

The Next Pandemic

Ali S. Khan, MD, MPH

Professor and Dean

Assistant Surgeon General (Ret., USPHS)

October 15-17, 2017



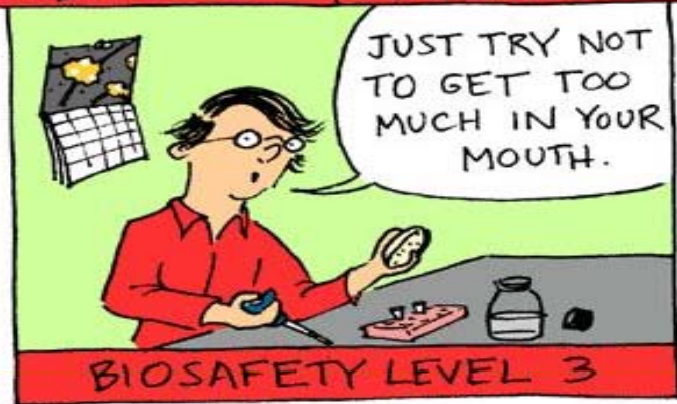
ABSA
INTERNATIONAL
The Association for Biosafety and Biosecurity

University of Nebraska
Medical Center



Nebraska
Medicine

WHAT IT **REALLY** MEANS...



EH



The
Economist

MAY 2ND - 8TH 2020

[Economist.com](http://economist.com)

First flash
Second flash
Third flash
Fourth flash
Fifth flash

The pandemic threat

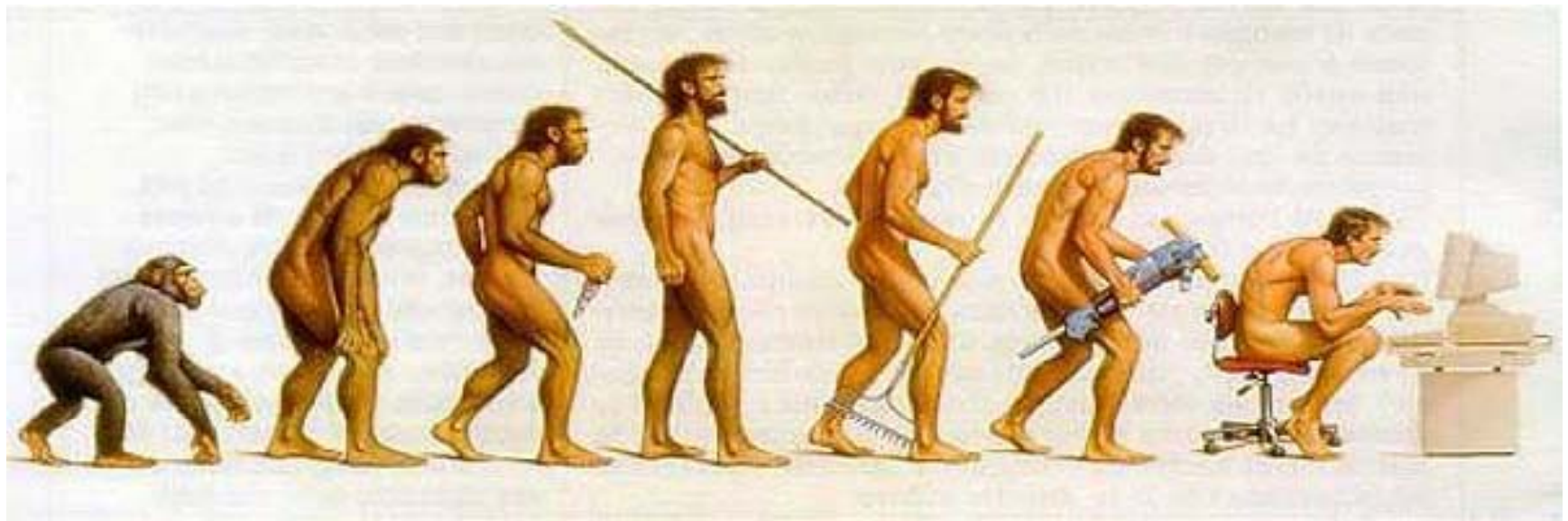
How scared should
you be?



<http://www.kaltoons.com/wordpress/category/economist/>



Epidemiological Transitions in Human History



Epidemiologic Transitions in Human History

Paleolithic Age



2.5 million years ago – 10,000 BC



"I'm a hunter, but I've been cross-trained as a gatherer."

Late *Paleolithic Age*

About 200,000 years ago

Hunters-gatherers

Nomadic

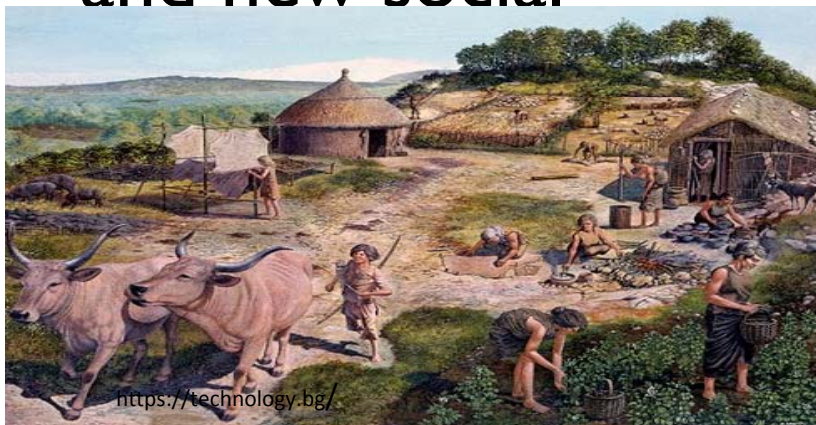
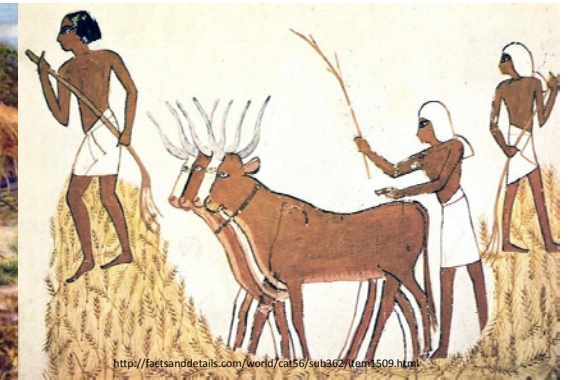
Small populations

Parasitic infections



Epidemiologic Transitions in Human History – The *FIRST* Transition

- About 10,000 years ago
- Early Agriculture and new social

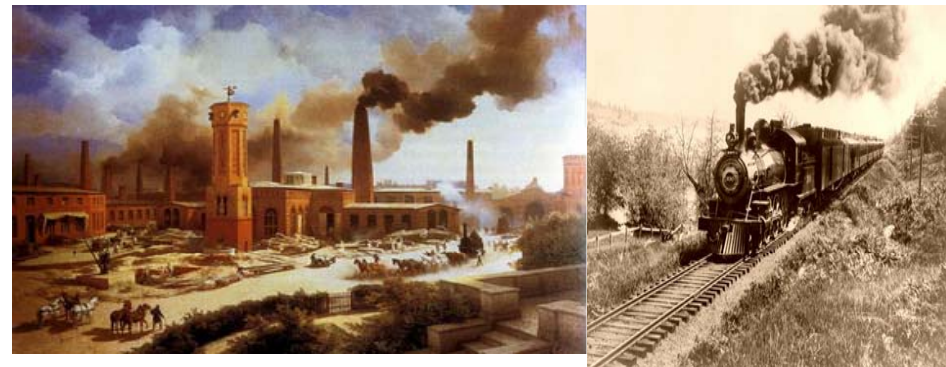


- **Zoonoses** with animal domestication
- **Increase** in infectious diseases
- **Epidemics** in non-immune populations



Epidemiologic Transitions in Human History –The *SECOND Transition*

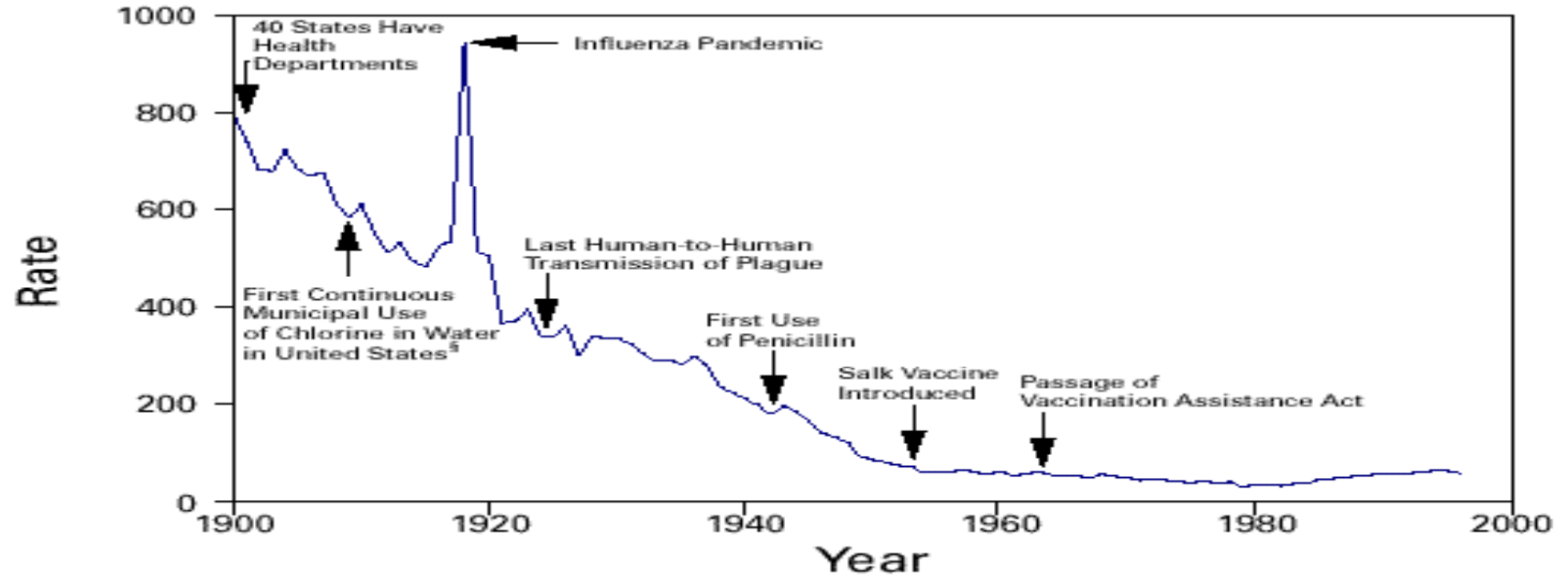
- *Decreased* infectious disease mortality
- *Increased* life expectancy
- Improved nutrition
- Antibiotics!
- “Diseases of Civilization”
 - ✓ Cancer, diabetes, obesity, heart disease, stroke
 - ✓ Environmental problems



<http://www.makingitmagazine.net/?p=8003>



FIGURE 1. Crude death rate* for infectious diseases — United States, 1900–1996[†]



*Per 100,000 population per year.

[†]Adapted from Armstrong GL, Conn LA, Pinner RW. Trends in infectious disease mortality in the United States during the 20th century. *JAMA* 1999;281:61–6.

[§]American Water Works Association. Water chlorination principles and practices: AWWA manual M20. Denver, Colorado: American Water Works Association, 1973.

“...one can think of the middle of the twentieth century as the end of one of the most important social revolutions in history, the virtual elimination of the infectious disease as a significant factor in social life.”

Sir Frank Macfarlane Burnet, 1962

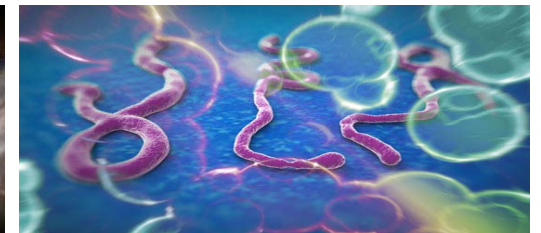


Epidemiologic Transitions in Human History

–Third Transition began 25+ years ago



- *New infectious diseases have emerged globally -75% are zoonotic*
- “Old” diseases re-emerged
- Antimicrobial drug resistance
- Anti-Vaxxers



Importance of Good Bacteria

Getting to know your gut microbiota

A huge quantity (hundreds of trillions) of bacteria and other microorganisms inhabit your intestines fulfilling key functions for your health and wellbeing

- Gut microbiota's weight can reach up to **1 to 2 kg**
- The GI tract surface is as big as 2 tennis courts **400m²**
- Bacteria are **10 to 50** times smaller than human cells
- In our body microbes outnumber human cells by **10 : 1**
- Laid end to end, our body's bacteria would circle the earth **2,5 times**

95% of our own bacteria located in the gastrointestinal (GI) tract

DRJOCKERS.COM

Gut microbiota, health and chronic disease

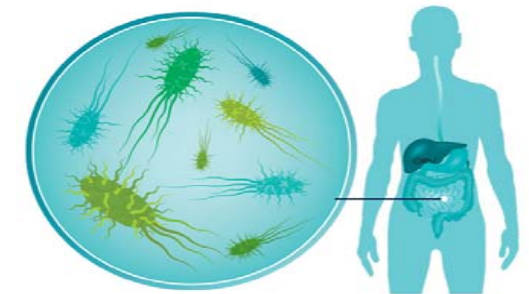
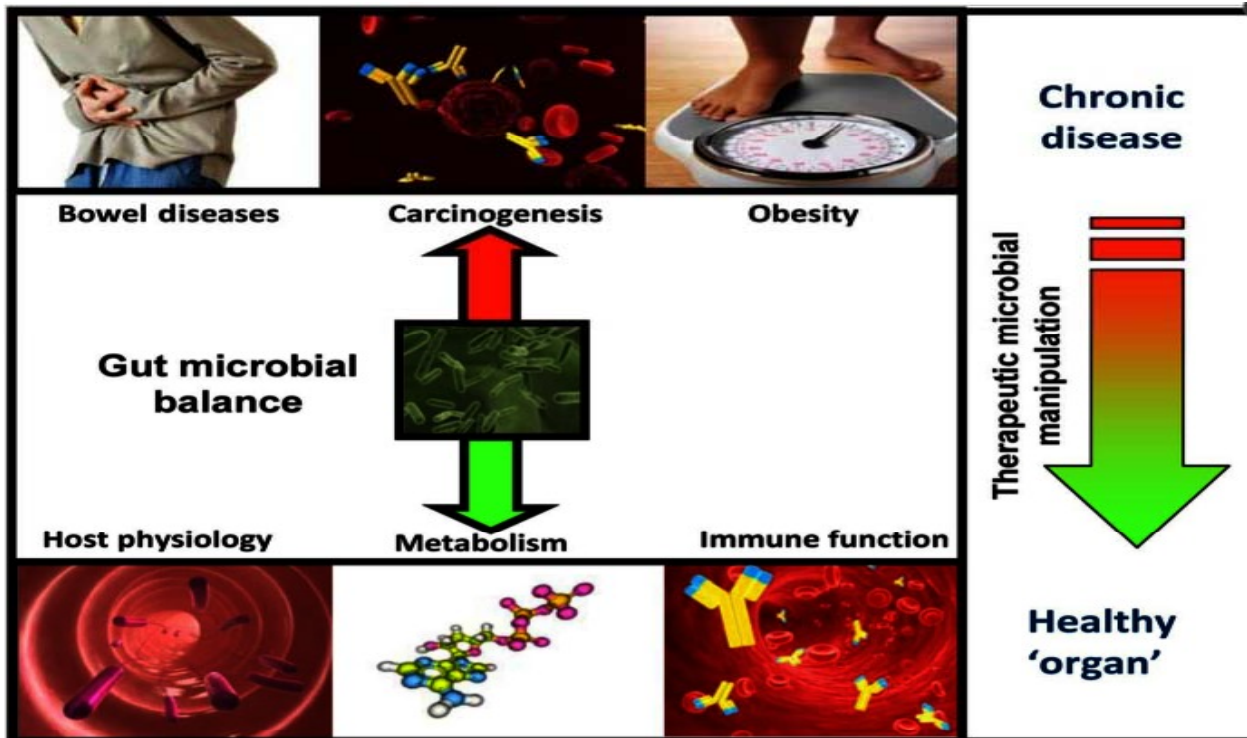


Image: newanyart/Thinkstock

<https://www.health.harvard.edu/staying-healthy/can-gut-bacteria-improve-your-health>

Guinane C.M., & Cotter P.D. 2013. Role of the gut microbiota in health and chronic gastrointestinal disease: understanding a hidden metabolic organ. *Therap Adv Gastroenterol*, 6(4): 295–308. doi: [10.1177/1756283X13482996](https://doi.org/10.1177/1756283X13482996)



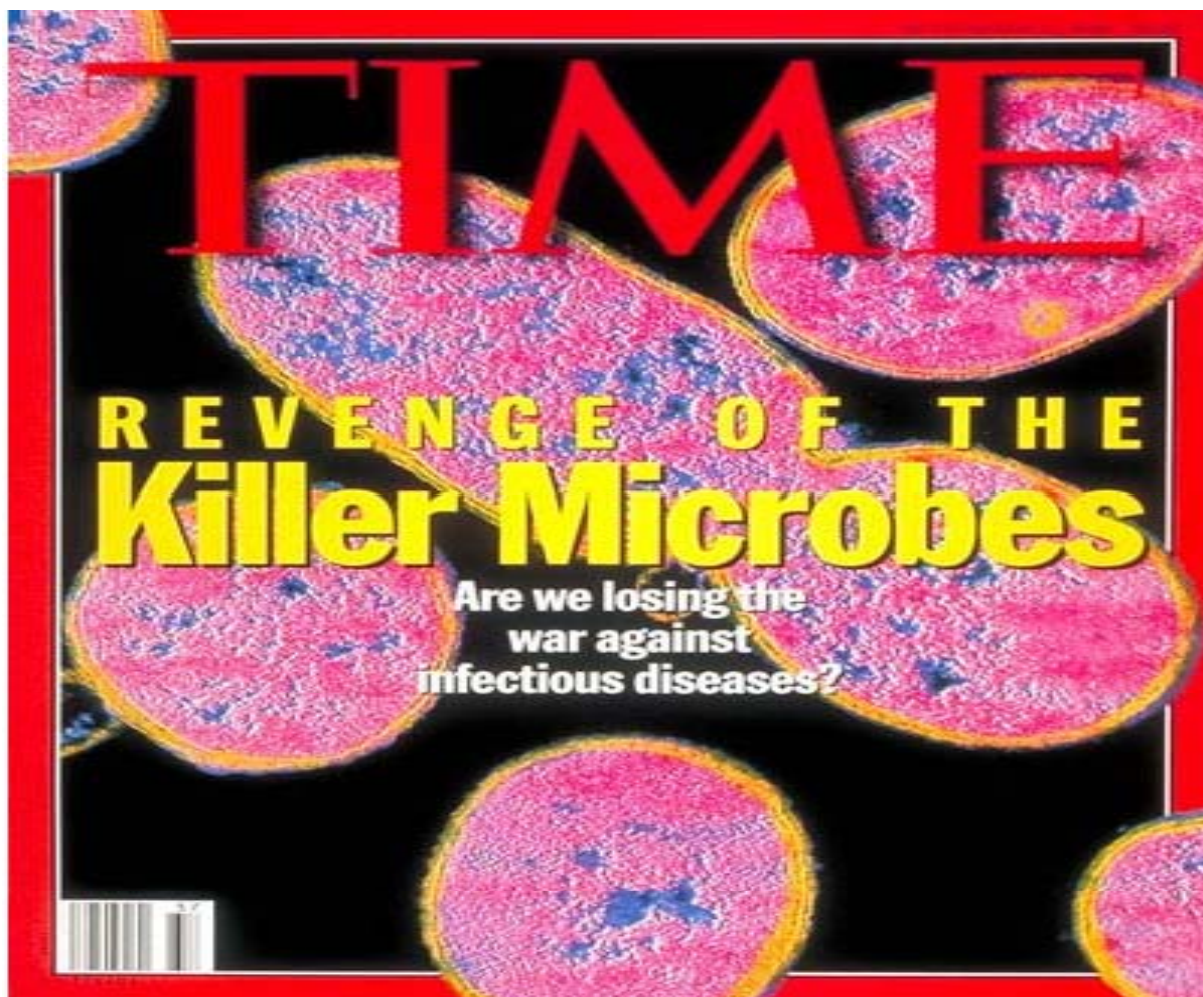
***Lactobacillus plantarum* beneficial to the health of newborns**

- Research conducted in India shows Synbiotic preparation (*Lactobacillus plantarum* plus fructooligosaccharide) was effective in reducing sepsis and death in newborns.
- Reductions observed for culture-positive and culture-negative sepsis and lower respiratory tract infections (Panigrahi et al. 2017).



Figure 1. Electron micrograph of *L. plantarum*[1] [🔗](#) [📄](#)





MORE MEASLES IN MINNESOTA: 69 CASES NOW CONFIRMED



Amy Forliti/AP

by MICHAEL PATRICK LEAHY 22 May 2017 69x

<http://www.breitbart.com/big-government/2017/05/22/more-measles-in-minnesota-69-cases-now-confirmed>

Number of measles cases in the US by year since 2010

Year	Cases
2010	63
2011	220
2012	55
2013	187
2014	667
2015	188
2016*	70
2017**	117

*Cases as of December 31, 2016. Case count is preliminary and subject to change.

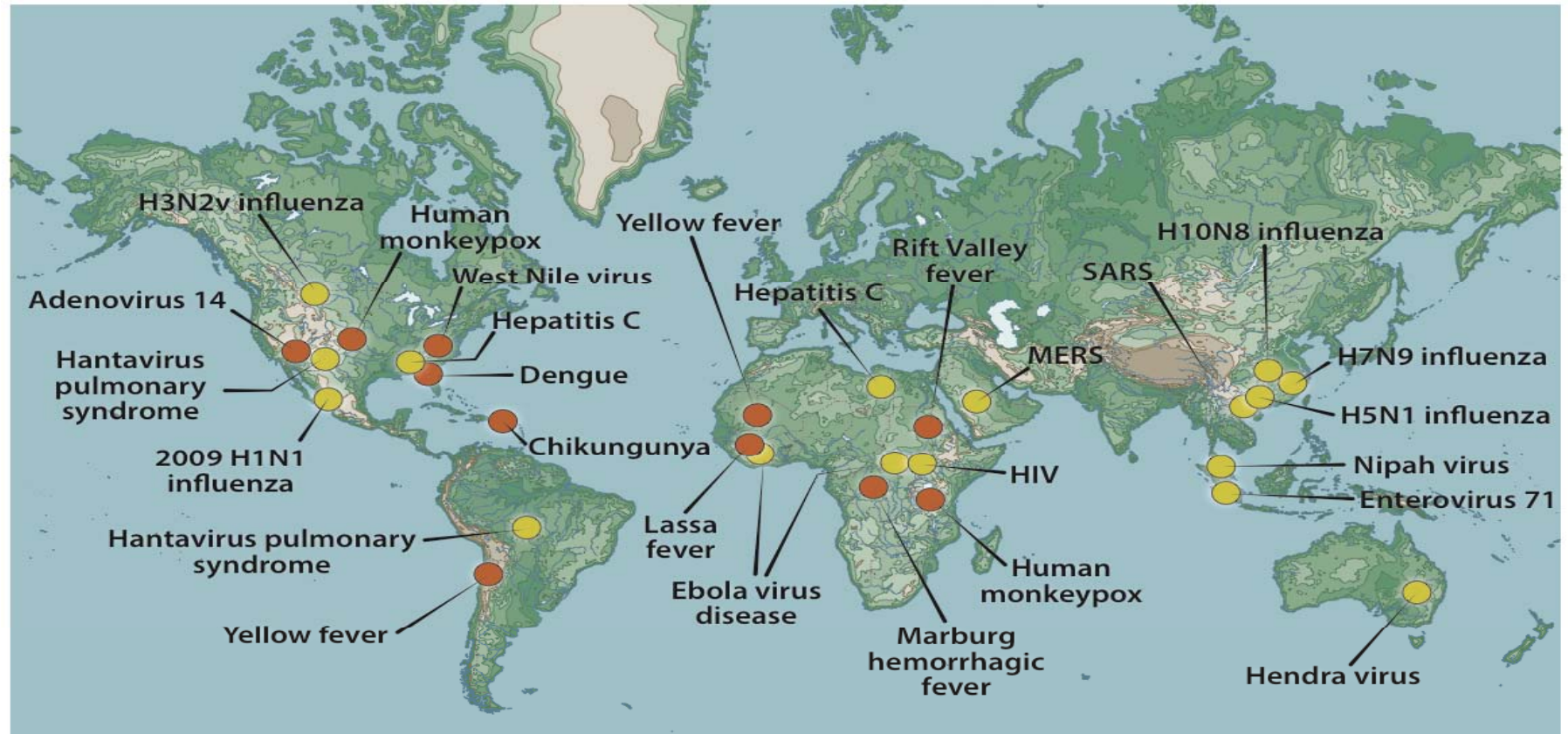
Cases as of July 15, 2017. Case count is preliminary and subject to change. **Data are updated monthly.

Source: [Morbidity and Mortality Weekly Report \(MMWR\), Notifiable Diseases and Mortality](#)

[Tables](#)

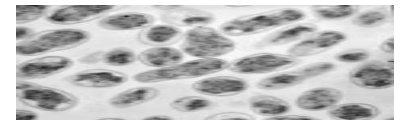
<https://www.cdc.gov/measles/cases-outbreaks.html>

Recently emerging—and some *re-emerging* – infectious Diseases



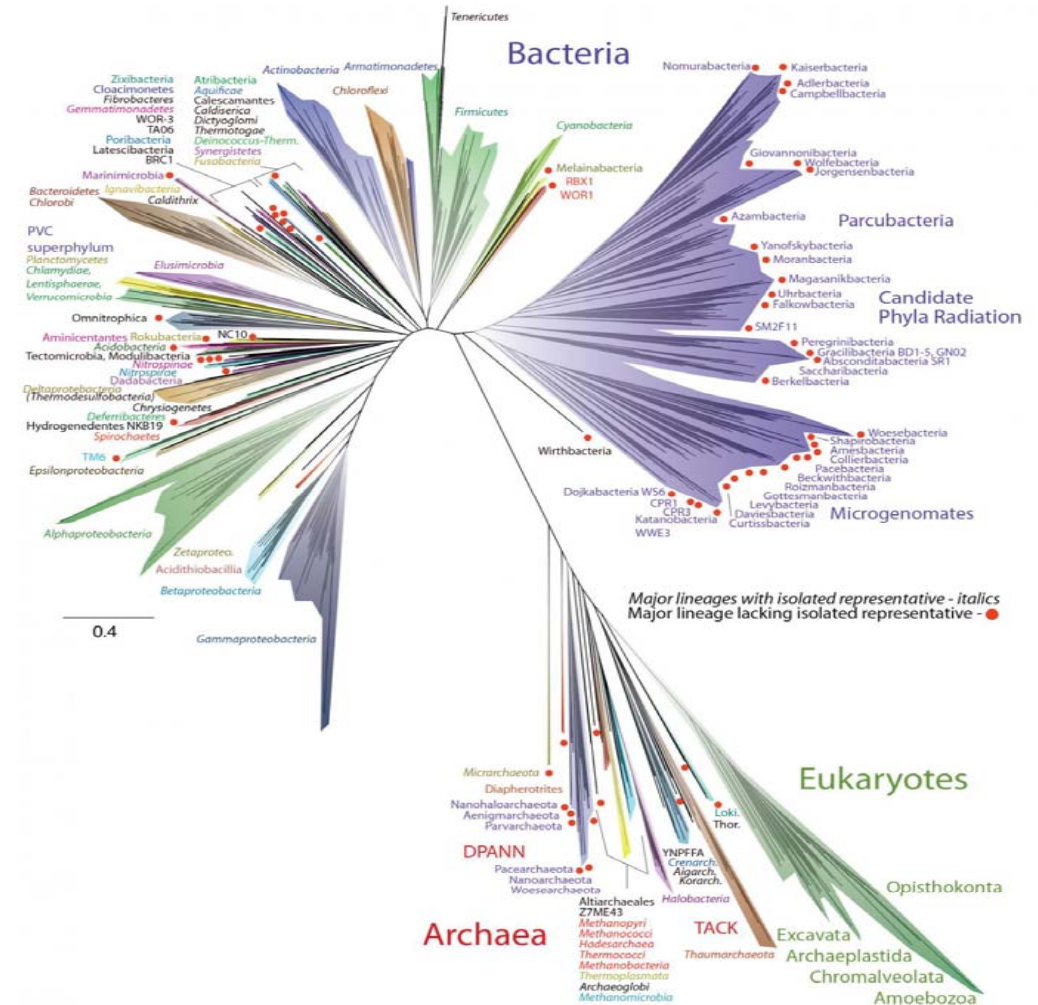
Underlying Factors in Emergence (the microbial “perfect storm”)

- **Genetic and Biological Factors**
 - Microbial adaptation and change
 - Human susceptibility to infection
- **Ecological Factors**
 - Changing ecosystems
 - Economic development and land use
 - Climate and weather
 - Human demographics and behavior
- **Social, Political, and Economic Factors**
 - International travel and commerce
 - Poverty and social inequity
 - War and famine
 - Lack of political will
 - Intent to harm



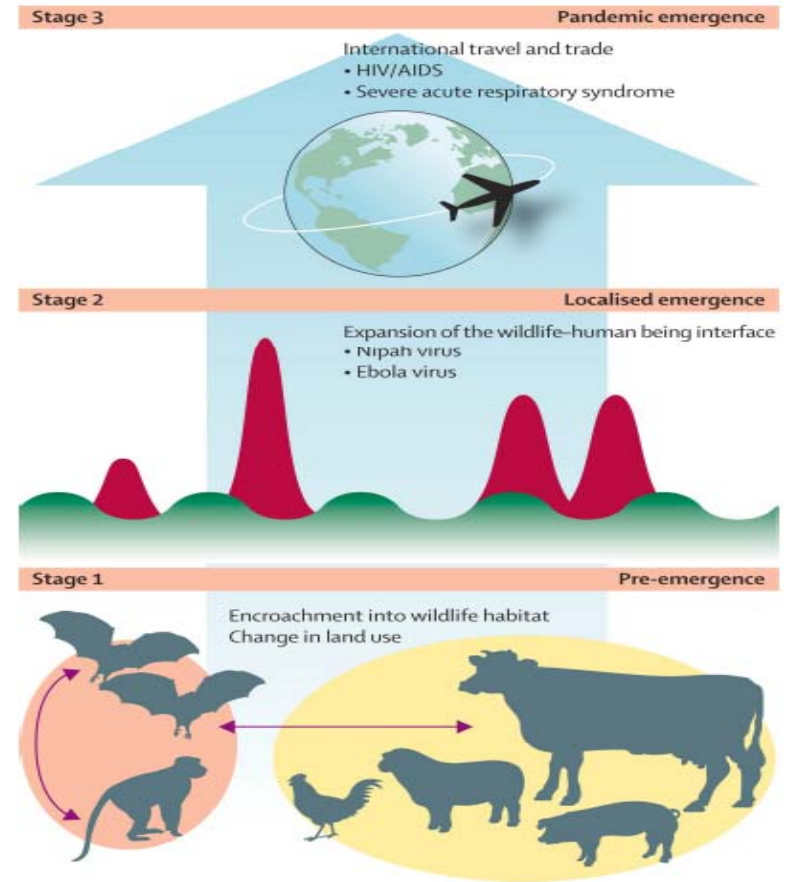
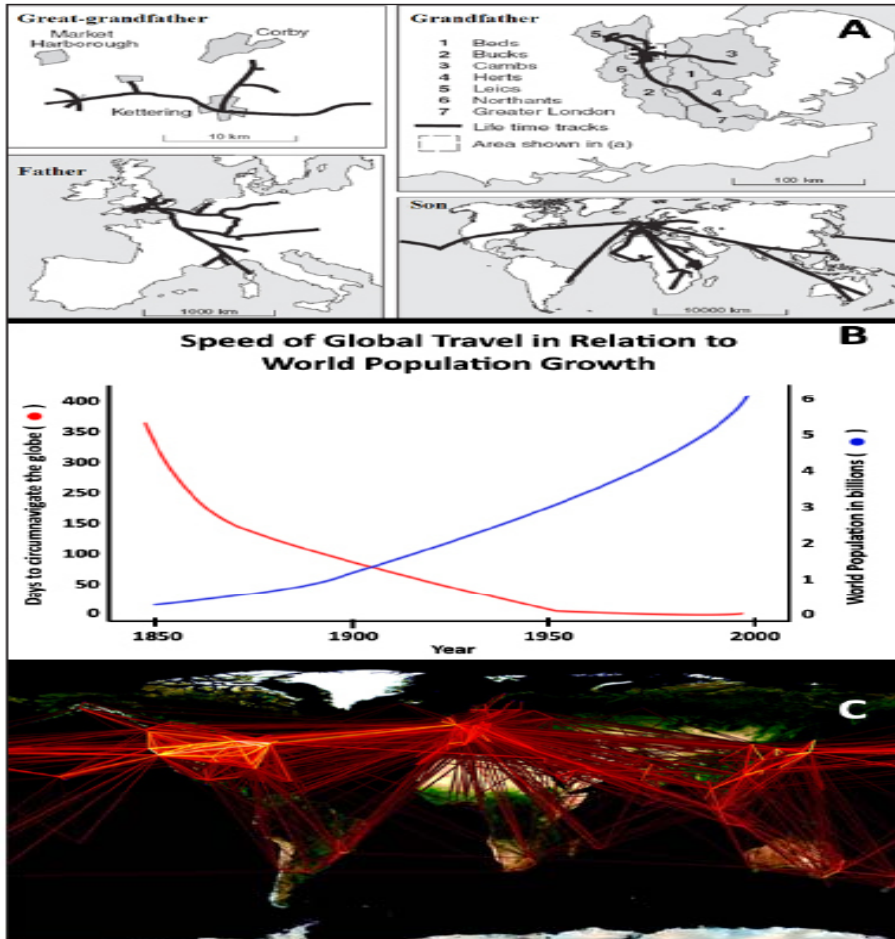
NEW “Tree of Life”

- Revolutionized by DNA sequencing
- Eukaryotes & Archaea dwarfed by Bacteria
 - 3.4 Billion years old
 - 3.5 Billion species
 - 90% of all life
- Bacteria advantage
 - 30 generations in a day
 - Readily exchange genetic material

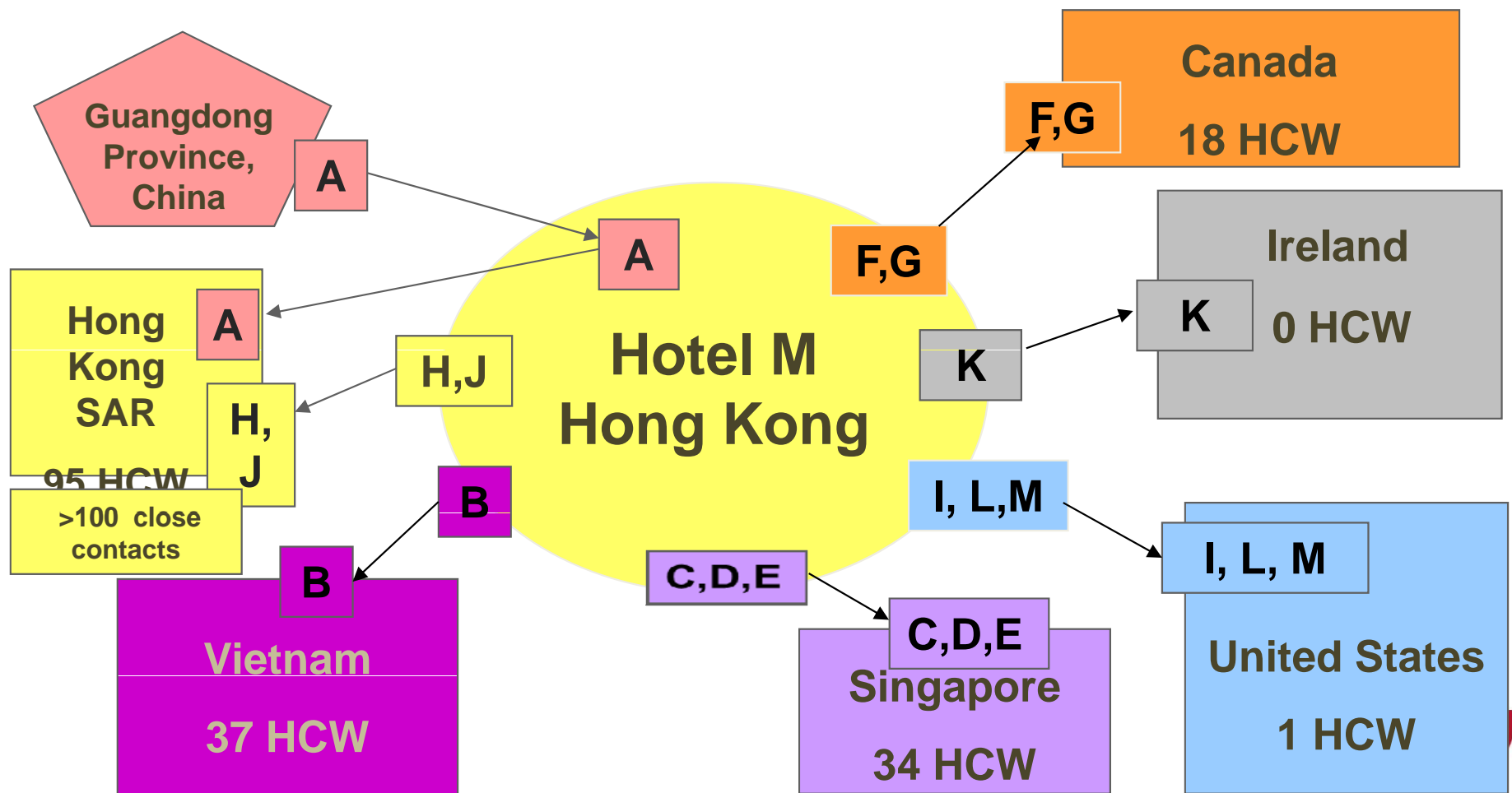


Hug et al., *Nature Microbiology*, 2016 April
 Wacey, Kilburn, et al. *Nature Geoscience*, 2011.
<https://www.sciencedaily.com/releases/2011/08/110821205241.htm>

Population Growth, Speed of Global Travel, Man-made Environmental Change



SARS: Clusters Linked to Hotel M





Potential Bioterrorism Threats

Priority Biological Agents

Viral

- Smallpox
- Viral Hemorrhagic Fevers
- Viral Encephalitis

Bacterial

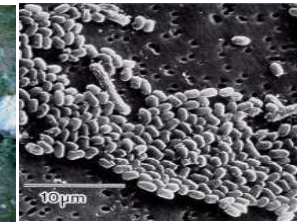
- Anthrax
- Plague
- Tularemia
- Glanders/Melioidosis
- Q Fever

Toxins

- Botulism
- Ricin toxin



Smallpox



Anthrax

Plague

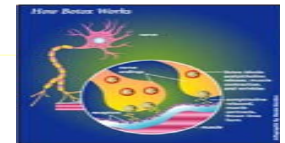


[FDA Home Page](#) | [Search FDA Site](#) | [FDA A-Z Index](#) | [Contact FDA](#)



Chili Products (Botulism) Recall
 (Includes Canned Chili, Stew, Hash, BBQ, Gravy, and Pet Food Products)
 Updated: September 4, 2007

Foodborne botulism



CBCnews
 Story Tools: EMAIL | PRINT | Text Size: S M L XL | REPORT TYPO | SEND

Toxic carrot juice paralyzes 2 in Toronto
 Last Updated: Monday, October 9, 2006 | 1:43 PM ET
 CBC News

Two Toronto residents are paralyzed after drinking carrot juice that tested positive for a botulism toxin, according to the city's public health department.

"There are two adults who are severely ill in hospital and they had a history of drinking the exact same juice that's been part of the carrot juice recall," Dr. Elizabeth Rea, an associate medical officer of health, told the Toronto Star on Sunday.

The juice, produced by Bolthouse Farms in Bakersfield, Calif., was ordered off North American store shelves



WEDNESDAY, 19 OCTOBER 2016 | 15:51

News

Photo

Video

Media

Home | Regions | Countries | News Analysis | Politics | Economy | Culture | Energy | Transport | Tourism | Science

ANSAmед > General news > ISIS 'plans to contaminate Turkish water with tularemia'

ISIS 'plans to contaminate Turkish water with tularemia'

Says intelligence report; symptoms difficult to diagnose

21 JANUARY, 16:41

+1 0


Tweet

Recommend 32

Back Back Send Scrivi alla redazione Suggest



Yemen Cholera Outbreak


Yemen اليمن
 برنامج الترصد الالكتروني للأمراض
 Electronic Disease Early Warning System (eDEWS)

الاستجابة للكوليرا Cholera Response
 التحديث اليومي
 Daily Epidemiological Update 2017-10-04
 Printed: 06:18 Thursday, 05 October 2017 UTC

A. ملخص المؤشرات Summary indicators

Cholera Response Cumulative figures 27/04/2017 to 4/10/2017		الاستجابة للكوليرا الأرقام التراكمية منذ 27 أبريل		
791,551	2,142	0.27%	96%	92%
حالات الاشتباه Suspected cases	الوفيات Associated deaths	معدل الاماته بين الحالات Case Fatality Rate	المحافظات المتأثرة بالوباء Governorates affected (23 / 22 محافظة) (22 / 23 governorates)	المدريات المتأثرة بالوباء Districts affected (333 / 305 مدينة) (305 / 333 districts)

Cumulative Cholera Cases from April 27th to October 4, 2017


World Health Organization
 Yemen cholera situation report no. 4
 19 JULY 2017



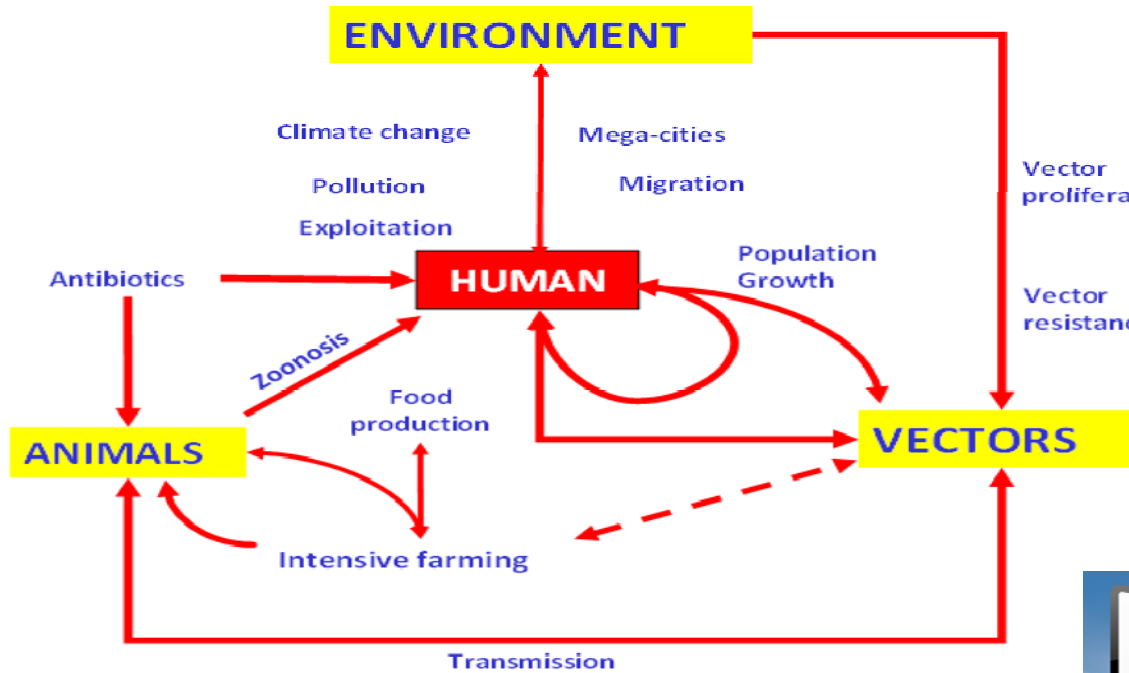
WHO-supported oral rehydration therapy corner in Sana'a
Photo: WHO/ S. Al-Wesabi

<http://www.emro.who.int/yem/yemeninfocus/situation-reports.html>



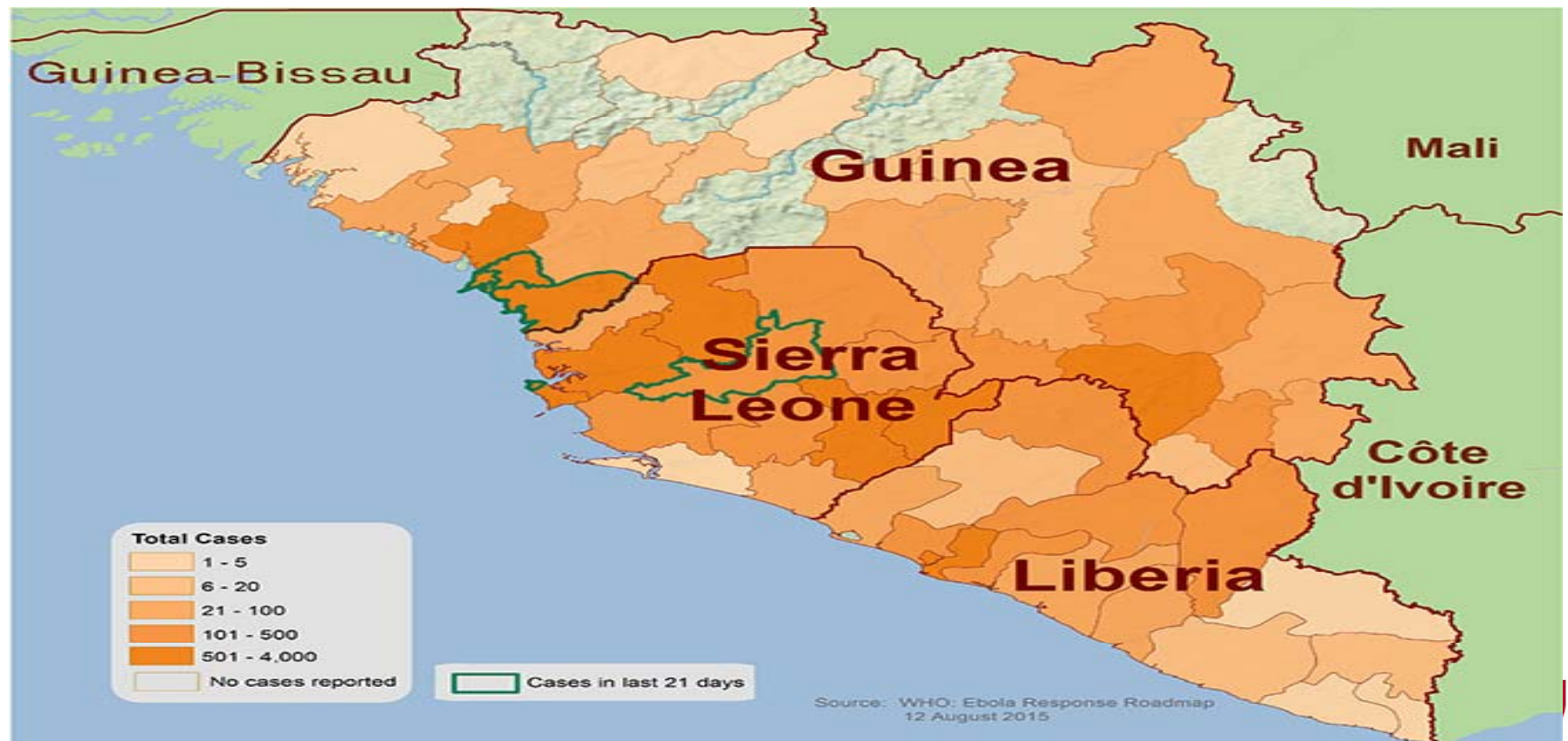
<http://www.aljazeera.com/news/2017/06/600-cholera-deaths-yemen-month-170602141857685.html>

Largely anthropogenic factors





Ebola Virus: 2014-2015 West Africa Epidemic



A personal view of Ebola in Sierra Leone ...







Ali S Khan- College of Public Health University of Nebraska Medical Center

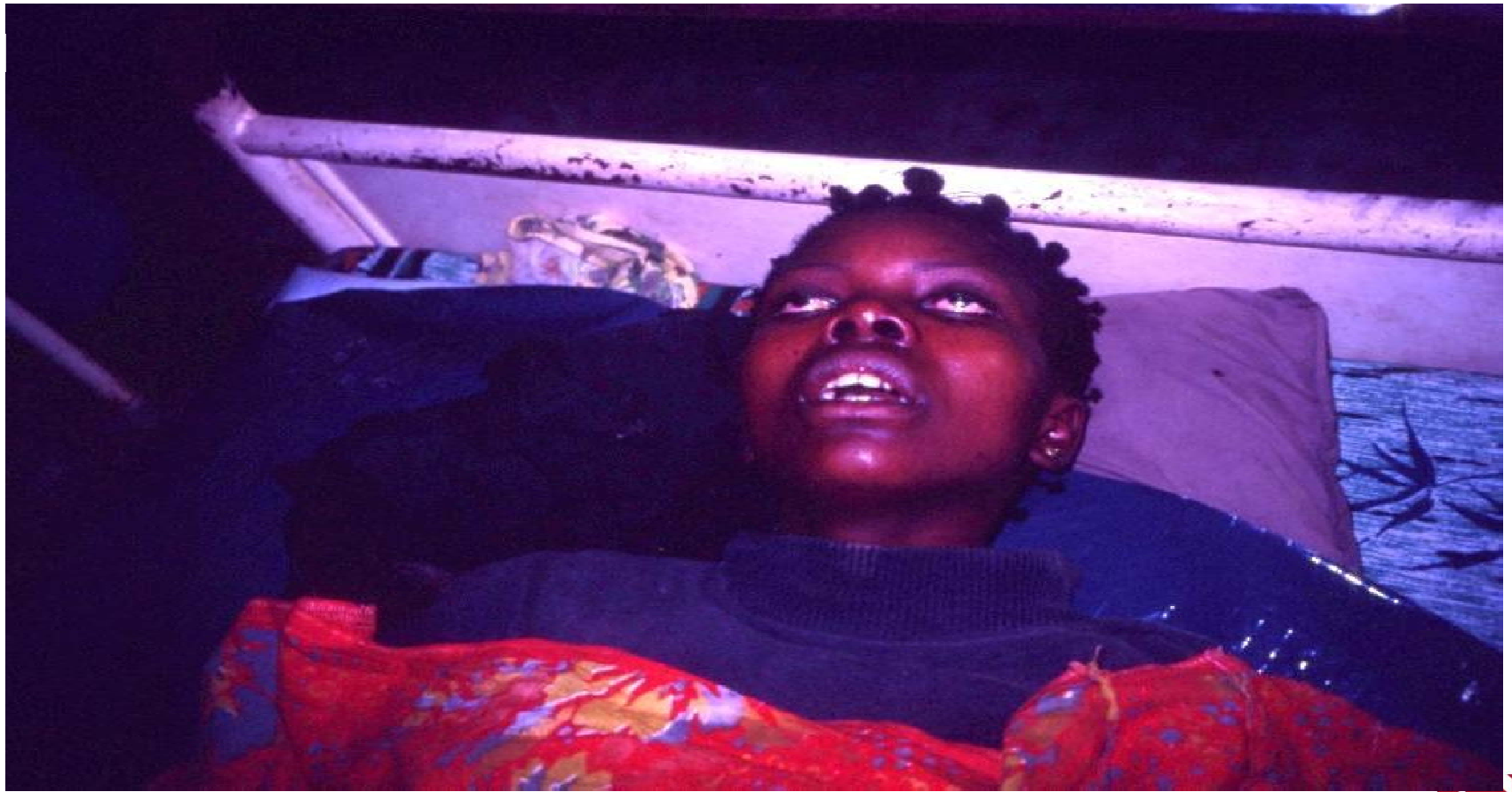




Surveillance

- ❖ Involve regular, ongoing collection and analysis of health-related data
- ❖ Monitor the frequency of occurrence and distribution of disease or a health condition in the population
- ❖ Generated data are used to manage public health programs














EBOLA KEY MESSAGES 

What is Ebola?
Ebola is a killer disease caused by a virus. It spreads quickly from person to person. Will it spread from an animal to a person?

Signs & Symptoms

How is Ebola Spread?

- It spreads through:
 - Direct contact with someone who has the blood, fluids, or sweat of an infected person or touching of such fluids from an infected person or an infected respiratory surface.
 - Using the same sharp instruments that have been used by an infected person.
 - Direct physical handling of people who have died of Ebola.
 - Eating food prepared by someone who has died of Ebola.
 - Eating fruit that has been cut and handled by someone who has died of Ebola.

How to Prevent Ebola

Treatment for Ebola

For More Information Call FREE 117





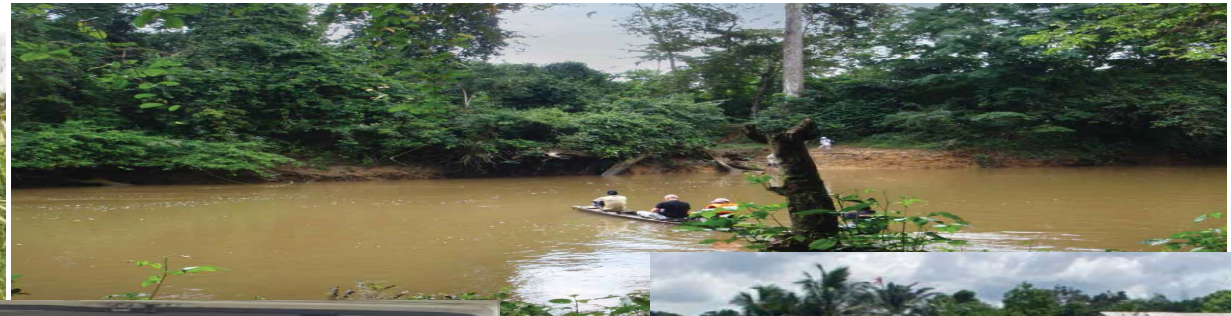
Ali S Khan- College of Public Health University of Nebraska Medical Center



Ali S Khan- College of Public Health University of Nebraska Medical Center

Contacts Tracing

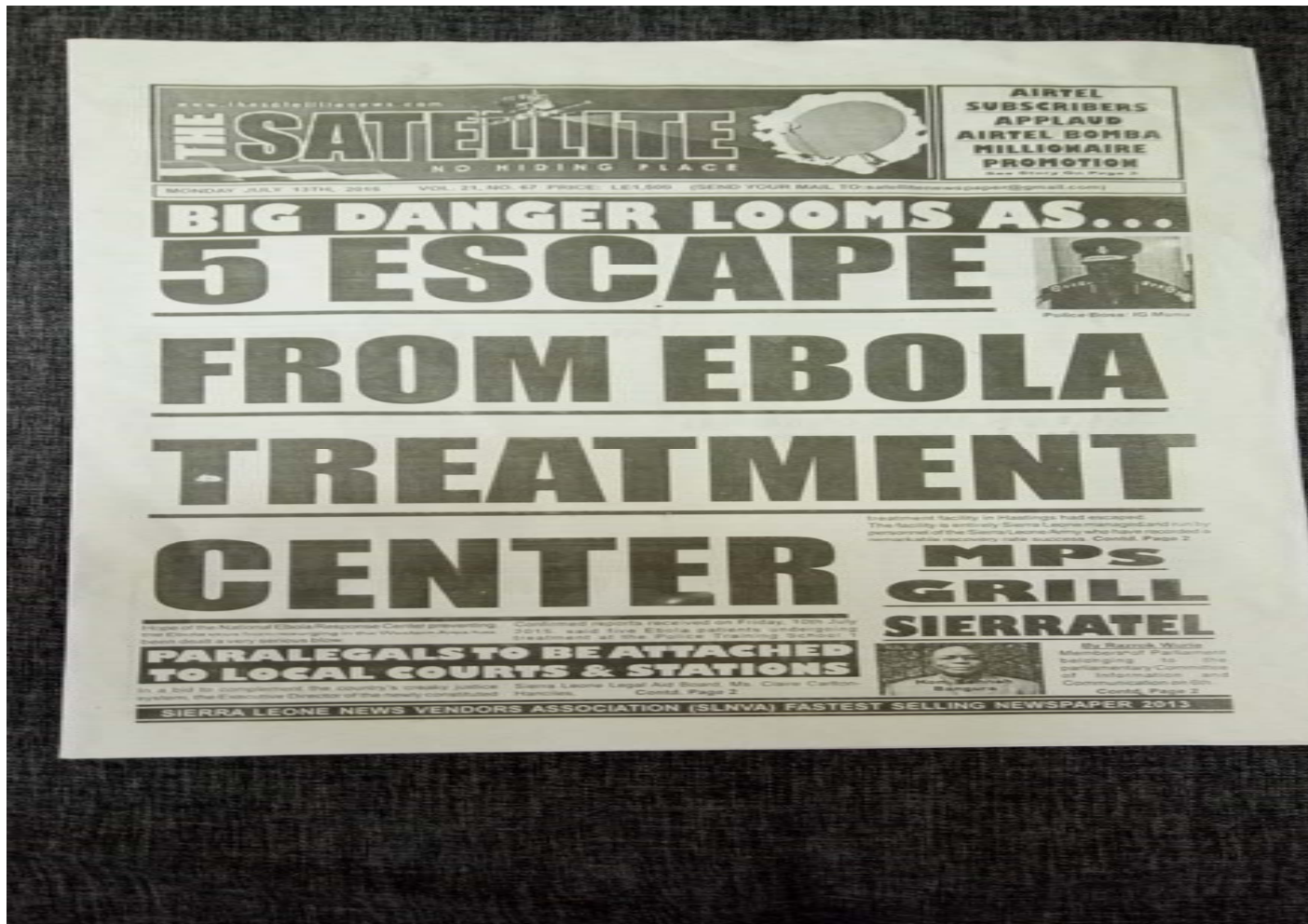
- ❖ Rapid case finding, paired with proper infection control, is critical to stop the spread of Ebola → solved immediate health problem by identifying new cases quickly, which increases patients' chances of survival.



<https://www.cdc.gov/about/ebola/index.html>







Ali S Khan- College of Public Health University of Nebraska Medical Center











...AND WHAT ARE YOU SUPPOSED TO BE?

UNDER QUARANTINE.

Mobilizing Laboratories

- ❖ Laboratories, and the Ebola tests performed, responded and solved an immediate problem which was to identify Ebola-positive or negative patients as quickly as possible.
- ❖ The knowledge gained from lab tests produced direct benefits



<https://www.cdc.gov/about/ebola/index.html>

Source: CDC (2010) "Distinguish Public Health Research and Public Health Nonresearch". CDC Office of the Associate Director for Science





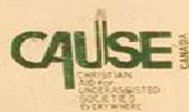
Strengthening Health Care and Preventing Infections

- Effective infection controls and strengthened health care through training and health education, helped protect communities and the healthcare workers who serve them.



KASUMPE EBOLA HOLDING CENTRE

Funded and Constructed by:



Doctors of the World



OXFAM

AID-SALONE





06 02 2015











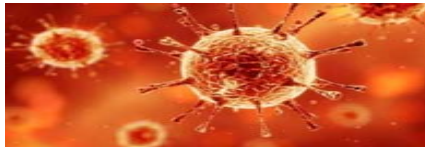
Ali S Khan- College of Public Health University of Nebraska Medical Center



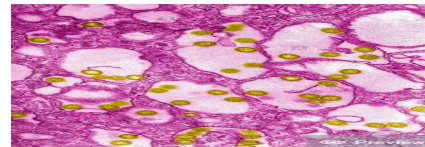
Ali S Khan- College of Public Health University of Nebraska Medical Center



What will be the *NEXT* pandemic?



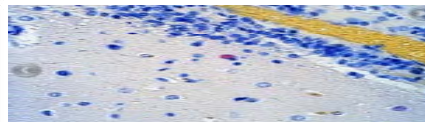
Crimean Congo
haemorrhagic
fever



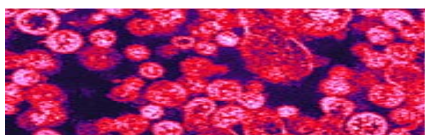
Rift Valley fever



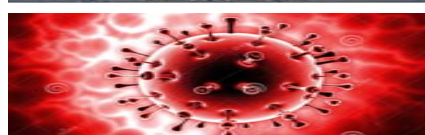
Ebola



Nipah Virus



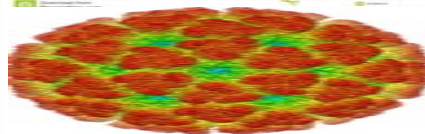
Lassa Fever



SARS



Marburg Virus



Chikungunya



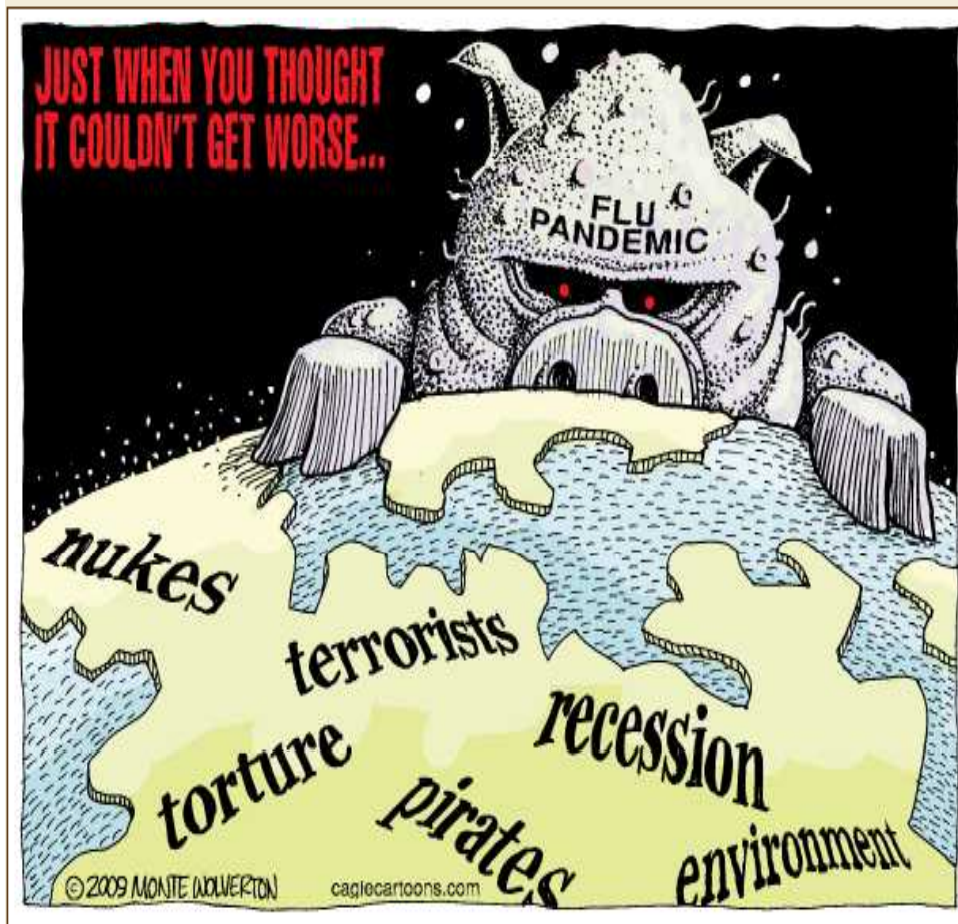
MERS-CoV



Zika Virus

(And when?)





Cartoon by Monte Wolverton, Cagle Cartoons

<http://thecomixnews.com/edtoons/archive/2009/0429/swineflu/04.php>



Dual Use Research and the Potential for Misuse of Biotechnology

Dual use life sciences research is legitimate research that could be misused to threaten public health or national security

- Primary goal of identifying dual use research:
 - to minimize the potential for misuse of biotechnology *without hindering the progress of science and the important benefits that it yields*



Example: Canadian Researchers Reconstitute Extinct Poxvirus for \$100,000 using mail order DNA

- Virologist David Evans of the University of Alberta in Edmonton, Canada
- In 2016, Evans was able to synthesize the horsepox virus, a relative of smallpox, from genetic pieces ordered in the mail
- It is believed that if horsepox could be created, so could smallpox

<http://www.sciencemag.org/news/2017/07/how-canadian-researchers-reconstituted-extinct-poxvirus-100000-using-mail-order-dna>

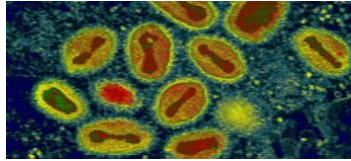


Example: Horsepox Virus Research

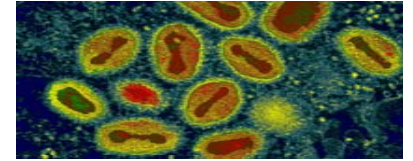
- Evans' research associate, Ryan Noyce, hoped to better understand the origins of the smallpox vaccine
- Major dual use threat -
 - Could be used to create a vaccine with fewer side effects
 - Could be used to create deadly diseases by terrorists

<http://www.sciencemag.org/news/2017/07/how-canadian-researchers-reconstituted-extinct-poxvirus-100000-using-mail-order-dna>





How Contagious Is Vaccinia?



Debate over vaccination using Vaccinia centered around:

1. The safety of the live vaccine
 2. The transmissibility of vaccinia virus from a recently vaccinated person to a susceptible host
- Literature indicates nosocomial transmission
 - credible estimates of the complication rates
 - Secondary cases reported among family members (Sepkowiz ; 2003)

US modern smallpox vaccination program in December 2002.

- Safely carried out with rates of adverse events below historical rates.
- No healthcare worker to patient transmission of vaccinia virus.
- Unexpected occurrence of cardiac conditions (myopericarditis) causally related to vaccinia.
- *Cases recovered with no progression to dilated cardiomyopathy.* (Poland et al 2005)

Current expert opinion recommends that vaccination of immunosuppressed persons should be avoided (Sepkowiz, 2003)

Gain of Function Research: the Potential Benefits and Risks of Gaining Function

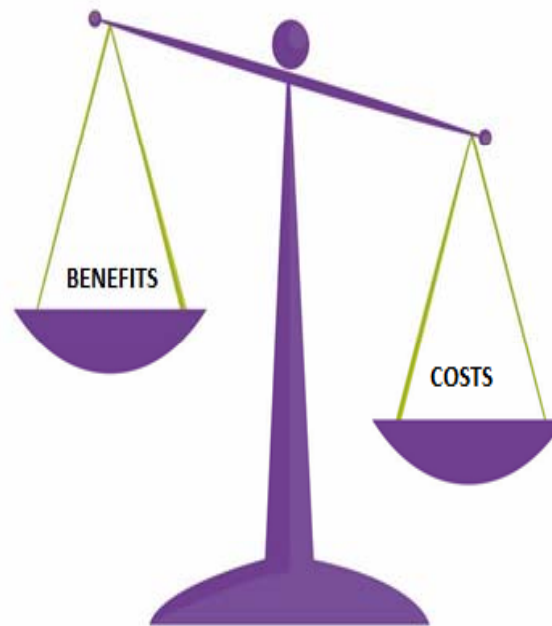
- Gain-of-function (GOF) research involves “experimentation that aims or is expected to increase the transmissibility and/or virulence of pathogens” (Selgelid M. J (2016).

Scientific knowledge

Biosurveillance

Medical applications
therapeutics, vaccines, and diagnostics

Economic benefits



Biosafety
laboratory accidents

Biosecurity
Crime, Terrorism

Proliferation

Agriculture
Animal health

Loss of public confidence

NATIONAL SCIENCE ADVISORY BOARD FOR BIOSECURITY (NSA)

Current Criteria for Dual Use Research

1. Enhances the harmful consequences of the agent or toxin;
2. Disrupts immunity or the effectiveness of an immunization against the agent or toxin without clinical and/or agricultural justification;
3. Confers to the agent or toxin resistance to clinically and/or agriculturally useful prophylactic or therapeutic interventions against that agent or toxin or facilitates their ability to evade detection methodologies;
4. Increases the stability, transmissibility, or the ability to disseminate the agent or toxin;
5. Alters the host range or tropism of the agent or toxin;
6. Enhances the susceptibility of a host population to the agent or toxin; or
7. Generates or reconstitutes an eradicated or extinct agent or toxin

Not currently defined in NSABB Criteria

- “Weaponization”
- Diagnostic and Detection Modalities
- Equipment



Ethical Considerations for Dual-Use Accountability

Retrospective:

- After a negative outcome occurs, may the researcher be considered responsible, blamed, and/or punished? How about the journal?

Prospective:

- Is a researcher morally bound to take preemptive precautions to avoid unwanted future outcomes? To predict how future technology may use his/her research?



Why Do We Care?

- “Genome Editing is a weapon of mass destruction”
 - Gene editing involves altering the DNA inside living cells
- Different countries have different standards for regulating gene editing
- CRISPR can be used to make animals that spread diseases

<https://www.technologyreview.com/s/600774/top-us-intelligence-official-calls-gene-editing-a-wmd-threat/>



Online Sale of Commercial DIY BioTech



Amino DNA Playground Set

ADD TO CART • \$389.00



Genetic Design Starter Kit - Engineer the Color of Bacteria
\$29.00



Genetic Engineering Home Lab Kit
\$1,399.00
★★★★★

<http://www.the-odin.com/gene-engineering-kits/>

SHENEMAN TRIBE CONTENT AGENCY



"I KNOW IT'S OUR JOB TO REASSURE THE PUBLIC, BUT IS ANYONE ELSE GOING TO ACKNOWLEDGE THAT THIS LOOKS LIKE THE BEGINNING OF EVERY ZOMBIE MOVIE EVER?"

11/6/2017

71



Acknowledgements

Philip S. Amara, MSc

Trang K. Hoang, MPH

Logan McNeil, undergraduate

Matthew Bosley, MD, FAAP, MPH-Candidate

Aleta Evans Gaertner, MPH



Contact: Ali S. Khan

984355 Nebraska ,Medical Center

Omaha, NE 68198-4355

Phone:402-559-4950

Email: ali.khan@unmc.edu

Twitter: @unmc_DrKhan



**University of Nebraska
Medical Center**



**Nebraska
Medicine**

