A patient with meningococcal meningitis was admitted last night. Nobody wore masks? Who was exposed and needs prophylaxis?

You see 5 MRSA surgical site infections on GI surgery when you go on service. The infections occurred over 3 weeks? What do you do? Is this an outbreak?

The influenza vaccination rate among HCWs is only 40% what do you do?
## Objectives

To review the roles and responsibilities of a hospital or healthcare epidemiologists

To review the primary tools used by healthcare epidemiologists and infection control practitioners to prevent and control HAI

To review some of the barriers and challenges with programs or healthcare epidemiology interventions

## Healthcare associated infections (HAIs)

- Infections that develop as a result of medical or surgical care and are not incubating on admission to the health care system
- Encompasses resistant and epidemiologically significant organisms that are acquired, develop or transmitted in the healthcare setting
What Do We Do?

A person (usually MD trained in Infectious Diseases and Epidemiology) who supervises a Hospital Epidemiology and Infection Control Program. They are responsible for preventing and controlling adverse events among patients and healthcare workers (patient safety). Their focus of prevention and control goes beyond the health of the individual patient or healthcare worker and often consider the population.
Definitions

- **Epidemiology** - the study of the determinants and distribution of health and disease in populations
  - Hospital epidemiology - the study of the determinants and distribution of health and disease among hospitalized patients
  - Healthcare epidemiology - the study of determinants and distribution of health and disease among those exposed to healthcare
  - Infection prevention/control - the practice of instituting measures to contain and/or prevent infection in populations

What Specifically Do We Do in Hospital or Healthcare Epidemiology?

We
- evaluate rates and use population based methods
- use traditional epidemiologic methods and molecular epidemiologic methods to evaluate risk factors and determine causality
- focus on infection but recently have expanded to study non-infectious outcomes of care
- measure complications and process of care measures
- implement and collaborate with interventions
- facilitate antibiotic choices and appropriate use of antibiotics
- Support management of infectious related mass casualty events
Primary Functions of Healthcare or Hospital Epidemiology

- Intervene to prevent transmission of resistant organisms & infections (includes surveillance)
- Implement guidelines and research findings
- Develop policies and procedures e.g., to decrease selection and transmission of resistant organisms
- Educate healthcare workers
- Conduct research or evaluate best practice—risk factors, outcomes, interventions
- Help manage mass infectious diseases casualty situations

Competing interests

Medical
- person-oriented
- non-maleficence
- confidentiality
- privacy
- autonomy

Epidemiological
- population-oriented
- non-maleficence
- confidentiality
- investigate/report
- justice

Herwaldt and Kaldjian, Ethical Aspects of Infection Control
The Practical Guide to Hospital Epidemiology
What Is the Problem and its Impact?
A Sobering Letter from a Family Member

“Today would have been my beloved wife’s birthday. She died in your hospital.” …

…I witnessed many gross violations of the standard "Universal Precautions“ posted everywhere within the hospital. They were not limited to one building, one floor, or one individual. They were widespread.” …

“I witnessed staff with colds coughing and sneezing in my wife's room without masks on, people coming in with gloves on they had just used with another patient, doctors not washing their hands upon entering the room, after touching my wife, after shaking my family members' hands, etc.; stethoscopes and other equipment being universally shared…”
“Even more shocking, while under quarantine during her various life-threatening infections, many, not just one or two, staff persons who directly touched my wife, her equipment, her waste products, etc. refused to wear either protective masks and/or gloves. This was in direct violation of the quarantine rules posted all over the entrance to her room. When I challenged these individuals, they replied that these were simply "guidelines", and that the staff person could opt to proceed at their own risk, if they chose to work without protective coverings.”

**Healthcare Associated Infections (HAIs)**

- A global issue
- In the US, they represent a significant portion of adverse events/medical errors
- Affect 2 - 10% of hospitalized patients and more than 2 million pts/yr
- Total excess costs $1 billion annually
- Most costs not reimbursed when DRGs used or if costs are capitated
- CMS will capitate reimbursement for several healthcare associated infections including CA-BSI, UTI and mediastinitis.
**Burden of Healthcare-Associated Infections in the US, 2002**

- 1.7 million infections in hospitals
  - Most (1.3 million) were outside of ICUs
  - 9.3 infections per 1,000 patient-days
  - 4.5 per 100 admissions
- 99,000 deaths associated with infections
  - 36,000 – pneumonia
  - 31,000 – bloodstream infections


**Costs of HAI s**

<table>
<thead>
<tr>
<th>Infection</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonia</td>
<td>24,408</td>
</tr>
<tr>
<td>Blood</td>
<td>12,774</td>
</tr>
<tr>
<td>SSI</td>
<td>7,059</td>
</tr>
<tr>
<td>UTI</td>
<td>3,936</td>
</tr>
<tr>
<td>VAP</td>
<td>22,875</td>
</tr>
<tr>
<td>Blood</td>
<td>18,432</td>
</tr>
<tr>
<td>SSI-CABG</td>
<td>17,944</td>
</tr>
<tr>
<td>CAUTI</td>
<td>1,257</td>
</tr>
</tbody>
</table>

*Medical Care 2008; 46:101*
Caveats

Agents

- An agent causing a nosocomial or healthcare-associated infection can be a bacteria (S. aureus), a fungus (candida), a virus (influenza), or a parasite (scabies)
  - For transmission to take place, the microorganism must remain viable in the environment until contact with the host has been sufficient to cause infection
    - Reservoirs exist in the hospital which allow the organism to survive and multiply
      - Animated (hands of healthcare providers)
      - Inanimate (touch surfaces and equipment)
Agents

• Nosocomial pathogens can originate from either endogenous or exogenous sources
  – *Endogenous pathogens* originate from flora that colonize the patient’s skin, respiratory, or GI tract
  – *Exogenous pathogens* are transmitted to the patient from external sources after admission to the hospital (HCWs, other patients, visitors, environment)

Agents

• Certain intrinsic properties may be important for the agent to survive in the environment and ultimately invade the host and cause disease
  – Infecting dose, toxin production, immunogenicity (interaction with the host immune system)
• If infection takes place, a measurable immune response will develop even if the infection is subclinical
The Host

- Infection depends on exposure of a susceptible host to an infecting agent

![Diagram showing Host and Organism with Colonization, Sub-clinical infection, and Clinical infection]

The Environment

- Provides the mutual background on which the host and agent interactions take place
  - In the hospital this includes
    - Climate (humidity, air exchanges)
    - Physical surroundings (beds, surfaces, medical equipment)
    - Special environments (ICU, BMT unit, Operating Room)
So What Are the Challenges and Pressures

Forces Impacting Infection Prevention and Control

Governmental
- CDC-guidelines, funding, public awareness
- AHRQ-guidelines, funding

Regulatory agencies
- CMS
- OSHA
- JCAHO

Professional organizations
- SHEA, APIC

Consumers
- Consumers Union
- National Public Safety Quorum

Providers
- Leaptfrog, BCBS

Legislators
- State legislators
Challenge 1: Resistance/Emerging Organisms

Native Organisms

Antibiotic Exposure

Genetic Transfers

Decontamination

Isolation/Barrier Precautions

Hand Hygiene

Health Policy

Humans

Animals

Resistant Organisms

Emergence

Transmission

Surveillance

Eradication
Vulnerable Patients at Risk

- Risk factors for the acquisition of MDR organisms include 1-3
  - Severity of illness
  - Prolonged hospital length of stay (LOS)
  - Prolonged intensive care unit (ICU) LOS
  - Transfer from another hospital or nursing home
  - Invasive procedure or device
  - Immunocompromised
  - Prior antibiotic therapy


ESBLs and Increased Mortality

A meta-analysis of Enterobacteriaceae producing ESBL bacteremia

### Change in Resistance 2007-2010 (NHSN)

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Resistance percentage, % (99% CI)</th>
<th>Overall change, %</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Klebsiella (pneumoniae/oxacina)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ES cephalosporins 4</td>
<td>31.7 (29.3, 34.2)</td>
<td>28.8 (26.9, 30.8)</td>
<td>-2.9</td>
</tr>
<tr>
<td>Carbapenems</td>
<td>13.9 (11.3, 16.3)</td>
<td>12.6 (10.3, 14.9)</td>
<td>-1.3</td>
</tr>
<tr>
<td>Multidrug resistant 1</td>
<td>18.1 (16.6, 20.2)</td>
<td>16.8 (15.1, 18.4)</td>
<td>-1.3</td>
</tr>
<tr>
<td><strong>E. coli</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ES cephalosporins 4</td>
<td>12.3 (9.7, 15.0)</td>
<td>10.9 (8.7, 13.1)</td>
<td>-2.4</td>
</tr>
<tr>
<td>Carbapenems</td>
<td>37.5 (33.8, 41.1)</td>
<td>41.8 (38.8, 44.6)</td>
<td>4.3</td>
</tr>
</tbody>
</table>

### % of Organisms (NHSN) Resistant to 3 or 4 Antibiotic Classes

<table>
<thead>
<tr>
<th>Organism</th>
<th>VAP</th>
<th>CA-BSI</th>
<th>CA-UTI</th>
<th>SSI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3 class resistance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>P. aeruginosa</em></td>
<td>36</td>
<td>16</td>
<td>43</td>
<td>5</td>
</tr>
<tr>
<td><em>A. baumanii</em></td>
<td>49</td>
<td>31</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td><em>K. pneumonia</em></td>
<td>13</td>
<td>35</td>
<td>46</td>
<td>6</td>
</tr>
<tr>
<td><strong>4 class resistance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>P. aeruginosa</em></td>
<td>40</td>
<td>10</td>
<td>45</td>
<td>5</td>
</tr>
<tr>
<td><em>A. baumanii</em></td>
<td>50</td>
<td>35</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td><em>K. pneumonia</em></td>
<td>13</td>
<td>40</td>
<td>37</td>
<td>9</td>
</tr>
</tbody>
</table>

Sievert et al. ICHE 2013: 34;1-14

Kallen et al. ICHE 2010: 31;528-31
Worldwide prevalence of MRSA

Grundmann et al. Lancet 2006; 368: 874-85

Global Distribution of ESBL’s

Turner et al. Clin Infec Dis 2005
Fluoroquinolone Use and Resistance Rates in *P. aeruginosa* and GNR

Does Antibiotic Use increase MRSA

- MRSA is in addition to other *S. aureus* infections
- Traditionally associated with exposure to healthcare or antimicrobials
- In Europe, total ambulatory antibiotic use correlated with MRSA blood cultures ($R=0.49$, $p=0.01$)

Monnet et al 2004:10: 1432
Wertheim et al 2006

Hand Imprint Cultures After Contact with Environmental Surfaces

Linking the environment to infection

**PFGE Profile J – Patient Number 319**
- Environmental contamination
- Patient admission
- Patient acquisition of MRSA
- Patient discharge
- October 20
- October 24
- October 31
- November 24

**PFGE Profile O – Patient Number 239**
- Environmental contamination
- Patient admission
- Environmental contamination
- Patient acquisition of MRSA
- Patient discharge
- February 4
- February 14
- February 20
- March 4

**PFGE Profile P – Patient Number 411**
- Patient admission and environmental contamination
- Patient acquisition of MRSA
- Patient discharge
- July 7
- July 14
- July 24

*Hardy et al. Infection Control and Hospital Epidemiology 2006;27:127-132*

Challenge 2: Knowledge, Attitudes and Behaviors
Compliance and profession

<table>
<thead>
<tr>
<th>Profession</th>
<th>N</th>
<th>Opportunities</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nurse</td>
<td>520</td>
<td>1875 (66%)</td>
<td>52%</td>
</tr>
<tr>
<td>Student nurse</td>
<td>48</td>
<td>131 (4.7%)</td>
<td>43%</td>
</tr>
<tr>
<td>Nurses’ aide</td>
<td>166</td>
<td>378 (13%)</td>
<td>47%</td>
</tr>
<tr>
<td>Mid-wife</td>
<td>14</td>
<td>35 (1.3%)</td>
<td>66%</td>
</tr>
<tr>
<td>Physician</td>
<td>158</td>
<td>281 (10%)</td>
<td>30%</td>
</tr>
<tr>
<td>Phys/Resp therapist</td>
<td>23</td>
<td>48 (1.7%)</td>
<td>28%</td>
</tr>
<tr>
<td>Radiology Technician</td>
<td>4</td>
<td>12 (0.4%)</td>
<td>8%</td>
</tr>
<tr>
<td>Others</td>
<td>58</td>
<td>74 (2.7%)</td>
<td>27%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2834</td>
<td>2834 (100%)</td>
<td>48%</td>
</tr>
</tbody>
</table>


Beliefs and perceptions affecting physician hand hygiene beliefs

Psycho-social variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio</th>
<th>95% CI*</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belief of being a model to others colleagues</td>
<td>2.10</td>
<td>1.35-3.27</td>
<td>0.001</td>
</tr>
<tr>
<td>Attitude towards HH after patient contact</td>
<td>3.87</td>
<td>1.73-8.65</td>
<td>0.001</td>
</tr>
<tr>
<td>Perception of risk for cross transmission</td>
<td>1.74</td>
<td>0.95-3.20</td>
<td>0.073</td>
</tr>
</tbody>
</table>

Number of observations (opportunities) = 811; number of physicians = 147
*95% CI = 95% Confidence Interval

Pittet et al, Ann Intern Med 2004; 141:1-8
Challenge 3: Public Perception and Consumers
Challenge 4: Pay For Performance

CMS No Pay for Performance

Conditions for 2008
- Air Embolism
- Blood Incompatibility
- Catheter-Associated Urinary Tract Infections
- Pressure Ulcers (Decubitus Ulcers)
- Vascular Catheter Associated Blood Stream Infections
- Surgical Site Infection After Elective Surgery (Orthopedic and Bariatric)
- Mediastinitis after coronary bypass surgery
- In Hospital Falls
- Postoperative Deep Vein Thrombosis, Pulmonary Embolism after Knee and Hip Replacement
- Glycemic Control Complications:
  - Diabetic Ketoacidosis
- Objects left in after Surgery
  - Hyperosmolar coma (Diabetic or Hypoglycemic Coma)

Conditions considered for 2009
- Ventilator-Associated Pneumonia
- Methicillin-Resistant Staphylococcus Aureus (MRSA)
- Clostridium Difficile-Associated Disease (CDAD)
- Staphylococcus aureus Septicemia
- Legionnaires Disease
- Delirium
- Iatrogenic Pneumothorax
Challenge 5: Public Reporting

Healthcare Associated Infections Reporting Laws: US

- States with study laws
- Mandates public reporting of infection rates
- Mandates reporting only to state government
- Voluntary

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Consequences of HAI Public Reporting and Reimbursement Changes

- Presumed to motivate quality improvement
  - Patients, physicians, purchasers select high quality physicians or institutions
  - Motivate physicians and institutions to compete on quality
- May have unintended or negative consequences
  - Also largely unexplored
  - e.g., Improper utilization of resources, adverse patient selection
Potential Prevention and Control Measures

- **Infection Prevention/Control**
  - Hand hygiene
  - Isolation and barrier precautions
  - Cohorting or separation of colonized/infected and non-colonized patients
  - Control of environmental or other potential sources
  - Technology
  - Immunization
- **Antibiotic stewardship/management**

Putting the Questions into Perspective

- A patient with meningococcal meningitis was admitted last night. Nobody wore masks? Who was exposed and needs prophylaxis?
- You see 5 MRSA surgical site infections on GI surgery when you go on service. The infections occurred over 3 weeks? What do you do? Is this an outbreak?
- The influenza vaccination rate among HCWs is only 40% what do you do?
How do you make a case for IC interventions and strategies?

- What are the facts?
  - What does the literature tell you?
  - Is the intervention evidence based?
- Are there regulatory issues?
- What are the medico-legal issues?
- Are there ethical considerations?
- What are the behavioral considerations (we have always done it this way)?
- How do you make your case and advertise—“selling your point of view”?

Considerations for the Healthcare Epidemiologist

- Are we surveying “significant” events?
  - Willie Sutton rule
- Are we meeting the regulatory requirements?
- Is our surveillance meaningful?
  - Defined events
  - Adequate case-finding strategies
  - Validated methodology esp with computerized systems
  - Inter-observer reliability
- Are we providing to the people who can change things in a meaningful way
Evidence-based infection control is...
...the explicit, judicious and conscientious use of current best evidence from infection control research in making decisions about the prevention and control of infection of individuals and populations.

Focus on the Evidence


Parachute use to prevent death and major trauma related to gravitational challenge: systematic review of randomised controlled trials

Gordon C S Smith, Jill P Poll

Abstract

Objectives To determine whether parachutes are effective in preventing major trauma related to gravitational challenge.

Design Systematic review of randomised controlled trials.

Data sources Medline, Web of Science, Embase, and the Cochrane Library databases; appropriate internet sites and citation lists.

Study selection Studies showing the effects of using a parachute during free-fall.

Main outcome measure Death or major trauma, defined as an injury severity score > 15.

Results We were unable to identify any randomised controlled trials of parachute intervention.

Conclusions As with many interventions intended to prevent ill health, the effectiveness of parachutes has not been subjected to rigorous evaluation by using randomised controlled trials. Advocates of evidence-based medicine have criticised the adoption of interventions evaluated by using only observational data. We think that everyone might benefit if the most radical proponents of evidence-based medicine organised and participated in a double-blind, randomised, placebo controlled, crossover trial of the parachute.
Oh the Places You Can Go—
JHH CA BSI Rates (1998-2008)

**In Sum**

- Healthcare epidemiologists do public health in the hospital and their role is to be the “consciousness” of the institution.
- The public and regulatory atmosphere has increased the visibility of infection prevention and control.
- Fellows have a huge role in 1) understanding the population implications of HAIs, epidemiologic significant organisms; 2) knowing the evidence behind prevention and control strategies; 3) identifying clusters; 4) spreading the word.
Finally—it’s a great job!