INFECTIOUS DISEASE MANAGEMENT

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Module Overview

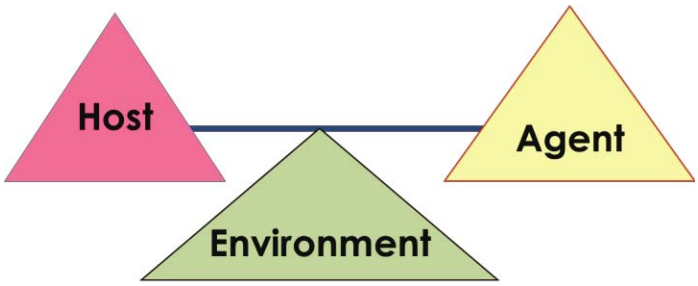
Infectious disease management is a comprehensive way of thinking and looking at the problem of infectious disease. The issue is considered from multiple perspectives, including the host, agent and environment, and through various disease management lenses such as surveillance, promotion, prevention, detection, treatment and rehabilitation.

This module fosters an understanding of the concept if infectious disease management in One Health programs at the individual and society levels. After the module, students will also understand the role of the interplay between agent, host and environment in developing interventions to control outbreaks and creating strategies to eradicate disease.

Module Competencies

Competencies#1	Learning Objectives to Develop Competencies
Be able to identify and analyze the risk factors of an outbreak.	1) Understanding principles of infectious disease risk 2) Understanding the mode of disease transmission 3) Identifying mode of transmission and control measures 4) Describing the specific risk factors for zoonotic diseases
Competencies#1	**Learning Objectives to Develop Competencies**
Ability to design and implement a One Health action plan for infectious disease management	1) Creating an infectious disease management plan

A. FACTORS INFLUENCING INFECTIOUS MANAGEMENT STRATEGY



Infectious diseases are diseases caused by microbes and that spread. The most common infectious disease-causing microbes are bacteria, viruses, fungi, and protozoa (a type of parasite). The disease may be passed from person to person, or sometimes the disease is passed through another medium, for example, by drinking water or eating food infected with bacteria. Some diseases, such as Lyme disease, are passed from an animal carrier to humans. Deer ticks pick up Lyme disease from small animals such as mice (who don't even get sick from the disease), lay their eggs and travel around on deer, and sometimes end up on humans who can get sick if bitten. Sometimes, the infectious diseases develop new strains that resist older treatments. During the 1980s, tuberculosis (TB) – a disease that had nearly been eliminated in developed countries through successful treatments with antibiotics – reemerged. In some cases, the new strain of TB was drug-resistant.

A.1. The Epidemiology Triangle

The epidemiology triangle is a model that scientist have developed for studying health problems that has three corners (called vertices)

- Agent, or microbe that causes the diseases (the 'what' of the triangle). Disease-causing microbes are bacteria, virus, fungi, and protozoa. They are what most people call "germs".
- Host, or organism harboring the disease (the 'who' of the triangle). Hosts are usually humans or animals that may or may not get sick. Although the host may or may not know it has the disease or have any outward signs of illness, the disease does take lodging from the host. The host heading also includes symptoms of the disease. Different people may have different reactions to the same agents.
- Environment, or those external factors that cause or allow disease transmission (the 'where' of the triangle). Some diseases live best in dirty water. Others survive in human blood. Still others, thrive in warm temperatures but are killed by high heat.

To be able to persist or live on, pathogens must be able to leave an infected host, survive transmission in the environment, enter a susceptible person or animal, and develop and/or multiply in the newly infected host (www.ec.europa.eu). In order to control or prevent infection, it is essential to understand transmission of a pathogen. There are six vital links that are called as disease cycle – the chain of events involved in the development of disease, including the stages of development of pathogen and the effects of the disease on the host plants. All infectious disease-causing agents go through a disease cycle. A generalized disease cycle illustrated in the figure below (Nelson, 1994).

Infectious Agents, - is a bug or micro-organism with the ability to cause disease. The greater the micro-organism's virulence (ability to grow and multiply) and pathogenicity (ability to cause disease), the greater the possibility that the microorganism will cause an infection. Infectious

agents are bacteria, virus, fungi, and parasites (WHO, 2001). Sometimes, microorganisms are part of patient's own body flora and can cause infection in the immune-compromised host. These infections are called endogenous infections. Infections which are required from external sources are called exogenous infections (www.cambridge.org).

Reservoir, - the second link in the chain of infection. Reservoir can be environment or object in or on which a microorganism can survive and, in some cases, multiply. Inanimate objects, human beings, and animals can all serve as reservoirs, providing essential requirements for a microorganism to survive at specific stages in its life cycle (www.cambridge.org).

Portal of Exit, - A place of exit providing a way for a micro-organism to leave the reservoir. It is required for microorganism to be transmitted from human sources. Portal of exit within healthcare settings include: intravenous lines, urinary catheters, wound sites, open skin lesions, invasive devices, the respiratory system, skin, and mucous membranes (WHO, 2001).

Means of Transmission, - The microorganism can be acquired by inhalation (through respiratory tract), ingestion (through gastrointestinal tract), inoculation (through accidental sharp injury or bites), contact (during sexual intercourse) and trans placental transmission (microbes may cross placenta from the mother to fetus). It is important to remember that some microorganism use more than one transmission route to get from the reservoir to a new host(www.cambridge.org).

In healthcare there are six main modes of transmission (WHO, 2001):

- Blood borne: through sexual transmission, injury or inoculation. The main concern in healthcare settings are the transmission of HIV, Hepatitis B, and C through sharp injuries or blood splashes.
- Airborne: through inhalation of small particles that remain suspended in the air for long periods of time and can be widely dispersed by air currents
- Droplet: also through inhalation. Droplet transmission differs as the particles are larger and therefore do not remain suspended in the air. Spread is therefore through close contact with infected persons who may be sneezing, coughing, talking, or undergoing airway procedures such as intubation or bronchoscopy.
- Contact: through direct or indirect contact. Direct is the transfer or organisms by contact with contaminated hands. Indirect is the transfer or organisms through fomites.
- Common vehicles: through food, water, drugs, blood, or other solutions
- Vector borne: usually through arthropods such as mosquitoes and ticks but cockroaches, ants, and flies can also transmit infection.

Portal of Entry, - An opening allowing the micro-organism to enter the host. Portals include body orifices, mucus membranes, or breaks in the skin. Portals also result from tubes placed in body cavities, such as urinary catheters. Usually this path is the same as the portal exit (Cork, and Kerry, 2012).

Susceptible Host, - The final link in the chain of infection. The human body has many defense mechanism for resisting the entry and multiplication of pathogens. When these mechanisms function normally, infection does not occur (www.cambridge.org). There are factors that affect the body's natural ability to fight infection include:

- Presence of underlying disease (diabetes)
- Immune-compromised status (HIV, chemotherapy treatment)
- Nutritional status
- Age (the very young and old)

Essential measures should be taken to help prevent and control this cycle of infection, including limiting sources, preventing the routes of transmission, minimizing portals of entry, and protecting susceptible patients. If measures are not taken, patients and staff may be exposed unnecessarily to pathogenic microorganisms.

A.2. Level of Prevention

The different points in the progression of a disease at which one can intervene can be classified according to three levels of prevention: primary, secondary, and tertiary.

Primary Prevention

At this level of prevention the effort is to reduce exposure of a risk factor that may lead to the disease. Primary preventive measures include healthy nutrition, regular physical activity, cessation of smoking, and etc. The objectives here are to promote health, prevent exposure, and prevent disease.

- *Health Promotion*. This consists of general non-specific intervention that enhance health the body's ability to resist disease, such as measures aimed at the improvement of socio-economic status through the provision of adequately-paid jobs, education and vocational training, affordable and adequate housing, clothing, and food, old-age pension benefits, emotional and social support, relief of stress, etc. in short, it is any intervention that promotes a healthier and happier life (Alemayehu, 2004).
- *Prevention of Exposure*. This includes actions such us the provision of safe and adequate water, proper excreta disposal, vector control, safe environment at home, at school and at work, and on the streets (Alemayehu, 2004).
- *Prevention of Disease*. This occurs during the latency period between exposure and the biological inset of disease. An example for this is immunization (Alemayehu, 2004).

Secondary Prevention

This level of prevention refers to early detection and prompt treatment of disease. Screening tools such as mammography and cervical cancer screening are considered examples of secondary prevention because they may detect disease before it spreads, thereby preventing further complications or disease progression. This prevention is applied after the biological onset of disease, but before permanent damage sets in. The objective here is to stop or slow the progression of disease so as to prevent or limit permanent damage, through the early detection and treatment of disease (Alemayehu, 2004).

Tertiary Prevention

This level of prevention is applied after permanent damage has set in. The objective is to limit the impact that damage. The impact can be physical, psychological, social, and financial. Rehabilitation refers to the retraining or remaining functions for maximum effectiveness, and should be seen in a very broad sense, not simply limited to the physical aspect. Thus the provision of special disability pensions would be a form of tertiary prevention (Alemayehu, 2004).

A.3. Public Health Surveillance

Public health surveillance is the continuous, systematic collection, analysis, and interpretation of health-related data needed for the planning, implementation, and evaluation of public health practice. Such surveillance can serve as an early warning system for impending public health emergencies, document the impact of an intervention, or track progress towards specified goals, and monitor and clarify the epidemiology of health problems, to allow priorities to be set and to inform public health policy and strategies. (www.who.int)

Sources of disease surveillance data could be from data collected in the field, both quantitative and qualitative data, through automatic web-based monitoring, population, laboratory, and data about a disease collected only from selected sites (useful information, but not necessarily complete or representative of the entire population). Public health surveillance is comprised of six

core activities: detection, registration, reporting, confirmation, analysis and feedback. Moreover, support activities include communications, supervision, training and resource promotion.

Ideally, effective disease surveillance systems should be able to identify key drivers of zoonotic disease emergence, detect disease outbreaks or new trends or patterns of diseases, forecast events that may lead to disease emergence, assist governments in the development of prevention strategies, provide accurate, timely information to program managers, and establish a sustainable, global early-warning system. The following criteria could be used to evaluate public health surveillance systems:

- **Simplicity** (For a public health surveillance system, refers to both its structure and ease of operation. Systems should be as simple as possible while still meeting their objectives.)[1]
- **Flexibility** (Refers to a system being able to adapt to changing information needs or conditions with little additional time, personnel or allocated funds, e.g., new health-related events, case definition or diagnostic test.)
- **Acceptability** (Willingness of persons and organizations to participate in the surveillance system.)
- **Sensitivity** (Reflects two levels: the proportion of cases or other health-related events detected by the system, and/or the ability to detect outbreaks and monitor changes in the number of cases over time.)
- **Specificity** (Proportion of healthy persons [without disease or health of interest] correctly classified as not infected.)
- **Accuracy** (e.g., how accurate is laboratory testing for confirmation?)
- **Positive predictive value (**The proportion of reported cases that actually have the health-related event under surveillance.)
- **Representativeness** (A system representative if it accurately describes the occurrence of a health-related event over time and its distribution in the population by place and person.)
- **Sustainability** (Whether adequate resources exist to sustain the activity.)
- T**imeliness** (Reflects the speed between steps in a public health surveillance system, e.g., the date the disease was identified and the date reported.)

EXERCISE#1

Discussion

Rabies Case Scenario

Observing that almost a year had passed since the last rabies case was reported on the island of Bali, Indonesia, the provincial administration expressed confidence that the island would soon be completely free of rabies. To be officially categorized as "rabies free," an area must have two consecutive years without a single occurrence of rabies in either animals or humans. "It could be possible that Bali will be free of rabies because the last rabies case found in a human was last April," the head of the Bali Health Agency, I Ketut Suarjaya, was quoted as saying.

Sanglah Hospital reported that, overall, only about 2 percent of dog bite cases developed rabies. Disease surveillance data showed that in 2008 a total of four persons with rabies infection ("cases") were reported, compared to 48 cases reported during 2009 and 82 cases during 2010. Following implementation of a mass dog vaccination campaign, a substantial reduction in the number of persons with rabies infection ("cases") was observed, a total of 24 in 2011, and by 2012, only 8 human cases were reported.

Meanwhile, Sanglah Hospital's Secretary of the Rabies Mitigation Team, Dr. Ken Wiransadhi, acknowledged that rabies vaccine distribution had become more selective recently. Distribution was prioritized for multiple and deep wounds caused by stray dogs. Free-of-charge rabies inoculations are provided at state-owned hospitals only for humans with dog bite wounds in vital organs, including the head, face, fingers and genitalia. The vaccine can also be purchased at medical clinics. Last week, the Bali Health Agency stocked up with 5,000 vials of anti-rabies vaccine, an amount estimated to be sufficient for approximately 1,250 people during the next few months. Some 750 vials have been distributed to rabies centers in regencies.

Over the past several years, Bali has attempted to control the spread of rabies through a mass dog vaccination program and sterilization. The head of Bali's Husbandry Agency, Putu Sumantra, recently announced that stage four of the mass dog vaccination campaign, which will include vaccine for all 300,000 dogs on Bali, would start mid-April and run through June this year. According to agency records, the latest mass rabies vaccination resulted in the immunization of approximately 80 percent of the dog population on the island (approximately 250,000 dogs), while 500 more had been sterilized. The Balinese administration remains confident that the island will be able to achieve its target of being a "rabies-free" area by 2015.

Residents are expected to bring their dogs to receive this free vaccination. But since the rabies outbreak began on the island in 2008, some experts have maintained that there has not been much improvement in behaviors related to rabies prevention strategies among pet owners in Balinese communities. "There's only been a small change in attitude in the way they care for their dogs. The dogs are still let loose to look for food on the streets," chairman of the Bali chapter of the Indonesian Association of Veterinarians, Gusti Ngurah Mahardika, said recently. Mahardika stated it was urgent for Balinese communities to properly care for their dogs by feeding them at home and vaccinating them regularly because, "Dogs do bite. Thus, preventing them from contracting rabies is most important." The virologist further stated that the main methods of prevention include the proper care and regular vaccination for dogs, as well as increasing public awareness about the need to have proper treatment, including a rabies shot, after being bitten by a dog.

Arie Rukmantara, spokesperson for the National Commission on Zoonoses, said that the main challenge to free the island from rabies was maintaining the commitment and participation of both individuals and communities. "If an outbreak occurs for several years, it is crucial to maintain the commitment of local people to participate in the eradication efforts." He said the 2015 target for being rabies-free was reasonable, considering that the administration had implemented efforts to accomplish this since the first case of rabies was found in Jimbaran during 2008.

Retrieved from the Jakarta Post

- ✓ How serious is the rabies outbreak?
- ✓ What are the most significant risk factors in the rabies outbreak?
- ✓ Who is responsible for monitoring risk factors for this disease?
- ✓ What is a major concern in a rabies outbreak situation?

- ✓ What would you do to mitigate risk factors for rabies during an outbreak?
- ✓ What is your group's plan of action?
- ✓ What are behaviors associated with infection?
- ✓ How these factors led to an increased disease risk in the scenario?

Notes:

B. INFECTIOUS DISEASE MANAGEMENT FUNDAMENTAL

To better understand the importance of the mode of disease transmission and possible risk factors, and to form a logical disease management plan, consider the following questions:

- What type of infectious organism is involved in outbreak?
- What host species are usually infected?
- Are there known reservoir hosts that spread organisms, but do not develop disease?
- How is the disease transmitted from host to host?
- What interventions (treatment, prevention, vaccination) are available?
- What are possible prevention strategies?
  - Lower the risk of infection by implementing interventions that limit contact between susceptible hosts and infectious agent.
  - Change high-risk behavior(s) through health education.
  - Quickly identify, properly treat and, where appropriate, isolate newly infected cases (i.e., persons or animals with the disease of interest).
- How to evaluate a plan. Positive and negative consequences.

EXERCISE#2

Discussion

Leptospirosis

Leptospirosis is a zoonotic waterborne infection with a global distribution caused by the bacteria (a "spirochete") of the genus *Leptospira*. Leptospirosis in humans results in damage to the liver, kidneys and the central nervous system. Humans can be exposed by contact with water, or vegetation or soil contaminated by the urine of infected animals. Possible animal reservoirs include livestock, dogs, rodents and wild animals. Leptospires enter the body through contact with cuts or abrasions in the skin or contact with mucous membranes (e.g., nose, mouth, eyes) and, occasionally, via drinking contaminated water. Upon entering the body, there is widespread dissemination to tissues and blood, and potentially to the central nervous system. Person-to-person transmission is rare. The occurrence of leptospirosis in humans depends on a complex set of interactions between ecological and social factors. Although leptospirosis is present ("endemic") worldwide, it is more common in tropical and sub-tropical regions where abundant precipitation, regular flooding and high temperatures enhance the distribution and survival of leptospires in the environment. Animal vaccination is practiced in some countries, but immunity is short-lived; human vaccination is not widely practiced.

Additional information is available in the One Health Compendium: http://www.onehealthinitiative.com/publications/OHOW_Compendium_Case_Studies.pdf

Streptococcus suis

Streptococcus suis is an important bacterial cause of zoonotic disease in both swine (pigs) and humans in many parts of the world. The organism may be isolated from healthy pig carriers, but reported infections among swine include arthritis, meningitis, pneumonia, septicaemia, endocarditis, abortions and abscesses. Humans at higher risk for infection include those in direct contact with pigs or raw pig products, including farmers and abattoir workers, and those with pre-existing illness resulting in immunosuppression. Human infection usually follows direct contact with infected pigs or raw pig products and is thought to occur through cuts or abrasions on the skin, handling infected pig material, or possibly inhalation or ingestion. In humans, *Streptococcus suis* infection may cause meningitis. Endocarditis, pneumonia, toxic shock–like syndrome and septic arthritis have also been reported.

Additional information available from the WHO Factsheet: http://www.who.int/foodsafety/micro/strepsuis/en/

Staats J.J., I. Feder, O. Okwumabua, and M.M. Chengappa. Streptococcus suis: past and present. *Vet Res Commun*. 1997 Aug; 21(6): 381–407. Abstract available online at: http://www.ncbi.nlm.nih.gov/pubmed/?term=9266659

Nghia H.D.T., N.T. Hoa, et al. Human case of Streptococcus suis serotype 16 infection. *Emerg Infect Dis* 2008 January. Available online at: http://wwwnc.cdc.gov/eid/article/14/1/07-0534.htm

Rabies

Rabies is a preventable zoonotic disease (i.e., a disease transmitted to humans from animals) that is caused by the rabies virus. The disease is endemic in many countries, affects mainly domestic and wild mammals, and is spread to humans through contact with infectious material, usually saliva, via bites or scratches by a rabid animal. Rabies is present on all continents with the exception of Antarctica, but more than 95% of human deaths occur in Asia and Africa, most often following contact with bats, dogs or carnivores with rabies infection. Once symptoms of the disease develop, rabies is nearly always fatal; currently, WHO estimates rabies causes 60,000 human deaths per year. The high mortality of rabies highlights the importance of a global canine rabies elimination strategy through dog vaccination, and the importance of preventing infection in humans exposed to potentially rabid animals by following effective post-exposure prophylaxis protocols, including proper wound care and post-exposure vaccination.

Additional information available in the WHO Fact Sheet: http://www.who.int/mediacentre/factsheets/fs099/en/

Additional information available in the One Health Compendium: http://www.onehealthinitiative.com/publications/OHOW_Compendium_Case_Studies.pdf

Steele JH, Fernandez PJ. History of rabies and global aspects. In: Baer GM, editor. *The natural history of rabies*, 2nd ed. New York: CRC Press; 1991. p. 1–24.

Dengue

Dengue is a mosquito-borne viral infection found in tropical and sub-tropical regions around the world. Dengue virus (DENV) is in the genus *Flavivirus* and exists in four serotypes (DENV 1, 2, 3 and 4). In recent years, DENV transmission has increased, predominantly in urban and semi-urban areas and has become a major international public health concern. Severe Dengue (previously known as Dengue Haemorrhagic Fever) was first recognized in the 1950s during dengue epidemics in the Philippines and Thailand. Today, Severe Dengue affects most Asian and Latin American countries and has become a leading cause of hospitalization and death among children in these regions. Dengue virus control strategies have focused mainly on vector control activities and enhanced disease surveillance. Although efforts to develop an effective dengue vaccine are continuing, no candidate vaccine has been proven effective against all four dengue fever virus serotypes. Transmission of dengue among forest monkeys has been reported in Asia and Africa, but human infection is sufficient to maintain transmission in cities, particularly in crowded urban areas where insects can breed in uncovered water storage containers, including flower dishes or vases, metal cans and discarded plastic or glass bottles, or auto tires containing water.

Information available from the WHO Factsheet: http://www.who.int/mediacentre/factsheets/fs117/en/index.html

Mahalingam S, Herring BL, Halstead SB. Call to action for dengue vaccine failure [letter]. *Emerg Infect Dis* 2013 August. Available online at: http://dx.doi.org/10.3201/eid1908.121864

- ✓ Create a plan to control the zoonotic disease through the appropriate diagnosis, disease prevention and public awareness campaigns through the following conceptual framework:
  - o What are the risk factors related to the host, the agent, and the environment?
  - o What is the transmission cycle for the disease?
  - o What are possible control or intervention points?
  - o What is the group's plan to control the disease based on the known risk factors and possible interventions?

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(Endnotes)
Updated Guidelines for Evaluating Public Health Surveillance Systems. Morbidity and Mortality Weekly Report (MMRW). U.S. Centers for Disease Control and Prevention. July 27, 2001 / 50(RR13);1-35. Available online at:www.cdc.gov/mmwr/preview/mmwrhtml/rr5013a1.htm.