A Brief History of the Hospital-Acquired Infection
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Disclosures: none
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Dedication

Goals
• To gain a historical perspective of illness and theories of contagion
• To understand how the microbiologic revolution led to a paradigm shift in this field
• To understand the basic development of modern hospital infection control

Infection Through the Centuries
• Ancient civilizations
• Middle ages
• Modern period before Pasteur and Lister
• Age of Microbes
• 20th century and development of antibiotics
• Contemporary hospital infection control

Ancient Civilizations
• Ancient Greeks and Romans
• Leprosy in the bible
• Ancient theories of infection
• Pagan beliefs
• God's will
Ancient Civilizations

- Ancient theories of infection
  - Pagan beliefs
  - God's will

Middle Ages

- Fever as a continuum to distinct disease entities
- Theory of Infection: Miasmas (6th to 19th cent)
  - Poisonous particles
  - Induced by extremes of weather
  - Associated with decay, putrid matter
  - Attacked humors to cause disease
  - "Exceptions" to above rule
    - Leprosy and Plague
      - Quarantine and burning of fomites practiced
      - Lazar houses

Middle Ages- Hospitals

- Arabian hospitals - roots in Greek thought and secular philanthropy
- European hospitals - monastic hospitals, supported by Church
  - Numerous hospitals founded 800-1600
  - Deterioration of conditions over time
    - Typhus, dysentery, skin conditions, wound infection

Modern Period: 18th-19th Centuries

- Advances in hospital design
  - Ventilation
  - Hygiene
  - Clean water
  - Smaller wards
  - In older medieval hospitals conditions often terrible
  - Fever hospitals and eventually wards
  - Advances pioneered by army MD's
Typhus and the military

- Rickettsia prowazeki
- Vector: body louse
- Illnesses: jail fever, camp fever, hospital fever
- Pioneering work by Pringle and Lind

Lying-in hospitals and puerperal fever

- Puerperal (childbirth) fever - endometritis
- Described by Hippocrates
- Lying-in hospitals opened for poor 1700’s-1800’s
- Numerous epidemics
- Correlation between “ulcerous sore throat” and puerperal fever

Lying-in hospitals and puerperal fever

- Improved statistics and observation
  - Dr Alexander Gordon (Aberdeen) 1795
  - “I myself was the means of carrying the infection to a great number of women.”
  - James Young Simpson (Edinburgh) 1850
  - Noted outbreak in obstetrician practices after autopsy
  - Collins (Dublin) 1826
  - Cohort nursing, washed wards with chloride of lime
  - Oliver Wendell Holmes (Harvard) 1843
  - Stressed connection between puerperal fever and other strep infections

19th Century prior to “age of microbes” military hospitals

- Severe outbreaks of infectious diseases
- Establishment of modern nursing
- Use of immediate amputation
  - Napoleonic Wars
  - Crimean War
  - US Civil War

19th Century Prior to “Age of Microbes” Industrial Revolution and hospitals

Mortality after limb amputation in Great Britain (1859)

<table>
<thead>
<tr>
<th>Size of Hospital (if of wards)</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>300-600</td>
<td>1 in 2.5</td>
</tr>
<tr>
<td>100-300</td>
<td>1 in 4</td>
</tr>
<tr>
<td>25-100</td>
<td>1 in 5.5</td>
</tr>
<tr>
<td>&lt;25</td>
<td>1 in 7</td>
</tr>
<tr>
<td>Cottage hospitals (room in countryside)</td>
<td>1 in 9</td>
</tr>
<tr>
<td>Hotel Dieu (Paris)</td>
<td>1 in 1.5</td>
</tr>
</tbody>
</table>

Simpson, J (1869) Some propositions on hospital. Lancet, 2: 688-700
Nightingale Ward circa 1940’s

19th Century Prior to “Age of Microbes”
Miasmatics Versus Contagionists

Early Age of Microbes
Louis Pasteur
• Fermentation caused by “living globules”
• “Pasteurization”
• Vaccination

Early Age of Microbes
Robert Koch
• Pioneered bacteriologic techniques
• Propounded “Koch’s postulates”
• Elucidated tubercle bacillus
• Identified Vibrio cholerae
• Researched disinfectants and sporidical techniques

Age of Microbes
Joseph Lister
• Sterile technique
• Disinfectants
• No handwashing
• No instrument sterilization

Age of microbes

Infection rate after clean wound operation, 1915

<table>
<thead>
<tr>
<th>Year</th>
<th>Procedure</th>
<th>Infection Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1896</td>
<td>baseline</td>
<td>39%</td>
</tr>
<tr>
<td>1897</td>
<td>modern OR and autoclave</td>
<td>9%</td>
</tr>
<tr>
<td>1899</td>
<td>sterile gloves, disinfectant in dressings</td>
<td>3%</td>
</tr>
<tr>
<td>1912</td>
<td>patient bathing, cleaning, disinfecting, of surgical site</td>
<td>2.4%</td>
</tr>
<tr>
<td>2013</td>
<td>peer review of surgical technique</td>
<td>1.8%</td>
</tr>
</tbody>
</table>

Brewer GE (1915) Studies on aseptic technic with a report of recent observations at the Roosevelt Hospital, NY. J. Am. Med. Assoc., 64, 1639-72. Adapted from Hospital Infection.

Early Twentieth Century

- Hospital Design
  - Subdivided wards
  -Fewer beds per room
  -Isolation hospitals
    - Tuberculosis (leprosy)
    - Smallpox
    - Scarlet fever, typhoid, polio, measles
- Epidemiologic advances
  - Asymptomatic carriers
  - Typing of staph into Lancefield Groups
- Antibiotics and “the end of staph”
  - Sulfonamides 1940’s
  - Penicillin 1940’s

Mid-Twentieth Century

- Emergence of Staph aureus
  - Outbreaks of penicillin resistant staph late 1940’s
  - More virulent strain spread 1950’s
  - Methicillin and cephalosporins introduced 1960’s
    - 1970’s outbreaks of methicillin-resistant staph aureus (MRSA)
    - Evidence of airborne spread in burn units, positive-pressure ventilation 1940’s-50’s
    - Some evidence for hospital design, single-bed isolation in prevention of transmission
    - Difficult to eradicate since many asymptomatic carriers, may be colonized nares, axillae, or groin, reinfection via fomites

Mid-Twentieth Century

- Gram-negative bacilli
  - 1950’s-60’s increased frequency
  - Pseudomonas
    - Environmental sources: medical equipment, contaminated disinfectants, eyewash, IV fluids
- Instrumentation
  - Urinary catheters
  - Flexible Endoscopes
  - Dialysis machines
  - Ventilators
- 1960’s mobile genetic elements
  - By end of century multidrug resistant isolates common

Mid-Twentieth Century

- Key developments in infection control
  - Improvements in autoclaving 1950’s
  - Central sterile supply departments from late 1940’s
  - Hospital sterilization and disinfection units
    - Challenges of waste and sterilization of heat-labile items
    - New chemicals, some toxic and allergenic:
      - disinfectants and gaseous sterilization
  - 1946 Centers for Disease Control (CDC) founded

Mid-Twentieth Century

- Key developments in infection control:
  - 1959 National Conference on hospital-acquired staph
  - Basic standards for tracking and control of transmission
  - 1960's operating room standards developed by Altemeier and Walter
    - Filtered air, positive pressure, air exchanges
    - Bacterial air counts "settle plates"

- Cohort nursing
- Bundling
- Infection control officers and nurses
- Eventually - infection control/team and committees
- Antibiotic stewardship 1970's
- Perioperative antibiotic prophylaxis 1960's
- CDC data collection - staph infection 1950's
- CDC National Nosocomial Infections Study (NNIS) 1969
- CDC Study on the Efficacy of Nosocomial Infection Control (SENIC) 1970's-80's

Late-Twentieth Century

- Key developments in infection control:
  - 1972 Association of Practitioners for Infection Control (APIC)
  - American Journal of Infection Control
  - Society for Healthcare Epidemiology of America (SHEA)
  - Infection Control and Hospital Epidemiology
  - HIV/AIDS and universal precautions

- Institute of Medicine Reports:
  - To Err is Human: Building a Safer Health System (1999)
  - Crossing the Quality Chasm: A New Health System for the 21st Century (2001)
  - 2002 Public reporting

East Bay Times. Dec 29, 2016

Hospital Acquired-Infections in the New Millennium

Come back next year!