dissemination

OIE disseminates official information about animal diseases including zoonoses in the three OIE official languages. The dissemination of emergency messages and follow-up reports (as per the OIE Early Warning System) is done using different tools: faxes, electronic distribution lists and the OIE website. Also, Animal Health Information, from the OIE six-monthly and annual monitoring system is disseminated using the OIE website and in hardcopy (World Animal Health publication).

FAO disseminates bulletins, reports, descriptive and analytical early warning and emergency messages. The tools used to disseminate information are: FAO/AGAH/EMPRES web site and electronic distribution lists. The EMPRES bulletin is also distributed in hardcopy. Concerning HPAI, a specific bulletin FAO AIDE News is issued every month or when appropriate.

WHO disseminates information through a restricted e-mail list, the WHO web site and information bulletin. The Weekly Epidemiology Record is available in hard copy and electronically. INFOSAN has been developed by WHO in cooperation with FAO to promote the exchange of information on food safety and to improve collaboration among food safety authorities at national and international levels.

3 GLEWS: A joint FAO/OIE/WHO initiative to enhance Early Warning and Response at international level

3.1 Project background and rationale

The GLEWS initiative started with the voluntary participation of representatives of FAO, OIE and WHO, who share the common objective to enhance the Early Warning and Response capacity for the benefit of the international community. Mutual benefit through collaboration has been identified throughout the Early Warning and Response process.

Early Warning

The three organizations use complementary and partly overlapping sources of information to identify infectious disease events. Through sharing of information on disease alerts, the capacity for early warning of the three organizations could be enhanced while avoiding unjustified duplication of efforts. In some instances the geographical coverage of disease alerts could be improved, e.g. through the use of FAO/AGAH animal health information for non OIE countries. For zoonotic events, alerts of animal outbreaks provide direct early warning so that human surveillance could be enhanced and preventive action taken. Similarly, there may be cases where human surveillance is more sensitive and alerts of human cases precede known animal occurrence of disease.

There is also added value in combining and coordinating the verification processes. One source of information is often not sufficient to verify or deny the presence of a disease in a country that did not spontaneously report it. A rumour might be denied by an official institution, although the epidemiological context tends to demonstrate the contrary. Each disease event tracked has therefore to be verified in light of the current and most updated epidemiological knowledge. Socioeconomics and demographic data on livestock also represent a valuable source of information in this exercise. Joint dissemination of risk assessment would also benefit from the different information sources providing a comprehensive analysis of the event and its possible consequences in its specific context.

Response

Sharing assessments of ongoing outbreak undertaken by either of the organizations, e.g. based on reports from local representation or field missions, would be of value to all three organizations. Furthermore, the organizations would, in accordance with their different mandates, bring together different pieces of information from different sources that would enable a joint assessment of the outbreak. Immediate notifications to the OIE would provide initial details of the outbreak and any immediate control measures taken. FAO would bring the integration of other data and information, e.g. on animal production systems, factors affecting movements of livestock etc, crucial for the assessment of the risk of further spread. Joint analysis and assessment by the three organizations would also benefit from the different specific competencies and resources of the three different organizations and may form the basis for a joint infection control strategy. Joint dissemination would enable harmonized communications by the three organizations regarding disease control strategies.

Table: List of diseases of common interest.

Zoonotic	Non zoonotic
1. Anthrax 2. Bovine Spongiform Encephalopathy (BSE) 3. Brucellosis (*B. melitensis*) 4. Crimean Congo Hemorrhagic Fever 5. Ebola Virus 6. Food borne diseases 7. Highly Pathogenic Avian Influenza (HPAI) 8. Japanese Encephalitis 9. Marburg Hemorrhagic Fever 10. New World Screwworm 11. Nipah Virus 12. Old World Screwworm 13. Q Fever 14. Rabies 15. Rift Valley Fever* (RVF) 16. Sheep Pox*/Goat Pox 17. Tularemia 18. Venezuelan Equine Encephalomyelitis 19. West Nile Virus	1. African Swine Fever (ASF) 2. Classical Swine Fever (CSF) 3. Contagious Bovine Pleuropneumonia (CBPP)* 4. Foot and Mouth Disease (FMD)* 5. Peste des Petits Ruminants (PPR) 6. Rinderpest, Stomatitis/Enteritis

*diseases for which trend analyses and forecasting will be emphasized

References for further reading:

The content in the text are coated from available WHO, FAO, OIE, websites etc.

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Livestock emergency guidelines and standards

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Millions of people worldwide depend on livestock for their livelihoods and many of them – and their animals – are affected by disasters, both natural and man-made. There is a growing realization that the response to these disasters needs to help save not just lives but also livelihoods, including protecting livestock. Livestock Emergency Guidelines and Standards (LEGS) takes into account that livestock are a crucial livelihood asset for people throughout the world and that livestock intervention are thus often an important feature of relief responses. When humanitarian emergencies arise, rapid assistance is needed to protect and rebuild the livestock assets of affected communities. In addition to emergency response, the guidelines are also concerned with recovery and long-term development processes. LEGS was developed by a steering group of professionals from the Feinstein International Center of Tufts University, the Food and Agriculture Organization of the United Nations, the International Committee of the Red Cross, the African Union and Veterinaires sans Frontieres, Belgium, working with a team of technical writers and contributors from around the world. The LEGS process was initiated by Tufts/FIC in early 2006. The LEGS were published by the LEGS Project in 2009 as a set of international guidelines and standards for the design, implementation and assessment of livestock interventions to assist people affected by humanitarian crises.

LEGS provide guidance on the identification of appropriate livestock responses, followed by detailed information on a number of interventions, namely: destocking, veterinary services, the provision of feed, the provision of water, livestock shelter and settlement, and restocking. Each technical chapter contains minimum standards, key indicators, and guidance notes, together with decision-making tools and a discussion of key cross-cutting issues. LEGS should be read by donors, programme managers and technical experts designing or implementing livestock interventions in disasters.

Objectives

LEGS aims to support both the saving of lives and the saving of livelihoods, through two key strategies: assisting in the identification of the most appropriate livestock interventions in emergencies, and providing standards, indicators and guidance notes for these interventions based on good practice.

Who should use LEGS?

LEGS is intended for all who are involved in livestock-based interventions in disasters. In particular, LEGS is aimed at NGOs, bi- and multi-lateral agencies and governments who are implementing emergency interventions in areas where livelihoods are derived in part or in full from livestock. LEGS is also relevant to policy and decision-makers within donor and government agencies whose funding and implementation decisions impact on disaster response. A third audience for LEGS includes educational institutions and community-based organizations.

What LEGS covers

From a global perspective, one of the most pressing needs is to improve livestock relief programming with communities who rely heavily on livestock for their social and economic well-being. LEGS covers livestock interventions in these areas, but also addresses livestock support to settled farming communities and livestock kept by people in urban areas. LEGS is founded on a rights-based approach, in particular the right to food and the right to a standard of living. In other words, disaster-affected populations have the right to the protection of their livelihood. LEGS' livelihoods perspective also means that the guidelines are concerned not only with immediate emergency response in acute situations, but also with recovery-phase activities and the linkages with long-term development processes. Preparedness is consequently a significant aspect of disaster response in LEGS, as is the importance of the preservation of livelihood assets in order to protect and maintain future livelihoods as well as to save human lives.

LEGS have nine chapter which address different issues related to the livestock during emergency which are as follows:

Chapter 1: Livelihoods-based livestock responses in emergencies
Chapter 2: Assessment and Response
Chapter 3: Minimum standards common to all livestock interventions
Chapter 4: Minimum standards for destocking
Chapter 5: Minimum standards for veterinary services
Chapter 6: Minimum standards for ensuring supplies of feed resources
Chapter 7: Minimum standards for the prevention of water
Chapter 8: Minimum standards for livestock shelter and settlement
Chapter 9: Minimum standards for the provision of livestock

Chapter 1: Livelihoods-based livestock responses in emergencies

There is increasing recognition that emergency responses need to take into account the livelihoods of the affected populations – not just 'saving human lives' but also 'protecting and strengthening livelihoods'. This not only helps the immediate recovery of those affected by an emergency, but can increase their long-term resilience and reduce their vulnerability to future shocks and disasters. For all livestock owners, livestock constitute an important financial asset (for many pastoralists their only financial asset) providing both food (milk, meat, blood and eggs) and income (through sale, barter, transport, draught power and work hire). Livestock are also significant social assets for many livestock owners, particularly pastoralists and agro-pastoralists. The protection and strengthening of livestock as a key livelihood asset is therefore central to livestock responses in emergency situations.

LEGS is founded on three livelihoods-based objectives:

1. To provide rapid assistance to crisis-affected communities through livestock based interventions;
2. To protect the key livestock-related assets of crisis-affected communities;
3. To rebuild key livestock-related assets among crisis-affected communities.

In all types of emergency, livelihoods-based approaches aim to design interventions that limit disruption to long-term development.

Chapter 2: Assessment and Response

Prior to any form of emergency response, an assessment is required to ascertain whether livelihoods-based livestock interventions are appropriate and feasible in the specific context, according to the type, phase and severity of the emergency, or indeed whether a response is necessary at all.

The LEGS assessment process is made up of three parts, which may be carried out concurrently, namely:

1. The role of livestock in livelihoods
2. The nature and impact of the emergency
3. Situation analysis.

Chapter 3: Minimum standards common to all livestock interventions

This chapter presents eight core standards that are common to each of the livestock related interventions described in later chapters. The standards are: 1) participation; 2) initial assessment; 3) response and coordination; 4) targeting; 5) monitoring and evaluation and livelihoods impact; 6) technical support and agency competencies; 7) contingency planning, preparedness and early response; and 8) advocacy and policy.

These common standards relate to each of the livestock-related interventions described in other chapters, and are integral to all of them. By implementing the standards described here, agencies will support the achievement of the standards described in the other chapters.

Chapter 4: Minimum standards for destocking

Destocking activities relate directly to the first LEGS livelihood objective of providing rapid assistance to crisis-affected communities through livestock-based interventions. Destocking can also contribute to the second LEGS objective, namely to protect key livestock assets of crisis-affected communities, to the extent that remaining livestock have a better chance of survival and cash received from destocking is often partly reinvested in animal health care, water and grazing provision to support the remaining stock. In times of disaster, livestock that are likely to perish remain a potential asset for their owners if timely action is taken, in that they can be converted into cash or meat through some form of destocking. Destocking helps to relieve pressure on natural resources to the benefit of the remaining stock and provides a direct or indirect source of food for crisis-affected families. Destocking is most commonly used in response to slow-onset emergencies and is usually considered inappropriate for rapid-onset disasters, since livestock usually are either killed or survive (rather than suffer deteriorating condition) and once the disaster has taken place, it is generally too late to carry out any type of destocking. However, in slow-onset emergencies such as drought, it can be a successful way of providing immediate assistance to affected families and also helping them to protect their remaining livestock assets.

Options for destocking

This chapter focuses largely on two types of destocking operations: accelerated off -take (commercial destocking) and slaughter destocking.

- *Accelerated livestock off-take*
- *Slaughter destocking*
- *Slaughter for disposal*

The minimum standards

Section 1: Destocking general standards

The type of destocking selected is appropriate to the stage of the emergency and other relevant indicators.

Section 2: Accelerated livestock off-take

Support is provided for accelerated off-take of marketable animals.

Section 3: Slaughter destocking

Value is salvaged from disaster-affected livestock to provide relief meat and/or cash to affected communities.

Chapter 5: Minimum standards for veterinary services

The provision of veterinary services in disasters is an important strategy for assisting people to protect their livestock. Many emergencies exacerbate animal health risks and increase livestock vulnerability to disease. Veterinary care can help to prevent sudden loss of livestock due to acute diseases that cause high mortality. For example drought or flood can weaken livestock condition and increase the risk of disease outbreaks, while flooding may remove topsoil, creating favourable conditions for the spread of anthrax.

Options for veterinary response

Primary clinical veterinary services

In many developing countries, veterinary services are in a state of transition from government to private-sector delivery of clinical veterinary care. In post-disaster situations, the growing private veterinary sector may comprise the main source of quality veterinary care. In general in a given country, most veterinarians are located in major cities and towns. In more remote, rural or marginalized areas, veterinary care is provided by para-veterinary workers who can be sub-contracted during crises to deliver veterinary services, or can provide services through mechanisms such as voucher schemes. Preventive and curative veterinary interventions in humanitarian crises fall into two broad categories, which can be implemented simultaneously**.**

- Examination and treatment of individual animals or herds
- Mass treatment or vaccination programmes

Support to public sector veterinary functions during emergencies

A consideration during more long-term crises is the need to support core public sector veterinary functions. Such support may be needed to assist a weakened government capacity, or in cases where no officially-recognized government authority is present.

- Veterinary public health
- Disease surveillance

The minimum standards

Section 1: Veterinary services general standards

Veterinary services general Standard 1: Assessment and planning

The disaster-affected population, including vulnerable groups, actively participates in the assessment and prioritisation of veterinary needs.

Section 2: Primary clinical veterinary services

Provision of primary clinical veterinary services Standard 1: Service design and implementation

Veterinary services are designed appropriately for the local social, technical, security and policy context and implemented with the active participation of disaster-affected communities.

Section 3a: Support to public sector veterinary functions – veterinary public health

Veterinary public health Standard 1: Zoonotic diseases

People have access to information and services that are designed to control zoonotic diseases.

Veterinary public health Standard 2: Sanitation and food hygiene

Sanitary and food hygiene measures related to the disposal of livestock and consumption of livestock products are established.

Section 3b: Support to public sector veterinary functions – livestock disease surveillance systems

Livestock disease information systems Standard 1: Livestock disease surveillance

In protracted emergencies a livestock disease surveillance system is supported to cover the disaster-affected population.

Chapter 6: Minimum standards for ensuring supplies of feed resources

Livestock are particularly vulnerable to short-term disruption of the resources on which they depend for their survival. In particular they need to be supplied with adequate feed and water if they are to survive times of difficulty. Any emergency response that aims to maintain livestock populations in an affected area must therefore make adequate provision for the continuing supply of feed resources. This may be particularly important in cases of drought, when stock generally die of starvation before they are killed by disease; in floods, where failure to take feed to stranded animals may result in their death; and in conflict situations where access to pasture is restricted because of insecurity or corruption.

Where feed stores have been destroyed by an emergency (such as a hurricane, earthquake or flood), there may be an urgent need to replenish feed reserves and to rebuild the necessary storage facilities; in order to enable livestock to survive in the short to medium term.

Options for feed provision

The standards presented in this chapter are essentially concerned with interventions that aim to ensure that an 'adequate' level of nutrition can be maintained in livestock populations throughout the period of an emergency.

Relocation of livestock

In many pastoral societies, bringing together groups of livestock belonging to different owners and moving them to areas where resources are more abundant has long been practiced in times of stress. In an emergency situation, this strategy may have other benefits such as protecting animals from infection, predation or theft although there are also risks associated with forming larger groups of animals. For large herds brought together in this way, it may prove difficult to find adequate feed and water to support them, exacerbating rather than alleviating problems, and some infectious diseases may ultimately spread more widely through the population as a result of closer contact.

Emergency feeding

Emergency feeding aims to substitute for feed resources that are no longer available in adequate quantities as a result of an emergency situation. This may be initiated by livestock keepers themselves who resort to the use of non-traditional, collected or purchased feeds, or to traditional fodder banks that have been preserved in anticipation of scarcity. Sometimes these options may not be open to livestock keepers who are not able to support the current needs of their animals. In such cases, externally-managed emergency feeding programmes may be able to assist through the provision of forage, concentrates or multi-nutrient blocks.

The minimum standards

Section 1: General feed standards

Ensuring feed supplies general feed Standard 1: Assessment and planning

The options for ensuring supplies of feed resources are assessed based on local needs, practices and opportunities.

Section 2: Relocation of livestock

Relocation of livestock Standard 1: Support for the initiation of livestock movements

Arrangements for the movement of livestock are based on a sound assessment of the benefits that will accrue, and build upon indigenous coping strategies.

Section 3: Emergency feeding

Emergency feeding Standard 1: Feeding levels

Levels of feeding supported by the programme should enable appropriate production outcomes and be sustainable over the life of the programme.

Emergency feeding Standard 2: Feed safety

Where feeds are imported into the affected area, proper attention is given to sanitary, phytosanitary and other aspects of feed safety.

Emergency feeding Standard 3: Sources and distribution of feed resources

Where possible, feed resources are procured locally, distributed safely, and in a manner that causes minimal disruption to local and national markets.

Chapter 7: Minimum standards for the prevention of water

Alongside the provision of veterinary care for traumatized or acutely diseased animals, the provision of water in an emergency is probably the intervention that has the most immediate and indispensable impacts for livestock owners. In the absence of any water, animals (with the exception of some camelids) do not survive for more than a few days. Therefore, in emergency situations where water sources have been seriously compromised, the provision of alternatives is of the highest priority. Even where water is currently available, relief programmes need to assess and, if necessary, implement appropriate responses to potential and future threats to water sources to ensure that other relief efforts are not undermined by water shortages.

Options for water provision

Water is a homogenous commodity but it may be available from a range of sources and deliverable by a number of methods. This can complicate the selection of appropriate interventions that will be capable of matching supply with demand.

Water points

Providing water points will almost invariably offer the most viable, longer-term solution to the problem of water shortages compared to the other main option (water trucking, see below), provided that it is feasible to implement a sustainable management plan for their use. Water distribution points may take a number of different forms including wells, boreholes and surface water harvesting systems (for example check dams and storage tanks).

Water trucking

Water trucking should generally be regarded as a last resort intervention for the first stages of an emergency only. It is expensive, resource inefficient and labour intensive. However, due to the critical nature of the impact of dehydration on livestock, it is sometimes the only option that can be implemented rapidly in order to keep animals alive in the short term. As a rule, therefore, trucking should be regarded as a temporary intervention that will be replaced, as soon as possible, by other means of providing water.

The minimum standards

Section 1: General water standards

Before engaging in water provision initiatives, the feasibility and costs of the different options should be carefully considered.

Water general Standard 1: Assessment and planning

Water provision for livestock is based on an analysis of needs, opportunities and local water management systems.

Section 2: Provision and management of water points

Water points Standard 1: Location of water points

Water source rehabilitation and establishment programmes are carefully located to ensure equitable access to water for the livestock of the most vulnerable households in the affected area.

Water points Standard 2: Water point rehabilitation and establishment

Rehabilitated or newly established water points represent a cost-effective and sustainable means of providing clean water in adequate quantities for the livestock that will use them.

Section 3: Water trucking

Water trucking Standard 1: Water sources and quality

Water for trucking is obtained from sources that can maintain an adequate supply of assured quality during the period over which the intervention will operate.

Water trucking Standard 2: Logistics and distribution

Proper arrangements are implemented for secure transport of water and its equitable distribution on arrival in the affected area.

Chapter 8: Minimum standards for livestock shelter and settlement

Livestock shelter can be defined as the protective physical infrastructure which animals require to survive. This chapter includes three components: settlement, which concerns the wider environment that supports livestock, for example site selection, issues of land rights and environmental management; settlement infrastructure, which encompasses the planning of buildings, roads and facilities; and shelter, which is the physical accommodation and buildings in which livestock take shelter.

Following a natural disaster or a crisis due to conflict, the safety, security and well-being of livestock is often a primary, if not the main, concern of affected owners. Patterns of movement for livestock-owning human populations following a disaster can be heavily influenced by the needs of their animals. Furthermore, livestock shelter and settlement infrastructure can play a key role in influencing the human shelter and settlement decisions taken by affected communities.

Options for livestock shelter and settlement

Livestock shelter and settlement interventions may take a range of forms, depending on the needs and nature of the emergency. These may include:

- Direct construction (by contractors or direct through beneficiaries) of shelters, for example secure compounds, shade, roofs and/or walls;
- Provision of materials to livestock owners for shelter construction;
- Training in shelter construction;
- Monitored cash distribution for animal shelter needs;
- Support to negotiations on land rights or access to grazing and/or shelter;
- Public awareness raising

The minimum standards

Before engaging in the provision of livestock shelter and settlement, the feasibility and appropriateness of the possible interventions should be carefully considered.

Livestock shelter and settlement Standard 1: Assessment and planning

Assessment and planning for livestock shelter and settlement infrastructure is based on community consultation, indigenous knowledge, and consideration of environmental impact and the potential for sustainable livelihoods.

Livestock shelter and settlement Standard 2: Livestock settlement

Livestock settlement supports safe cohabitation with humans, minimizes negative environmental impact, and supports recovery and sustainable livelihoods.

Livestock shelter and settlement Standard 3: Livestock settlement infrastructure

Livestock settlement infrastructure provides a secure, healthy and sustainable environment for livestock.

Livestock shelter and settlement Standard 4: Livestock shelter

Livestock are provided a healthy, secure living environment that is appropriate to the context and for its intended use.

Livestock shelter and settlement Standard 5: Disaster risk reduction and preparedness

Livestock shelter and settlement infrastructure reduces the impact of future disasters.

Chapter 9: Minimum standards for the provision of livestock

When disasters result in substantial loss of livestock, the restoration of livestock assets in the post-disaster phase can be a valuable approach to rebuilding people's economic assets and providing high-quality livestock-derived foods, such as milk or eggs.

Based on the livelihood strategies and opportunities of the beneficiary populations, livestock provision may take the form of replacing livestock assets in some quantity in order to reconstitute a herd, or the distribution of livestock in smaller quantities to replace lost stock that provide food and/or income, or as a new initiative to generate income or provide food as a supplement to other livelihood activities.

Options for the provision of livestock

This chapter outlines two key types of livestock provision, namely herd reconstitution (sometimes called 'restocking' or 'redistribution') and other livestock distribution approaches. The chapter contains four standards that apply equally to both interventions.

- Herd reconstitution
- Other livestock distribution approaches

The minimum standards

Before engaging in the provision of livestock, the feasibility and appropriateness of the intervention should be carefully considered.

Provision of livestock Standard 1: Assessment

An analysis is carried out to assess the current and potential role of livestock in livelihoods and the potential social, economic and environmental impact of the provision of livestock.

Provision of livestock Standard 2: Definition of the package

Appropriate livestock types are distributed in adequate numbers and through appropriate mechanisms to provide viable and sustainable benefits to the target communities.

Provision of livestock Standard 3: Credit, procurement, transport and delivery systems

Credit, procurement, transport and delivery systems are efficient, cost-effective and support quality provision of livestock.

Provision of livestock Standard 4: Additional support

Additional support (veterinary care, training, food) is provided to beneficiaries to help ensure a positive and sustainable impact on livelihoods.

Conclusions

Livestock play a crucial part in people's livelihoods throughout the world and when humanitarian emergencies arise, rapid assistance is needed to protect and rebuild the livestock assets of affected communities. The Livestock Emergency Guidelines and Standards (LEGS) are a set of international guidelines and standards for the design, implementation and assessment of livestock interventions to assist people affected by humanitarian crises**.** LEGS should enable various agencies to provide more appropriate, more accountable, more consistent and better quality emergency livestock programming.

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Efficient utilization of fallen livestock

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India is bestowed with vast livestock wealth and it is growing at the rate of 6% per annum. The contribution of livestock including poultry and fish is increasing substantially in GDP of country which accounts for >40% of total agricultural sector and >12% of GDP. This contribution would have been much greater had the fallen animals been also efficiently utilized. Efficient utilization of fallen animals has direct impact on the economy and environmental pollution of the country. Non-utilization or under utilization of this not only lead to loss of potential revenues but also lead to the added and increasing cost of disposal of these products. Non-utilization of fallen animals in a proper way may create major aesthetic and catastrophic health problems. Utilization of fallen livestock helps to facilitate prevention of environmental pollution and check spread of livestock diseases, provides employment opportunity to rural poor engaged in carcass collection, flaying and by-product processing by producing better quality hides and skins and thus improves the income levels.

Utilization of blood

Animal blood has a high level of protein and heme iron, and is an important edible by-product. In Europe, animal blood has long been used to make blood sausages, blood pudding, biscuits and bread. In Asia, it is used in blood curd, blood cake and blood pudding. It is also used for non-food items such as fertilizer, feedstuffs and binders. Blood is used in food as an emulsifier, a stabilizer, a clarifier, a color additive, and as a nutritional component. Most blood is used in livestock feed in the form of blood meal. It is used as a protein supplement, a milk substitute, a lysine supplement or a vitamin stabilizer, and is an excellent source of most of the trace minerals. Plasma is the best water and fat binder of the blood fraction. Plasma gels appear very similar to cooked egg whites. Blood plasma also has an excellent foaming capacity, and can be used to replace egg whites in the baking industry. Blood factor XIII is a transglutaminase that occurs as an enzymogen in plasma, placenta and platelets. Transglutaminase can be use to improve the binding ability of fresh meat products at chilling temperature. In the laboratory, many blood products are used as a nutrient for tissue culture media, as a necessary ingredient in blood agar, and as peptones for microbial use. Glycerophosphates, albumins, globulins, sphingomyelins, and catalase are also used for biological assay. Many blood components such as fibrinogen, fibrinolysin, serotonin, kalikreninsa, immunoglobulins and plasminogen are isolated for chemical or medical uses. Purified bovine albumin is used to help replenish blood or fluid loss in animals. It is used in testing for the Rh factor in human beings, and as a stabilizer for vaccines. It is also used in antibiotic sensitivity tests.

Utilization of hides and skins

Animal hides have been used for shelters, clothing and as containers by human beings since prehistoric times. The hides represent a remarkable portion of the weight of the live animal, from 4% to as much as 11%. Hides and skins are generally one of the most valuable by-products from animals. Examples of finished products from the hides of cattle and pigs, and from sheep pelts, are leather shoes and bags, rawhide, athletic equipment, reformed sausage casing and cosmetic products, sausage skins, edible gelatin and glue. Gelatin is produced from hides and bones contain large quantities of collagen. Gelatin extracted from animal skins and hides can be used for food. In countries, pork skin is immersed, boiled, dried and then fried to make a snack food (pork rinds/pork scratching). Collagen from hides and skins also has a role as an emulsifier in meat products because it can bind large quantities of fat. This makes it a useful additive or filler for meat products. Collagen can also be extracted from cattle hides to make the collagen sausage used in the meat industry. Gelatin is added to a wide range of foods, as well as forming a major ingredient in jellies and aspic. Its main use is the production of jellied desserts, because of its "melt in the mouth" properties, but is also added to a range of meat products, in particular to meat pies. Gelatin is also widely used as a stabilizer for ice cream and other frozen desserts. High-bloom gelatin is added as a protective colloid to ice cream, yoghurt and cream pies. Most of gelatin is used to make the outer covering of capsules in the pharmaceutical industry. Gelatin can also be used as a binding and compounding agent in the manufacture of medicated tablets and pastilles. It is used as an important ingredient in protective ointment, such as zinc gelatin for the treatment of ulcerated varicose veins. Gelatin can be made into a sterile sponge by whipping it into foam, treating it with formaldehyde and drying it. Such sponges are used in surgery, and also to implant a drug or antibiotic directly into a specific area. Because gelatin is a protein, it is used as a plasma expander for blood in cases of very severe shock and injury. Gelatin is an excellent emulsifier and stabilizing agent for many emulsions and foams. It is used in cosmetic products, and in printing for silk screen printing, photogravure printing etc.

Utilization of bone

Eleven percent of pork carcasses, 15% of beef carcasses and 16% of lamb carcasses are bone. These values are higher if they include the meat clinging to the bone. The marrow inside some of the bones can also be used as food. The marrow may be 4.0–6.0% of the carcass weight. For centuries, bones have been used to make soup and gelatine. In recent years, the meat industry has been trying to get more meat from bones, and new techniques have been used for this purpose. Meat and bone meal (MBM) was widely recommended and used in animal nutrition as a protein source in place of proteinaceous feeds because of its content of available essential amino acids, minerals and vitamin B_{12}. MBM and related rendered protein commodities have potential for use in applications other than animal feed, including use as a fuel or a phosphorus fertilizer.

Utilization of glands and organs

Animal organs and glands offer a wide variety of flavors and textures, and often have a high nutritional value. Cholesterol is also used as an emulsifier in cosmetics. The hormone melatonin is extracted from the pineal gland. Bile consists of acids, pigments, proteins, cholesterol etc., and can be obtained from the gall bladder. It is used for the treatment of indigestion, constipation and bile tract disorders. It is also used to increase the secretory activity of the liver. Bile from cattle or pigs can be purchased as a dry extract or in liquid form. Some ingredients of bile, such as prednisone and cortisone, can be extracted separately, and used as medicines. Gallstones are reported to have aphrodisiac properties, and can be sold at a high price. They are usually used as ornaments to make necklaces and pendants. Liver extract is used as a raw material by the pharmaceutical industry. Liver extract can be obtained from pigs and cattle, and has been used for a long time as a source of vitamin B12, and as a nutritional supplement used to treat various types of anaemia. Heparin can be extracted from the liver, as well as the lungs and the lining of the small intestines. It is used as an anticoagulant to prolong the clotting time of blood. It is also used to thin the blood, to prevent blood clotting during surgery and in organ transplants. Progesterone and oestrogen can be extracted from pig ovaries. It may be used to treat reproductive problems in women. Relaxin is a hormone taken from the ovaries of pregnant sows, and is often used during childbirth. The pancreas provides insulin, which regulates sugar metabolism and is used in the treatment of diabetes. Glucagon extracted from the cells of the pancreas is used to increase blood sugar, and to treat insulin overdoses or low blood sugar caused by alcoholism. Chymotrypsin and trypsin are used to improve healing after surgery or injury. The intestines of sheep and calves are used for the manufacture of catgut, to make internal surgical sutures.

Utilization of edible tallow and lard

Animal fats are an important by-product of the meat packing industry. The major edible animal fats are lard and tallow. Lard is the fat rendered from the clean tissues of healthy pigs. Tallow is hard fat rendered from the fatty tissues of cattle or sheep. Lard and edible tallow are obtained by dry or wet rendering. Traditionally, tallow and lard were used for deep frying. However, this use is declining in the fast-food industry, due to consumer health concerns. An alternative liquid tallow product has been developed for the preparation of French fries and other fast foods, since less fat is absorbed. Tallow and lard are also used for margarine and shortening. Some edible lasrds are used in sausages or emulsified products.

Fish waste/by-products utilization

Fish waste is a great source of minerals, proteins and fat. Enzymes and bioactive peptides obtained from fish waste used for fish silage, fish feed or fish sauce production. Waste fish viscera are subjected to auto-hydrolysis to produce peptone hydrolysates and used in microbiological media to support growth and bacteriocin production by lactic acid bacteria. There are several alternative uses of fish waste, like utilization of fish mince, applications of fish gelatin, fish as a source of nutraceutical ingredients, fishmeal production, the possible use of fish and protein concentrate as a food source. Production of organic acids and amino acids from fish meat by sub-critical water hydrolysis would be an efficient process for recovering useful substances from organic waste such as fish waste discovered from fish markets. Use of fish waste for animal feed production was investigated and the considerable potential for use of fish waste for poultry feeding was established. Fish collagens are of interest to the food processing industry as they are used to produce gelatin which is extracted from the collagen.

Utilization of waste as biofuel

The availability of wet biomass as waste from industrial processes and the need to meet the environmental standards stand for the main stimuli towards investigating all options in order to dispose this waste. The thermal recycling of residues as secondary fuel is of increasing interest for power plant operators. Studies documented the usage of poultry litter as an alternative for natural fuel source generation. It is noteworthy that poultry litter with water contents less than 9% can burn without extra fuel. Therefore these samples were suitable for being used as fuel for generation of electrical power. Physicochemical treatment of meat industry waste-water is used to increase the organic matter removal efficiency, and it generates great amounts of sludge. Due to sanitary, environmental problems and operational costs related to the discharge, land disposal and re-use of wastes, the utilization of this Biofuel (dried sludge) for steam generation has shown to be a viable alternative. This type of fuel has a high heating value, and it is a renewable energy source. The combustion test with a Biofuel to sawdust ratio of 4:1 met the technical requirements for the characterization of this promising fuel; nevertheless, operating conditions must be well designed to achieve NO_2 and SO_2 emissions below local and/or international limits. Biodiesel fuel acquired from the oils and fats of meat and fish is a substitute for, or an additive to diesel fuel derived from petroleum.

Conclusion

Now a days our society, in which there is great demand for appropriate nutritional standards, is beset by rising cost and often decreasing availability of raw materials together with much more concern about environmental pollution, leading to the consequence that there is much occupation with recovery and recycling of wastes. Beside pollution and hazard aspects, in many cases, meat waste have a potential for recycling raw materials, or for conversion into useful products of higher value as by product, or even as raw material for other industries, or for use as food or feed after biological treatment. Particularly utilization of meat wastes is receiving increased attention in view of the fact that these wastes represent a possible and utilizable resource for conversion to useful products. Today, with the increased concerns over health, technology has been developed to permit more efficient utilization of these byproducts. These innovations also increase the value of the carcass, and increase the profits of livestock raisers. We have not quite reached the point where "The packer uses everything but the squeal", but we are improving all the time.

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Zoonoses often fall, overlooked, into the gap between veterinary responsibilities and medical needs.

Winyi Koboyo

Data collection in livestock during natural disasters

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Global data indicates that in the last decade natural disasters occurred more frequently than in the past and were more destructive. Losses caused by natural disasters such as earthquakes, tsunami, storms (hurricanes/tropical cyclones, tornadoes, sand/dust storms), floods, draught and heavy rains have had huge impacts on nation revenue and the safety of humans and animals. They hamper sustainable rural development initiatives and aggravate other financial, health and environmental blows, and can determine the emergence of complex political disasters. During natural calamities attention usually goes primarily towards human welfare, however, safety of animal is also very importance considering their causalities from draught and flood prone diseases, starvation, epidemics and different feed poisoning. One thing that became increasingly evident over the years is that each disaster event has its own unique set of issues and impacts depending on the magnitude and duration of the event. In some cases, such as draught it lowers down productivity per animal and auction of superior germplasm happens. In others, the number and extent of the impacts can be much more aching and challenging. Identifying these impacts and potential effects through assessments of physical and quality losses and estimates of resulting economic damages is important for policy makers, government agencies and researchers in targeting assistance. Since these assessments are often requested for true data with very short timelines, having a set of strategic procedures has proven to be necessary to meet deadlines and still maintain the reliability and accuracy of the assessment. Emergence of organization is always an evolutionary process. Damage assessment requests are typically made by government agencies and private organizations after a natural disaster. Most of times geographical and demographical distribution of different breeds of livestock was not correctly available and after the disaster happened it became very awkward procedure to collect true data for further compensation. This data was very useful for giving damage cost to farmers, insurance for valuable genetic resources and to know the total economic damage occurs due to disaster. The desires to respond quickly to these requests can compromise the ability to adequately and accurately depict the nature of the damage. Experience has shown that damage estimates calculated in haste can be significantly overstated. Overestimated damage does however provide additional political leverage to increase the money received from federal disaster programs (Kliesen, 1994). As such, there is a delicate balance that must be navigated between the timeliness and accuracy of a damage assessment and so it is very important for livestock data collection during natural disasters.

The need to understand the depth and breadth of the impacts is critical to effectively assist the livestock industry in formulating a plan to respond to and recover from a natural disaster. Disaster management plan for animals shall essentially include retrospective epidemiological study of the disasters including, herd health promotion, disease prevention, therapy and rehabilitation. In abnormal situations like the super cyclone in Orissa (in India), experience of other states like Andhra Pradesh or Gujarat could be useful. Steps like resource planning (for veterinary medical facilities, establishing shelter, grazing and watering facilities) are also needed. Other requirements includes training, canvassing for political and administrative support, involving volunteer groups, arranging communication, alternate channels for power and communication, publicity and public relation and rehabilitation of animal owners. Planning (short term and long term) may have to be followed up by monitoring, impact assessment and evaluation. Control Rooms, Temporary Veterinary hospital, equipment and other infrastructure are provided along with stockpile of equipment and drugs. For planning it is also important to understand animal behavior, in each disaster situation. Importance of Animal resource information in preparedness and mitigation (i.e. including recovery, relief and rehabilitation) is also having prime agenda during disaster data collections.

Pre disaster data collection:

Emergency planning is an integral part of the overall loss control program during natural disaster. Work done in advance of possible emergencies and disasters is a vital aspect of disaster management. It enables a reduction in the number and severity of disasters, through prevention and mitigation, as well as enhanced emergency response, through preparation and planning. Pre-disaster information capture is important for natural disaster mitigation. The community can make effective plans to reduce risk only if it has knowledge of the assets that are at risk. Most of the essential demographic, building and infrastructure information has a spatial context and so this information is best collected by GIS/GPS support tools. Spatially-located information is also critical to plan for response to natural hazard events and for response training. In case of livestock, census should be breedwise so it will be more useful. In figure 1 it has been shown that how the vulnerability reduction during disaster event.

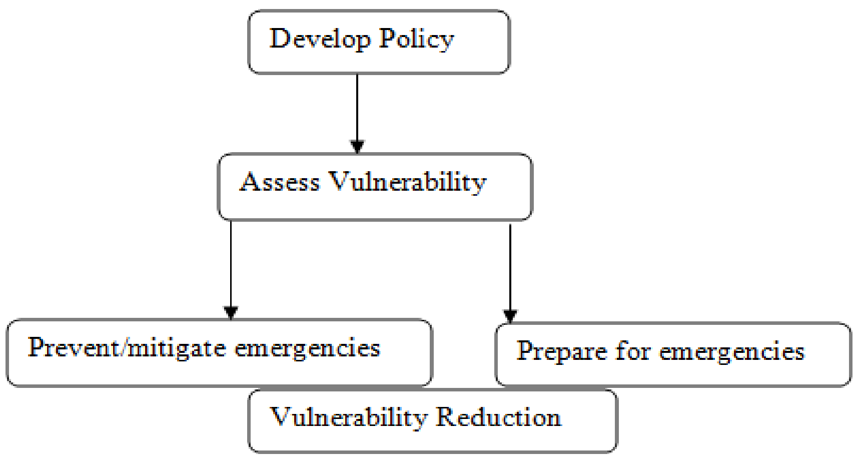

Fig. 1: Vulnerability reduction (WHO, 1999)

Post disaster data collection:

A natural disaster event can stretch emergency personnel to breaking point. However, at the very time that the community is most pre-occupied with response, important but perishable information on the event is available. The information helps us to understand how and why the event impacted on the community and livestock and systematic efforts are needed to collect the data. Risk managers need to base their decisions on accurate and reliable forecasting of the future. Different Organisations such as National Disaster Management Authority (NDMA) of India, Geosciences Australia provide risk assessments to assist this decision making. Post-disaster data collection is essential to test risk assessment models against what has happened in real events. Data collection technologies can also assist *response* teams by transmitting near real-time spatial information between field personnel and coordinating centres. Geosciences Australia has developed the capability to collect post-disaster information. Data collection equipment also accompanied GA personnel to the scene of the devastating January, 2001, Gujarat, India, earthquake. The structure of national response mechanism in India is shown in figure 2.

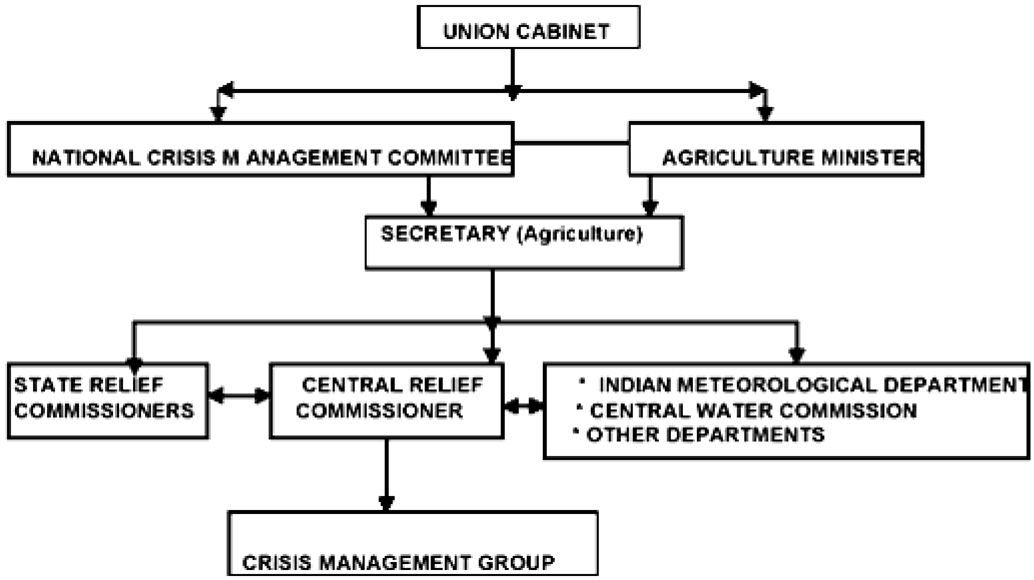

Fig.2: National response mechanism

Livestock related impacts:

Assessing economic damages resulting from natural disasters to a livestock industry requires a different approach than for row crops. Reduced grazing potential and hay production are only two aspects of livestock disaster estimates. Direct impacts on livestock production are also assessed through forced liquation of breeding stock above normal culling rates. The value of those breeding stock which are forced to be liquidated is calculated, but this only accounts for part of the economic loss. The difference per head between the replacement value and the cull value is used to determine the economic estimate for forced liquidation of breeding stock. Higher than normal mortality is also accounted for in calculated economic damages for all classes of cattle. One challenge that has arisen in developing economic damages for the livestock has been a lack of price information. Limited and sporadic pricing information is available from selected auction markets in India. However, available prices are self-reported by the sale barns and may not cover the bulk of sales as with the standard Services. The result of using prices from biased sources is economic damage estimates that are less reliable than for other agricultural commodities. As sale barns infrequently post prices, important information on the number of head liquidated pre- and post-disaster and price of animals sold is lost.

Challenges in shaping livestock damage:

The short timeframe often faced when developing damage estimates requires having a strategic plan or system for conducting an assessment. The sheer magnitude of the natural disasters in India showed the need for a system that would allow for an effective flow of information from the village level to the state level. Information on the physical damages collected at the ground level had to flow to the state level where it was collected, summarized, and used in developing economic impact estimates. Variability in data collection made it extremely difficult to quickly and accurately develop Statewise economic impact estimates. It was found that having a system that provided guidelines to district level personnel in conducting the physical damage assessment and which provided uniformity in the type and amount of information being collected, increased not only the timeliness of the assessment, but also provided an avenue to increase the detail and reliability of the estimates.

It also became apparent during the cyclones that decisions had to be made on what issues could and could not be adequately addressed. Unlike direct impacts, indirect impacts on rural economies were found to be more difficult to identify and often evolve more slowly over time. Also, depending on the severity of the storm, economic linkages used in the creation of an industry multiplier for a region may no longer exist making them invalid for assessment purposes (Guidry *et al*., 2008 and Fannin and Guidry, 2010).

Data collection tools:

There is different data collection tools such as palm PC, GPS positioning linked to database customised GIS databases. In case of technologies available include near real time telemetry to/from coordinating centre, and web data entry from the field. There are quite a large number of tools available to assist the disaster management agencies. These software tools range from simple document templates and online web questionnaires to sophisticated, multi-user workflow and document management systems. Developing and monitoring policies for disaster management requires an active process of data analysis, consultation and negotiation. This process should involve consultation among a wide variety of institutions, groups and individuals.

Data integration and ingestion in disaster management:

Data integration is the process of combining data residing at different sources and providing the user with a unified view of these data (Lenzerini, 2002). This process emerges in a variety of situations both commercial (when two similar companies need to merge their databases) and scientific (combining research results from different bioinformatics repositories). The problem of data integration becomes more critical as the amount of data that need to be shared increases. By data ingestion, we mean the process of inserting to a system data, which is coming from multiple heterogeneous sources. Scalability is an important issue in data ingestion, since the flow of information may be very high during the time of a critical event. Hence, technologies are needed for data integration and ingestion so that it is possible to query distributed information for disaster management. A disaster data management (DisDM) system was proposed to address the needs and requirements for information integration and information sharing solutions (Naumann and Raschid, 2006). There are different Key components of data integration and ingestion for disaster data management as shown in figure 3.

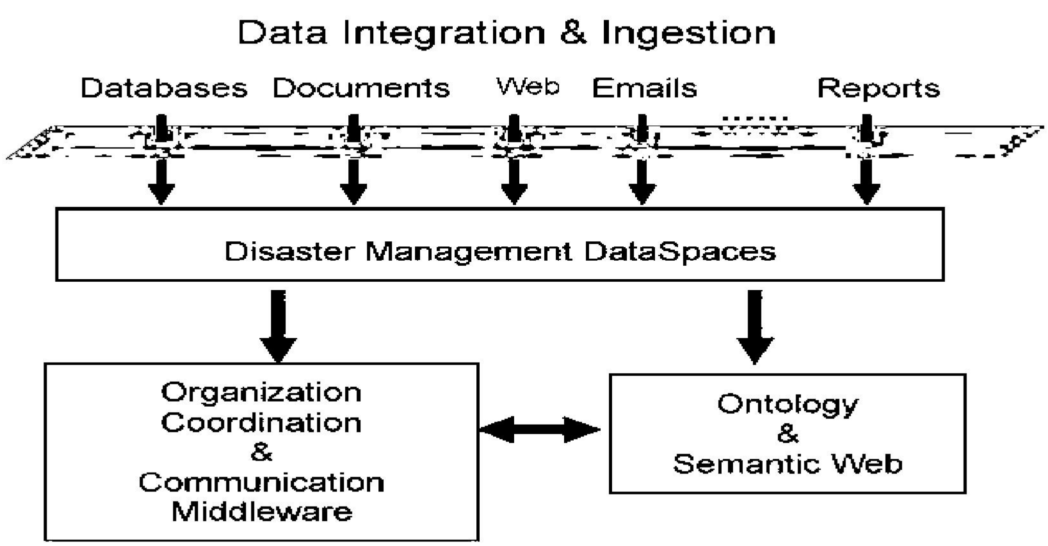

Fig. 3: Key components of data integration and ingestion for disaster data management

Issues and lessons learned

While conducting damage assessments can be viewed as a vague science, years of conducting assessments in India have provided several lessons. First and foremost, a strategic plan for conducting and implementing the assessment is critical to guard against potential biases as well as the temptation to overestimate damages. Also, a plan is critical to be able to address in as accurate manner as possible policy makers, industry leaders, and others with a vested interest in the assessment. Since moving toward a standardized, strategic approach after the 2005 by establishing NDMA, the ability to quickly respond for disaster damage assessment requests has improved as has the level of detail and the number of critical issues that are able to be addressed. The strategic survey approach has accomplished this by creating an environment in which all personnel involved have an obvious understanding of why and how the assessment will be conducted.

Every attempt is made to balance accuracy with timeliness. Credibility of the disaster estimates is improved by limiting initial assessments to major commodities directly impacted and by supplementing assessments with published data from respected sources. Follow-up can be done at a later time to conduct a more detailed, comprehensive assessment of the impacts of a natural disaster. Another lesson learned is that the timing of the natural disaster will likely impact the accuracy of assessments. It wrongly estimates pre and post season of production damage in agriculture. Impacts on commodities from natural disaster can vary significantly from disaster to disaster and within a disaster event. For some commodities, the impact may be limited to yield losses while others may have experienced yield losses in addition to quality losses and increased production costs. Lumping all of the impacts into one single damage estimate may miss the fact that a commodity was faced with multiple issues and impacts. Finally, as noted in the discussion of valuing the sale of breeding stock and its replacement cost, consideration is given to the values of stock and flows for capital assets. Sales of capital assets such as breeding stock will result in higher farm incomes in the year of a natural disaster, but farm incomes will decline in subsequent years unless that stock asset is replaced. Estimates attempt to account for the increased cost incurred by agricultural producers to replace capital assets where appropriate. While producers have an incentive to replace capital assets and restore production as quickly as possible following a disaster, each disaster is different in nature. As a result, it can be difficult to accurately determine the true length of the disaster's impact and how long it will take an operation to return to normal. So it is very necessary and urgent to collect livestock data during natural disaster to reduce the loss.

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Safe disposal of animal carcass

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Whether at the hand of accidental disease entry, typical animal-production mortality, natural disaster, or an act of terrorism, livestock deaths pose daunting carcass-disposal challenges. Effective means of carcass disposal are essential regardless of the cause of mortality but are perhaps most crucial for disease eradication efforts. Rapid slaughter and disposal of livestock are integral parts of effective disease eradication strategies. Realization of a rapid response requires emergency management plans that are rooted in a thorough understanding of disposal alternatives. Strategies for carcass disposal, especially large-scale carcass disposal, require preparation well in advance of an emergency in order to maximize the efficiency of response. There are many methods available to dispose of fallen stock. Here is a brief overview of some of these options both conventional and those which are rather more unique.

Burial

Burial involves one of three techniques trench burial of individual animals, mass burial or utilization of land fill. Burial is now a banned method of disposal in many countries. This was a decision taken because of fears of pollution in watercourses and because it was uncertain how resistant the BSE and scrapie prion would prove in the soil.

Incineration

Incineration has traditionally played a major role in the disposal of fallen stock. The advantages lie with the relative cheapness of this method, the lower pollution risk from fixed-facility incinerators and that with the high temperatures achieved most disease agents should be eradicated. However if poorly managed there can be severe environmental pollution risks.

Composting

This is illegal in few countries but is widely used by pig and poultry producers in Canada and the United States. This was proposed by ADAS as an environmentally friendlier method of dealing with fallen stock.

The general principle is that a bin is constructed to contain the carcasses. Proper airflow and a uniform temperature is essential in order to maximize the destruction of pathogens. The carcasses are then allowed to decompose until a suitable end product, similar to humus is achieved. This can then be spread on the land as fertilizer.

Composting can serve as an acceptable disposal method, but it is not certain that all pathogens will be destroyed in the process. Nor is it likely to be economically or logistically possible for enterprises dealing with a large number of small or medium sized carcasses.

Rendering

The rendering industry processes the by-products from slaughter houses and abattoirs. The actual process involved crushing and grinding of animal by-products, followed by heat treatment to reduce the moisture content and kill micro-organisms. Separation of the melted fat (tallow) from the solid (protein) is achieved through centrifuging (spinning) and pressing. The solid fraction is then ground into a powder, such as meat meal or meat and bone meal.

Lactic acid fermentation

This is a technique designed to store carcasses before they can be removed for rendering. It is a simple procedure which requires little equipment.

Carcasses are ground into small particles, added to the required chemicals and then added to a container. Carcasses can then be stored for up to 25 weeks. However there are issues regarding containment of pathogens, corrosion of the storage facility and contamination of the fermentation tank.

Alkaline hydrolysis

This is a relatively new process which involves using sodium hydroxide or potassium hydroxide to catalyze material into a sterile solution of peptides, amino acids, soaps and sugars. The undigested 2% of the carcass can be used as a fertilizer. The process is carried out in a digester. This method although comparatively untested has several advantages in that it reduces waste volume by up to 97% without producing significant air pollution or odor. Most significantly research suggests that it can completely destroy pathogens including prions.

Anaerobic digestion

This method has been used as early as the 10th century BC for disposing of animal waste. It involves the biological breakdown of waste materials without the input of oxygen to create methane. It is both economically and environmentally sound for disposing of carcasses both during a large scale epidemic (such as Foot & Mouth disease) or day-to-day mortalities. However corrosion can be a problem in facilities several years old. There are also concerns as pathogen containment; although more expensive it is suggested that additional heat be employed to ensure total destruction of such pathogens.

Novel techniques

There are a range of techniques suggested as methods for carcass disposal which are still in their infancy. These are assessed briefly below:

Thermal depolymerisation: this utilizes high levels of heat and pressure to convert pre-processed carcasses into a fuel oil. Its effectiveness at destroying pathogens requires further research.

Plasma Arc Process: this has so far not been used to dispose of livestock carcasses. However potentially there is no reason why this technology could not be used in the future. It relies on hot plasma torches to vitrify and gasify hazardous material. There are suggestions that this technology could be utilized alongside burial to treat material and enhance biosecurity.

Ocean Disposal: this would involve loading carcasses onto barges, sailing outside of territorial limits and sending them overboard. Despite the arguments of this being the cheapest method and the benefits to the ocean food chain the negatives appear to outweigh any positives. There are serious concerns relating to the attraction of scavengers to the areas of disposal and whether there will be material floating in the water. It has also been recommended that such a method should not be used for carcasses which were diseased.

Novel Pyrolysis Technology: This technique utilizes electromagnetic waves to vaporize material and destroy the strong bonds in hazardous material. It is as y*et al*most entirely untested and has not to date been used on an actual complete carcass. However research has suggested that it could have many benefits. It requires a very small energy input for the process and it is estimated that this will be enough to entirely eliminate the carcass and any hazardous agents it contains.

Protocols for safe handling & disposal of carcasses

1. All dead animals should be handled only while wearing gloves; this includes carrying of dead animals, during necropsy procedures, and the dressing out of carcasses. There are several types of gloves to choose from, including leather, rubber, and latex gloves. Rubber or latex gloves are preferred due to their low cost, wide availability, and ease of disinfecting.

2. The carcass should be placed in a plastic body bag and sealed as soon as possible. If a zoonotic disease is suspected (i.e., rabies, tularemia), it is recommended to double bag the carcass.
3. Avoid direct contact with the dead animal's body fluids (i.e., blood, urine, feces). If contact does occur, wash the skin area contacted with soap and water as soon as possible.
4. Avoid contact with the dead animal's external parasites (i.e., fleas and ticks). If possible, spray the carcass with a flea & tick spray prior to handling it. If pesticide poisoning is suspected as the cause of death and laboratory testing is to be performed on the animal's tissues, avoid spraying the carcass as it will interfere with laboratory results.
5. Proper disposal of the carcass (incineration, burying, etc.) is critical to prevent exposure of other wildlife and humans to disease. Three common effective methods of carcass disposal are: incineration, burying, and rendering. Incineration is the preferred method to use when the carcass is diseased; however, it can also be the most expensive. An acceptable alternative is to bury the carcass. The carcass should be buried at least 4 feet deep and covered with lime to discourage scavengers from uncovering and consuming it.
6. Persons who have direct contact with wildlife, especially carnivorous animals, on a regular basis are highly recommended to receive the rabies pre-exposure vaccination series. The pre-exposure series consists of a total of three vaccinations and is highly efficacious in preventing rabies. It is also recommended to have a rabies antibody titer tested every two years to determine the level of protection.
7. Whenever there is an unusual mortality or die-off of wildlife the Wildlife Investigations Lab should be contacted to determine if a necropsy and disease investigation is recommended. The carcass(s) should be refrigerated as soon as possible until a decision is made as to its disposition.

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The foundations of veterinary medicine are as comprehensive and subtle as those of human medicine and it is not possible to place one above the other.

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