Environmental Controls for droplet and airborne transmissible pandemic disease containment

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Disclosures-Disclaimer

• David Lutz works for Mintie Technologies
• Mintie is a provider of Portable Airborne Particulate Containment and Filtration solutions.
  – Construction and Maintenance
  – Patient Isolation
  – Pandemic Preparedness

• David works with many Epidemiologists, IPs and Facility Engineers but is not one himself
• 30-50% of US could contract A/H1N1
• 30-90,000 potential mortalities
• 1.8 million potential hospital admissions

• Based on the assumption A/H1N1 does not become more severe
Surge Capacity Issues

• Environmental Controls:
  ▪ Limited number of private rooms and even fewer true AIIRs
    ▪ U.S. GAO report, 2000: >50% hospitals have ≤ 4 AIIRs/100 staffed beds
    ▪ Smaller facilities may have 1-2, or no AIIRs
    ▪ 38.3% of Hospitals do not have an AIIR (2004 AHA)
  ▪ Existing HVAC - Very limited capability to isolate sections of a facility

• Patient-Related Factors:
  – Likely will be unaware/ignore federal hospital designation and will present at their usual hospital
  – Expect a significant proportion of the surge to be “worried but well”
    – Are there alternative sites for them?
  – Endemic needs of the population, e.g. heart attack, injury, etc., will require judicious use of emergency care services
    – ER can be overwhelmed by surge
A/H1N1 Prep Nurse Survey

• Nurses cited inadequate isolation of A/H1N1 patients in a quarter of hospitals

• At 49% of facilities, nurses say they have not been adequately trained to identify and care for infected patients

California Nurses Association/National Nurses Organizing Committee
many-hospitals-are-not-ready-for-h1n1-nurse-survey-shows-deficiencies-in-hospital-swine-flu-readiness.html
Objectives

• Review regulations / guidelines

• Identify locations requiring containment

• Discuss environmental control options
Agenda

• Tools for Responding to Pandemics
• Recommendations and Guidelines
• Containment Locations
• Environmental Control Solutions
• Recap
• Questions
Pandemic Response Tools

• Anti-Viral drugs
  – Reactive
  – Influenza focused
  – Vulnerable to resistance

• Vaccines
  – Proactive
  – Strain specific
  – Production lead time
  – Pre exposure application
Pandemic Response Tools

• Administrative
  – Reduce opportunities for exposure

• Environmental / PPE
  – Proactive
  – Non disease specific
  – Reduces exposure risk
  – Location oriented (environmental)
CDC/HICPAC Guideline

• Tier 1 - **Standard Precautions**: Implemented for all patient care.
  – Hand hygiene; PPE; Respiratory Hygiene; Patient placement (e.g. single occupancy room vs ward);
    Safe injection practices

• Tier 2 - **Transmission-based Precautions**: documented or suspected infection or colonization with highly transmissible or epidemiologically-important pathogens.
  – Contact
  – Droplet
  – Airborne

Guideline for Isolation Precautions :
Preventing Transmission of Infectious Agents in Healthcare Settings 2007
Modes of Transmission

- **Contact:**
  - **Direct** = microbe transferred directly from patient to caregiver; example: scabies
  - **Indirect** = transfer of germs via intermediate object or person; caregiver picks up germs from contaminated surface and transfers to the patient, example: methicillin-resistant S. aureus (MRSA)

- **Droplet:** microbe in respiratory droplets produced by cough or sneeze; droplets travel 3-6 feet; examples: influenza, SARS-CoV

- **Airborne:** germ in respirable droplet nuclei becomes airborne and can travel long distance and be inhaled deep into lung; examples: *Mycobacterium tuberculosis*, *Aspergillus spp.*
"5 microns" Rule Overturned

• Diameter related to unique pathogenesis of pulmonary *Mycobacterium tuberculosis* infection
  – Terminal alveolar deposition
  – "Obligate" inhalational transmission via droplet nuclei

• However, we know that:
  – Much larger particles can float and are inhaled.
  – Most inhaled particles are not infectious.
  – Most respiratory pathogens do not require terminal alveolar deposition, but infect the upper respiratory mucosa.
  – "Opportunistic" inhalational transmission? [e.g. SARS-CoV]

Source: Michael Bell, MD – Exec. Secretary, Healthcare Infection Control Practices

Advisory Committee (HICPAC), CDC
Droplet & Airborne
Infection Prevention and Control IC.01.06.01

- The hospital describes, **in writing**, how it will respond to an influx of potentially infectious patients. **D** [IC.01.06.01.04]
  - Note: One acceptable response is to decide not to accept patients.
- If the hospital decides to accept an influx, then the hospital describes **in writing** its methods for managing these patients over an extended period of time. **D** [IC.01.06.01.05]
- EP 6. When the hospital determines it is necessary, the hospital activates its response to an influx of potentially infectious patients. [IC.01.06.01.06]
• **Emergency Management (EM) 03.01.03**
  
  – As an emergency response exercise, the hospital activates its Emergency Operations Plan twice a year at each site included in the plan. [EM.03.01.03.01]
  
  – For each site of the hospital that offers emergency services or is a community-designated disaster receiving station, at least one of the hospital’s two emergency response exercises includes an influx of simulated patients. [EM.03.01.03.02]
    
    • Note 1: Tabletop sessions, though useful, cannot serve for this portion of the exercise.
  
  – For each site of the hospital that offers emergency services or is a community-designated disaster receiving station, at least one of the hospital’s two emergency response exercises includes an escalating event in which the local community is unable to support the hospital. [EM.03.01.03.03]
    
    • Note 1: This portion of the emergency response exercise can be conducted separately or in conjunction with EM 03.01.03, EPs 2 and 4
CMS

• EMITALA
  – Intended to prevent patient dumping
  – Complaint based system
  – Does not prevent on campus redirection
  – Medical Screening Exam ≠ Full triage

• Waiver
  – President and HHS Secretary take action
  – State & Hospital emergency plans activated
Influenza Like Illness (ILI)
Patient presents

Underlying or Acute Condition

Healthcare Facility

Alternate Care Site (ACS)

Pandemic ILI Confirmed

Main ACS

Protected ACS / Transfer
Patient Types

• ILI patients presenting at ER
  – 1) Need to be at Main Facility
  – 2) End up at Main Facility

• ILI patients presenting / redirected to ACS
  – 3) Pandemic disease patients
  – 4) Non-pandemic disease patients
    • Seasonal
    • Other
    • Worried Well
Containment Locations

- Emergency Room (ER) Waiting Area
- Medical Screening
- Exam
- Hospital
- Individual Patient Room
- Mass Isolation (Cohort) Area
- ACS
  - Non Pandemic Patients

Orange box indicates areas that require containment.
Containment Options

- ER
- Individual Patient Room
- Mass Isolation (Cohort) Area
- ACS

Reputable Manufacturer
HVAC Systems

- Does not provide containment
- Dilution Ventilation, Exhaust Ventilation
- Supply only option
Emergency Room
Emergency Room

- Freestanding NAM
- HEPA Filtered
- 99.99% Effective @ 3μ
- Visible Reminder
- Social Distancing
  - ILI area
- Make Available
  - Surgical Masks
  - Hand wash dispensers
ER Layout & Patient Flow
Surge Plan Elements

• **Administrative Strategies:**
  – Respiratory hygiene / cough etiquette
  – Spatial separation, e.g. febrile respiratory illness (FRI) in waiting areas
  – Detection & response activation; follow emergency operations & disaster plans + hospital incident command
## Response Phases

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<tr>
<th>Response Phase</th>
<th>Trigger threshold</th>
<th>Interventions</th>
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| 1              | Between 5 - 20 patients; similar symptoms present over matter of hours | • Notices placed  
• Check resp. hyg. supplies  
• Empty Pediatric waiting (glass-enclosed)  
• Move current patients to fast track  
• New triage station at “infectious patient entrance”  
• Notify Pt Resource Mgr (aka “bed manager”)  
• Dedicated discharge pathway; infect. pts. |
Surge Response Planning

- Dedicated Discharge pathway
- Perimeter corridor
- Infectious Pt. entrance
### Response Phases, cont.

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| 2              | ≥ 20 patients; similar symptoms – hours to days | • Incident command activated  
• Deploy environmental containment equipment at perimeter corridor  
• PRM assess (Med. PCU + MICU) & expedite transfers/discharges  
• Suspend elective care  
• Surge staffing plan activated  
• Regional collaboration activated |  
| Total capacity = 52 patient surge |  |  

20 patients; similar symptoms – hours to days  
Total capacity = 52 patient surge
Individual Patient Room
Freestanding HEPA

- Does not provide containment (to corridor)
- Noise in room
- Poles and plastic sheeting are unreliable
Window/Exhaust Conversion

- Requires Room Modification
- Tied to specific room
- Breaches Building
- Unbalances HVAC
- Weather exposure
- Noise in room
Portable Anteroom

• Physical / Pressure Containment
• AIIR equivalent isolation
• NAM outside room
• No Building Modification
• Visual reminder
Portable Anteroom

- External Frame
- Set up
  - Quick, Easy
  - 1 Person
- Few Pieces
- Convenient to
  - Store
  - Move
- Scalable
Operating Room
Operating Room

- Freestanding NAM
  - Loud
  - Disrupted Airflow
  - Less efficient filtration
- Anteroom
  - Quieter
  - Directional Airflow
  - More efficient filtration

Pilot study of directional airflow and containment of airborne particles in the size of *Mycobacterium tuberculosis* in an operating room.
Olmsted RN. Am J Infect Control 2008;36:260-7
Anteroom Efficiency

- Submicron Particle release
  - Baseline concentration = 6,468 particles / cu. Ft [p/cu.ft] (before particle release)
  - Initial quantity = 500,000 p/cu.ft.
  - 5 min. = 303,701
  - 10 min. = 116,664
  - 20 min = 28,034
- Removal efficiency after 20 minutes = 94.5%

Particles: poly-alpha olefin (PAO); final conc. = 500,000 particles / cubic foot

Mass Isolation
Mass Isolation - Droplet

- Physical barrier separation
- Negative pressure at entrances
- Visual alert of contained area
  - Staff PPE Reminder
  - Prevents Patient Wander
Mass Isolation – Airborne

- Physical barrier separation
- Negative pressure separation
- Extended space for gurneys, etc.
- Easily Expanded
Alternate Care Sites (ACS)
Mobile Hospitals

- Provide “full” hospital capability
- State/region owned
- Planned as regional response
- Operated by Mobile Field Medical Teams (consistent with FEMA resource typed definition)
- Take time to deploy
- Very expensive
Mobile Hospital

• Michigan Transportable Emergency Surge Assistance (MI-TESA) Medical Unit
  - Michigan has purchased two interoperable mobile medical facilities from Western Shelter Systems that have the capability to join as a statewide 140-bed mobile medical facility.
  - The MI-TESA Medical Units will be operated by Mobile Field Medical Teams (consistent with the FEMA resource typed definition) under the guidance of the Regional Medical Coordination Centers.
Mobile Hospital

**MI TESA Medical Unit**
40-Bed
Mobile surge facility in Southwest Michigan (Region 5)

**MI TESA Medical Unit**
100-Bed
Mobile surge facility in Southeast Michigan (Region 2S)
Mobile Hospital

- Oriented on disaster response
- Internal separate isolation area
Other ACS

- Medical Office Buildings (MOB)
- Schools
- Gyms
- Hotels

- Individual Patient Room Solutions
  - Protective Environment (~neutropenic)
Portable Anteroom

- Physical / Pressure *Isolation*
- Protective Environment
- NAM outside room
- No Building Modification
- Visual reminder
Key Points

• Identify Isolation Areas
• Determine how to redirect to ACS
• Evaluate HVAC
• Temporary Environmental Controls
  – Easy to set-up
  – Easy to use
  – Scaleable
  – Portable
Thank You

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