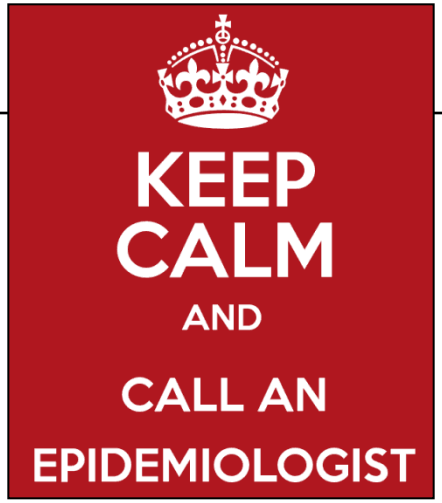
EPI(DEMIOLOGY)

SAVES THE DAY!



Dr. Meredith Faires BSc(Agr), DVM, MSc, PhD

Presentation Outline

FUN ANIMAL FACTS!

- What is epidemiology (Epi)?
- Examples of Traditional Epi
- Examples of Epi in the field
- Epi Expanded
- Questions

Epidemiology is NOT

- The study of insects (entomology)
- The study of skin diseases (dermatology)
- Diagnosis and treatment of foot disorders (podiatry)
- Anatomy, functions, and diseases of the eye (ophthalmology)
- Proctology

Epidemiology – What is it?

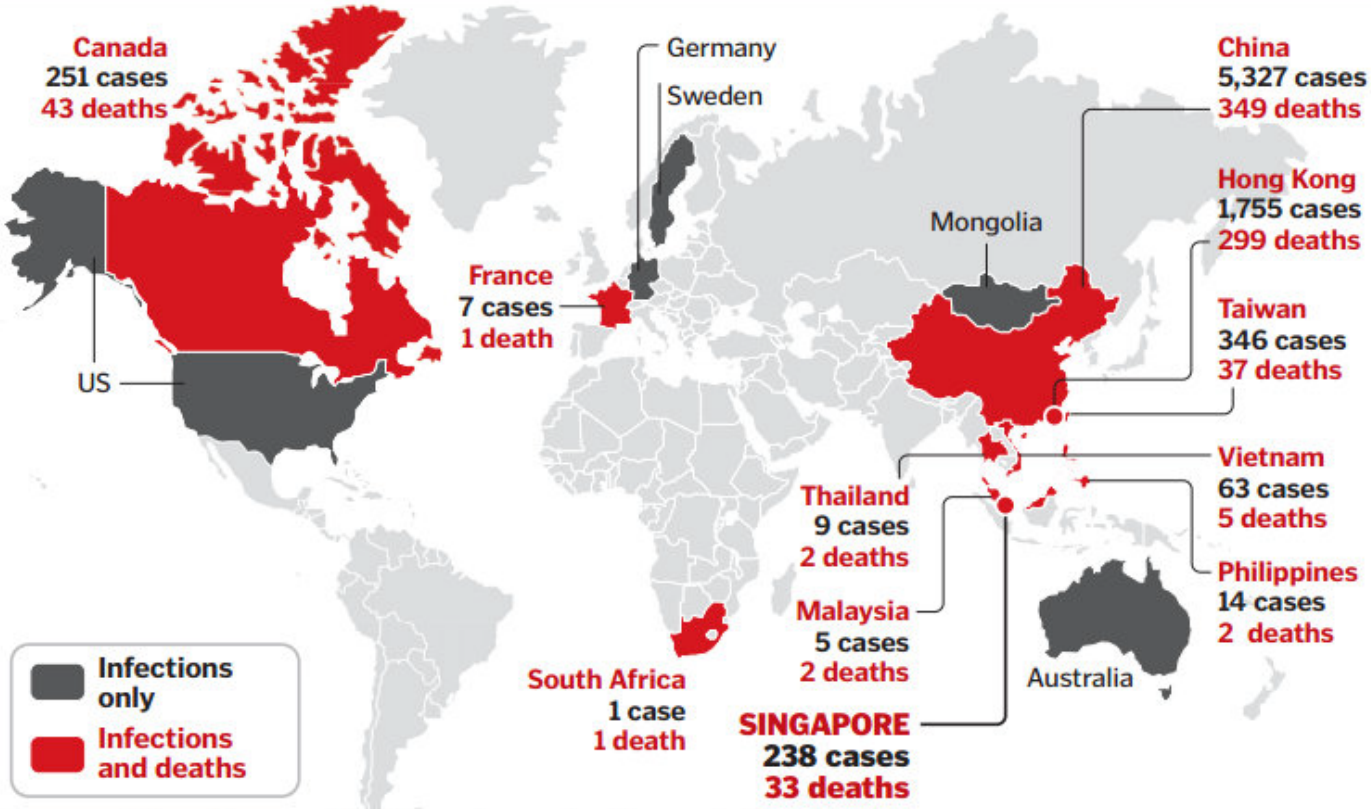
- The study of the frequency, distribution, and determinants of health and disease within populations…

  and

- …the application of this study to the control of health problems
- CDC: Disease Detectives

SARS 2003: DEADLY VIRUS

774 deaths and 8,096 infections reported from November 2002 to July 2003



Some of the changes that have been implemented post-Sars

CANADA

- Public health reform, including the creation of a federal-level health agency
- Three national disease-related surveillance networks to monitor emerging infectious diseases

CHINA

- Robust online reporting system that allows hospitals to report suspected disease cases directly to the authorities
- Laws amended or added to allow central leaders to act swiftly to deal with outbreaks

HONG KONG

- Face masks commonly used and public toilets dilligently cleaned
- Heavy investments to redesign hospital wards to minimise infection.

SINGAPORE

- New infectious disease hospital by mid-2018
- Every new school-going child gets an oral digital thermometer

TAIWAN

- Better personal hygiene encouraged, staying home when ill, courtesy bowing in place of handshakes
- Constant cleaning and sterilisation of public transport during pandemics

Source: WHO

Outbreak of HIV Infection Linked to Nosocomial Transmission, China, 2016–2017

Xiaohong Pan,[1] Jianmin Jiang,[1] Qiaoqin Ma, Jiafeng Zhang, Jiezhe Yang, Wanjun Chen, Xiaobei Ding, Qin Fan, Zhihong Guo, Yan Xia, Shichang Xia,[2] Zunyou Wu[2]

On January 25, 2017, a physician from ZC Hospital in Hangzhou, China, reported to the Zhejiang Provincial Center for Disease Control and Prevention that a potential HIV outbreak might have occurred during lymphocyte immunotherapy (LIT) performed at the hospital on December 30, 2016. We immediately began investigating and identified the index case-patient as an LIT patient's husband who donated lymphocytes for his wife's LIT and later screened HIV-reactive. Subsequent contamination by a technician resulted in the potential exposure of 34 LIT patients. Acute HIV infection was diagnosed in 5 persons. Phylogenetic analysis confirmed that the HIV-1 *gag*, *pol*, and *env* gene sequences from the index and outbreak-related cases had ≥99.5% similarity. Rapid investigation and implementation of effective control measures successfully controlled the outbreak. This incident provides evidence of a lapse in infection control causing HIV transmission, highlighting the need for stronger measures to protect patients from infectious disease exposure.

Lymphocyte immunotherapy (LIT) to treat recurrent miscarriage involves receipt of lymphocytes to a patient from a donor, usually the patient's male partner. Although the European Society of Human Reproduction and Embryology (*1*), the Royal College of Obstetricians (*2*), and the American College of Obstetricians and Gynecologists (*3*) have issued clear guidance against LIT, supported by a 2014 Cochrane review (*4*), more recent meta-analyses support its use (*5*,*6*), as do 4 newer intervention control studies conducted in China (*7*–*10*). Although the number of LIT recipients in China is estimated to be large, no statistics are available. Within China's healthcare system, LIT is a category III medical service, meaning that each hospital regulates itself (*11*).

On January 24, 2017, a woman receiving LIT at ZC Hospital in Hangzhou, China, called a hospital staff member, Dr. X, asking if she had risk for HIV infection. She explained that her husband had just received a confirmed diagnosis of HIV infection and that on December 30, 2016, she had received LIT using lymphocytes her husband donated. Dr. X immediately reported this information to the hospital's deputy director, who informed the clinical medical laboratory director, Dr. Y. At ≈4:00 PM the same day, Dr. Y informed the responsible laboratory technician, Dr. Z, and requested that she stop LIT. One hour later, Dr. Z voluntarily reported to Dr. Y that she had deviated from protocol on December 30 and that other patients who received LIT on the same day might have been exposed. At 5:30 PM, the director of ZC Hospital called an emergency meeting with department directors, who decided to request help from the Zhejiang Provincial Center for Disease Control and Prevention (Zhejiang CDC). On January 25, 2017, Zhejiang CDC epidemiologists began investigating a possible HIV outbreak among LIT recipients at ZC Hospital. We report on the investigation conducted, control measures implemented, and outcomes observed.

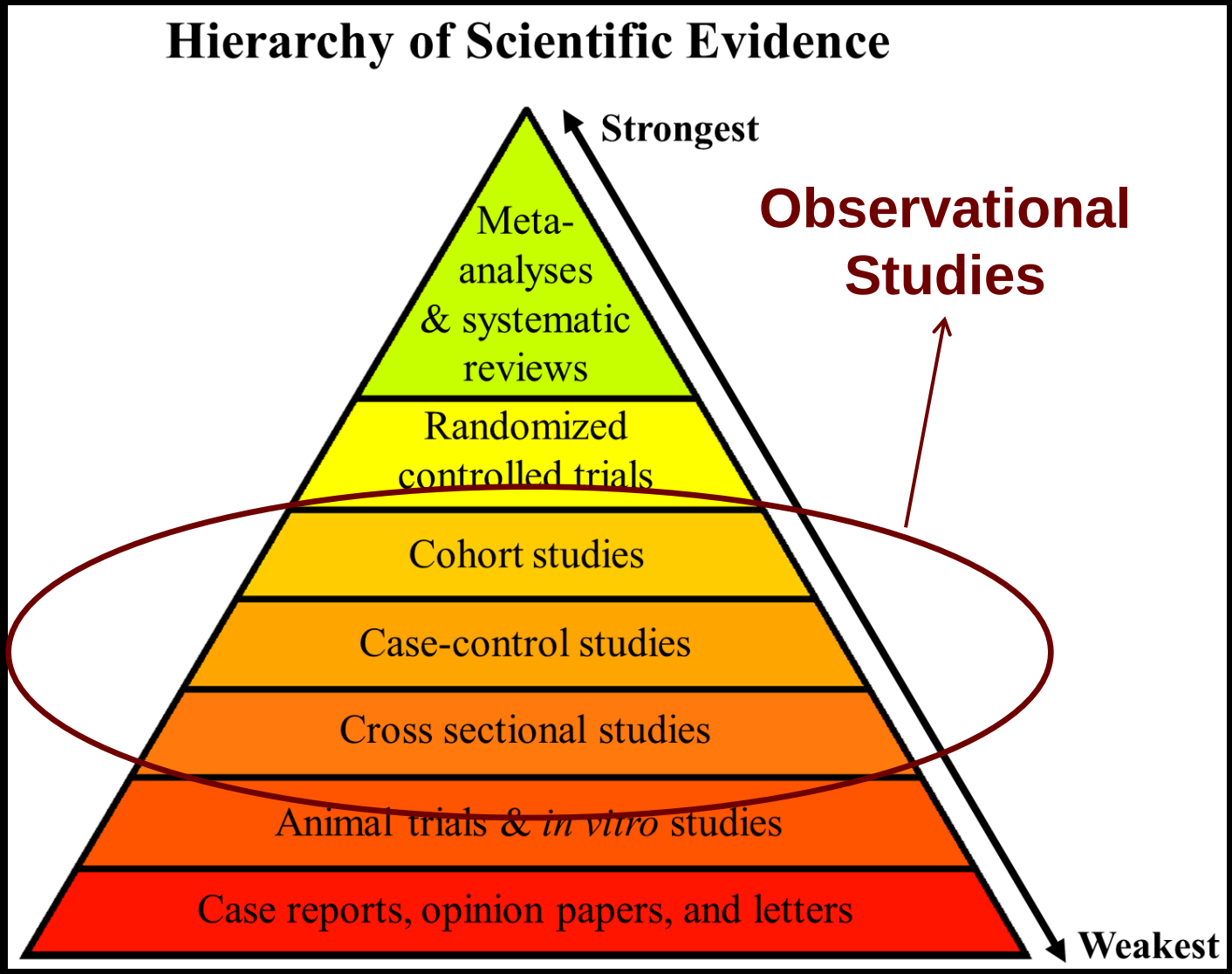
Methods

The potential HIV outbreak at ZC Hospital was declared a public health emergency, and a formal investigation began on January 25, 2017, supported by provincial (Zhejiang Health Commission and Zhejiang CDC) and national (National Health Commission and National Center for AIDS/STD Control and Prevention, Chinese Center for Disease Control and Prevention [China CDC]) authorities and resources. Neither institutional review board approval nor individual informed consent was required for the investigation. Routine informed consent for HIV,

Author affiliations: Zhejiang Provincial Center for Disease Control and Prevention, Hangzhou, China (X. Pan, J. Jiang, Q. Ma, J. Zhang, J. Yang, W. Chen, X. Ding, Q. Fan, Z. Guo, Y. Xia, S. Xia); National Center for AIDS/STD Control and Prevention, Beijing, China (Z. Wu); University of California, Los Angeles, California, USA (Z. Wu)

DOI: https://doi.org/10.3201/eid2412.180117

[1]These first authors contributed equally to this article.
[2]These senior authors contributed equally to this article.


Hierarchy of Scientific Evidence
Strongest
Observational Studies
Meta-analyses & systematic reviews
Randomized controlled trials
Cohort studies
Case-control studies
Cross sectional studies
Animal trials & *in vitro* studies
Case reports, opinion papers, and letters
Weakest

Example of Epidemiology in Action

- 1957: Scientists describe neurodegenerative disease called Kuru
  - Headache & joint pain, loss of coordination, difficulty walking, tremors, dementia, unresponsive
  - Fore people, Okapa district, Papua New Guinea
  - 60% adult females, 2% adult males, 38% children both sexes
  - 4 – 60 years of age
  - Disposal of dead – consumption by family
    - Female and children: eat whole body (including brain)
    - Males (adults, >7 years): rarely consumed

International Journal of Epidemiology, 2019, 1–9
doi: 10.1093/ije/dyz089
Original article

Original article

Preterm birth and selection *in utero* among males following the November 2015 Paris attacks

Tim A Bruckner,[1]* Élodie Lebreton,[2] Natalie Perrone,[3] Laust H Mortensen[4] and Béatrice Blondel[5]

Abstract

Background: On 13 November 2015, coordinated terrorist attacks swept through Paris. This large stressor, like earlier terrorist attacks in the USA, may have perturbed the health of pregnant women. We test whether the attacks preceded an increase in the risk of preterm parturition among live-born males as well as excess male loss *in utero*. We focused on males on the basis of previous findings of elevated male frailty following population stressors.

The Journal of Infectious Diseases

SUPPLEMENT ARTICLE

The Epidemiology of Carbapenem-Resistant Enterobacteriaceae: The Impact and Evolution of a Global Menace

Latania K. Logan[1,3] and Robert A. Weinstein[2,3]

[1]Section of Pediatric Infectious Diseases, Department of Pediatrics, [2]Division of Infectious Diseases, Department of Internal Medicine, Rush Medical College, Rush University Medical Center, and [3]Cook County Health and Hospitals System, Chicago, Illinois

Carbapenem-resistant Enterobacteriaceae (CRE) are a serious public health threat. Infections due to these organisms are associated with significant morbidity and mortality. Mechanisms of drug resistance in gram-negative bacteria (GNB) are numerous; β-lactamase genes carried on mobile genetic elements are a key mechanism for the rapid spread of antibiotic-resistant GNB worldwide. Transmissible carbapenem-resistance in Enterobacteriaceae has been recognized for the last 2 decades, but global dissemination of carbapenemase-producing Enterobacteriaceae (CPE) is a more recent problem that, once initiated, has been occurring at an alarming pace. In this article, we discuss the evolution of CRE, with a focus on the epidemiology of the CPE pandemic; review risk factors for colonization and infection with the most common transmissible CPE worldwide, *Klebsiella pneumoniae* carbapenemase–producing *K. pneumoniae*; and present strategies used to halt the striking spread of these deadly pathogens.

Keywords. epidemiology; gram-negative bacteria; Enterobacteriaceae infections; carbapenemases; drug resistance; antibacterial agents; carbapenems; adult; child; global health.

The prevalence of multidrug-resistant organisms (MDROs), a major public health threat, continues to increase on a global level and is associated with significant morbidity and mortality. Historically, MDROs have affected patients in hospital settings, where exposure to antibiotics, frequent and/or long-term hospitalization, use of in-dwelling devices, and host factors provide risks for acquisition [1, 2]. However, the distinction between multidrug-resistant healthcare-acquired and community-onset bacterial infections has become blurred over the last 2 decades,

There is a dearth of drugs capable of treating MDR GNB infections [7]. As carbapenem-resistant Enterobacteriaceae (CRE) have become increasingly prevalent worldwide, carbapenems, long a last line of defense, more and more are challenged by MGEs harboring carbapenemases and other drug resistance genes [8]. As the molecular mechanisms of resistance continue to evolve, the epidemiology of CRE is changing, and growing numbers of people worldwide are being affected by these dangerous organisms.

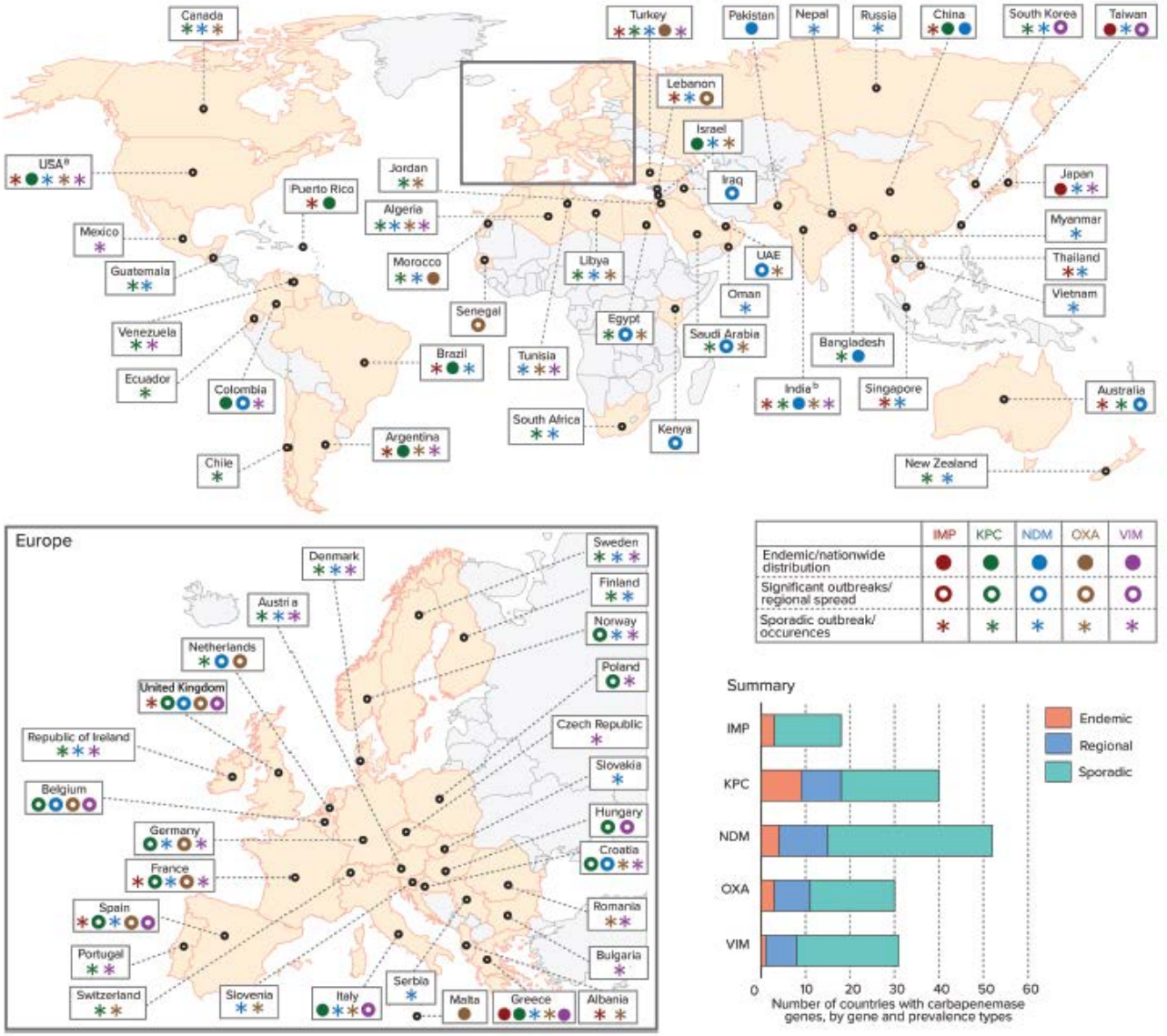


Figure 1. Global distribution of carbapenemases in Enterobacteriaceae, by country and region. Data are adapted from [8, 12, 13, 15, 25, 32–40]. [a]KPCs are endemic in some US states; [b]OXA mainly refers to OXA-48, except in India, where it refers to OXA-181. Abbreviations: IMP, active on imipenem metallo-β-lactamase; KPC, *Klebsiella pneumoniae* carbapenemase; NDM, New Delhi metallo-β-lactamase; OXA, oxacillinase-type carbapenem-hydrolyzing β-lactamase; VIM, Verona integron-encoded metallo-β-lactamase.

CONTROLLING THE SPREAD OF CRE IN HEALTHCARE SETTINGS

Interventions to curtail the spread of CRE in healthcare facilities most often have involved bundled infection control measures; so, the success of one individual measure cannot simply be compared directly to another. However, successful solutions based on multiple studies include using patient cohorts, contact isolation, and dedicated staffs; daily bathing of all patients with chlorhexidine; educating and training staff; limiting use of invasive devices; shortening the duration of mechanical ventilation; improving hand hygiene rates and antimicrobial stewardship; and, in some studies, enhancing environmental cleaning [84, 85, 94].

In high-prevalence areas, regional surveillance can be extremely useful when paired with the sharing of patient information among facilities; a strategy recommended by the CDC is to "detect and protect" through early identification of patients infected with CRE, followed by prevention of transmission through implementation of infection control precautions [95]. An example of this is the statewide registry of extensively drug-resistant organisms in Illinois, an interactive public health informatics tool that provides a mechanism for standardized reporting of CRE-carrier patients from all healthcare facilities throughout the state. This unique partnership of public health, academia, and non-profit organizations aids in decreasing spread of CRE through communication, which allows for early detection and intervention by receiving facilities [96].

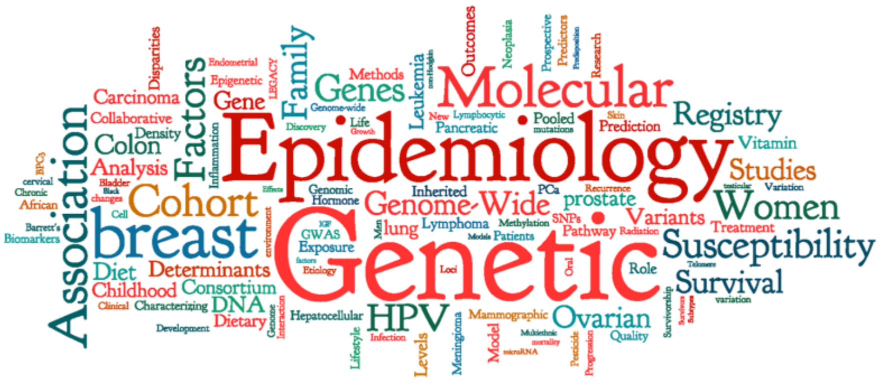
Potential interventions in US facilities where CRE rates are still low include screening high-risk patients for CRE carriage on admission, such as patients transferred from long-term care facilities; while awaiting screening results, hospitals may use preemptive contact precautions for such admissions, especially if rates are high in referring facilities.

FUN ANIMAL FACT #1

Sea otters hold hands while they sleep so they don’t drift apart!

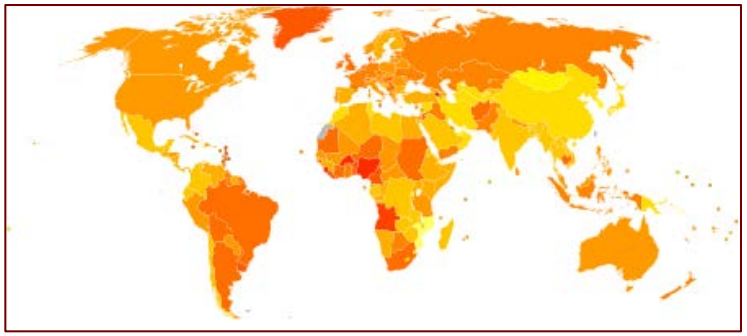
Epi Expanded

- Geographical Epi
- Molecular Epi
- Social Network Analysis



Geographical Epidemiology

- Describe the spatial distribution of health/disease
  - Rooms, houses, neighbourhoods, cities, provinces
- Birthplace
- Workplace
- Natural boundaries (e.g., river, canyon)
- Political boundaries
- Environmental factors

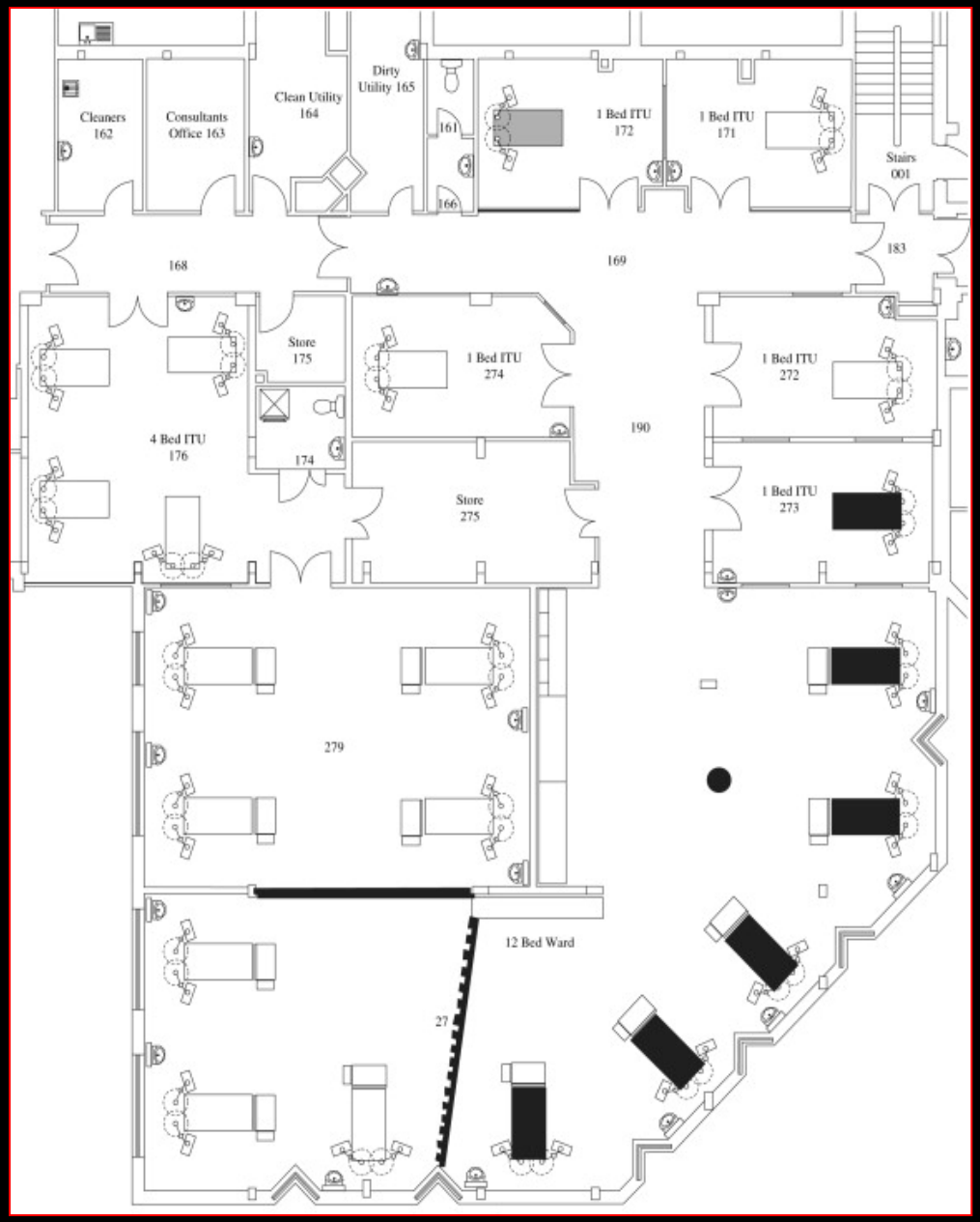


Where is the disease?

- Go for a ‘walkabout’
- Visually inspect maps for clustering
- Statistical packages
- Remember John Snow and the Pump!

C. F. Cheffins, Lith, Southampton Bldgs. London.

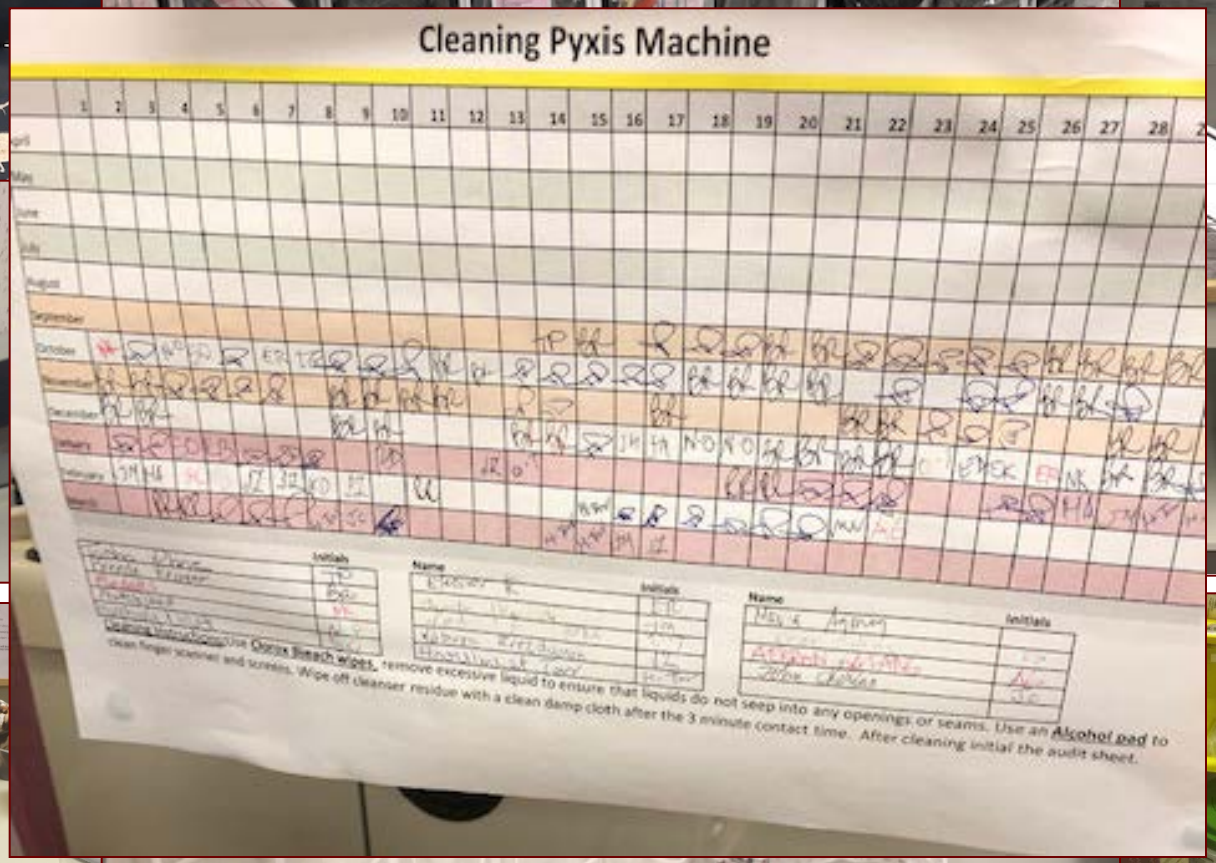
SCALE 30 INCHES TO A MILE.

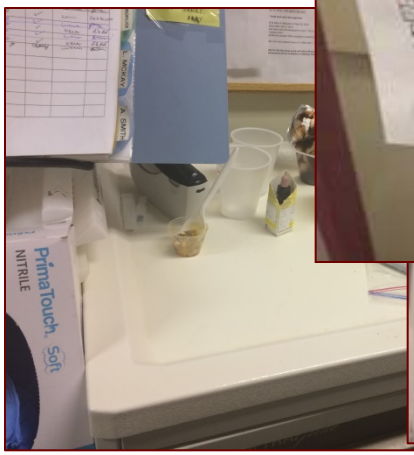


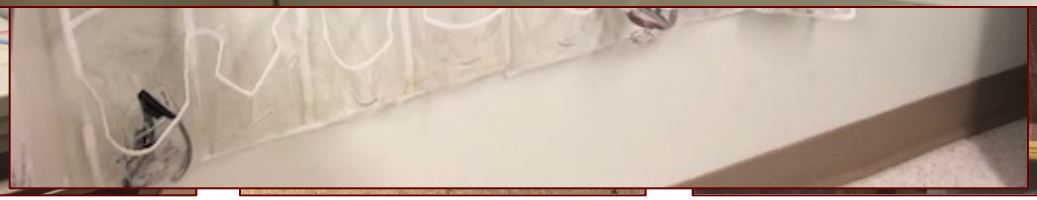
Enoch et al. J Hosp Infect, 2008

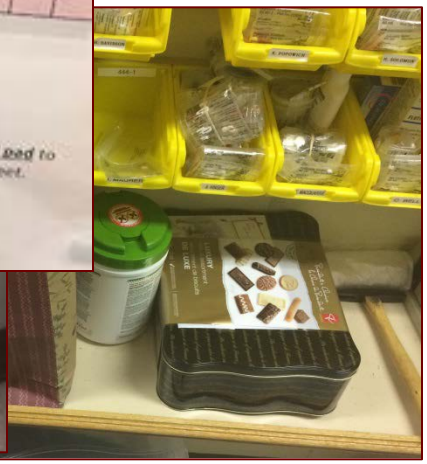
Investigation of an outbreak of multidrug-carbapenem-resistant *Acinetobacter baumannii* in an UK hospital ICU


USED
Batteries
Pens
PRN BEER


Cleaning Pyxis Machine
Initials
Name
Initials
Name
Initials
Use Clorox Bleach wipes, *remove excessive liquid to ensure that liquids do not seep into any openings or seams. Use an Alcohol pad to
clean finger scanner and screens. Wipe off cleanser residue with a clean damp cloth after the 3 minute contact time. After cleaning initial the audit sheet.


PrimaTouch
Soft
NITRILE





FUN ANIMAL FACT #2

Yes, Bees Get Sexually Transmitted Diseases Too

And when they do get a sexually transmitted disease, the bees' immune system launches an efficient response to protect their sperm—and ultimately their queen—against the disease.

AsianScientist (Aug. 10, 2016) – Scientists in Australia are a step closer to protecting honey bees from a sexually transmitted disease that causes dysentery and weakens hives considerably. The study was published in the *Journal of Proteome*.

Molecular Epidemiology

- Epidemiology and medical science
- Looking at the molecular level
- Improves understanding of pathogenesis of disease by identifying pathways and genes

Example of Molecular Epidemiology in Action

(Price et al., Molecular epidemiologic investigation of an anthrax outbreak among heroin users, Europe. Emerg Infect Dis 2012;18(8))

- 2009: 2 cases injectional anthrax, heroin users, Scotland
- 14 anthrax deaths, 119 suspected cases, England and Germany
- All cases had same strain
- Afghanistan produces 90% world's heroin
- Anthrax spores accidentally introduced into heroin supply in Turkey before smuggled in Europe
- Animal-derived cutting agent (bone meal) or wrapping heroin in animal hide for transporting

AAC
Journals.ASM.org

Gram-Negative Bacteria That Produce Carbapenemases Causing Death Attributed to Recent Foreign Hospitalization

Jasmine Ahmed-Bentley,[a,b] A. Uma Chandran,[a,c] A. Mark Joffe,[a,c] Desiree French,[b] Gisele Peirano,[d] Johann D. D. Pitout[d,e]

University of Alberta,[a] DynaLIFE$_{DX}$,[b] and Royal Alexandra Hospital,[c] Edmonton, Alberta, Canada; Division of Microbiology, Calgary Laboratory Services,[d] and Departments of Pathology and Laboratory Medicine, Microbiology, and Immunology and Infectious Diseases, University of Calgary,[e] Calgary, Alberta, Canada

Overseas travel, as a risk factor for the acquisition of infections due to antimicrobial-resistant organisms, has recently been linked to carbapenemase-producing Gram-negative bacteria. Multiresistant *Klebsiella pneumoniae*, *Escherichia coli*, and *Acinetobacter baumannii* strains were isolated from a wound of a Canadian patient with a recent history of hospitalization in India. This resulted in the initiation of outbreak management that included surveillance cultures. Epidemiological and molecular investigations showed that NDM-1-producing *K. pneumoniae* ST16 and OXA-23-producing *A. baumannii* ST10 strains were transmitted to 5 other patients, resulting in the colonization of 4 patients and the death of 1 patient due to septic shock caused by the OXA-23-producing *A. baumannii* strain. The high rate of false positivity of the screening cultures resulted in additional workloads and increased costs for infection control and clinical laboratory work. We believe that this is the first report of an infection with carbapenemase-producing Gram-negative bacteria resulting in death attributed to a patient with recent foreign hospitalization. We recommend routine rectal and wound screening for colonization with multiresistant bacteria for patients who have recently been admitted to hospitals outside Canada.

A Comparison with the Number of Biting Injuries Occurring Annually in New York City

BITING INJURY	1981	1984	1985	1986	1987
Dog bites human	12,656	10,593	9,809	8,870	8,064
Human bites human	*	1,589	1,591	1,572	1,587
Cat bites human	826	*	879	*	802
Wild rat bites human	60	*	311	*	291
Squirrel bites human	81	*	*	*	95
Hamster bites human	52	*	*	*	*
Rabbit bites human	37	*	*	*	*
Raccoon bites human	18	*	*	*	11
Horse bites human	18	*	*	*	*
Gerbil bites human	17	*	12	*	*
Lab rat bites human	15	*	9	*	*
Monkey bites human	11	*	*	*	*
Snake bites human	8	*	4	*	*
Bat bites human	7	*	4	*	*
Ferret bites human	5	*	5	*	7
Guinea pig bites human	5	*	*	*	*
Parrots bite human	5	*	6	*	*
Blue Jay bites human	2	*	*	*	*
Spider bites human	*	*	2	*	*
Skunk bites human	1	*	*	*	3
Parakeet bites human	1	*	*	*	*
Opossum bites human	1	*	*	*	*
Sea lion bites human	1	*	*	*	*
Lion bites human	1	*	*	*	*
Ocelot bites human	1	*	*	*	*
Lion fish stabs human	1	*	*	*	*
SHARK INJURIES IN U.S.A.	**12**	**14**	**12**	**6**	**13**

** Information not available.*

Sharks vs. Home Improvement Injuries

A Comparison with the Number of Injuries Associated with Home-Improvement Equipment: 1996

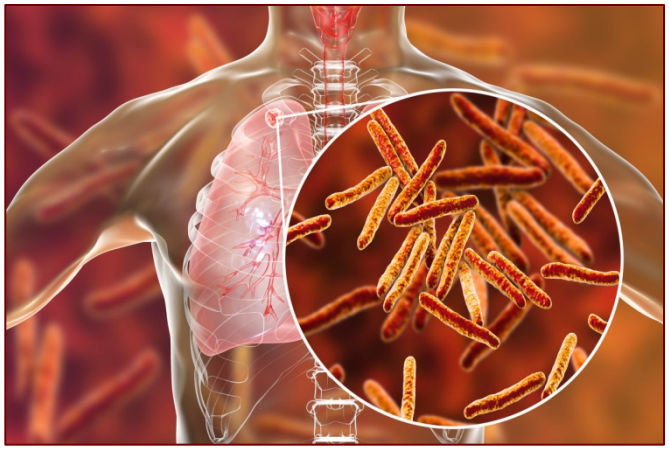
EQUIPMENT	NUMBER OF INJURIES
Nails, screws, tacks, and bolts	198,849
Ladders	138,894
Toilets	43,687
Pruning, trimming, edging	36,091
Chain saws	13,458
Pliers, wire cutters, and wrenches	15,957
Manual-cleaning equipment	14,386
Power grinders, buffers, and polishers	13,458
Buckets and pails	10,907
Room deodorizers and fresheners	2,599
Toilet-bowl products	1,567
Paints or varnish thinners	1,549
SHARK INJURIES AND DEATHS IN U.S.A.	**13**

Social Network Analysis

- Social networks: family, work, play
- Examines the structure of social relationships in a group to uncover the informal connections between people

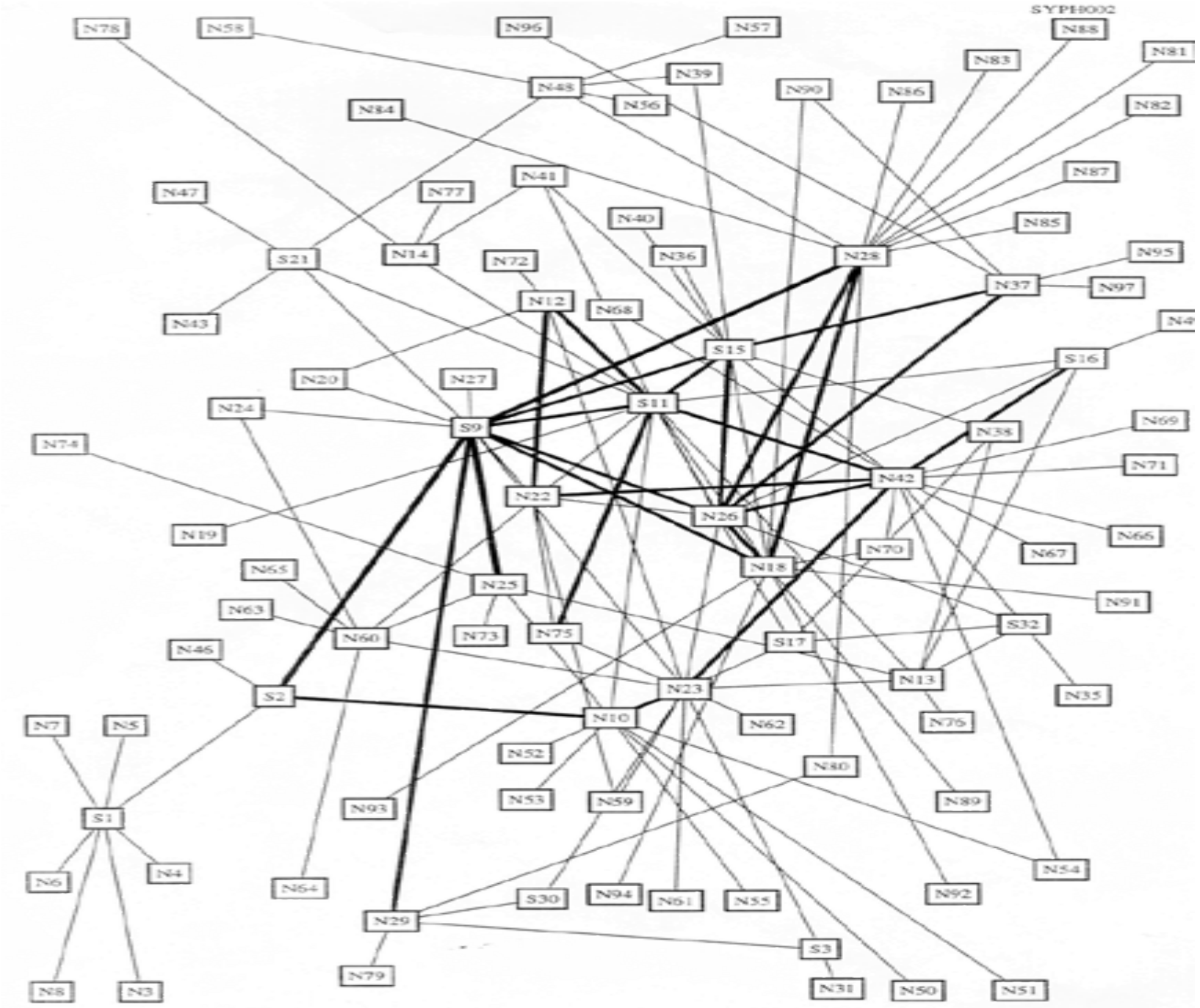
TB Example

- Increase in TB rates in Canadian city
- Men
  - Construction workers
  - Business men – financial district
- Traditional Epi: contraction
- Social Network Analysis
  - Sexual orientation
  - Bar
    - TB transmission



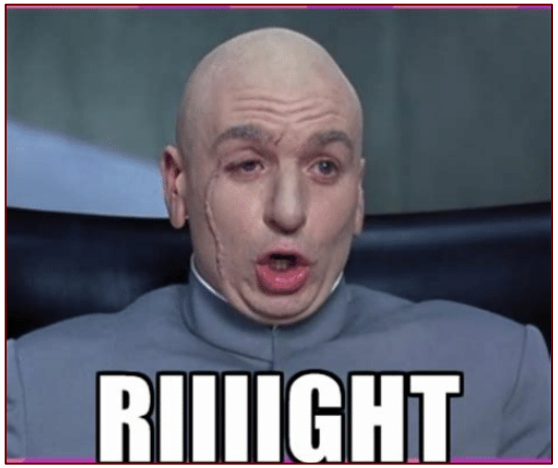
Syphilis Example

- Atlanta in 1996, cluster of cases
- Investigation started by public health
- Initial assessment – LOTS of people
  - 10 cases
    - 6 females (< 16 years), 4 males (16, 17, 19 years)
  - Home of one cases - parents absent
  - Use drugs (marijuana, cocaine) and drink
  - Sexual interactions – multiple partners
  - Complex picture


SYPHOO2
N78
N58
N96
N57
N88
N81
N83
N39
N48
N90
N86
N84
N56
N82
N87
N41
N47
N77
N40
N85
N14
N28
N95
S21
N72
N36
N37
N97
N12
N68
N43
N4
S15
S16
N20
N27
S11
N24
S9
N69
N74
N38
N71
N42
N22
N26
N19
N66
N70
N67
N65
N18
N25
N91
N63
N73
N75
S32
N60
S17
N46
N13
N23
S2
N35
N7
N5
N10
N62
N76
N52
N80
N53
N59
N89
N93
S1
N54
N6
N4
N64
N92
S30
N94
N61
N55
N29
S3
N79
N8
N3
N31
N50
N51

So what have we learned…

- Epidemiology = outbreaks
- Epidemiology is much more!
- Epi + other fields
  - Geographical epi
  - Puzzle pieces
  - Understanding connections
- Teenagers studying
- Think twice visiting New York
  - Tetanus shot



Epidemiologists

What my friends think I do

What my parents think I do

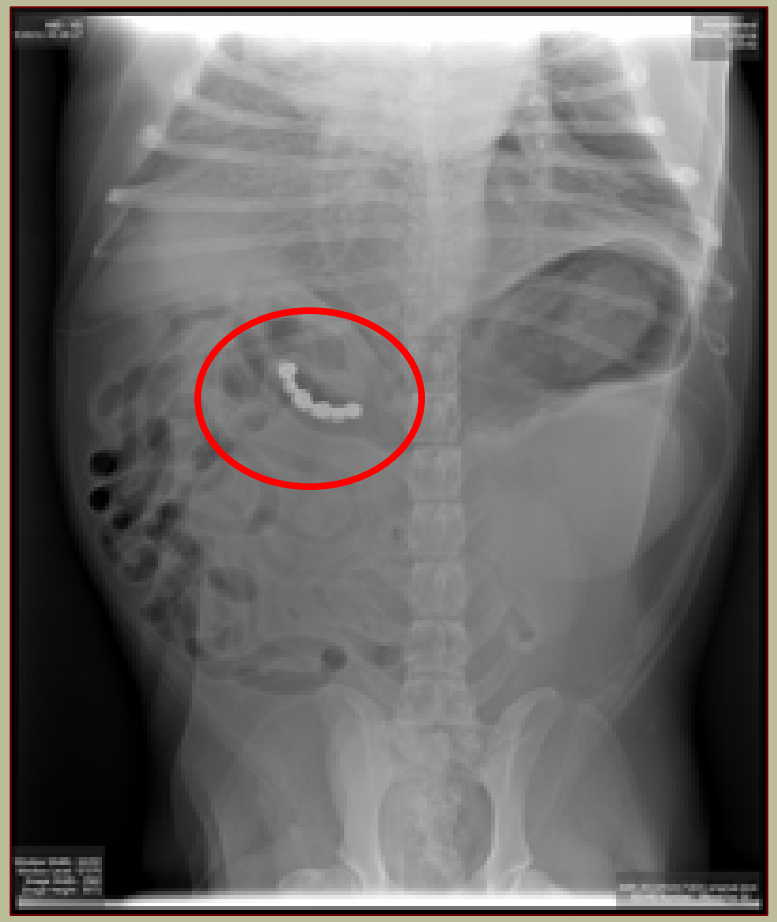
What society thinks I do

What grandma thinks I do

What I think I do

What I really do

Thank You – Questions?



9 year-old bulldog ate his owner's false teeth (teeth were returned to owner)