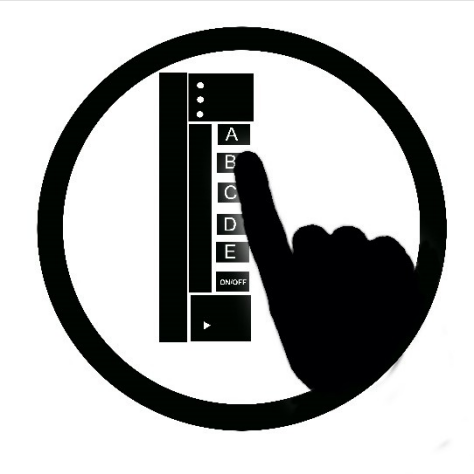
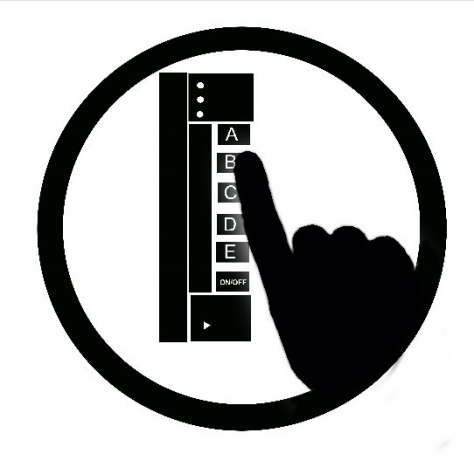
A NEW SCREENING PROGRAM IS INITIATED IN A POPULATION FOR DISEASE X…

- There is no effective treatment available for disease X (to change the natural history of the disease or the outcome)



THE SCREENING TEST HAS PROVEN TO BE 98% EFFECTIVE IN CORRECTLY IDENTIFYING PEOPLE WHO HAVE DISEASE X IN ITS EARLIEST STAGES. THIS IS REFERRED TO AS THE SCREEN'S:

A. Reliability
B. Specificity
C. Sensitivity
D. Positive Predictive Value

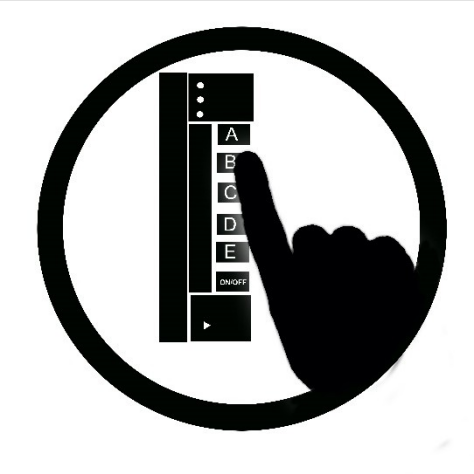


WHAT WILL HAPPEN TO THE INCIDENCE IN THIS POPULATION ONE-YEAR AFTER SCREENING IS INITIATED?

A. It will decrease

B. It will increase

C. It will remain constant

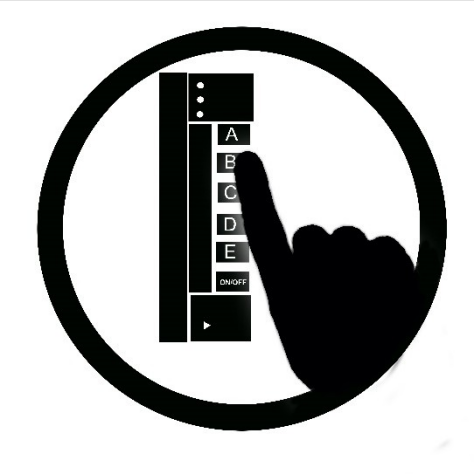


WHAT WILL HAPPEN TO PREVALENCE ONE YEAR AFTER INITIATION OF SCREENING IN THIS POPULATION?

A. It will decrease

B. It will increase

C. It will remain constant

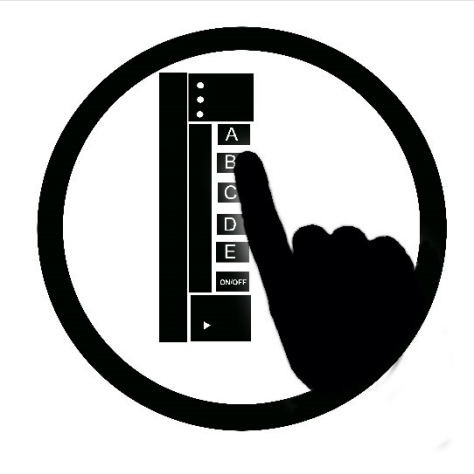


WHAT WILL HAPPEN TO THE CASE-FATALITY OF DISEASE X?

A. It will decrease

B. It will increase

C. It will remain constant

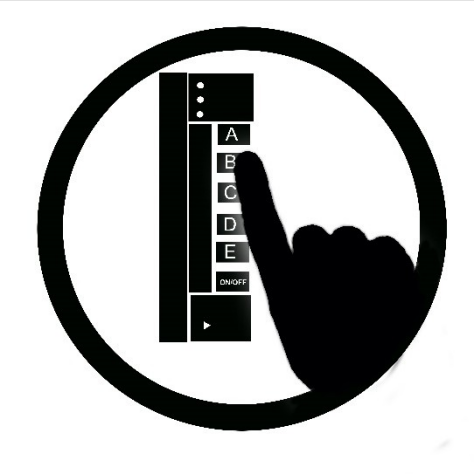


WHAT WILL HAPPEN TO THE MORTALITY RATE FROM DISEASE X?

A. It will decrease

B. It will increase

C. It will remain constant



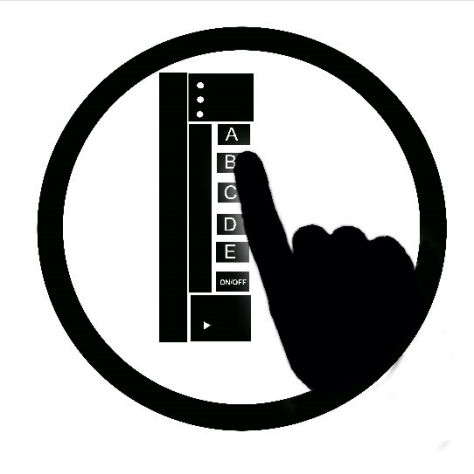
THE OVER-REPRESENTATION OF SLOWLY PROGRESSING DISEASE AS A RESULT OF SCREENING IS REFERRED TO AS:

A. Lead-time Bias

B. Volunteer Bias

C. Latency Bias

D. Length-time Bias

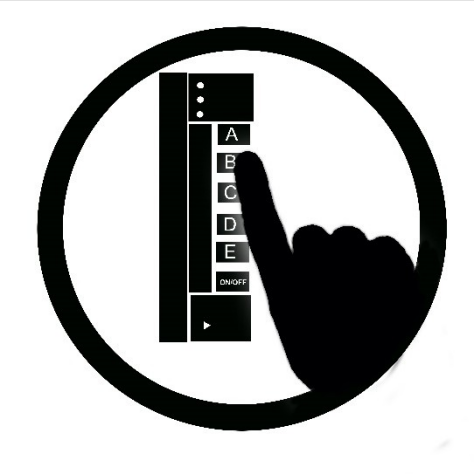


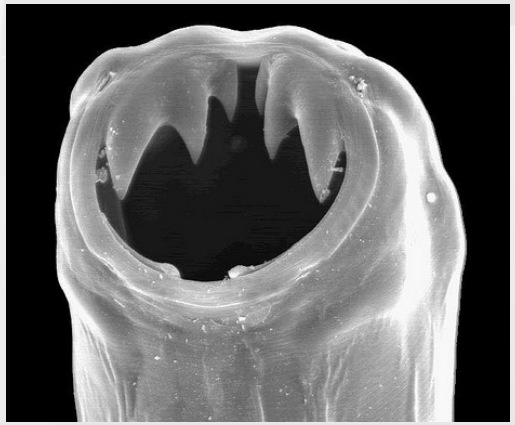
WHAT WILL HAPPEN TO THE SURVIVAL RATES FOR DISEASE X AS A RESULT OF SCREENING?

A. It will decrease

B. It will increase

C. It will remain constant



CLASS 15: 

THE EPIDEMIOLOGY OF INFECTIOUS DISEASE

HLSC 2003 | Walker | Faculty of Health Sciences

Lots of terminology and definitions…

CLASS OBJECTIVES:

1. Definition and overview of infectious disease
2. Epidemiologic Triangle
3. Determinants of disease transmission
4. Principles of outbreak investigation

MALARIA PRIMER: LINK

AGENT: protozoan parasite – genus Plasmodium (*P. falciparum, P. vivax, P. ovale, P. malariae*)

TRANSMISSION: through bites from infected female Anopheles Mosquitoes (bite between dusk and dawn).

PATHOLOGY: Once inside the human body, parasites multiply in the liver and invade red blood cells

SYMPTOMS: Signs and Symptoms: fever, headache, vomiting; life-threatening if not treated as blood supply to vital organs disrupted (e.g. kidney failure, low BP, problems with coagulation, severe anemia, ect.)

INCUBATION PERIOD: Infects 7-30 days after bite

HIGH-RISK GROUPS: children, pregnant women, international travellers, immigrants people with HIV/AIDS, geographic location (endemic areas)

MALARIA PRIMER: IN 2013…

GLOBAL MORTALITY:

- 584 000 deaths(90% of deaths from malaria occur in Africa)
- Mortality rates decreased by 74% between 2010 and 2013
- Globally, 453 000 children died before their fifth birthday due to malaria

GLOBAL MORBITIDY:

- 198 million cases

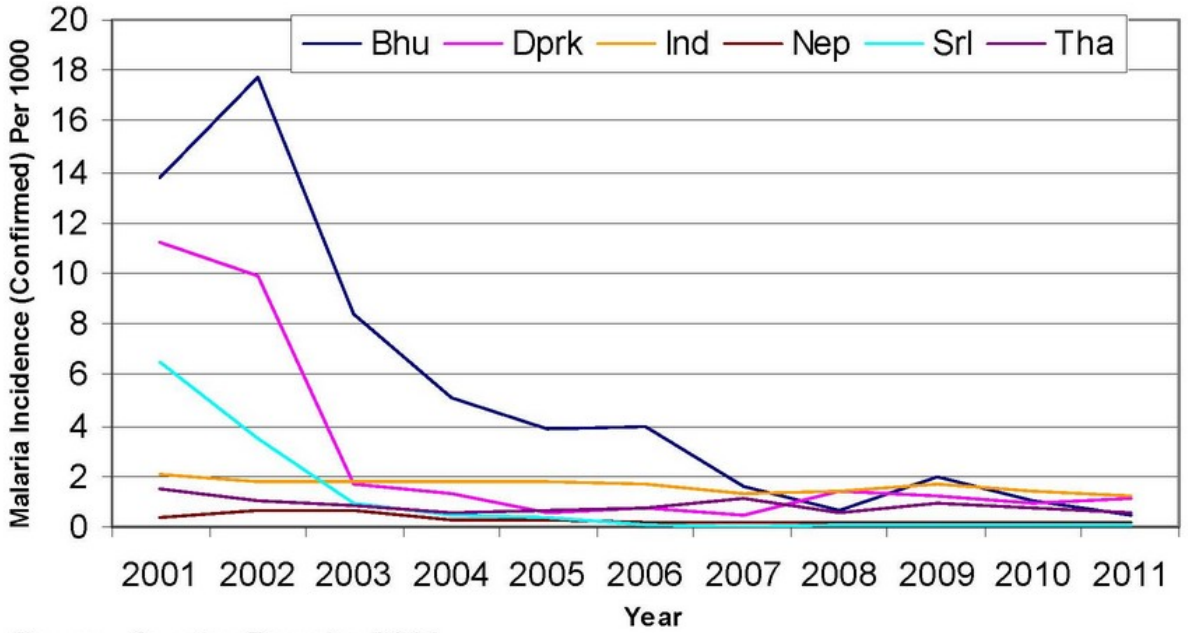
PREVENTION & TREATMENT: preventable and treatable

- Personal protection
- Control of mosquitoes
- Early Diagnosis
- Prophylactic and disease treatment
- No vaccine
- Elimination goals

DESCRIPTIVE EPI: SECULAR TRENDS

LINK to source

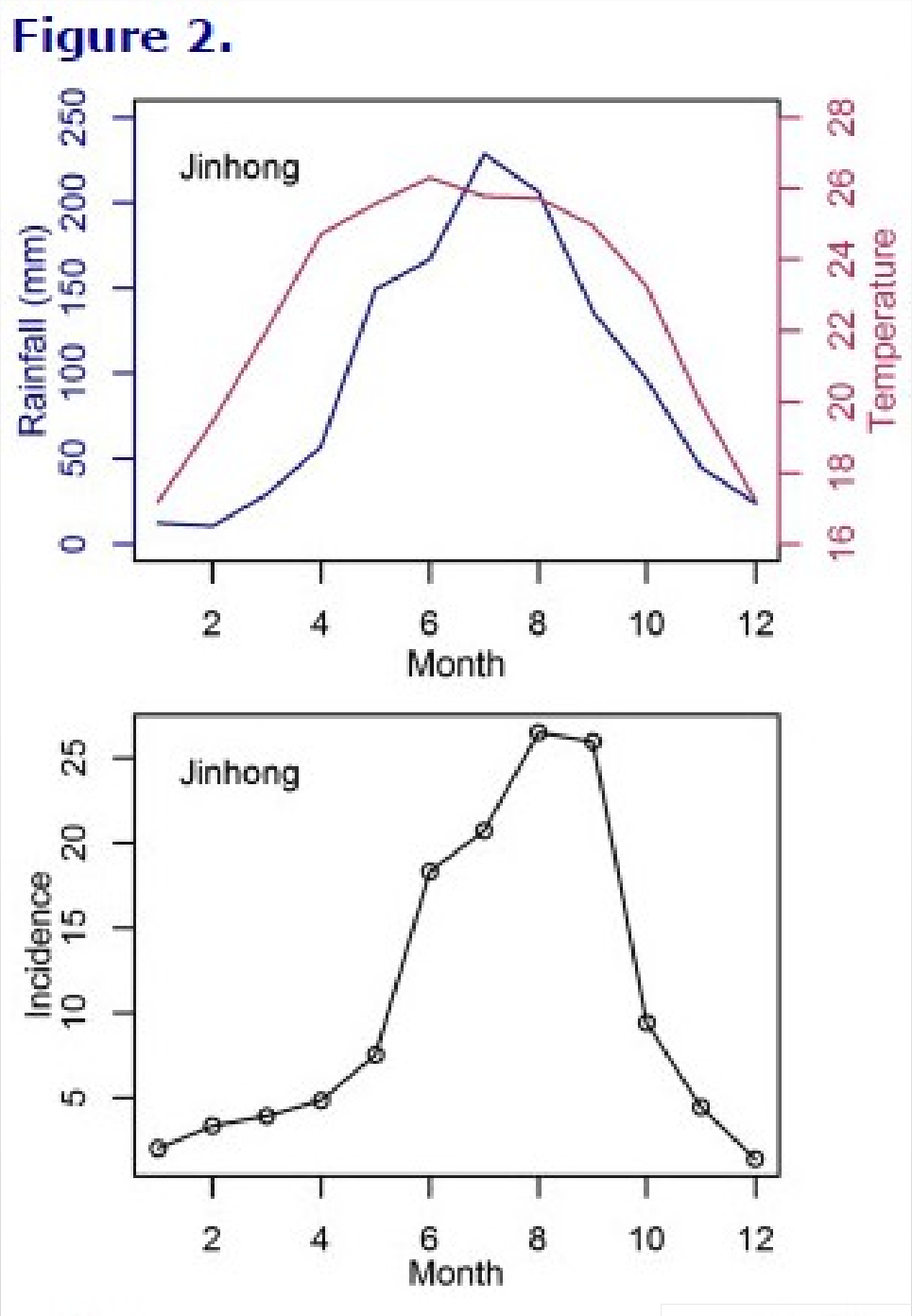
- Gradual changes in disease frequency over a long period of time.



Source :Country Reports, 2011

DESCRIPTIVE EPI: SEASONAL (CYCLICAL) TRENDS

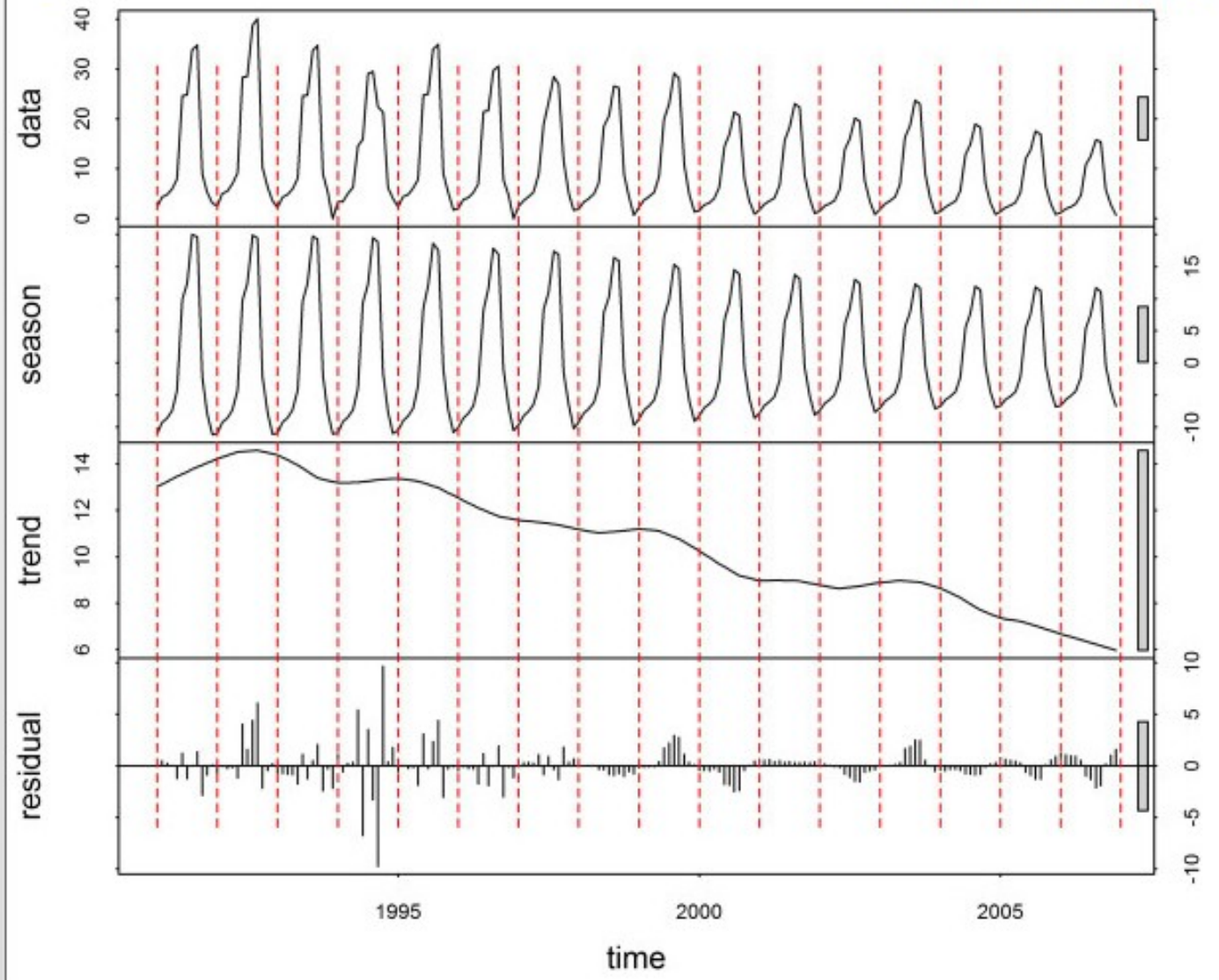
- Increases and decreases in disease frequency over a period of several years or within a year



LINK to source

Figure 3.

Resolution: **standard** / high



Decomposed *Plasmodium vivax* time-series for Jinhong. Data presented as incidence rates per 100,000 population.

Wardrop *et al. Malaria Journal* 2013 **12**:452 doi:10.1186/1475-2875-12-452

Download authors' original image

Describing Malaria by time: Secular and cyclical trends

LINK

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Aims and scope | Open access | Article-processing charges | Indexing services | Publication and peer review process | Editorial policies | Citing articles in *Malaria Journal* | Why publish your article in *Malaria Journal*?

This page includes information about the aims and scope of *Malaria Journal*, editorial policies, open access and article-processing charges, the peer review process and other information. For details of how to prepare and submit a manuscript through the online submission system, please see the instructions for authors.

Aims & scope

Malaria Journal is aimed at the scientific community interested in malaria in its broadest sense. It is the only journal that publishes exclusively articles on malaria and, as such, it aims to bring together knowledge from the different specialities involved in this very broad discipline, from the bench to the bedside and to the field. *Malaria Journal* offers a fast publication schedule while maintaining rigorous peer-review; this is achieved by managing the whole of the publication process electronically, from submission to peer-review

EPI IN THE NEWS:

LINK to news
LINK to article

Drug-Resistant Malaria Strain Alarms Researchers

Date: February 21, 2015

Source: Newsy / Powered by NewsLook.com

Summary: The main drug used to treat Malaria has shown to be ineffective in a recent strain found in Myanmar. Doctors say it's spreading at an alarming rate. Video provided by Newsy

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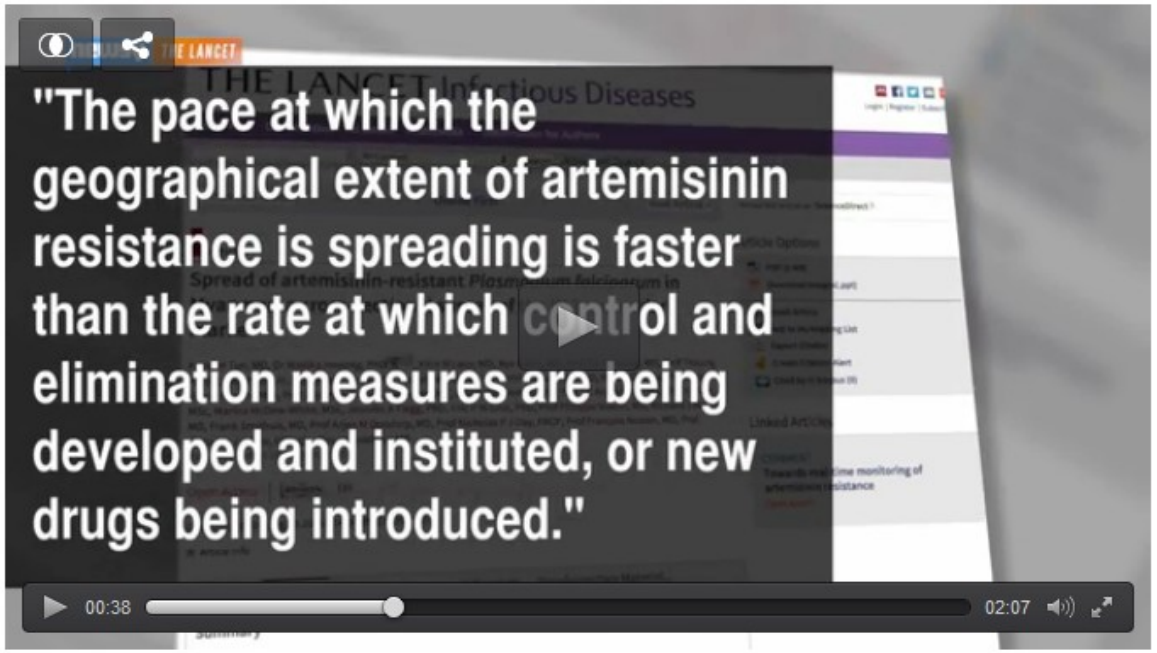


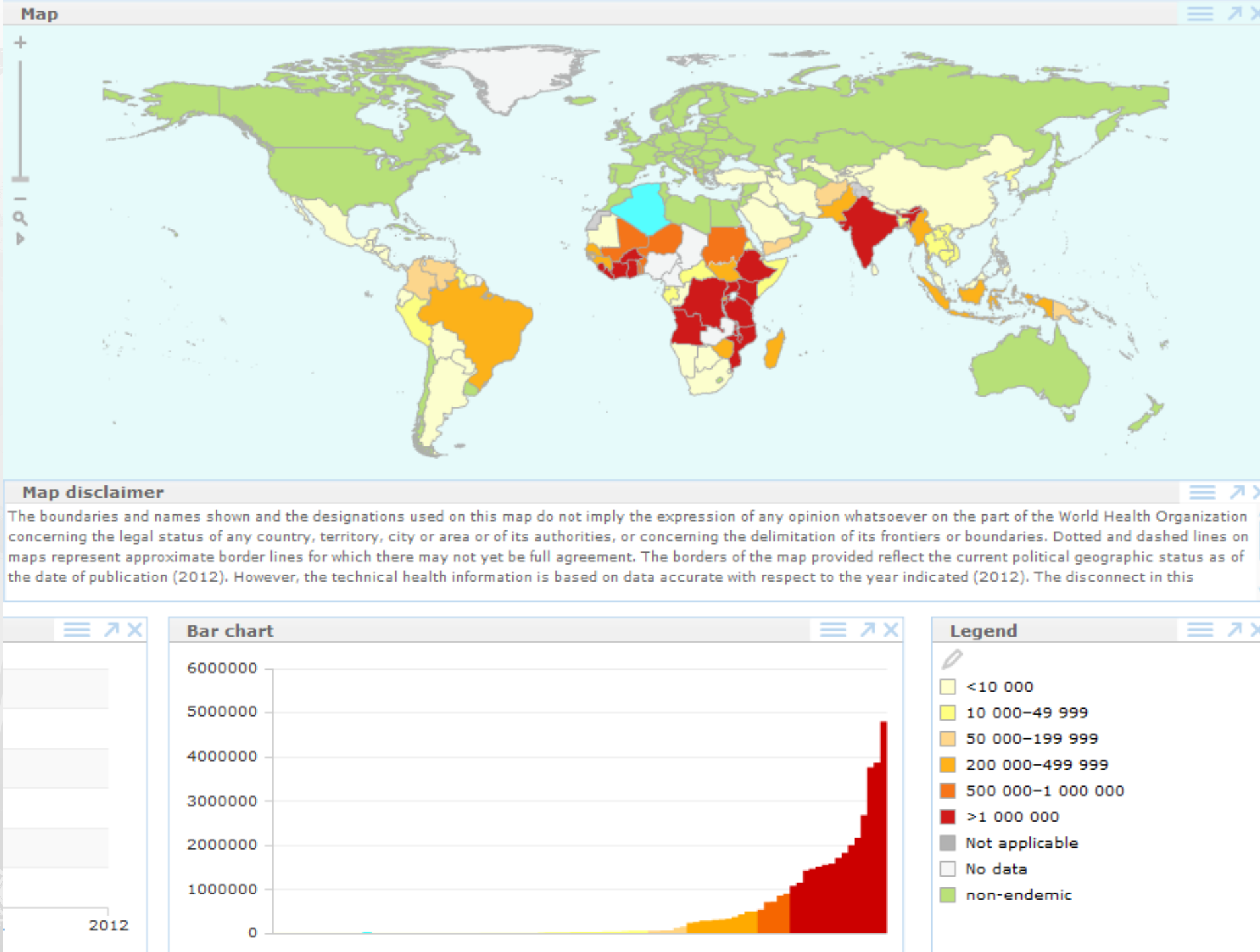
If resistance to artemisinins develops and spreads to other large geographical areas, the public health consequences could be dire.

MALARIA:

Confirmed cases in 2012

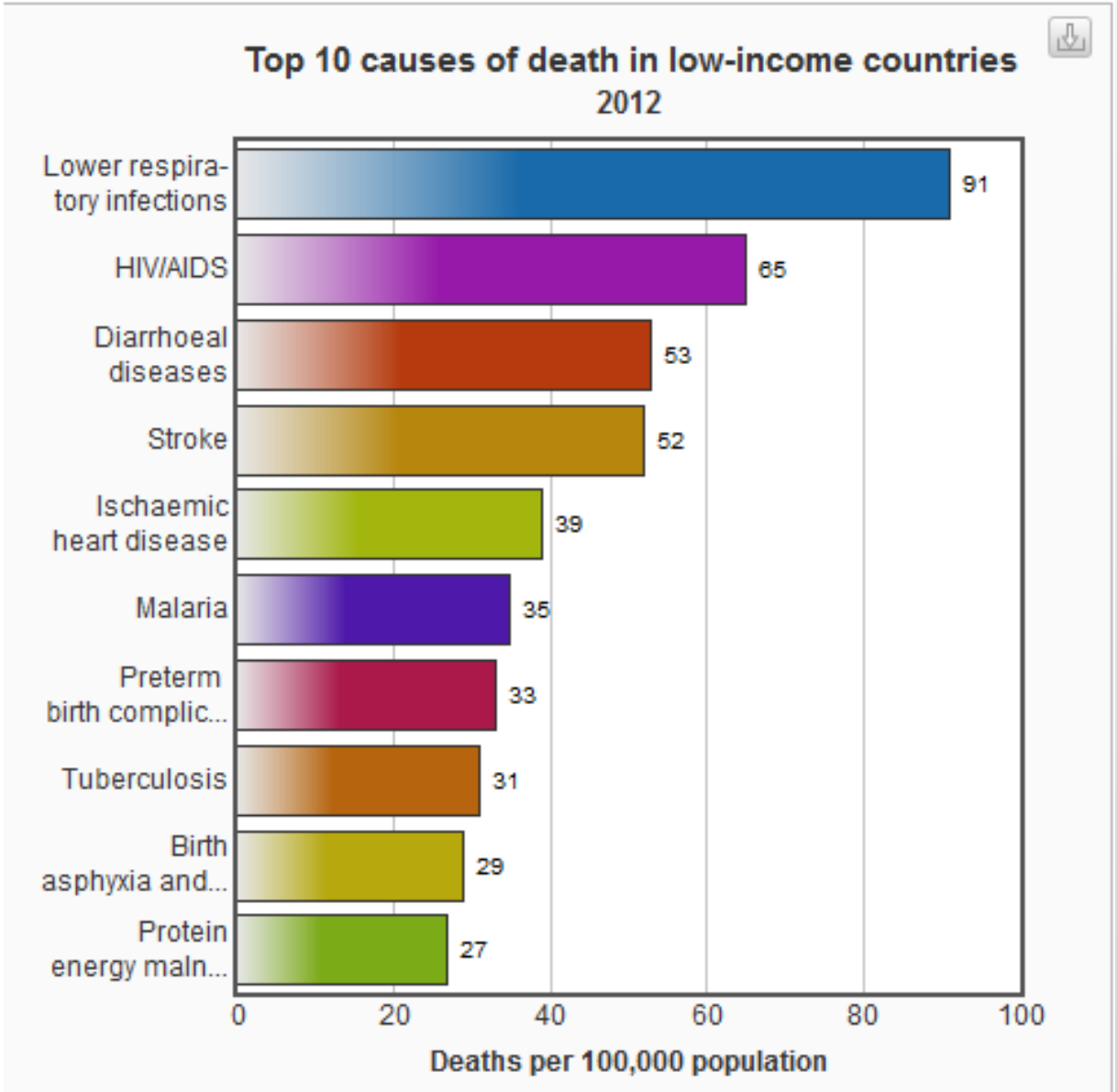
How many in Canada?

SO…who cares?

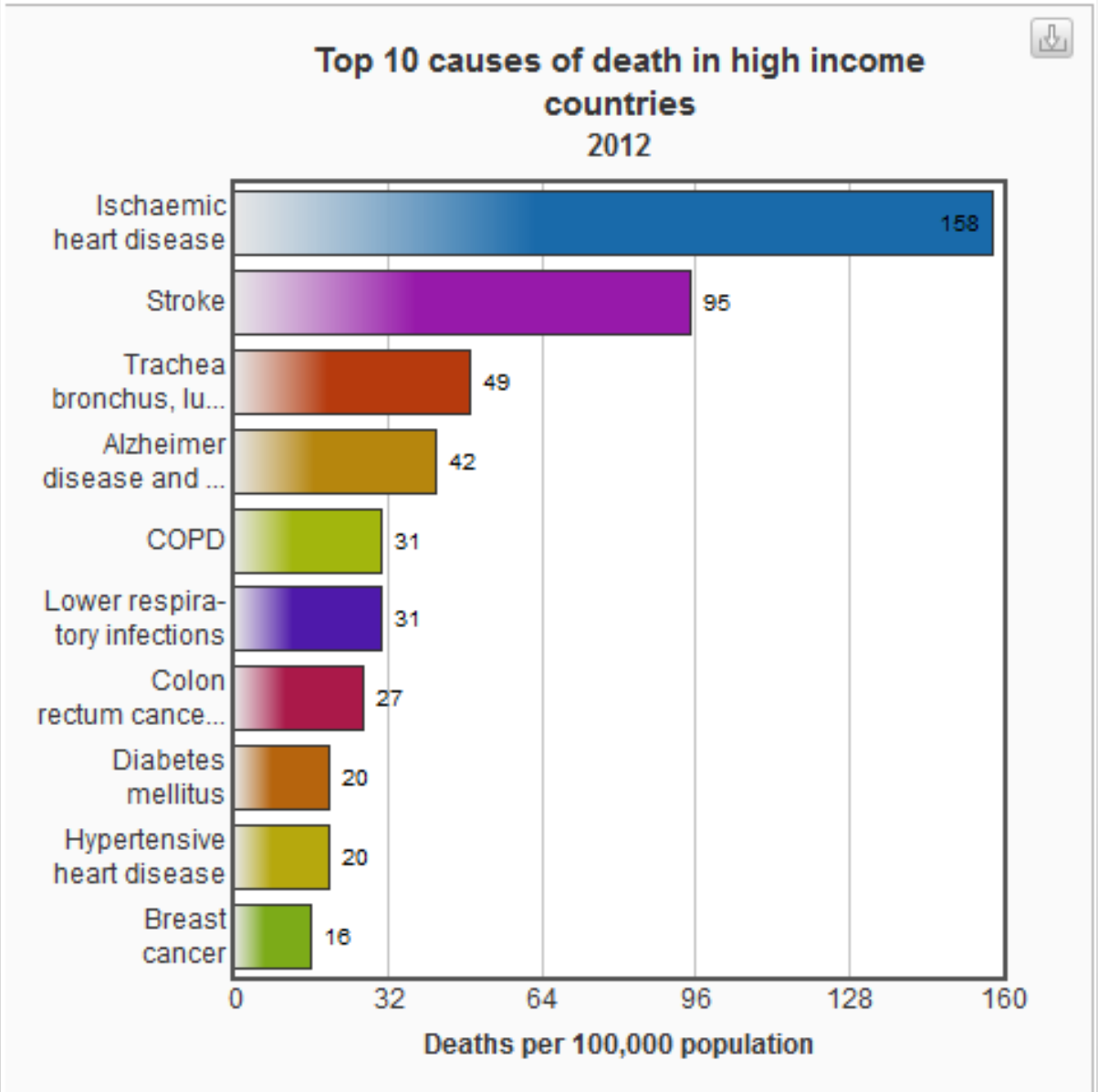


TOP 10 CAUSES OF DEATH GLOBALLY

Low income



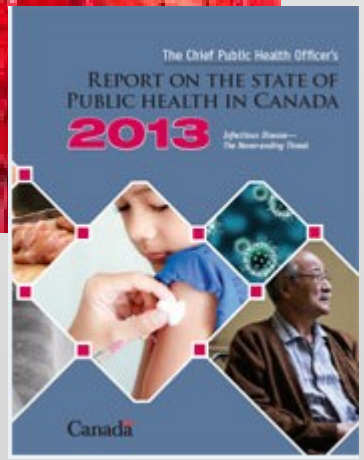
High income



“we must not become complacent”
“we must remains vigilant”
“we will continue to be challenged by infectious disease in the future”

CANADA: INFECTIOUS DISEASE THREATS?

- Non-immunized populations
- Antibiotic resistance
- Nosocomial infections
- Food and water-borne infections
- Tuberculosis/STIs
- Emerging threats
- Globalization
- Others unknown…



Chief Public Health Officer Report PHAC, 2013

CBCnews | Calgary

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Southern Alberta measles outbreak up to 40 confirmed cases

Alberta Health Services confirms total of 40 measles cases in southern Alberta

CBC News Posted: Nov 21, 2013 7:33 PM MT | Last Updated: Nov 21, 2013 7:33 PM MT

(U.S. Centre for Disease Control and Prevention)

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The confirmed number of measles cases in southern Alberta has risen to 40 as of Thursday, according to Alberta Health Services.

All of the cases so far are in the AHS's South zone, which does not include Calgary. The incidents are counted from October 18, when the measles outbreak was first declared.

On November 13, there were 28 confirmed cases.

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Syphilis o

CBC News Posted: Dec 23, 201

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- Syphilis kills 5 Alberta babies since 2005:

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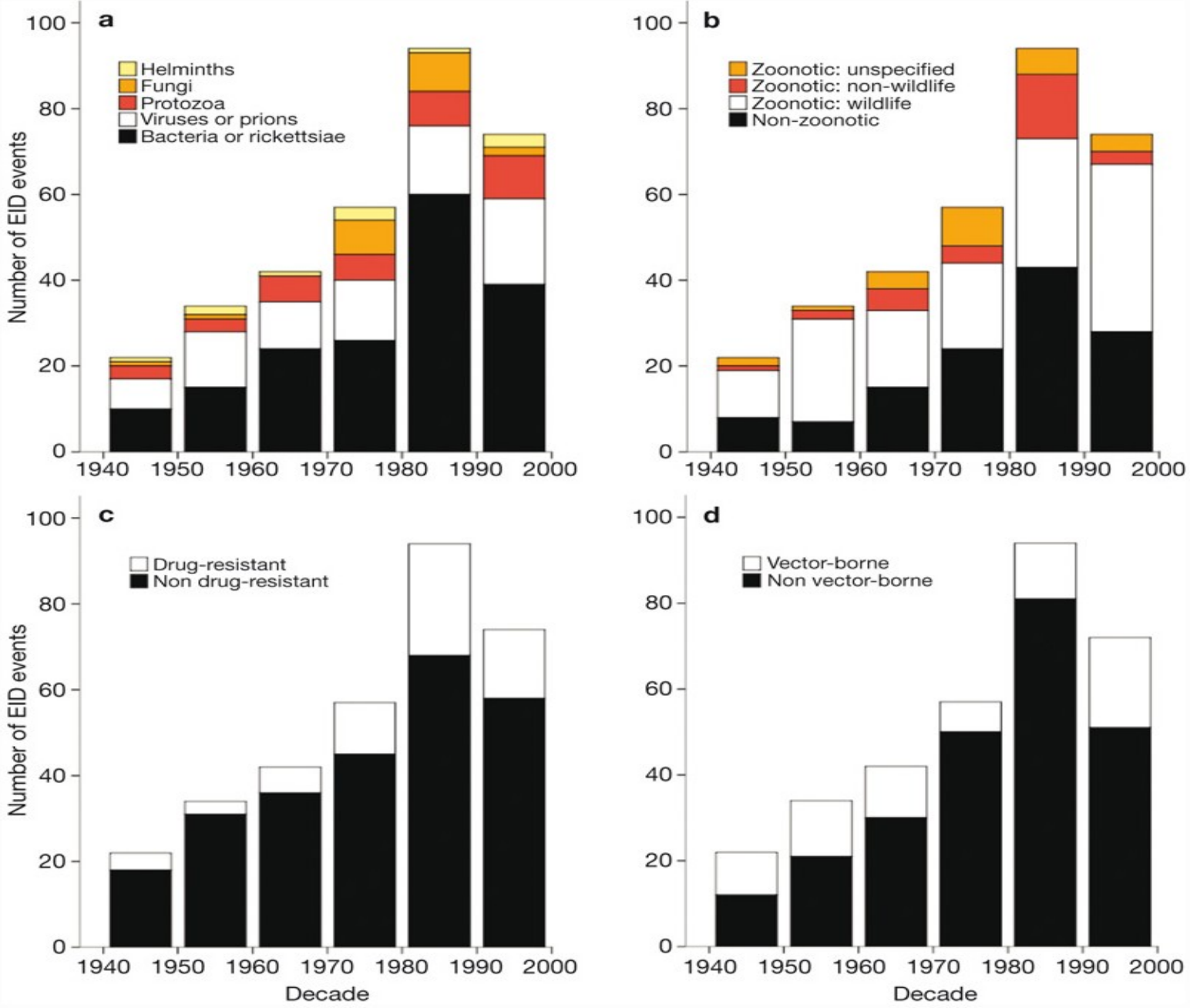
Link measles

EMERGING INFECTIOUS DISEASES (EID)

- Original case or cluster of cases representing an infectious disease emerging in human populations
- 335 between 1940 and 2004

LINK to article



EID events (defined as the temporal origin of an EID, represented by the original case or cluster of cases that represents a disease emerging in the human population—see Methods) are plotted with respect to **a**, pathogen type, **b**, transmission type, **c**, drug resistance and **d**, transmission mode (see keys for details).

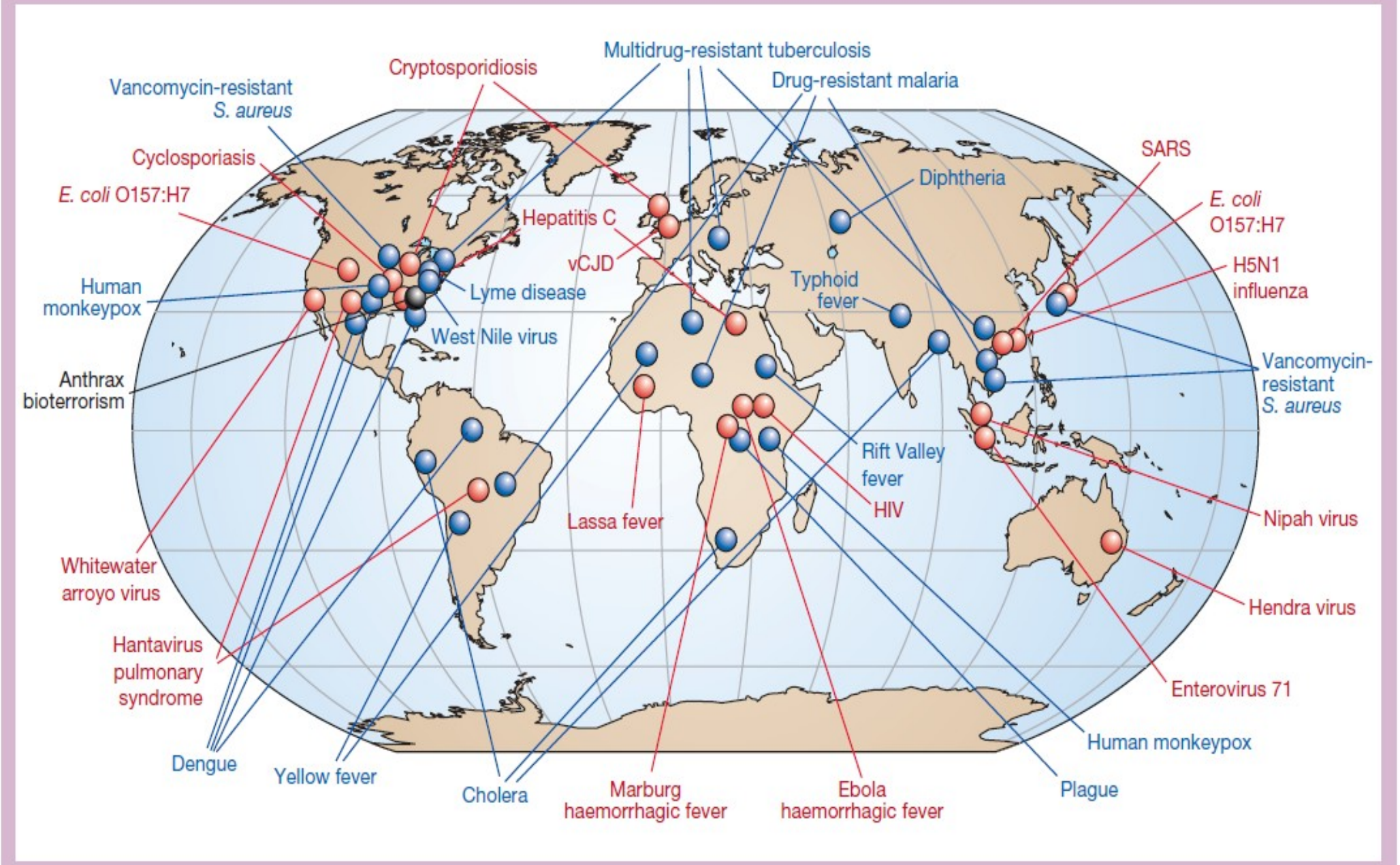
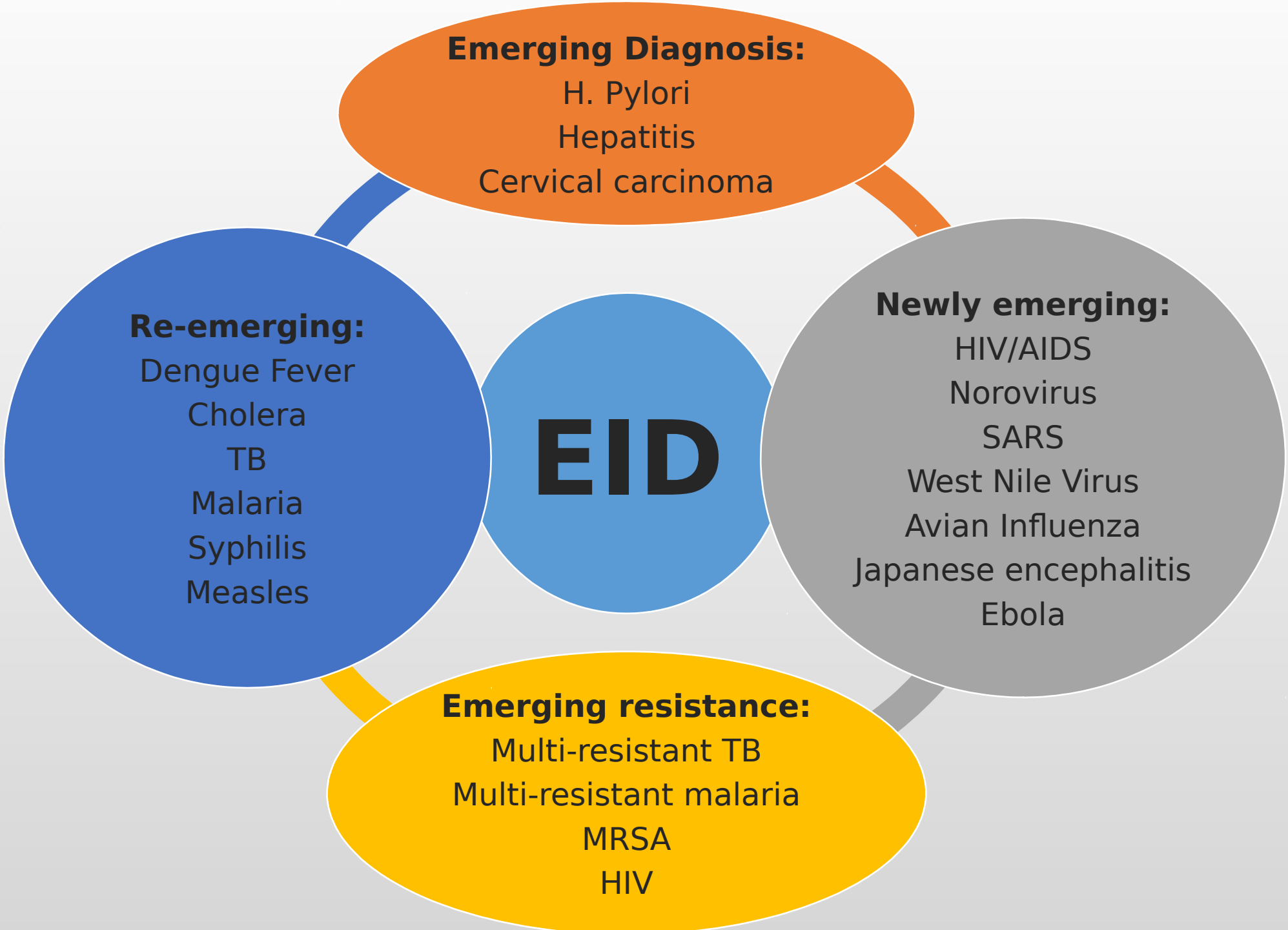


Figure 1 Global examples of emerging and re-emerging infectious diseases, some of which are discussed in the main text. Red represents newly emerging diseases; blue, re-emerging/resurging diseases; black, a 'deliberately emerging' disease. Adapted, with permission, from ref. 23.

Morens, Folkers, & Fauci (2004).

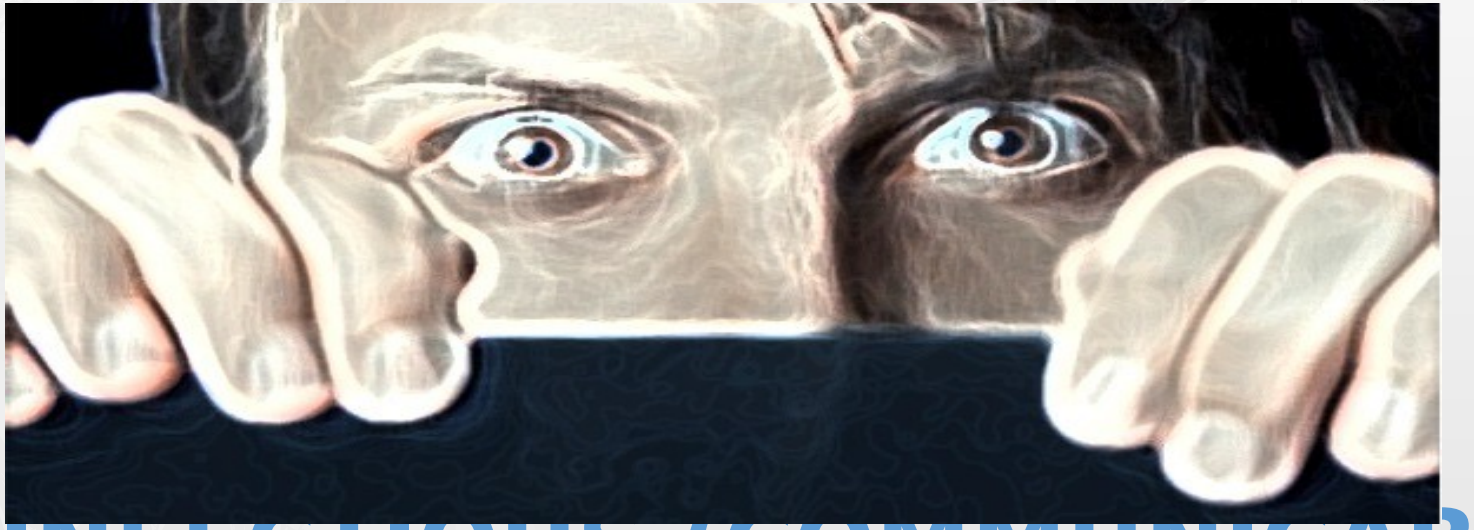


Adapted from Kramer, Kretzschmar, Krickeberg (2010). *Modern Infectious Disease Epidemiology…*

FACTORS LEADING TO EMERGENCE OF INFECTIOUS DISEASES

- Population growth
- Climate change
- Increased antibiotic use (in humans and animals)
- Encroachment of human populations in forest habitats
- War as social disruption
- Relocation of animals
- Changing social environments (e.g. daycare)
- Aging population
- Human-animal contact
- Intent to harm (bioterrorism)
- Microbial adaptation
- International travel
- Advancements in science

Image: http://gaia-health.com/wp-content/uploads/2015/02/Fearful-Man.jpg



INFECTIOUS (COMMUNICABLE) DISEASE:

Disease caused by a specific ***pathogenic agent*** *within a* ***susceptible host***

KEY TERMS:

EPIDEMIC (OUTBREAK) – the occurrence of disease in a community or region **clearly in excess of what is expected**

ENDEMIC – the constant presence of a disease or infectious agent within a given geographic areas or population group

- **Holoendemic** – infects everyone, but children most intensely affected; most adult immune (malaria)
- **Hyperendemic** – constantly present with high incidence and prevalence rates and affecting large proportion of all age groups (influenza)

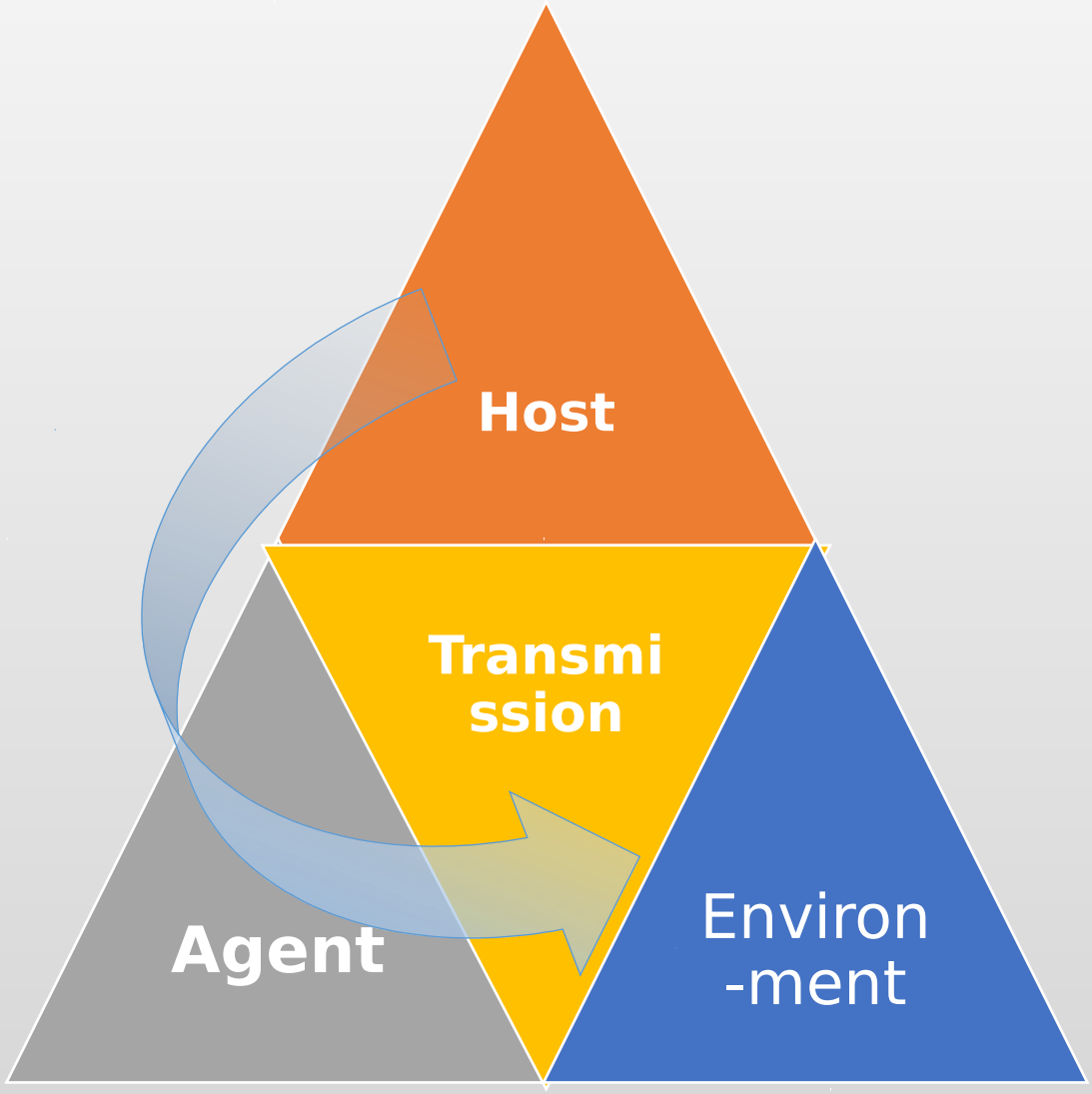
PANDEMIC – diseases affecting large numbers of people and crossing international boundaries

CLUSTER – aggregation of relatively uncommon disease in a space and/or time in amounts that are perceived to be greater than could be expected by chance (often environmentally driven)

NATURAL HISTORY OF DISEASE

Every disease follows a potentially predictable life cycle from onset to outcome. Understanding the natural history of disease allows for more effective prognosis, treatment, prevention, and control.

EPIDEMIOLOGIC TRIANGLE Link

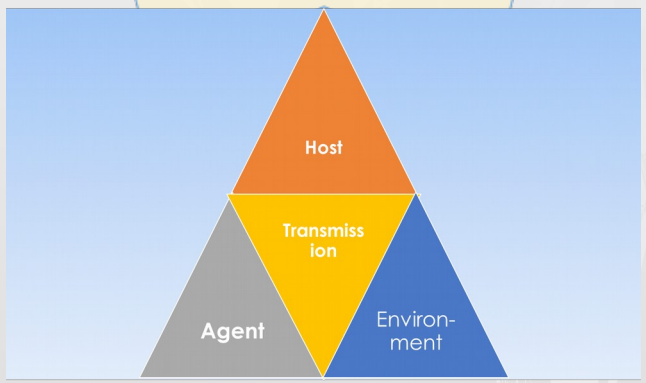


http://pathmicro.med.sc.edu/para-lab3/plasmodium_falcipurum_100X.htm

TYLENOL

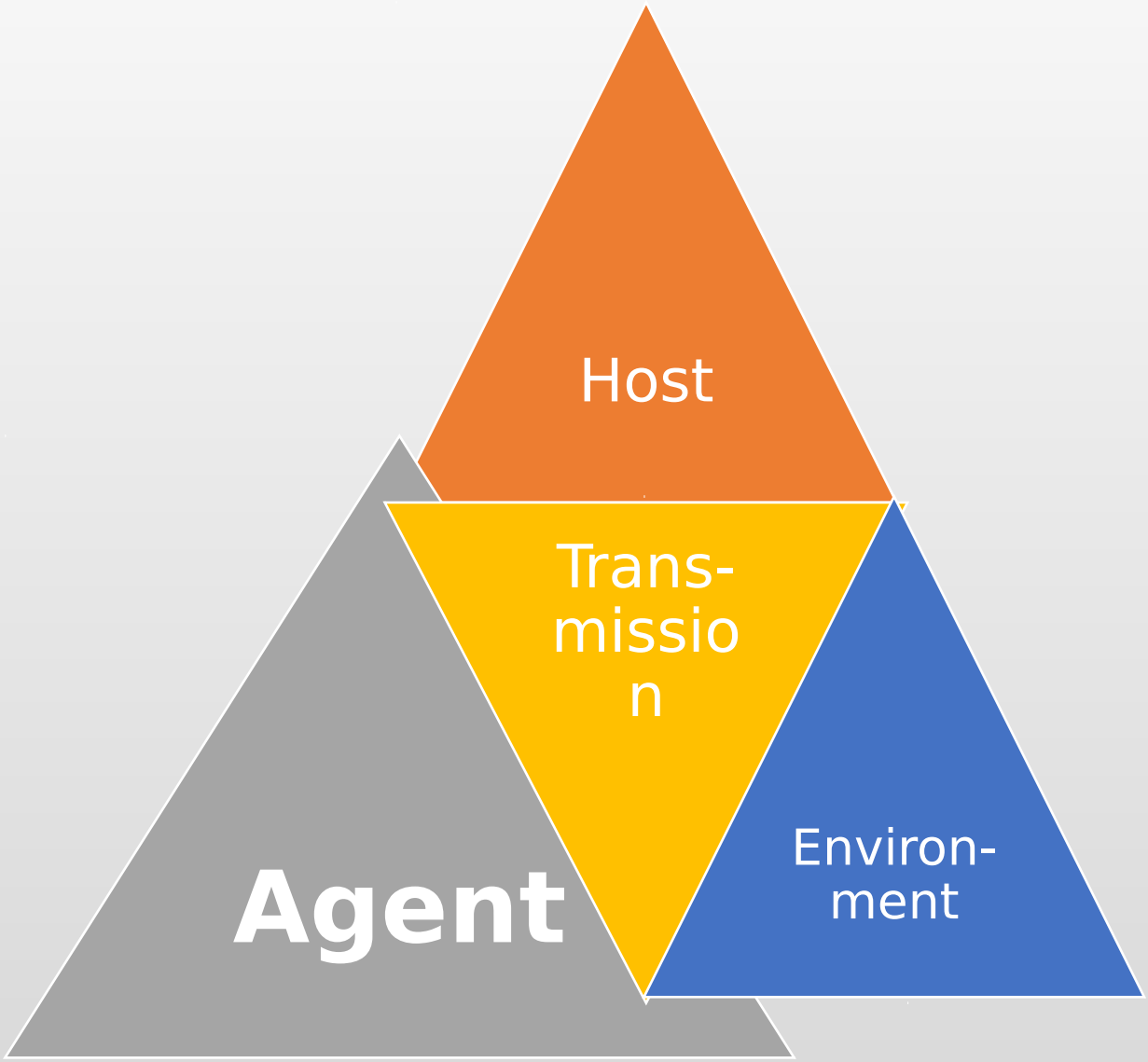
http://grannyherbs.com/?p=146

Goal is to intervene and disrupt/break connections within this triangle



"It is important to maximize our knowledge of the biology and pathogenesis of disease, but…the absence of this knowledge should not be a hindrance or an excuse for not implementing effective preventative services."

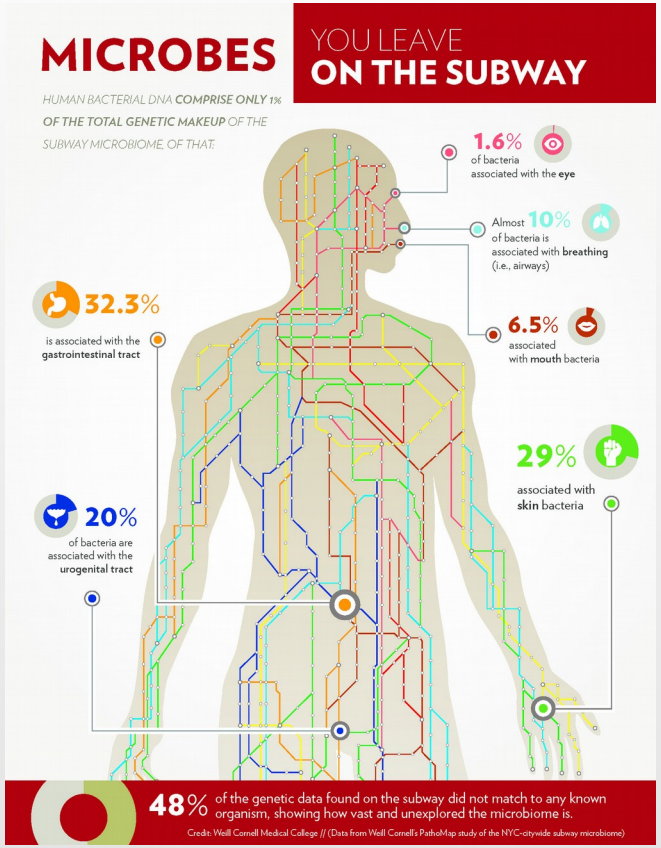
Gordis (2014, p. 15)


Host
Trans-
missio
n
Environ-
ment
Agent

AGENT:

Classified into groups: [monsters inside me]

1. Bacteria
2. Viruses
3. Fungi
4. Protozoa (including parasites)

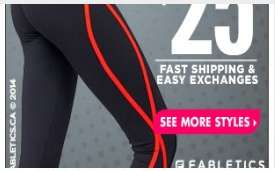


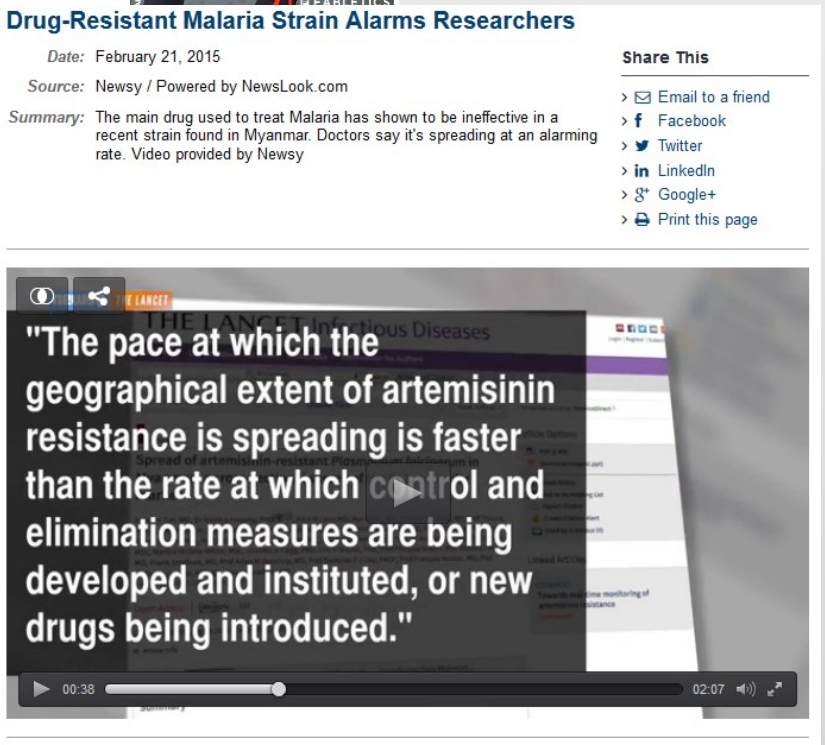
Agents exist everywhere…[Bubonic plague in the NYC Subway?!]

- **Antimicrobials** kill or inhibit growth of infectious agents and are grouped according to the microorganism they act against (e.g. antibiotics, antivirals, antifungals, antimalarials)

ANTIMICROBIAL RESISTANCE:

- Resistance of a microorganism to an antimicrobial drug that was once effective for treatment of infections





The fight against Multi-drug resistant Tuberculosis
LINK (WHO)
LINK (PHAC)

CHARACTERISTICS OF AGENTS:

INFECTIVITY – the ability of the agent to invade and multiply in the host (and thus result in infection)

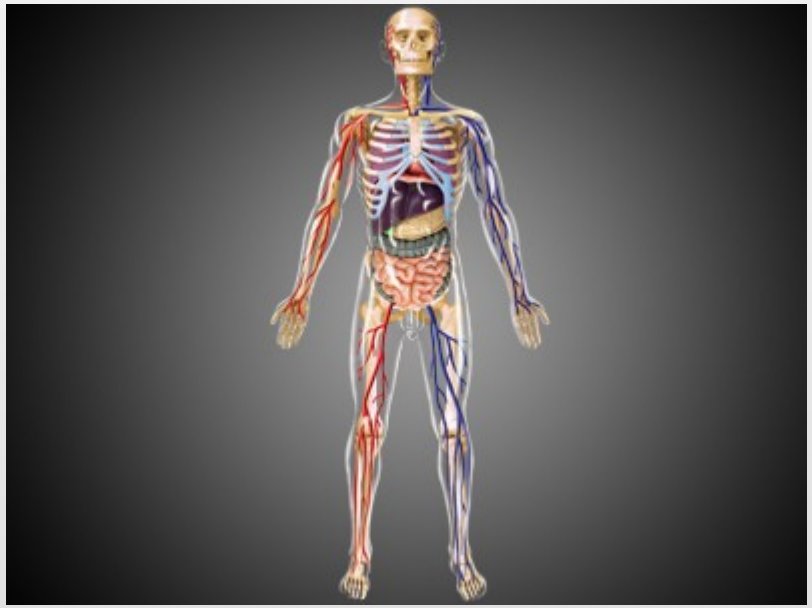
PATHOGENICITY – the power of the agent to produce overt illness in the host

VIRULENCE – the ability of the agent to produce serious illness or death

ANTIGENICITY – ability of the agent to induce antibody production in the host (stimulating and immune response)

AGENT PORTALS OF ENTRY

- Inhalation
- Ingestion
- Absorption
- Vertical transmission (parent to child)
- Sexual contact
- blood borne



**portals of exit are also important to recognize!*

INFESTATION VS. INFECTION

- Infestation is when the agent lives on the external surface of the host (e.g. scabies, lice) and an infection is when the agent enters into the host.

RESERVOIRS

Animate or inanimate sources which normally harbor infectious agents and serve as potential sources of disease outbreak

HUMAN – Sexually transmitted diseases, measles, mumps, *small pox

ANIMAL – anthrax (sheep), plague (rats), rabies (rabies)

ENVIRONMENTAL – soil (tetanus, fungus), water (legionnaires disease)

ATTACK RATE: TELLS US WHAT PROPORTION OF PEOPLE WHO WERE EXPOSED (I.E. AT RISK), BECAME ILL. OFTEN USED IN OUTBREAK MANAGEMENT RELATED TO FOOD-BORNE ILLNESS

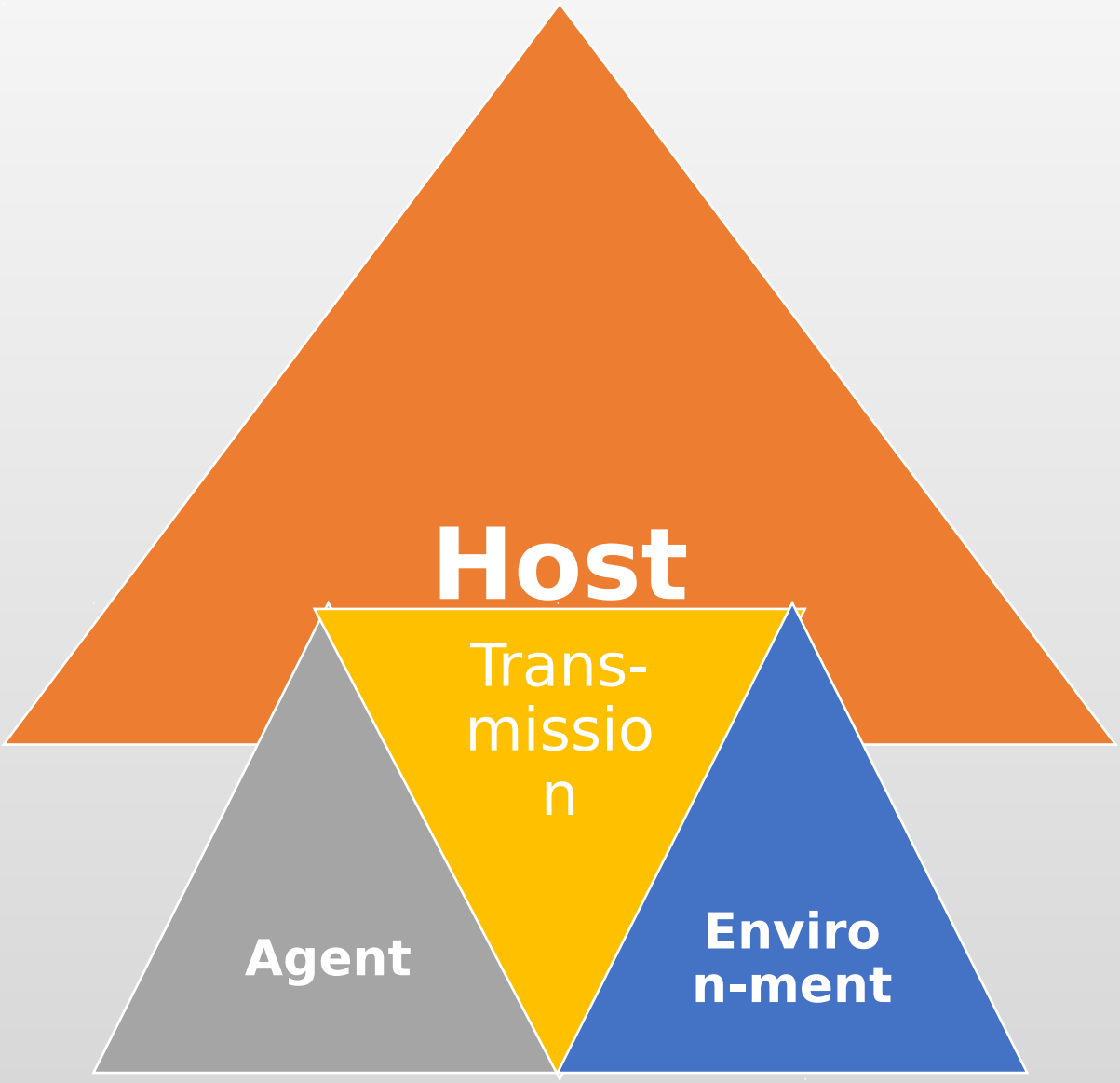
CAN ALSO HAVE **SECONDARY ATTACK RATE** – THOSE WHO BECAME ILL AS A RESULT OF BEING EXPOSED TO A PRIMARY CASE

$$\frac{\text{\# of people exposed (at risk) to agent who become ill}}{\text{\# of people who were exposed (at risk)}} \times 100$$

CASE FATALITY RATIO:

$$\frac{\text{\# deaths due to diagnosed case in a given period}}{\text{\# of diagnosed cases during the same period}} \times 100$$

*Typically used to measure **short-term mortality** from an **acute** disease


Host
Trans-
missio
n
Agent
Enviro
n-ment

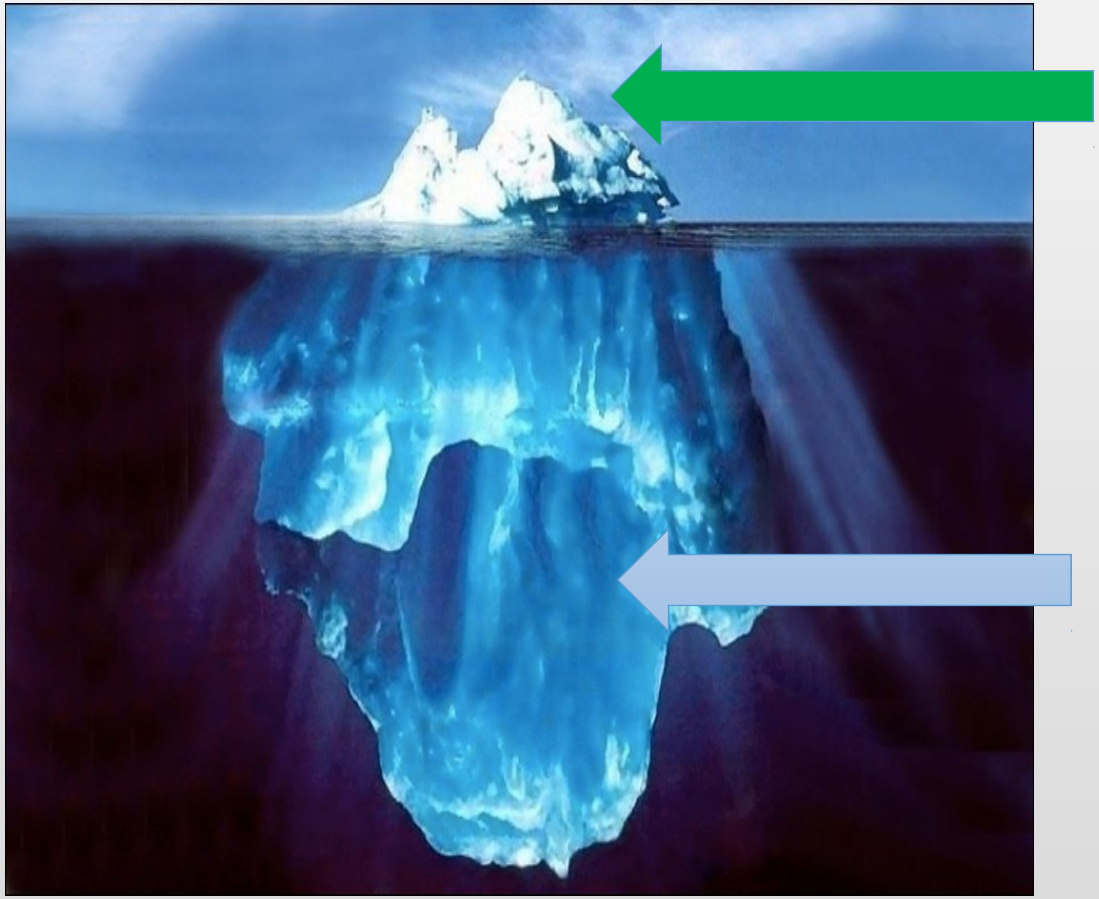
HOST SUSCEPTIBILITY

- The human to which an agent gains entry and multiplies, causing infection
- Host reaction to an infectious agent is variable – depending on agent characteristics, dose of exposure, and host immune response

INCUBATION PERIOD – time between initial infection and onset of *clinical disease*

LATENT INFECTIONS – agent has entered the host and may be transmitted (with or without clinical signs). Latency period may be longer than the incubation period (e.g. measles, flu) or shorter (e.g. SARS and EBOLA). Latent infections may or may not become clinical in the primary host.

CLINICAL AND SUBCLINICAL DISEASE



Clinical Disease – disease is apparent due to signs and symptoms

Subclinical Disease: - no clinical signs and/or symptoms

Host may harbour and agent, but not be infected or have clinical disease, but they are able to transmit disease to others (i.e.

HOST DEFENSE MECHANISMS:

Degree and severity of infection is dependant upon the **host's ability to divert agents from finding entrance** in the first place (skin, mucosal surfaces, flushing, sweat, and avoidance!) and the **ability of the host to respond to an infectious agent's entrance by fighting it** (immune response)

VACCINATIONS FOR DISEASE CONTROL

- First vaccine developed was for smallpox
- “vacca” – meaning cow
- Edward Jenner (1796)
- Based primarily on observational data and not on any real solid understanding of biology or the concepts of infectious disease

HOST IMMUNITY

Developed through the presence of disease specific antibodies which are developed to neutralize or destroy agents.

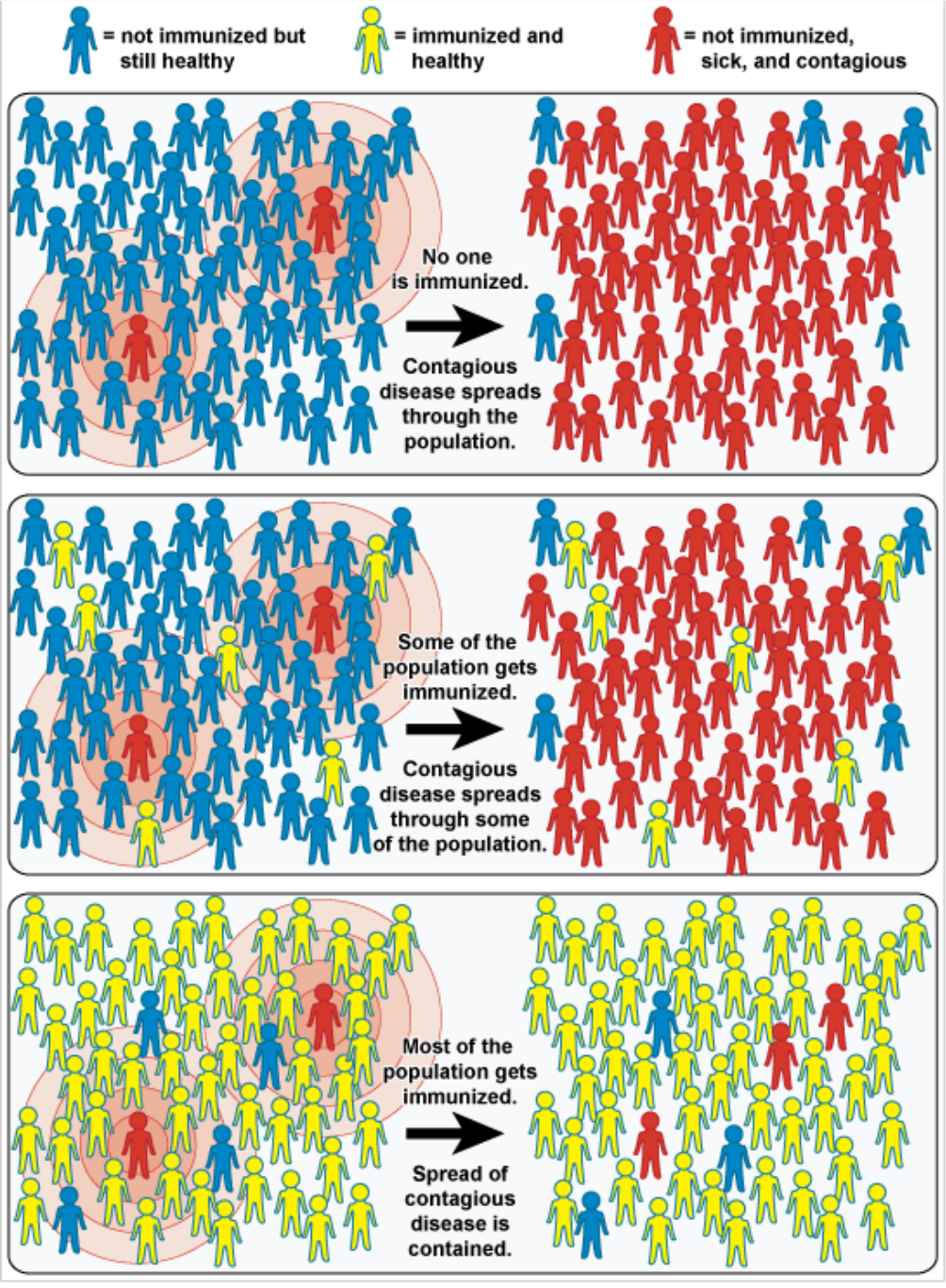
ACITVE IMMUNITY – occurs when disease triggers the immune system to produce antibodies either naturally (infection with disease) or vaccine-induced immunity (introduction of disease in killed or weakened form). Protection is delayed, but lasts potentially a life-time.

PASSIVE IMMUNITY – host acquires disease-specific antibodies naturally (e.g. mother to baby transfer) or artificially with direct administration of immune globulins (e.g. rabies). Protection is immediate, but short lived.

HERD IMMUNITY: LINK TO VIDEO 1

LINK TO VIDEO 2

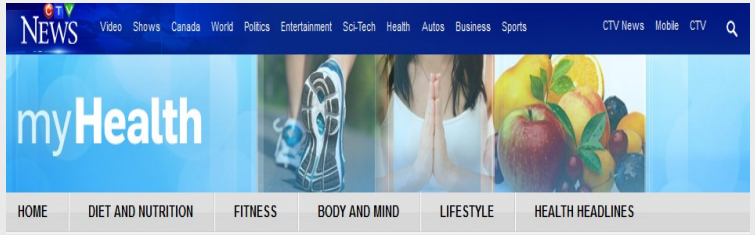
Protectionfor all, based on immunity of many


= not immunized but still healthy
= immunized and healthy
= not immunized, sick, and contagious
No one is immunized.
Contagious disease spreads through the population.
Some of the population gets immunized.
Contagious disease spreads through some of the population.
Most of the population gets immunized.
Spread of contagious disease is contained.

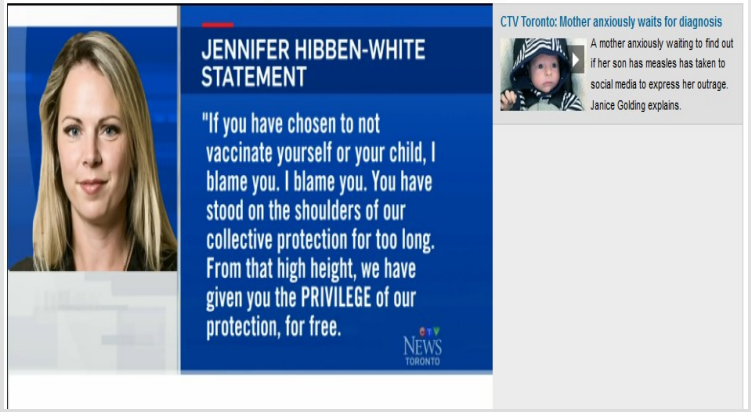
LINK

WHY VACCINATE?

YOU DECIDE, BUT KNOW THE SCIENCE…



Canadian mother's powerful post on measles: 'I blame you'



LINK to article/video

Table 1 Incidence of selected vaccine-preventable disease in Canada, pre-vaccine era compared with 2007 to 2011[1, 22-28, 30, 31]

Disease	Pre-vaccine era* Peak annual number of cases	2007–2011 Peak annual number of cases
Congenital rubella syndrome (CRS)	29 (1979–1983)	0
Diphtheria	9,010 (1925–1929)	4
Haemophilus influenzae type b (Hib) (children <5 years)	526 (1986–1990)	12
Measles	61,370 (1950–1954)	750
Mumps	43,671 (1950–1954)	1,110
Pertussis (whooping cough)	19,878 (1938–1942)	1,967
Poliomyelitis	1,584 (1950–1954)	0
Rubella	37,917 (1950–1954)	12
Tetanus	19 (1957–1961)	6

* Five years preceding vaccine introduction.

However, as the incidence of a vaccine-preventable disease decreases following successful immunization programs, there is a potential for Canadians to become complacent and question the role of vaccines in preventive healthcare. This could lead to lower immunization coverage and resurgence of the disease.[1, 7, 10, 32-34] The viruses and bacteria that cause such diseases are still common and circulate within Canada and around the world, meaning that people who are not protected by immunization can become infected with the disease.[7, 35]

WHERE ARE VACCINE DECISION MAKERS GETTING THEIR INFORMATION?

ARTICLE

The Impact of Social Networks on Parents' Vaccination Decisions

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KEY WORDS
immunizations, decision-making, social network analysis

ABBREVIATIONS
AIC—Akaike Information Criterion
CI—confidence interval
OR—odds ratio

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COMPANION PAPER: A companion to this article can be found on page e1619, and online at www.pediatrics.org/cgi/doi/10.1542/peds.2013-0531.

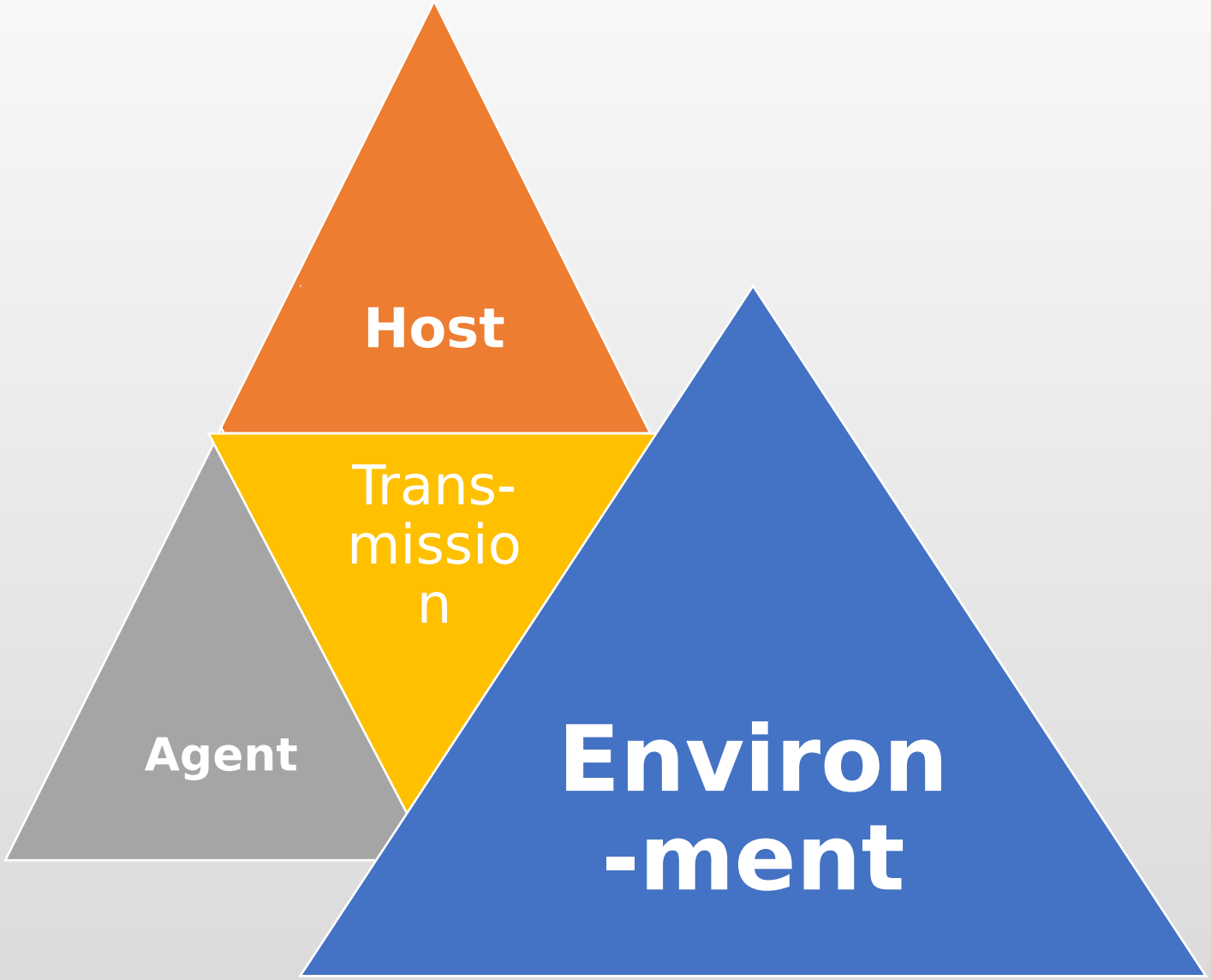
WHAT'S KNOWN ON THIS SUBJECT: Previous studies have suggested that health care providers, family members, friends, and others play a role in shaping parents' vaccination decisions. Other research has suggested that the media can influence whether parents decide to vaccinate their children.

WHAT THIS STUDY ADDS: Through the application of social network analysis, this study formally examines and quantifies how parents are influenced by the people and sources around them. Its findings suggest that social networks are important, particularly for parents who do not completely vaccinate.

abstract

BACKGROUND AND OBJECTIVE: Parents decide whether their children are vaccinated, but they rarely reach these decisions on their own. Instead parents are influenced by their social networks, broadly de-

CONCLUSIONS: These results strongly suggest that social networks, and particularly parents' people networks, play an important role in parents' vaccination decision-making.


Host
Trans-
missio
n
Agent
Environ
-ment

ENVIRONMENTAL DETERMINANTS: AFFECT THE AGENT'S ABILITY TO SURVIVE & THRIVE , AND THE HOST'S POTENTIAL EXPOSURE & SUSCEPTIBILITY TO THE AGENT

Physical environment – climate change, changes to land, human interaction with agent reservoirs, environments not conducive to protection, creation of breeding sites

Social environment – burial practices, overcrowding, contact behaviours, travel, urbanization,

Political environment – war, globalization, migration, economics, tourism, support/implementation of programs

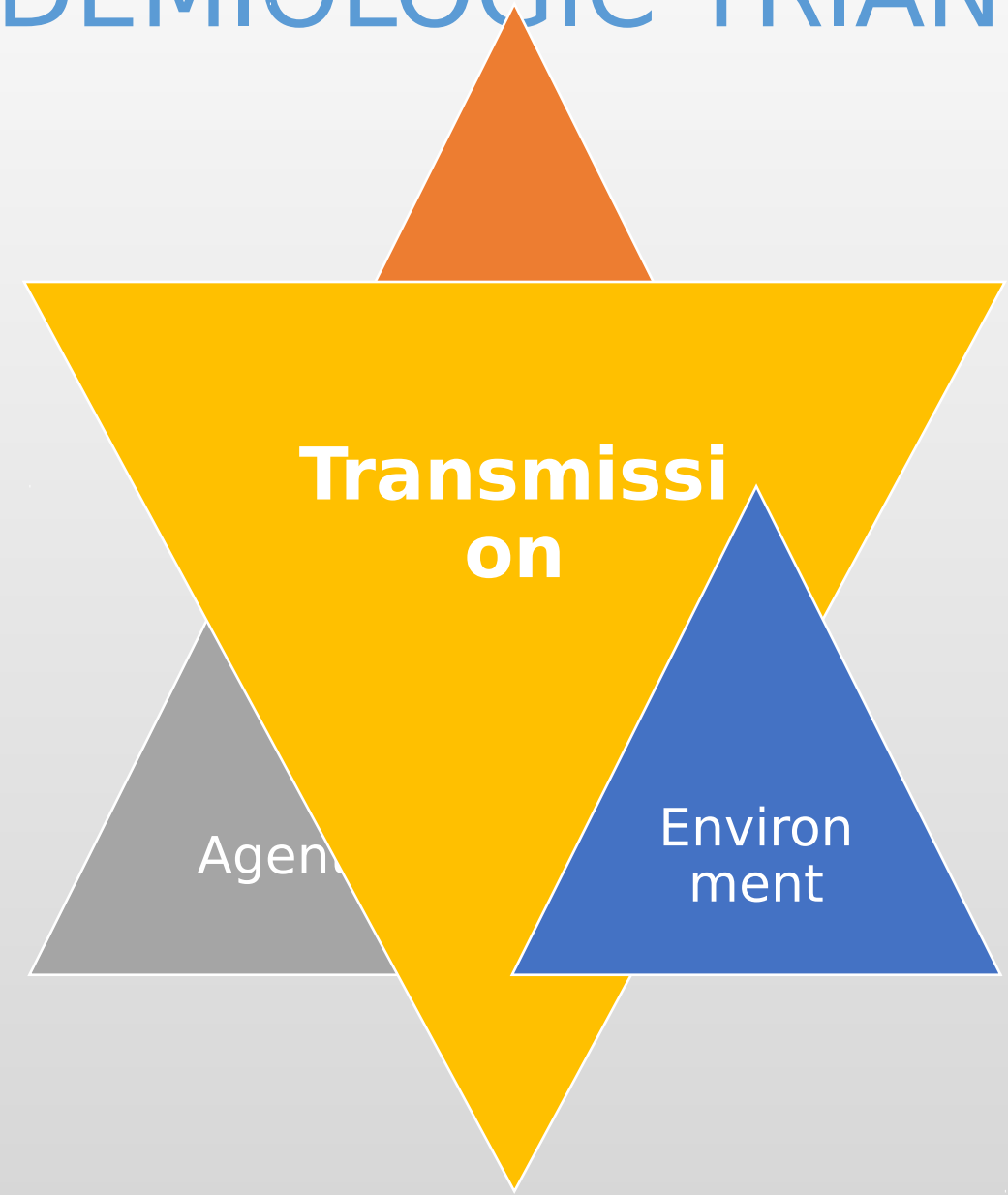
Often environments are influenced by humans, making them more favourable. (humans may also deliberately make environments less conductive to agent's survival or

MALARIA AND THE ENVIRONMENT?

- Stagnant water
- Farming practices
- Control measures
- Travel practices
- Urbanization
- Level of education
- Familial practices
- Building structure
- Rainfall and humidity
- Political will

<u>LINK</u>
Mosquito control in Lethbridge?

EPIDEMIOLOGIC TRIANGLE



Link

CONTACT TRANSMISSION

- **DIRECT** - Person to person through direct physical contact between infected person and susceptible host (e.g. kissing, touching, sexual contact)

- **INDIRECT** – agent deposited on a fomite and survives long enough to transfer to susceptible host

fomite is an inanimate object that can be a vehicle for transmission

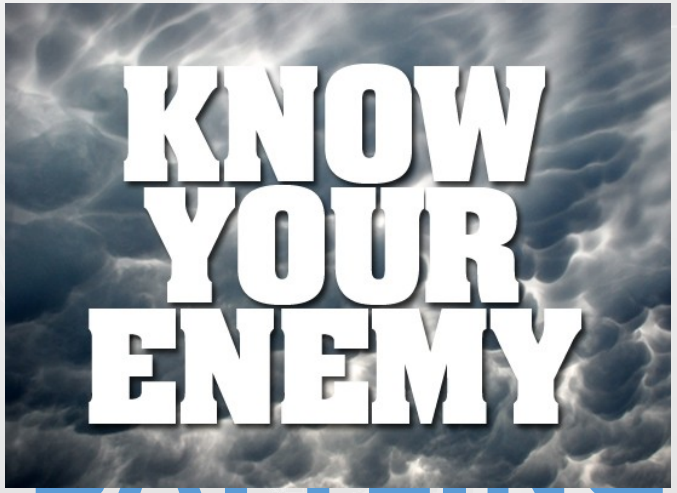
- **DROPLET** – via coughing or sneezing from infected person to susceptible host

NON-CONTACT TRANSMISSION
(A FORM OF INDIRECT TRANSMISSION)

AIRBORNE – transmission via aerosols which enter through the respiratory tract. Can be present in the air, ventilation systems, abattoirs and remain there for a long time

VEHICLE – a contaminated source which can act as a point source for agent transmission (e.g. food, water, soil)

VECTOR – transmission of agent from a living organism to another (e.g. mosquitos, ticks, lice, other mammals)



INFECTIOUS DISEASE:

“Man’s struggle against emerging infections has been a fundamental determinant of the existence and evolution of the human species.”

-Morens et al. (2008)

PUTTING UP A FIGHT

CONTROL – goal is to reduce infection incidence, prevalence, morbidity, and mortality to an acceptable level (e.g. diarrhoeal disease) so that it is no longer considered a population health concern

ELIMINTATION – reduction of incidence to zero from specific geographic areas (e.g. polio)

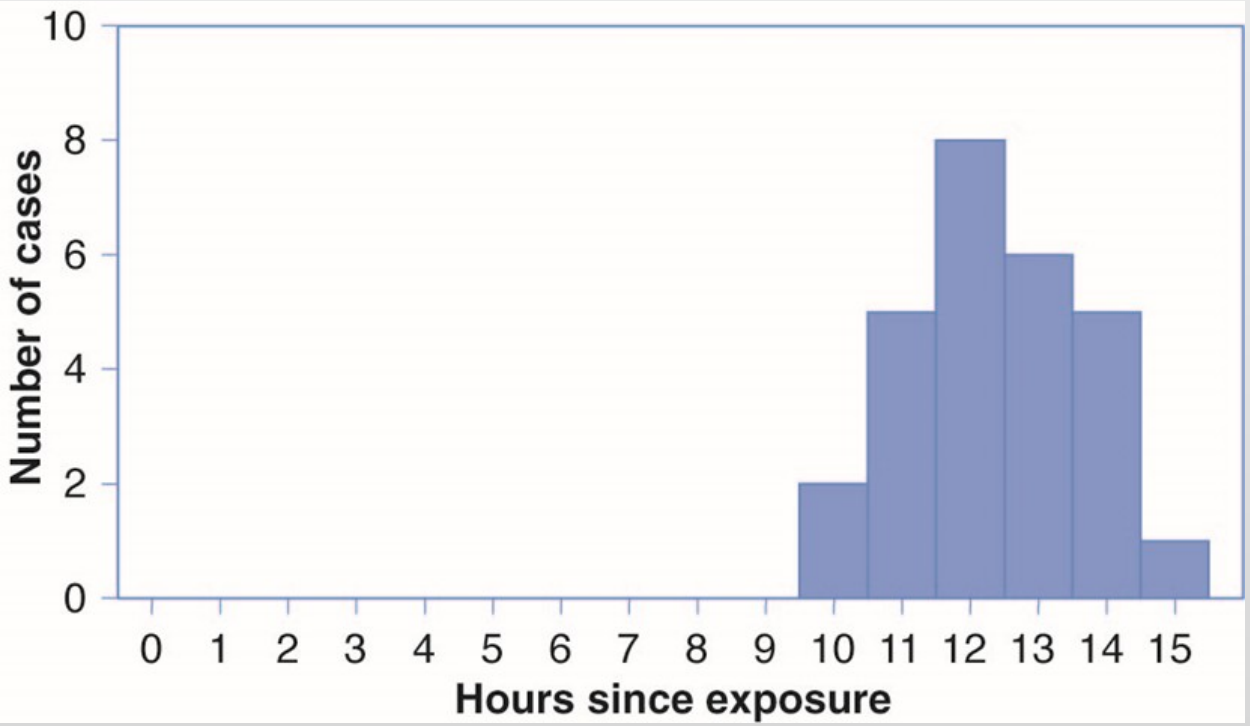
ERRADICATION – reduction of worldwide incidence of disease to zero (e.g. small pox)

EXTINCTION - infectious agent no longer exists naturally or in the laboratory (none known)

POINT SOURCE EPIDEMICS

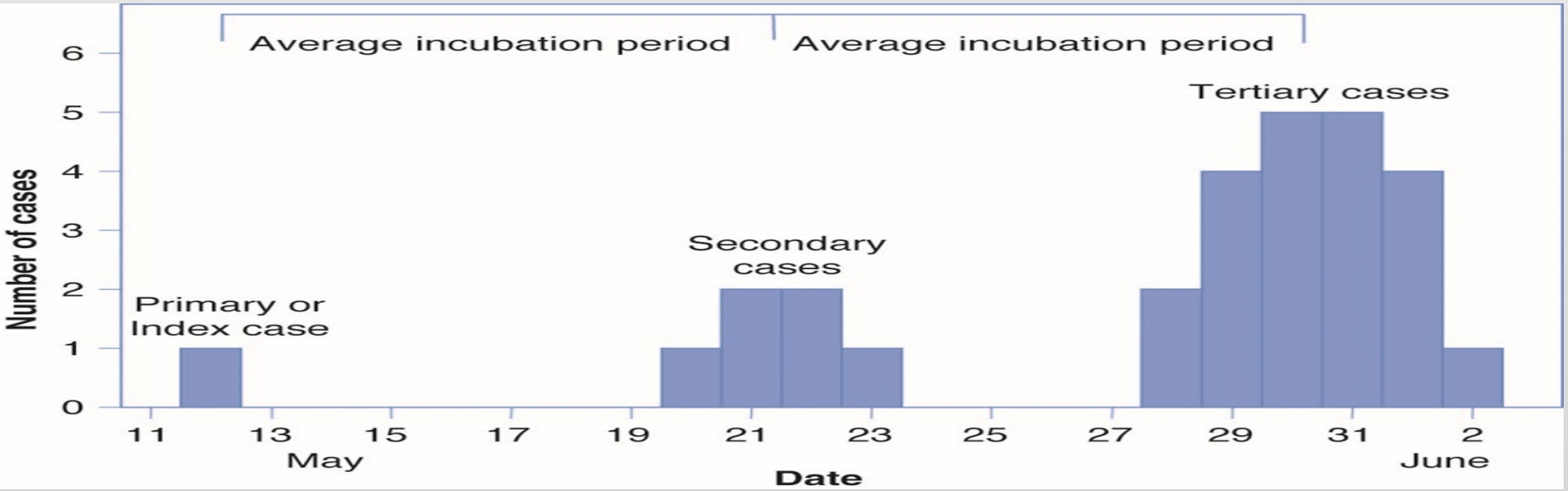
- A sudden exposure to the same infectious agent from a common point or a common vehicle
- Can plot this on an **epidemic curve**

Cases (defined by onset of Symptoms) are plotted against time since exposure… This tells us about the average incubation period



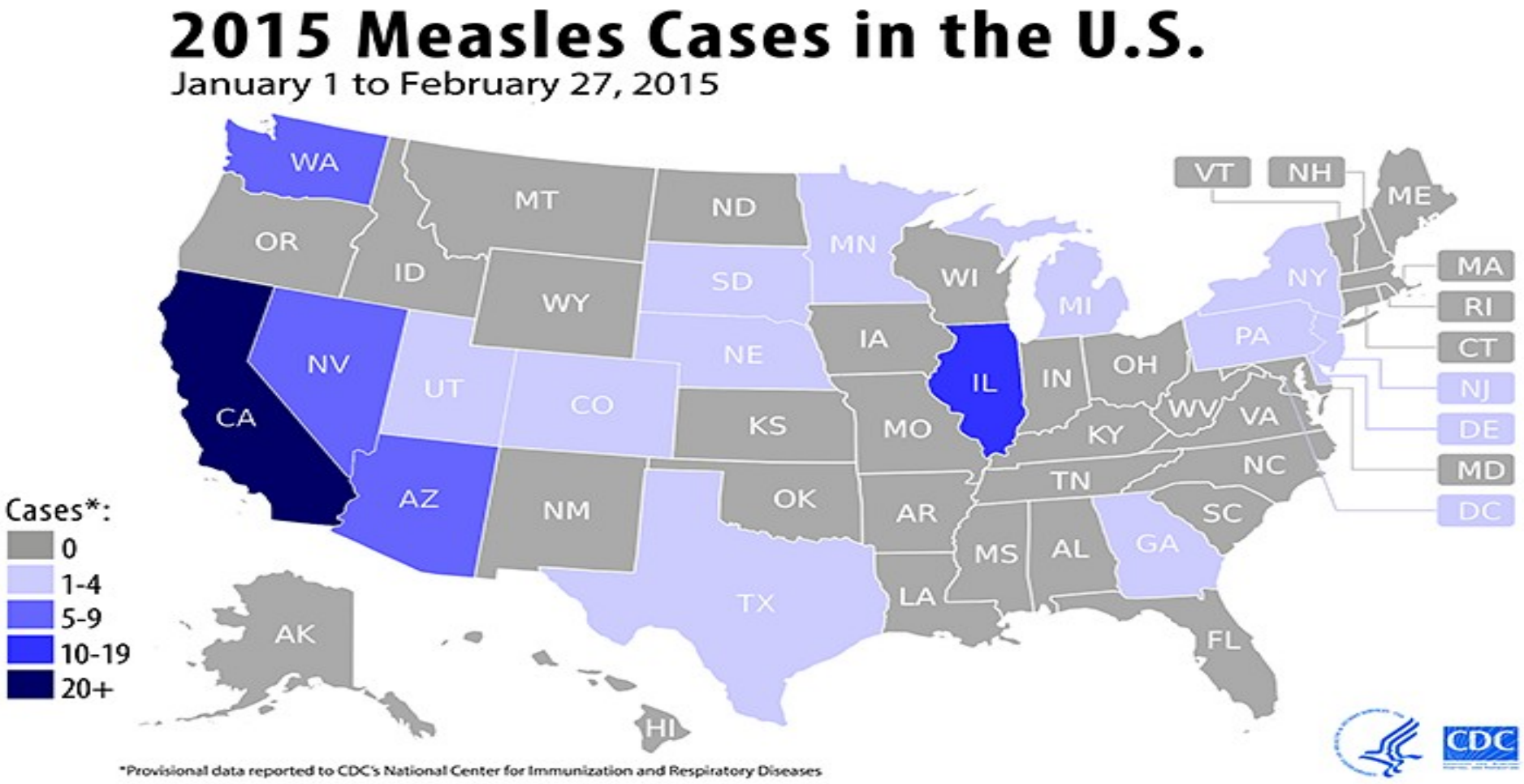
PROPAGATIVE (PROGRESSIVE) EPIDEMICS

- Introduction of agent to a susceptible population with subsequent transmission from person to person and increasing incidence.
- First cases is the INDEX (PRIMARY) case, then there are secondary and then third, forth, etc. generation cases



Measles Cases

From January 1 to February 27, 2015, 170 people from 17 states and the District of Columbia were reported to have measles [AZ (7), CA (113), CO (1), DC (2), DE (1), GA (1), IL (15), MI (1), MN (1), NE (2), NJ (2), NY (3), NV (8), PA (1), SD (2) TX (1), UT (2), WA (7)]†. Most of these cases [125 cases (74%)] are part of a large, ongoing multi-state outbreak linked to an amusement park in California.



Point source or propagative epidemic?

Reason for the outbreak?

† CDC will update these data weekly on Mondays.

The United States experienced a record number of measles cases during 2014, with 644 cases from 27 states reported to CDC's National Center for Immunization and Respiratory Diseases (NCIRD). This is the greatest number of cases since measles elimination was documented in the U.S. in 2000.

BASIC REPRODUCTION NUMBER(R_O):

The average # of secondary cases of disease that are generated by a typical primary case in a **susceptible population.**

- ***R_o = 1*** *= each primary case replaces itself and the disease will be endemic*
- ***R_o > 1*** *= each primary case produces more than one secondary case and cause an epidemic*
- ***R_o < 1*** *= each case does not produce enough cases to replace itself and disease will be elimination of disease*

QUARANTINE & ISOLATION MEASURES

Quarantine separates or restricts movement of people who were exposed (at risk) to an infectious agent to see if they become sick.

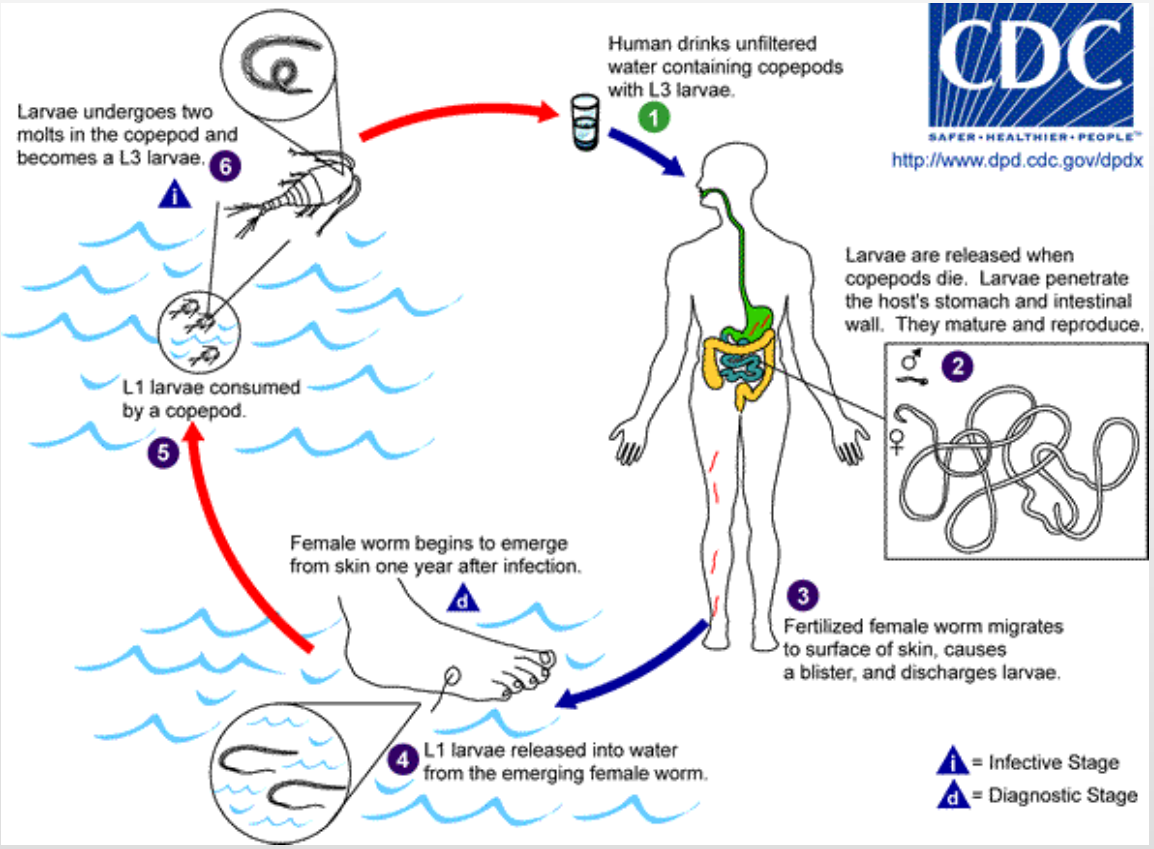
Isolation separates people infected from those who are not si

ERADICATED: SMALL POX

- Small pox emerged ~10,000 BC. Evidence of small pox on Egyptian mummies.
- Case-fatality ratio: 20-60%. Responsible for 300-500 million deaths in the 20th century *INOCULATION EFFORTS
  - Strong vaccination uptake after invention.
  - 1979 - WHO certified the eradication of smallpox. But still exists in various labs
  - Considered bioterrorist weapon as mass vaccinations ended in the 1970s.

LINK to Smallpox Timeline

2ND INFECTIOUS DISEASE TO BE ERADICATED? PROGRESS BEING MADE: GUINEA WORM DISEASE



- Roundworm ingested in water.
- One year later – Female worm burrows to skin surface.
- Creates burning sensation

Wait for human host to go into water – live oral birth of worms from her mouth (up to 3 million) back into water.

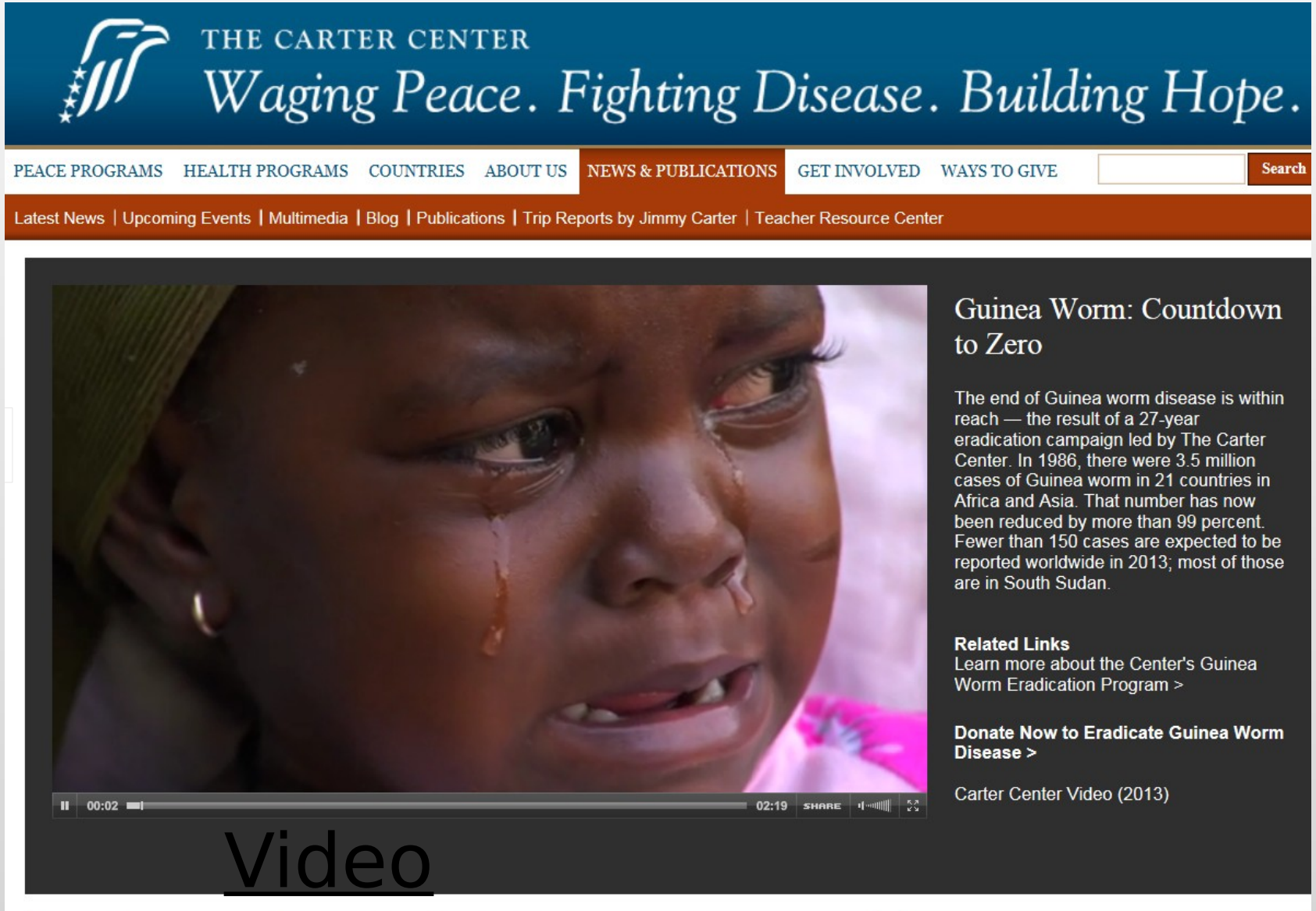
Link to Centres for Disease Control

FINALLY, A GOOD NEWS STORY…

LINK to National Geographic article

LINK to CDC

LINK to Carter Center



Video

CRITERIA FOR ERADICATION

- It is biologically and technically possible to eradicate the disease
- The benefits of eradication outweigh the cost of eradication efforts
- Social and political acceptance and support

CONDITIONS FOR OCCURRENCE OF EPIDEMICS

- Emerging (re-emerging) infectious agent
- Increasing susceptibility of the host
- Altered environments, enabling agent transmission
- Introduction of new route of transmission
- Failure of control methods (e.g.

EPIDEMIC (OUTBREAK) MANAGEMENT:

1. **Confirm that an epidemic exists** *(is it clearly "in excess of what normally exists in this population in this time"?)*
2. **Establish a case definition and count cases as they occur** *(what is the criteria for being a case - this may change)*
3. **Assess the extent of the outbreak and the features of the suspected disease** *(may need to find those who are mildly or moderately ill and not presenting in the hospital. Consider survey to locate potential cases)*

OUTBREAK MANAGEMENT CON'T:

What will you communicate with the public?

4. **Define the population at risk** *(determine who may be at risk due to exposure - these become the denominator in your attack rate)*

5. **Formulate a working hypotheses and test – what is the source or nature of the epidemic?** *(document cases, create spot maps, look for clusters, draw an epidemic curve, note anomalies). Try to isolate the source and agent.*

6. **Plan for long-term prevention and control** *(determine ways to prevent future outbreaks. Immunization?)*