Imaging in Infectious Disease-
North America: Imaging and Health Care-Associated Infections

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I have no disclosures
Outline

- Introduction
- Common HAIs in Children
- Becoming Infected
- Preventing infection
- Special Considerations
  - Highly Contagious disease
  - Management of bloodborne exposure
Health Care-Associated Infections (HAIs)

- Acquired while receiving treatment for another condition within a health care setting including imaging dept.
- Caused by any infectious agent,
- Significant cause of morbidity, mortality; economic cost
  - 1 in 25 inpatients with HAI, cost billions of dollars and tens of thousands of lives annually
- Risk factors include invasive devices (ETT, vascular lines, urinary catheters), surgery, immunocompromise
Radiology and Healthcare Associated Infections

- Risk of highly contagious diseases growing in North America
- Radiology exams performed across broad range of patients daily including many with infection not yet diagnosed
- Little education in infection control and limited experience imaging patients with potentially lethal infections
- Role in ensuring patient and staff safety in dept
Common HAIs in Pediatric Patients

- Bloodstream infections (2.8%)
- Invasive device related infections-CVL, ETT etc (2%)
- Hospital acquired pneumonia including Ventilator associated (1.5%)
- Surgical site infections (1%)
- Includes MRSA, VRE, C. diff, multiple resistant gram-ve bacteria well known hazards of inpatient care
- Colonized vs infection
## Prevalence of patients with HAI

Overall-9.2% of all pediatric inpatients

<table>
<thead>
<tr>
<th>Ward type</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU/pediatric ICU</td>
<td>17.7</td>
</tr>
<tr>
<td>Medical hematology/oncology</td>
<td>14.4</td>
</tr>
<tr>
<td>Transplant</td>
<td>10.8</td>
</tr>
<tr>
<td>Surgery</td>
<td>10.1</td>
</tr>
<tr>
<td>Pediatric/medicine</td>
<td>8.4</td>
</tr>
<tr>
<td>Neonatal ICU</td>
<td>6.6</td>
</tr>
<tr>
<td>Medical-surgical</td>
<td>3.9</td>
</tr>
<tr>
<td>Other (cardiology, pediatric orthopedics, medical special care, PICU step-down, trauma)</td>
<td>2.0</td>
</tr>
</tbody>
</table>

A point prevalence survey of health care-associated infection in Canadian pediatric inpatients Am J Infection Control 2012::40:491-6
Becoming Infected - Routes of Transmission

Direct

Droplet

Indirect

Airborne

Examples of Microorganisms encountered in the Radiology Department by Route of Transmission

Direct Contact

Ebola virus, **hepatitis B virus**, hepatitis C virus, human immunodeficiency virus, herpes simplex virus, rabies virus, varicella-zoster virus, *Bacillus anthracis*

Indirect Contact

Ebola virus, norovirus, respiratory syncytial virus, varicella-zoster virus, *Clostridium difficile*, methicillin-resistant *S. aureus*, *Pseudomonas aeruginosa*, vancomycin-resistant *Enterococcus* species

Droplet


Airborne

**Influenza virus**, measles virus, norovirus, severe acute respiratory syndrome coronavirus, varicella-zoster virus, *M tuberculosis*, *Aspergillus* species

Becoming Infected: The transmission Chain

**Infectious Agent**
- Bacteria
- Virus
- Fungi
- Protozoa
- Parasite

**Reservoir**
- People
- Equipment
- Water

**Susceptible**
- Cancer Patients
- Elderly Patients
- Surgical Patients
- Burns
- Diabetes

**Portal of Entry**
- Respiratory Tract
- Gastrointestinal Tract
- Genitourinary tract
- Mucous Membrane
- Skin

**Mode of Transmission**
- Contact
- Droplets
- Airborne
- Vectorborne

**Portal of Exit**
- Excretions
- Secretions
- Droplets

**Break the Link**
- Treatment of Primary Disease
- Recognize High Risk Patients
- Aseptic Technique
- Wound Care
- Hand Hygiene
- Catheter Care
- Proper Attire
- Hand Hygiene
- Control of secretions and excretions
- Prompt Treatment
- Decontamination
- Rapid Identification of Organism
- Good Health and Hygiene
- Environmental Sanitation
- Disinfection/Sterilization
- Proper Food Handling
- Isolation Precautions

**Break the Links**
- Hand Hygiene
- Airflow Control
- Disinfection/Sterilization
- Proper Food Handling
- Isolation Precautions
Becoming Infected- The Radiology Environment

- Healthcare workers underestimate their role in HCAs- 20-40% of infections
- Patient and Healthcare worker zones
- Xray workers cross multiple patient zones and healthcare areas per day
- Ineffective cleaning procedures and infection control may result in contamination.
# Contamination in Radiology Department

<table>
<thead>
<tr>
<th>Department Location</th>
<th>Susceptible Places</th>
<th>Causative Organisms</th>
</tr>
</thead>
</table>
| General usage areas | • Sink/scrub areas/ soap dispenser, floors, doors  
• Patient transport equipment (wheelchairs/trolleys), Rolla-boards/spinal transfer boards  
• Patient beds/bed railings | • Klebsiella species  
• MRSA, VRE, Staph species.  
• A baumannii |
| Patient waiting area | • Chairs/water fountains | • Staph species |
| Imaging suite | • X-ray machine  
• Touch screen  
• ECG leads  
• Keyboards  
• Mouse  
• Radioactivity decay box  
• Syringe, Imaging bed, immobilization straps, Collimator, Patient transfer device/injection chair | • Staphylococcus Aureus  
• Pseudomonas aeroginosa  
• Staphylococcus species  
• Corynebacterium, Bacillus, Lactobacillus  
• Strept viridans,  
• Haemophilus parainfluenza |
| Radiology equipment | • Imaging equipment gantry  
• Control panel / surfaces  
• X ray cassettes  
• Portable ultrasound/probes/gel  
• MRI bore / coils | • Staph species, MRSA  
• Staph, baccili sp  
• S. Aureus, MRSA  
• MRSA |

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<tbody>
<tr>
<td>Medical devices</td>
<td>• Catheter/central line/ventilator/shunts/IV lines</td>
<td>• Coagulase negative staph, diphtheroids</td>
</tr>
</tbody>
</table>
| Reporting areas | • Computer screens, headphones | • Staph species  
• A baumannii |
| Radio pharmacy/ Injection site | • Lab coats/flow cabinet/Geiger counters/radiographic markers/CT contrast/pump injector | • Coagulase-negative Staphylococcus  
• A baumannii |
| Conference room | • Computer/projector/chairs | • Staph, P. aeroginosa |
| Interventional radiology suite | • Equipment trolley, Anesthesia and patient monitoring equipment, Lead shielding/clothing/rubber aprons | • Staph species, diphtheroid, bacilli, fungi spores |
| Waste management areas | • Sharp bins/waste disposal bins/recycling bins | • Vibrio cholera and other species |
Preventing Infection-Infection Control

- Aims: protection of patients and staff, protection and decontamination of equipment
- Education is lacking among radiologists
  - Limited use of protective eyewear, face masks, or face shields during interventions
  - Many needlestick injuries not reported
- CDC: 2 Tiers of precautions - standard and transmission based
Standard Precautions

- Universal, apply to all patients at all times

- Components of standard precautions include
  - Hand hygiene and infection control practice
  - Use of appropriate personal protective equipment when contact with blood or body fluid is anticipated
  - Respiratory hygiene and cough etiquette
  - Safe injection practices (single use vials)
  - Use of face masks for spinal procedures when placing catheters into epidural or subdural spaces
## Transmission-Based Precautions

<table>
<thead>
<tr>
<th>Type of isolation</th>
<th>Personal protective equipment required</th>
<th>Hand Hygiene</th>
<th>Cleaning of equipment</th>
<th>Examples of diseases requiring isolation</th>
</tr>
</thead>
</table>
| Contact           | Gown and gloves                        | Hand hygiene - if hands are visibly soiled, use soap and water | Hospital-approved disinfectant to clean equipment between patients (stethoscopes, noncritical equipment) | MRSA  
VRE  
Extended-spectrum B-lactamase Carbapenem-resistant  
*Enterbacteriaceae* respiratory syncytial virus and scables |
| Airborne          | Particulate respirator  
Respirator mask | Hand hygiene | Hospital-approved disinfectant to clean equipment between patients | TB, pulmonary and laryngeal Zoster, disseminated requires airborne and contact precautions Varicella- requires airborne and contact precautions |
| Droplet           | Surgical mask within 3 ft of patient | Hand hygiene | Hospital-approved disinfectant to clean equipment between patients | Influenza  
Group A streptococcus major wound/skin infection requires contact precautions in addition  
Meningococcal disease (sepsis, pneumonia, meningitis)  
Pertussis |
<p>| Enteric contact precautions | Gown and gloves | Soap and water (not alcohol hand gel) | Equipment wiped with 1:10 bleach disinfectant to water before removing from room | <em>C. difficile</em>, Norovirus |</p>
<table>
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<tr>
<th>Decontamination Type</th>
<th>Definition</th>
<th>Method and Use</th>
</tr>
</thead>
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<tr>
<td>Cleaning</td>
<td>The removal of foreign material from a device surface</td>
<td>Manually or mechanically with water, enzymes or detergents</td>
</tr>
<tr>
<td>Disinfection</td>
<td>Reduction of the microorganism burden without the elimination of all microorganisms; disinfection does not eliminate bacterial spores</td>
<td></td>
</tr>
<tr>
<td>Low-level disinfectants</td>
<td>Eliminate most bacteria (not including <em>M. tuberculosis</em>), some viruses, and some fungi; comprise EPA-approved hospital disinfectants that are labeled “non-tuberculocidal”</td>
<td>Generally safe for use on environmental surfaces; short contact times (&lt;10 min)</td>
</tr>
<tr>
<td>Intermediate level disinfectants</td>
<td>Eliminate most bacteria (including <em>M. tuberculosis</em>), most viruses, and all fungi; comprise EPA-approved hospital disinfectants that are labeled “tuberculocidal”</td>
<td>Widely used and generally safe for use on environmental surfaces</td>
</tr>
<tr>
<td>High-level disinfectants</td>
<td>Eliminate all bacteria, viruses and fungi but not bacterial endospores</td>
<td>For use on medical devices, not environmental surfaces</td>
</tr>
<tr>
<td>Sterilization</td>
<td>The elimination of all microorganisms from a surface, including bacterial endospores; the chance that a microorganism survives sterilization is less than 1 in 1 million</td>
<td>Medical devices should be sterilized according to the device manufacturer’s instructions to avoid instrument damage</td>
</tr>
</tbody>
</table>

Contagious and Potentially Lethal Viral Infections

- Outbreaks of highly infectious disease increasing worry
  - Influenza, Ebola, MERS-CoV
  - SARS challenge in 2003 very similar to today with Ebola and MERS-CoV
- Diagnostic imaging often required in initial assessment or once admitted
- Radiographers have become infected with highly contagious diseases—SARS, TB
- Nosocomial transmission can be prevented by strict adherence to infection control measures and correct use of personal protective measures
Protection of Radiology Staff

- Measures to reduce staff exposure
  - Plan for the possibility, establish predefined protocols
  - Limit the number of staff entering patient’s room
  - Limit imaging to bedside imaging to avoid patient transport
  - Invest in a CR system so cassettes can be left in the patient’s room
  - Careful screening to identify possible cases
  - Mock practice sessions organized and regularly repeated to train staff, with staff monitor of PPE use
  - Environmental controls- use of rooms with anterooms, portable isolation chambers, use of PPE
Exposure to Bloodborne Pathogens

- Common exposure routes for staff
  - Needlestick, mucous membrane splashes
  - Vascular access, solid organ biopsy, lumbar puncture etc
  - Also patient transfer, emptying urine bags, changing linens

- Seroconversion rates after needlestick
  - HIV - 0.3%, Hep C -1.8%, Hep B -23-62%

- Transmission of HBV infection
  - Blood, also contact with contaminated objects on surfaces
  - Can survive for at least one week at room temperature

- Timely medical attention and follow-up with institutional reporting
  - May need prophylactic antivirals
Conclusion

- Radiology has 2 unseen concerns- radiation and infection
- We have dedicated much effort for one and little systematic efforts to the latter- it is time we change
- Hand Hygiene and best care practices vital
- Infection control must be considered when planning radiologic facilities
- Recommend development of shared standards for the evaluation of microbiological contamination in Radiology depts