



BIOL 466: Emerging Infectious Diseases

2022/2023

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Outline

- What are emerging/Re-emerging infectious diseases?
- Factors contributing to their emergence
- Examples of recent EIDs
- Investigating EIDs
- Dealing with EIDs/Controlling EIDs

Learning objectives

- Define emerging and re-emerging infections
- List some important emerging and re-emerging infections globally
- Describe the risk factors for emerging and re-emerging diseases
- Recognize some handicaps when dealing with EIDs
- Describe preventive and curative ways for EIDs

Emerging Infectious Disease

- Emerging Infectious Disease (EID)
 - Newly identified or previously unknown infectious agents that cause public health problems either locally or internationally

**1 newly identified infectious disease every year
for the last 30 years**



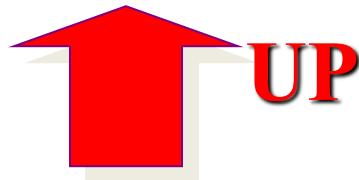
Re-emerging infectious diseases

Re-emerging – Diseases that once were major health problems globally or in a particular country, and then declined dramatically, but are **again becoming health problems** for a **significant proportion of the population**

New diseases – Emerge
Old diseases – Re-emerge

EIDs: A world in Transition

AIDS
Avian Influenza
Ebola
Marburg
Cholera
Monkeypox
Coronaviruses
Rift Valley Fever
Tuberculosis
Leptospirosis
Chikungunya
Dengue
JE
Antimicrobial resistance



Guinea worm
Smallpox
Yaws
Poliomyelitis
Measles
Leprosy
Neonatal tetanus

What do most EIDs have in common?

- **Zoonotic pathogens (60-70%)**
- Spread by modern transportation
- Laboratory and clinical diagnoses are problematic
- Poor communication among countries
- Major economic impact

Factors Contributing to emergence of EIDs

Agent/Pathogen

Host

Environment



Environment

- Climate and changing ecosystems (Warm and humid climate)
- Economic development and Land use (urbanization, deforestation)
- Richness in wildlife host species
- Breakdown of public health measure (war, unrest, overcrowding)
- Deterioration in surveillance systems (lack of political will)

Jones et al., 2008



Agent

Type of microorganism?

- Virus-related factors
 - RNA viruses (evolve rapidly in many hostile environments)
 - Exhibit error-prone gene replication
 - Mutation
 - Reassortment
 - Recombination at a very high evolution rate

Agent

- Evolution of pathogenic infectious agents (microbial adaptation and change)
- Development of resistance to drugs: Wrong prescribing practices
 - Non-adherence by patients
 - Counterfeit drugs
 - Use of anti-infective drugs in animals and plants
- Resistance of vectors to pesticides/insecticides

Host - Terminologies

Infection
Diseased state
Index case
Epicentre
Epidemiology
Hotspot
Heat map
Holoendemic
Hyperendemic

Endemic
Epidemic
Primary case/s
Secondary case/s
Symptomatic
Asymptomatic
Incubation period
Prodromal phase

Host – Humans/Animals

- Demographic change (inhabiting new areas)
- Behaviour (sexual, eating habits and drug use)
- Susceptibility to infection (Immunosuppression)
- Poverty and social inequality
- **Close contact between human and livestock populations** === provides excellent conditions for the frequent exchange of pathogens between animal and human populations.

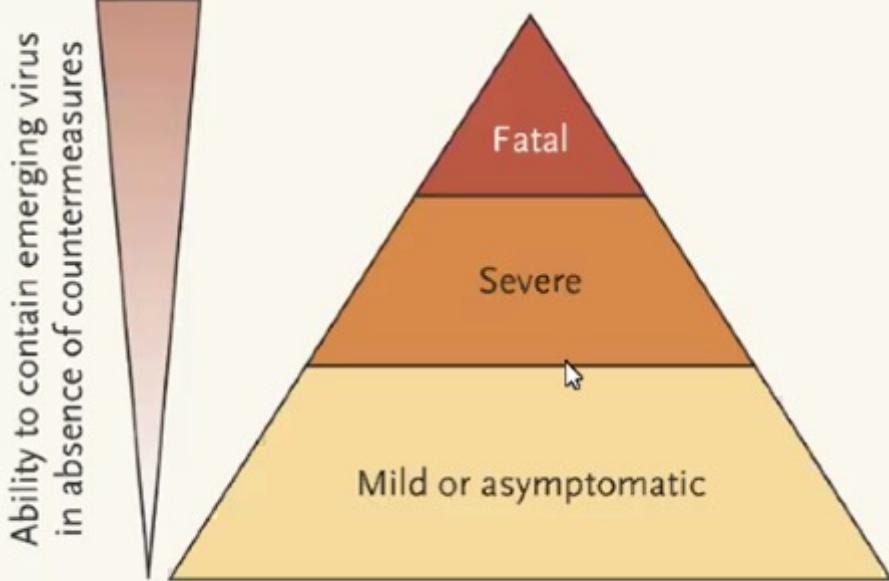
Factors responsible for the emergence/Re-emergence of Infectious diseases

- Unplanned and under-planned urbanization
- Overcrowding and rapid population growth
- Poor sanitation
- Inadequate public health infrastructure
- Resistance to antibiotics
- Increased exposure of humans to disease vectors and reservoirs of infection in nature

Factors responsible for the emergence/Re-emergence of Infectious diseases

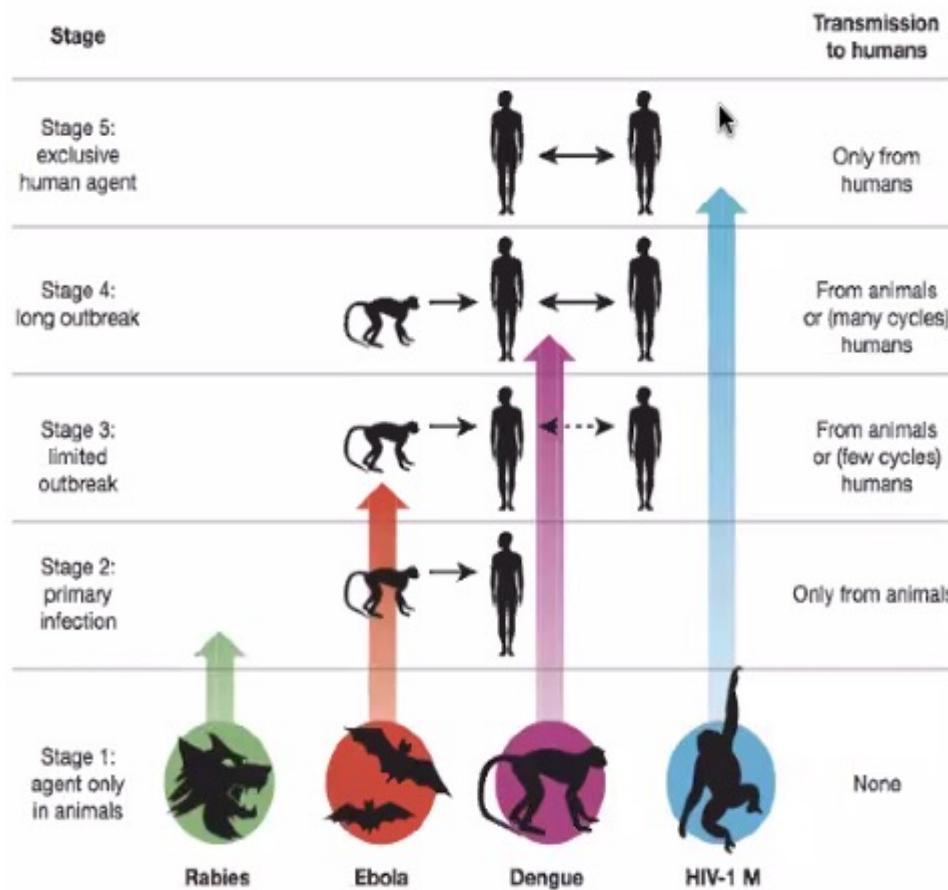
- Rapid and intense international travel
- Practice of modern medicine and relaxation in immunization practices
- Deforestation
- Changes in genetic make up of the pathogen
- High risk human behaviour
- Channelling of funds to other problems

How severe and widespread it is: a challenging question



- No diagnostic tests
- Symptoms are non specific
- People with mild illness are not reported
- Requires well-powered population studies
- Timeline: weeks to months!

Questions about Spill over – Zoonotic diseases

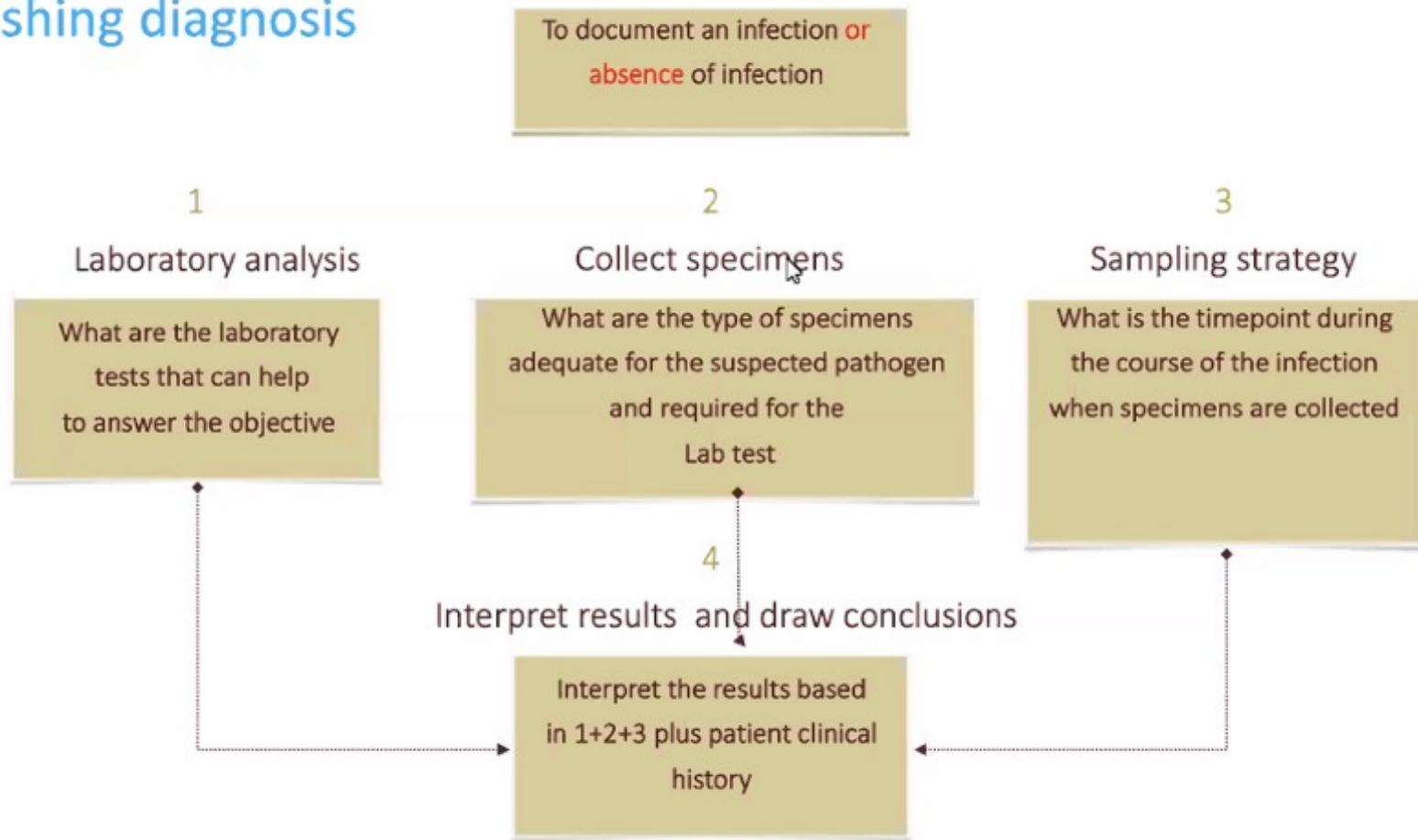


Questions about Spill over – Zoonotic diseases

- What is it?
- How can I detect it?
- What is the reservoir
- Who can be infected
- What is the mode of transmission
- How widespread is it?
- How contagious is it?
- Who is most at risk?
- (How) can it be stopped, prevented

INVESTIGATING EIDS

Establishing diagnosis



INVESTIGATING EIDS

- Epidemiological information
- Culture
- ELISA
- IFA
- Molecular-based assays
 - PCR
 - Sequencing

Epidemiology

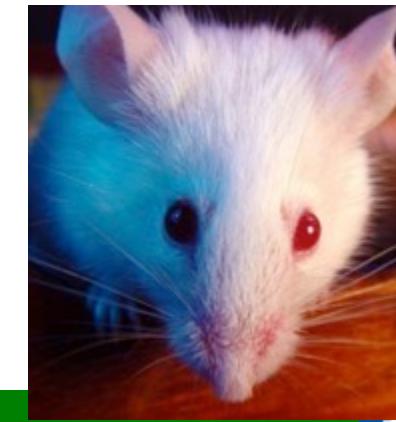
- Cornerstone of public health
- Identifying **risk factors** for disease and targets for preventive healthcare.
 - Informs policy decisions and evidence based practice

Key Tasks in Dealing with Emerging Diseases

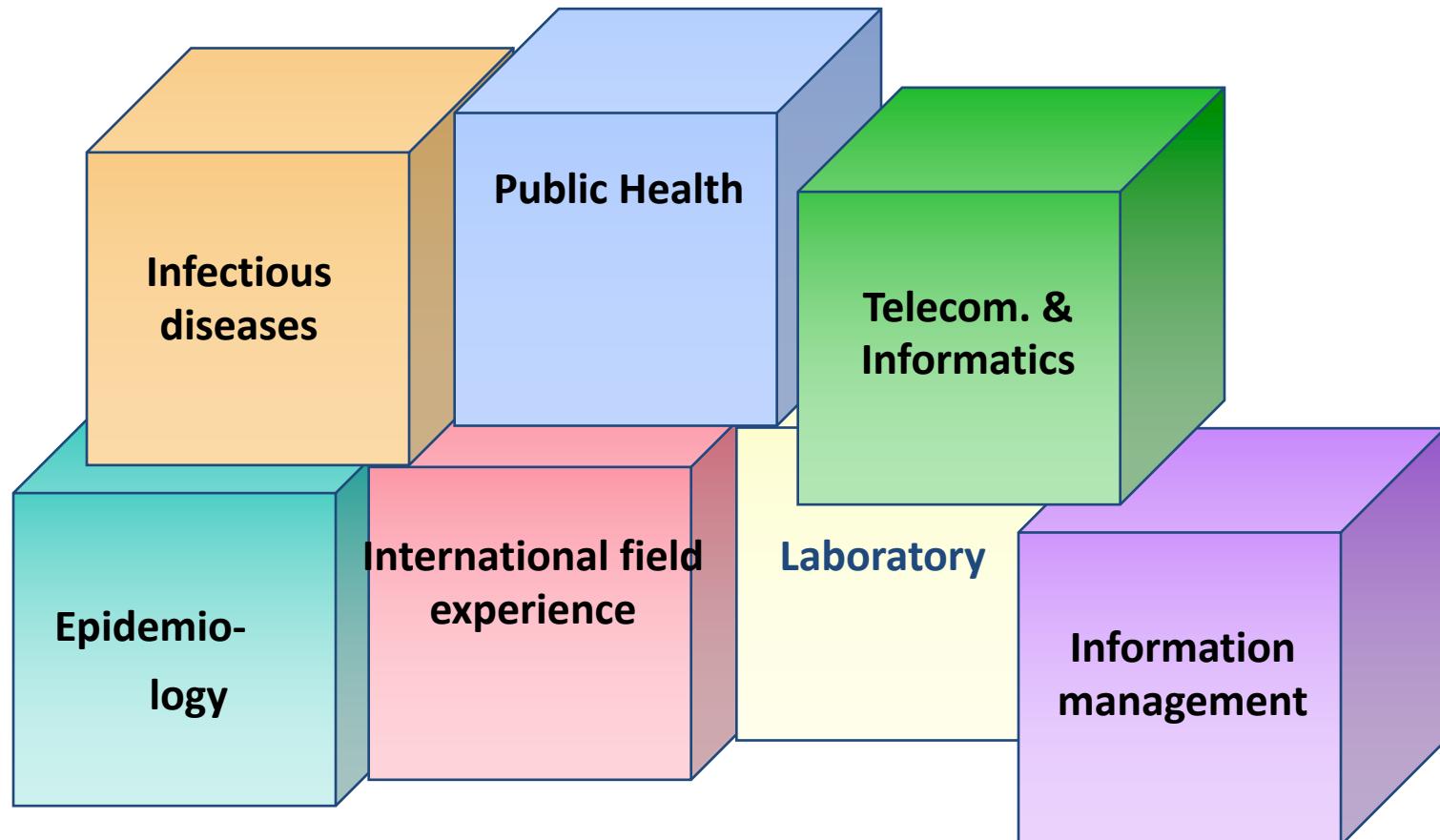
- Surveillance at national, regional, global level
 - clinical/epidemiological
 - laboratory
 - ecological
 - anthropological/Sociological
- Investigation and early control measures
- Implement prevention measures
 - Behavioural, political, environmental
- Monitoring, evaluation

Develop new diagnostic tools : new sensitive and accessible serological, molecular, virological, methods to detect the new microorganisms

Characterize new pathogens with the involvement of experts from various fields: genomics, proteomics, pathophysiology, immunology, epidemiology, ecology, entomology, zoology.



What skills are needed?



Multiple expertise needed!

Some Recent EIDS



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Arenaviruses Transmission – Lassa fever

- Virus transmission and **amplification** occurs in **rodents**
- Shed virus through urine, feces, and other excreta
- Human infection
 - Contact with excreta
 - Contaminated materials
 - Aerosol transmission
- Person-to-person (H2H) transmission



Filoviruses: Marburg and Ebola viruses

Marburg virus

- 1967, European laboratory workers

Ebola virus

1976

- Ebola Zaire
- Ebola Sudan

1989 and 1992

Ebola Reston

- USA and Italy
- Imported macaques from Philippines

1994: Ebola Côte d'Ivoire

2003: Ebola Republic of Congo

2004-5: Angola

2012, 2014:????

Annan et al. BMC Public Health (2017) 17:546
DOI 10.1186/s12889-017-4474-6

BMC Public Health

RESEARCH ARTICLE

Open Access



Health care workers indicate ill preparedness for Ebola Virus Disease outbreak in Ashanti Region of Ghana

Augustina Angelina Aninan^{1,2*}, Denis Dekugmen Yar¹, Michael Owusu^{1,2}, Eno Akua Biney², Paa Kobina Forson², Portia Boakye Okyere¹, Akosua Adumea Gyimah³ and Ellis Owusu-Dabo^{1,4}

Abstract

Background: The recent Ebola Virus Disease (EVD) epidemic that hit some countries in West Africa underscores the need to train front line high-risk health workers on disease prevention skills. Although Ghana did not record (and is yet to) any case, and several health workers have received numerous training schemes, there is no record of any study that assessed preparedness of healthcare workers (HCWs) regarding EVD and any emergency prone disease in Ghana. We therefore conducted a hospital based cross sectional study involving 101 HCWs from two facilities in Kumasi, Ghana to assess the level of preparedness of HCWs to respond to any possible EVD.

Methods: We administered a face-to-face questionnaire using an adapted WHO (2015) and CDC (2014) Checklist for Ebola Preparedness and assessed overall knowledge gaps, and preparedness of the Ghanaian HCWs in selected health facilities of the Ashanti Region of Ghana from October to December 2015.

Results: A total 92 (91.09%) HCWs indicated they were not adequately trained to handle an EVD suspected case. Only 25.74% ($n = 26$) considered their facilities sufficiently equipped to handle and manage EVD patients. When asked which disinfectant to use after attending to and caring for a suspected patient with EVD, only 8.91% ($n = 9$) could correctly identify the right disinfectant ($\chi^2 = 28.52$, $p = 0.001$).

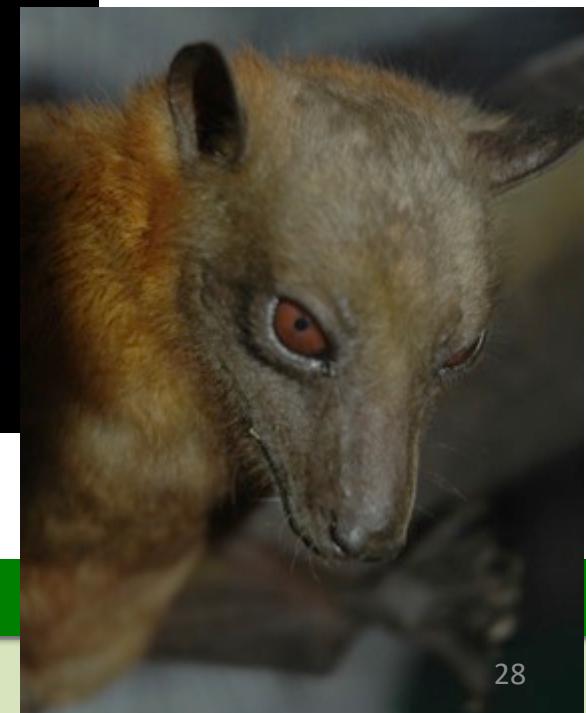
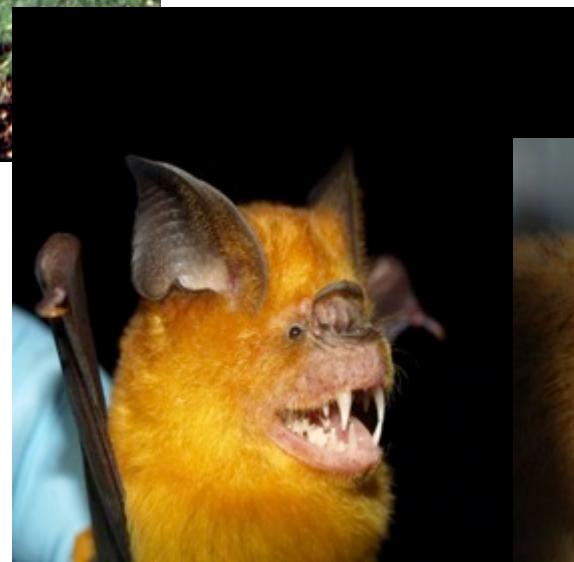
Conclusion: Our study demonstrates poor knowledge and ill preparedness and unwillingness of many HCWs to attend to EVD. Beyond knowledge acquisition, there is the need for more training from time to time to fully prepare HCWs to handle any possible EVD case.

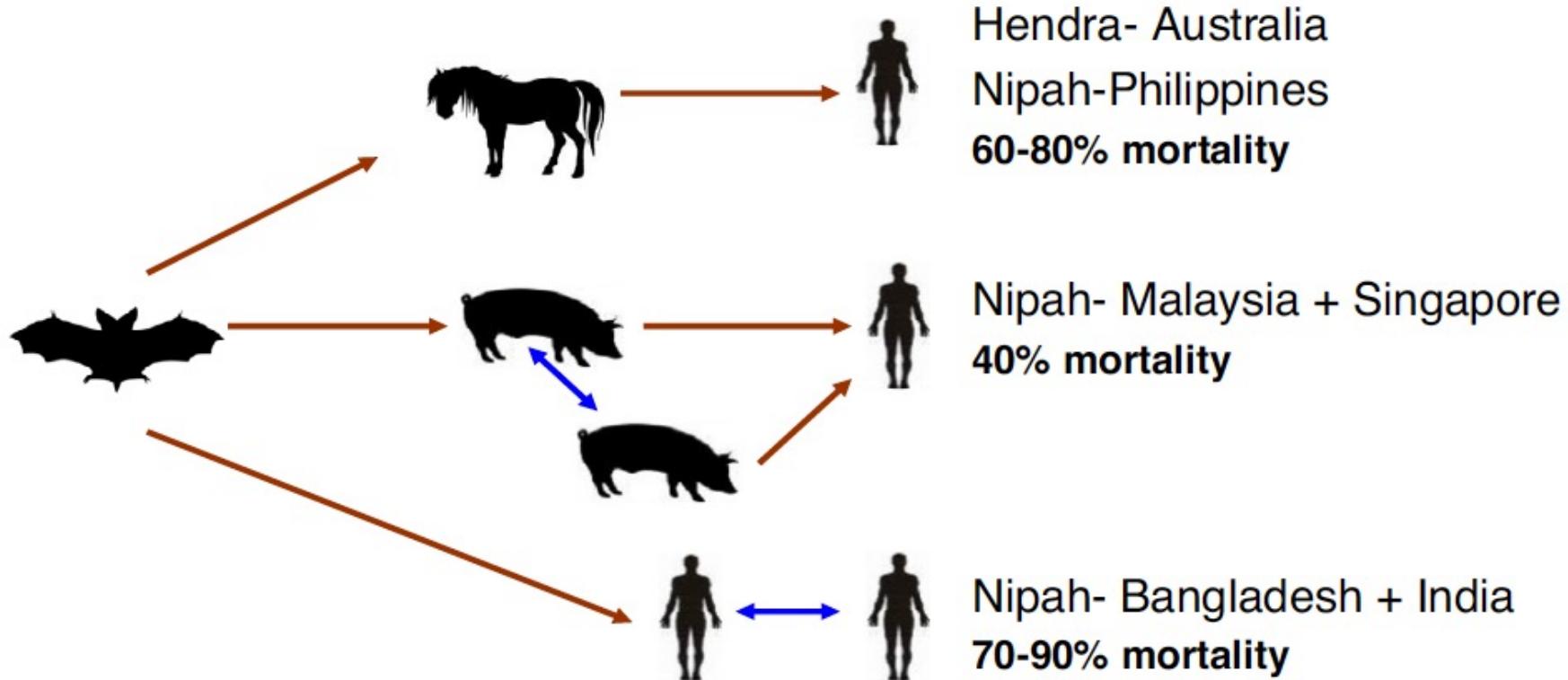
Keywords: Ebola Virus disease, Healthcare workers, Preparedness, Ghana



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Transmission - Reservoir....Monkeys, bats?



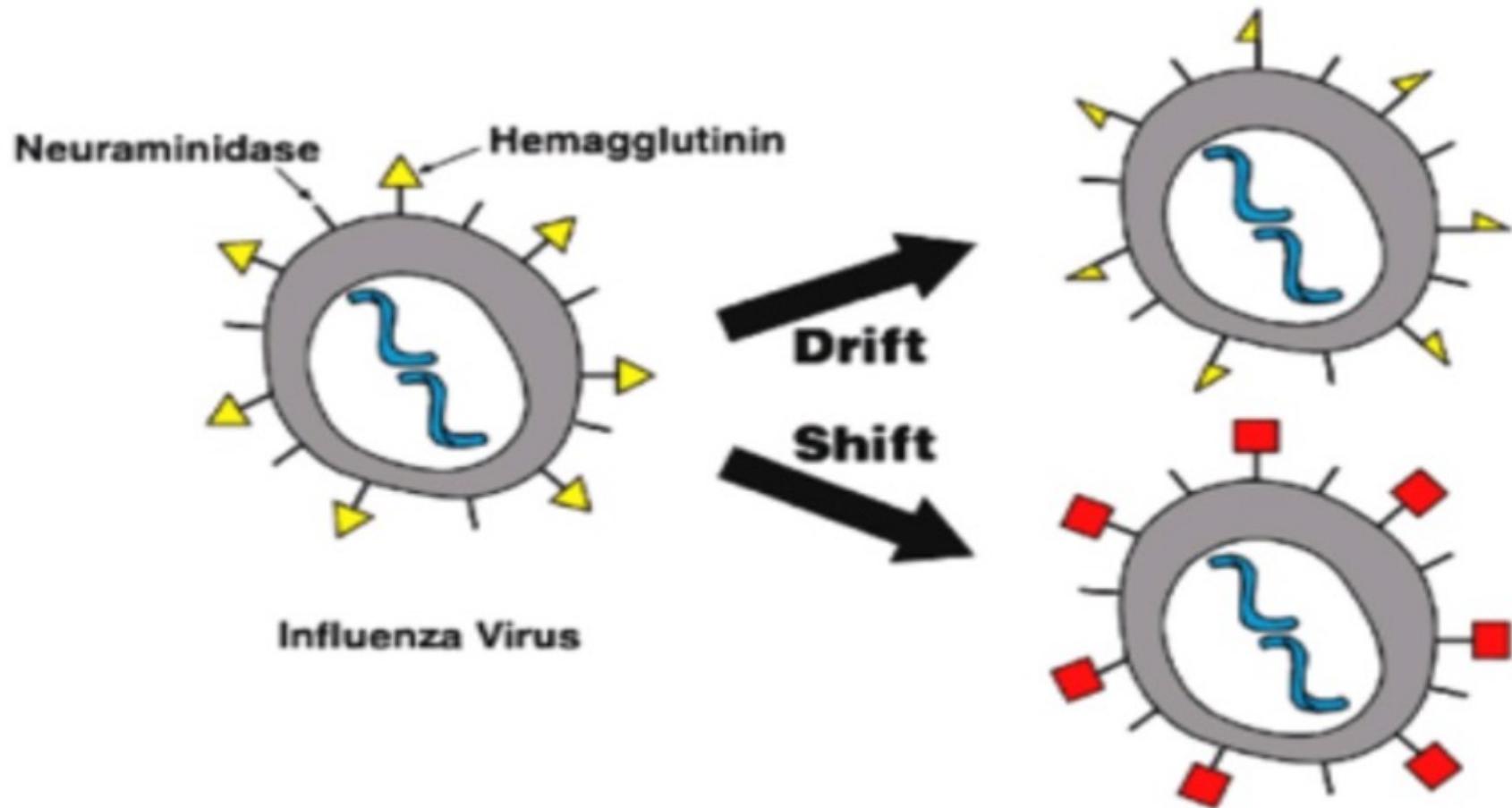


*Wang and Anderson, 2019
Current Opinion in Virology*

Popular Influenza.....

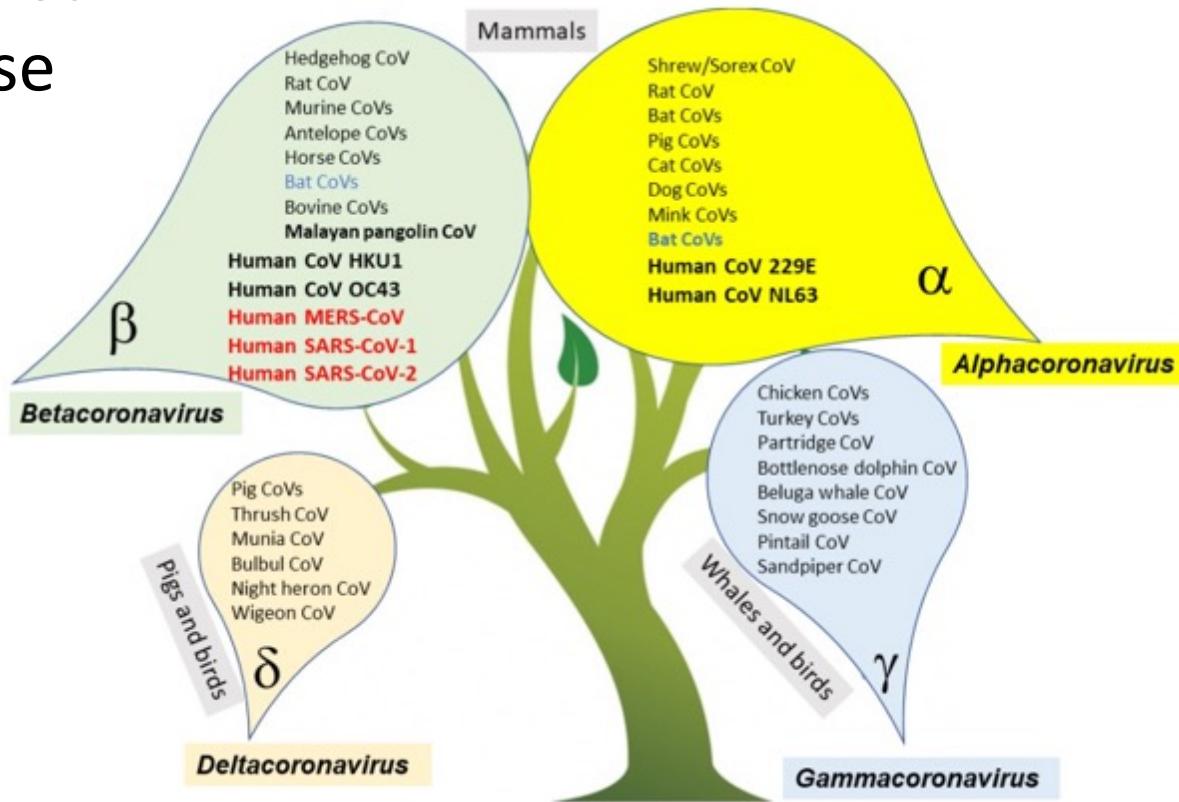
- Highly pathogenic avian influenza (H5NI)
- Novel swine influenza (HINI)
- **On April 1, 2013, first known human cases of infection with avian influenza (H7N9)**

Antigenic variations



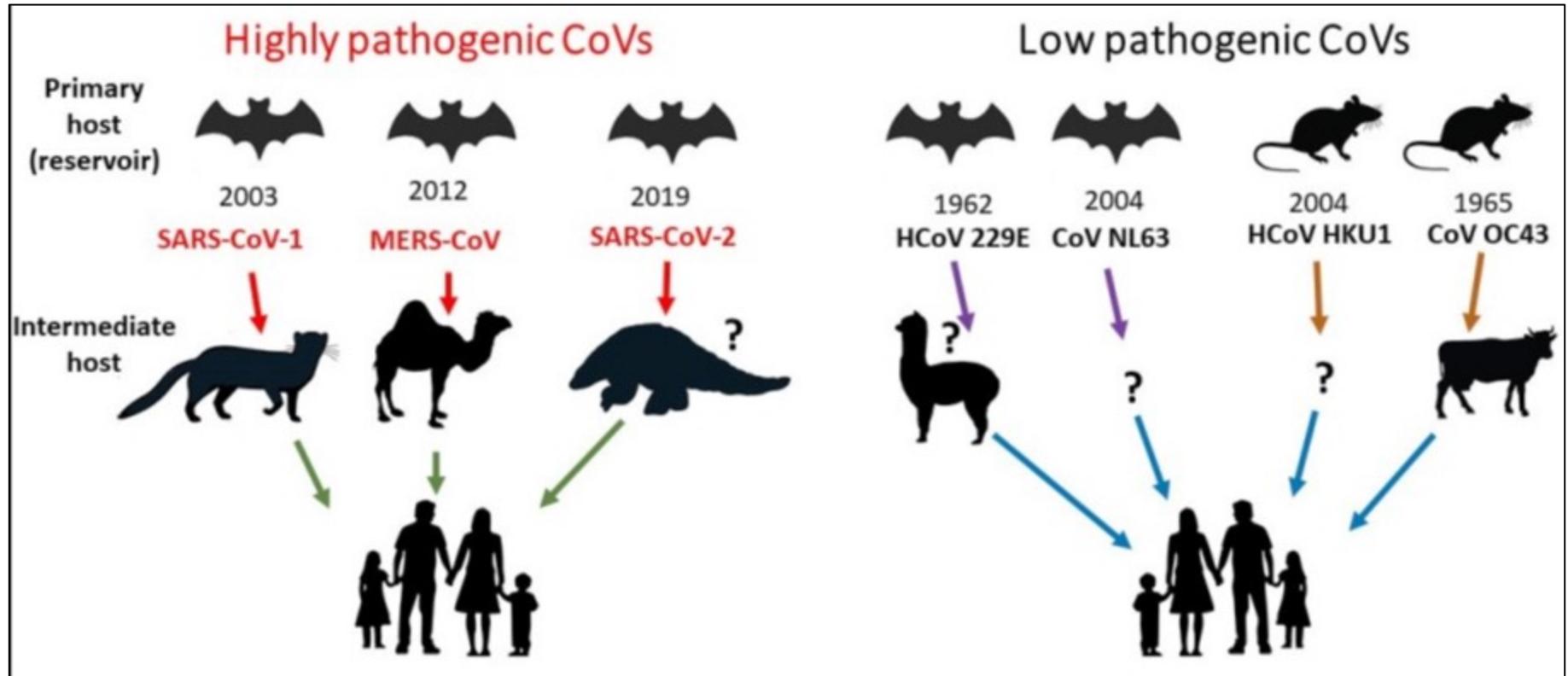
More recently.....

- Single stranded
- Positive sense
- RNA



Teri, 2020, AccessScience

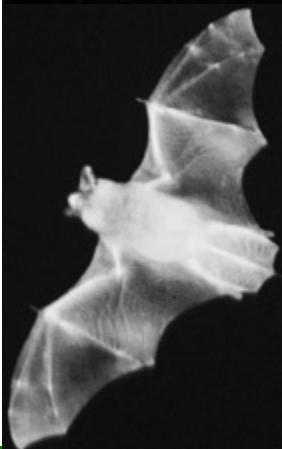
Where do all these Coronaviruses come from?



Humans are the 'Dead end host'

Teri, 2020, AccessScience

Why Bats?



Recognized mammalian species: ~6600
Recognized bat species: ~ 1100

Live in dense populations
Large population sizes

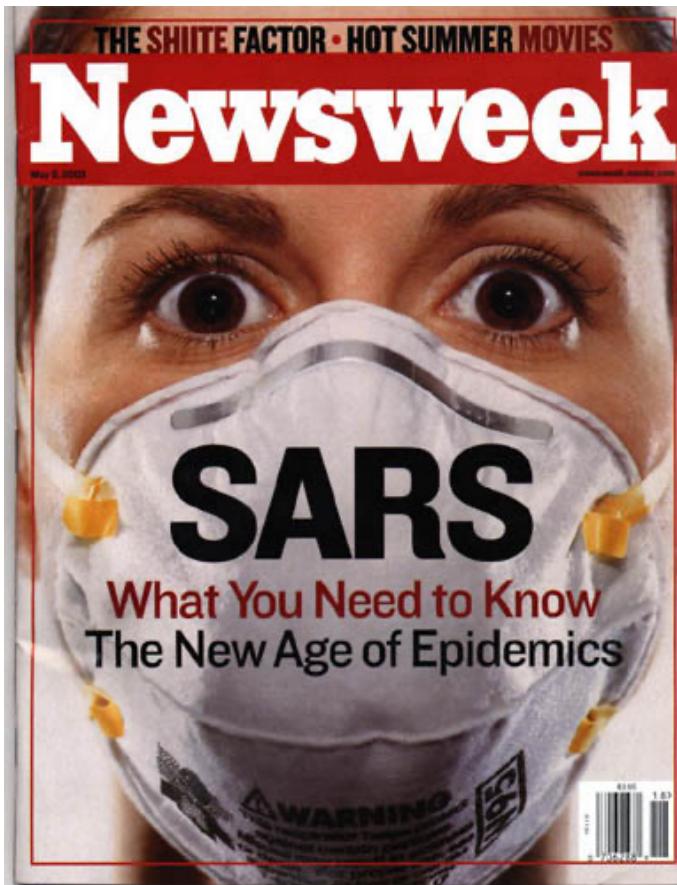
Flight – comparable to birds

Mammals



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2002.....Where did it come from?



Will it return?



SARS.....Will it return?

No infectious disease has spread so fast and far as SARS did

**SARS Cases
19 February to 5 July 2003**

**Total: 8,439 cases, 812 deaths,
30 countries in 7-8 months**



Case fatality rate= 10%

Source: www.who.int/csr/sars

SARS-CoV

4

NEWS

THE TIMES

Sars will return say experts after latest death

By Nigel Hawkes
Health Editor

NESTOR YANGA had been living in a ventilator for five months since he was found to have the Sars virus.

Dr Yanga, 54, caught the disease from a patient who came to his office. For four months his condition appeared to improve, but this week he succumbed to the assault of a virus whose effects are still not fully understood.

A member of Toronto's Filipino community, he was the 44th victim in Canada and the 90th in the world. But he may not be the last; many experts fear that Sars will return next winter.

Those concerns have increased in recent weeks from China that the exotic animal behind the disease has been the close of the wild civet cat, which had been back on the plates of diners in China where the disease first emerged. The final patients were due to have hospital visitors; in experts' terms, the "social closure" of Canada has led to the "social self-isolation" that will keep the disease reported. The main source of reports from the World Health Organization, the Food and Agriculture Organization of the United Nations and the World Health Organization.

The main source of reports from the World Health Organization, the Food and Agriculture Organization of the United Nations and the World Health Organization.



Dr Nestor Yanga caught the virus from a patient

Airline passengers spread mystery killer bug – Times 17-03-03

Chinese told not to spit!

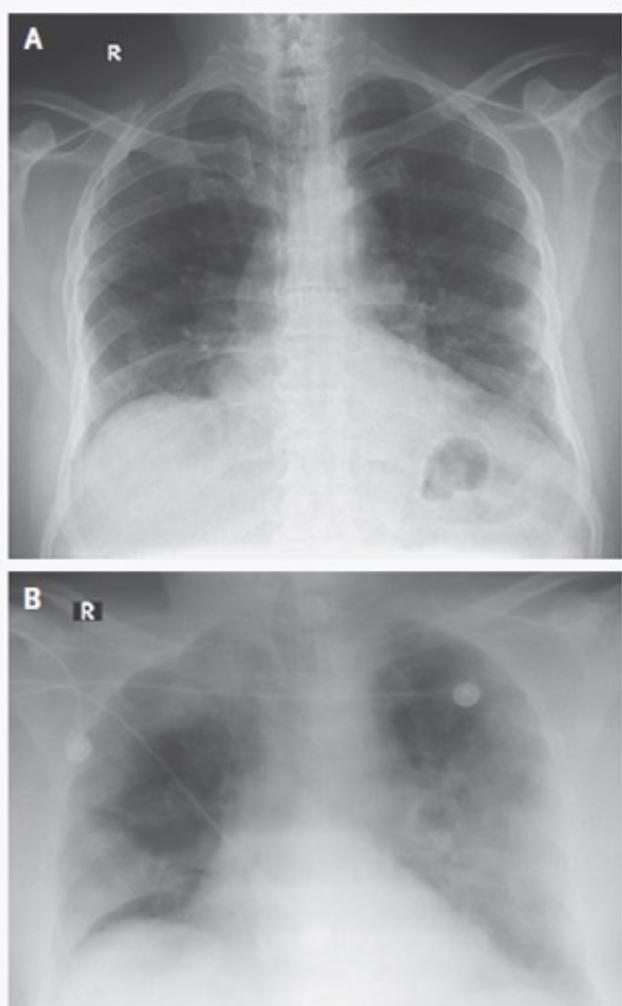


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A Novel Coronavirus Called "MERS-CoV" in the Arabian Peninsula – 2013 (Middle East Respiratory Syndrome CoV)



An incidental finding



The NEW ENGLAND JOURNAL of MEDICINE

BRIEF REPORT

Isolation of a Novel Coronavirus from a Man with Pneumonia in Saudi Arabia

Ali Moh Zaki, M.D., Ph.D., Sander van Boheemen, M.Sc., Theo M. Bestebroer, B.Sc.,
Albert D.M.E. Osterhaus, D.V.M., Ph.D., and Ron A.M. Fouchier, Ph.D.

Patient with atypical pneumonia

Blind isolate in Vero cells by “a brave
microbiologist” (R. F.)

Identification (NGS) by Ron Fouchier

Zaki et al., NEJM 2012



www.knust.edu.gh

Clinical features and virological analysis of a case of Middle East respiratory syndrome coronavirus infection

2012

Munich case

Christian Drosten, Michael Seilmäier, Victor M Corman, Wulf Hartmann, Gregor Scheible, Stefan Sack, Wolfgang Guggemos, René Kallies, Doreen Muth, Sandra Junglen, Marcel A Müller, Walter Haas, Hana Gublerina, Tim Röhnisch, Monika Schmid-Wendtner, Souhaib Aldabbagh, Ulf Dittmer, Hermann Gold, Petra Graf, Frank Bonin, Andrew Rambaut, Clemens-Martin Wendtner

two 3' positions. This method of primer design can decrease sensitivity, but it prevents mispriming within the product, which can improve the success of

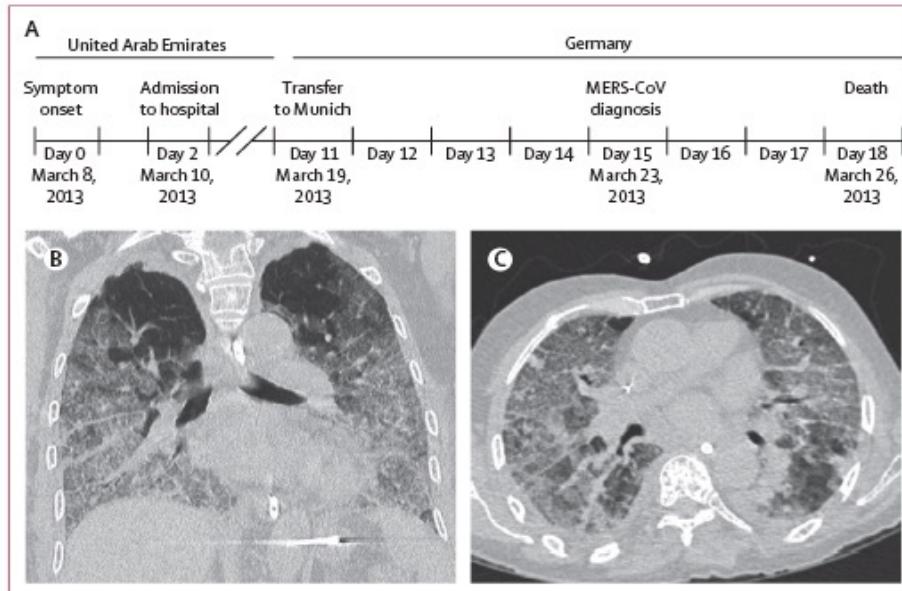


Figure 1: Disease and treatment

(A) Chronology. Frontal (B) and horizontal (C) CT scans done on day 12 of disease, showing intense basally-pronounced congestions indicative of atypical pneumonia and acute respiratory distress syndrome. MERS-CoV=Middle East respiratory syndrome coronavirus.

Results

On March 8 (day 0), the patient—a 73-year-old man from Abu Dhabi, United Arab Emirates—abruptly developed flu-like symptoms, with fever and non-productive cough. He was admitted to Mafraq hospital (Abu Dhabi) on day 2 (figure 1), and was diagnosed with pneumonia. He was intubated on day 9 because of progressive hypoxia and acute respiratory distress syndrome (fraction of inspired oxygen 60%; positive end-expiratory pressure 10 cm H₂O). The patient had received intensive antimicrobial treatment with meropenem, levofloxacin, vancomycin, caspofungin, aciclovir, and oseltamivir during his stay in an intensive care unit in Abu Dhabi, without major improvement in his pulmonary function. The patient was transferred to Klinikum Schwabing (Munich, Germany) on March 19, 2013 (figure 1).

The patient had been diagnosed with multiple myeloma in 2008, and had received several lines of treatment in the previous few years, such as high-dose chemotherapy with autologous stem-cell transplantation in 2009. At relapse of his multiple myeloma in November, 2012, he was given lenalidomide plus dexamethasone. Relatives reported that the patient owned camels, and had taken care of a diseased animal shortly before onset of symptoms. No animal samples, or further details about potential sources or exposures could be retrieved.

Drosten et al., LID July 2013



www.knust.edu.gh

MER-CoV - Hosts

- **Animals**

Bats

Camels

Livestock

Stray animals

Pet birds

Rodents

- **Food items**

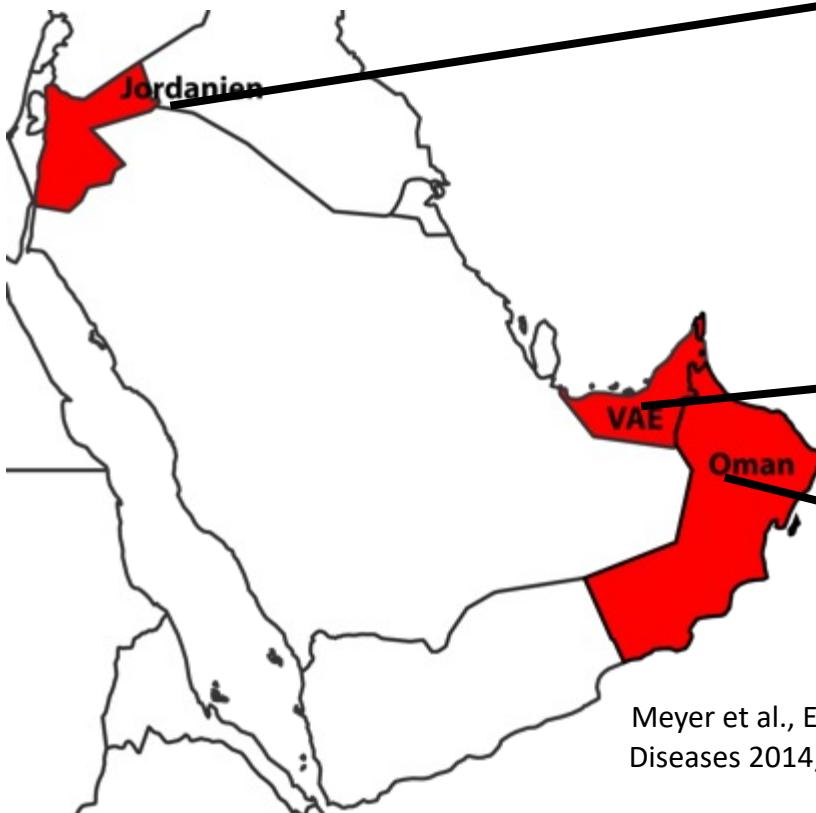
Dates – Dried and fresh

Water sources



Middle East respiratory syndrome coronavirus neutralising serum antibodies in dromedary camels: a comparative serological study

Chantal B E M Reusken*, Bart L Haagmans*, Marcel A Müller*, Carlos Gutierrez, Gert-Jan Godeke, Benjamin Meyer, Doreen Muth, V Stalin Raj, Laura Smits-De Vries, Victor M Corman, Jan-Felix Drexler, Saskia L Smits, Yasmin E El Tahir, Rita De Sousa, Janiko van Beek, Norbert Nowotny, Kees van Maanen, Ezequiel Hidalgo-Hermoso, Berend-Jan Bosch, Peter Rottier, Albert Osterhaus, Christian Gortázar-Schmidt, Christian Drosten, Marion P G Koopmans



Early antibody studies

	2013: 11/11 (100%)
	2013: 0/150 (0%)
	2013: 6/126 (4.8%) -> NT negative
	2013: 0/91 (0%)
	2003: 151/151 (100%)
	2013: 481/500 (96.2%)
	2013: 0/192 (0%)
	2013: 50/50 (100%)

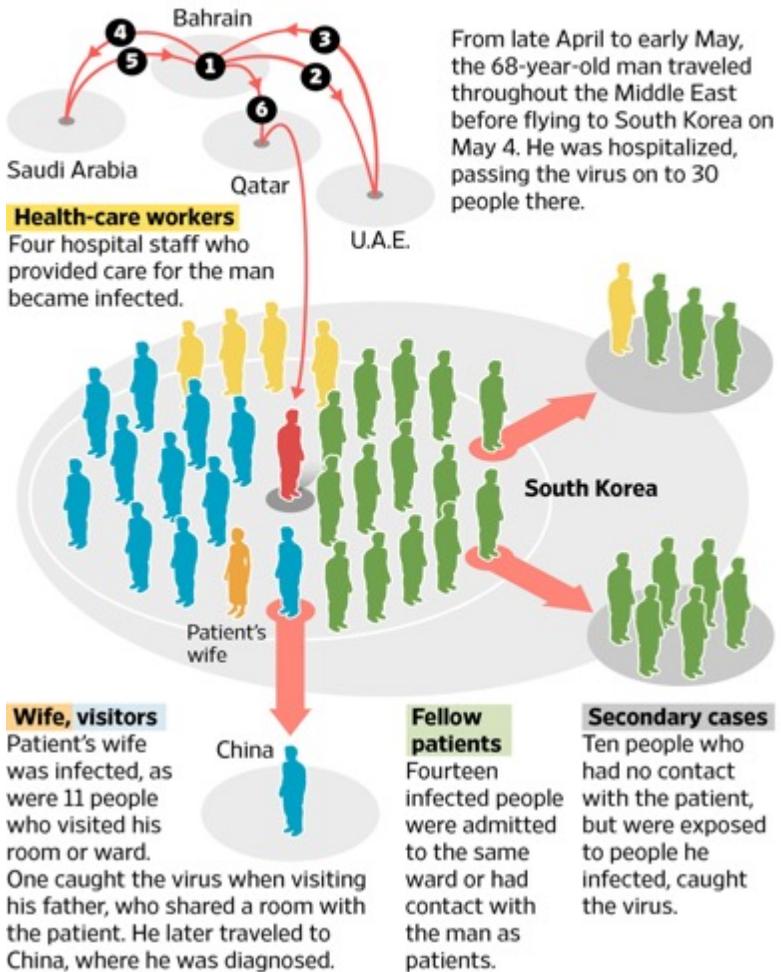
Meyer et al., Emerging Infectious Diseases 2013; Meyer et al., Emerging Infectious Diseases 2014; ; Reusken et al., Euro Surveillance 2013; Reusken et al., The Lancet Infectious Diseases 2013



Photo: The Malaysianinsider

How MERS Spread in South Korea

About a month after the country's first patient arrived from the Middle East, the virus had spread to 40 other people. A look at its initial path:



Wall Street Journal June 5th, 2015

Take Coronavirus threat seriously – Health experts warn Hajj pilgrims

From: Ghana | Myjoyonline.com

Published On: September 17, 2013, 02:25 GMT

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Health News of Friday, 11 October 2013

Source: peacefm

MERS Disease: Ghanaian pilgrims are safe

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The fear of Ghanaian Pilgrims contracting the deadly Middle East Respiratory Syndrome Coronavirus (MERS-CoV) has been allayed.



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Going to Mecca..... Hajj Pilgrims?



High prevalence of common respiratory viruses and no evidence of Middle East Respiratory Syndrome Coronavirus in Hajj pilgrims returning to Ghana, 2013

Augustina Annan¹, Michael Owusu¹, Kwadwo Sarfo Marfo¹, Richard Larbi¹, Francisca Naana Sarpong¹, Yaw Adu-Sarkodie², Joseph Amankwa³, Samuel Fiafemetsi⁴, Christian Drosten^{5,6}, Ellis Owusu-Dabo¹ and Isabella Eckerle⁵

¹ Kumasi Centre for Collaborative Research in Tropical Medicine, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

² Department of Clinical Microbiology, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

³ Public Health Division, Ghana Health Service, Accra, Ghana

⁴ Port Health Division, Ghana Health Service, Accra, Ghana

⁵ Institute of Virology, University of Bonn Medical Centre, Bonn, Germany

⁶ German Centre for Infection Research, Braunschweig, Germany

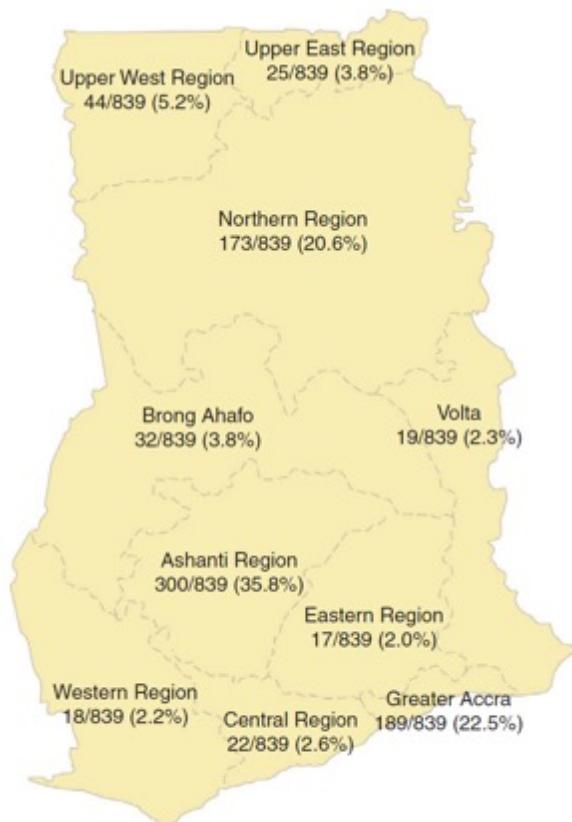
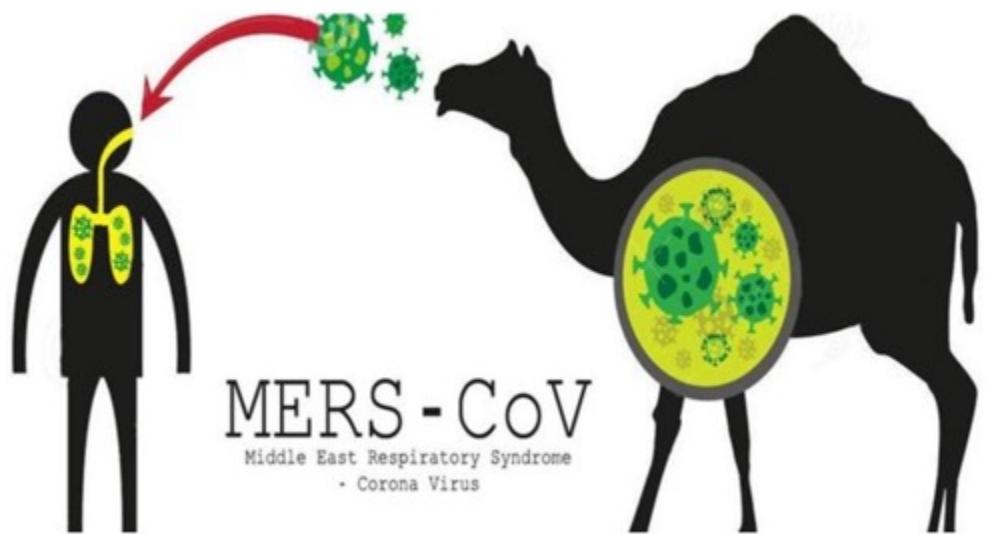


Figure 1 Regional map of Ghana showing the geographical distribution of the Hajj pilgrims.

Annan et al., 2015, TMIH

The Camel connection



Results

On March 8 (day 0), the patient—a 73-year-old man from Abu Dhabi, United Arab Emirates—abruptly developed flu-like symptoms, with fever and non-productive cough. He was admitted to Mafraq hospital (Abu Dhabi) on day 2 (figure 1), and was diagnosed with pneumonia. He was intubated on day 9 because of progressive hypoxia and acute respiratory distress syndrome (fraction of inspired oxygen 60%; positive end-expiratory pressure 10 cm H₂O). The patient had received intensive antimicrobial treatment with meropenem, levofloxacin, vancomycin, caspofungin, aciclovir, and oseltamivir during his stay in an intensive care unit in Abu Dhabi, without major improvement in his pulmonary function. The patient was transferred to Klinikum Schwabing (Munich, Germany) on March 19, 2013 (figure 1).

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Drosten et al., LID July 2013

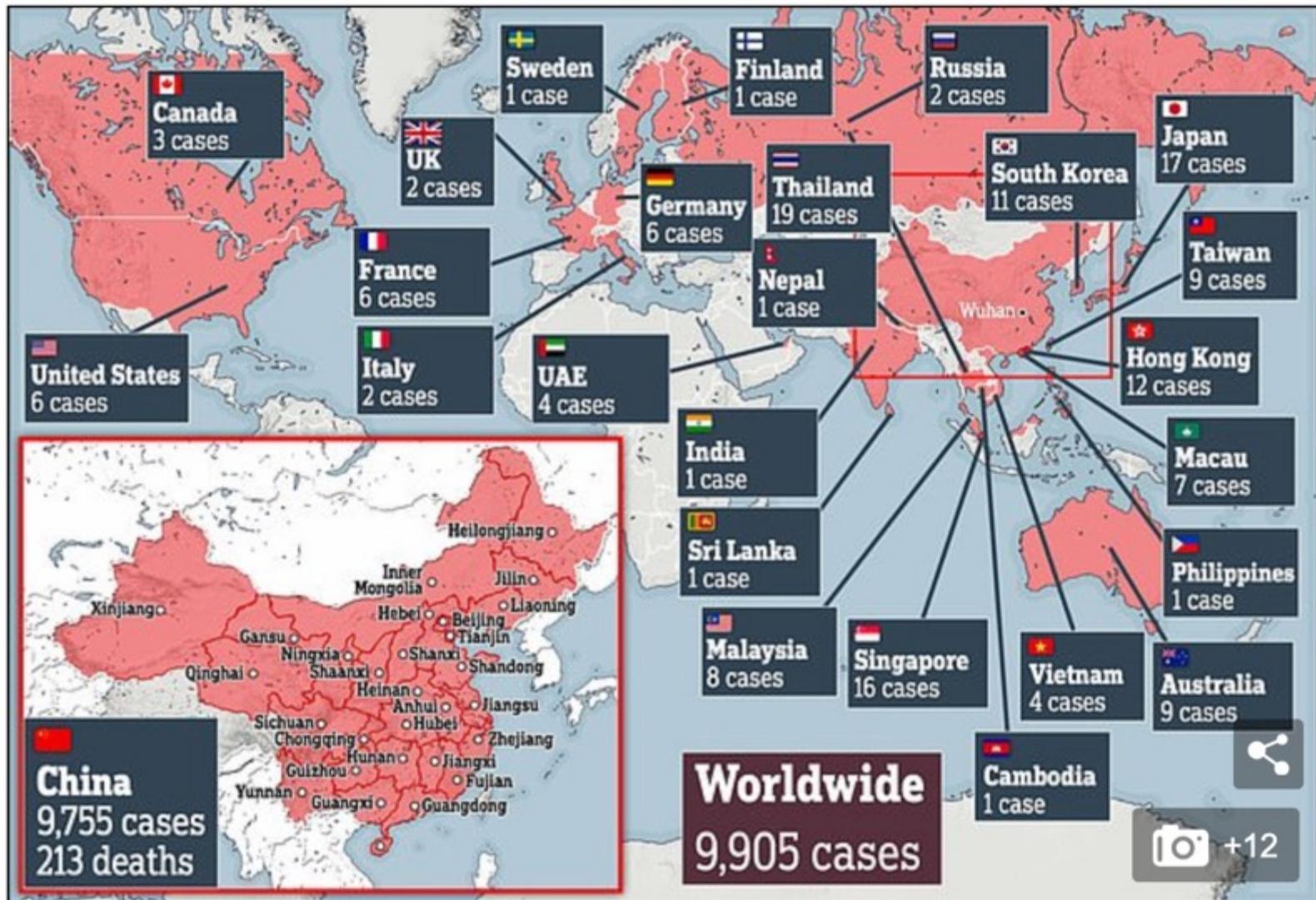
MERS.....Will it return??



Viivaldo et al., 2020, Archives of Virology

Case fatality rate = 35%

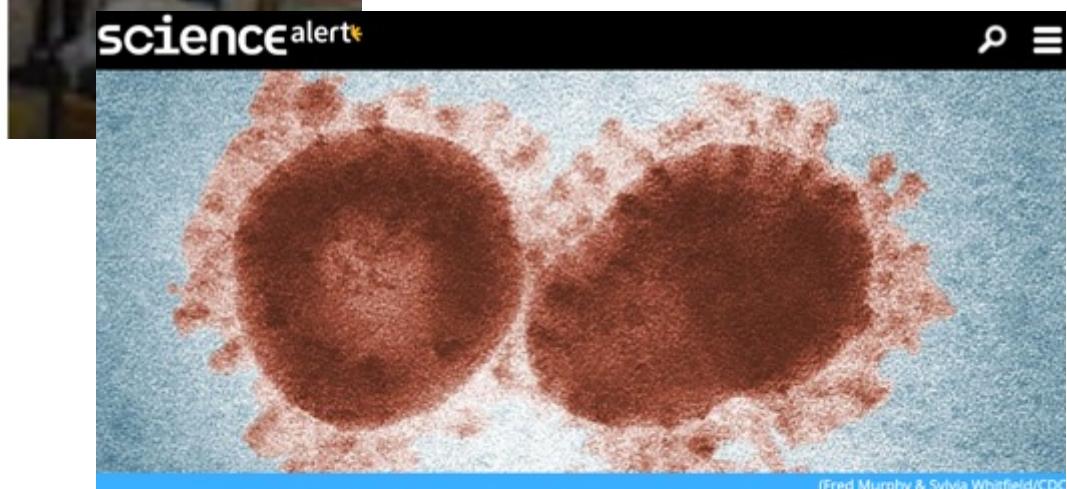
2019.....Wuhan Coronavirus





Health News

Deadly coronavirus outbreak DID start at Wuhan animal market



HEALTH

Latest Study Suggests The New Coronavirus Is Also Spreading Via Feces

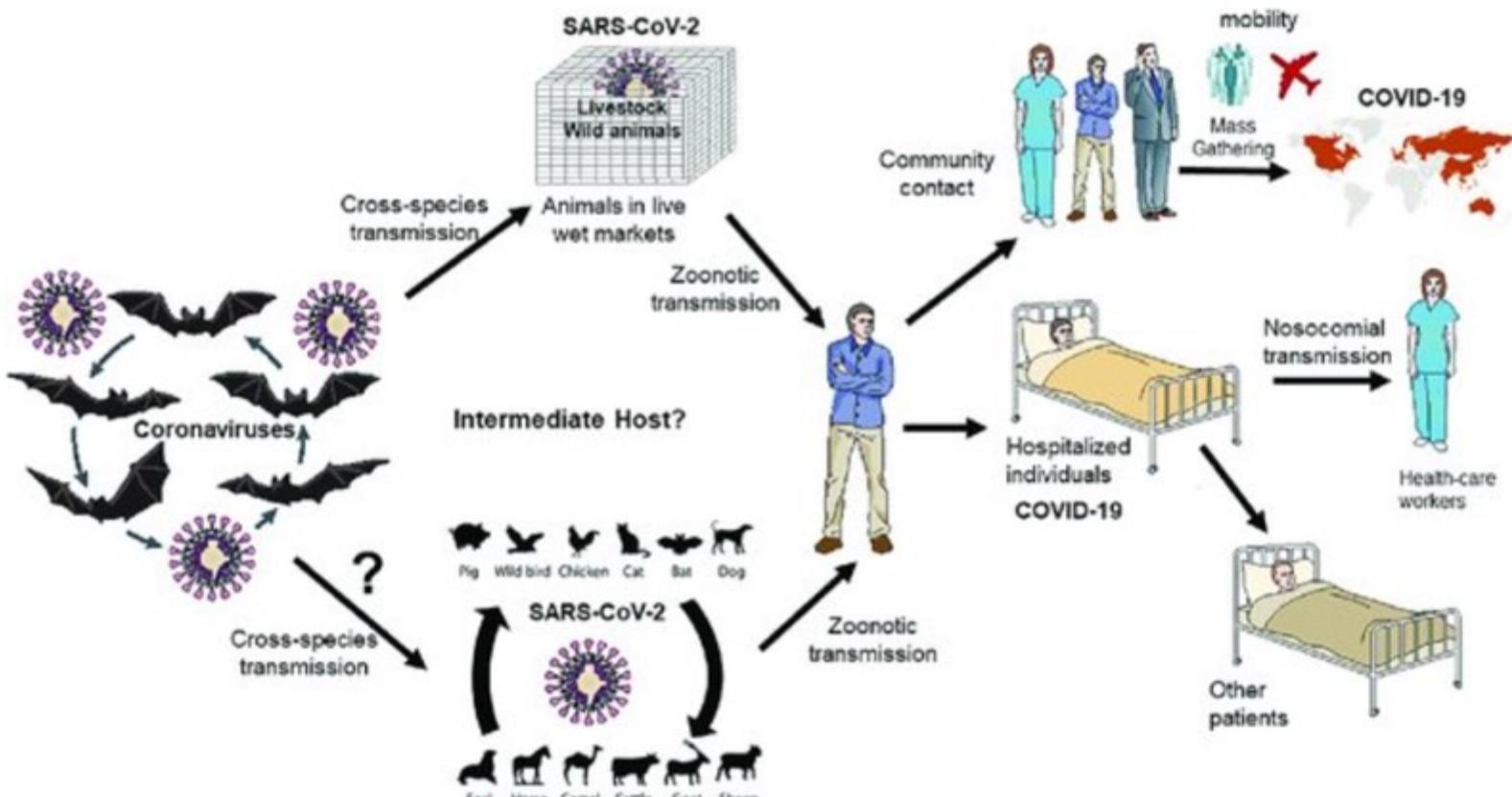
AFP 9 FEB 2020

Diarrhea may be a secondary path of transmission for the novel coronavirus, scientists said Friday following the publication of the [latest study](#) reporting patients with abdominal symptoms and loose stool.



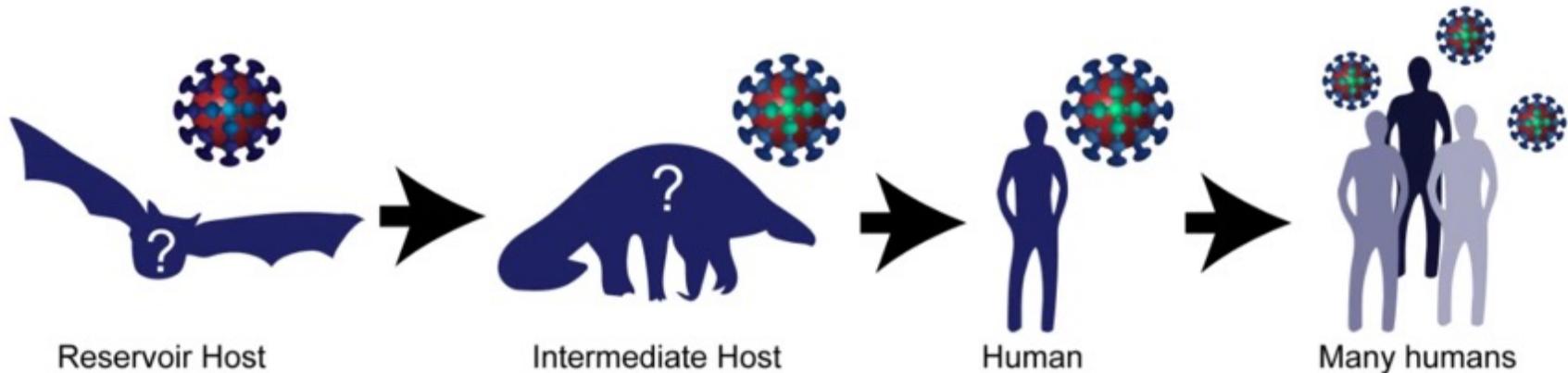
www.knust.edu.gh

Hypothesized origin of SARS-CoV-2



Zowalaty and Järhult, 2020

SARS-CoV-2 Transmission cycle



The process of an animal virus or bacteria infecting humans is termed a **“zoonotic shift,”** and if humans get sick from the infection, the disease is called a **Zoonotic disease or Zoonosis.**

Chen, 2020

What makes CoVs ‘jump’ from Animals to Humans?

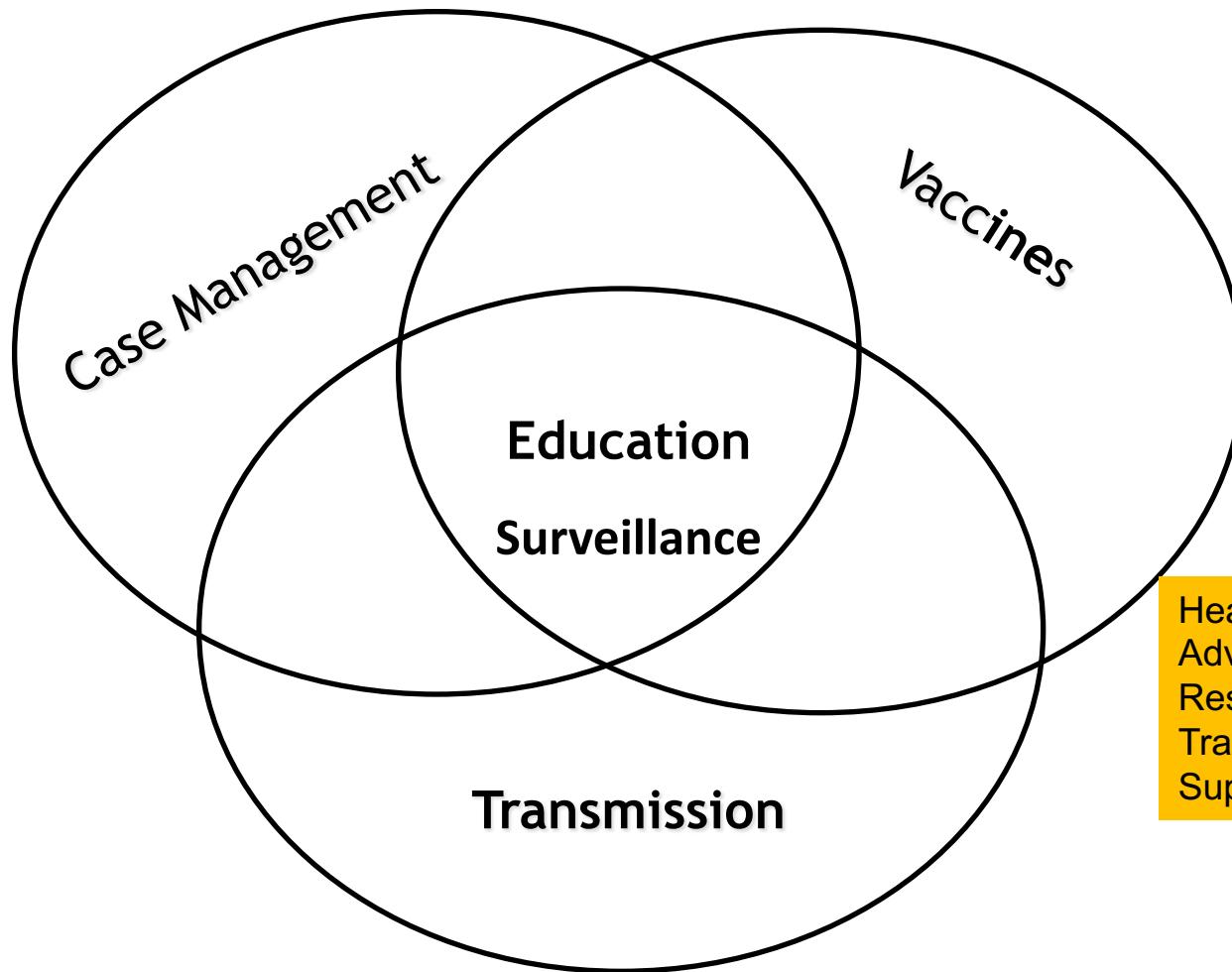
Exposure to:

- Animals that naturally harbor the virus (reservoir host)
- Animals that carry the virus transmitted from the reservoir host (intermediate host).

Ability to infect humans:

- Virus needs to enter our cells (Portals of entry)
- Multiply and avoid destruction by immune systems
- Successfully colonize one human
- Get out of the body and disseminate (Portals of exit)
- Infect additional humans/Several humans and remain **viable**

General control strategy for infectious diseases



Health system strengthening
Advocacy & partnerships
Research
Training
Supervision, Monitoring, Evaluation

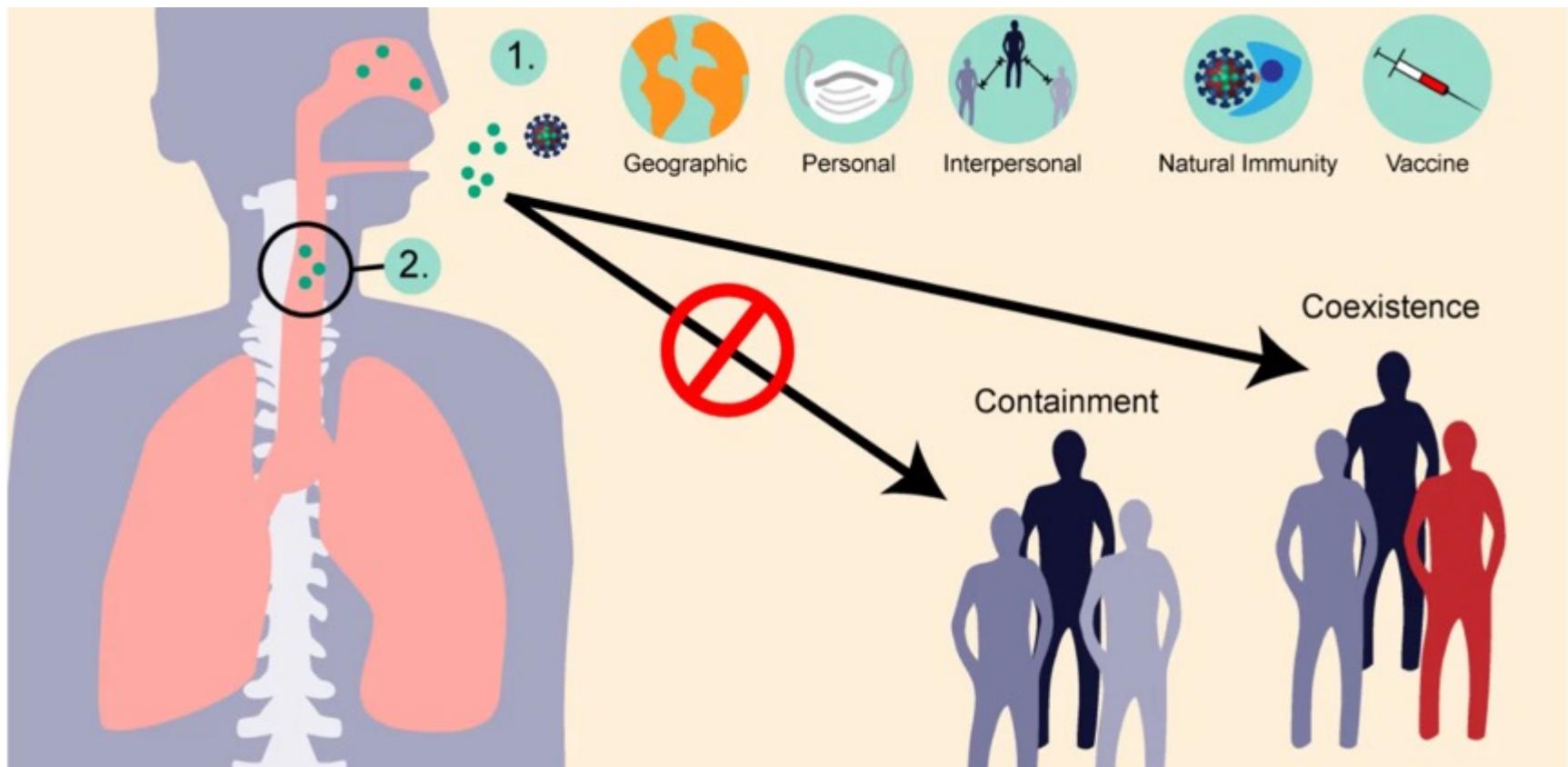
Importance of diagnostic confirmation



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1. Barriers to CoVs entry

2. Pathways to immunity



Pathways to immunity

- Natural immunity??
- Vaccine??
- Home remedies??