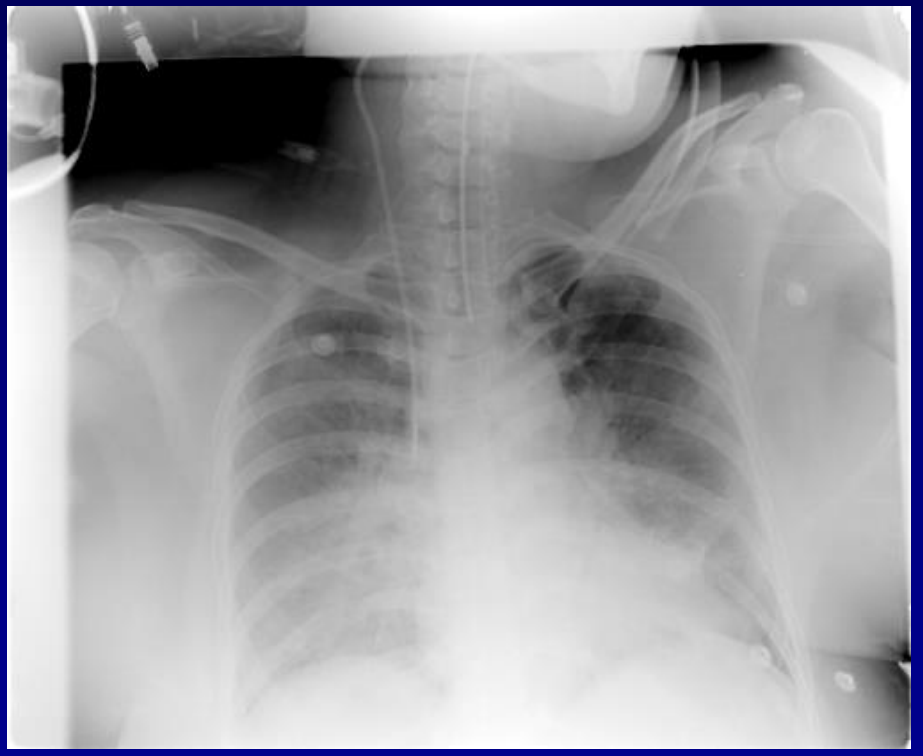
Critical care considerations in Pandemic preparedness

Paul Ananth Tambyah

Initial presentation

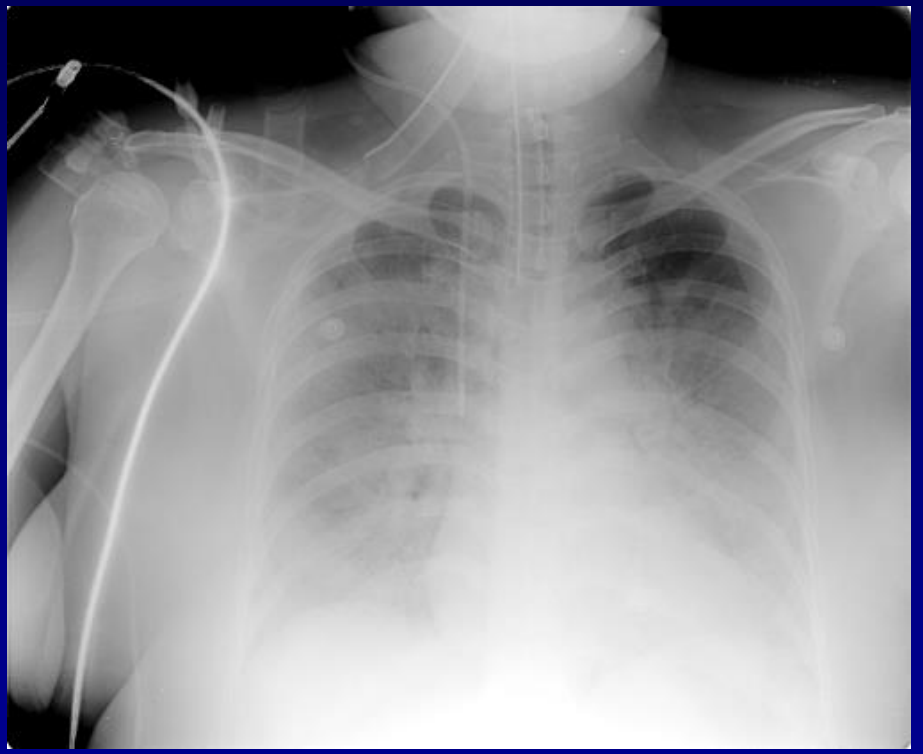
- 43 year old woman no PMHx except HTN
- Admitted 23 Mar 03 with fever, cough, SOBOE x 1 week
- On admission, T 38.9C
- Initial wbc 19K, creat 257
- Admitted to isolation ward



X-Ray at ER

In the ward

- Was hypoxic, lethargic
- 25 March, LDH 2001, ALT 36, AST 50, wbc 11.4, lym 0.8, plt 174.
- Treated with levofloxacin, imipenem
- Not responding, transferred to MICU



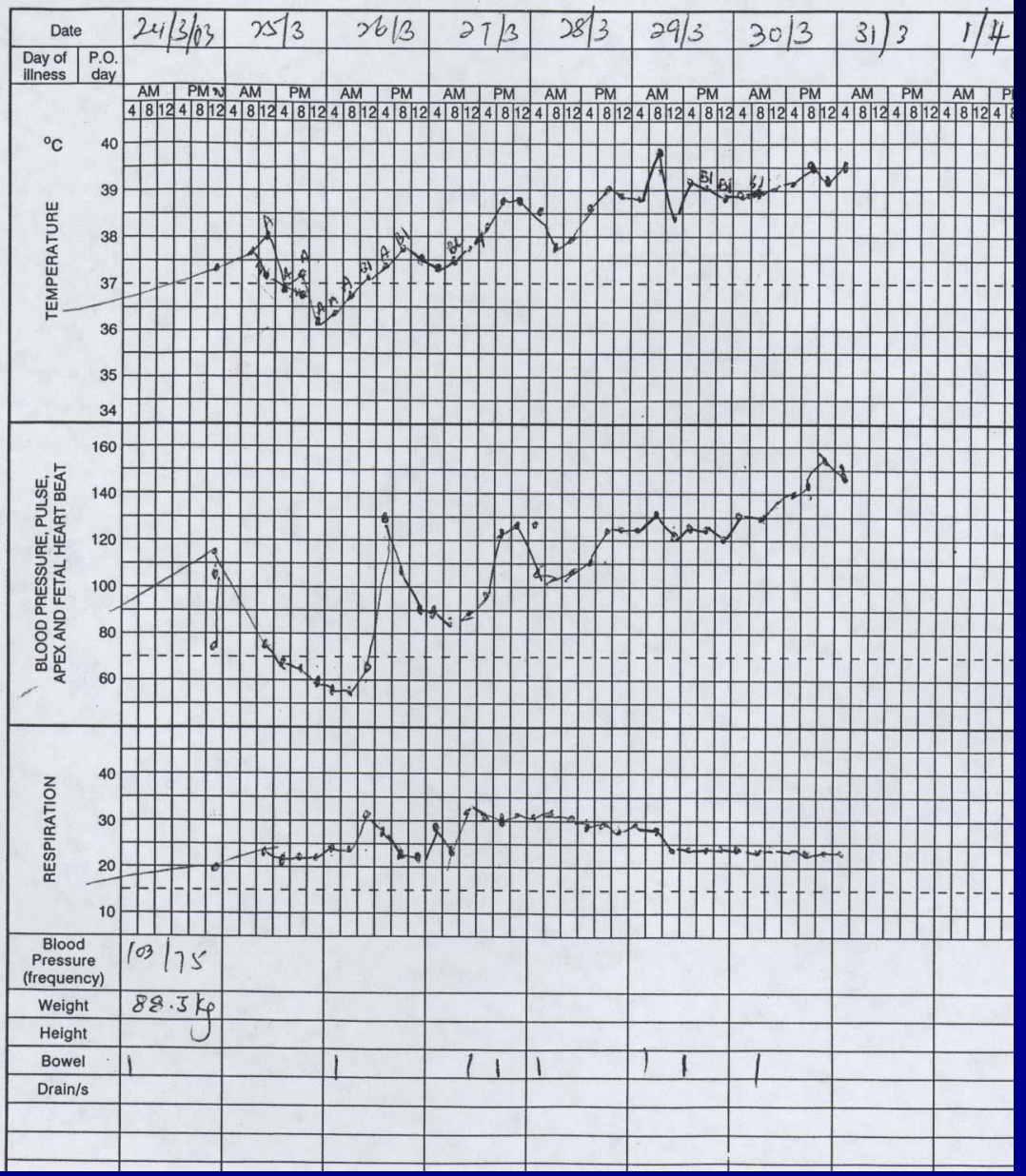
X_Ray: Day # 3

CLINICAL CHART

UNIT	WARD	BED
	21 A6	18 B3

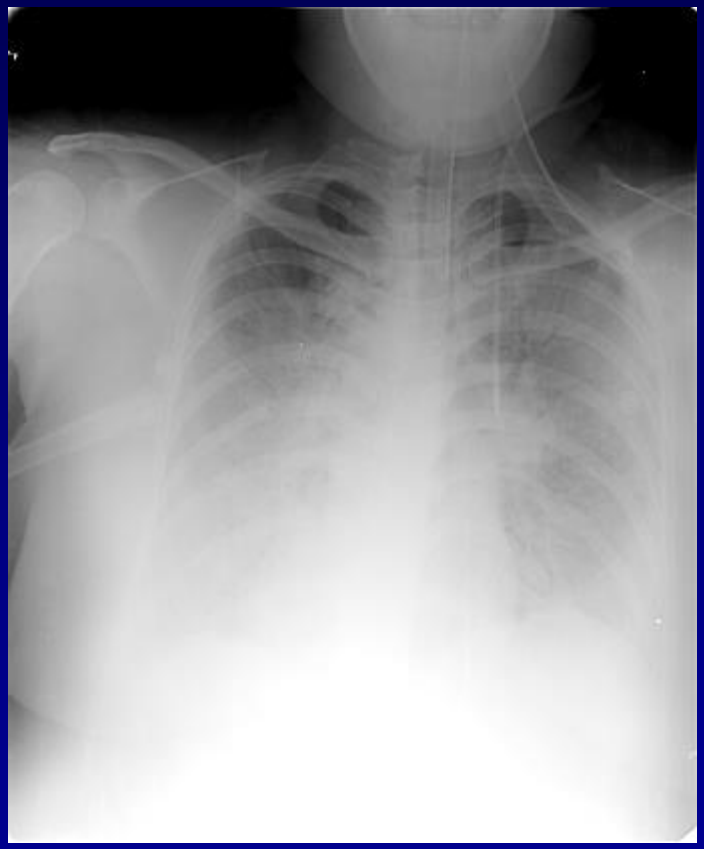
BLK 205 #08-48 SVC 07
BUKIT BATOK STREET 21

S 650205 TEL 65619915 ADM. 23/03/2003 23:03



Subsequently

- Remained ill
- History clarified - Had been visiting her friend with hepatitis in TTSH, where the SARS outbreak had occured
- Deteriorated, needed iv adrenaline, HFOV
- Died 31 March 2003



X_Ray: Day # 7

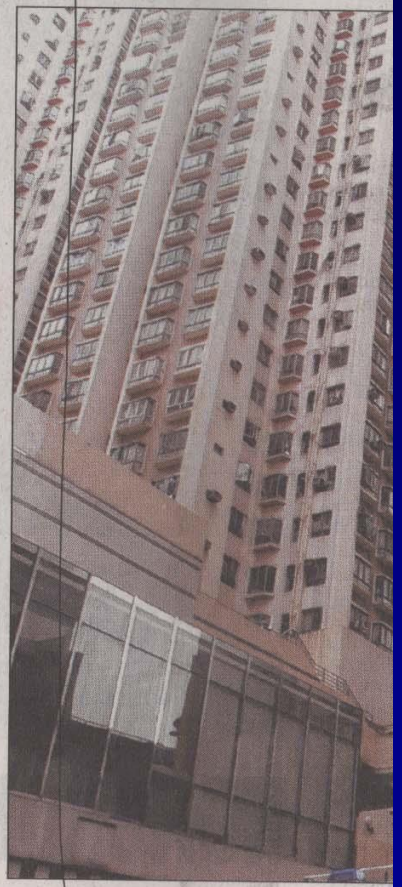
The Straits

PACIFIC AREA NEWSPAPER OF THE Y

Tuesday • April 1, 2003 • 82 Pages in five parts • MITA (P) 033/03/2003

Surprise Sars death at NUH

First case outside Tan Tock Seng; NUH staff 'not at risk' says ministry



A FOURTH person has died of Sars in Singapore, but not at Tan Tock Seng Hospital where all cases of the new and deadly form of pneumonia were believed to be.

Instead, the Health Ministry revealed last night, a woman died yesterday at the National University Hospital

not tell medical staff if she had been in contact with a Sars patient.

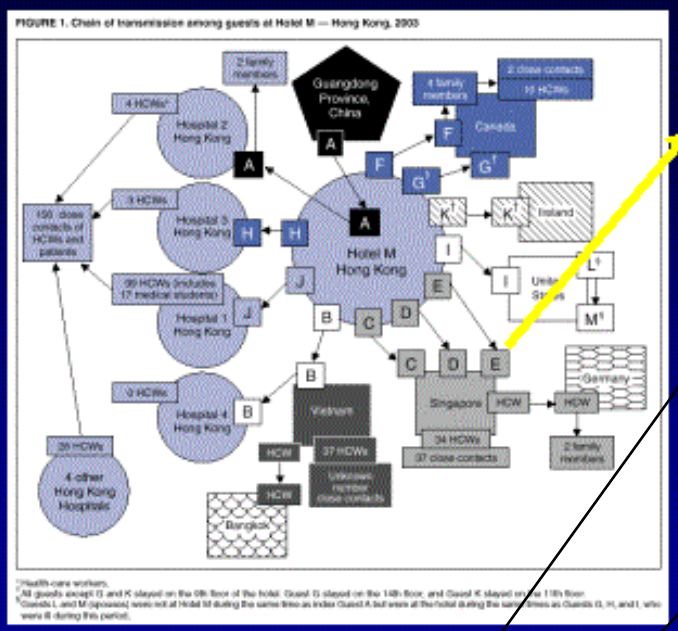
She had also visited Sarawak, not one of the areas affected by Sars, such as Hongkong, Guangdong or Hanoi.

"She was too unwell to be transferred to TTSH," the ministry said, adding that she

Starting from 8 pm, masked, gloved and gowned nurses were stationed at aerobridges to look out for unwell passengers arriving from Sars hotspots.

As passengers left the aircraft in single file, the nurses looked at them one by one and

Patient B:
Contact history



1 Pt
10 HCW
9 others

7 RNs, 6 visitors
3 patients

16 HCW
1 patient
3 visitors

Pt A + 4 family

Patient S
NON-SARS

SARS pt #1
SARS pt #2

Visitor 1

Patient B

Son of patient B

MICU Director

Friend

SARS in a hospital visitor and her intensivist

Sir,

Severe acute respiratory syndrome (SARS) is a novel infectious disease in humans caused by a coronavirus that was first recognized in Southeast Asia in late February 2003.[1] The World Health Organization (WHO) has issued definitions for probable and suspected cases.[2] Most transmissions occurred by close hospital or household contact with infected individuals suggesting a predominant droplet mode of spread.[3] Widespread use of personal protective equipment (PPE) including N95 respirators is thought to have been instrumental in controlling the epidemic. We report a patient who had had no direct contact with SARS patients and who subsequently transmitted the infection to her intensivist who was wearing standard PPE during a bronchoscopy.

A 43-year-old woman was admitted to our hospital with a respiratory and systemic illness of 1-week duration. She had had no direct contact with any patients suffering from SARS, but had visited a friend with hepatitis in hospital who was at least two cubicles (approximately 10 m) away from a patient later confirmed to have SARS. On examination, she was tachypnoiec and febrile.

Three days after the bronchoscopy, the intensivist (K.-H.L.) who performed the procedure developed fever and myalgia and was subsequently diagnosed as having SARS with pneumonia, despite wearing a N95 mask, glasses, gown, and gloves throughout the procedure. He required admission to intensive care unit and mechanical ventilation, and survived the episode.

The patient's serology was positive for SARS by a dot-blot immunoassay using a viral lysate in a post-mortem analysis of a serum sample taken on day three of admission. Her intensivist was also seropositive 4 weeks after hospitalization.

A. Mukhopadhyay, P.A. Tambyah, K.S. Singh, T.K. Lim, K.-H. Lee*
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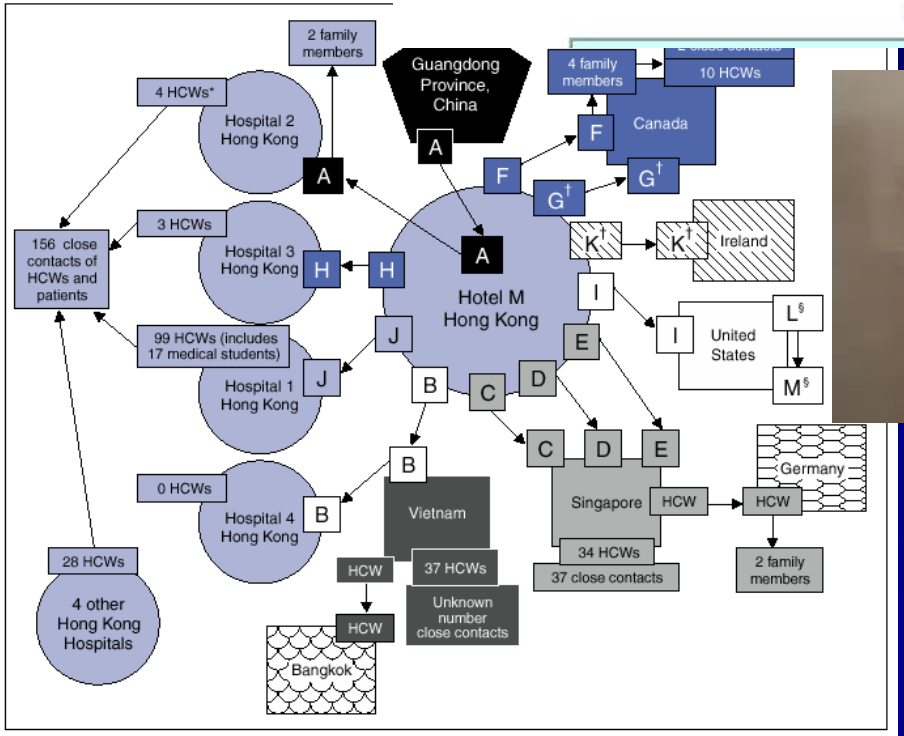
J Hosp Infect. 2004;56:249-50
doi:10.1016/j.jhin.2003.12.015

METROPOLE HOTEL 京華國際酒店

75 Waterloo Road,
Mongkok, Kowloon,
Hong Kong

Internet Reservation Office in Hongkong:
Tel: (852) 2736-0922 Fax: (852) 2405-0922
Contact person: Joe or Melizza

FIGURE 1. Chain of transmission among guests at Hote



*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.

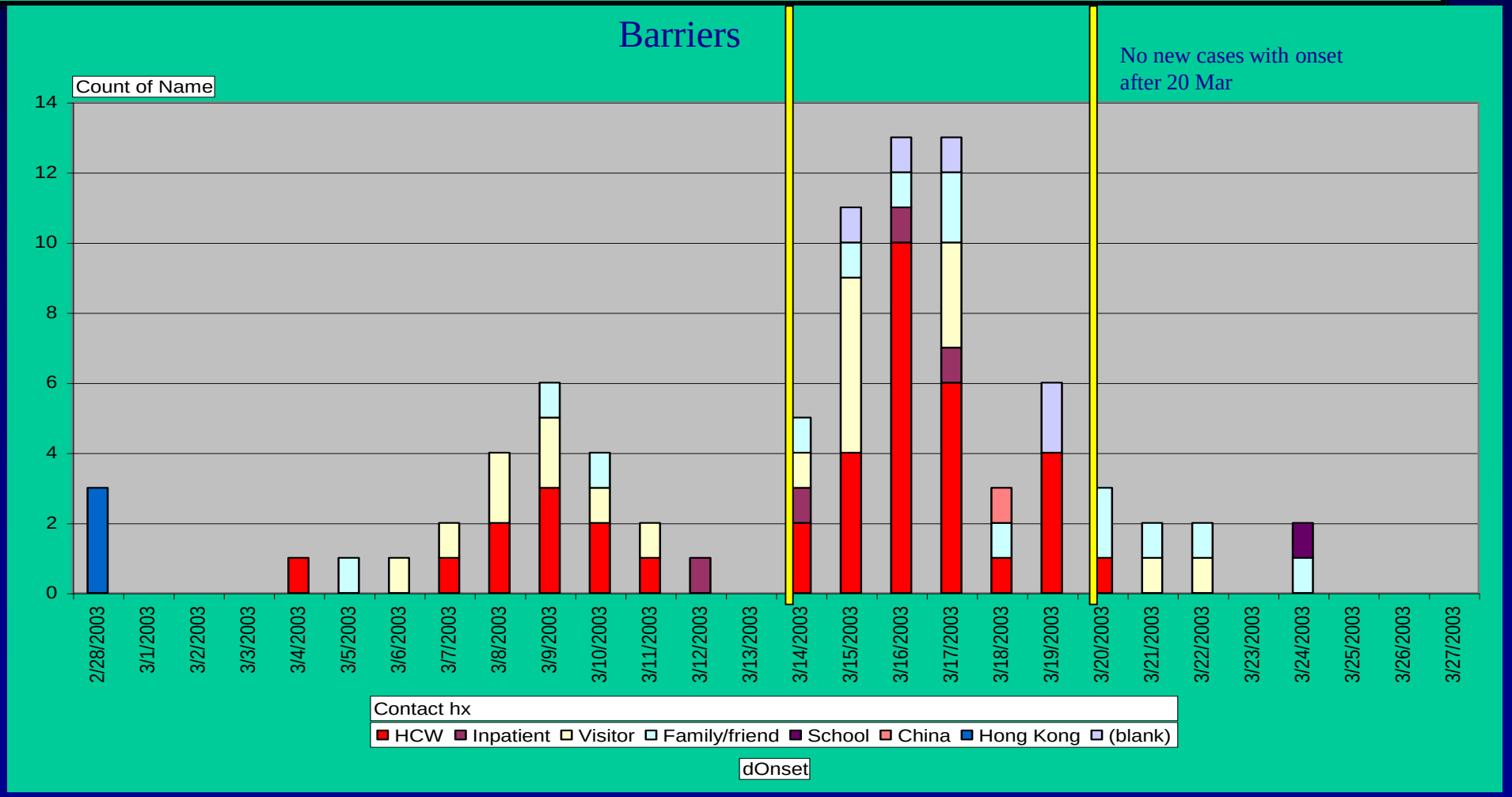
SARS trauma persists in HK

http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5212a1.ht

The ICU in pandemics

- Protecting staff and other patients from EIDs
- Treating and supporting patients with severe disease
- Surveillance and surge capacity
- Protecting patients from us and our devices (and drugs)

TTSH demonstrated the Effectiveness of Barrier Precautions in protecting Healthcare Workers



Data courtesy of Dr Lim Suet Wun, Dr Leo YS, TTSH, Singapore

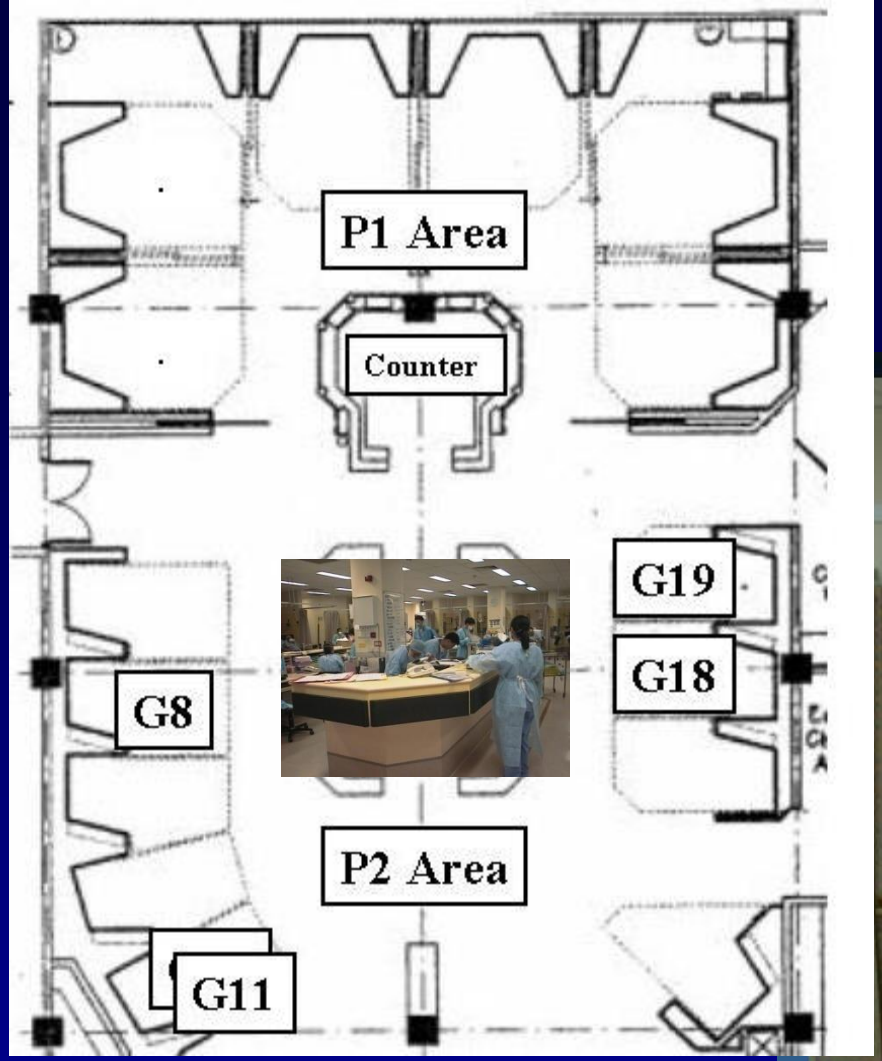
Table 2. Factors Shown to Be Important in the Transmission of Common Respiratory Agents.

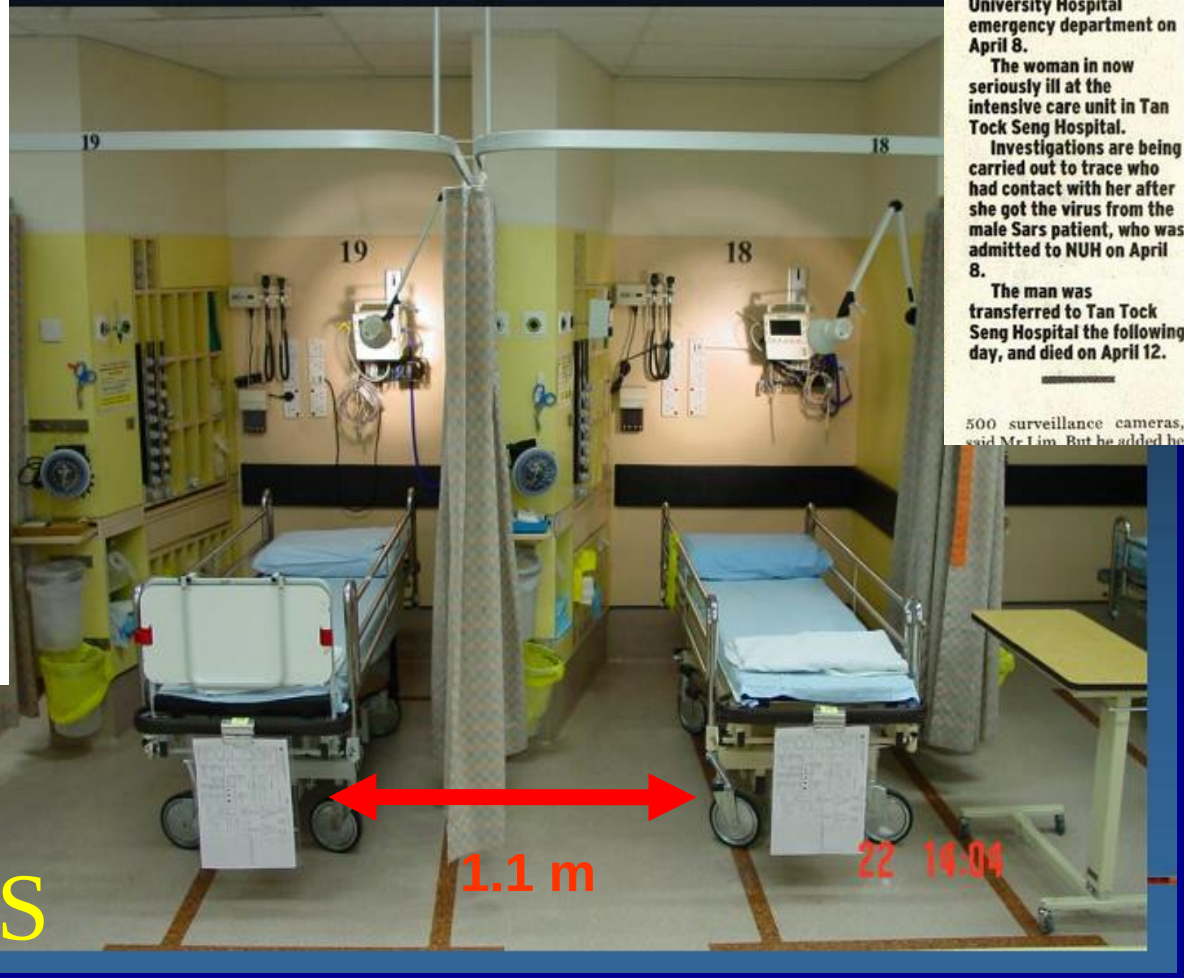
Agent	Direct Contact	Large- or Medium-Droplet Aerosol	Tiny-Droplet Aerosol (Droplet Nuclei)
Bacteria			
Neisseria meningitidis	Yes	Yes	No
Streptococcus pyogenes	Yes	Yes	No
Streptococcus pneumoniae	Yes	Yes	No
Mycobacterium tuberculosis	No	No	Yes
Viruses			
Influenzavirus	Yes	Yes	Yes
Adenovirus	Yes	Yes*	Yes*
Respiratory syncytial virus	Yes†	Yes	No
Rhinovirus	Yes†	Yes	No

* Inhaling large or medium-size droplets that are trapped in the nose may cause upper respiratory tract infection, whereas inhaling tiny droplets (droplet nuclei) causes pneumonia.
† This virus may also be transmitted by inanimate vectors.

NEJM ***2003;348:1256-1266***

Droplet Transmission





New case traced to NUH visit

A NEW Sars case was reported yesterday, bringing the total infected in Singapore to 178.

The new patient is a 28-year-old woman who is believed to have caught the bug when she visited a friend at the National University Hospital emergency department on April 8.

The woman in now seriously ill at the intensive care unit in Tan Tock Seng Hospital.

Investigations are being carried out to trace who had contact with her after she got the virus from the male Sars patient, who was admitted to NUH on April 8.

The man was transferred to Tan Tock Seng Hospital the following day, and died on April 12.

500 surveillance cameras,

ER
Transmission of SARS

Tambyah, Ooi, Am J Med. 2004;116:486-9

Droplet precautions are adequate protection for healthcare workers managing mechanically ventilated patients with severe influenza

Virk RK [1], Balasingam S [1], Wang DA [2], Sessions OM [3], Phua J [2], Koay E [1], Tambyah PA [1]

National University of Singapore[1], National University Health System [2], Duke-NUS [3]

Influenza is one of the most important public health threats worldwide. The disease is highly contagious and is characterized by seasonal epidemics and periodic pandemics upon introduction of new subtypes of the virus. Despite the enormous burden of the disease, there are surprisingly little data on the transmission of influenza virus to healthcare workers (HCWs) in the intensive care unit (ICU) where the most critically ill patients are cared for. In the present study, we report on the transmission of influenza in patients admitted to ICU to healthcare workers using contact and droplet precautions.

- Five ICU patients (two on ECMO; one continuously mechanically ventilated; one intermittently ventilated and one not ventilated) were identified with laboratory-confirmed influenza infection by polymerase chain reaction (PCR) of a routine clinical sample.
- All attending HCW's (including physicians, nurses, allied health personnel and cleaners) were invited to take part in the study.
- HCW's who gave informed consent provided the following samples between the first day (day 0) the ICU patient was confirmed with influenza until day 10 unless the patient was discharged earlier:
  - Day 0 and 10 serum samples for serology by the haemagglutination
  - Day 0, 1, 2, 5 and 10 nasal swabs for virus detection by PCR
  - Day 0, 1 and 2 hand swabs for virus detection by PCR

In addition HCWs provided morning and evening temperature readings using a standardized oral thermometer and filled in daily diary cards to record contact time with the patient, length of shift and any symptoms (runny nose, stuffy nose, malaise, sneezing, sore throat, cough, headache, muscle/ joint pain, earache and shortness of breath) being experienced.

Environmental swabbing was also performed on sites in the room housing the ICU patient on days 0,1 and 2. These sites included the bedside table, the inside door knob, the stethoscope, call bell, bedrail and three discarded suction catheters.

Results

92 HCWs attending to the five ICU patients were recruited

Serology

Two HCWs were found to have seroconverted against H3N2 virus which was not the same influenza subtype as the index ICU patient (pandemic H1N1 2009). This suggests that they might have had mild influenza infection but did not contract it from the ICU as there was no other influenza admission concurrently at that time.

HAI	Mean HAI titre/50µl	
	Pre	Post
Nurses	45	44.26
Non Nurses	79.59	65

The data from this preliminary study indicate that there is little to no risk of transmission of Influenza from an infected patient to the healthcare workers or cleaners in the ICU with the use of routine droplet and contact precautions in mechanically ventilated patients.

- Environmental Swabs

Table 2: Percentage of surfaces positive by PCR - virus detected

Patient	%age of Surfaces Positive by PCR for Influenza virus		
	Day 0	Day 1	Day 2
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	14	42

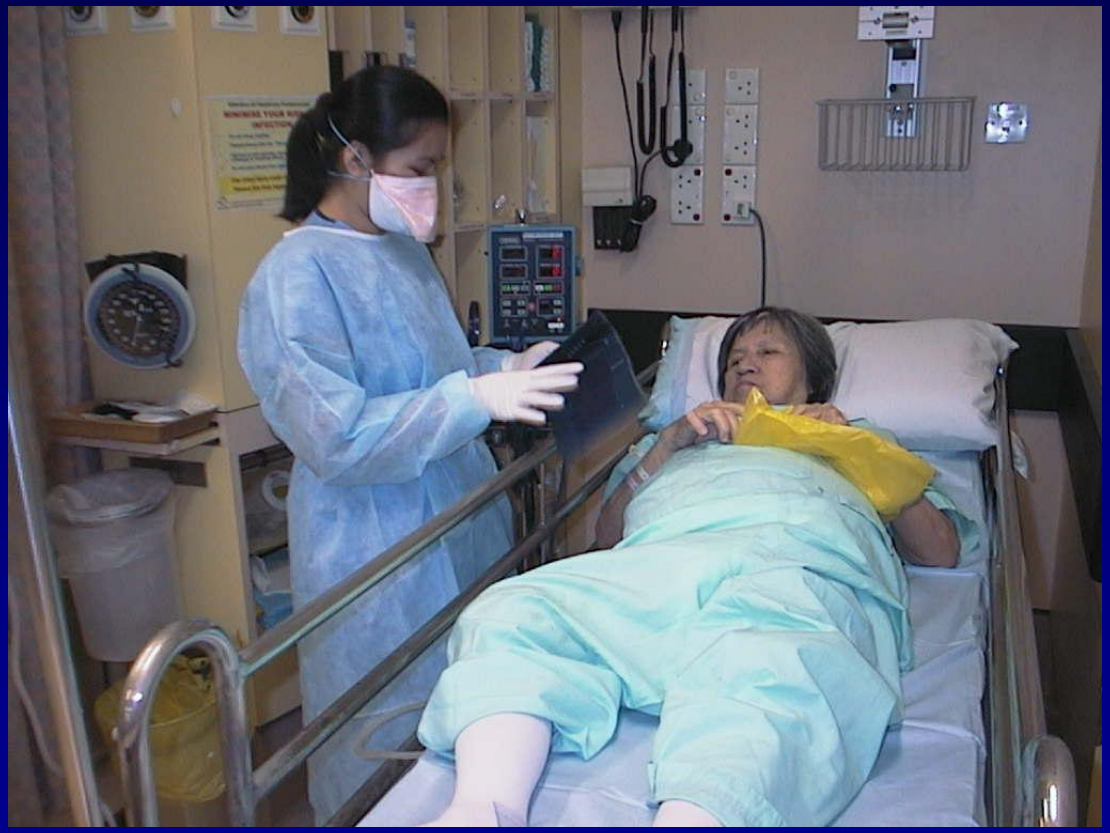
Virus ***was*** detected in the room housing the 5th ICU patient. Virus was detected on suction catheters, bed rail and the call bell.

- Hand Swabs

There was no virus detected by PCR in any of the hand swab samples

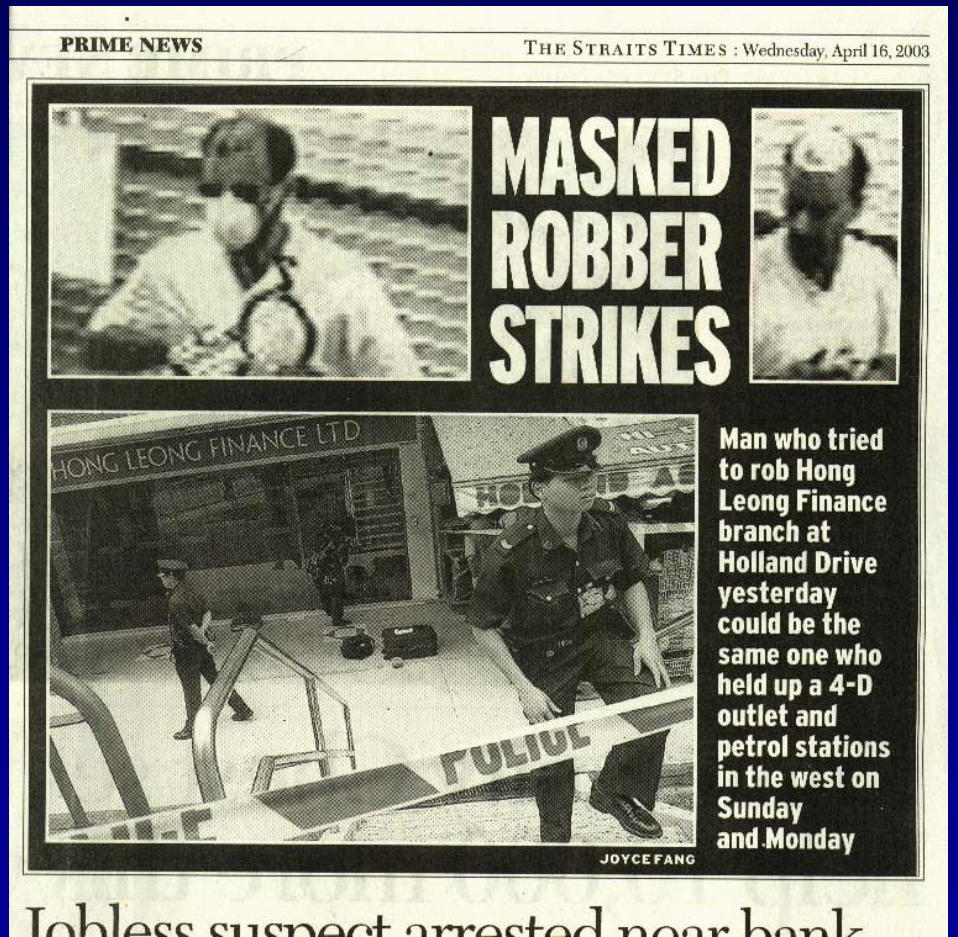
We would like to thank Dr Jingxiang Li for his assistance in recruiting HCWs on to the study.

Staff were fully protected during SARS



Powered Air Purifying Respirators are available

Even bank robbers started to use N95 masks but they found them uncomfortable!



PRIME NEWS

THE STRAITS TIMES : Wednesday, April 16, 2003

MASKED ROBBER STRIKES

HONG LEONG FINANCE LTD

JOYCE FANG

Man who tried to rob Hong Leong Finance branch at Holland Drive yesterday could be the same one who held up a 4-D outlet and petrol stations in the west on Sunday and Monday

Jobless suspect arrested near bank

Now they use surgical masks

TODAY
THURSDAY 08 FEBRUARY 2018

Man in surgical mask robs SingPost branch at Potong Pasir of S$3,000

By LOW YOUJIN AND SIAU MING EN

Prevention question: Is Influenza Airborne? Results of observational studies

A
A
A

	Number	Setting	Population	Case identification	
				Diagnostic criteria	Number (%) laboratory tested
Blumenfeld et al[33]	62	Hospital	Medical patients and staff	Viral isolation; serology	55 (89%)
McLean[34]	1116	Hospital housing tuberculosis patients	Medical patients and staff	Clinical; serology	1116 (100%)
Moser et al[35]	53	Aircraft	Healthy adults	Clinical; viral isolation; serology	Unclear
Klontz et al[36]	110	Naval base aircraft	Healthy adults	Clinical; viral isolation; serology	105 (95%)
Morens and Rash[37]	39	LTCF	Elderly residents	Clinical; viral isolation; serology	37 (95%)
Drinka et al[38]	690	LTCF	Elderly residents	Viral isolation	241 (35%)
Munoz et al[39]	15	NICU	Critical care neonates	Clinical; viral isolation; antigen detection	4 (27%)
Cunney et al[40]	54	NICU	Critical care neonates	Clinical; antigen detection	54 (100%)
Awofeso et al[41]	59	Correctional facility	Healthy adults	Clinical; viral isolation; antigen detection	21 (36%)

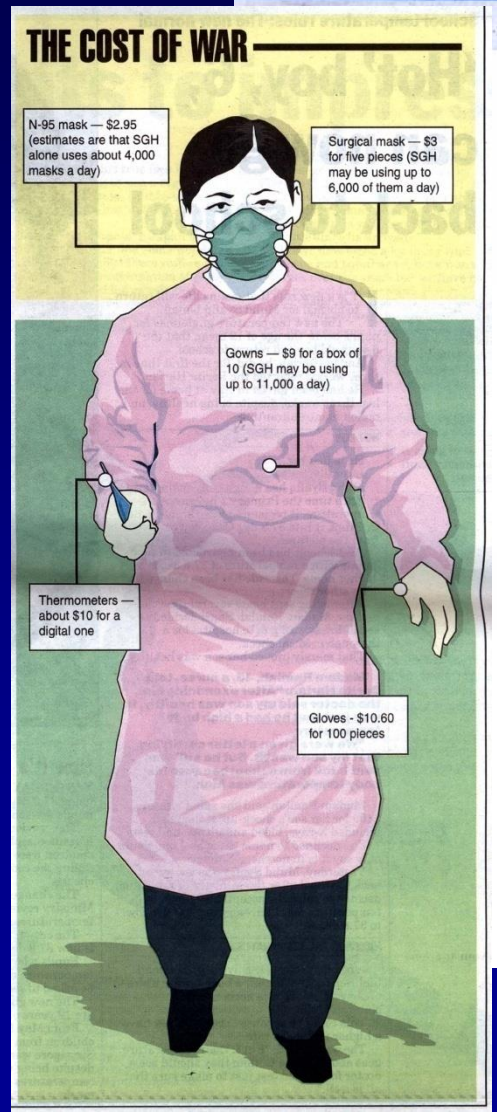
LTCF=Long-term care facility; NICU=neonatal intensive care unit.

Table 5: **Summary of influenza epidemiological studies**

Brankston et al Lancet Infectious Disease 2007;7:257-65

Evidence based IP is critical

The costs Were tremendous



TUESDAY, MAY 27, 2003
the new paper

Sars: The high-cost dilemma

$20,000 a day on safety gear at just one hospital

Your money or your life

Cost-effectiveness Analysis of Hospital Infection Control Response to an Epidemic Respiratory Virus Threat

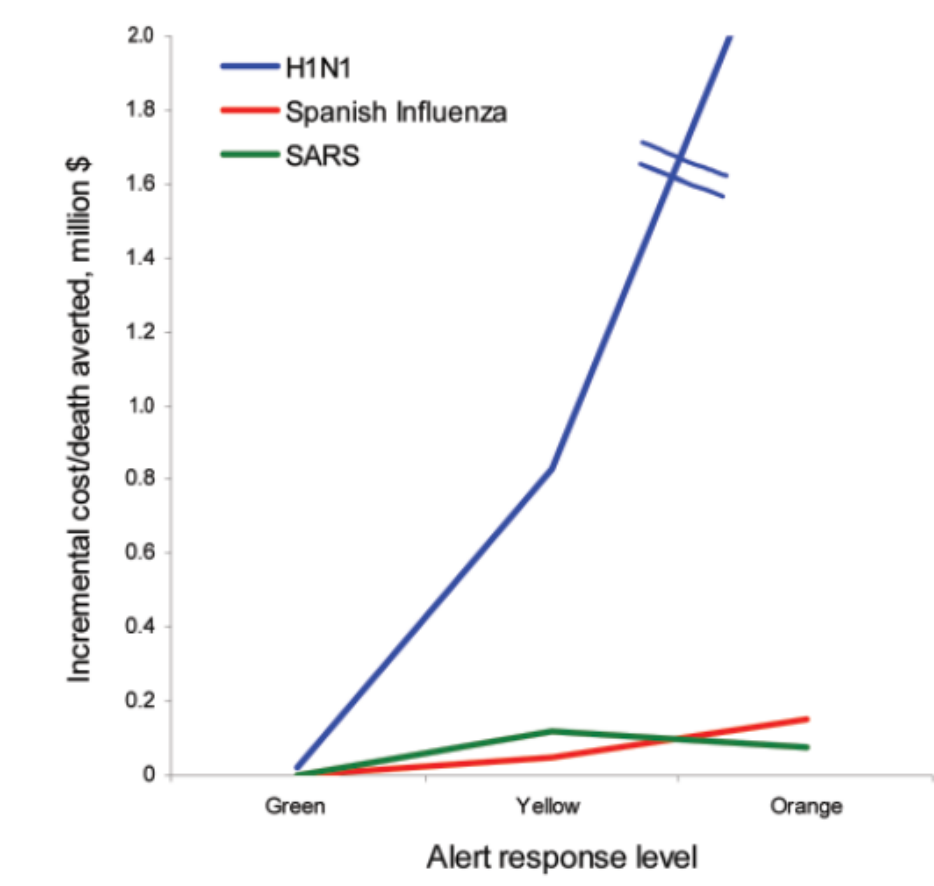
Yock Young Dan, Paul A. Tambyah, Joe Sim, Jeremy Lim, Li Yang Hsu, Wai Leng Chow, Dale A. Fisher, Yue Sie Wong, and Khek Yu Ho

Table 3. Results of cost-effectiveness analysis of potential outbreaks and responses, Singapore*

Alert level and disease	No. infected	No. deaths	Additional cost	Cost/case prevented†	Cost/death prevented†	Incremental cost/case‡	Incremental cost/death‡
None							
Pandemic (H1N1) 2009	2,580	10	25,200				
Spanish influenza	3,210	161	80,000				
SARS	825	83	99,200				
Green							
Pandemic (H1N1) 2009	316	1	326,430	95	23,644		
Spanish influenza	624	31	468,000	107	2,140		
SARS	105	11	220,500	120	1,195		
Yellow							
Pandemic (H1N1) 2009	59	0.2	1,485,500	414	103,274	3,221	827,907
Spanish influenza	120	6	2,212,000	493	9,857	2,472	49,829
SARS	43	4	1,188,000	995	9,945	11,146	121,241
Orange							
Pandemic (H1N1) 2009	24	0.1	1,836,000	506	126,807	7,153	2,503,600
Spanish influenza	59	2.95	2,856,000	629	12,590	7,541	153,333
SARS	12	1.2	1,537,000	1,263	12,601	8,041	7,541

*SARS, severe acute respiratory syndrome. All costs given in US$.
†Compared with no policy.
‡Compared with 1 alert level down.

Bottom line: Depends on the virus



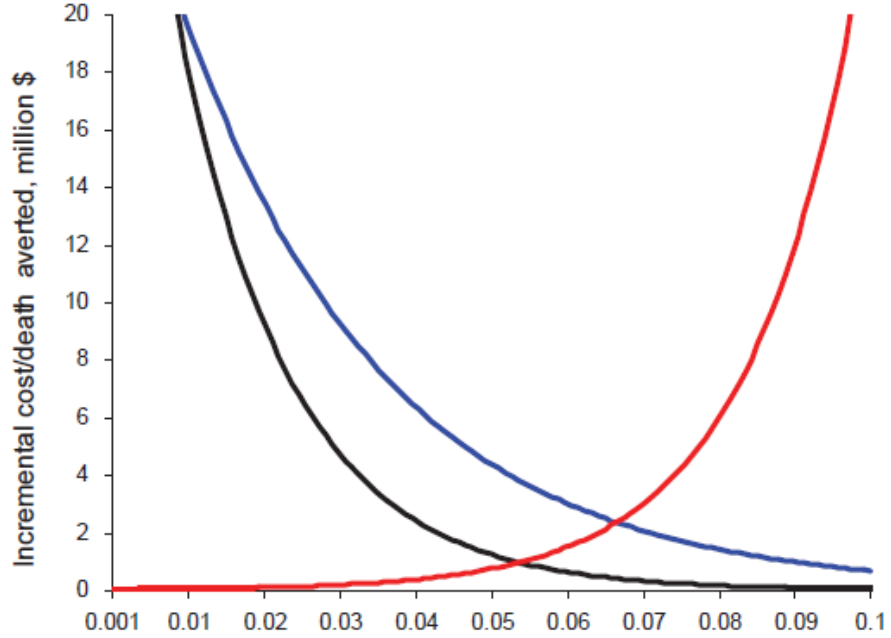
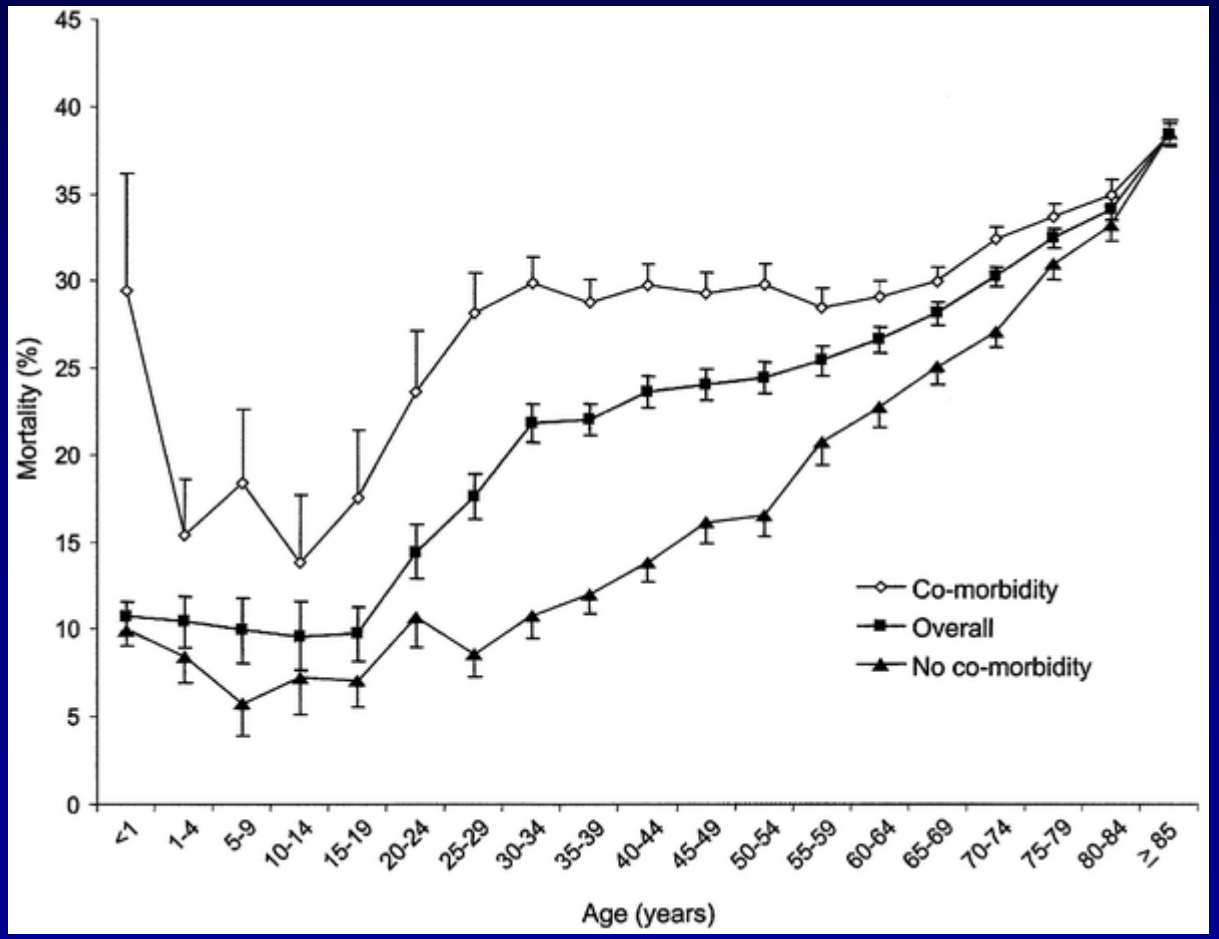


Figure 4. Sensitivity analysis for case-fatality rate (black line), % exposure reduction (red line), and secondary attack rate (blue line). Exponential graphs show poor cost-effectiveness at extremes of low case-fatality rate and low transmissibility (high % exposure reduction and low secondary attack rate).

The ICU in pandemics

- Protecting staff and other patients from EIDs
- Treating and supporting patients with severe disease
- Surveillance and surge capacity
- Protecting patients from us and our devices (and drugs)

Sepsis is bad



Angus et al Crit Care Med 2001; 29:1303–10

Sepsis outcomes in Developing Countries can improve

Personal View

Surviving sepsis in low-income and middle-income countries: new directions for care and research

Joseph U Becker, Christian Theodosis, Shevin T Jacob, Charles R Wira, Nora Ellen Groce

Sepsis is a disorder characterised by systemic inflammation secondary to infection. Despite recent progress in the understanding and treatment of sepsis, no data or recommendations exist that detail effective approaches to sepsis care in resource-limited low-income and middle-income countries (LMICs). Although few data exist on the burden of sepsis in LMICs, the prevalence of HIV and other comorbid conditions in some LMICs suggest that sepsis is a substantial contributor to mortality in these regions. In well-resourced countries, sepsis management relies on protocols and complex invasive technologies not widely available in most LMICs. However, the key concepts and components of sepsis management are potentially translatable to resource-limited environments. Health personnel in LMICs should be educated in the recognition of sepsis and the importance of early and appropriate antibiotic use. Simple and low-cost standardised laboratory testing should be emphasised to allow accurate diagnosis, prognosis, and monitoring of treatment response. Evidence-based interventions and treatment algorithms tailored to LMIC ecology and resources should thus be developed and validated.

Lancet Infect Dis 2009; 9: 577–82

Section of Emergency Medicine, Department of Surgery, Yale University School of Medicine, New Haven, CT, USA (J U Becker MD, C R Wira MD); Department of Medicine, University of Chicago, Chicago, IL, USA (C Theodosis MD); Division of Allergy and Infectious Diseases, Department of Medicine, University of Washington Medical Center, Seattle, WA, USA (S T Jacob MD); and

Panel 1: Sepsis bundle for low-income and middle-income countries

Laboratory testing

- Blood count (including haematocrit, leucocytes)
- Blood chemistry (lactate, urinalysis)
- Cultures (blood, urine, and other body fluids)
- HIV rapid test
- Malaria thick and thin blood smear
- Other (depending on local relevance)

Source identification and control

- Eg, abscess drainage

Antimicrobials

- Early administration of appropriate antimicrobials
- Antimalarial(s)
- Antibiotic(s)
- Other (depending on local relevance)

Fluid resuscitation

- Intravenous or oral

Assessment of endpoints (treatment response)

- Lactate clearance
- Blood pressure
- Heart rate

Panel 2: Suggested schedule of research and programming priorities in sepsis in low-income and middle-income countries (LMICs)

1. Educate providers and clinicians throughout LMICs about the clinical signs, symptoms, and pathophysiology of sepsis.
2. Develop and validate sepsis management algorithms for LMICs either independently or extrapolated from established data.
3. Develop and validate cost-effective, easily used, and clinically appropriate diagnostic tests to identify ill patients and guide endpoints of resuscitation.
4. Develop clinical laboratory capacity including microbiological testing.
5. Develop regional recommendations regarding initial broad-spectrum antimicrobial coverage for patients with sepsis based on local ecology and resistance patterns.
6. Improve and augment LMIC critical-care systems and resources including referral systems and tertiary-care centres.
7. Develop systems to assure high quality, cost-effective, and affordable sepsis care.

care infrastructure should be developed in LMICs to support and provide oversight to these efforts. Further

Lancet Infect Dis 2009; 9: 577–82

Section of Emergency Medicine, Department of Surgery, Yale University School of Medicine, New Haven, CT, USA (J U Becker MD, C R Wira MD); Department of Medicine, University of Chicago, Chicago, IL, USA (C Theodosis MD); Division of Allergy and Infectious Diseases, Department of Medicine, University of Washington Medical Center, Seattle, WA, USA (S T Jacob MD); and

ECMO increasingly used post H1N1 2009

Intensive Care Med
DOI 10.1007/s00134-014-3405-6

Graeme MacLaren
Kollengode R. Ramanathan
Vitaly Sorokin

Extubation to facilitate mother–baby bonding in refractory acute respiratory distress syndrome

Received: 9 July 2014
Accepted: 10 July 2014

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G. MacLaren
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A 25-year-old pregnant woman presented at 37 weeks gestation with worsening respiratory distress. A diagnosis of influenza A (H1N1) pneumonitis with acute respiratory distress syndrome (ARDS) was established. Following tracheal intubation, emergency Cesarean section, and delivery of a healthy baby boy, she developed progressive, severe respiratory failure with a PaO_2/FiO_2 ratio of 50. She was referred to our centre and cannulated onto venovenous extracorporeal membrane oxygenation (ECMO).

The ARDS persisted and the patient was unable to be weaned from ECMO after 7 days of extracorporeal support (Fig. 1). However, influenza was no longer detectable on repeat polymerase chain reaction testing

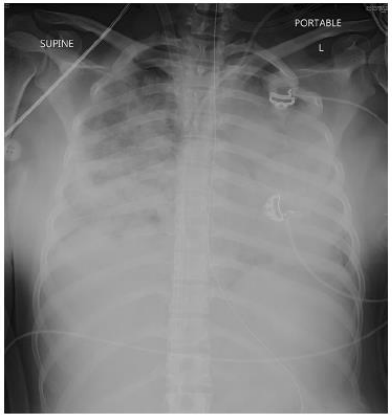

Fig. 1 Chest X-ray after one week of ECMO

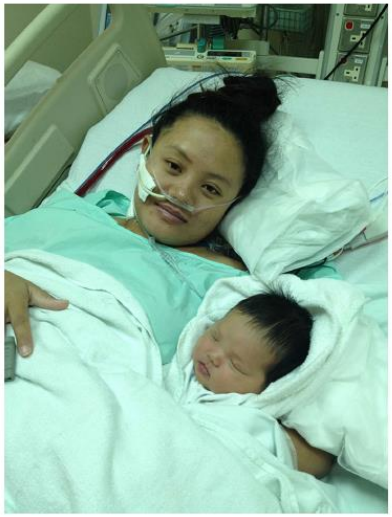

Fig. 2 Photograph of the patient and her son taken on the same day

Mediterranean region and first documented in the United States (New York City) in the summer of 1999. By the end of 2002, the CDC had recorded 3,873 laboratory-positive human cases and 246 deaths nationwide. South Carolina was the last state east of the Rocky Mountains to report West Nile virus, the first infection appearing in a dead bird on 13 August 2002. The state's first human infection (nonfatal) was discovered in a 30-year old woman on 29 August 2002. The woman, however, had returned from Louisiana, where West Nile was flaring, just six days before manifesting symptoms.

Although human cases of Saint Louis encephalitis have been documented from all surrounding states, none have been reported from South Carolina. Nonetheless, probable Saint Louis encephalitis virus, as well as Jamestown Canyon variant virus, Tensaw virus, and several other arboviruses of questionable pathogenicity to humans, have been found in mosquitoes in South Carolina, suggesting the potential for human infection (Wozniak et al. 2001).

Dengue

Two competent mosquito vectors, *Aedes aegypti* (L.) and, to a lesser extent, *Aedes albopictus* (Skuse), transmit dengue viruses (*Flavivirus*). Dengue is an immigrant disease that presumably arrived in the New World with the African slaves, appearing first in the Carribean in the 1600s. The disease was unknown in the United States before 1779 (Waring 1967).

Dengue was sporadic during South Carolina's first 200 years (Waring 1967). Charleston might

Poverty: aider and abettor of arthropod-borne diseases in South Carolina (South Carolina Department of Health and Environmental Control (archives), Columbia, SC).

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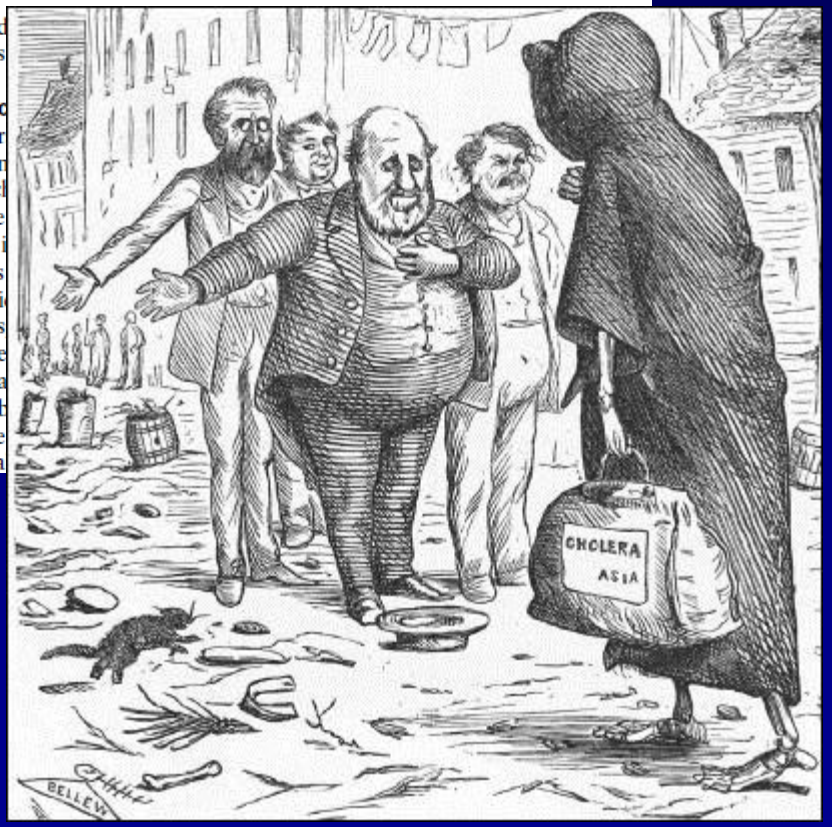
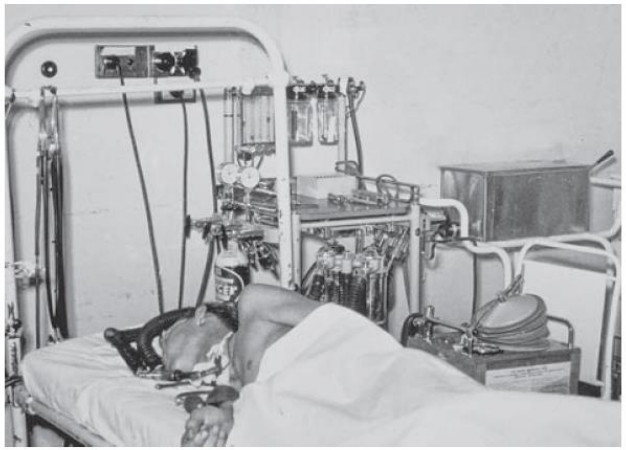


Public Health in 18th-19th century USA: Dengue in S.Carolina & Cholera in NYC

http://www.entsoc.org/PDF/Pubs/Periodicals/AE/AE-2003/winter/Feature-.pdf

http://www.scienceclarified.com/everyday/Real-Life-Chemistry-Vol-6/Infectious-Diseases.html

Figure 1. Bear ventilator with anaesthesia machine used in tetanus treatment, Royal Adelaide Hospital, 1959



Photograph courtesy of Royal Adelaide Hospital intensive care unit.

Tetanus and the evolution of intensive care in Australia

John E (Fred) Gilligan, AO, James R Lawrence, AO, David Clayton and Robert Rowland

SUMMARY

- A review of two series of patients with tetanus from the Royal Adelaide Hospital provides a historical perspective on the evolution of intensive care in Australia. Nine consecutive severe cases presenting in 1957 constituted one of the first series published. Four patients died. The second series of 38 severe cases, among a total of 56 cases presenting between 1967 and 1985, included two deaths, comparing favourably with survival in other contemporary series. The specialty of intensive care evolved considerably during this time.
- Neuromuscular blockade introduced in the first series produced radical changes in management. Supportive measures that were not then widely practised, involving intermittent positive pressure ventilation, were used in the second series for up to 46 days and evolved into standard ICU practice. The option of using a tank respirator was rejected. Older patients were susceptible to complications commonly related to respiratory, cardiovascular and diabetic comorbidities, but most returned to their previous lifestyle.
- Severe tetanus often resulted from mild injuries in patients who were incompletely immunised. Four patients developed tetanus following surgical procedures.
- The use of nitrous oxide in the first series was abandoned owing to adverse effects on bone marrow function. Complications reported in early literature, such as fractures and myositis ossificans, presumably related to unrelieved spasm, are no longer seen.
- Clinicians are now likely to see the condition only if working with counter-disaster teams overseas.

Crit Care Resusc 2012; 14: 316–323

Tetanus has a long history. Hippocrates wrote,[1] "A convulsion after a wound is lethal ... In tetanus and opisthotonos it is a fatal sign to sweat and for the body to be relaxed"; and textbooks of the 1950s described devastating spasms, often beginning with risus sardonicus and culminating with opisthotonos — arching of the body between the heels and the head.[2] Death from asphyxia and exhaustion often followed.

The patients included in our review were all admitted to AH); initially, to the specific intensive care unit. The two preceding the emergence of New Zealand and extending was well established. Some ed hesitantly have become ments and clinical problems

severe cases that presented y JRL,[3] who was then the dicine at the RAH. His co- ando OBE (hereafter "MS"), trar in anaesthesia, and later, f Anaesthesia and Intensive aculty of Anaesthetists of the Surgeons. The second series managed by JEG, RR and gust 1985, of which 38 were

agement

Five patients in the first case series survived. Four patients died with major comorbidities (Table 1); one, with 40% full-thickness burns, also suffered severe anaphylaxis associated with equine ATS; another, with an abortion site infected with *Clostridium tetani,* required a hysterectomy and apparently also developed a septic syndrome; and a third was dehydrated and in renal failure on admission when dialysis and venous pressure assessment of rehydration were not yet used at RAH.

In the second case series, 36 survivors of 38 severe cases were discharged from hospital. Major problems encountered in their management are listed in Table 4. Episodes of acute respiratory distress syndrome (ARDS)[5,6] followed inhalation of gastric content from tracheostomy cuff leakage. These resolved with continued IPPV, positive end-expiratory pressure, antibiotics and mild dehydration measures. One patient developed a residual restrictive ventilatory defect, prompting lung function tests on a random selection of six other patients, which were normal. One tracheostomy-

le 1), major spasms were

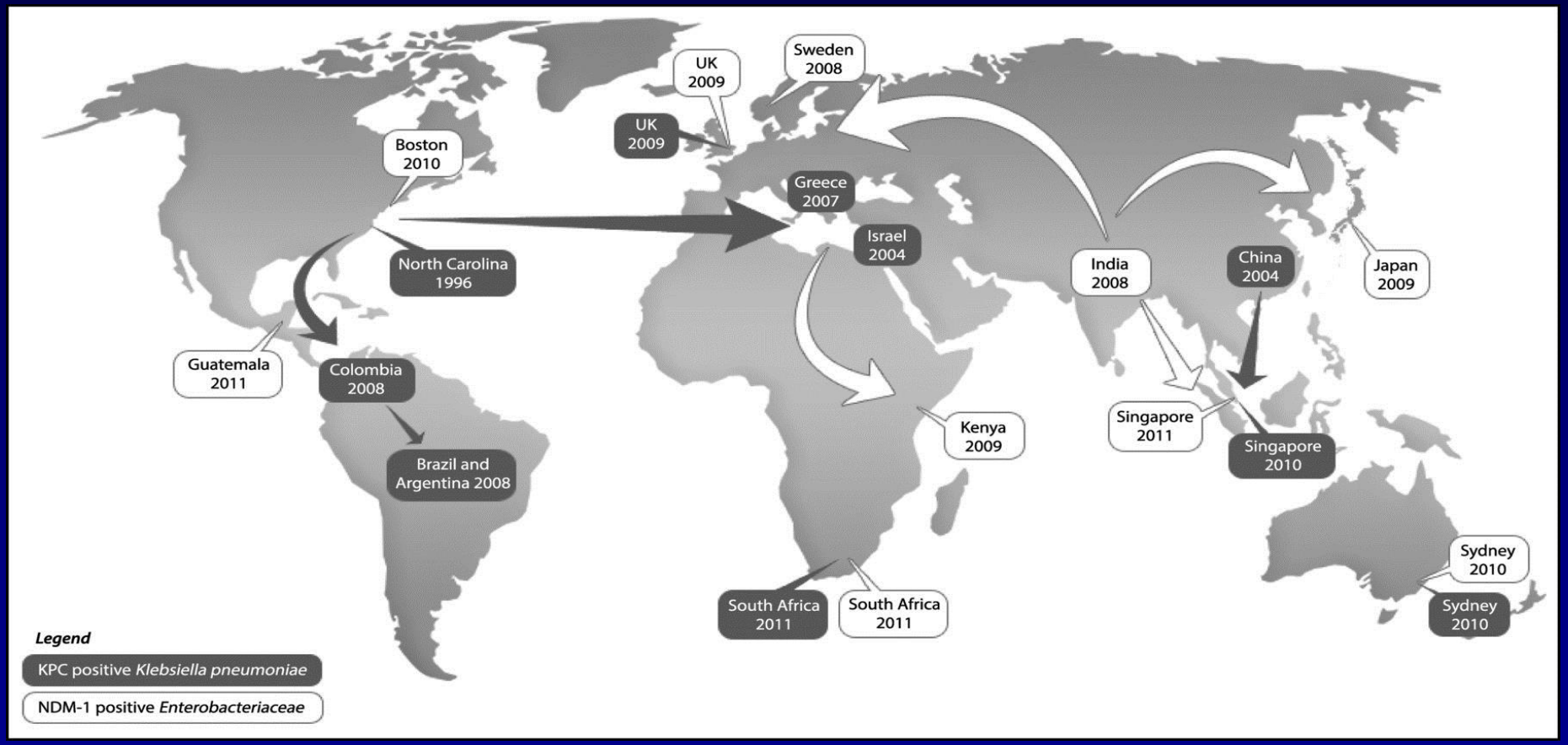
The ICU in outbreaks

- Protecting staff and other patients from EIDs
- Treating and supporting patients with severe disease
- Surveillance and surge capacity
- Protecting patients from us and our devices

Why do ICU surveillance?

- Early warning
- Most vulnerable
- Most controlled environment

Global dissemination of Klebsiella pneumoniae carbapenemase–producing K. pneumoniae and New Delhi metallo-β-lactamase-1–producing Enterobacteriaceae.



Molton J S et al. Clin Infect Dis. 2013;56:1310-1318

Clinical Infectious Diseases

ELSEVIER

Burns 28 (2002) 349–357

BURNS

www.elsevier.com/locate/burns

Multi-resistant *Acinetobacter baumannii* on a burns unit—clinical risk factors and prognosis

Ting Hway Wong, Ban Hock Tan*, Moi Lin Ling, Colin Song

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Accepted 27 November 2001

Abstract

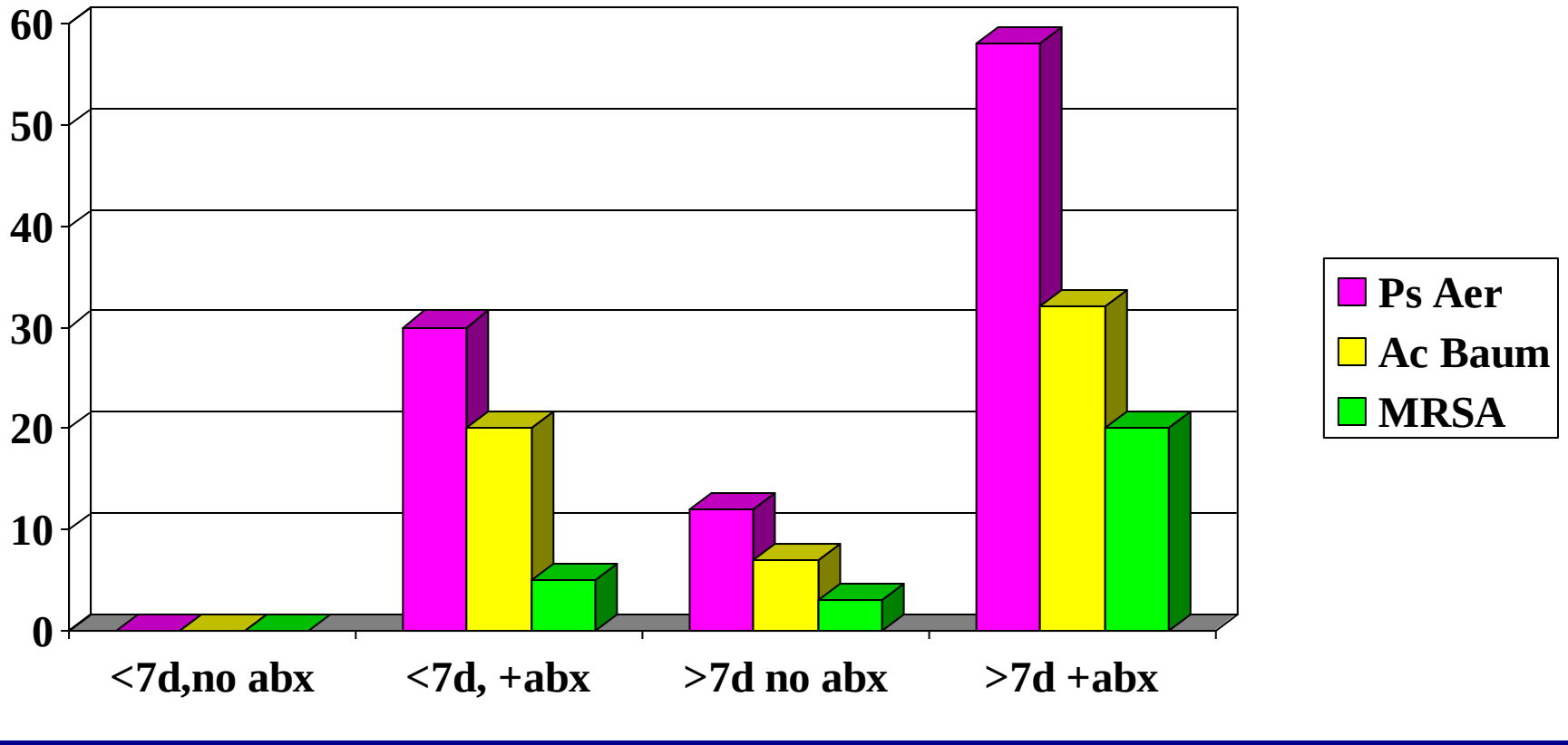
Burns patients are highly susceptible to infection, and preventing and treating infection are integral to the successful management of severe burns.

Multi-resistant *Acinetobacter baumannii* (MR-AB) strains are becoming increasingly important in nosocomial infections. We conducted a retrospective study of all adult admissions to the Singapore General Hospital (SGH) National Burns Center over an 18-month period.

The only independent risk factors for the acquisition of MR-AB were the APACHE II score on admission and the number of intravascular lines placed. The only independent predictor of infection with MR-AB was the number of intravascular lines placed. The only independent predictors of longer length of stay were the total number of operations required and infection with MR-AB. The only independent predictor of mortality was the APACHE II score. This is in contrast to other studies that have suggested that the acquisition of MR-AB is an independent risk factor for mortality.

Keywords: *Acinetobacter baumannii*; Burns; Multi-resistant; Risk factors

Antibiotic resistance in the ICU



Trouillet JL et al. Am J Resp Crit Care Med 1998;157:531-9

IT'S TOO LATE, WHEN EMOTIONS ESCALATE...

'By promoting mediation directly to the public, they can turn to the option earlier, before emotions escalate, positions harden and costs rise.'

— Senior Minister of State (Law and Home Affairs) Ho Peng Kee, urging people to talk things out instead of going to court

The Sunday Times

Sunday, March 23, 2003

home

Tan Tock Seng HOSPITAL

SORRY, NO MORE ADMISSIONS

For next 2 weeks: TTSH won't take in new patients, A&E also closed

-ANN WEE

Tock Seng Hospital H) is not where you go in the next fortnight, you suspect you may be g down with the severe respiratory

afternoon that it was decided in the morning that it was better to centralise the treatment of all suspected and confirmed cases at TTSH and the Communicable Disease Centre (CDC).

ed of having Sars.

And there is also a list of 228 people the ministry is keeping tabs on, said Mr Lim. These are people who have been in contact with

patients in the hospital.

Non-Sars cases now in the hospital will continue to be treated there with no contact whatsoever with the Sars

FROM 3 VICTIMS TO 44...

THREE infected women returned from Hongkong late last month. Two were discharged from hospital early this month. These three were the "index cases" from which the disease spread to others.

March 6: Hospitals here take precautionary measures to isolate the patients.

March 14: Nine confirmed cases
Three index cases, four family/friends, two hospital staff.

March 15: 14 confirmed cases
Two family/friends, three hospital staff.

March 16: 20 confirmed cases
Four family/friends, two hospital staff.

March 17: 21 confirmed cases
Four family/friends, four hospital staff.

March 20: 34 confirmed cases
Three family/friends
One more moved to ICU.

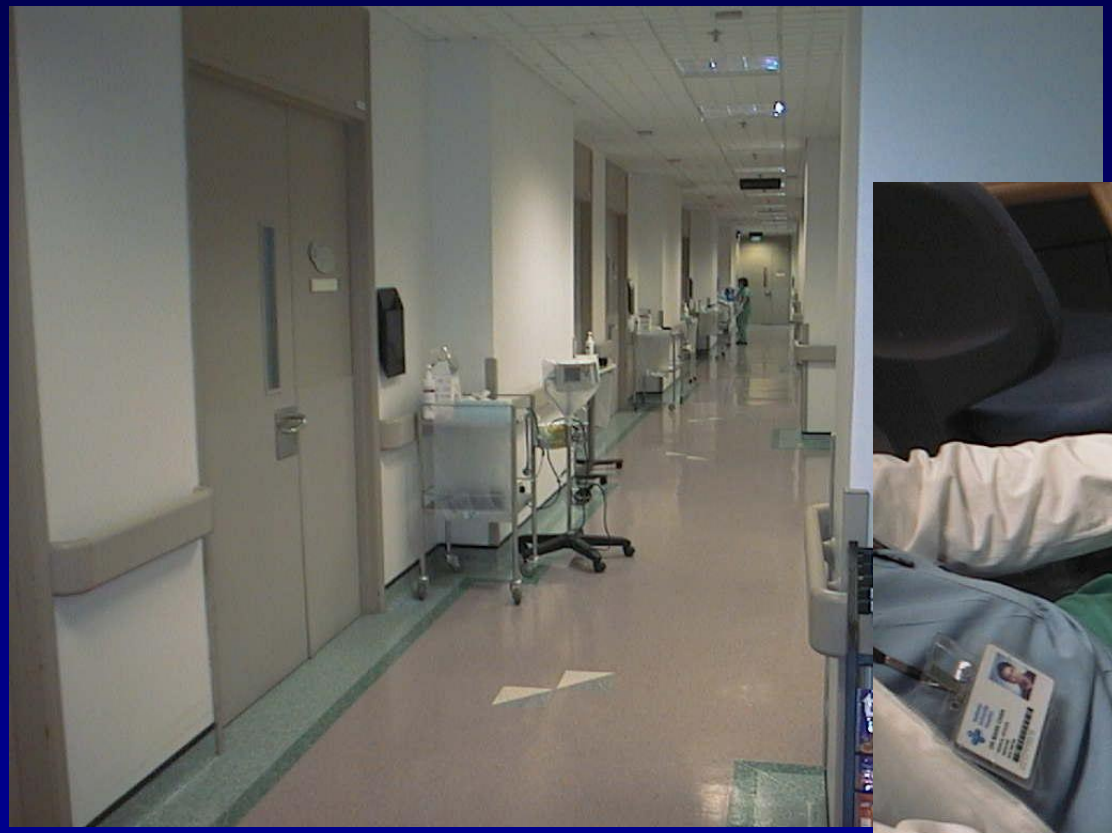
March 21: 39 confirmed cases
One family/friend, four hospital staff.
Two more moved to ICU.

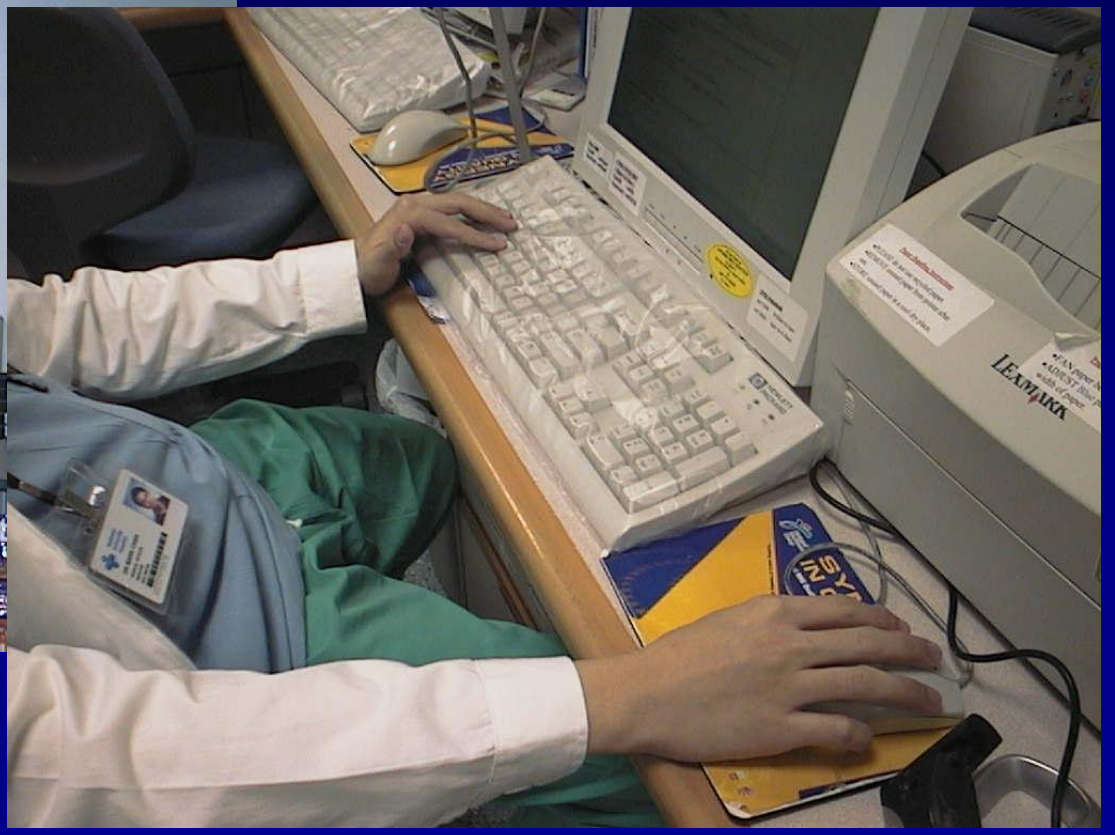
March 22: 44 confirmed cases
One family/friend, four hospital staff.
One more moved to ICU.

TOTAL

Index cases: 3
Family/friends: 20
Hospital workers: 21
(Five doctors, 14 nurses, one ward clerk and one

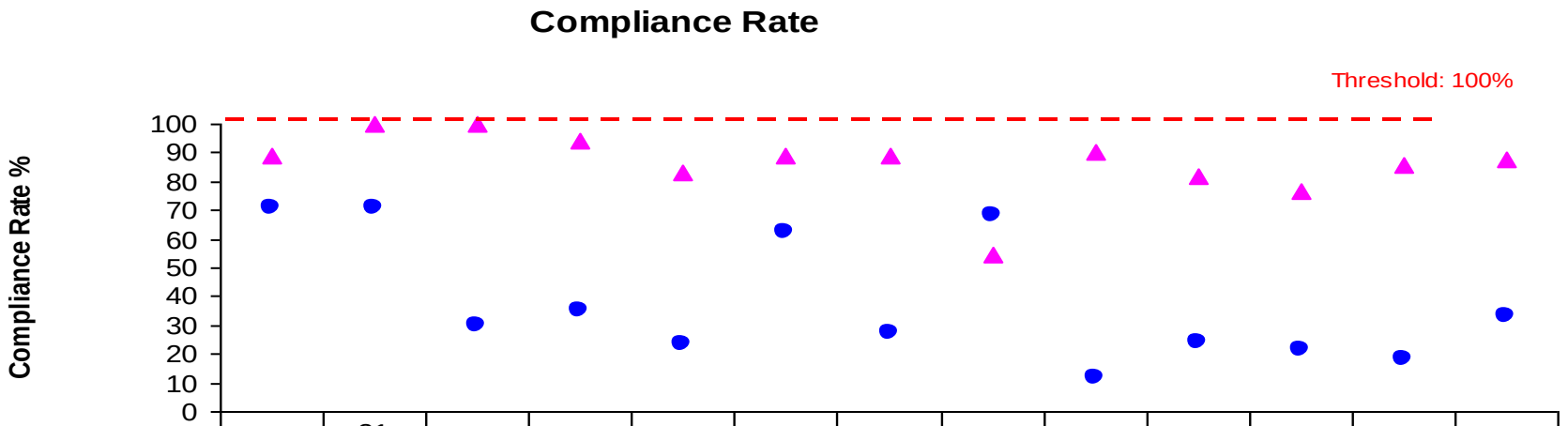
Improvisation for continuity of care





Hand Hygiene Audit

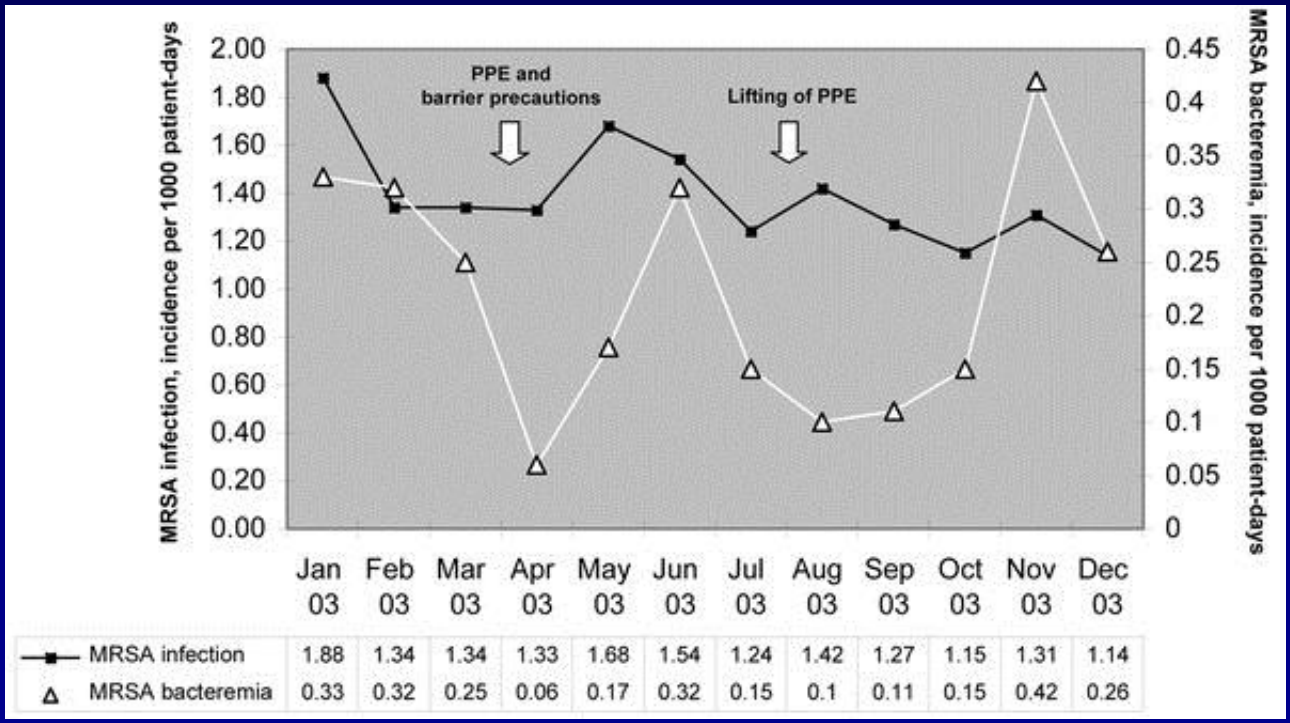
February - March & June 2003



	20 CTICU	21 MICU / SICU	41	43	44	47/PIC C	51	52	53	55	57	58H	Overall
● Compliance (%) (Pre-SARS)	70.6	71	29.7	35.1	23.6	62.5	27.4	68.5	12.0	24	21.3	18	33.4
Compliance #	12	53	22	26	17	21	20	50	9	18	16	13	277
Sample Size	17	75	74	74	72	74	73	73	75	75	75	72	829
▲ Compliance (%) (Post-SARS)	88.9	100	100.0	94.4	83.3	88.9	88.9	54.5	90.0	82	76.9	85.7	87.4
Compliance #	16	18	14	17	10	16	16	6	9	9	10	12	153
Sample Size	18	18	14	18	12	18	18	11	10	11	13	14	175

Courtesy of Deborah & QIU team

Hand hygiene needs a comprehensive approach



Chai et al *Clinical Infectious Diseases* *2005;40:632-633*

The ICU in pandemics

- Protecting staff and other patients from EIDs
- Treating and supporting patients with severe disease
- Surveillance and surge capacity
- Protecting patients from us and our devices

The Pathogenesis of Ventilator-Associated Pneumonia

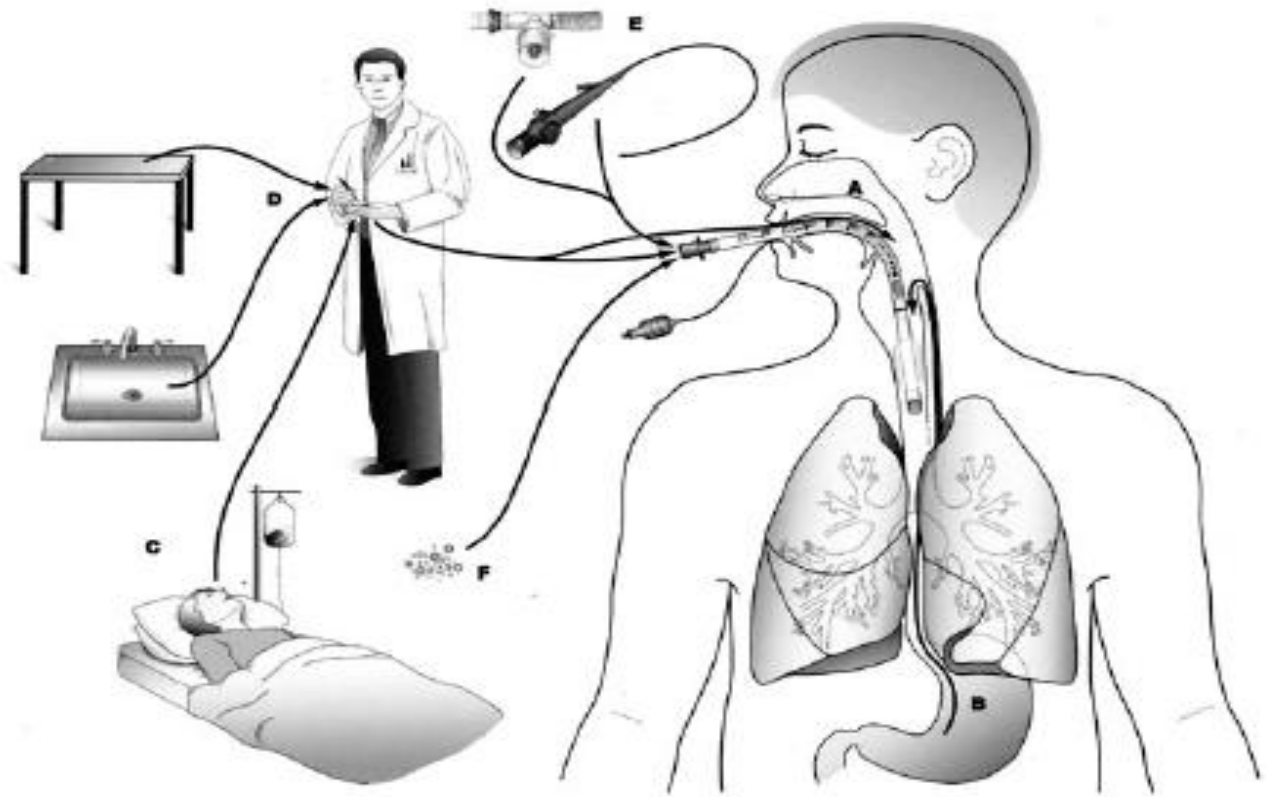


Fig. 1. Routes of colonization/infection in mechanically ventilated patients. Colonization of the aerodigestive tract may occur endogenously (A and B) or exogenously (C through F). Exogenous colonization may result in primary colonization of the oropharynx or may be the result of direct inoculation into the lower respiratory tract during manipulations of respiratory equipment (D), during using of respiratory devices (E), or from contaminated aerosols (F).

Safdar N, Crnich CJ, Maki DG. Respir Care. 2005;50:725-39

Comparison of Device Use and Rates of Device-Associated Infection in the Intensive Care Units of the International Nosocomial Infection Control Consortium and of the U.S. National Nosocomial Infection Surveillance System*

Table 5. **Comparison of Device Use and Rates of Device-Associated Infection in the Intensive Care Units of the International Nosocomial Infection Control Consortium and of the U.S. National Nosocomial Infection Surveillance System***

Variable	U.S. NNIS ICUs: 1992–2004	INICC ICUs: 2002–2005
Rate of device use†		
Mechanical ventilators	0.43 (0.23–0.62)	0.38 (0.19–0.64)
CVCs	0.57 (0.36–0.74)	0.54 (0.22–0.97)
Urinary catheters	0.78 (0.65–0.90)	0.73 (0.48–0.94)
Rate per 1000 device days†		
Ventilator-associated pneumonia	5.4 (1.2–7.2)	24.1 (10.0–52.7)
CVC-associated bloodstream infection	4.0 (1.7–7.6)	12.5 (7.8–18.5)
Catheter-associated UTI	3.9 (1.3–7.5)	8.9 (1.7–12.8)
Proportion of device-associated infections with resistance, %‡		
MRSA	59	84
Ceftriaxone-resistant *Enterobacteriaceae*	19	55
Ciprofloxacin-resistant *Pseudomonas aeruginosa*	29	59
Vancomycin-resistant enterococci	29	5

* Data are from an NNIS report (1). CVC = central venous catheter; ICU = intensive care unit; INICC = International Nosocomial Infection Control Consortium; MRSA = methicillin-resistant *Staphylococcus aureus*; NNIS = National Nosocomial Infection Surveillance System; UTI = urinary tract infection.
† Overall (pooled) and 10th to 90th percentile range for U.S. NNIS teaching hospitals; overall (pooled) and range of individual countries for the INICC hospitals.
‡ Overall (pooled) data from NNIS, 1992–2004 (300 hospitals), and from INICC, 2002–2005.

Rosenthal, V. D. et. al. Ann Intern Med 2006;145:582-591

Annals of Internal Medicine

It all begins with the patient

- 75 year old woman
- DM ,Hypertension
- IHD s/p CABG 2011
- Bilateral OA knees
- ESRF – hemodialysis with access issues

Presenting complaint Nov 2013

- Fever and chills for 1 day during dialysis
- Yellowish pus from new right femoral perm catheter
- Physical exam unremarkable
- Found to have intramuscular abscesses
- Multiple positive blood c/s for MSSA
- Treated with vancomycin then cefazolin
- Improved

Progress

- Remained well, intramuscular abscesses smaller
- Placement issues

Spiked a fever early in the new year

- Blood cultures peripheral and line: gram negative rods

Blood O2 AnO2 c/s

Sample Origin	Blood, vein	
Specimen comment	Serial Number : SFN1XBX8 SGK5C4YR	
Request status	Completed	
Direct Exam	.	
Visual Aspect	.	
Neg AnO2 comment	No anaerobic bacterial growth after 5 days	
Identification	.	
Organism 1	Elizabethkingia meningoseptica	
Comment	Isolated from aerobic bottle only	
Sensitivity 1	.	
Organism 1	Elizabethkingia meningoseptica	
Ceftazidime MIC	Resistant	
Ceftazidime MIC	> 256.000	mg/L
Pip/Tazobactam	Intermediate	
Pip/Tazobactam	6.000	mg/L
Cotrimoxazole	Sensitive	
Cotrimoxazole	0.500	mg/L

- Started bactrim and levofloxacin
- Blood cultures cleared after 1/52

Complained of blurring of vision

Vitreal aspirate cultures

Identification	.	
Organism 1	Elizabethkingia meningoseptica	
Growth	(Light)	
Sensitivity 1	.	
Organism 1	Elizabethkingia meningoseptica	
Vancomycin MIC	32.000	mg/L
Ceftazidime MIC	Resistant	
Ceftazidime MIC	> 256.000	mg/L
Gentamicin	Resistant	
Gentamicin	> 256.000	mg/L
Amikacin	Resistant	
Amikacin	> 256.000	mg/L
Ciprofloxacin MIC	Sensitive	
Ciprofloxacin MIC	0.750	mg/L
Levofloxacin	Sensitive	
Levofloxacin	0.750	mg/L
Cotrimoxazole	Sensitive	
Cotrimoxazole	0.500	mg/L
Minocycline	Sensitive	
Minocycline	1.500	mg/L

Progress

- Converted to intravitreal levofloxacin and topical levofloxacin
- PO levofloxacin 6/52

- Improved clinically (although still blind)
- Inflammatory markers improved
- discharged

Young et al. Antimicrobial Resistance and Infection Control 2014, 3:35
http://www.aricjournal.com/content/3/1/35

ANTIMICROBIAL RESISTANCE & INFECTION CONTROL

CASE REPORT Open Access

Elizabethkingia Meningoseptica Engodenous Endophthalmitis – a case report

Stephanie Ming Young[1*], Gopal Lingam[1] and Paul Anantharajah Tambyah[2]

Abstract

Elizabethkingia meningoseptica is a nosocomial non-fermenting gram-negative bacillus that has an increasing prevalence in health care settings, especially in intensiv
cause of neonatal meningitis and sepsis, its
of *E. meningoseptica* endogenous endopht
aggressiveness and virulence in the eye,
endophthalmitis especially given its low
bloodstream infections for endophthalmiti
Klebsiella bacteraemia to ophthalmologists

Keywords: Elizabethkingia meningoseptica

Table 1 Summary of outbreaks of *Elizabethkingia meningoseptica*

Period of outbreak	Type of unit	Population involved	Source of outbreak	Control measures	Outcome
April to October 2002 [6]	Neonatal intensive care unit	4 neonates	Not found	Controlled by reinforcement of usual measures	No additional colonization/infection confirmed for >1 year after last case
July 2006 and January 2007 [7]	Neonatal intensive care unit and pediatric wards	8 newborns and 5 older children	Hand cultures obtained from a senior resident; Environmental cultures obtained from powdered infant formula, an electrical button, a computer keyboard, phone, a doorknob, and an Ambu bag	Staff exchange in wards restricted; All units thoroughly scrubbed using 2 disinfectants 3 times a day until outbreak controlled; Contact precautions.	Nine patients improved on antimicrobial treatment, and 4 premature infants died after infection.
December 2007 through April 2008 [8]	Long-term acute care hospital	19 patients with respiratory failure on mechanical ventilation	Environmental sampling: one swab out of 106 surfaces; Patient sampling: *E. meningoseptica* isolated from blood, respiratory specimen, catheter tip	Training on handwashing and disinfection practices, isolation policies, use of gowns and gloves, policies implemented regarding proper disposal of body fluids	Eight out of 19 died
Fall, 2006 [9]	Orthopaedic wards	2 patients who had allograft-associated surgical site infections	*E. meningoseptica* was recovered from sink drains and traps in clean rooms where tissues were processed	All clean-room sink drains and traps at processing facility replaced, check valves in drains installed, routine sanitization of drains started,	Tissue-processing resumed following these changes; sterility failure rates returned to baseline levels with no identification of E. meningoseptica or other waterborne gram-negative bacteria
August and September 2012 [10]	Intensive care units (ICUs).	5 patients	E. meningoseptica was isolated from from aerators, hand hygiene sinks	Urgent education programme instituted; Taps were cleaned systematically and aerators were changed.	Temporary reduction in case numbers achieved.

Heard of a cluster of Elizabethkingia infections in CTICU

patient	Jul-12	Aug-12																														Sep-12				
	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5
1	wd 26															wd20/ 10				X			X	X						X				wd 20/ 11	wd 26/ 14		
2	wd44/ 18																	wd 20/ 7									X								wd 20/ 6			
3			wd 26/ 13				wd28/ 22										wd44/ 38															X		wd 20/ 8				

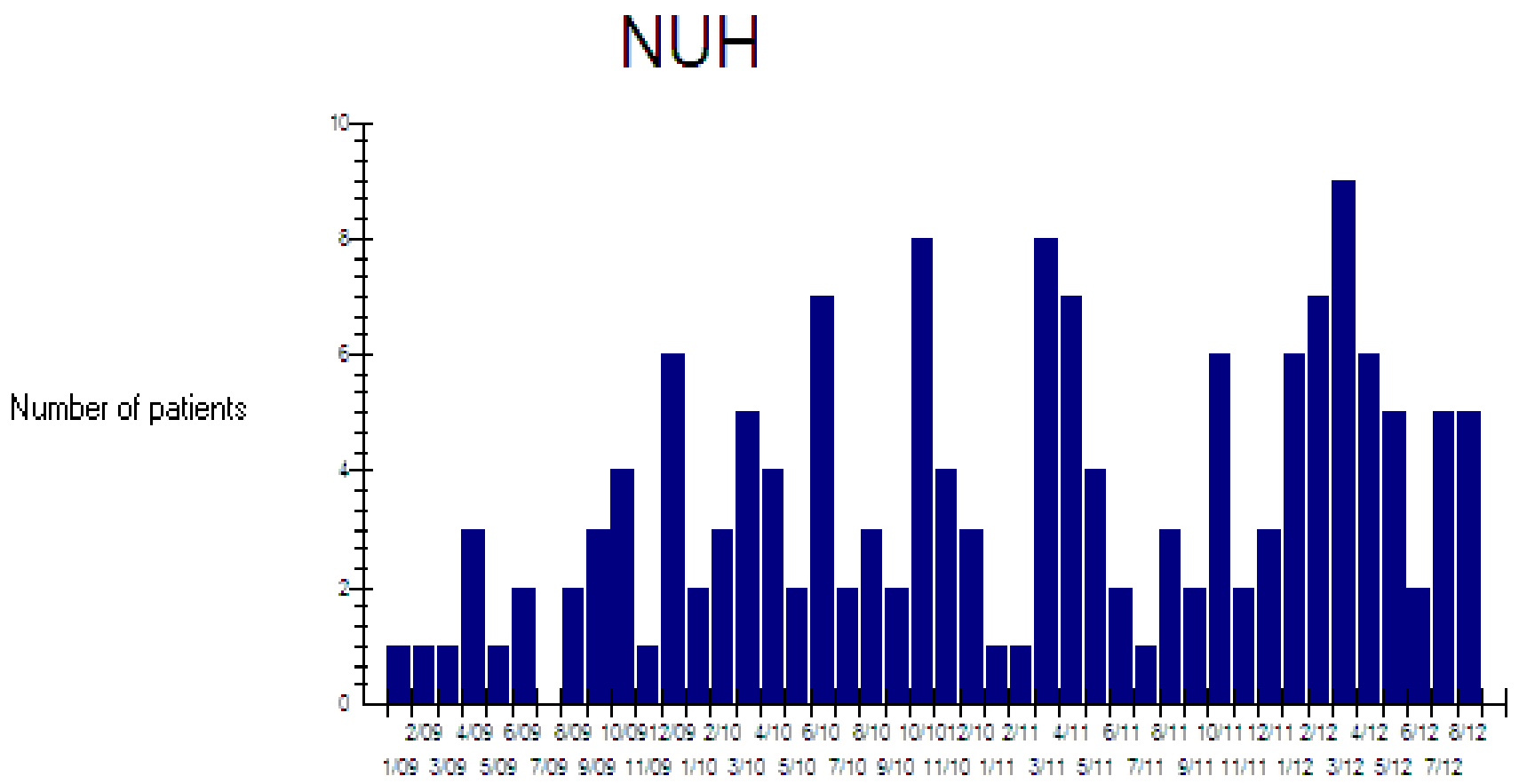
Review of the Elizabethkingia outbreak literature

- Outbreaks identified since 1961
- Often in ICU or particularly NICU
  - Underlying co-morbidity common in adults
- Often prolonged
- Where source identified:
  - Faucets, taps (not central water supply)
  - Distilled water (contaminated distillation machine)
  - Secondary source – HCW hands
    - But primary environmental source not found
- Infection control interventions:
  - Hand hygiene
  - Sterile water for cleaning patient equipment
  - Environmental cleaning
  - Cleaning of taps

Review of the earlier cases

- 3 in CTICU were clinical samples , 2 in SICU were respiratory samples
- Identified using MALDITOF
- Treated with combination of pip tazo, levofloxacin or Bactrim
- 3/5 died

Epidemic Curve



Environmental sampling

- Swab cultures taken from faucets in:
  - ICU A:
    - Sinks in rooms: 5/11 grew *E. meningosepticum*
    - Pantry, staff room, clean utility sinks, CHG dispensors – *None*
  - ICU B:
    - Central area sinks – *None*
    - Sinks in rooms: 3 of 4 grew *E. meningosepticum*
  - ICU C:
    - Sinks: 2 of 3 grew *E. meningosepticum*
    - Breast feeding room -*None*
    - Milk rooms 1&2 - *None*
  - Ward A(control ward – no cases)
    - Sinks in Rooms: 7/7 grew *E. meningosepticum*

Outcomes of Process Discussions

- Hand hygiene audits:
  - Daily in ICU A
- Tap water use:
  - Patient bed baths on ICU A
  - Cleaning of tracheostomy inner tube
  - Tracheal suctioning
- Environmental cleaning:
  - High touch cleaning not routinely performed in ICUs
  - Monitoring equipment cleaned by nurses
    - No regular roster, not monitored

ERIC PCR


lane 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
A b c 1 2 3 4 5 8 16 18 6 7 9 10 11 12 17
A :
B:
C:
Isolates 1 to 17 - environmental

ERIC PCR results

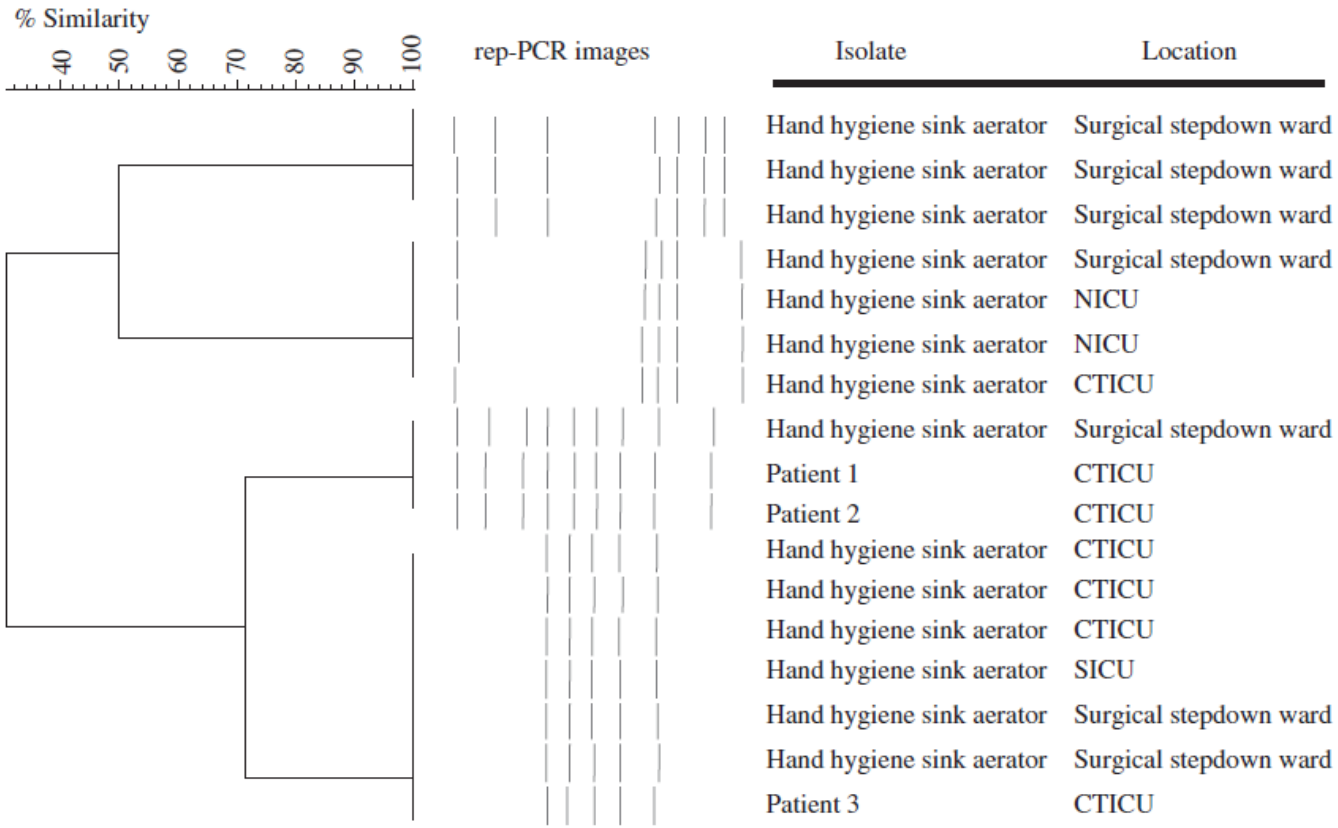
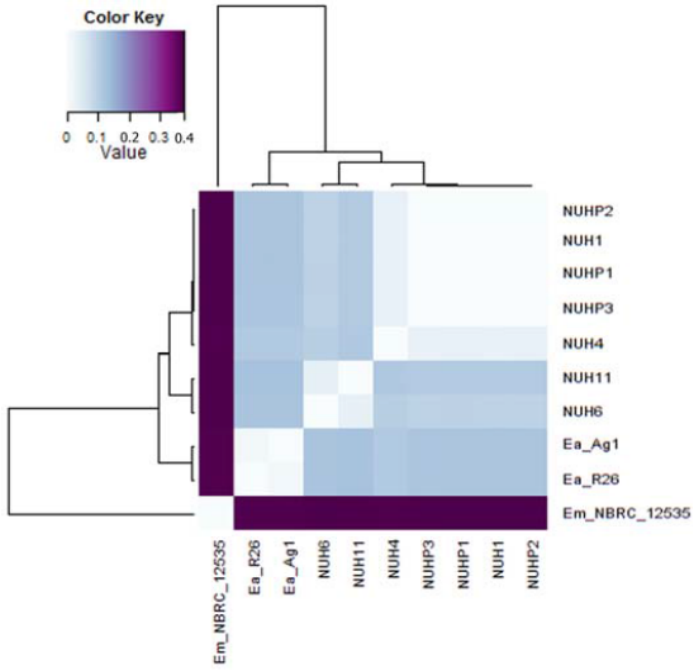


Figure 2. Dendrogram showing patient and environmental isolates of *Elizabethkingia meningoseptica*. Repetitive element palindromic polymerase chain reaction (rep-PCR) performed using HotStar Taq Plus Master Mix Kit (Qiagen, Hilden, Germany) with primers ERIC 1R (5′ ATGTAAGCTCCTGGGGATTCAC-3′) and ERIC 2 (5′-AAGTAAGTGACTGGGGTGAGCG-3′). Thermal cycling parameters: initial denaturation at 94 °C for 5 min, 35 cycles of denaturation at 94 °C for 30 s, annealing at 50 °C for 30 s, extension at 68 °C for 5 min, and a final extension at 68 °C for 10 min. Amplified DNA fragments separated on 1.5% ethidium-bromide stained agarose gel. Gel images analysed with Bio-Numerics software (Version 5.1, Sint-Martens-Latem, Belgium) by calculating cluster analysis using the band-based Dice method to illustrate pairwise similarities between all isolates and the dendrogram-type unweighted-pair group method using average linkages (UPGMA). Band position tolerance of 1.00% was used. NICU, neonatal intensive care unit; CTICU, cardiothoracic intensive care unit; SICI, surgical intensive care unit.

WGS Results

Figure legend

Figure 1: Heat map based on a pair-wise distance matrix of whole-genome alignment as computed by Progressive Mauve [3]. Pair-wise genome alignments were performed using the genomes of the seven *E. anophelis* strains reported in this study: three patient (NUHP1, NUHP2, and NUHP3) and four environmental isolates (NUH1, NUH4, NUH6, and NUH11), as well as three reference outbreak strains (*E. meningoseptica* NBRC 12535, *E. anophelis* Ag1, and *E. anophelis* R26). This heat map was created using the R statistical program (http://www.r-project.org/) with heat map clustering methods. Dendrograms across the top and left of the diagram indicate the relatedness of the genomes based on genome conservation, while strain names are listed below and to the right of the heat map. Distance values range from 0.0 to 0.4 and correspond to a gradient of color steps ranging from light blue (lowest distance value) to dark purple (highest distance value).



First case of *E anophelis* outbreak in an intensive-care unit

The hospital infection-control team at the National University Hospital of Singapore identified three patients in the cardiothoracic intensive-care unit (ICU) and two patients from the surgical ICU that were colonised with *Elizabethkingia* during a 3 week period in 2012.[1] The *Elizabethkingia* strains were identified as *Elizabethkingia meningoseptica* on the basis of matrix-assisted laser desorption-ionisation time-of-flight mass spectrometry analysis. The five patients, who were ventilated via tracheostomy and had central venous catheters in situ, received multiple courses of broad-spectrum antibiotics. Before isolation of *Elizabethkingia*, three of the patients had underlying solid-organ malignancy, one patient had multiple abdominal surgeries, two patients underwent thoracic surgery, and one patient was on extracorporeal membrane oxygenation. After isolation of the *Elizabethkingia* strain, all patients intensive-care admission, with sepsis contributing to the death of two patients. Isolates of *Elizabethkingia* (designated as NUHP1, NUHP2, and NUHP3) were obtained from the three patients who had been warded at the cardiothoracic ICU. NUHP1 and NUHP3 isolates were recovered from the sputum, whereas NUHP2 was isolated from a blood specimen. Unfortunately, isolates from patients who had been warded in the surgical ICU were no longer available for further analysis.

Environmental sampling was also done in the hospital, and 14 *Elizabethkingia* strains were isolated from hand hygiene sink aerators in the cardiothoracic and surgical ICU and in a surgical ward to which patients were often transferred from the ICU.[1] Four of these environmental isolates (NUH1, NUH4, NUH6, and NUH11), which represent each of the four genotypes identified,[1] were further analysed. The genomes of seven selected *Elizabethkingia* spp

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1 Balm MND, Salmon S, Jureen R, et al. Bad design, bad practices, bad bugs: frustrations in controlling an outbreak of *Elizabethkingia meningoseptica* in intensive care units. *J Hosp Infect* 2013; published online Aug 19. DOI:10.1016/j.jhin.2013.05.012.

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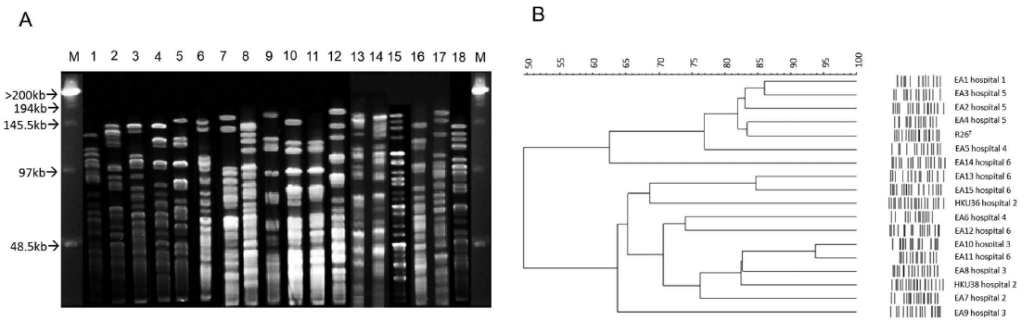

Figure 3. Pulsed-field gel electrophoresis (PFGE) analysis of the 17 *E. anophelis* isolates and *E. anophelis* type strain R26^T. (lane 1 = EA1, lane 2 = EA2, lane 3 = EA3, lane 4 = EA4, lane 5 = EA5, lane 6 = EA6, lane 7 = EA7, lane 8 = EA8, lane 9 = EA9, lane 10 = EA10, lane 11 = EA11, lane 12 = EA12, lane 13 = EA13, lane 14 = EA14, lane 15 = EA15, lane 16 = HKU38, lane 17 = HKU36, lane 18 = R26^T, M = lambda marker). In Panel (**A**), PFGE was performed using CHEF Mapper XA system (Bio-Rad) and restriction endonuclease *Xba*I. Results showed that the 17 isolates possessed distinct PFGE patterns. In Panel (**B**), dendrogram was constructed with PFGE data by similarity and clustering analysis using the Dice coefficient (1% tolerance and 0.5% optimization) and unweighted pair-group method using average linkages with GelCompar II.

SCIENTIFIC REPORTS

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Elizabethkingia anophelis bacteremia is associated with clinically significant infections and high mortality

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Unlike *Elizabethkingia meningoseptica*, the clinical importance of *E. anophelis* is poorly understood. We determined the clinical and molecular epidemiology of bacteremia caused by *Elizabethkingia*-like species from five regional hospitals in Hong Kong. Among 45 episodes of *Elizabethkingia*-like bacteremia, 21 were caused by *Elizabethkingia*, including 17 *E. anophelis*, three *E. meningoseptica* and one *E. miricola*; while 24 were caused by other diverse genera/species, as determined by 16S rRNA gene sequencing. Of the 17 cases of *E. anophelis* bacteremia, 15 (88%) were clinically significant. The most common diagnosis was pneumonia (n = 5), followed by catheter-related bacteremia (n = 4), neonatal meningitis (n = 3), nosocomial bacteremia (n = 2) and neutropenic fever (n = 1). *E. anophelis* bacteremia was commonly associated with complications and carried 23.5% mortality. In contrast, of the 24 episodes of bacteremia due to non-*Elizabethkingia* species, 16 (67%) were clinically insignificant. Compared to non-*Elizabethkingia* bacteremia, *Elizabethkingia* bacteremia was associated with more clinically significant infections ($P < 0.01$) and positive cultures from other sites ($P < 0.01$), less polymicrobial bacteremia ($P < 0.01$), and higher complication ($P < 0.05$) and mortality ($P < 0.05$) rates. *Elizabethkingia* bacteremia is predominantly caused by *E. anophelis* instead of *E. meningoseptica*. *Elizabethkingia* bacteremia, especially due to *E. anophelis*, carries significant morbidity and mortality, and should be considered clinically significant unless proven otherwise.

Report from our contractors

ANALYSIS RESULTS

		ALLOWABLE LIMITS	METHOD
1. PHYSICAL EXAMINATION and ANALYSIS			
APPEARANCE	CLEAR	-	[APHA 2110]
COLOUR (in HAZEN UNITS)	<5	< 5	[APHA 2120B]
pH VALUE at 25°C	7.3	7.0 - 9.0	[APHA 4500-H-B]
TURBIDITY (in NTU)	0.20	< 5	[APHA 2130B]
CONDUCTIVITY uS/cm	147.3	80 - 550	[APHA 2510B]
2. CHEMICAL ANALYSIS (expressed in mg/l)			
IRON (as Fe 3+)	<0.02	max 0.3	[APHA 3111B]
FREE RESIDUAL CHLORINE	<0.1	< 2.0	[APHA 4500C1 G]
3. BACTERIOLOGICAL EXAMINATION			
TOTAL COLONY COUNT, cfu/ml [PCA, 35°C, 48HRS]	72	< 500	[APHA 9215B]
E. COLI COUNT, cfu/100ml [EC-MUG,44.5°C, 24HRS]	<1	<1	[APHA 9222B & G]

4. REMARKS:

THE ABOVE RESULTS WERE TESTED AS PER SAMPLE SUBMITTED IN ACCORDANCE WITH PUB'S POTABLE WATER QUALITY (TYPICAL VALUES) FOR TAP POINTS AND WATER STORAGE TANKS (FOR TOTAL COLONY COUNT); WHO GUIDELINES (2011) FOR IRON CONTENT. THE RESULTS ARE AS FOLLOWS:

PHYSICALLY : SATISFACTORY
CHEMICALLY : SATISFACTORY
BACTERIOLOGICALLY : SATISFACTORY

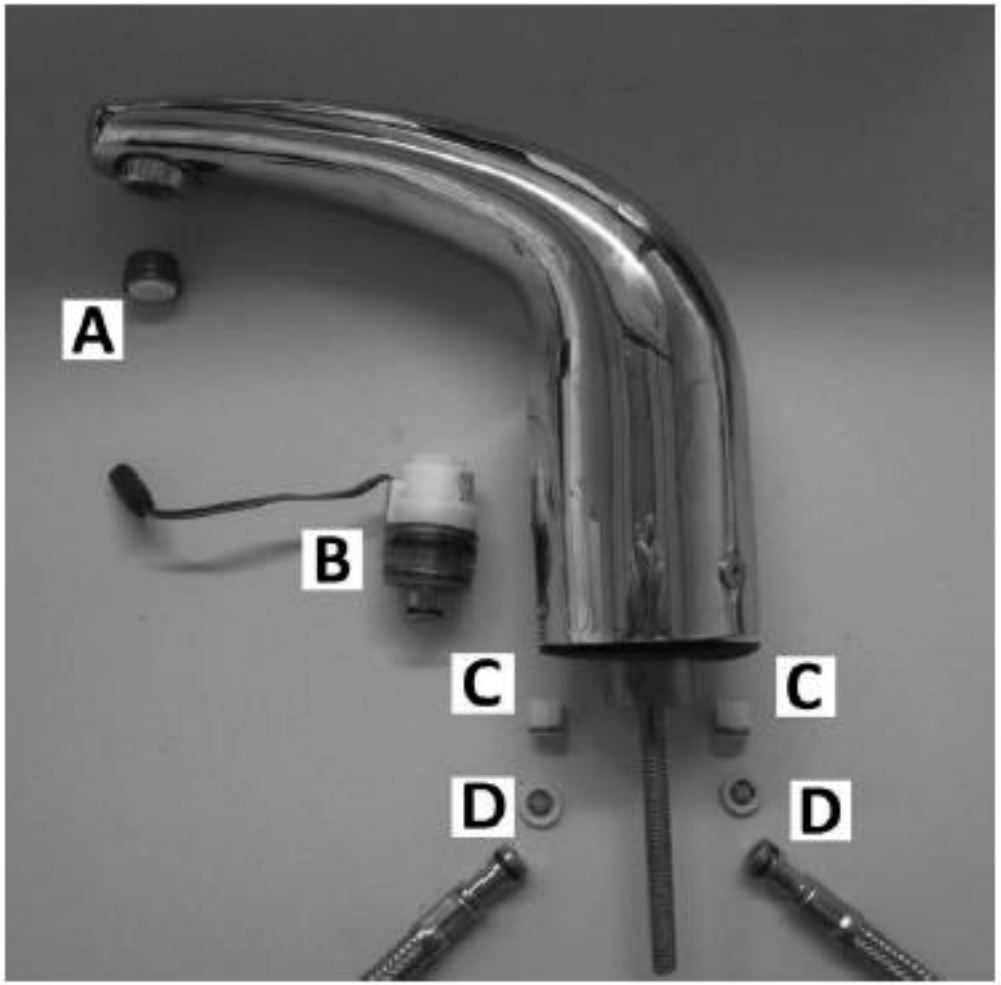

FIGURE 1. Disassembled electronic-eye faucet. *A*, Aerator; *B*, solenoid valve; *C*, check valve; *D*, inline filter. A color version of this figure is available in the online edition of the journal.

Sydnor ICHE 2012:33:235

Electronic Faucets

TABLE 1. Frequency of Isolation of *Legionella* Species and Significant Heterotrophic Plate Count (HPC) Growth from Water Samples Collected from Nontouch Electronic Faucets and Manual Faucets

	Total, proportion (%)			Before ClO_2 remediation, no. (%)			After ClO_2 remediation, no. (%)		
	Manual faucet samples	Electronic faucet samples	P[a]	Manual faucet samples	Electronic faucet samples	P[a]	Manual faucet samples	Electronic faucet samples	P[a]
HPCs[b]	6/45 (13)	15/58 (26)	.14	4 (27)	7 (23)	1.0	2 (7)	8 (29)	.04
Legionella species	11/75 (15)	54/108 (50)	<.01	10 (22)	50 (63)	<.01	1 (3)	4 (14)	.19
L. anisa	2/75 (3)	29/108 (27)	<.01	1 (2)	26 (33)	<.01	1 (3)	3 (11)	.34
L. pneumophila	9/75 (12)	25/108 (23)	.08	9 (20)	24 (30)	.29	0 (0)	1 (4)	

NOTE. ClO_2, chlorine dioxide.

[a] χ^2 or Fisher's exact test.

[b] At least 500 colony-forming units per milliliter was considered significant.

Sydnor ICHE 2012:33:235

Case control study

Table I
Association between sink misuse and colonization with *Elizabethkingia meningoseptica* ($N = 79$)

Frequency of sink misuse	Number of culture-negative aerators ($N = 44$)	Number of culture-positive aerators ($N = 35$)	OR (95% CI)	*P*-value
No misuse	28	10	1.0	—
Any misuse	16	25	4.38 (1.68–11.39)	0.004
Sometimes	8	6	1.75 (0.46–6.61)	0.63
Frequent	8	19	6.65 (2.22–19.92)	0.001

OR, odds ratio; CI, confidence interval.
P-value compared with no misuse of sinks.
Test of homogeneity (equal odds): $P = 0.002$.
Test for trend of odds: $P = 0.047$.

Initial Infection Control Interventions

- Hand Hygiene
  - Use alcohol hand rub after washing hands with soap and water
- Patient
  - Use sterile water for any nursing care that requires water including bathing(E.g. Oral toilet)

Interventions

- Urgent education and feedback
- Rooms underwent terminal cleaning
- Faucets were systematically cleaned and aerators were changed (once every ? Years)
- Following 3 months, no further cases in CTICU and SICU
- One month after aerators changed, new aerators were free of E meningoseptica

Cleaning sinks

Instructions continue
(this is the real world)

Report published

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Bad design, bad practices, bad bugs: frustrations in controlling an outbreak of *Elizabethkingia meningoseptica* in intensive care units

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A prolonged problem

Elizabethkingia anophelis Is the Dominant *Elizabethkingia* Species Found in Blood Cultures in Singapore

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KEYWORDS 16S, nosocomial, outbreak, PCR, whole genome, susceptibility testing

Shortly after the discovery of *Elizabethkingia anophelis* from the mosquito *Anopheles gambiae*, clinically significant infections attributed to this species were repeatedly described (1); they include a large outbreak involving 69 isolates in Wisconsin, USA (2), and also an intensive-care unit outbreak that occurred at our hospital (3). *E. anophelis* is genetically distinct from *Elizabethkingia meningoseptica* and *Elizabethkingia miricola* (4, 5). However, factory default databases accompanying the matrix-assisted laser desorption ionization–time of flight (MALDI-TOF) identification systems, such as Vitek mass spectroscopy (MS) (bioMérieux, Marcy l'Etoile, France) and the Bruker MALDI Biotyper (Bruker Daltonics, Bremen, Germany), cannot accurately distinguish between *E. anophelis* and *E. meningoseptica* unless the user supplies his/her own mass spectrometry data set of characterized isolates (1, 6, 7).

In this study, we were interested to see if there were misidentified cases of *E. anophelis* among our *Elizabethkingia* spp. Seventy-nine retrospective blood isolates spanning the time period from 2009 to May 2017 were analyzed. All isolates were identified as either *E. meningoseptica* (96.2%) or *E. miricola* (3.8%) by the Bruker MALDI Biotyper (bioMérieux). Almost-full-length 16S rRNA gene sequencing was performed using the universal primers fD1 (5′-AGAGTTTGATCCTGGCTCAG-3′) and rP2 (5′-ACGGCTACCTTGTTACGACTT-3′), with sequencing results indicating that 78/79 (98.7%) isolates were *E. anophelis* and that the remaining single isolate was *E. meningoseptica*. Specifically, 73 isolates had 99.8 to 100% nucleotide identity to *E. anophelis* strain 0422, 2 isolates had 100% nucleotide identity to *E. anophelis* strain 107618, and 1 isolate each had 100% nucleotide identity to *E. anophelis* strain HKU36, *E. anophelis* strain F3543, or *E. endophytica* strain F3201. *E. endophytica* has since been recognized as an additional strain of *E. anophelis* and not as a separate species (8). These results reiterate the genomic heterogeneity of this species (5). The *E. meningoseptica* isolate had 100% 16S sequence identity to *E. meningoseptica* strain KC1913. Strains NUHP1 (GenBank accession number NZ_CP007547.1) and *E. meningoseptica* ATCC 13253 (GenBank accession number ASAN00000000.1) were used as controls for both the sequencing and the PCR validation assay.

For rapid PCR differentiation between *E. anophelis* and *E. meningoseptica*, species-specific gene targets were identified based on the comparative analysis of the complete genomes (as of 31 August 2017) of *E. anophelis*, *E. meningoseptica*, and *E. miricola* using the MAUVE software (9). The gene encoding lipid A-disaccharide synthase (GenBank locus tag BD94_RS01570) was utilized for *E. anophelis* detection with primers anoR (5′-TGCGTTATTACCAGGTAGTCGG-3′) and anoF (5′-GACTTCCGCGGTAGCAAACAA-3′). For the detection of *E. meningoseptica*, a putative sodium-proton antiporter (GenBank locus tag BBD35_RS10505) was targeted, using primers mengF (5′-TGGGACCTATTGCTGTTGGTT-3′) and mengR (5′-ACCACTTCCTGTGTACCTGC-3′). PCR amplifications were

TABLE 2 Susceptibility profiles for 79 *Elizabethkingia* species strains isolated from blood

Antibiotic(s)[a]	MIC range (mg/liter)	MIC(s) (mg/liter)		Susceptibility (%)[b]		
		MIC_{50}	MIC_{90}	S	I	R
Amikacin	4 to >32	>32	>32	6.3	35.4	58.2
Gentamicin	4 to >8	>8	>8	1.3	3.8	94.9
Tobramycin	8 to >8	>8	>8	0.0	3.8	96.2
Levofloxacin	≤1 to >8	2	>8	78.5	2.5	19.0
Ciprofloxacin	0.25 to >2	>2	>2	21.5	26.6	51.9
Colistin	>4	>4	>4	0.0	0.0	100.0
Polymyxin B	>4	>4	>4	0.0	0.0	100.0
Doxycycline	<2 to 8	<2	4	92.4	7.6	0.0
Minocycline	<2 to >16	<2	<2	97.5	1.3	1.3
Tigecycline	<0.25 to >8	2	8	5.1	1.3	92.4
Trimethoprim-sulfamethoxazole	0.5 to 4, 9.5 to 76	1, 19	2, 38	92.4	0.0	7.6
Ceftazidime	>16	>16	>16	0.0	0.0	100.0
Cefotaxime	16 to >32	32	>32	0.0	86.1	13.9
Cefepime	16 to >16	>16	>16	0.0	36.7	63.3
Imipenem	8 to >8	>8	>8	0.0	2.5	97.5
Meropenem	8 to >8	>8	>8	0.0	3.8	94.9
Doripenem	>4	>4	>4	0.0	0.0	100.0
Aztreonam	8 to >16	>16	>16	1.3	2.5	96.2
Piperacillin-tazobactam	8 to 64	16	16	92.4	6.3	1.3
Ticarcillin-clavulanic acid	16 to >128	64	>128	21.5	27.8	50.6
Ampicillin-sulbactam	16 to >64	64	64	0.0	0.0	100.0

[a]For drug combinations, tazobactam was held constant at 4 mg/liter, clavulanic acid was held constant at 2 mg/liter, the ampicillin-sulbactam combination was in a 2:1 ratio, and the trimethoprim-sulfamethoxazole combination was in a 1:19 ratio.
[b]S, susceptible; I, intermediate; R, resistant. The interpretive criteria applied were those of the Clinical and Laboratory Standards Institute (CLSI) for non-*Enterobacteriaceae*, except for tigecycline, doripenem, colistin, and polymyxin B, for which CLSI breakpoints were unavailable. For tigecycline and doripenem, the European Committee on Antimicrobial Susceptibility Testing (EUCAST) non-species-specific breakpoints were used. For colistin and polymyxin B, *Pseudomonas aeruginosa* CLSI breakpoints were used.

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Editor Sandra S. Richter, Cleveland Clinic

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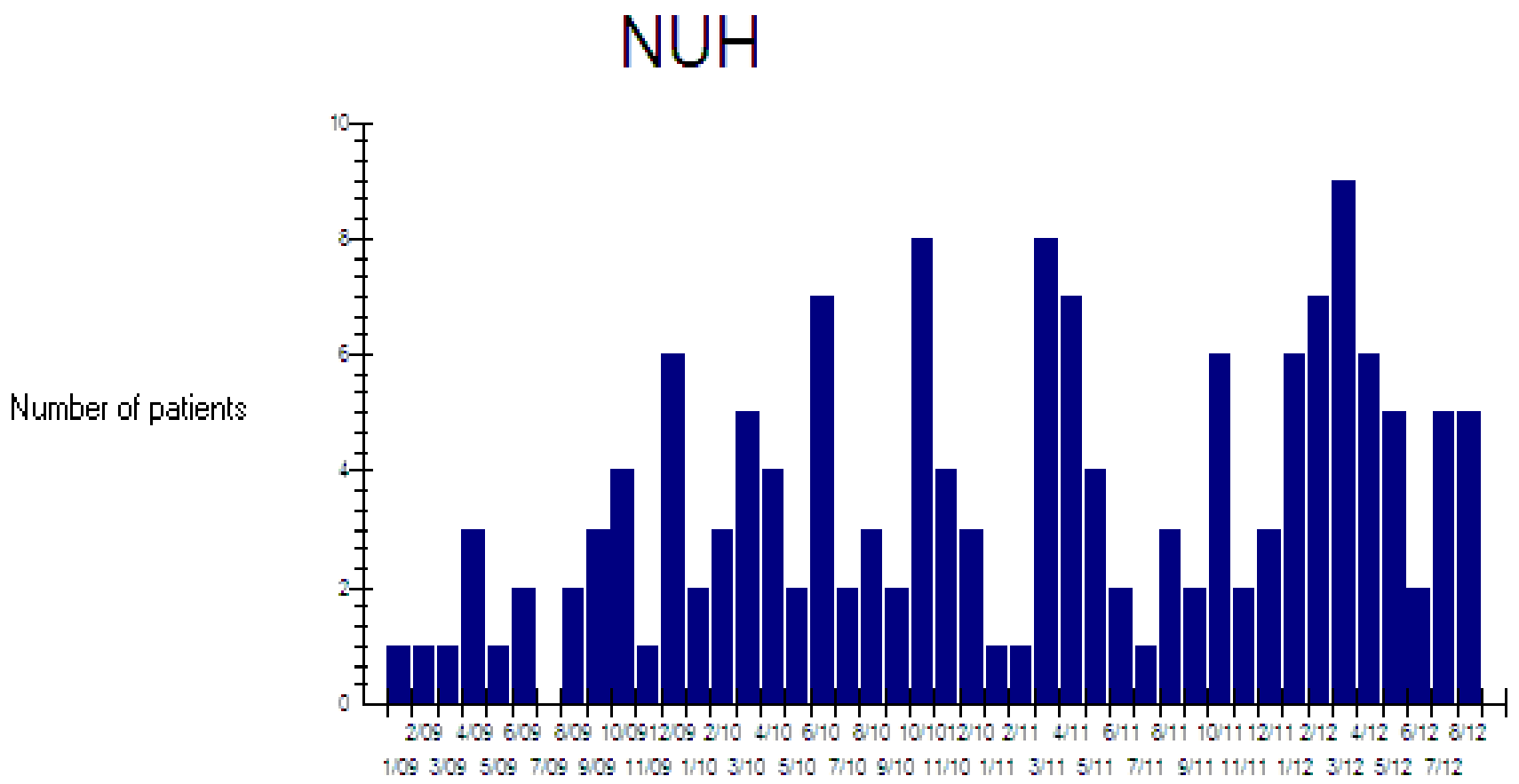
Epidemic Curve



A global problem

EDITOR'S PICK | SPOTLIGHT

Officials test water, skin care products in mysterious Wisconsin bacteria outbreak

DAVID WAHLBERG dwahlberg@madison.com, 608-252-6125 Mar 4, 2016 9

National Institutes of Health

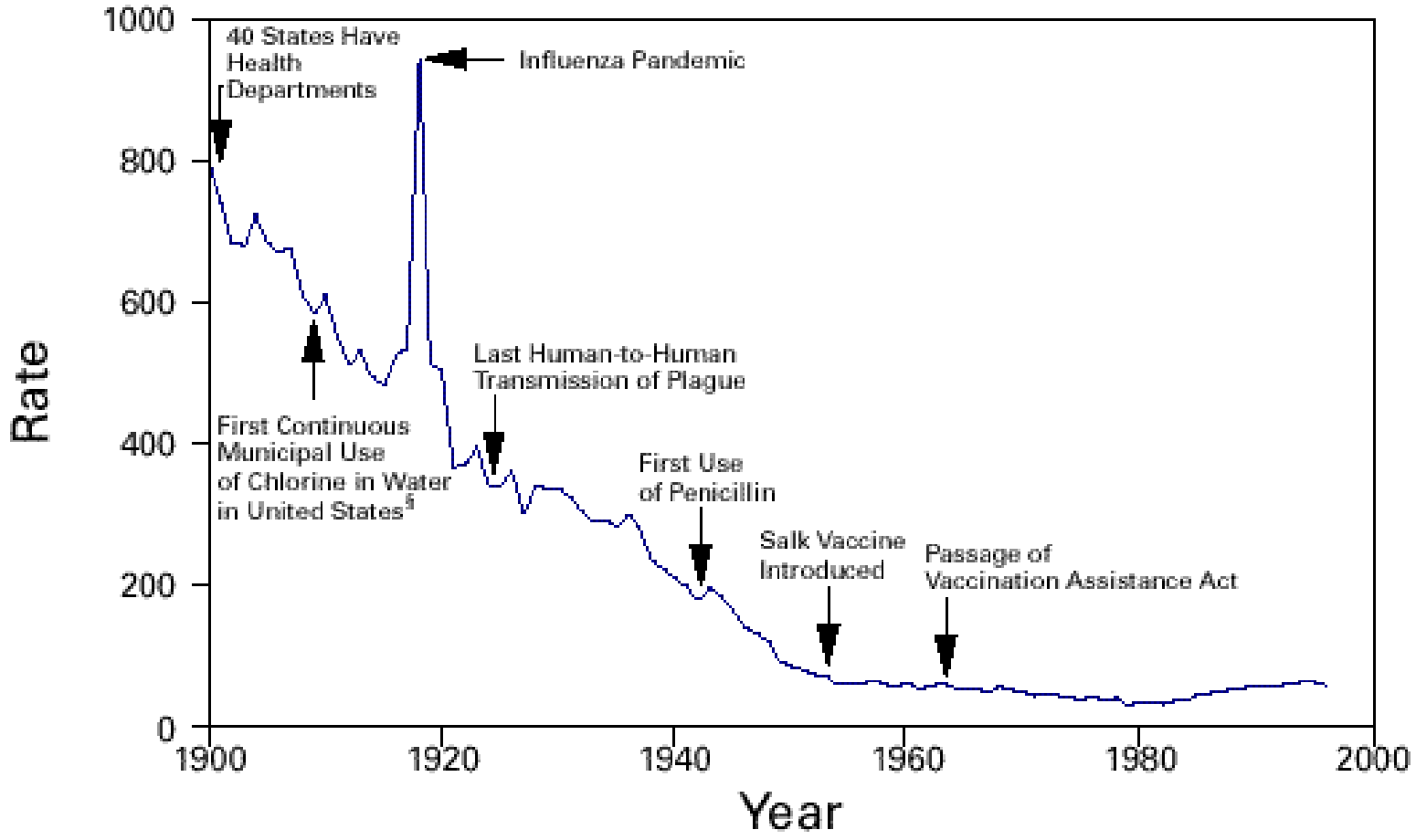
A lab dish shows a sample of Elizabethkingia bacteria from a previous outbreak.

POPULAR IN NEWS

The ICU in outbreaks

- Protecting staff and other patients from EIDs
- Treating and supporting patients with EIDs
- Surveillance and surge capacity
- Protecting patients from us and our devices

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



*Per 100,000 population per year.

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

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

MMWR 1999 / 48(29);621-629

More questions?

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