Controlling Microbial Threats:
New Approaches and Ongoing Challenges

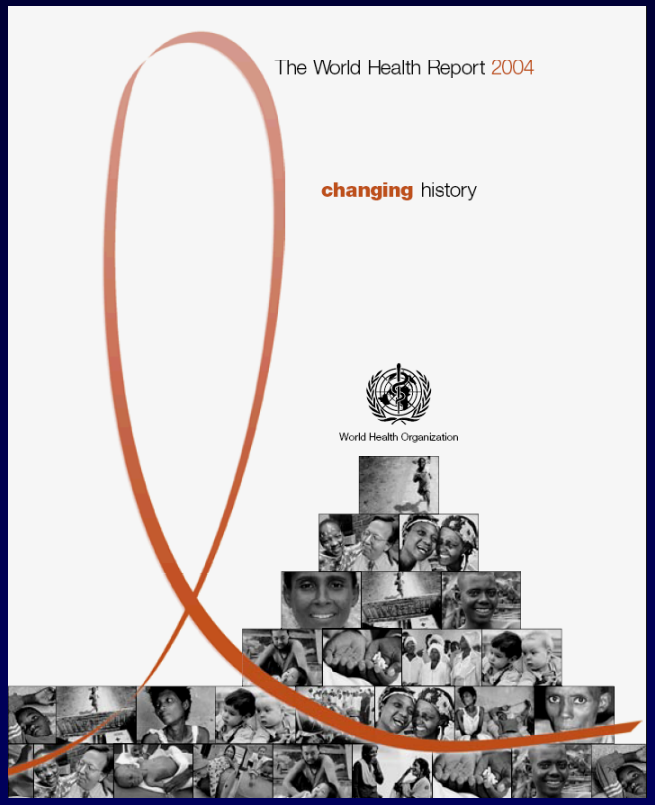
Rima F. Khabbaz, M.D.
Director
National Center for Preparedness, Detection,
and Control of Infectious Diseases

Centers for Disease Control and Prevention

Overview

- Global Burden
- Factors Contributing to Emergence and Spread
- Recent Challenges
- Lessons Learned
- Opportunities

Leading Infectious Causes of Death 2003

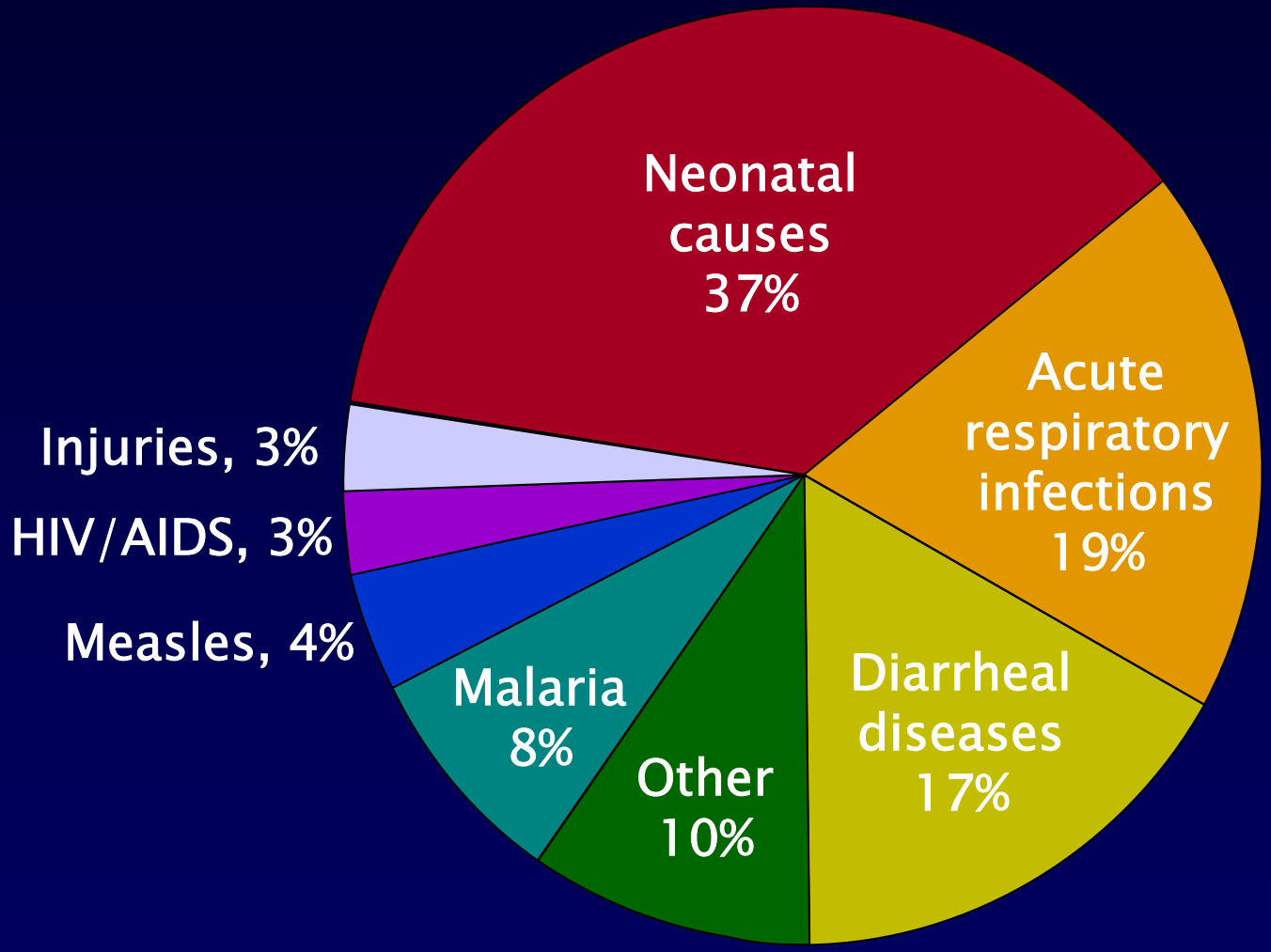


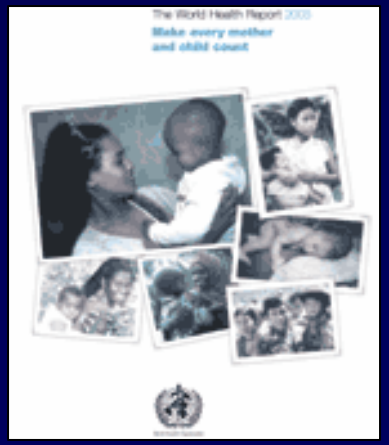
Lower respiratory infections	3.9 million
HIV/AIDS	2.8 million
Diarrhea	1.8 million
Tuberculosis	1.6 million
Malaria	1.2 million

Total deaths 2003: ~57 million

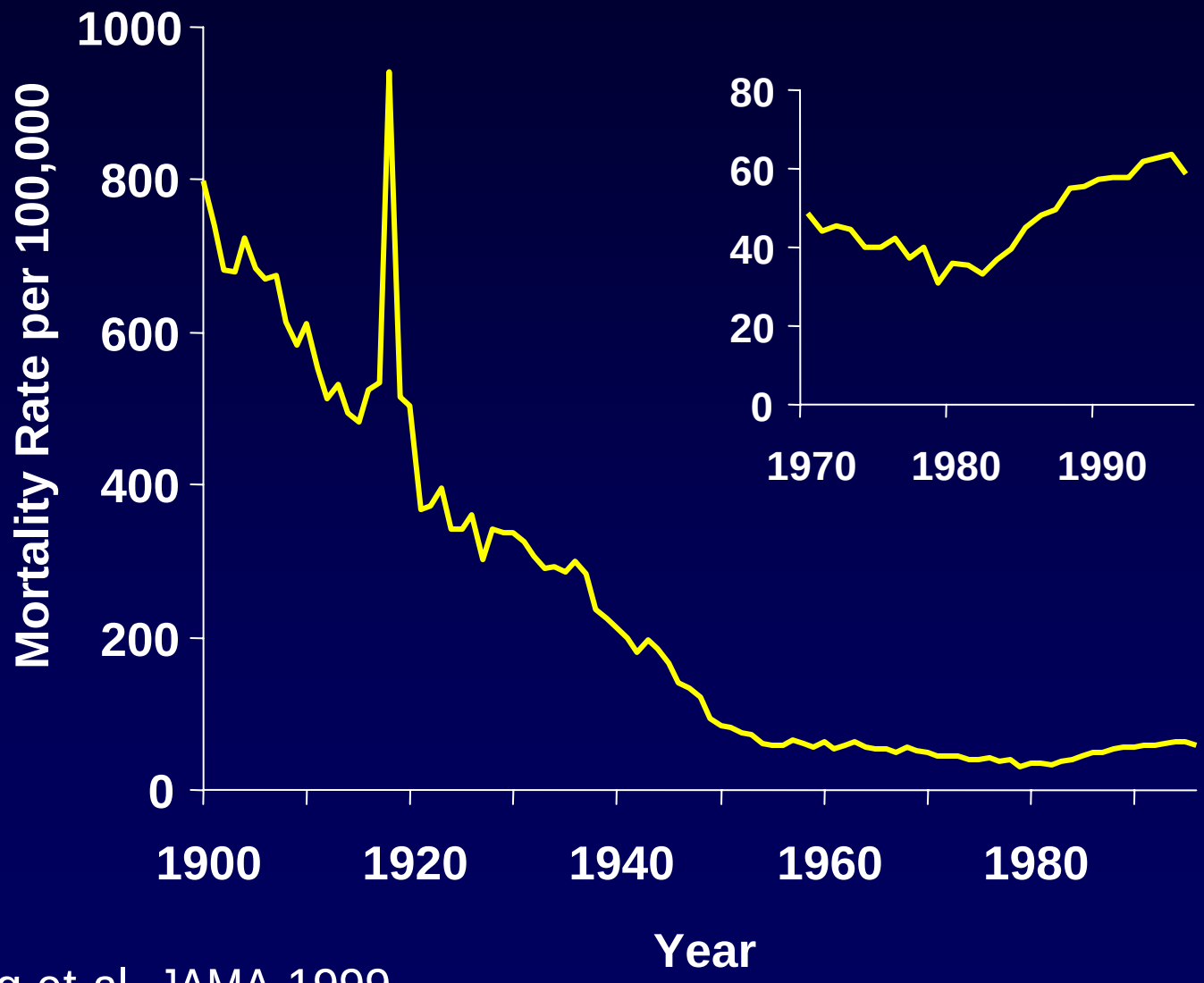
Infection-related : ~15 million

Leading Causes of Death among Children <5 Years of Age in WHO Member States, 2000–2003





Infectious Disease Mortality United States, 1900-1996



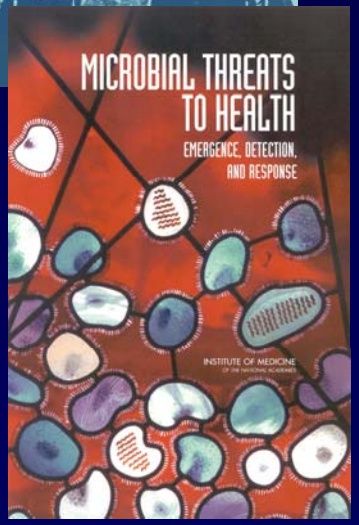
Armstrong et al, JAMA 1999

Overview

- Global Burden
- Factors Contributing to Emergence and Spread
- Recent Challenges
- Lessons Learned
- Opportunities

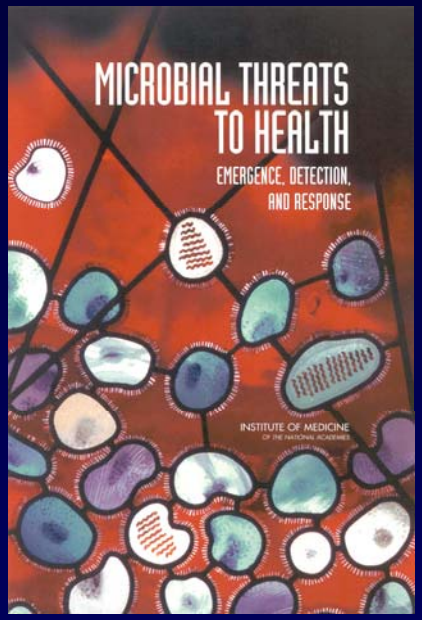
Factors Contributing to the Emergence of Infectious Diseases

- Human demographics and behavior
- Technology and industry
- Economic development and land use
- International travel and commerce
- Microbial adaptation and change
- Breakdown of public health measures

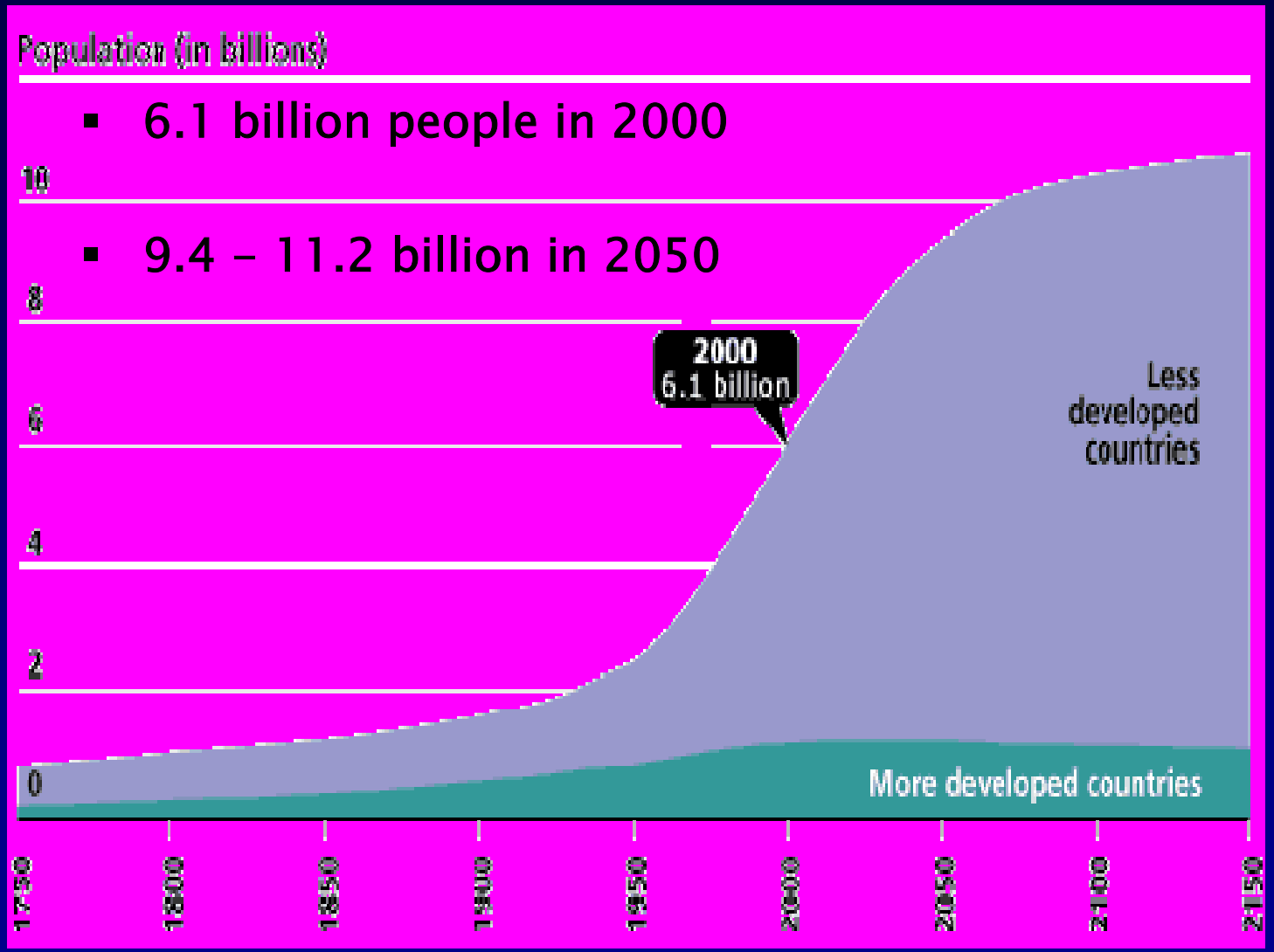


Factors Contributing to the Emergence of Infectious Diseases

- Human susceptibility to infection
- Climate and weather
- Changing ecosystems
- Poverty and social inequality
- War and famine
- Lack of political will
- Intent to harm



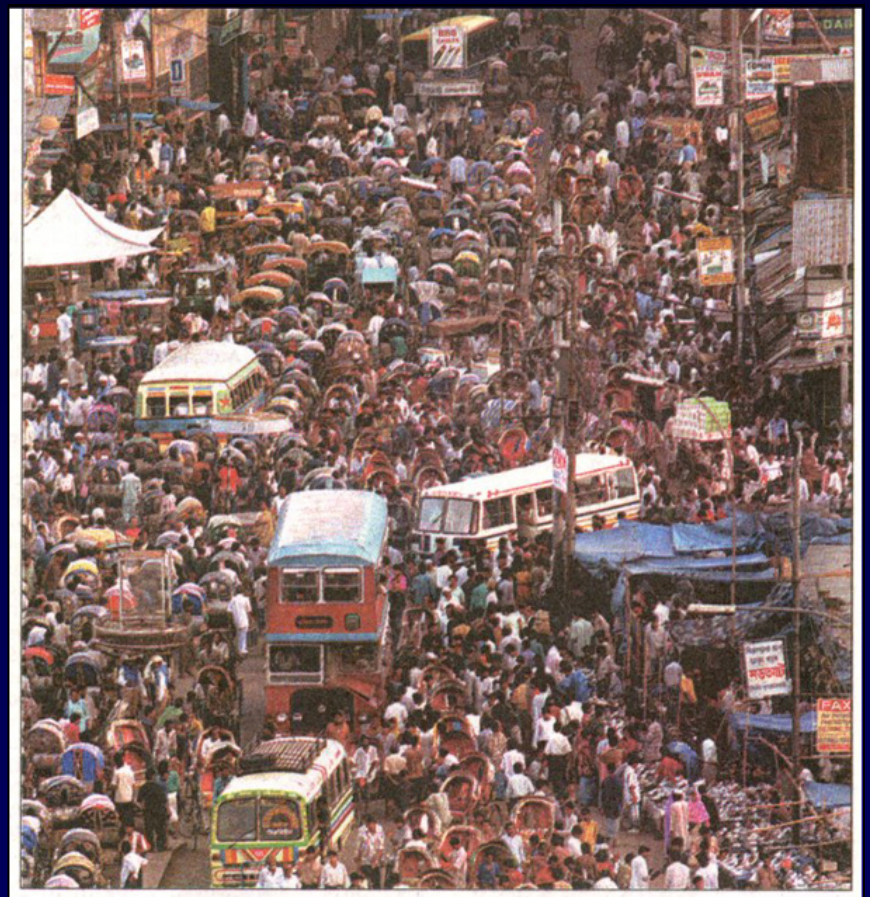
Rapidly Increasing Human Population



- 6.1 billion people in 2000
- 9.4 – 11.2 billion in 2050

Source: United Nations, World Population Prospects, The 1998 Revision; and estimates by the Population Reference Bureau.

Human Demographics and Behavior



Associated Press

Bicycles, rickshaws, buses and pedestrians jam a street in Dkaha, Bangladesh.

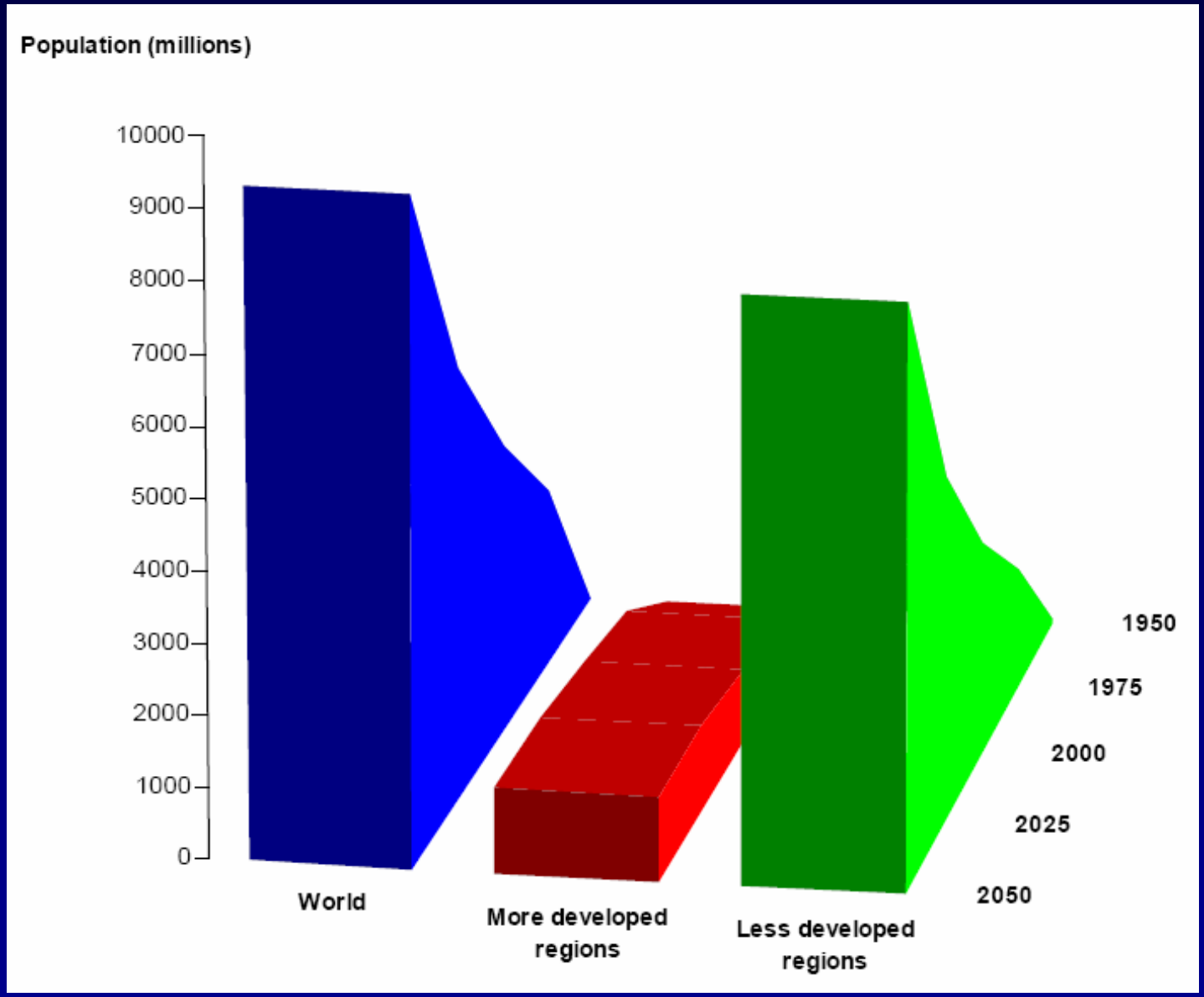
Number and Location of Megacities* by Setting and Year, 1950–2015

	1950	1975	2003	2015
Number	2	4	20	22
Number (%) in developing world	0(0)	2(50)	15(75)	16(73)

*≥10 million people

Source: World Urbanization Prospects: The 2003 Revision, UN Dept of Economic and Social Affairs.

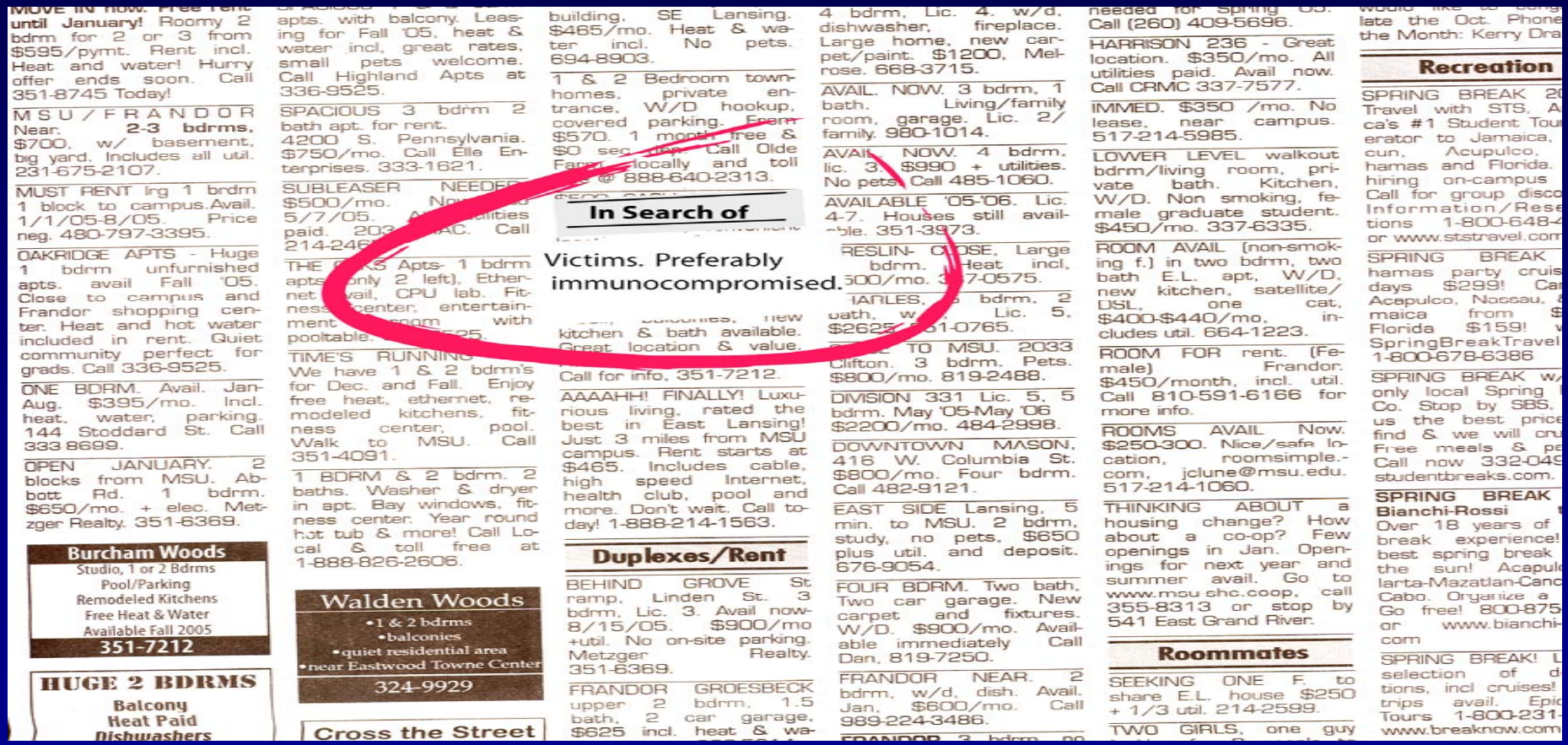
Growth of Cities, 1950–2050



Source: UN, 2000

By 2020, ~1billion people will be >60 years of age

Increase in Immunocompromised Population



In Search of

Victims. Preferably immunocompromised.

Duplexes/Rent

Roommates

Recreation

Burcham Woods
Studio, 1 or 2 Bdrms
Pool/Parking
Remodeled Kitchens
Free Heat & Water
Available Fall 2005
351-7212

HUGE 2 BDRMS
Balcony
Heat Paid
Dishwashers

Walden Woods
•1 & 2 bdrms
•balconies
•quiet residential area
•near Eastwood Towne Center
324-9929

Cross the Street

BACK PRINT

Hepatitis C Scare At Las Vegas Clinic

LAS VEGAS, Feb. 28, 2008

(CBS/AP) A Las Vegas clinic may have infected a handful of patients with he
Wednesday.

Six people who underwent procedures at the Endoscopy Center of Southern

Five of those received treatment at the facility on the same day in late Septe

An investigation determined that "unsafe injection practices related to the a
the statement said.

Officials said the unsafe practices had been in place for several years and
are being notified of the potential exposure in letters arriving next week.

Chief health officer Lawrence Sands said anyone who received anesthesia

"We are recom
A routine invest
of other patient

"During the cou
labeled for sing
District told KL

Hepatitis C is a
cases each yea

The district sai

Endoscopy Cer

"All concerns n
center said in a

To retain its sta

Health officials

MMWR
Morbidity and Mortality Weekly Report

MMWR Dispatch
Vol. 54 / May 26, 2005

Lymphocytic Choriomeningitis Virus Infection in Organ Transplant Recipients — Massachusetts, Rhode Island, 2005

On May 3, 2005, CDC received a report of severe illness in four patients who had received solid organ transplants from a common donor. All four organ recipients subsequently were found to have evidence of infection with lymphocytic choriomeningitis virus (LCMV), a rodent-borne Old World arenavirus. Preliminary findings from the ensuing investigation indicate the source of infection likely was an infected hamster in the donor's home. This report summarizes the ongoing investigation and provides information on exposure risks and possible prevention measures.

histochemical staining, reverse transcriptase-polymerase chain reaction (RT-PCR), enzyme-linked immunosorbent assays (i.e., IgM capture and indirect IgG), and viral culture on Vero E6 cells. Sequencing of the virus genome confirmed its identity as LCMV. Based on the diagnosis of LCMV infection, the surviving kidney transplant recipient was treated with intravenous ribavirin and reduction in his immunosuppressive drug regimen; the patient improved clinically.

Epidemiologic Investigation

Medscape Medical News

Tuberculosis Transmitted Through Organ Transplant

Emma Hitt, PhD

Medscape Medical News 2008. © 2008 Medscape

March 18, 2008 (Atlanta) — Organs transplanted from a donor with disseminated tuberculosis (TB) resulted in disease transmission to 2 of 3 organ recipients, according to a study presented here at the International Conference on Emerging Infectious Diseases 2008.

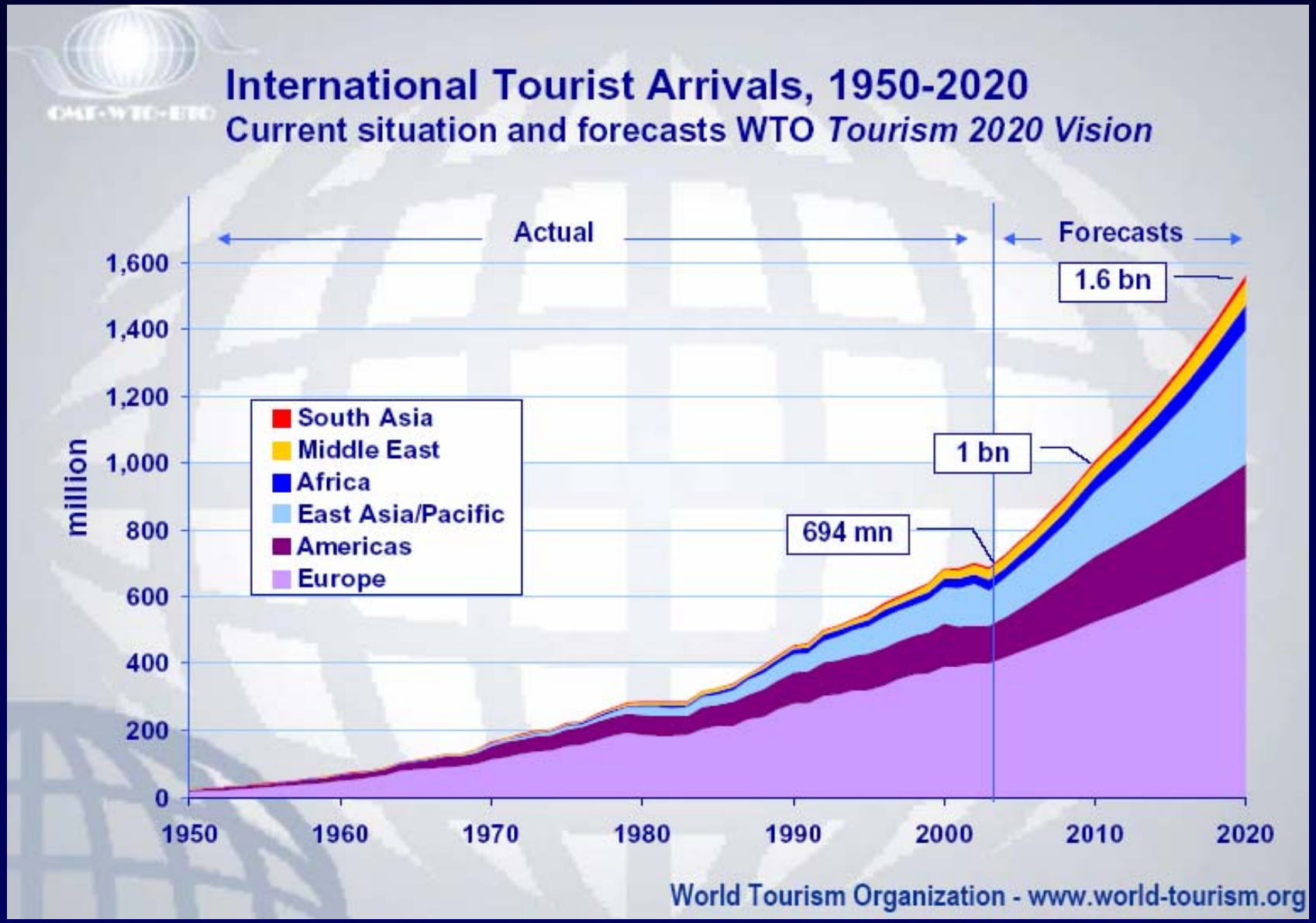
These findings represent the first TB transmission through transplantation documented by matching genotype isolates of donor and recipients, according to Emily Piercefield, MD, DVM, EIS, officer with the Acute Disease Service for the Oklahoma State Department of Health..

The donor in the study had a history of homelessness and alcohol use and was hospitalized for cerebral vasculitis. He had no known history of TB, and previous tuberculin skin tests had been negative.

Technology and Industry

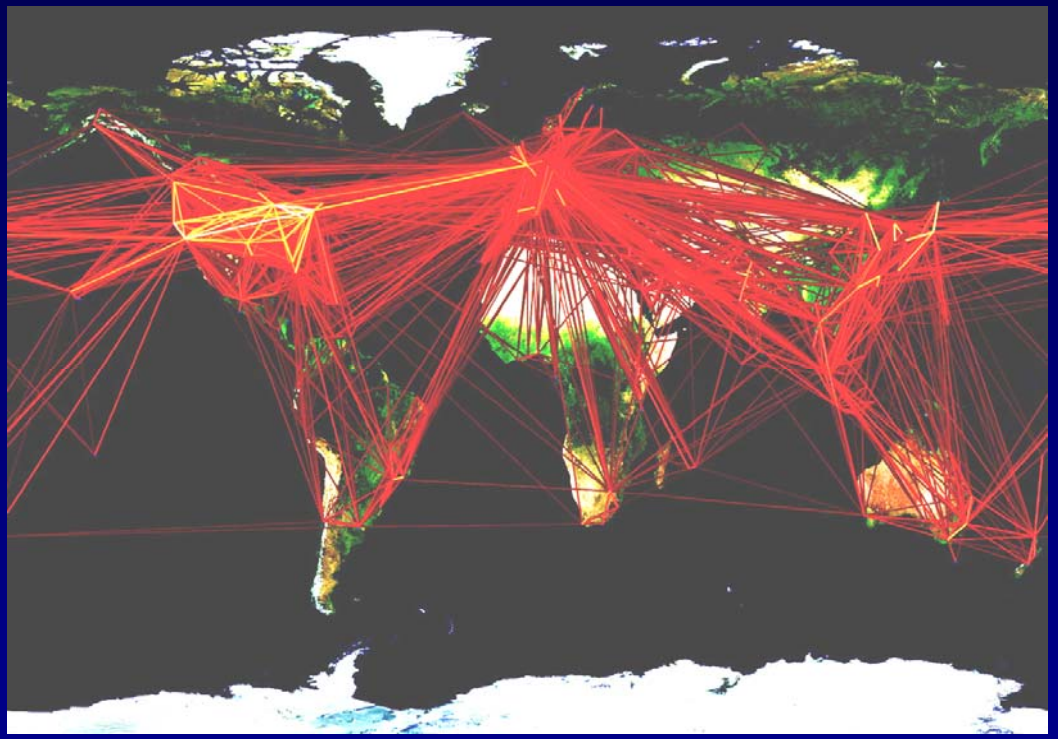
Concentrated Animal Feeding Operations (CAFOs

International Travel and Commerce



Movement and Interactions of People and Commerce

- Distance and speed of travel increased 1000-fold since 1800
- 1.4 billion air travelers per year
- Global trade of food, animals and plants



PNAS 2004;101:15125.

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

The Detection of Monkeypox in Humans in the Western Hemisphere

Kurt D. Reed, M.D., John W. Melski, M.D., Mary Beth Graham, M.D.,
Russell L. Regnery, Ph.D., Mark J. Sotir, Ph.D., M.P.H.,
Mark V. Wegner, M.D., M.P.H., James J. Kaz
Erik J. Stratman, M.D., Yu Li, Ph.D., Jan
H., Victor
ehl, Ph.D.,
ly, M.D., J
non, M.D.,

N Engl J Med 2004.

A2 MONDAY, JUNE 9, 2003 DC MD VA

NATIONAL NEWS

Officials Scramble to Contain Monkeypox

Outbreak of Virus in Midwest Is the First Reported in Western Hemisphere

By Rob Stein
Washington Post Staff Writer

Tammy Kautzer's 3-year-old daughter had never been so sick. Her fever spiked above 103. Her glands were so swollen they looked like they were popping out of her neck. And then small, tender red welts began erupting all over her body.

"She kept getting worse. All she did was sleep. And when she wasn't sleeping, all she would do is cry," Kautzer said yesterday. "I don't know what the doctors were thinking, but I really didn't know if she was going to make it."

Kautzer's daughter, Schyan, did recover, but only after a harrowing week in the hospital, during which time Kautzer and her husband also got milder versions of the same sickness.

The illnesses of the family in Dorcester, Wis., were the start of the first outbreak reported in the Western Hemisphere of monkeypox, a sometimes life-threatening disease related to smallpox.

At least 20 people in three Midwestern states have been stricken in the outbreak, which state and federal health officials are urgently working to contain.

"We're doing everything possible to contain it," said Jeffrey P. Davis, Wisconsin's chief medical officer.

Eighteen of the cases have been reported in Wisconsin, with one additional case in Illinois and one in Indiana. More potential cases were being investigated, officials said.

State and federal authorities are tracing about 200 animals that were distributed in 15 states by an exotic pet dealer in Illinois. The dealer sold rodents known as prairie dogs, which are believed to be the source of the outbreak.

"There's the potential of transmission from animal to human, so certainly we are concerned," said Jeff Squibb of the Illinois Department of Agriculture.

In addition to trying to prevent more infections, officials are worried that the animals could spread the disease to wild rabbits and other indigenous creatures, allowing the virus to become entrenched in the United States. The last time a new disease became established in this country was in 1999, when the West Nile virus arrived. It has subsequently spread nationwide.

"That's probably the biggest concern we have other than the immediate concern of trying to get the message out as quickly as possible to try to identify people who might have been exposed," said Stephen Ostroff, deputy director of the National Center for Infectious Diseases in Atlanta.

The monkeypox outbreak came just as concerns were subsiding over severe acute respiratory syndrome (SARS), a deadly permutations of potential transmissions."

One of the Wisconsin cases involved a rabbit owner who was infected by his pet, which apparently became infected during a visit to the same veterinarian who treated a sick prairie dog, Davis said.

Although no cases of the disease apparently have spread directly from person to person in the United States, that has been known to occur with monkeypox in Africa.

At the same time, investigators are tracking the disease backward to try to determine how it first arrived in the Western Hemisphere.

Monkeypox is usually found only in central and western Africa. It is caused by a virus in the same family as the smallpox virus. It triggers similar symptoms—fever, cough and a rash of small red blistering welts that eventually break open and scab over, sometimes leaving scars.

Monkeypox is believed to be much less deadly than smallpox, with a mortality rate of 1 percent to 10 percent compared with about 30 percent for smallpox, which has been eradicated from the wild. There is no known treatment for monkeypox, and it is unclear how the virus would behave in a new environment.

The outbreak was apparently started by a shipment of 38 prairie dogs that an exotic pet dealer, Phil's Pocket Pets of Villa Park, Ill., sold to another dealer, EK Exotics in Milwaukee. Phil's Pocket Pets purchased

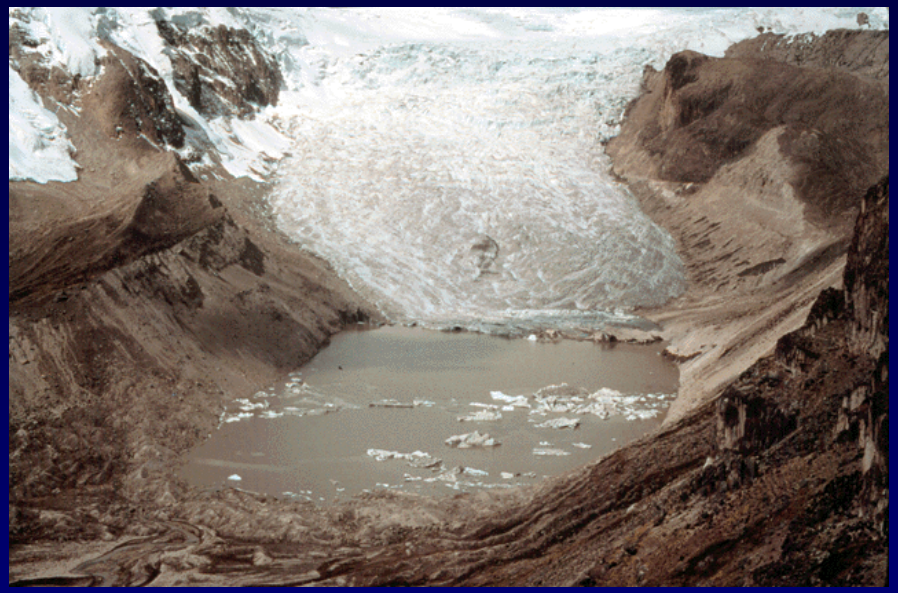
Prairie dogs are believed to be the source of an outbreak of the monkeypox virus, which has sickened at least 20 people in the Midwest, health officials said.

as the Kautzers' home, a farm that houses an assortment of pets.

Officials are tracking down 115 customers who bought animals from Phil's Pocket Pets since April 15, when the first shipments arrived from Texas. All sick animals and people are being kept isolated to prevent further spread.

One of those buyers was EK Exotics,

Changing Climate and Ecosystems



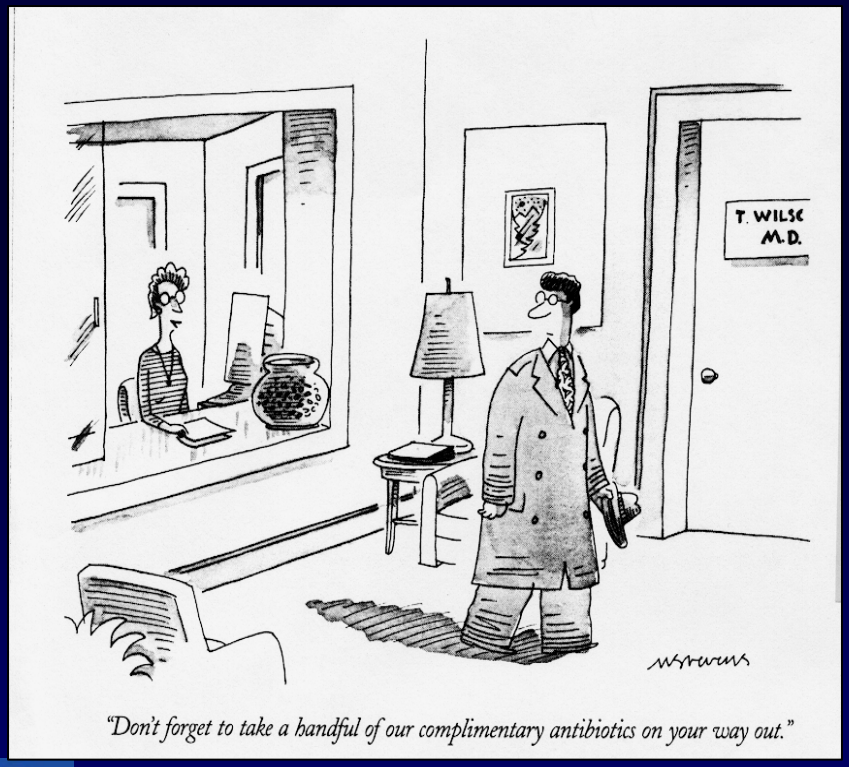
Microbial Adaptation and Change

50 YEARS AFTER THE ADVENT OF PENICILLIN,

DOCTORS FEAR ANTIBIOTICS ARE LOSING THEIR PUNCH

RUNNING OUT OF WONDER DRUGS

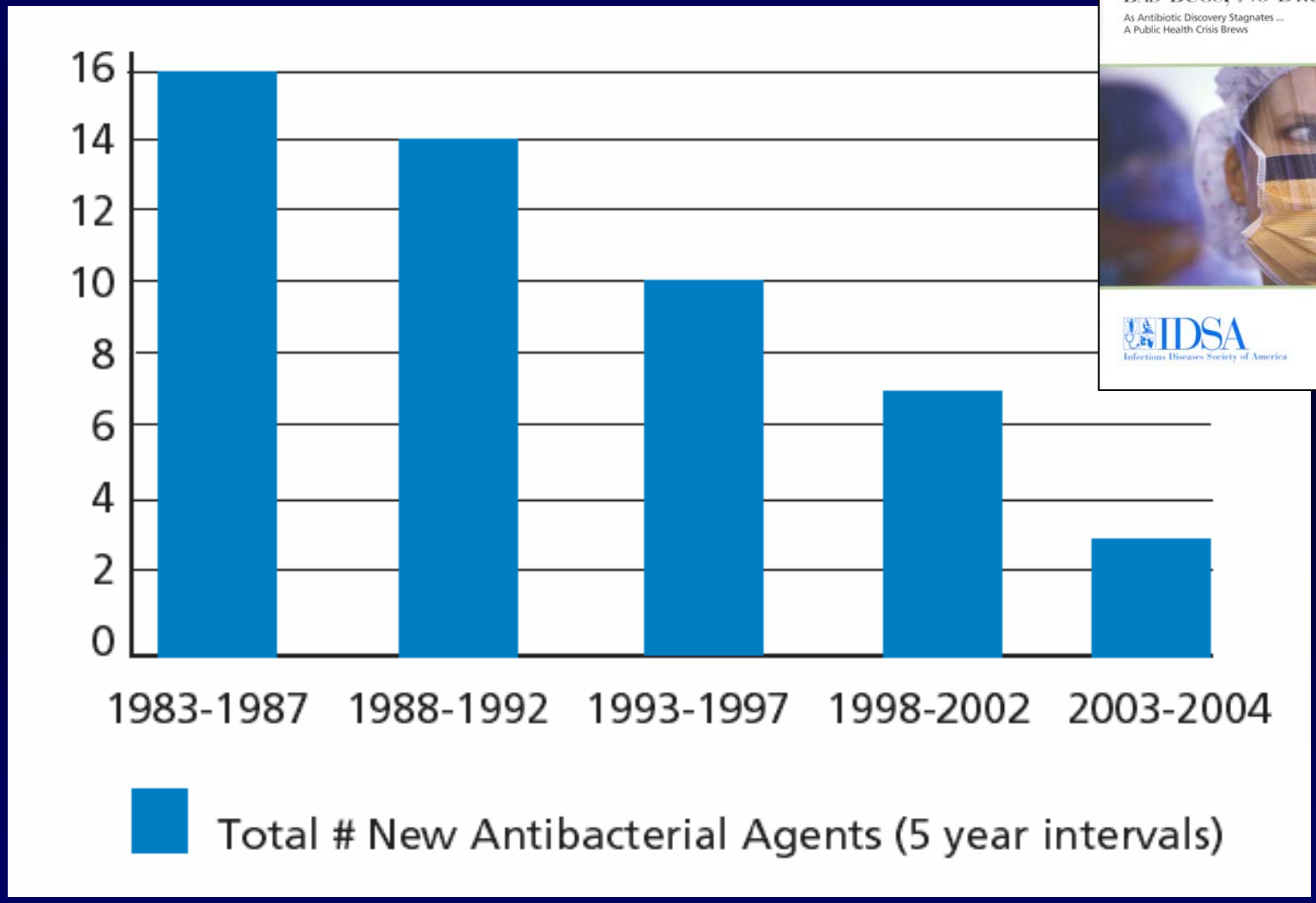
The Washington Post, March 16, 1993

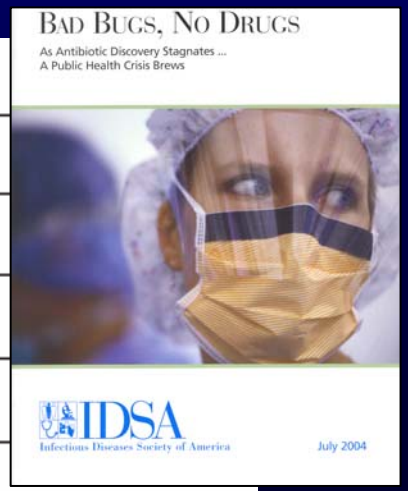


"Don't forget to take a handful of our complimentary antibiotics on your way out."

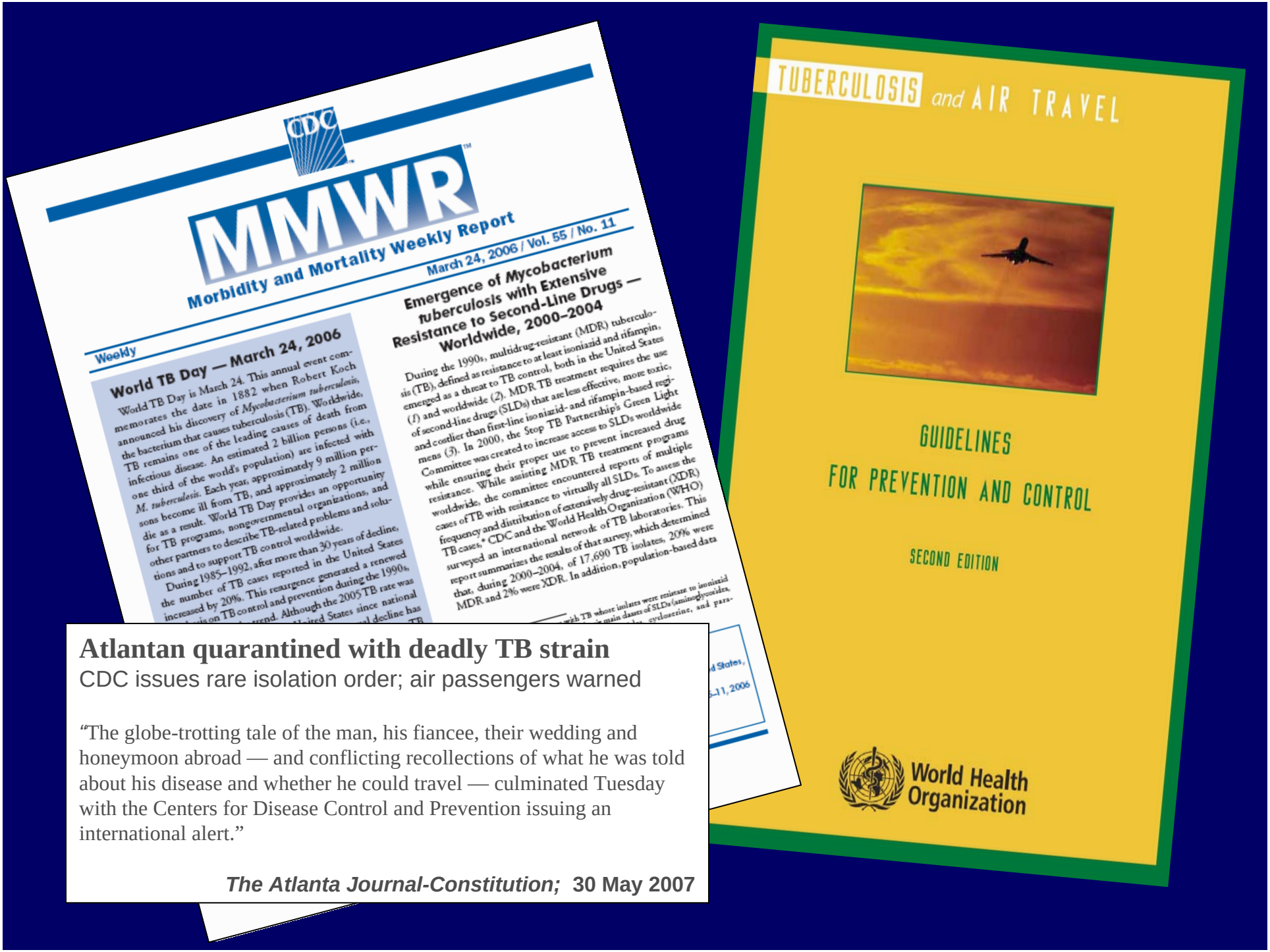
THE NEW YORKER, January 12, 1998

Antibacterial Agents Approved in the United States, 1983–2004





Adapted from Spellberg et al. Clin Infect Dis 2004;38:1279–86.



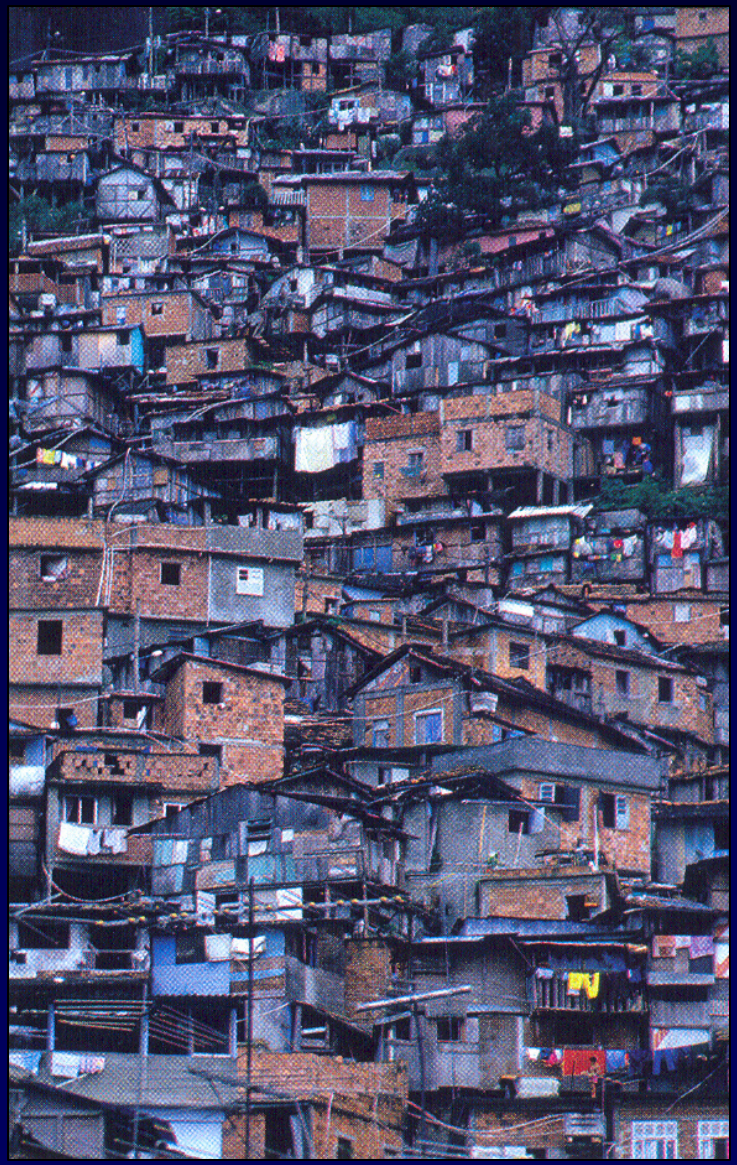
Atlantan quarantined with deadly TB strain

CDC issues rare isolation order; air passengers warned

"The globe-trotting tale of the man, his fiancee, their wedding and honeymoon abroad — and conflicting recollections of what he was told about his disease and whether he could travel — culminated Tuesday with the Centers for Disease Control and Prevention issuing an international alert."

The Atlanta Journal-Constitution; **30 May 2007**

Poverty and Social Inequality



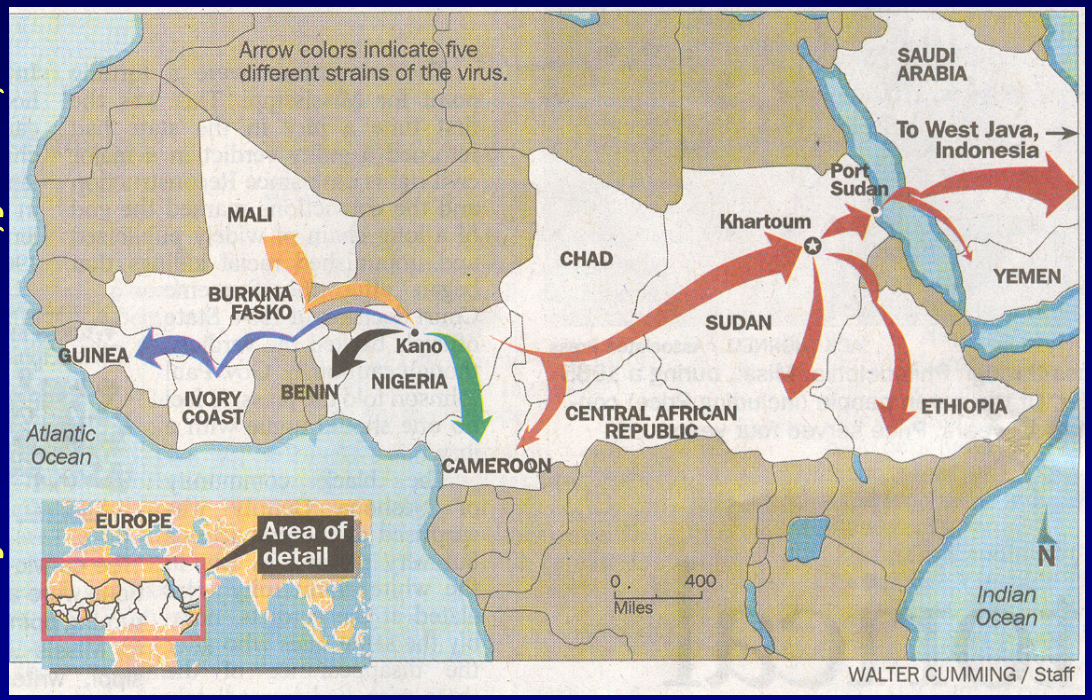
NEJM 2004; 350:1483.

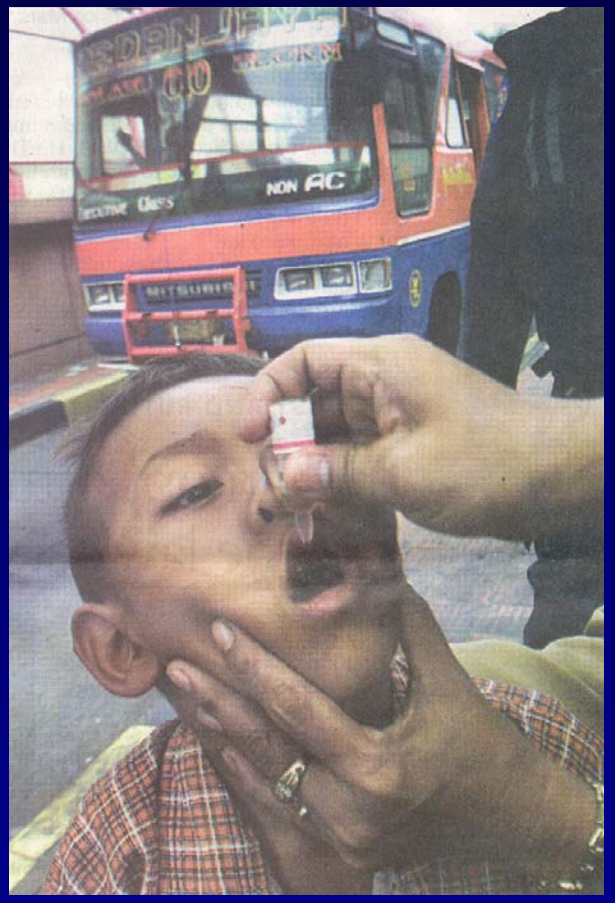
Lancet 2005;365:901-3.

Lack of Political Will

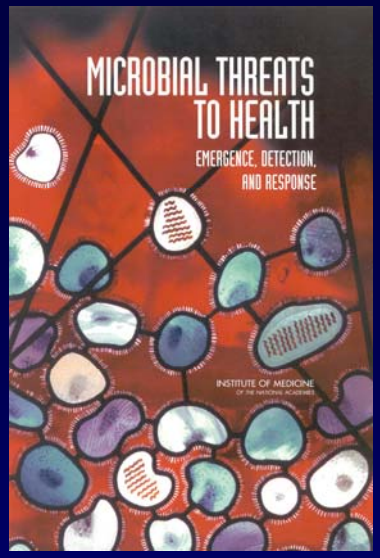
Polio: Obstacles keep eradication out of reach

Atlanta Journal-Constitution, June 12, 2005





Polio resurgence in Nigeria resulted in the spread of WPV during 2003–05 into 18 countries that had been polio-free for 1 or more years, including 3 countries outside Africa (*MMWR* 2005;54:873–7).



Convergence Model

PHYSICAL ENVIRONMENTAL FACTORS

GENETIC AND BIOLOGICAL FACTORS

Microbe

Human

ECOLOGICAL FACTORS

SOCIAL, POLITICAL, AND ECONOMIC FACTORS

CDC
Centers for Disease Control and Prevention

Selected Emerging Infectious Disease Challenges 1993–2008

Hantavirus pulmonary syndrome
Plague
Ebola hemorrhagic fever
New variant Creutzfeldt-Jakob disease
Cyclospora
H5N1 influenza
Nipah virus encephalitis
West Nile virus neuroinvasive disease
Rift Valley fever
Anthrax
Vancomycin-resistant *S. aureus*
SARS
Monkeypox
Transplant-associated infections
Community-associated methicillin-resistant *S. aureus*
Poliomyelitis
Marburg hemorrhagic fever

nature Vol 451|21 February 2008|doi:10.1038/nature06536

LETTERS

Global trends in emerging infectious diseases

Kate E. Jones[1], Nikkita G. Patel[2], Marc A. Levy[3], Adam Storeygard[3]†, Deborah Balk[3]†, John L. Gittleman[4] & Peter Daszak[2]

Emerging infectious diseases (EIDs) are a significant burden on global economies and public health[1–3]. Their emergence is thought to be driven largely by socio-economic, environmental and ecological factors[1–9], but no comparative study has explicitly analysed these linkages to understand global temporal and spatial patterns of EIDs. Here we analyse a database of 335 EID 'events' (origins of EIDs) between 1940 and 2004, and demonstrate non-random global patterns. EID events have risen significantly over time after controlling for reporting bias, with their peak incidence (in the 1980s) concomitant with the HIV pandemic. EID events are dominated by zoonoses (60.3% of EIDs): the majority of these (71.8%) originate in wildlife (for example, severe acute respiratory virus, Ebola virus), and are increasing significantly over time. We find that 54.3% of EID events are caused by bacteria or ri reflecting a large number of drug-resistant microbes in base. Our results confirm that EID origins are significant lated with socio-economic, environmental and ecologica and provide a basis for identifying regions where new most likely to originate (emerging disease 'hotspots'). reveal a substantial risk of wildlife zoonotic and vector-bo originating at lower latitudes where reporting effort is conclude that global resources to counter disease emerg poorly allocated, with the majority of the scientific and lance effort focused on countries from where the next i EID is least likely to originate.

In the global human population, we report the emergen infectious diseases between 1940 and 2004. Here we define temporal origination of an EID (that is, the original case or cases representing an infectious disease emerging in human tions for the first time—see Methods and Supplementary T an EID 'event'. Our database includes EID events caused by newly evolved strains of pathogens (for example, multi-drug-resistant tuberculosis and chloroquine-resistant malaria), pathogens that have recently entered human populations for the first time (for example, HIV-1, severe acute respiratory syndrome (SARS) coronavirus), and pathogens that have probably been present in humans historically, but which have recently increased in incidence (for example, Lyme disease). The emergence of these pathogens and their subsequent spread have caused an extremely significant impact on global health and economies[1–3]. Previous efforts to understand patterns of EID emergence have highlighted viral pathogens (especially RNA viruses) as a major threat, owing to their often high rates of nucleotide substitution, poor mutation error-correction ability and therefore higher capacity to adapt to new hosts, including humans[5,6,10,11]. However, we find that the majority of pathogens involved in EID events are bacterial or rickettsial (54.3%). This group is typically represented by the emergence of drug-resistant bacterial strains (for example, vancomycin-resistant *Staphylococcus aureus*). Viral or

nature International weekly journal of science

global health, in which different pathogen strains can cause separate significant outbreaks[12]. In broad concurrence with previous studies on the characteristics of emerging human pathogens[5,6,11], we find the percentages of EID events caused by other pathogen types to be 10.7% for protozoa, 6.3% for fungi and 3.3% for helminths (see Supplementary Data and Supplementary Table 2 for a detailed comparison to previous studies).

EID events are dominated by zoonoses (60.3% of EIDs): the majority of these (71.8%) originate in wildlife (for example, severe acute respiratory virus, Ebola virus), and are increasing significantly over time.

gence of new diseases associated with the HIV/AIDS pandemic[5,13].

The majority (60.3%) of EID events are caused by zoonotic pathogens (defined here as those which have a non-human animal source), which is consistent with previous analyses of human EIDs[5,6]. Furthermore, 71.8% of these zoonotic EID events were caused by pathogens with a wildlife origin—for example, the emergence of Nipah virus in Perak, Malaysia and SARS in Guangdong Province, China. The number of EID events caused by pathogens originating in wildlife has increased significantly with time, controlling for reporting effort ($GLM_{P,BD}$ $F = 60.7$, $P < 0.001$, d.f. = 57), and they constituted 52.0% of EID events in the most recent decade (1990–2000) (Fig. 1). This supports the suggestion that zoonotic EIDs represent an increasing and very significant threat to global health[1,2,7,13,14]. It also highlights the importance of understanding the factors that increase contact between wildlife and humans in developing predictive approaches to disease emergence[4,6,9,15].

Vector-borne diseases are responsible for 22.8% of EID events in our database, and 28.8% in the last decade (Fig. 1). Our analysis

Overview

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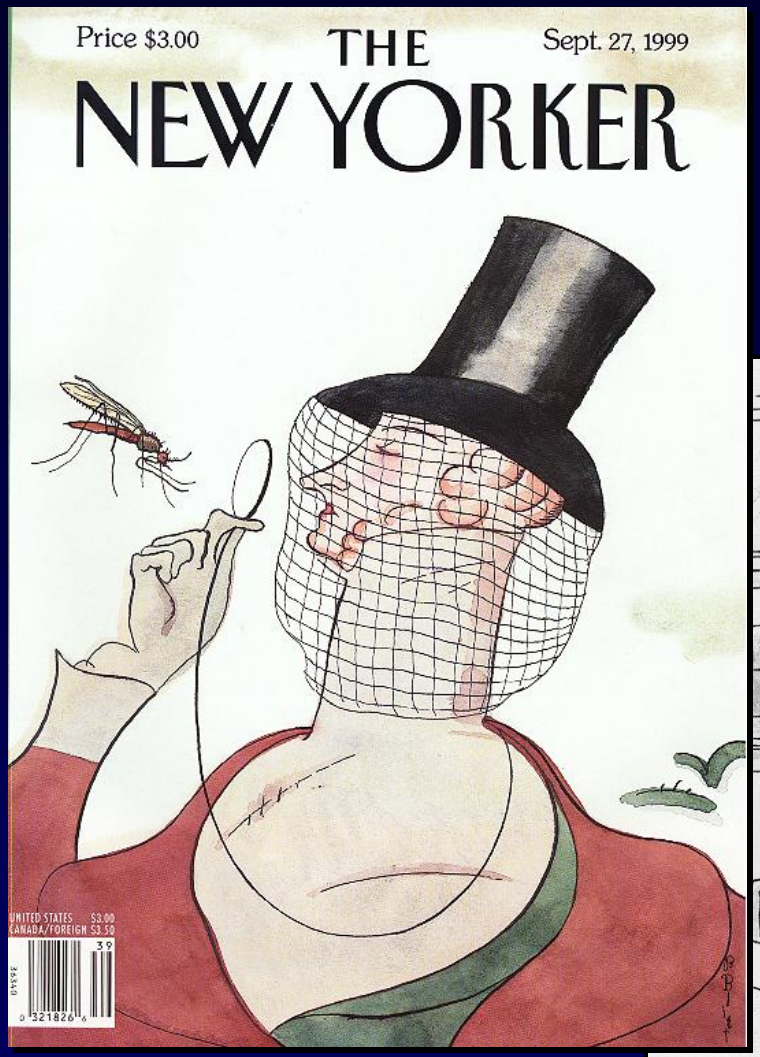
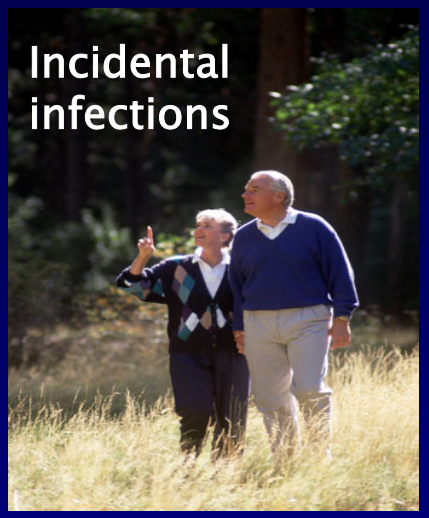


"We're pretty sure it's the West Nile virus."

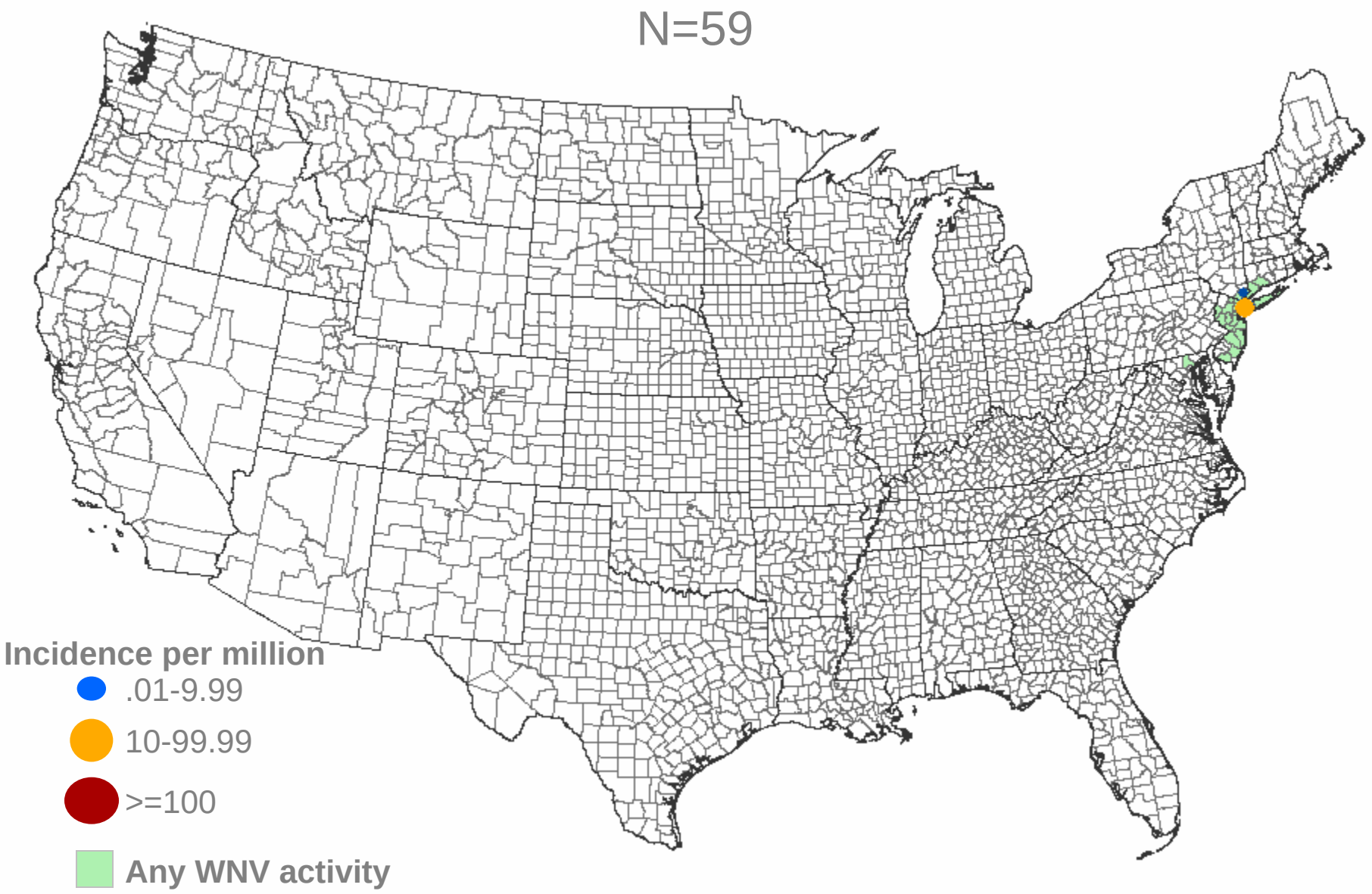
West Nile Virus Transmission Cycle

West Nile Virus

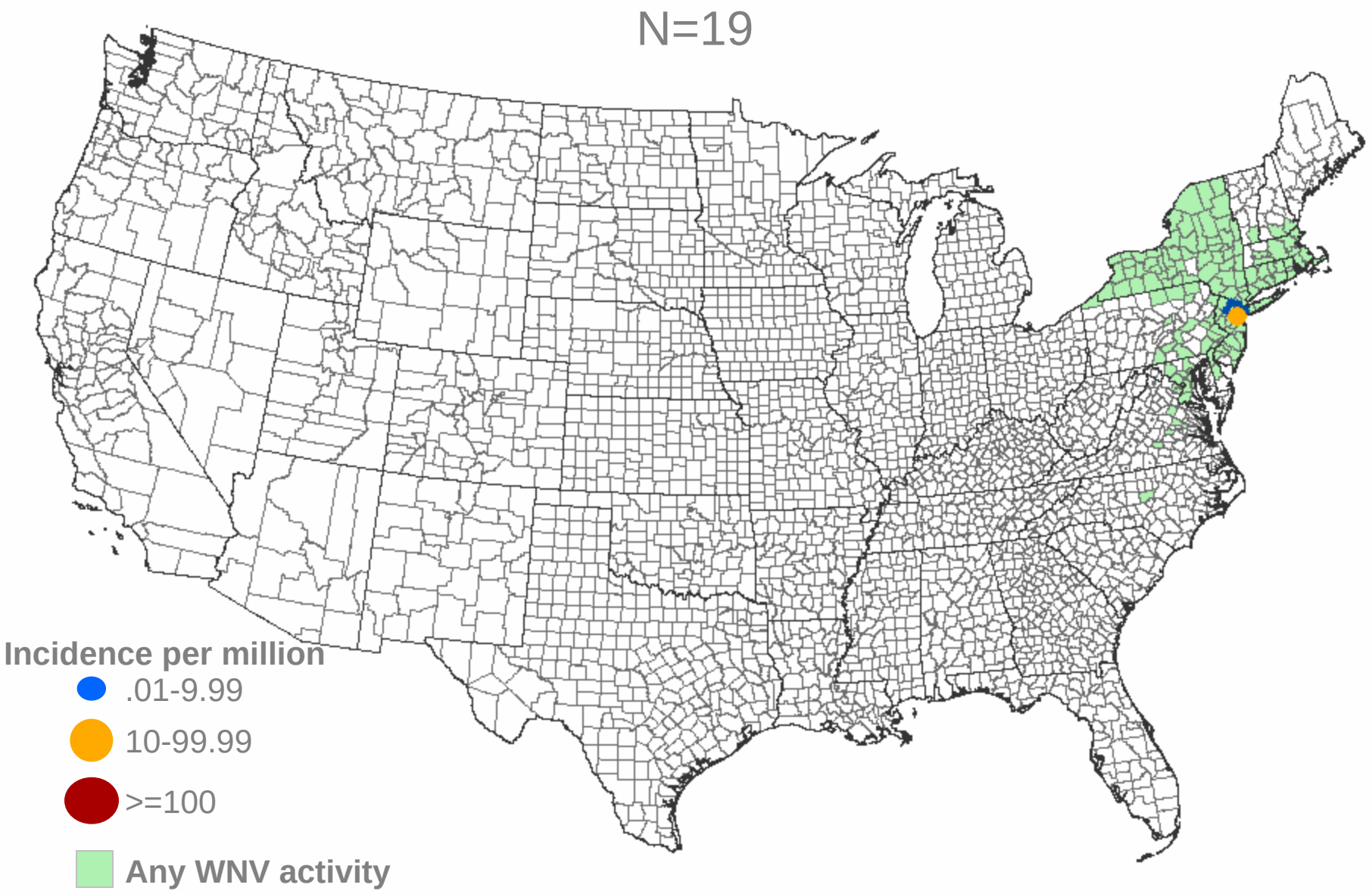
West Nile Virus



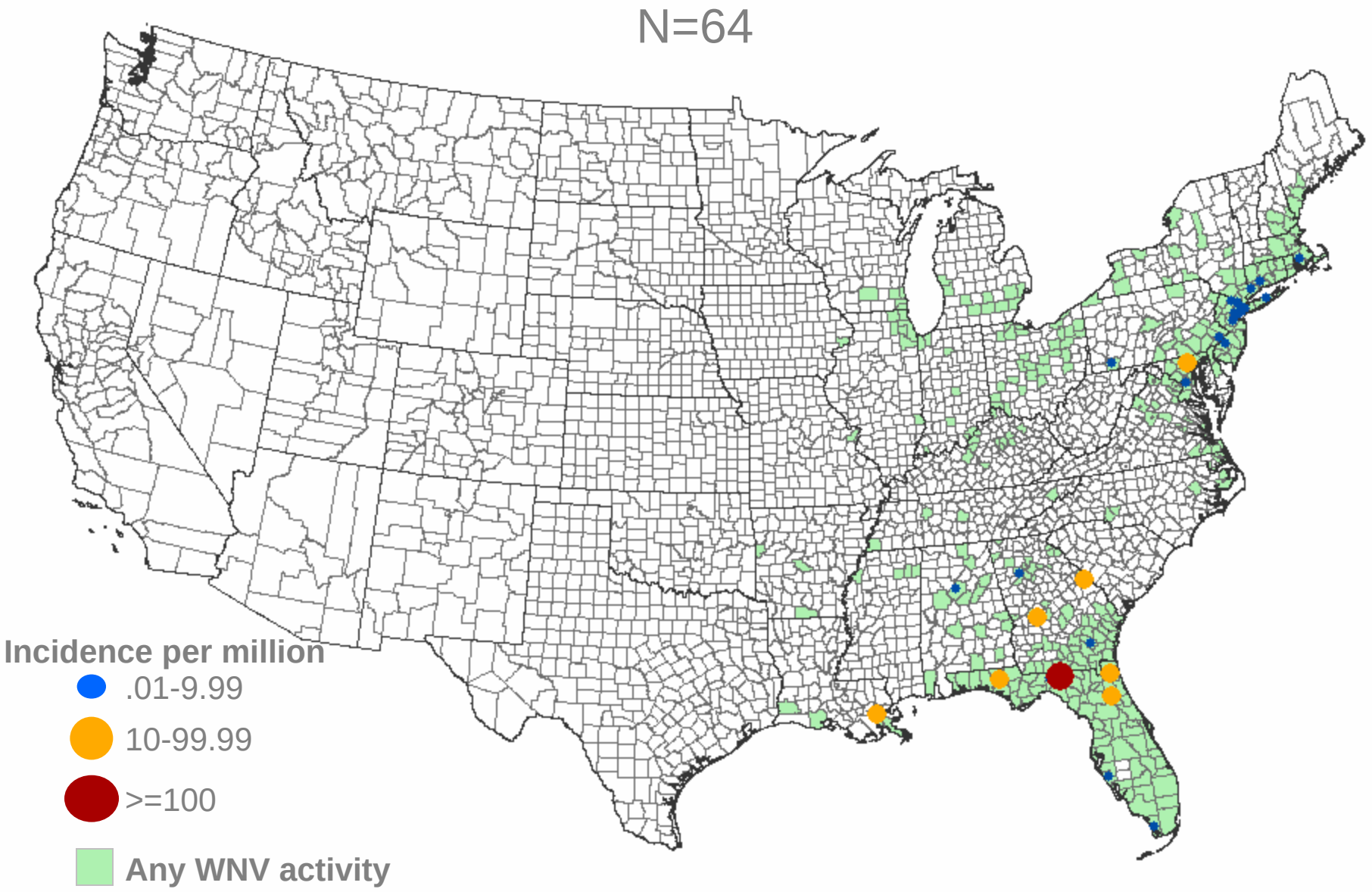
WNV Neuroinvasive Disease Incidence, by County, US, 1999



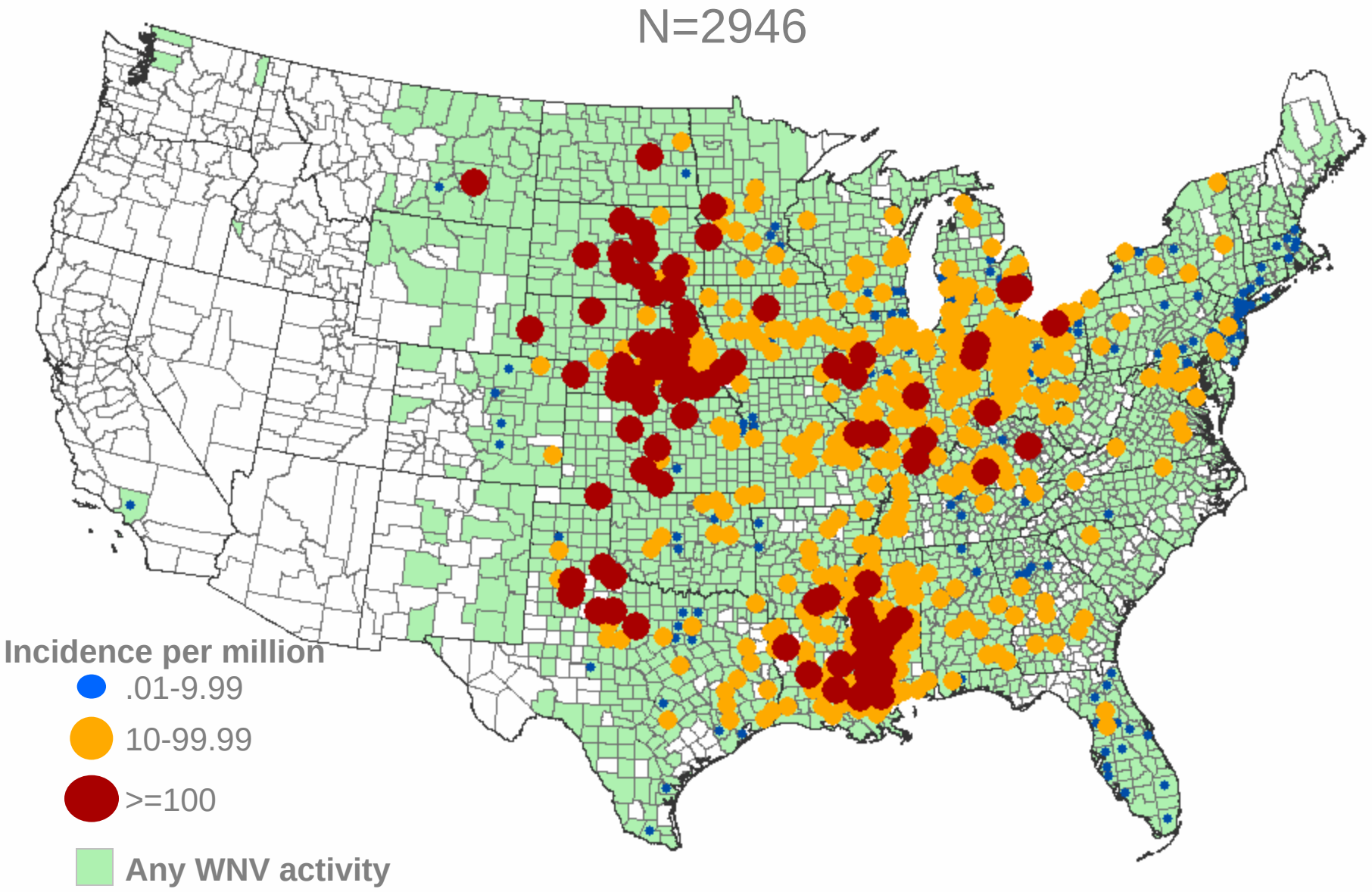
WNV Neuroinvasive Disease Incidence, by County, US, 2000



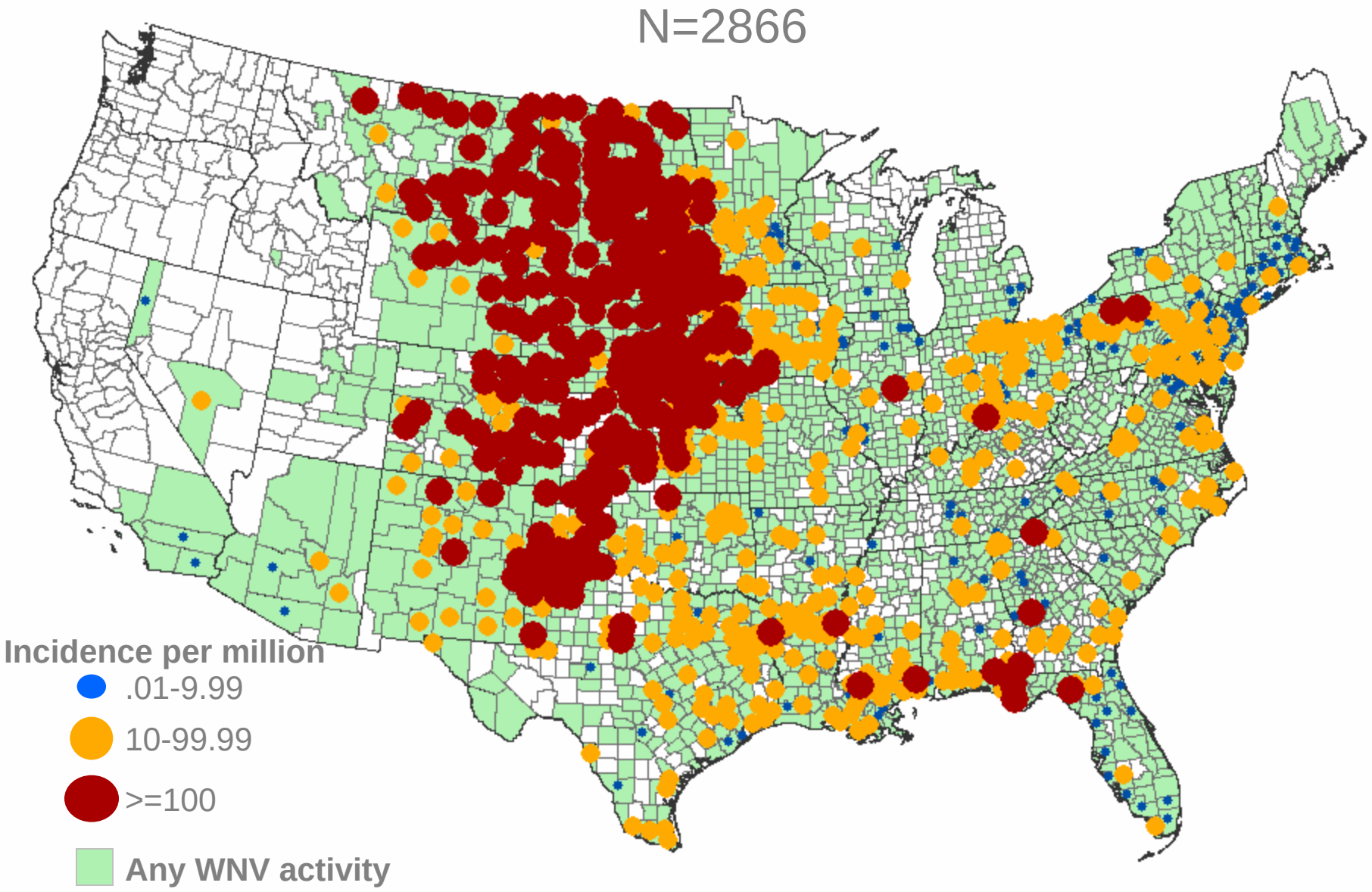
WNV Neuroinvasive Disease Incidence, by County, US, 2001



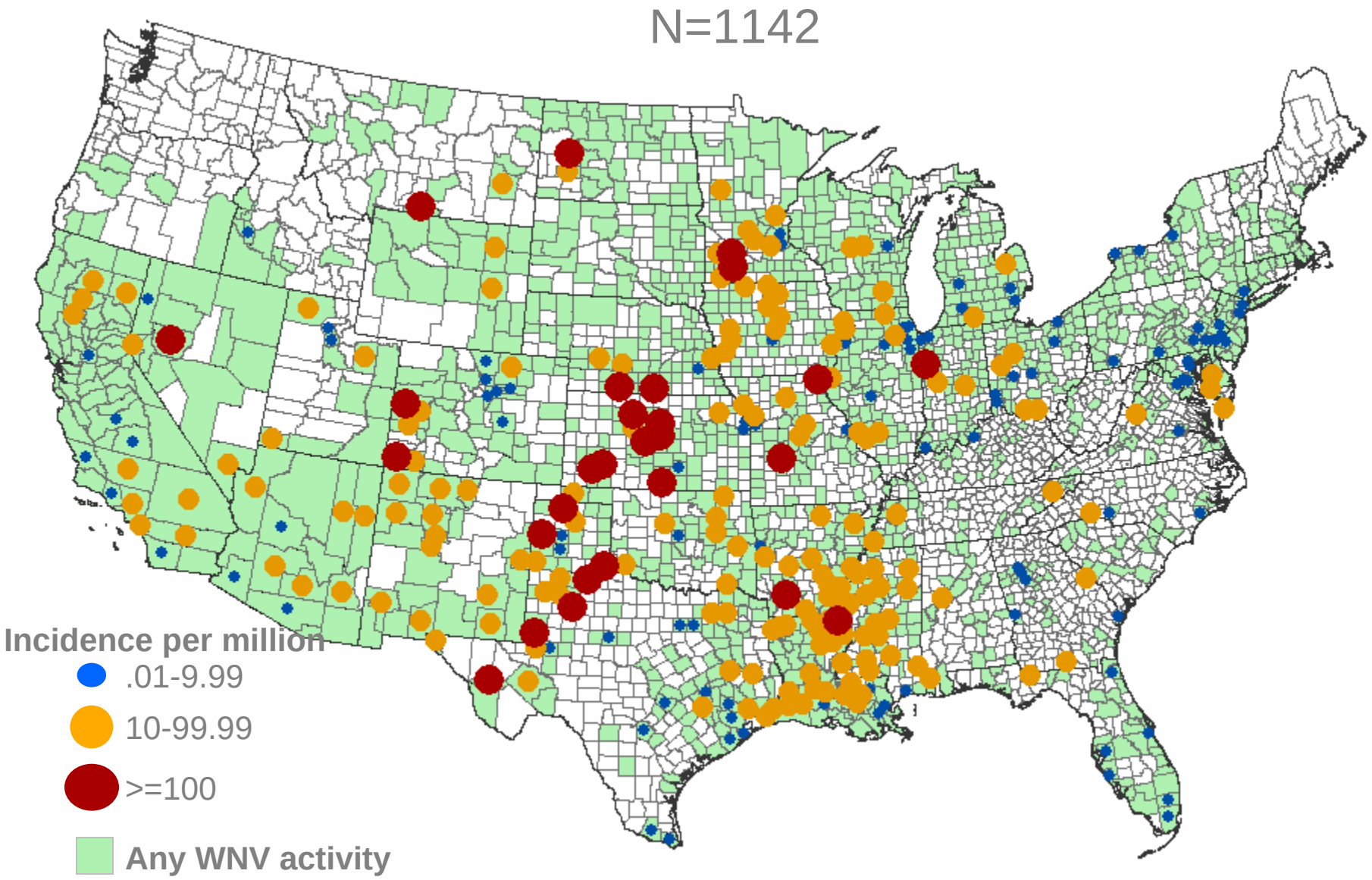
WNV Neuroinvasive Disease Incidence, by County, US, 2002



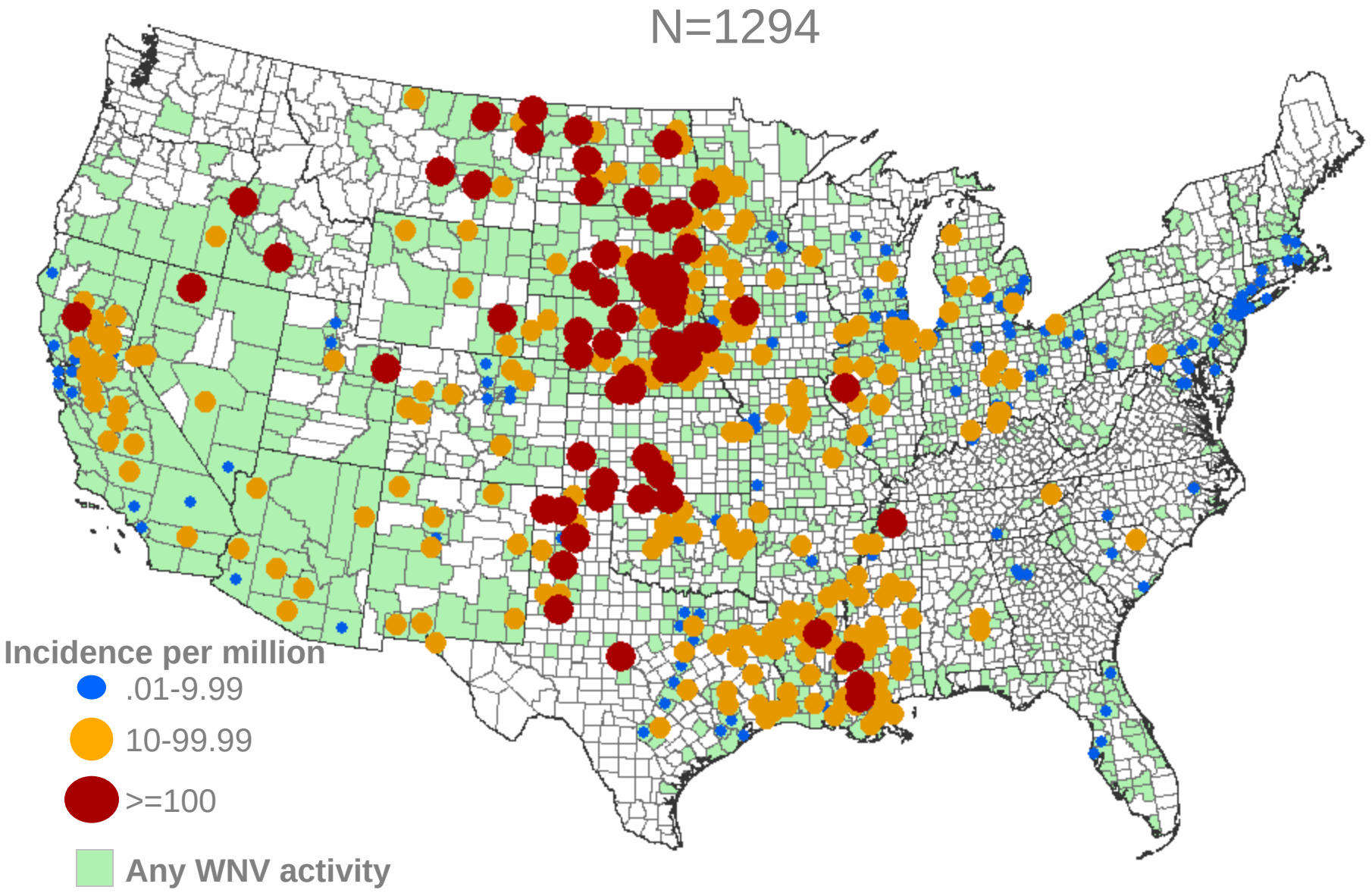
WNV Neuroinvasive Disease Incidence, by County, US, 2003



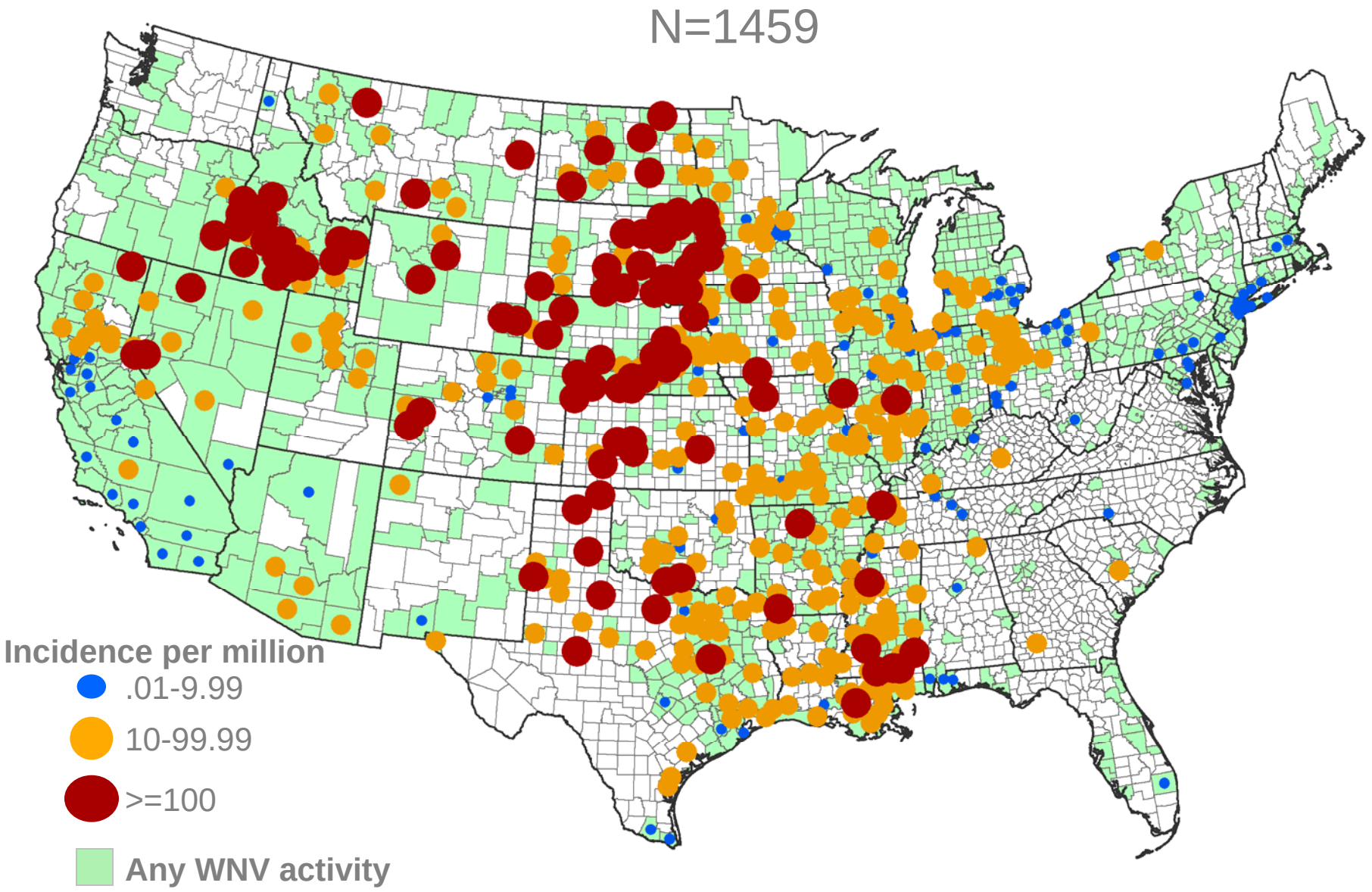
WNV Neuroinvasive Disease Incidence, by County, US, 2004



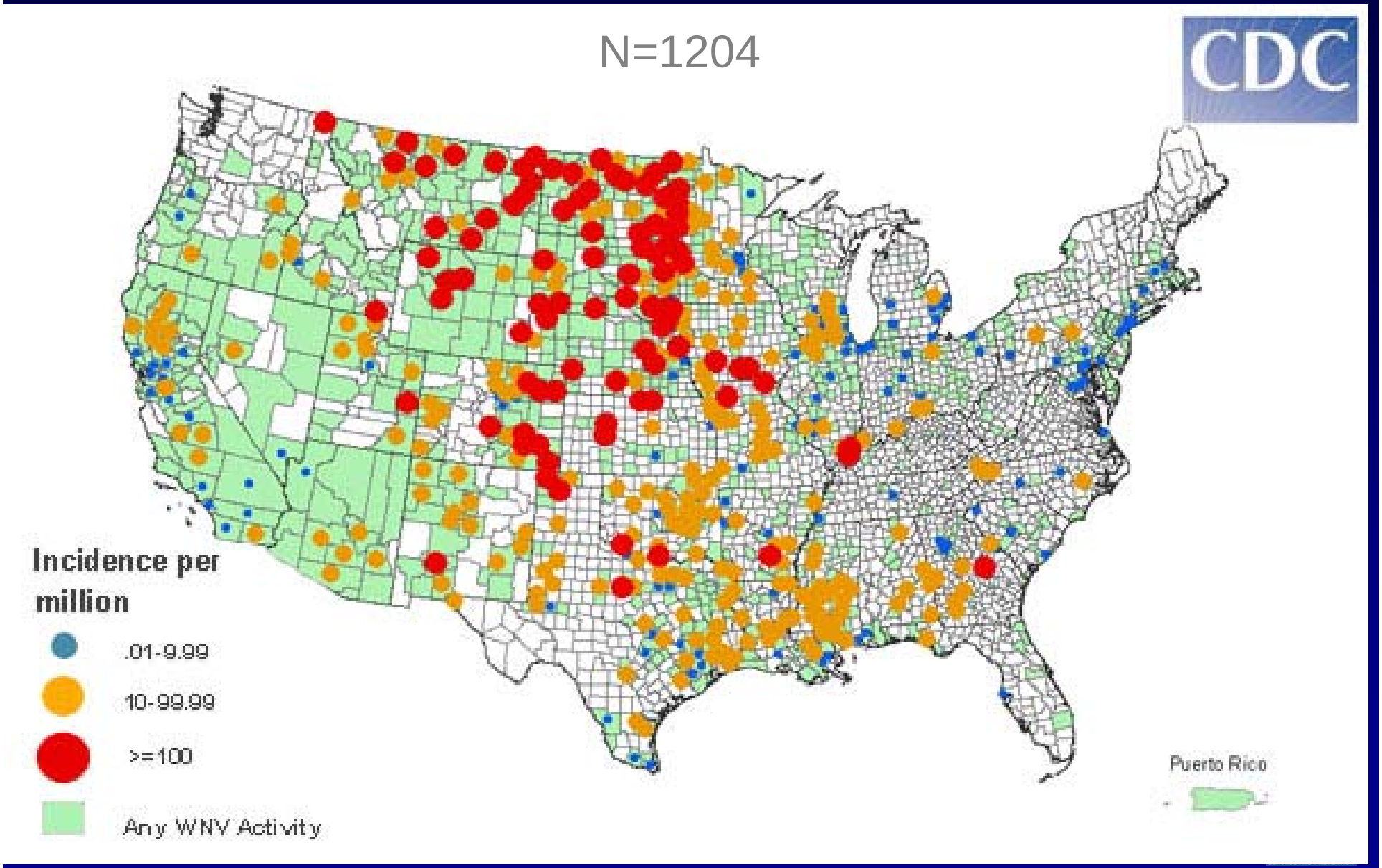
WNV Neuroinvasive Disease Incidence, by County, US, 2005



WNV Neuroinvasive Disease Incidence, by County, US, 2006



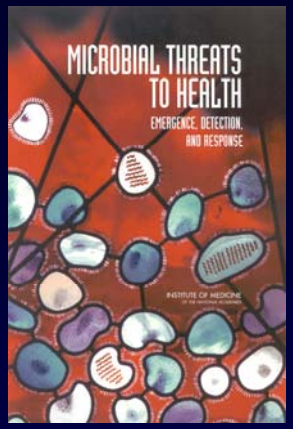
WNV Neuroinvasive Disease Incidence, by County, US, 2007 (reported through March 4, 2008)



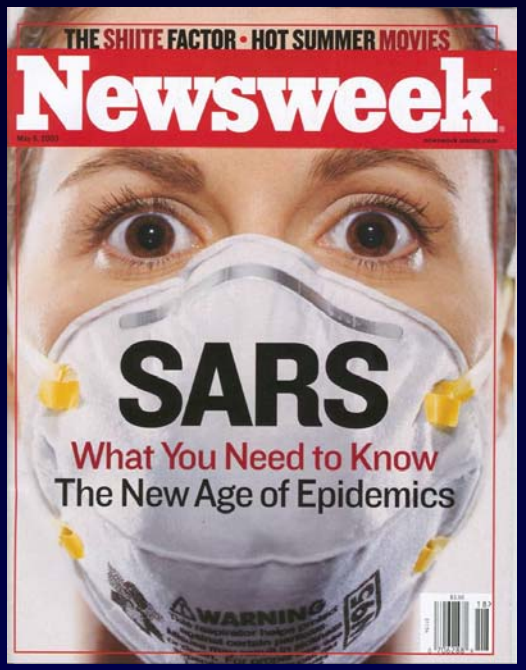
Reported WNV Disease Cases in Humans, United States, 1999–2007*

Year	Encephilitis/ Meningitis	Fever	Other clinical /unspecified	Total cases	Deaths
1999	59	3	0	62	7
2000	19	2	0	21	2
2001	64	2	0	66	9
2002	2,946	1,160	50	4,156	284
2003	2,866	6,830	166	9,862	264
2004	1,142	1,269	128	2,539	100
2005	1,294	1,607	99	3,000	119
2006	1,459	2,616	194	4,269	177
2007	1,204	2,331	63	3,598	121
Total	11,053	15,820	700	27,573	1083

* Reported as of March 2008

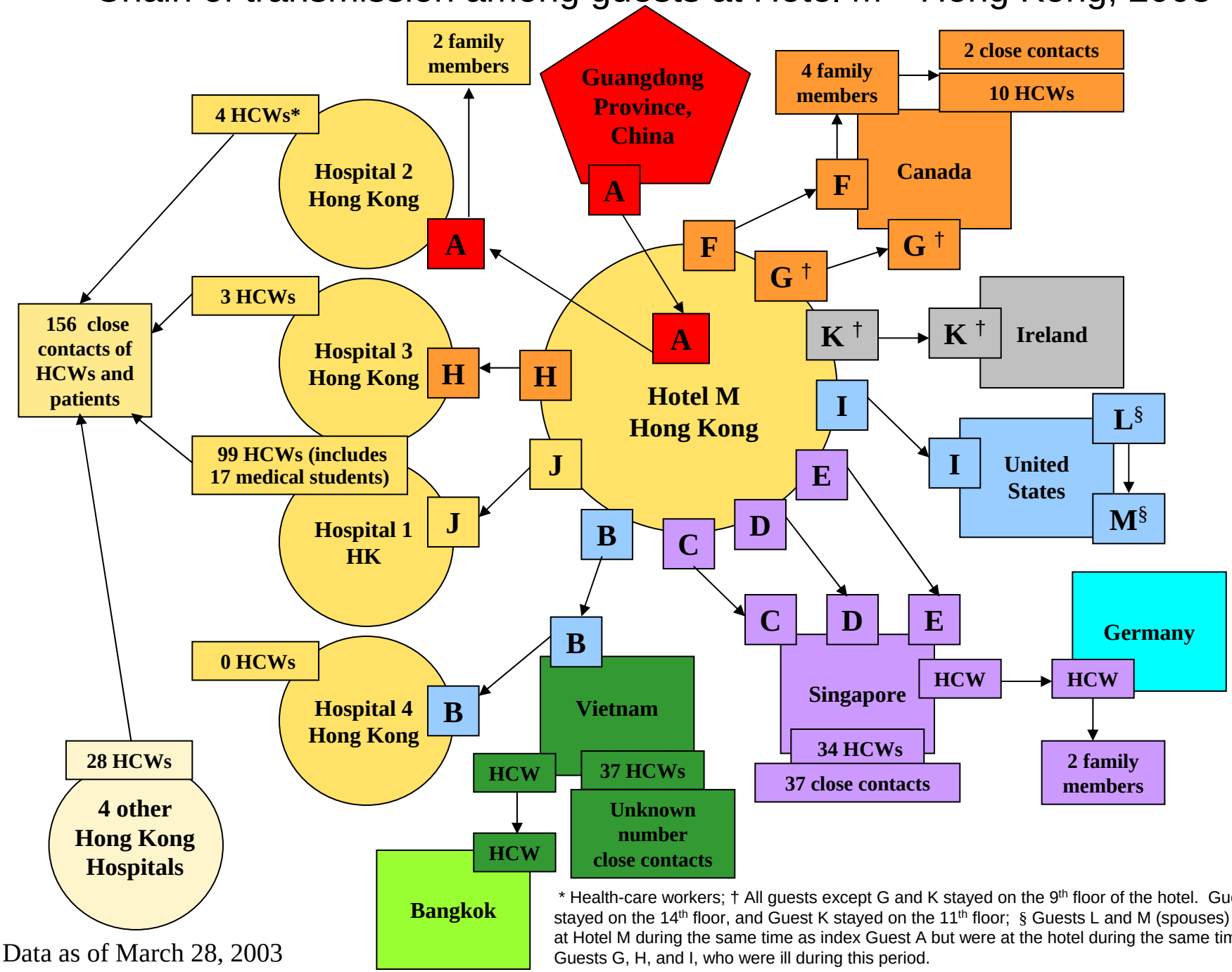


SARS 2003: A Global Microbial Threat



Early Cases of SARS: Guangdong Province, China

Chain of transmission among guests at Hotel M—Hong Kong, 2003



Data as of March 28, 2003

* Health-care workers; † All guests except G and K stayed on the 9th floor of the hotel. Guest G stayed on the 14th floor, and Guest K stayed on the 11th floor; § Guests L and M (spouses) were not at Hotel M during the same time as index Guest A but were at the hotel during the same times as Guests G, H, and I, who were ill during this period.

SARS Declared Contained, With No Cases In Past 20 Days

By KEITH BRADSHER

HONG KONG, July 5 — The World Health Organization declared today that SARS had been contained around the world, with no new cases reported to the agency by any country since June 15. But it warned that the disease could still pose a threat.

The W.H.O. removed the last place on its list of SARS-affected areas, Taiwan. No new cases have been found there for 20 days, a span the agency believes to be twice the disease's incubation period.

SARS, or severe acute respiratory syndrome, has infected 8,439 people in 30 countries on five continents and has killed 812 people. Nearly 200 people with SARS are still being treated in hospitals around the world under strict isolation procedures to prevent them from infecting health-care workers.

New York Times
July 6, 2003

World Health Organization

Update 96 - Taiwan, China: SARS transmission interrupted in last outbreak area

5 July

WHO is today removing Taiwan from its list of areas with recent local transmission of SARS. This achievement means that all known chains of pe transmission of the SARS virus have now been broken.

"With the last known chain of transmission interrupted in Taiwan, the whole world can breathe an initial sigh of relief," said Dr David Heymann, th Director for communicable diseases. "At the same time, public health must not let down its guard, as more cases could still surface somewhere in has taught us that a single case is capable of igniting an outbreak."

Country	No. of Cases	HCWs	Deaths (CFR)
China	5,327	19%	349 (7)
Hong Kong	1,755	22%	299 (17)
Taiwan	346	20%	37 (11)
Canada	251	43%	43 (17)
Singapore	238	41%	33 (14)
Other	182	25%	13 (7)
Total	8,098	21%	774 (10)

Bloomberg News

A masked bellboy in the empty lobby of the Mandarin Hotel in Hong Kong, where a deadly virus is keeping residents at home and tourists away. Some businesses are seeking tax relief from the government.

The New York Times
April 12, 2003

WHO Falls Short in Bid For Help in SARS Fight

Agency's Efforts to Raise $200 Million in Business, Government Aid Falters

By Gautam Naik

LONDON—An ambitious plan by the World Health Organization to raise $200 million from companies and governments to strengthen public-health infrastructure in China and elsewhere has fallen massively short of its goal, leaving the world potentially more vulnerable to scourges like SARS, experts say.

In May, WHO and the World Economic Forum, an international business and economic network, launched a much-publicized effort to raise by September $100 million from businesses to improve public-health systems in China, believed to be the breeding ground for severe acute respiratory syndrome, new flu viruses and other deadly bugs. The second $100 million was meant to bolster disease-monitoring and response systems of other devel-

tend that WHO and the World Economic Forum have failed to follow through aggressively on their plan.

Kate Taylor, director of the World Economic Forum's Global Health Initiative, declines to say how many companies were approached by the forum. "We didn't make a huge outreach effort," she concedes. "The fund has been put on hold." Dow Jones & Co., publisher of The Wall Street Journal, is a business member of the World Economic Forum.

Public-health experts warn that the consequences of the failure could be severe. There's a chance SARS will resurface this winter, when respiratory diseases tend to spread most easily. While the Chinese government, which bungled its initial handling of the SARS outbreak, has strengthened its disease-surveillance network, huge gaps remain. Rural China is a potential breeding ground for exotic new viruses because of a dense population that lives in close proximity to animals. In that area, there is still a shortage of laboratories, equipment and personnel that can quickly identify, track and contain outbreaks.

The Asian Wall Street Journal
October 10, 2003

Estimated Economic Impact of SARS

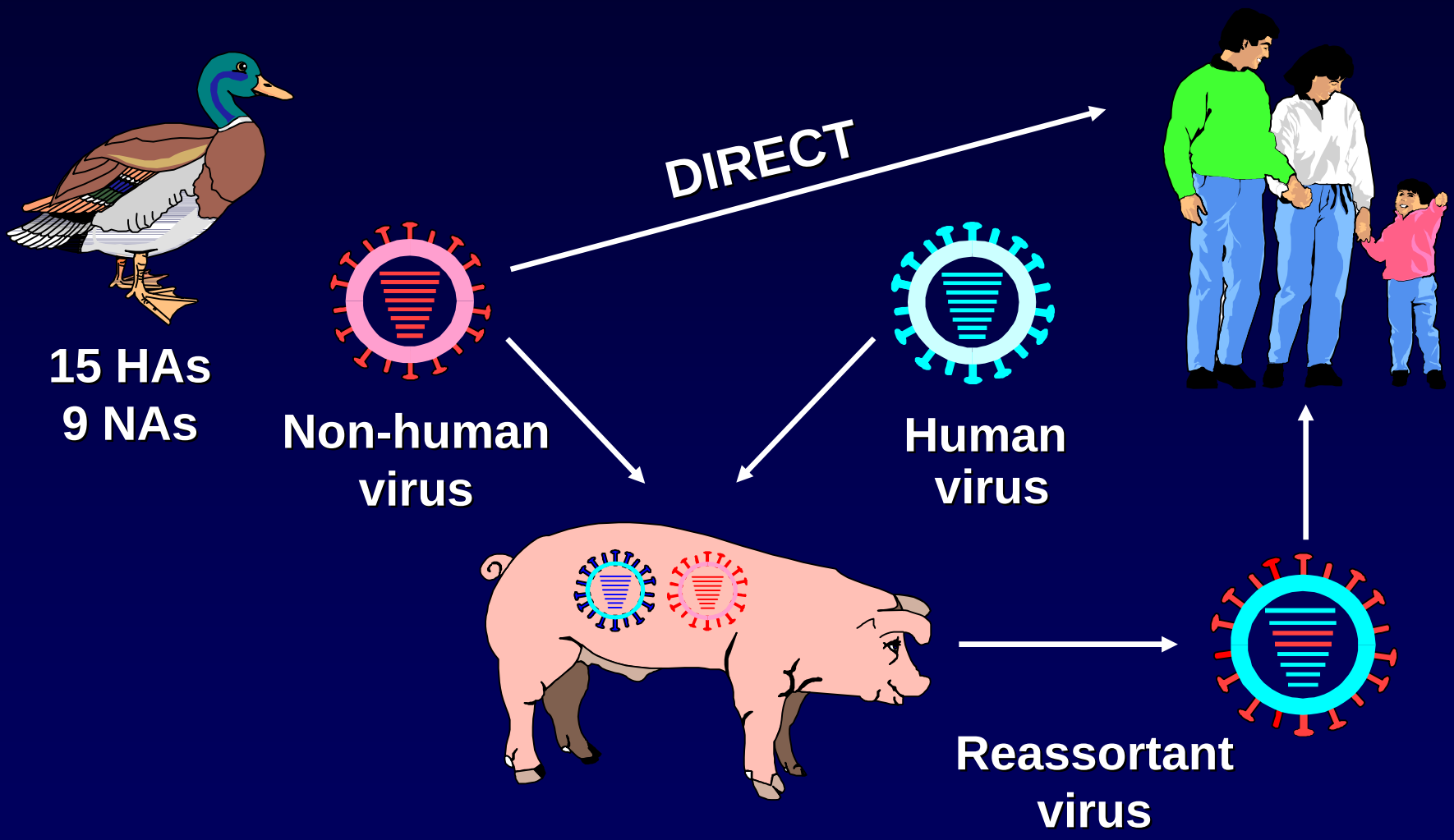
$30 billion (Stanley Morgan)

$100 billion (*Nature*)

$48 billion in China alone
(Chinese Center for Economic Research)

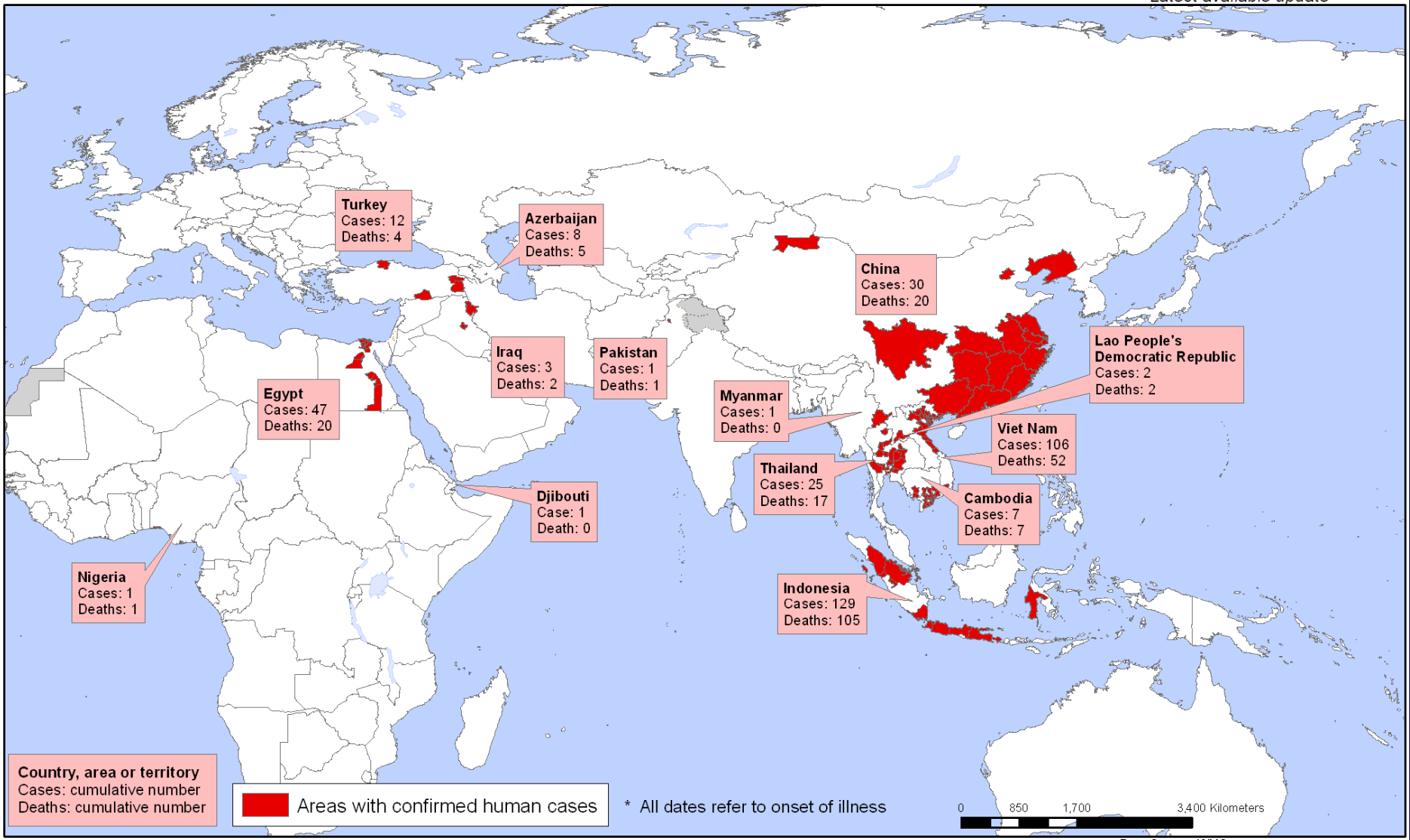
www.timeasia.com
FEBRUARY 9, 2004
TIME
BIRD FLU
Is Asia hatching the next human pandemic?

Mechanisms of Influenza Virus Antigenic "Shift"



Areas with confirmed human cases of H5N1 avian influenza since 2003 *

Status as of 18 March 2008
Latest available update



World Health Organization

The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: WHO
Map Production: Public Health Mapping and GIS
World Health Organization
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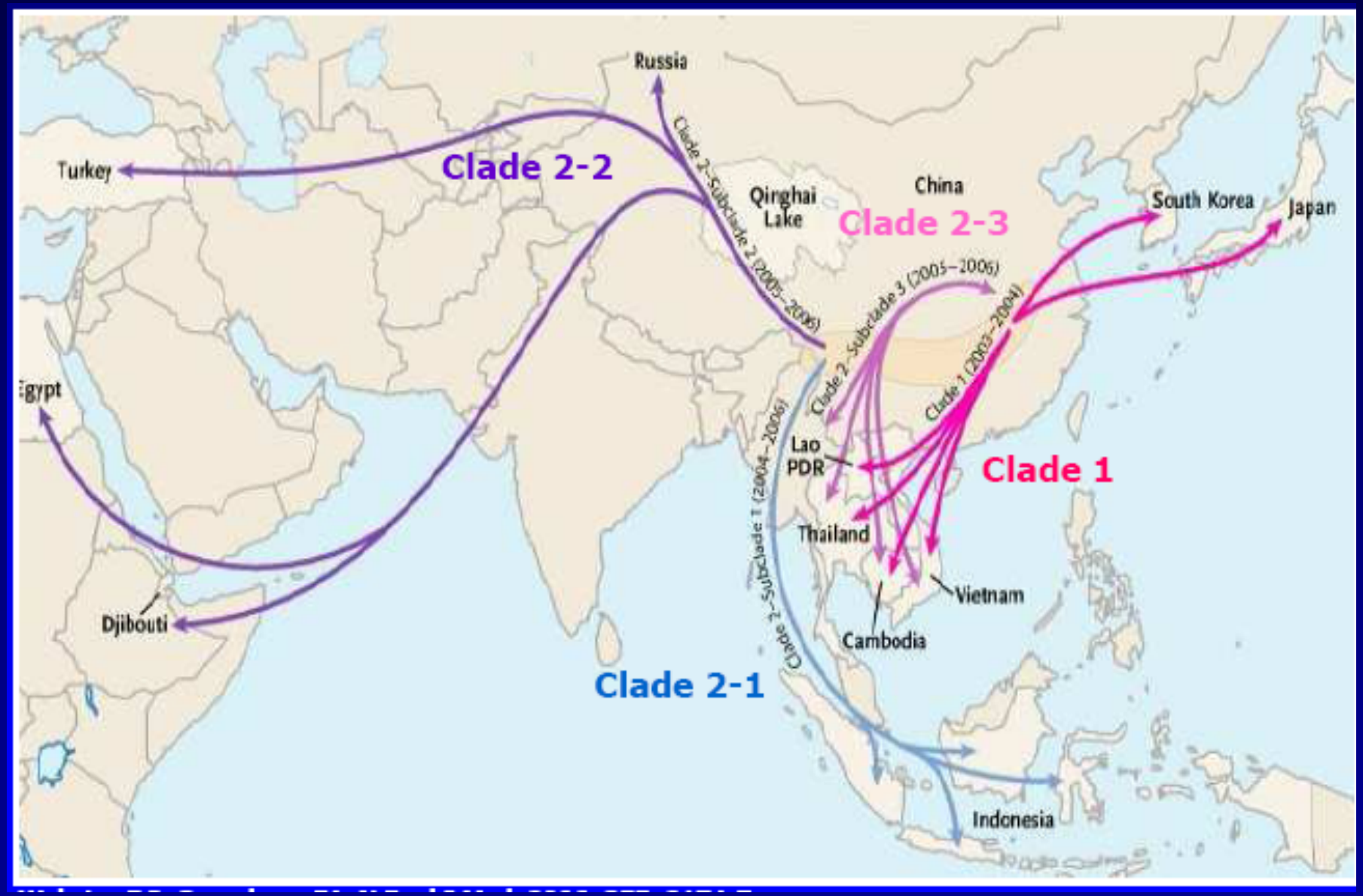
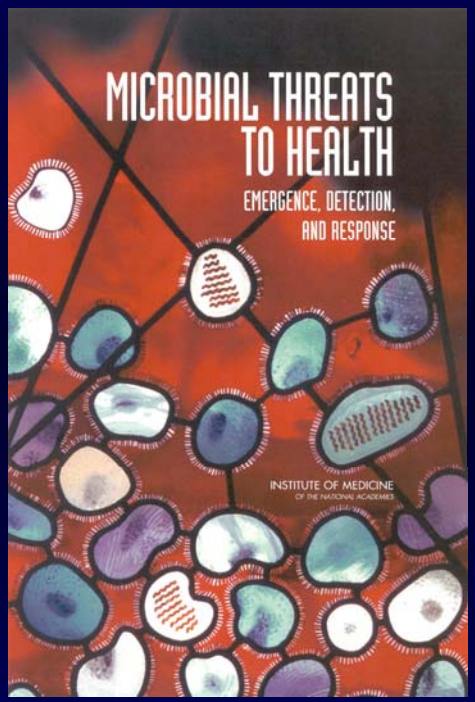
Circulating of influenza A/H5N1 viruses



Spectrum of Microbial Threats



- The global burden of AIDS, tuberculosis, and malaria
- Emerging infectious diseases
- Antimicrobial-resistant infections
- Chronic diseases with infectious etiology
- Microbes intentionally used for harm

Evolution of Drug Resistance in *Staphylococcus aureus*

Penicillin

Methicillin

Vancomycin

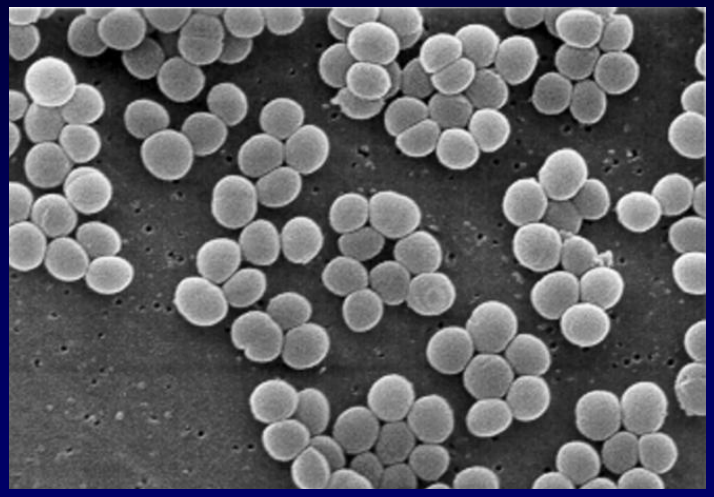
1950s | 1960s | 1970s | 1980s | 1990s | 2000s

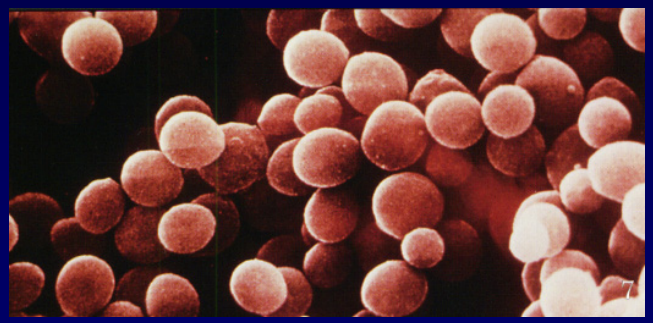
Penicillin-resistant *S. aureus*

Methicillin-resistant *S. aureus* (MRSA)

1997 Vancomycin intermediate-resistant *S. aureus* (VISA)

2002 Vancomycin-resistant *S. aureus* (VRSA)





42 ISSUES IN INFECTION CONTROL

INFECTIOUS DISEASE NEWS • MAY 2004

CDC reports ~~third~~ 9th case of VRSA

The case appears unrelated epidemiologically to previous cases in Michigan and Pennsylvania.

by Bryan Bechtel

care Epidemiology of America.

Clifford McDonald, MD, a medical officer with the division of health care quality promotion of the CDC.

A March 17 urine culture obtained from the patient and tested for susceptibility using a Microscan (Dade Behring) Etest (AB Biodisk North America) showed a MIC to vancomycin of >256 µg/mL. After the New York State Department of Health was notified, the isolate was forwarded to the CDC for confirmatory testing.

Using the National Committee for Clinical Laboratory Standards broth microdilution reference method, CDC ...wed a MIC to vancomycin ...nL, confirming that the iso- ...fact resistant.

...estigation

...ent testing showed the isolate ...tible to chloramphenicol, line-

ANTIMICROBIAL AGENTS AND CHEMOTHERAPY, Feb. 2008, p. 452–457 Vol. 52, No. 2
0066-4804/08/$08.00+0 doi:10.1128/AAC.00908-07

Vancomycin-Resistant *Staphylococcus aureus* Isolates Associated with Inc18-Like *vanA* Plasmids in Michigan▽

Wenming Zhu, Nancye C. Clark, Linda K. McDougal, Jeffery Hageman, L. Clifford McDonald, and Jean B. Patel*

Division of Healthcare Quality Promotion, Centers for Disease Control and Preven...

Received 11 July 2007/Returned for modification 11 September 2007/Accepted 13...

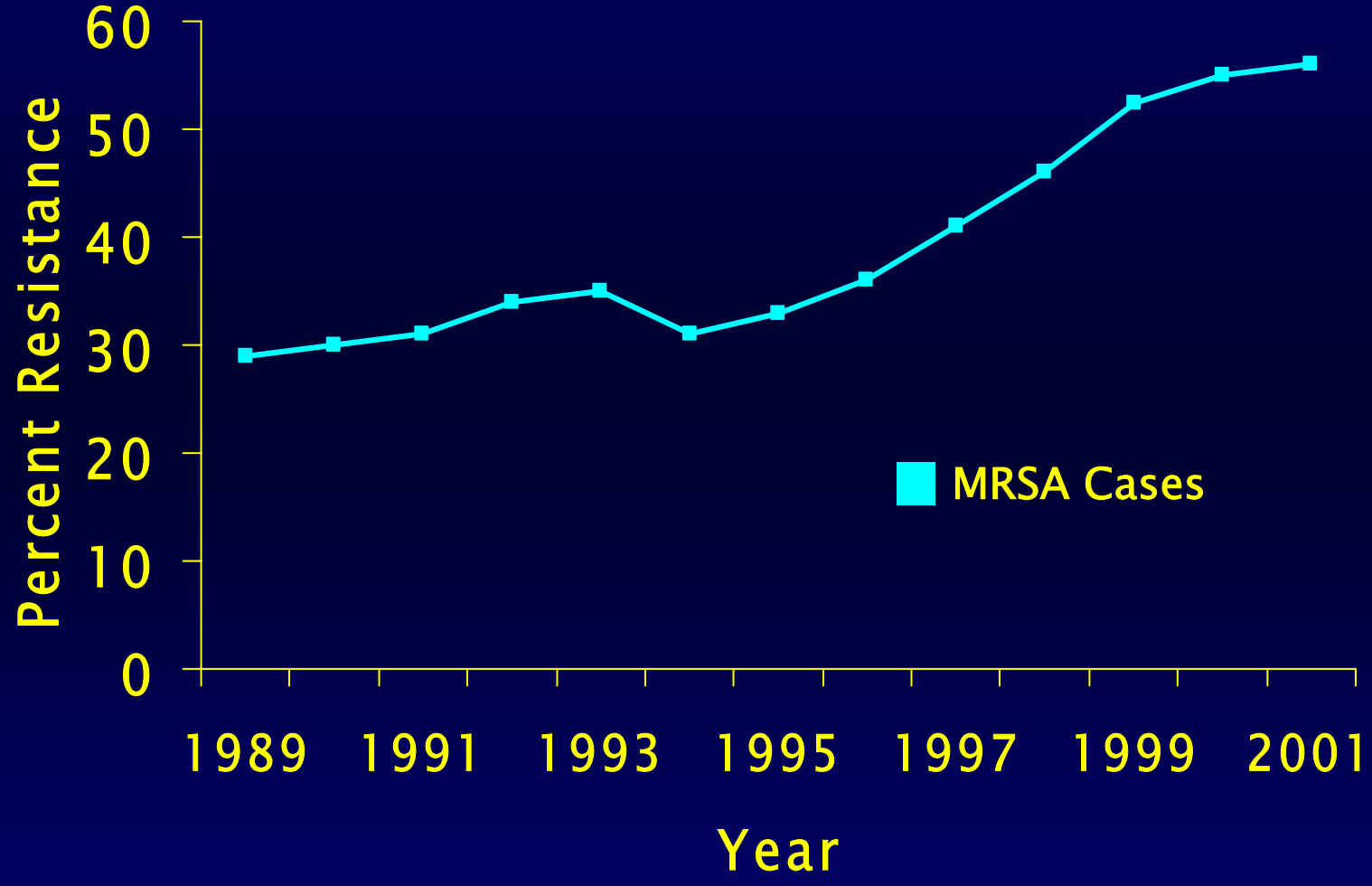
Five of the seven cases of vancomycin-resistant *Staphylococcus aureus* (VRSA) infect... occurred in southeastern Michigan. VRSA isolates from the four most recent cases ... characterized. The *vanA* gene was localized to a single plasmid in each VRSA iso... electrophoresis patterns of chromosomal DNA and the restriction profile of the plasm... four isolates were unique and differed from the first three VRSA isolates. Vancomy... (VRE) isolates, all of which were *Enterococcus faecalis*, were recovered from case p... isolate transferred vancomycin resistance to *E. faecalis* JH2-2 by conjugation. PCRs f... plasmid genes *traA* and *repR* confirmed the presence of an Inc18-like *vanA* plasmi... transconjugants. An Inc18-like *vanA* plasmid was identified in the VRSA isolate fr... findings suggest a role of Inc18-like plasmids as *vanA* donors.

Brief Report

Vancomycin-Resistant *Staphylococcus aureus* — New York, 2004

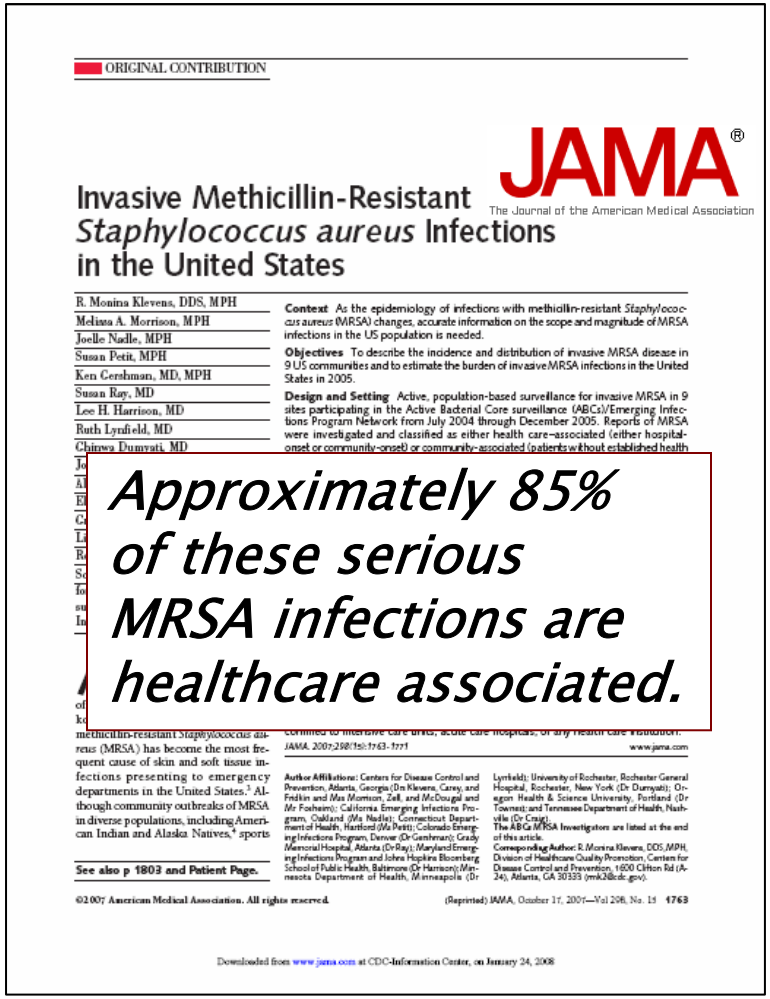
Staphylococcus aureus is a common cause of hospital- and community-acquired infections (*1,2*). The development of vancomycin-resistant enterococci in 1988 led the way to the emergence of vancomycin-resistant *S. aureus* (VRSA) (minimum inhibitory concentration [MIC] ≥32 µg/mL [*3*]), first recognized in 2002 (*4–7*). This report describes the third documented clinical isolate of VRSA from a patient in the United States and provides evidence of failure to detect this VRSA by commonly used automated antimicrobial susceptibility testing.

MRSA in Healthcare Settings



Source: NNIS DATA, Clinics Chest Med: 20:303-315.

Invasive MRSA in the US



ORIGINAL CONTRIBUTION

JAMA®
The Journal of the American Medical Association

Invasive Methicillin-Resistant *Staphylococcus aureus* Infections in the United States

R. Monina Klevens, DDS, MPH
Melissa A. Morrison, MPH
Joelle Nadle, MPH
Susan Petit, MPH
Ken Gershman, MD, MPH
Susan Ray, MD
Lee H. Harrison, MD
Ruth Lynfield, MD
Chinwa Dumyati, MD

Context As the epidemiology of infections with methicillin-resistant *Staphylococcus aureus* (MRSA) changes, accurate information on the scope and magnitude of MRSA infections in the US population is needed.

Objectives To describe the incidence and distribution of invasive MRSA disease in 9 US communities and to estimate the burden of invasive MRSA infections in the United States in 2005.

Design and Setting Active, population-based surveillance for invasive MRSA in 9 sites participating in the Active Bacterial Core surveillance (ABCs)/Emerging Infections Program Network from July 2004 through December 2005. Reports of MRSA were investigated and classified as either health care–associated (either hospital-onset or community-onset) or community-associated (patients without established health

Approximately 85% of these serious MRSA infections are healthcare associated.

methicillin-resistant *Staphylococcus aureus* (MRSA) has become the most frequent cause of skin and soft tissue infections presenting to emergency departments in the United States.[1] Although community outbreaks of MRSA in diverse populations, including American Indian and Alaska Natives,[4] sports

confined to intensive care units, acute care hospitals, or any health care institution.

JAMA. 2007;298(15):1763-1771 www.jama.com

Author Affiliations: Centers for Disease Control and Prevention, Atlanta, Georgia (Drs Klevens, Carey, and Fridkin and Mss Morrison, Zell, and McDougal and Mr Foxhein); California Emerging Infections Program, Oakland (Ms Nadle); Connecticut Department of Health, Hartford (Ms Petit); Colorado Emerging Infections Program, Denver (Dr Gershman); Grady Memorial Hospital, Atlanta (Dr Ray); Maryland Emerging Infections Program and Johns Hopkins Bloomberg School of Public Health, Baltimore (Dr Harrison); Minnesota Department of Health, Minneapolis (Dr Lynfield); University of Rochester, Rochester General Hospital, Rochester, New York (Dr Dumyati); Oregon Health & Science University, Portland (Dr Townes); and Tennessee Department of Health, Nashville (Dr Craig).
The ABCs MRSA Investigators are listed at the end of this article.
Corresponding Author: R. Monina Klevens, DDS, MPH, Division of Healthcare Quality Promotion, Centers for Disease Control and Prevention, 1600 Clifton Rd (A-24), Atlanta, GA 30333 (mnk2@cdc.gov).

See also p 1803 and Patient Page.

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Downloaded from www.jama.com at CDC-Information Center, on January 24, 2008

- ~500,0000 persons in the US hospitalized with *Staph* each year
- MRSA bloodstream infections alone are responsible for ~94,000 hospitalizations and ~19,000 deaths each year.
- Estimated U.S. costs for all *Staph* infections, including MRSA, have increased from $8.7 billion in 1998 to $14.5 billion in 2004.
- Within the Medicare program alone, healthcare charges for *Staph* bloodstream infections exceeded $2.5 billion in 2005.

ORIGINAL CONTRIBUTION

JAMA®
The Journal of the American Medical Association

Invasive Methicillin-Resistant *Staphylococcus aureus* Infections in the United States

Table 2. Observed Incidence Rates of Invasive Methicillin-Resistant *Staphylococcus aureus* (MRSA) by Active Bacterial Core Surveillance Site and Epidemiologic Classification, United States, 2005[a]

		Incidence per 100 000			
			Health Care–Associated		
Surveillance Site No. (Location)[b]	No. of Cases	Community-Associated	Community-Onset	Hospital-Onset	Total
1 (Connecticut)	952	2.7	15.6	8.4	27.1
2 (Atlanta, GA, metropolitan area)	1165	5.1	16.7	10.3	33.0
3 (San Francisco, CA, Bay Area)	936	4.5	15.9	7.7	29.2
4 (Denver, CO, metropolitan area)	480	2.8	12.3	6.0	21.2
5 (Portland, OR, metropolitan area)	305	4.7	11.4	3.6	19.8
6 (Monroe County, NY)	307	2.7	22.2	16.8	41.9
7 (Baltimore City, MD)	742	29.7	62.9	19.7	116.7
8 (Davidson County, TN)	305	6.8	30.4	13.9	53.0
9 (Ramsey County, MN)	95	1.6	11.5	6.1	19.2

[a] Epidemiologic classification of disease consisted of health care–associated (either hospital-onset cases with a culture collected >48 h after hospital admission or community-onset cases with health care risk factors but a culture collected ≤48 h after hospital admission) and community-associated cases (no health care risk factors).
[b] Site numbers were assigned in descending order of population size.

CDC — CENTERS FOR DISEASE CONTROL AND PREVENTION

Press Release

FOR IMMEDIATE RELEASE
October 19, 2006

Contact: CDC Media Relations
404-639-3286

CDC Urges Hospitals and Healthcare Facilities to Increase Efforts to Reduce Drug-Resistant Infections

The Washington Times

Hospitals' hidden danger

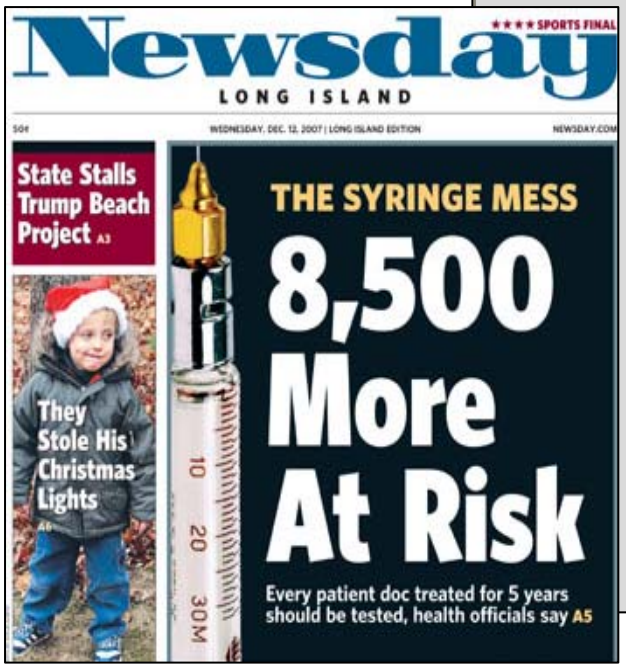
By Joyce Howard Price
THE WASHINGTON TIMES

February 25, 2007

Hospital patients in the United States have to worry about something other than their illness or pending surgery -- the very real threat of acquiring an infection while hospitalized, which may be far more serious than the original problem.

"These infections, many of which are drug-resistant, affect one in 20 patients -- or about 2 million people -- each year, according to the Centers for Disease Control and Prevention (CDC)."

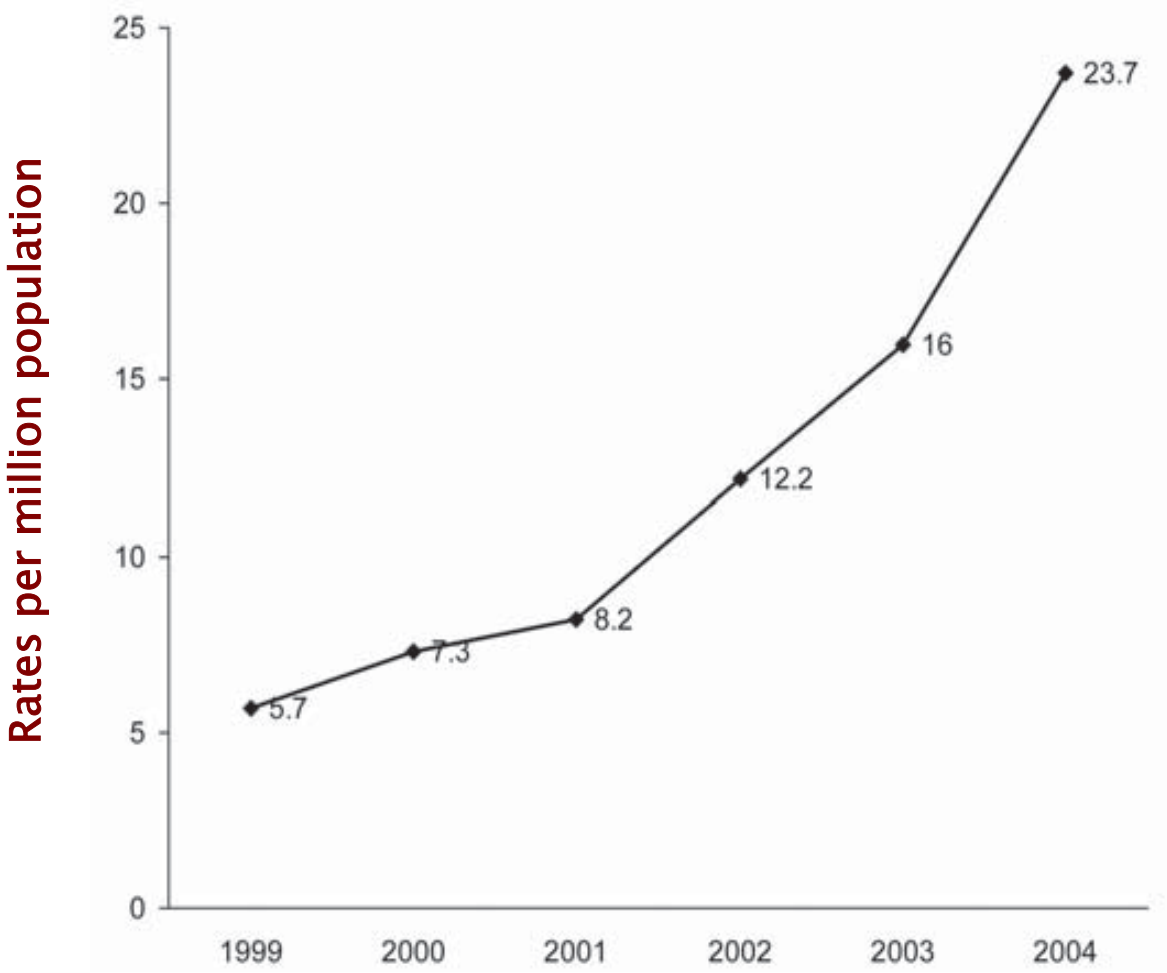
Patient Safety Challenges



Multiple outbreaks of hepatitis B and C viruses in outpatient settings
- associated with unsafe injections
- *preventable with basic infection control practices*

Patient Safety Challenges

Deaths caused by gastrointestinal infections (Clos*tridium difficile)* acquired in healthcare, United States, 1999–2004



Redelings, et al. *Emerg Infect Dis* 2007;13:1417-19

Overview

- Global Burden
- Factors Contributing to Emergence and Spread
- Recent Challenges
- Lessons Learned
- Opportunities

Improving Preparedness and Response:
Lessons Learned from Recent Outbreaks

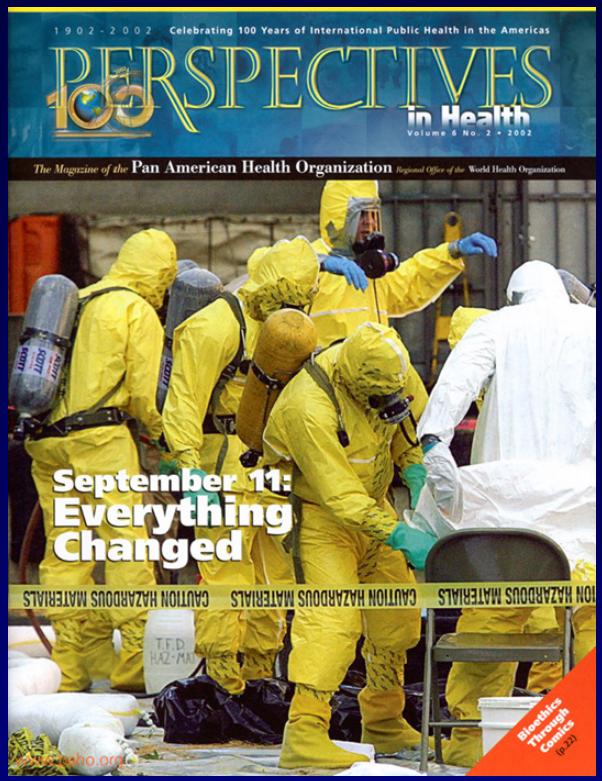
"We must never take for granted the precious gift of hindsight."

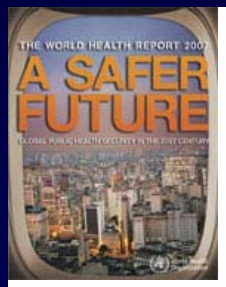
The New Yorker
http://www.cartoonbank.com

Infectious Diseases

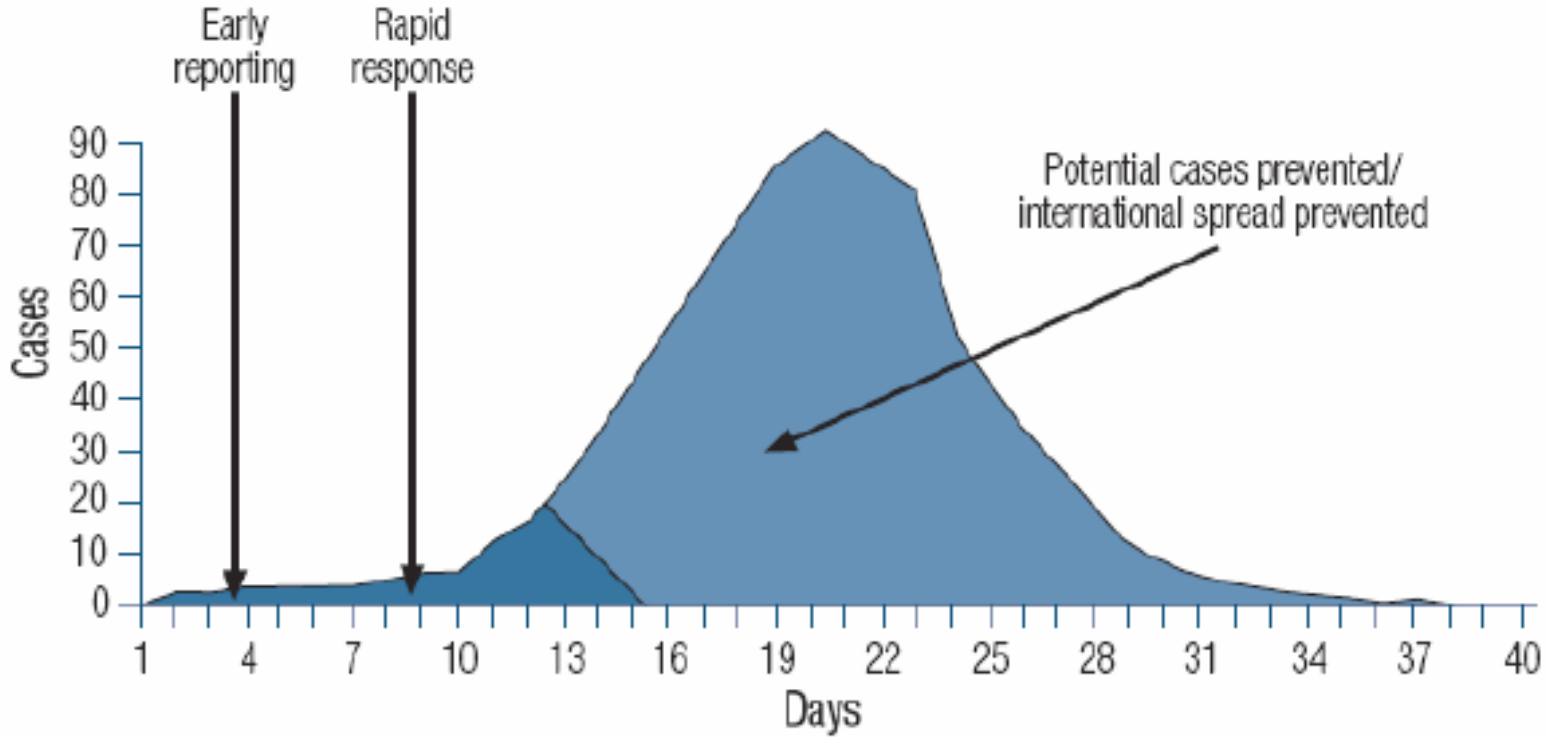
New Public Health Perspective

- Infectious disease outbreaks can impact national security and global economy
- Local outbreaks/problems now recognized as having much wider implications
- Rapid and collaborative responses essential and expected





Global outbreaks, the challenge: late reporting and response



Addressing the Threats: *Lessons Learned*

- Building and enhancing national and global public health capacity
- Improving global infectious disease surveillance, response capacity, disease reporting
- Developing and Using Diagnostics
- Preparedness planning
- Education, proactive communications, fast and reliable information
- Strong national and international partnerships
- Expect the unexpected

Addressing the Threats: Critical Needs

- Vaccine Development and Production
- Judicious Use of Antimicrobials
- Need for New Antimicrobial Drugs
- Vector-borne and Zoonotic Disease Control

Overview

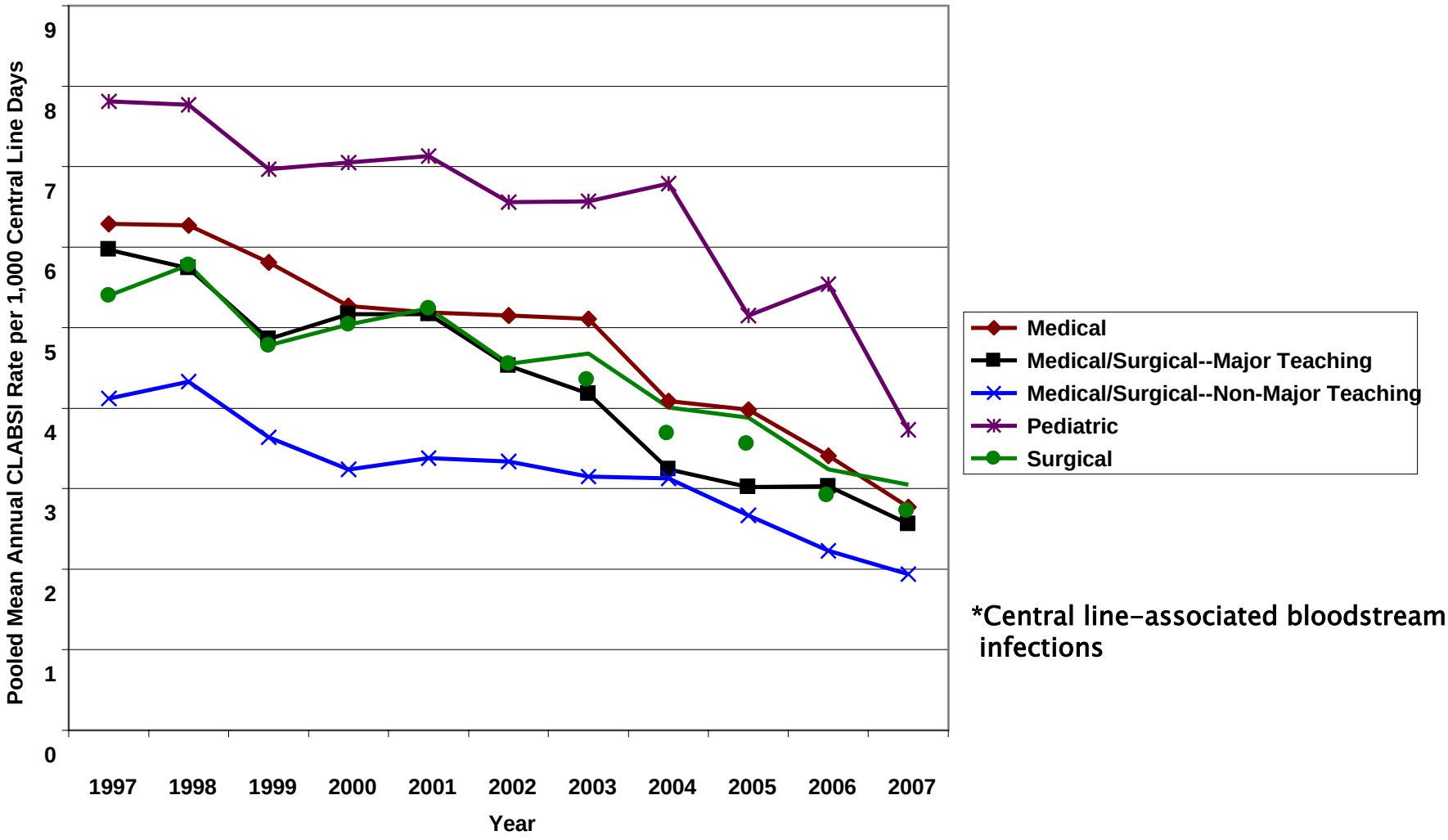
- Global Burden
- Factors Contributing to Emergence and Spread
- Recent Challenges
- Lessons Learned
- Opportunities

- Through CDC-supported efforts in Pennsylvania, local hospitals have successfully reduced bloodstream and MRSA infections as much as 70% by fully implementing CDC prevention recommendations.

- Replicating these efforts nationally could dramatically reduce *Staph*-related deaths and complications and yield estimated short-term (<3 years) cost savings to the Medicare program of up to $1 billion.

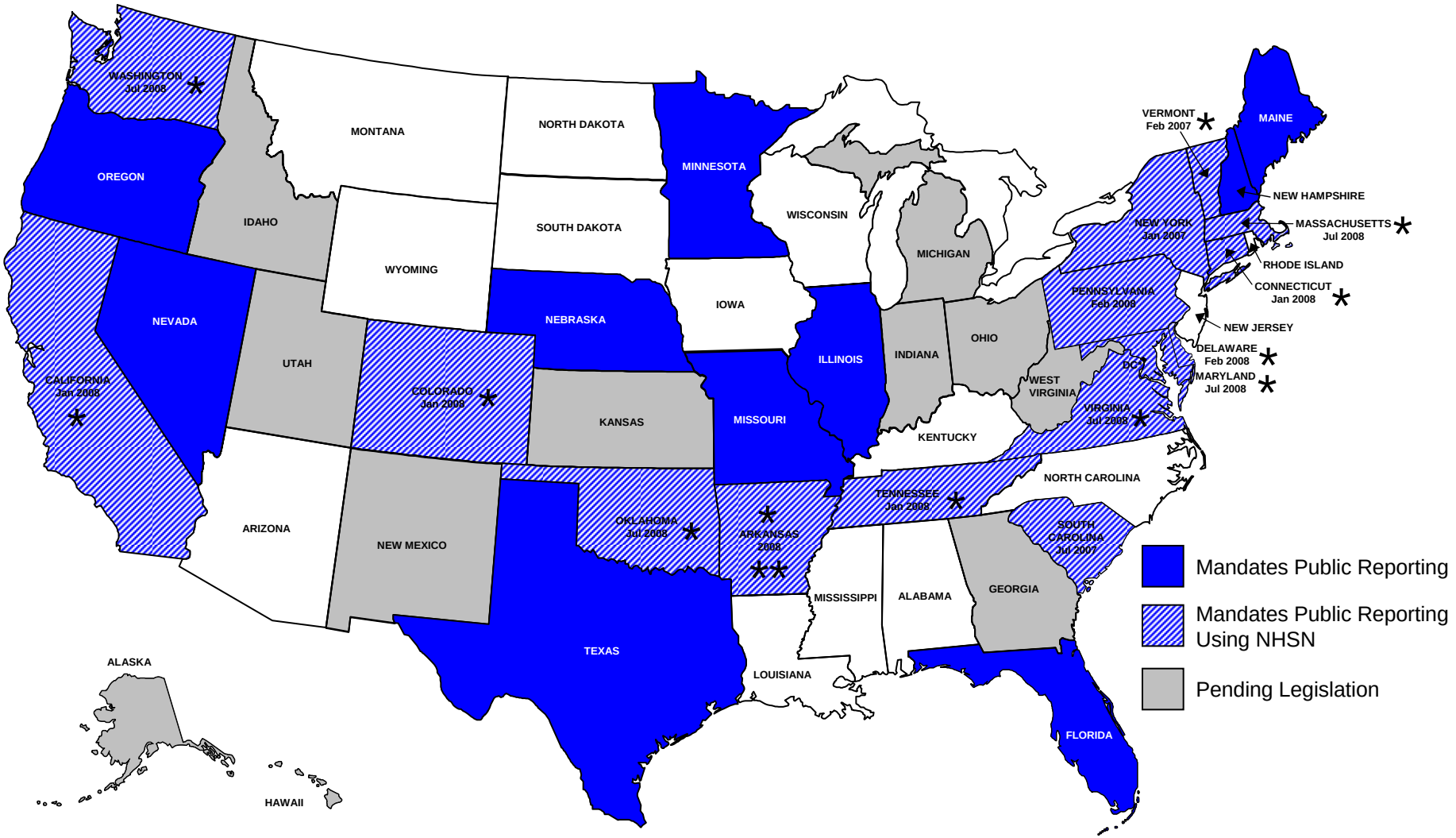
Patient Safety: Successes

Trends in Bloodstream Infections* by ICU Type, United States, 1997–2007



*Central line–associated bloodstream infections

National Healthcare Safety Network



* States that have not enrolled 100% of facilities into NHSN:
<25%: AR, CA, MA, MD, OK, VA, WA 50-60%: CT, TN 70-80%: CO, DE, VT

** Arkansas will begin voluntary reporting using NHSN in 2008.

CDC Quarantine Stations
2007 Jurisdictions
AK
Anchorage
Seattle
WA
MT
ND
Minneapolis
MN
Chicago
WI
MI
Detroit
NY
ME
VT
NH
MA
Boston
New York
Newark
Philadelphia
Washington, D.C.
PA
NJ
MD
DE
WV
VA
OR
ID
WY
SD
NE
IA
IL
IN
OH
KY
NV
UT
CO
KS
MO
TN
NC
SC
Atlanta
GA
AL
MS
LA
AR
OK
Dallas
North TX
West TX
East TX
Houston
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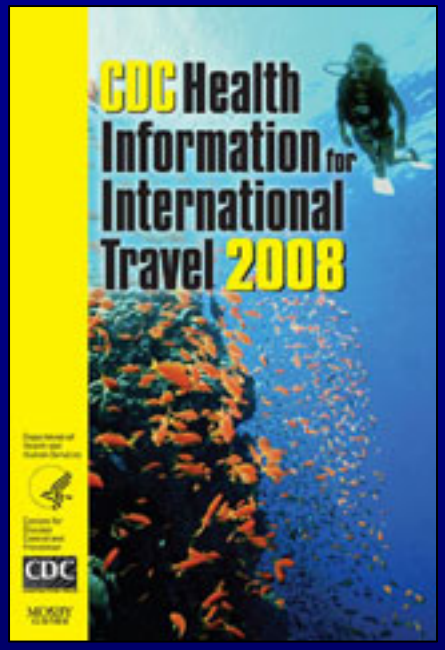
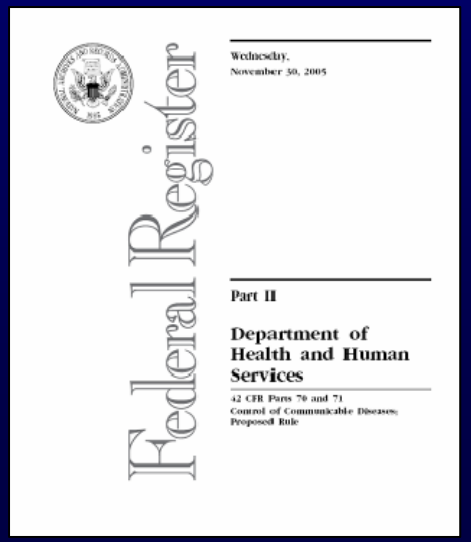
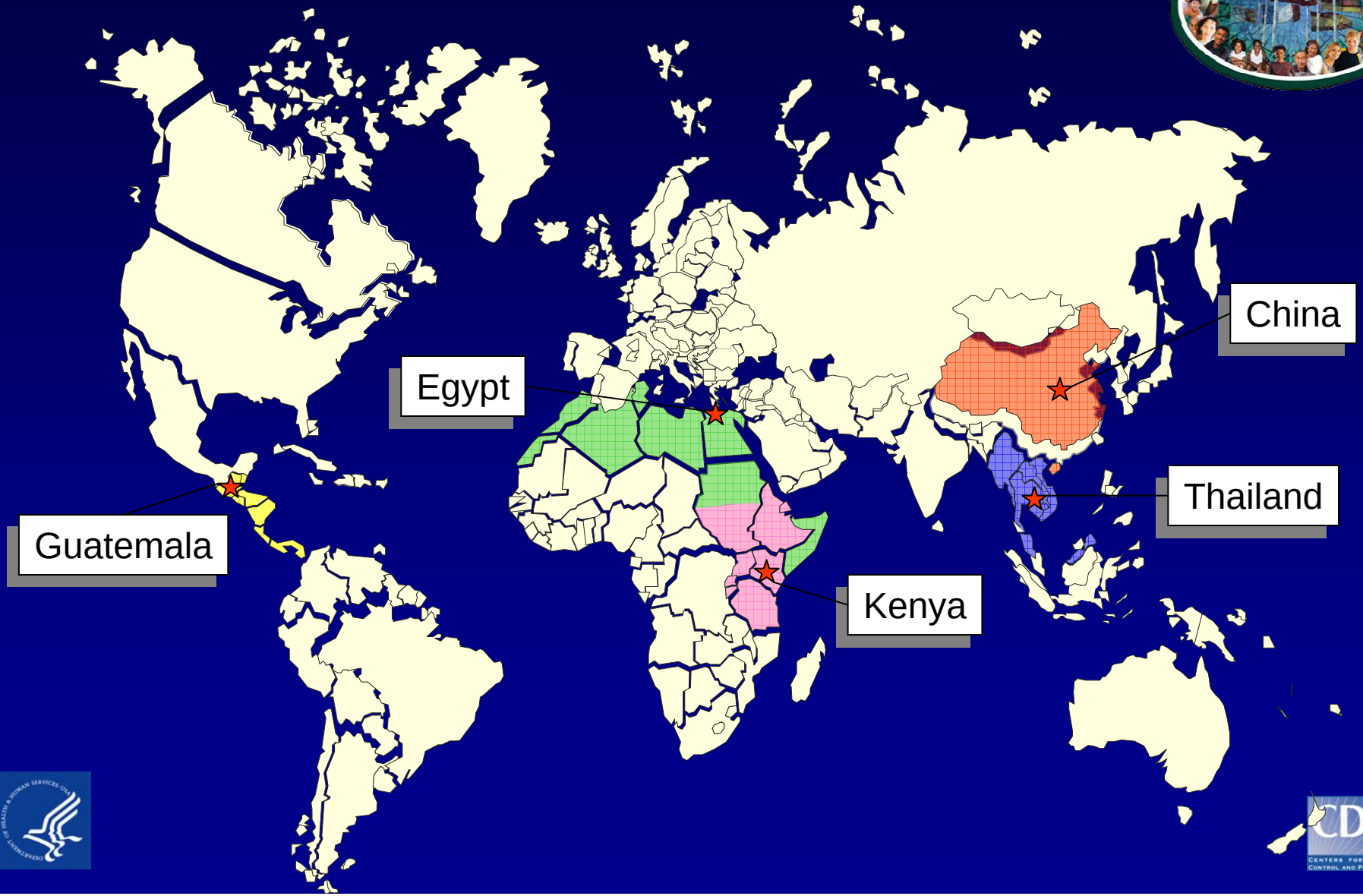
San Francisco
So.CA
Los Angeles
San Diego
Honolulu
HI
FL
Miami
PR
San Juan
CDC Quarantine Station


CDC Health Information for International Travel 2008
CDC

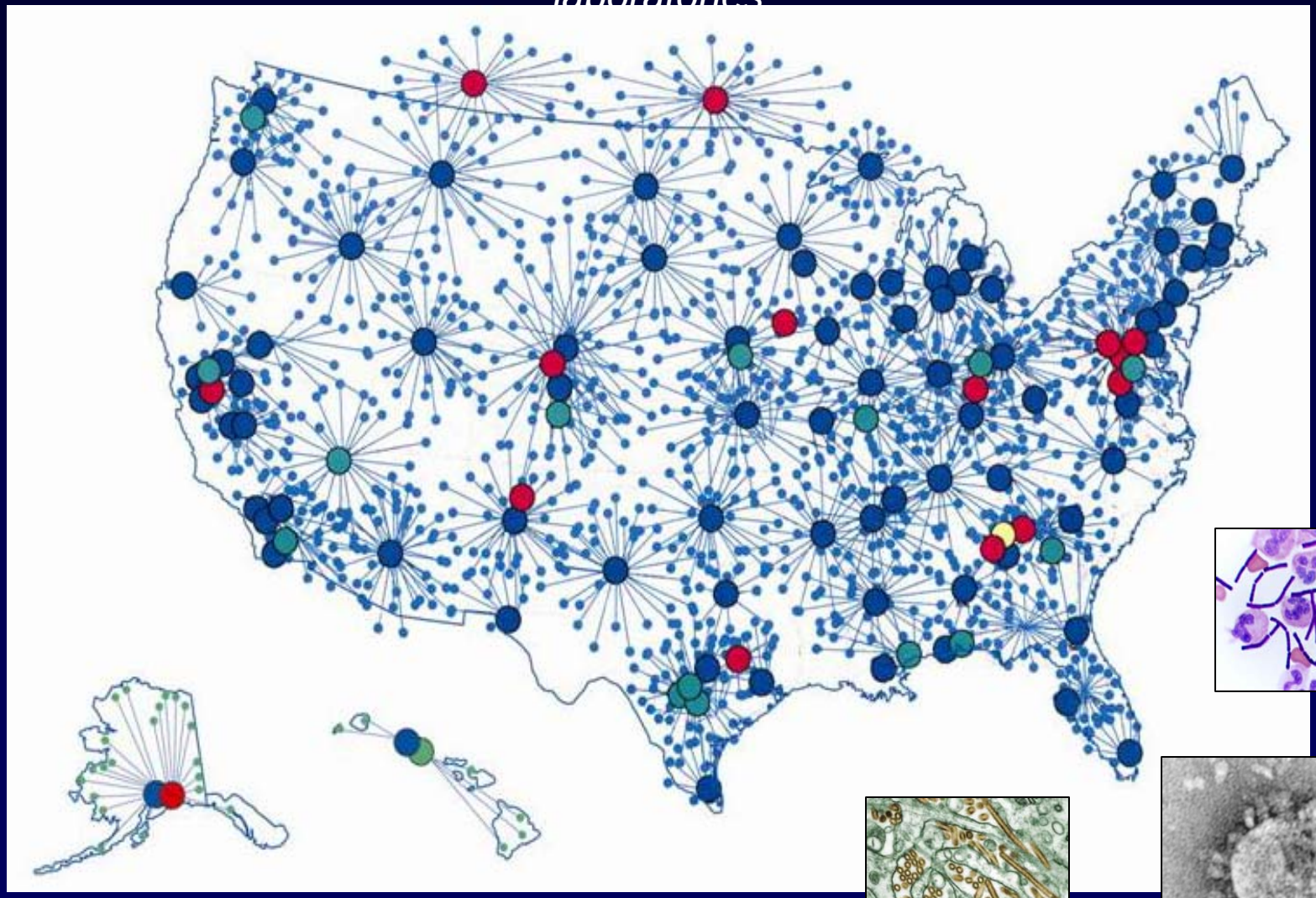

Federal Register
Wednesday,
November 30, 2005
Part II
Department of Health and Human Services
42 CFR Parts 70 and 71
Control of Communicable Diseases;
Proposed Rule

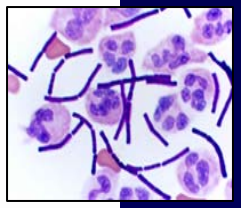
International Emerging Infections Programs

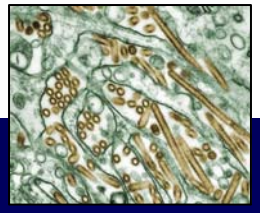


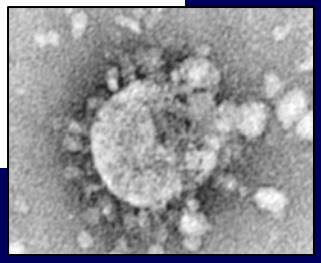
Laboratory Response Network

More than 160 public health, military, federal, food, veterinary, and international laboratories







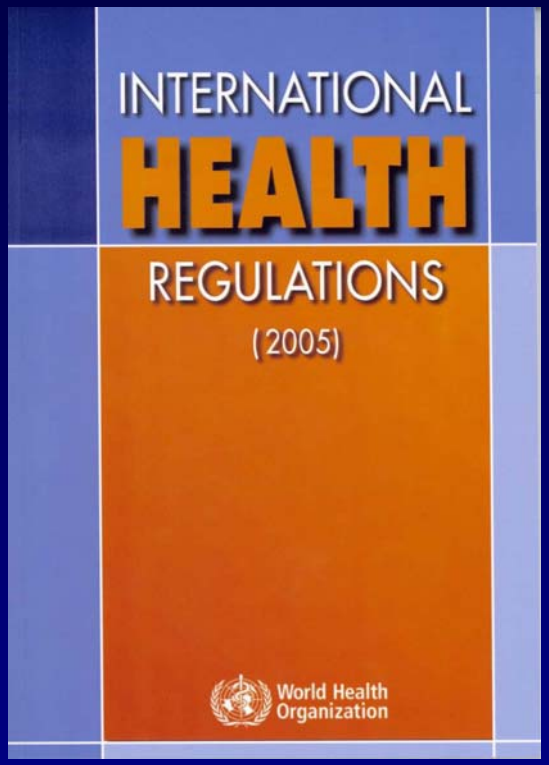


International Health Regulations

Legal framework for defining WHO and member states' roles/responsibilities for controlling spread of disease

Requires reporting of all public health emergencies of international concern (PHEICs)

Expands beyond infectious diseases to include biological, chemical, or radionuclear events and natural disasters.



Requires member states to notify WHO of a single case of smallpox; poliomyelitis due to wild-type poliovirus; SARS; and human influenza caused by a new subtype.

Global Commitment to Addressing Inequities

care

GAVI
THE GLOBAL ALLIANCE FOR VACCINES & IMMUNIZATION
Partnering with The Vaccine Fund

World Health Organization

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HIGHLIGHTS

WHO/Ahmed Tajudin

Somalia is again polio-free

25 March 2008 -- With no new cases reported in a
polio-free, the Global Polio Eradication Initiative an
10 000 volunteers and health workers vaccinated r
children under the age of five to wipe out the disea

News release on polio in Somalia

GLOBAL NETWORK
NEGLECTED TROPICAL DISEASES

Investing in our future
The Global Fund
To Fight AIDS, Tuberculosis and Malaria

Global Initiatives to Enhance Capacity

Global Health and Security Initiative
Working for a Safer World

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Spotlight

Leading experts call for urgent action to enhance global infectious disease surveillance

Twenty-three representatives from infectious dise
surveillance networks in Africa, the Americas, Asi
Europe and the Middle East, including leading exp
epidemiological surveillance and health informatic
from December 3-6, 2007 at the Rockefeller Conf
Centre in Bellagio, Italy.

Their aim was to share best practices and lessons
learned and recommend action required to advan
global capacity for public health surveillance with
particular attention to infectious disease surveillar
developing countries. NTI's Global Health and Sec
Initiative, with support from the **Rockefeller Foundation**, led the organization of the Bellagio
and is the focal point for future action.

BILL & MELINDA GATES *foundation*
Bringing innovations in health and learning to the global community

NTI
Working for a Safer World

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NTI's mission is to strengthen global security by reducing the risk of use and preventing the spread of nuclear, biological and chemical weapons and to work to build the trust, transparency and security which are preconditions to the ultimate fulfillment of the Non-Proliferation Treaty's goals

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Preparedness Planning

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  - Bioterrorism
  - Chemical Emergencies

Bioterrorism >

Preparation and Planning for Bioterrorism Emergencies

NOTE: the following is a list of preparation and planning resources related specifically to bioterrorism. For resources relevant to preparation and planning for *all* types of emergencies, please see Emergency Preparedness and Response: Preparation and Planning.

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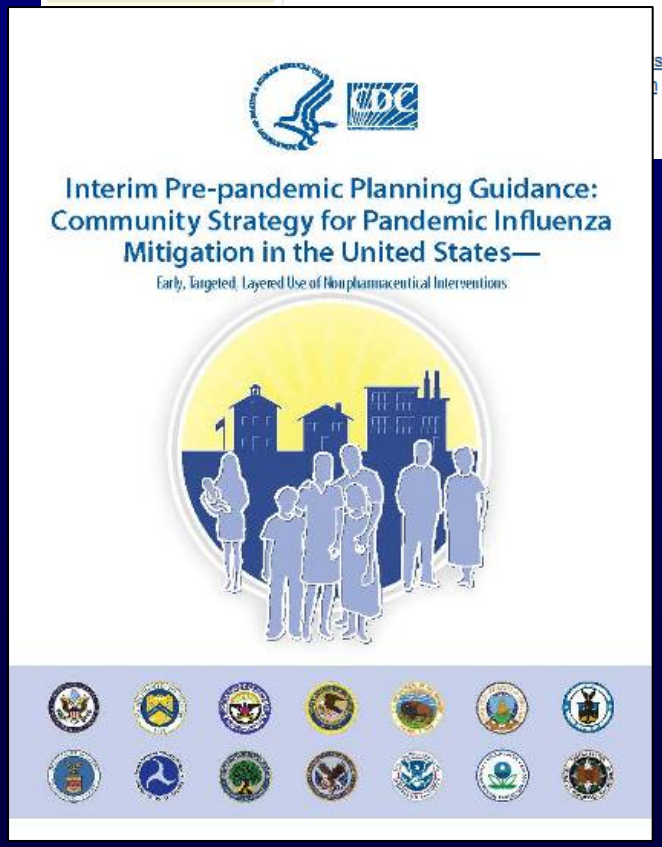
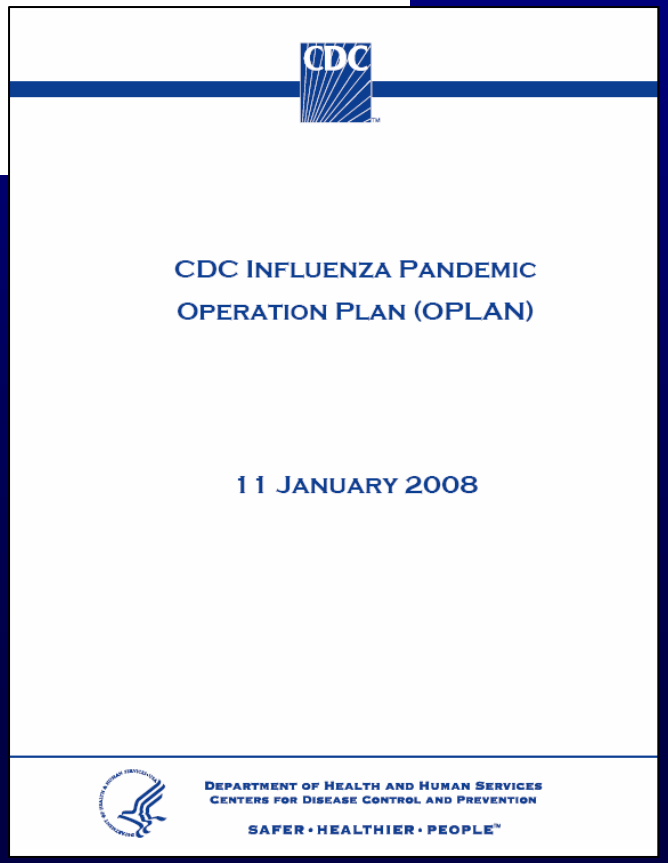
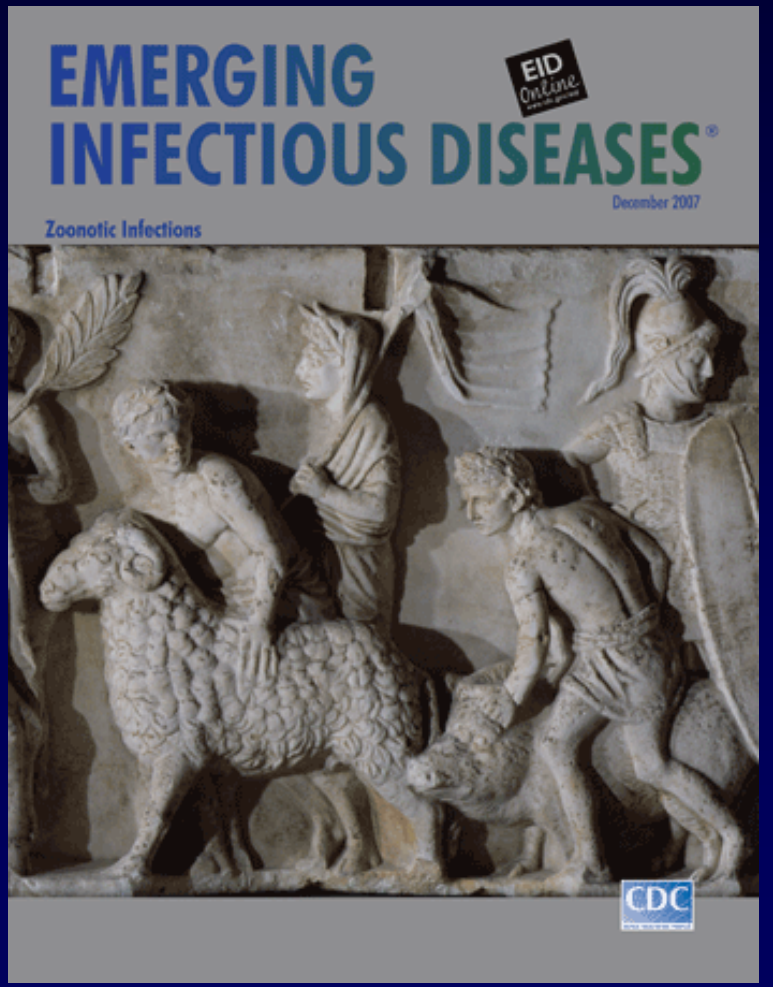


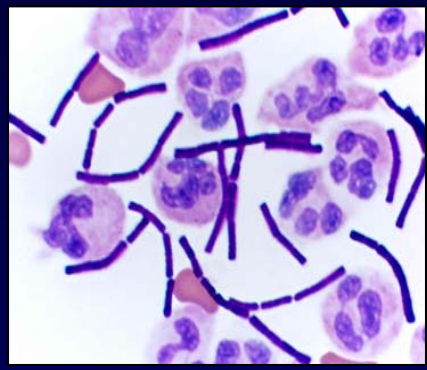


Increased collaborations between human and animal health



Expect the Unexpected

- The "Alert" Clinician
- The "Alert" Laboratorian
- The "Alert" Veterinarian
- The "Alert" Public



Transplants led to rabies deaths

3 cases traced to lone donor could prompt new screening

By DAVID WAHLBERG
dwahlberg@ajc.com

Three people died from rabies after receiving organs from a donor later found to have had the disease — the first reported cases of rabies spread through organ transplants, health officials said Thursday.

Federal officials say they will review whether more screening is necessary. Transplant agencies currently test organs for HIV, hepatitis and other viruses, but not for rabies, though some agencies ask if potential donors were exposed to possibly rabid animals.

"We are learning as we go," said Dr. Mitchell Cohen, an infectious disease expert with the Centers for Disease Control and Prevention. "This has never happened before."

The organ recipients, from Texas and Oklahoma, received a liver and two kidneys on May 4 at Baylor University Medical Center in Dallas. The donor, a 20-year-old Arkansas man, had died the previous day at Christus St. Michael Health System in Texarkana, Texas, hospital spokeswoman Francine Francis said.

The donor had gone to the Texarkana hospital April 28 for treatment of nausea and vomiting, Francis said.

He developed "severe mental status changes" and was diagnosed with a brain hemorrhage, Cohen said.

The transplant patients died from rabies June 7-21, Cohen said. A fourth patient, who received two lungs from the donor, died from surgical complications during the

organ donor from Arkansas contracted the virus, but the strain found in all of the patients suggests it came from a bat, Cohen said.

and Services Administration. Organs from live donors are now also tested for West Nile virus — which was transmitted from a Georgia organ

BULL'S-EYE: UNRAVELING THE MEDICAL MYSTERY OF LYME DISEASE

By Jonathan A. Edlow. 285 pp., illustrated.
New Haven, Yale University Press, 2003. $29.95.
ISBN 0-300-09867-7.

JONATHAN EDLOW'S BOOK, *BULL'S-EYE: Unraveling the Medical Mystery of Lyme Disease*, was published at a particularly fitting time. This year marks the 20th anniversary of the discovery by Burgdorfer, Benach, and Barbour of the causative agent of Lyme disease, a spirochete we now know as *Borrelia burgdorferi*. That discovery pulled together many of the diverse scientific and historic aspects of Lyme

Deer Tick Nymph.