Indiana University Health

Infection Prevention

Douglas H. Webb MD
Medical Director, Infection Control/Hospital Epidemiology

Infection Prevention – top nine 2011

- Hand hygiene
- Device-related infections
  - Central line-associated bloodstream infections
  - Catheter-associated urinary tract infections
  - Ventilator-associated pneumonias
- Surgical site infections
- Problem pathogens
  - Clostridia difficile-associated disease
  - MDROs/antibiotic stewardship
- Viral respiratory pathogens/Hospital-acquired pneumonias
- Environmental cleaning issues
- Final thoughts

Hospital-Acquired Infections

- Annual Healthcare-associated infections (HAI) in U.S. = 1.7 million
  - 4.5 infections per 100 admissions
- Deaths associated with HAIs
  - Pneumonia 35,967
  - Bloodstream infections 30,665
  - Urinary Tract Infections 13,088
  - Surgical Site Infections 8,205
  - Other sites 11,062

The Cost of Healthcare-associated Infections

- APIC analysis (2007)
  - Analyzed 1.69 million admissions from 77 hospitals
  - Estimated average reduction in inpatient net margins per infected patient of $5,018
  - Determined average incremental direct **cost** for patient with HAI as $8,832

The Cost of Healthcare-associated Infections

- APIC analysis (2007): payer mix
  - Patients without infection
    - 36.7% Medicare
    - 28.1 % Commercial
    - 13.7% Medicaid
    - 21.4% Other
  - Patients with infection
    - 57.2% Medicare*
    - 17.2% Commercial
    - 11.4% Medicaid
    - 14.2% Other

The Cost of Healthcare-associated infections

- JSI Massachusetts study

	xs-Cost	xs-LOS
– Median cost by infection:		
• VAP	$17,904	9.6
• BSI	$15,153	12.0
• CABG-associated SSI	$18,057	25.7
• UTI	$ 1,257	n.e.
– Increased resistance, increased cost		
• MRSA bacteremia	$ 6,916	2.2
• MRSA surgical infection	$13,901	2.6
• VRE infection	$12,766	6.2
• R-Pseudomonas infection	$11.981	5.7
• R-Enterobacter infection	$29,379	9.0

MDROs responsible for nosocomial infections

Organism	CLABSI	CAUTI	VAP	SSI
• **S. aureus**				
– MRSA	57%	65%	54%	49%
• **Enterococcus**				
– VRE	36%	29%	33%	20%
• **Ps aeruginosa**				
– 3 class resistance*	16%	43%	36%	5%
• **K. pneumoniae**				
– 3 class resistance*	35%	46%	13%	6%
• **A. baumanni**				
– 3 class resistance*	31%	16%	49%	4%
• **E. coli**				
– Quinolone R	30%	25%	23%	23%

*3 class resistance: resistant to all antibiotics tested in 3 classes. (Penicillins, Cephalosporins, Carbapenams, Fluoroquinolones, or Aminoglycosides)

10/16/2011 7

Challenge #1: a dearth of resources

- Infection Control is a worthwhile investment
  - Data shows as numbers of ICP increase, infection rates decline (C. difficile)
  - Recommendations for 1 ICP:100 beds
- Role of ICP has increased in quantity and scope of tasks
  - Conducting epidemiological investigations, problem-solving
  - Educating staff regarding antibiotic resistance, isolation
  - Tracking real-time surveillance efforts
  - Engaging staff in infection control campaigns
  - Liaison between departments
  - Planning for potential outbreaks (pandemic flu) or threats of bioterrorism (anthrax)
  - Reporting of infection metrics to internal and external groups

10/16/2011 8

Challenge #2: growing problem of antimicrobial resistance

- The effects of "overuse and misuse":
  - Rates of bacterial resistance have risen steadily over the past decade – much of this due to inappropriate or unnecessary antimicrobial use
  - Resistance impacting quality = Increased risk of death
    - MRSA bacteremia 1.9
    - MRSA surgical site infection 3.4
    - VRE infection 2.1
    - Resistant Pseudomonas infection 3.1
    - Resistant Enterobacter infection 5.0
- "Nothing new" on the horizon: **(Bad bugs, no new drugs)**
  - total number of new antimicrobial agents approved:
    - 1983-1987 16
    - 1988-1992 14
    - 1993-1997 10
    - 1998-2002 7
    - 2003-2007 4
    - 2008 – ?....

10/16/2011 9

Proposed Timeline for HAI

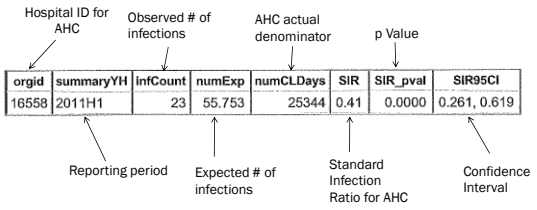
Indicator	Reporting Effective Date	Affects Annual Payment Update
Central Line Associated Bloodstream Infection	Ongoing	Ongoing
Surgical Site Infections*	January 2012	FY 2012
Central Line Insertion Practices	January 2012	FY 2014
Catheter Associated Urinary Tract Infection	January 2012	FY 2014
MRSA Bacteremia	January 2013	FY 2015
Clostridium Difficile	January 2013	FY 2015
Healthcare Personnel Influenza Vaccination Rate	January 2013	FY 2015

SSI procedures are colon and abdominal hysterectomy
Red- deferred in final rule
Green-proposed for FY 2015 Annual Payment Update

Risk Adjustment

NHSN Procedure	Validated Parameters for Risk Model
Colon	Age, ASA, duration, endoscope, medical school affiliation, hospital bed size, wound class
Rectal	Duration , gender, hospital bed size
Abdominal Hysterectomy	Age, ASA, duration of procedure, hospital bed size
Vaginal Hysterectomy	Age, duration, medical school affiliation
Hip Arthroplasy	Total/partial/revision. Age, anesthesia, ASA, duration, medical school affiliation, hospital bed size, trauma
Knee Arthroplasy	Age, ASA, duration, gender, medical school affiliation, hospital bed size, trauma, revision
Coronary artery bypass graft	Age, duration, gender, medical school affiliation, age gender (interaction)
Other Cardiac	Age, duration, emergency
Vascular-abdominal aortic aneurysm repair	Duration, wound class
Vascular-Peripheral vascular bypass	Age, ASA, duration, medical school affiliation

Sample Report from NSHN



Improvement Plan

- 2010 Marketing and communication Plan with increased emphasis of engaging the patient and family
  - Facility based teams to determine additional improvement strategies
  - Recommended Approaches
    - Use Targeted Solution Tool from JC
    - Leadership lead SWAT Team
    - Development of Unit Based Infection Control experts
    - Addressing the culture of safety and speaking up

10/16/2011 13

Why is Hand Hygiene important?

Actual IU Health Employee hand without hand hygiene

Actual IU Health Employee after hand hygiene

Hand Hygiene

•Save Lives

•Prevents patient harm

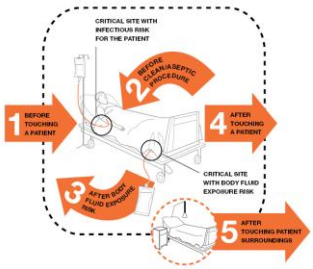
•Prevents us from taking germs home to our families

10/16/2011 14

Moments for Hand Hygiene

While **entry** and **exit** are "moments" for hand hygiene there are other times we should always perform hand hygiene:

1. Before clean or aseptic procedures such as handling a IV or foley
2. After exposure to body fluid exposure risk such as emptying a foley or urinal
3. After touching patient surroundings



10/16/2011 15

Measuring HCW Hand Hygiene Compliance: Emerging Technologies

- Observational surveys by trained personnel considered the "gold standard"
- Self-reporting
- Measuring product consumption
- Electronic hand hygiene monitoring systems
  - Dedicated hand hygiene monitoring systems
  - Real-time locating systems (RTLS) for tracking HCWs and hand hygiene events
    - HCWs badged, wireless systems
  - Video monitoring of hand hygiene activity

Device-related infections

- Central line-associated bloodstream infections
- Catheter-associated urinary tract infections
- Ventilator-associated pneumonias

CVL-BSI Independent risk factors (in 2 or more published studies)

- Prolonged hospitalization before catheterization
- Prolonged duration of catheterization
- Heavy microbial colonization at the insertion site
- Heavy microbial colonization of the catheter hub
- Internal jugular catheterization
- Neutropenia
- Prematurity (birth at an early gestational age)
- Total parenteral nutrition
- Substandard care of the catheter (excessive manipulation of the catheter or reduced nurse-to-patient ratio)

Major organisms responsible for nosocomial infections

- CLABSI
  - Coag neg Staph 34%
  - Enterococcus sp. 16%
  - Candida sp. 12%
  - Staphylococcus aureus 10%
  - Klebsiella pneumoniae 5%
  - Enterobacter sp. 4%
  - Pseudomonas aeruginosa 3%
  - E. coli 3%
  - Acinetobacter baumanni 2%
  - Klebsiella oxytoca 1%
  - Other 10%

10/16/2011 19

Strategies to Prevent CVL-BSI: Before Insertion!

- **Educate** healthcare personnel:
  - Include indications for use, risks, and appropriate insertion and maintenance
  - Require an educational program of those performing insertion and maintenance of central line catheters
  - Require a credentialing process for those inserting a CVL to ensure competency before they independently insert a CVL
  - Periodically assess HCW knowledge of and adherence to preventive measures

10/16/2011 20

Strategies to Prevent CVL-BSI: At time of insertion

- Use a catheter checklist to ensure and document compliance with aseptic technique
  - HCWs empowered to stop procedure if breaches in aseptic technique are observed!
- Perform hand hygiene prior to catheter insertion or manipulation
- Avoid using femoral vein for CVL access
- Use an all-inclusive catheter cart or kit
- Use maximal sterile barrier precautions during CVC insertion
- Use chlorhexidine (CHG)-based antiseptic for skin preparation in patients older than 2 months of age (and allow to dry)

10/16/2011 21

Strategies to Prevent CVL-BSI: After insertion

- Disinfect catheter hubs, needleless connectors, and injection ports before accessing the catheter
  - Using either alcohol-CHG or alcohol preparation
- Remove nonessential catheters
- Change dressings and perform site care with CHG-based antiseptic
  - Every 5-7 days for transparent dressings or more frequently if dressing is soiled, loose or damp
  - Every 2 days or more frequently if dressing is soiled, loose or damp
- Replace administration sets not used for blood, blood products, or lipids at intervals no longer than 96 hrs
- Perform surveillance for CVL-BSI,
  - Unit-specific rates reported regularly to the units, physician and nursing leadership and hospital administrators overseeing the units

10/16/2011 22

Strategies to Prevent CVL-BSI: accountability

- The hospital's CEO and senior management are responsible for ensuring that the healthcare system supports an infection control program and effectively prevents CVL-BSIs.
  - Adequate number of infection control practitioners
  - HCWs competent to perform job responsibilities
- Direct HCWs are responsible for ensuring that appropriate infection prevention and control practices are used at all times
  - Unit leadership to hold these individuals accountable
- Infection control program leadership responsible for ensuring that an active program to identify CVL-BSIs is implemented, that data is analyzed and feedback provided.

10/16/2011 23

Strategies to Prevent CVL-BSI: special approaches available

- Bathe ICU pts > 2 months of age with CHG daily
- Use antiseptic or antimicrobial-impregnated CVLs for adult patients
- Use of CHG-containing sponge dressings for CVLs in patients older than 2 months of age
- Coated Luer-activated devices (needleless connectors) with impregnated alcohol/antimicrobials
- Use antimicrobial locks for CVLs (consider only for the following):
  - Prophylaxis for patients with limited venous access and history of recurrent CVL-BSIs
  - Patients who are at heightened risk for severe sequelae from CVL-BSI (recently implanted intravascular devices)

10/16/2011 34

Strategies to Prevent CVL-BSI: UNresolved issues

- Nurse-pt ratio and use of float nurses in ICUs
  - Observational studies suggest at least 2:1 ratio in ICUs where nurses are managing patients with CVLs, and that float nurses be minimized
- IV therapy teams
  - Studies show reduction in infection rates with peripheral vascular catheters, but few studies performed assessing CVL-BSIs.
- Surveillance of other types of catheters (arterial)
- Estimating catheter days for determining incidence density of CVL-BSIs (use with limited workforce)

Performance Measures: CVL-BSI

- Process measures
  - Compliance with checklist in all hospital settings where CVLs are inserted
  - Compliance with documentation of daily assessment regarding need for continuing CVL access
  - Compliance with cleaning of catheter hubs and injection ports before they are accessed
  - Compliance with avoiding femoral vein site for CVC insertion in adults
- Outcome measures
  - CVL-BSI rates

Central line bundle

- Hand hygiene
- Maximal barrier precautions
- Chlorhexidine (CHG) skin antisepsis
- Optimal catheter site selection, with the subclavian vein as the preferred site for non-tunneled catheters
- Daily review of line necessity, with prompt removal of unnecessary lines

Ventilator-associated Pneumonia

- Pathophysiology: VAP arises when there is bacterial invasion of the pulmonary parenchyma in a patient receiving mechanical ventilation by
  - Aspiration of secretions, or
  - Colonization of the aerodigestive tract, or
  - Use of contaminated equipment or medications
- Risk Factors:
  - Prolonged intubation
  - Enteral feeding
  - Witnessed aspiration
  - Paralytic agents
  - Underlying illness
  - Extremes of age

10/16/2011 28

Major organisms responsible for nosocomial infections

- VAP
  - Staphylococcus aureus 24%
  - Pseudomonas aeruginosa 16%
  - Enterobacter sp. 8%
  - Acinetobacter baumanni 8%
  - Klebsiella pneumoniae 8%
  - E. coli 5%
  - Candida sp. 3%
  - Klebsiella oxytoca 2%
  - Coag negative Staph 1%
  - Enterococcus 1%
  - Other 23%

10/16/2011 29

Strategies to Prevent VAP: General Measures

- Conduct active surveillance for VAP
- Adhere to hand hygiene guidelines
- Use non-invasive ventilation whenever possible
- Minimize the duration of ventilation
- Perform daily assessments of readiness to wean and use weaning protocols
- Education of HCWs who care for patients on mechanical ventilation about VAP

10/16/2011 30

Strategies to Prevent VAP: Prevent Aspiration

- Maintain patients in a semi-recumbant position (elevate HOB 30-45 degrees) unless contraindicated
- Avoid gastric overdistention
- Avoid unplanned extubation and re-intubation
- Use a cuffed endotracheal tube with in-line or subglottic suctioning

10/16/2011 31

Strategies to Prevent VAP: Reduce Colonization

- Orotracheal intubation preferred over nasotracheal intubation
- Avoid H2 blocking agents and proton pump inhibitors for patients who are not at high risk for developing a stress ulcer or stress gastritis
- Perform regular oral care with an antiseptic solution. Optimal frequency not established

10/16/2011 32

Strategies to Prevent VAP: Minimize Contamination

- Use sterile water to rinse reusable respiratory equipment
- Remove condensate from ventilatory circuits, keeping the circuit closed
- Change the ventilatory circuit only when visibly soiled or malfunctioning
- Store and disinfect respiratory therapy equipment properly

10/16/2011 33

Performance Measures: VAP

- Process measures
  - Compliance with hand hygiene guidelines
  - Compliance with daily sedation interruption and assessment of readiness to wean
  - Compliance with regular antiseptic oral care
  - Compliance with semi-recumbent positioning or all eligible patients
- Outcome measures
  - VAP rates

Vent bundle

- Elevation of head of bed 30-45 degrees
- Daily sedation vacation and daily assessment of readiness to extubate
- Peptic ulcer disease prophylaxis
- Deep vein thrombosis prophylaxis unless contraindicated

The Burden of Catheter-associated Urinary Tract Infections (CAUTI)

- UTI – most common hospital-acquired infection
  - 80% are associated with an indwelling catheter
- 12-16% of hospitalized patients will have a urinary catheter sometime during their hospital stay
- Daily risk of acquiring a urinary tract infection is between 3-7% with an indwelling urinary catheter in place

Major organisms responsible for nosocomial infections

- CAUTI
  - E. coli 21%
  - Candida sp. 21%
  - Enterococcus 15%
  - Pseudomonas aeruginosa 10%
  - Klebsiella pneumoniae 8%
  - Enterobacter sp. 4%
  - Coag negative Staph 3%
  - Staphylococcus aureus 2%
  - Acinetobacter baumanni 1%
  - Klebsiella oxytoca 1%
  - Other 14%

10/16/2011 37

Strategies to Prevent CAUTI

- Provide and implement written guidelines for catheter use, insertion and maintenance
- Ensure that only trained, dedicated personnel insert urinary catheters
- Ensure that supplies necessary for aseptic technique catheter insertion are available
- Implement a system for documenting the following information in the patient record:
  - Indication for catheter insertion
  - Date, time and person who inserted catheter
  - Date and time of catheter removal
- Ensure that there are sufficient trained personnel and technology resources to support surveillance of catheter use and outcomes

10/16/2011 38

Indications for the use of indwelling urethral catheters

- Peri-operative use for selected surgical procedures
- Urine output monitoring in critically ill patients
- Management of acute urinary retention and urinary obstruction
- Assistance in pressure ulcer healing for incontinent residents
- As an exception, at patient request, to improve comfort

10/16/2011 39

UNresolved issues in CAUTI

- Use of antiseptic solution vs. sterile saline for meatal cleaning before catheter insertion
- Use of antimicrobial catheters for selected patients at high risk of infection

Performance Measures: CAUTI

- Process measures
  - Compliance with documentation of catheter insertion and removal dates
  - Compliance with documentation of indication for catheter placement
- Outcome measures
  - Rates of CAUTI

Surgical Site Infections

- SSIs occur in 2-5% of patients undergoing inpatient surgery in the U.S. (approximately 500,000 SSIs/year)
- Each SSI is associated with approx 7-10 additional post-op hospital days.
- Patients with SSIs have a 2-11 times higher risk of death, compared with operative patients without an SSI.
  - 77% of deaths among patients with SSIs directly attributable to SSI
- Attributable costs of SSIs vary, depending on type of operative procedure and type of infecting pathogen; published estimates range from $3,000 - 29,000.

Major organisms responsible for nosocomial infections

- SSI
  - Staphylococcus aureus 30%
  - Coag neg Staph 14%
  - Enterococcus 11%
  - E. coli 10%
  - Pseudomonas aeruginosa 6%
  - Klebsiella pneumoniae 3%
  - Candida sp. 2%
  - Klebsiella oxytoca 1%
  - Acinetobacter baumanni 1%
  - Other 20%

10/16/2011 43

Major organisms causing nosocomial infections: SSIs

Abdominal
- E. coli 19%
- Enterococcus 19%
- S. aureus 13%

Cardiac
- S. aureus 33%
- Coag neg Staph 22%
- Ps. aeruginosa 7%

Neurological
- S. aureus 51%
- Coag neg Staph 16%
- Enterobacter 5%

OB/GYN
- S. aureus 28%
- Coag neg Staph 12%
- E. coli 10%

Orthopedic
- S. aureus 49%
- Coag neg Staph 15%
- Enterococcus 9%

Vascular
- S. aureus 31%
- Ps. aeruginosa 9%
- E. coli 9%

10/16/2011 44

Existing guidelines and recommendations to prevent SSIs

- **HICPAC 1999**
  - Intrinsic (patient-related) characteristics
  - Extrinsic, procedure-related factors
- **SIP collaborative (CMS) 2002**
  - Focused on 3 performance measures for quality improvement related to ATB prophylaxis (timing, choice and discontinuation), and 7 procedures (cardiac surgery, hip and knee arthroplasty, vascular surgery, colorectal surgery, abdominal and vaginal hysterectomy)
- **SCIP (extension of SIP) 2003 – IHI supported**
  - Added 3 additional performance measures (proper hair removal, blood glucose control on post op days 1 and 2, and maintenance of perioperative normothermia for patients undergoing colorectal surgery

10/16/2011 45

Prevention of Surgical Site Infections

- Intrinsic, patient related
  - Unmodifiable (age)
  - Modifiable
    - Glucose control
    - Obesity
    - Smoking cessation
    - Immunosuppressive medications
- Extrinsic, procedure-related

Prevention of Surgical Site infections

- **Extrinsic, procedure-related**
  - Preparation of the patient
    - Hair removal appropriate
    - Pre-op infections treated
  - Operative characteristics
    - Surgical scrub
    - Skin preparation
    - Antimicrobial prophylaxis (timing, choice and discontinuation)
    - Surgeon skill/techniques
    - Asepsis standards
    - Operative time
  - Operating room characteristics
    - Ventilation
    - Traffic
    - Environmental surfaces
    - Sterilization of surgical equipment

Prevention of Surgical Site Infections

- **SCIP 1** antibiotic timing < 1 hr prior to incision
- **SCIP 2** appropriate antibiotic choice
- **SCIP 3** discontinuation of antibiotics within 24 hrs post- op (48 hrs for CV surgery)
- **SCIP 4** glucose control in CV patients
- **SCIP 6** appropriate hair removal (no razors)
- **SCIP 7** normothermia in colorectal surgery
- **SCIP 9** discontinuation of foley catheter by POD 2
- **SCIP 10** use of normothermia devices post-op

Preventing Surgical Site Infections

- NEJM Jan 2010, Darouiche (6 centers in U.S.)

  849 pts undergoing clean-contaminated surgery, pre-op skin prep randomized to CHG-alcohol (**ChloraPrep**) vs. povidone-iodine with 30 day follow up.

  Overall SSI Results:
  - CHG-Alcohol 9.5% (**60% reduction in SSIs**)
  - Pov-Iodine 16.1%

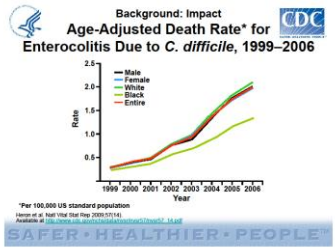
Preventing Surgical Site Infections

- NEJM Jan 2010, Bode (5 hospitals - Netherlands study group)

  6771 patients screened on admission with 1251 patients (18.8%) having + nasal swabs for S. aureus. 808 of these 1251 patients underwent a surgical procedure. Patients who were > 18 yrs old and anticipated to be hospitalized for 4 days or more and were colonized (but not actively infected) with S. aureus (918 pts) were randomized to receive either **nasal Mupiricin 2% BID + CHG daily x 5 days** vs. placebo with 6 wk follow up.

  Results:
  - 49 patients (includes both surgery and non-surgery patients) developed nosocomial S. aureus infections
    - 17 in Mupiricin/CHG group (3.4%)
    - 32 in the placebo group (7.7%)
  - The majority of patients colonized with S. aureus underwent surgical procedures and deep and superficial surgical site infections occurred less often in those given mupiricin/CHG vs. those given placebo. (**> 40% reduction in SSIs**)
    - Mupiricin/CHG group 4 of 441 deep SSI (0.9%); 7 superficial SSI
    - Placebo group 16 of 367 deep SSI (4.4%) 13 superficial SSI

Clostridia difficile



Clostridia difficile-associated diarrhea

- Initially described in 1978
- Increasing in frequency and CDI-associated mortality rates
  - Recent association with recognition of **new epidemic NAP1 strain**
- Risks (historical and well supported)
  - Advanced age
  - Antibiotic use
    - Clindamycin initial association
    - Third generation Cephalosporins
    - Fluoroquinolones (epidemic NAP1 strain)
  - Hospitalization in acute care facility or residence in a Long Term Care facility
- Recent associations
  - Prior use of proton-pump inhibitor drugs
  - Pregnancy
  - No antibiotic use
- Suspect in patients with diarrhea, fever, cramps, and leukocytosis. May have distinctive stool odor, abnormalities seen on CT or endoscopy.
- Diagnose with stool detection of toxin **(sensitivity best with RT-PCR)**

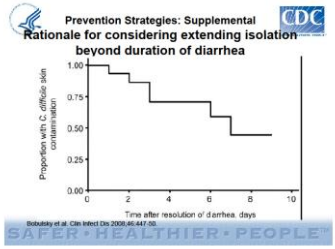
CDI – NAP1 Strain

- Recent epidemiology
  - Colonization? (est. 10-30% of hosp patients on antibiotics)
  - Incidence: 500,000 cases/yr; 15-20,000 deaths/yr
  - Virulence: (hypervirulent strains, NAP1)
    - 10x more toxin A; 20X more toxin B; binary toxin
    - Resistant to quinolones
- Recent Risk Factors
  - NG tubes, prolonged hospital stays, PPIs, steroids, other immunosuppressives all associated with increased risk of CDI in hospitalized patients
  - Peak WBC, creatinine levels during admission and WBC counts at time of admission with CDI associated with risk for colectomy or short term mortality
  - Patients exposed to corticosteroids within 15 days of diagnosis of CDI found to have a mortality rate twice that of those not treated with these agents

Compendium of Strategies to Prevent HA-CDI (SHEA 2008)

- The (official) IDSA/SHEA Practice Recommendations
- 16 Recommended practices listed in this document:
  - 12 practices graded B-III
    - Mod strength of evidence to support the recommendation and evidence from opinions of respected authorities, clinical experience, or descriptive studies.
  - 2 practices graded B-II
    - Mod strength of evidence to support the recommendation and evidence from non-randomized trials, cohort or case-control studies, multiple time series or dramatic results from uncontrolled experiments.
  - 1 practices graded A-I
    - Good evidence to support the recommendation (evidence from a randomized trial):
      - **"WEAR GLOVES WHEN CARING FOR A PATIENT WITH CDI"**
  - 1 practice graded A-II
    - Good evidence to support the recommendation (evidence from successful control during two outbreaks).
      - **"ANTIBIOTIC STEWARDSHIP"**

Clostridia difficile



10/16/2011 55

Dilute Bleach for Environmental Cleaning

- Hacek et al. Am J Infection Control 2010; 38:350-3 (NorthShore University Health System)
- Implemented a dilute bleach-containing solution (10 parts bleach to 90 parts tap water) to clean rooms/surfaces of patients with CDAD on discharge (replacing quaternary ammonium compound) for terminal cleaning.
  - Bleach was used only for terminal cleaning
  - Only used in patient rooms who had been diagnosed with CDAD.
- 48% reduction in prevalence of CDAD after implementing process.

10/16/2011 56

C.Difficile

	2009 Rate	2010 Rate	% Change
MH	202/35288 = 5.72	236/36151 = 6.53	↑ 13%
UH	131/17400 = 7.53	181/19292 = 9.38	↑ 20%
RI	64/15552 = 4.11	63/15789 = 3.99	↓ 3%

MH Bleach Clean Trial- All three units have seen reduction that are enrolled in bleach clean trial

Unit	PRE-INTERVENTION RATE	POST-INTERVENTION RATE	% CHANGE
B5C5	33/4280 = 7.71	18/3838= 4.69	40% reduction (p<.05)
A2N/A3N	21/6512 = 3.22	3/2744 = 1.09 *Q2&Q3 Rate	66% reduction
A4N	24/3641 = 6.59	4/1580 = 2.53 *Q2&Q3 Rate	62% reduction

10/16/2011 57

C. Difficile

- Treatment
  - Discontinuing antibiotics that may be contributing to the problem (15-25% may resolve with this maneuver)
  - Metronidazole – 500mg TID x 2 wks for mild-mod dis
  - Vancomycin – 125 – 500mg QID QID x 2 wks for mod-severe disease (taper – pulse Rx for recurrences?)
  - Saccharomyces boulardii 500mg BID x 28 days ?
  - Rifaximin 200-400 mg BID-TID x 28 days
  - Fidaxomycin 200 mg BID x 10 days – appears to result in less recurrences
  - Toxin binders (cholestyramine)?
  - Immunoglobulins?
  - Fecal microbiota transplantation?

10/16/2011 58

Multidrug-resistant organisms (MDROs)

- ESKAPE
  - Enterococcus faecium (VRE)
  - Staphylococcus aureus (MRSA)
  - Klebsiella pneumoniae
  - Acinetobacter baumanni
  - Pseudomonas aeruginosa
  - Enterobacter species
- New mechanisms of resistance among GNRs
  - New Delhi metallo-B-lactamase

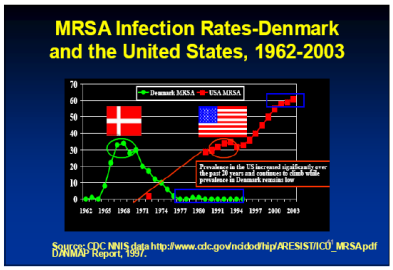
10/16/2011 59

MDR-GNRs: new strategies?

- Empiric combination therapy using a carbapenam with other antibiotic classes should be used first-line in critically ill patients at risk for MDR-GNR
- Pharmacokinetic/pharmacodynamic optimization of antibiotics with GNR activity can overcome resistance associated with MDR-GNRs
- Strategies to limit antibiotic exposure, such as shorter courses of antibiotics attenuates the emergence of MDR-GNRs
- Active surveillance of MDR-GNRs with isolation should be an active component of infection control bundles to prevent proliferation of MDR-GNRs

10/16/2011 60

U.S. vs. Europe MRSA Different Strategies



10/16/2011 61

MRSA Control: What can we do?

- 2003 SHEA guidelines for control of MRSA and VRE:
  - Active surveillance cultures to identify the reservoir for spread
  - Hand hygiene
  - Barrier precautions for patients known or suspected to be colonized or infected
  - Antibiotic stewardship
  - Decolonization or suppression of colonized patients
  - Other
    - Education
    - Environmental Cleaning
    - Hospital information systems to recognize returning MRSA patients
    - Dedicated non-critical patient care equipment for colonized/infected patients

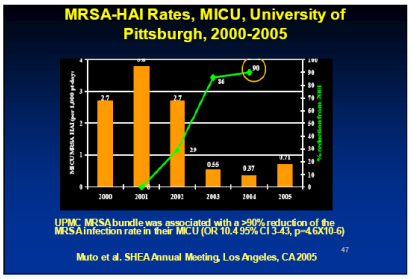
10/16/2011 62

MRSA Transmission in Healthcare Settings

- Unidentified Colonized Patient is the "Hidden Reservoir" for Spread of these infections!
  - We will miss 85% if these patients if we depend on clinical cultures alone
  - Active Surveillance Cultures (ASC) used to detect these patients
    - 90% should be identified by nasal swabs (best by PCR vs. culture)
    - Once identified as colonized with MRSA → Contact Isolation
      - Private room
      - Gowns/gloves
      - Hand hygiene

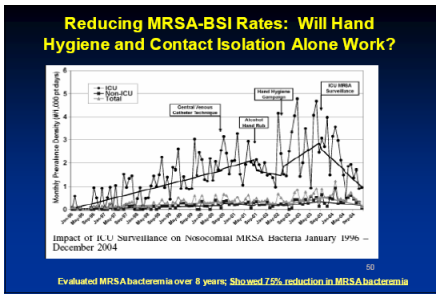
10/16/2011 63

University Of Pittsburgh MRSA Control 2000-2005



10/16/2011 64

Harvard: Sequential Tools For MRSA Control 1996 – 2004



10/16/2011 65

Asymptomatic MRSA colonization: Is it important?

- Does it predict infection?
- Two 3-month study periods in 2000: 209 patients identified as newly colonized or infected with MRSA (BWH, Harvard) – followed for 18 months
  - 60 patients **(29%)** developed new MRSA infections within 18 months
    - 48 of 60 (80%) developed the next infection at a **"new" site**
    - 90 infections occurred in these 60 patients
      - 25 of 90 (28%) were bacteremias
      - 50 of 90 (56%) were pneumonias, soft tissue, or bone/joint infections (osteomyelitis or septic arthritis)
      - 44 or 90 (49%) became manifest after discharge from the hospital

    Huang et al. CID 2003; 36:281-285

10/16/2011 66

Asymptomatic MRSA vs. MSSA Colonization: Is it important?

Does it predict infection?

- Of 758 patients cultured at time of admission and followed for 18 months:
  - **3.4% colonized with MRSA → 19% subsequently developed infections**
  - **21% colonized with MSSA → 1.5% subsequently developed infections**
    - **Davis et al. CID 2004; 39:776-782**

MRSA Colonization Is Important

- Of those that acquired colonization during their hospitalization:
  - **if it was MRSA → 25% developed infection**
  - **if it was MSSA → 2% developed infection**
  - **Davis et al. CID 2004; 39:776-782**

Is S. aureus nasal colonization important in ICU patients?

- Prospective Cohort Study: to determine whether MRSA colonized patients admitted to ICUs are more likely to develop any S. aureus infection in the ICU, compared with patients colonized with MSSA or not colonized with S. aureus, independent of predisposing risk factors. (note short follow up period)
- 24 bed SICU, 19 bed MICU, 1252 bed academic hospital (Barnes-Jewish) 2002 – 2007
- 9,523 patients swabbed on admission to units (98.9%)
  - 234 had S. aureus infection at time of admission (excluded)
  - 4,128 had ICU stay less than 48 hours (excluded)
  - 5,161 had ICU stay > 48 hours
    - No colonization
    - 674 colonized with MRSA (13.1%)
    - 759 colonized with MSSA (14.7%)

Honda et al, ICHE 2010; 31(6);584-591

Is S. aureus colonization important in ICU patients?

Results of study:

- Patient characteristics
  - Median age of patients colonized with MRSA (63) were older than those colonized with MSSA (55) or not colonized with S. aureus (61)
  - MRSA colonized patients were more likely to have multiple co-morbidities and recent exposures to healthcare facilities
- S. aureus infections
  - 113 patients developed 128 S. aureus infections "during their ICU stay" (11 developed multiple infections) with median time to develop the infection was 7 days after ICU admission
    - 75 MRSA infections (64%)

Honda et al. ICHE June 2010

Is S. aureus colonization important in ICU patients?

Results of study: S. aureus infections in ICU study patients

- Types of infections
  - VAP 39 (30%)
  - CABSI 19 (15%)
  - Surgical site infection 11 (8%)
  - primary bloodstream infection, without central line 16 (12%)
- Of those colonized with
  - MRSA (674) → 37 (**5.5**%) developed infections (all MRSA)
  - MSSA (759) → 26 (3.4%) developed infections (18 MSSA, 8 MRSA**)
  - Not colonized with S. aureus (3,728) → 50 (1.3%) developed infections (20 MSSA, 30 MRSA)

Nasal colonization with MRSA at ICU admission was the strongest independent predictor for the development of S. aureus infection.

"These findings support the use of strategies such as decolonization of MRSA-colonized patients in the ICU to try to reduce subsequent development of S. aureus infections in the ICU"

Honda et al. ICHE June 2010

MRSA Decolonization: Mupiricin

- Bradley, CID Dec 2003 (Ann Arbor, Michigan)
- Mupiricin nasal ointment applied BID x 2 wks in ECF patients (double blind, placebo control)
- 127 patients enrolled
  - 64 Mupiricin →
    - 93% decolonized at day 15
    - 88% decolonized at day 30
    - 79% decolonized at day 60
    - 61% decolonized at day 90
  - 63 Placebo →
    - 15% decolonized at day 15
    - 13% decolonized at day 30
- Of 14 patients in the study group that became re-colonized with MRSA, 12 (86%) were due to the same strain, and 2 (14%) were due to new strains.

CHG Bathing ("Source Control")

- Vernon et al. Archives Internal Med 2006; 166:306-12
  - Decreased acquisition of VRE in Medical ICU
- Bleasdale et al. Archives Internal Med 2007; 167:2073-9
  - Decreased acquisition of CVL-BSI in Medical ICU where CHG daily bathing was used (crossover study between two units)

10/16/2011 73

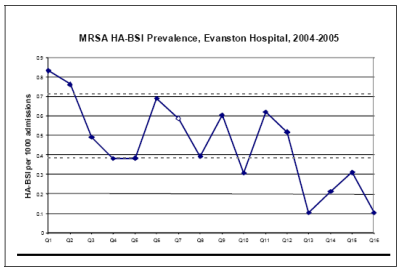
CHG bathing in all ICU patients: impact on other patients

CDC epicenters program – initially reported at SHEA 2007.

- Daily CHG bathing in all ICU patients – 6 month study period at 5 major healthcare centers)
  - Reduced acquisition of MRSA by 32%
  - Reduced acquisition of VRE by 50%
  - Reduced incident CVL-BSIs by 21%

10/16/2011 74

NorthShore U Health System: ASC and CHG/decolonization



10/16/2011 75

Chlorhexidine (CHG) bathing: Where's the evidence?

- ICHE: Oct 2007 Ridenour (Virginia Commonwealth, Wake Forest) ICU patients: CHG baths x 7 days + mupirocin BID x 5 days → **52% decline in MRSA colonization and infection**
- Ann Int Med: Mar 2008 Robicsek (Evanston, Northwestern) universal (all patients) surveillance with decolonization (CHG every other day x 5 days + mupirocin BID x 5 days) for MRSA + patients → **greater than 50% drop in MRSA infections**
- Crit Care Med: Oct 2009 Climo (4 major academic centers/6 ICUs): daily CHG baths (4 oz CHG in 6 qts water) → **52% decline in acquisition of VRE, 32% decline in MRSA**. Also saw associated decline in MRSA and VRE bacteremias
- ICHE: Oct 2009 Popovich (Rush/Stroger Hosp) ICU patients: CHG daily baths (impregnated cloths) → **BSI rate dropped 87%** from 5.31 to 0.69 / 1000 CVC days
- ICHE: Nov 2009 Munoz-Price (Rush/Stroger Hosp) LTAC patients: daily CHG baths (2% solution) → **BSI rate dropped 60%** from 9.5 to 3.8 (per 1000 CVC days)

10/16/2011 76

MRSA Decolonization Protocol for MRSA colonized patients (Aug 09)

- Daily CHG baths x at least 5 days
- CHG mouthwash daily
- Mupiricin 2% nasal ointment BID x 5 days
- Primary goal: Intended to reduce the incidence of MRSA infection in those colonized for a critical time period (remainder of hospitalization and for months afterward)
- Stretch goal: Hope to see some patients decolonized permanently – remove from long-term isolation lists

10/16/2011 77

Proposed protocol for MRSA screening/prophylaxis

CABG/CV surgery planned →

Hip/Knee/Spine surgery planned →

- All patients
  - Pre-op chlorhexidine (CHG) baths x 2
  - Pre-op mupiricin nasal ointment x 5 days
  - Add Pre-op testing for MRSA colonization →
- If MRSA swab + (or history of MRSA and in contact isolation) →
  - Add Vancomycin x 1 pre-op/prophylaxis (in addition to Cefazolin or Cefuroxime) to cover MRSA colonization

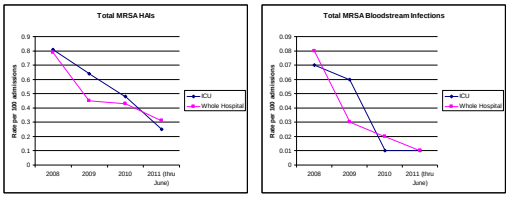
10/16/2011 78

Summary: MRSA Control Strategies

- **For patients without MRSA**
  - Prevent acquisition: hand hygiene! CHG baths (ICU/PCU +?)
  - Isolate those patients on unit known to be colonized with MRSA: Monitor isolation compliance and hand hygiene
- **For patients colonized with MRSA**
  - Prevent infection: good aseptic technique and attention to detail in handling devices; decolonization regimen
  - Prevent spread to others: hand hygiene, CHG baths
- **For patients undergoing surgical procedures**
  - Appropriate antibiotics pre-op
    - Consider Vancomycin if colonized with MRSA and undergoing major surgery with implants
  - Pre-op skin antisepsis: ChloraPrep; CHG baths/Mupiricin
  - Wound care, meticulous line care post-op

10/16/2011 79

Methodist Hospital Nosocomial MRSA Infection Rate/admissions 2008 - 2011



10/16/2011 80

Invasive MRSA among Dialysis Patients – U.S. 2005

- CDC Emerging Infections Program (EIP) using the Active Bacterial Core (ABC) population-based surveillance program
  - State of Connecticut + 23 counties in eight other states: MRSA infections from dialysis patients in 2005
- 5,287 cases of invasive MRSA infections reported during 2005
  - 813 (15.4%) occurred in dialysis patients
    - 70% of these in patients aged > 50 yrs
- Rate of invasive MRSA infection is higher than for any other known patient population and is 100 times higher than for the general population!
  - MMWR March 9, 2007 56(09);197-199

10/16/2011 81

Staphylococcus aureus colonization among HCWs

- **ICHE Dec, 2007 Johnston et al**.
  - **National estimates** 2001-2002 suggest that 32.4% of the general population is colonized with S. aureus, and only 0.8% of the population is colonized with MRSA
  - **HCW study**: 200 HCWs (MDs, nurses) followed for 6 months
    - Monthly nasal swabs, baseline and exit questionnaires describing risk factors
    - 58.5% never colonized with S. aureus
    - 13.5% were consistently colonized with S. aureus
    - 24% were found to be intermittently colonized with S. aureus
    - 4 HCWs colonized with MRSA at start of study, 4 HCWs acquired MRSA during the study. None were CA-MRSA and there were no MRSA infections in this group.
  - **Prevalence of MRSA among patients during the study**
    - Inpatient HIV was unit 33-37%
    - MICU was 21-28%

10/16/2011 82

How often do Asymptomatic HCWs cause MRSA outbreaks?

- ICHE Oct 2006, Vonberg et al.
- Aug 30, 2005 Medline and PubMed search (1966-2005): 191 outbreaks screened.
  - 11 studies provided strong evidence that a particular HCW had been the source of the nosocomial outbreak. In 8 studies, the strains of MRSA from the HCW and patients were indistiguishable.
    - In 8 of the 11 outbreaks, the implicated HCWs had an ACTIVE INFECTION due to MRSA (respiratory, or skin, particularly eczema).
    - In only 3 outbreaks (1.6%) was the implicated HCW asymptomatic

10/16/2011 83

VRSA: a perfect storm on the horizon?

- MRSA – first emerged in U.S. in the 1970s and by 1990s was endemic in most large urban medical centers
- VRE – first reported in a U.S. hospital in 1989 and has rapidly become a common cause of healthcare-associated infections
- 1992 Noble et al. demonstrated that conjugal transfer of the vanA gene (which mediates Vancomycin resistance) from VRE → MRSA on the skin surface of hairless mice could be achieved, creating Vancomycin-resistant S. aureus (VRSA)….

10/16/2011 84

VRSA: a perfect storm on the horizon?

- 1997 – first case of Vancomycin-intermediate S. aureus (VISA) reported (Japan)
- June 2002 – first clinical case of VanA-mediated VRSA infection reported (Michigan)
- Since then, six additional cases confirmed by CDC
  - 1 from Pennsylvania
  - 1 from New York
  - 5 from Michigan

VRSA: A perfect storm on the horizon?

- Infection Control:
  - Once VRSA was identified, contact precautions were reinforced, and enhanced measures were instituted:
    - Private room, dedicated staff and equipment
    - New gloves and gowns for each patient contact
    - Masks with eye protection if deemed necessary (during wound care)
    - Thorough cleaning and disinfection of all patient rooms and equipment after each use and after discharge from hospital.
- Lab results:
  - 5 of the isolates were USA 100, 1 was USA 800, and 1 not defined
  - All isolates were susceptible to > 5 antimicrobial agents approved by FDA for treating S. aureus infections
    - All susceptible to TMP-SMX and Linezolid
    - 6 of 7 susceptible to Daptomycin and Quinupristin-dalfopristin

VRSA: A perfect storm on the horizon?

The good news:

- No secondary transmission
- Occurred in patients with underlying medical conditions, not healthy individuals
- All 7 isolates remained susceptible to multiple antimicrobial agents
- VRSA should be readily identified by the lab

The bad news:

- These 7 isolates evolved through 3 distinct genetic mechanisms
  - S. aureus is continually seeking new pathways to Vancomycin resistance
- Co-colonization of patients with MRSA and VRE is common, making the possibility of further VRSA strains developing very likely.....

It looks clean, but is it really?

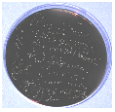



10/16/2011 88

Cleaning Practices Are Often Suboptimal

- Daily cleaning of surfaces near patients is often performed poorly
- Terminal cleaning of rooms after patient discharge is often inadequate
  - Carling et al. found that only 47% of surfaces targeted for terminal cleaning had been cleaned

Overbed Table Before Cleaning | Overbed Table After Cleaning



VRE on call button after cleaning

Carling PC et al. Clin Infect Dis 2006;42:385
Eckstein BC et al. BMC Infect Dis 2007;7:61

10/16/2011 89

Contaminated Surfaces Can Contribute to Transmission

- Patients admitted to a room formerly occupied by a patient with VRE or MRSA are at increased risk of acquiring the organism, suggesting that
  - terminal cleaning of rooms was inadequate
  - patients acquire the organism
    - directly from contaminated surfaces
    - from HCWs who contaminate their hands in the room

Martinez JA et al. Arch Intern Med 2003;163:1905
Huang SS et al. Arch Intern Med 2006;166:1945
Drees M et al. Clin Infect Dis 2008;46:678

10/16/2011 90

Does Increased Cleaning/Disinfection Help Reduce Transmission of Pathogens?

- **A number of studies have shown that improved cleaning and disinfection of environmental surfaces can reduce transmission of pathogens such as *C. difficile,* vancomycin-resistant enterococci (VRE), and methicillin-resistant *S. aureus* (MRSA)**

Kaatz GW et al. Am J Epidemiol 1988;127:1289
Mayfield JL et al. Clin Infect Dis 2000;31:995
Hayden MK et al. Clin Infect Dis 2006;42:1552
Boyce JM et al. Infect Control Hosp Epidemiol 2008;29:723
Dancer SJ et al. BMC Med 2009;7:28

Comparison of Cleaning Inspection Methods

Method	Advantages	Disadvantages
Visual inspection	Simple	Does not provide reliable assessment of cleanliness
Fluorescent marker system	Inexpensive Minimal equipment needed	Must mark surfaces before cleaning, and check them after cleaning
Aerobic colony counts	Relatively simple Detects presence of pathogens	More expensive Results not available for 48 hrs later
ATP bioluminescence assay systems	Provides quantitative measure of cleanliness Quick results	More expensive Requires special equipment New technology

ATP Bioluminescence Assay Systems

Step 1

Use special swab to sample surface

Step 2

Place swab in reaction tube

Step 3

Place tube in luminometer
Results: Relative Light Units

Monitoring Cleaning Practices

- **ATP bioluminescence methods have been used for years to monitor adequacy of cleaning procedures**
  - **in beverage and food processing industries**
- **Methods detect ATP from bacteria, human secretions, food**

Luciferase + D-Luciferin + O_2 + ATP ➡
Luciferase + oxy-luciferin + CO_2 + AMP + PP_i + **Light**

- **Amount of light is proportional to concentration of ATP present**

Griffith CL et al. J Hosp Infect 2000;45:19
Malik RE et al. Am J Infect Control 2003;31:181
Lewis T et al. J Hosp Infect 2008;69:156

10/16/2011 94

The Grading Project

- Team assembled to grade high touch surfaces in discharge clean rooms on three trial units
- Use of technology:
  - UV Pen- high touch surfaces marked with invisible ink pen and detected through UV light
    - Presence of marking after cleaning = dirty
  - ATP Device- surface is swabbed and device measures the amount of ATP (energy) that bacteria emits.
    - Any quantifiable number >30 = dirty
- High touch surfaces are graded using a combination of Pen/ATP.
  - Letter grade = Percentage of cleaned/total tested

10/16/2011 95

New Room Decontamination Methods 2011

- Adequacy of room cleaning and disinfection using chemical germicides, even post-intervention is 85% at best (focusing only on high-risk objects)…
  - Current IUHealth initiatives include
    - Infection Control practitioner embedded in the Environmental Services Dept x 6 months to assist in training/educating EVS personnel on the importance and implications of cleaning – patient safety
    - Immediate feedback (invisible markers, ATP pens, etc.) to improve cleaning techniques
    - Use of dilute bleach for all terminal cleans, daily cleaning on patients in isolation for C.difficile
- "No-touch" methods for room decontamination beginning to emerge
  - UV Irradiation
  - Hydrogen peroxide systems
  - Hydrogen peroxide/Peracetic acid system (Altapure)

10/16/2011 96

Ultraviolet Light Systems

Automated mobile UV light units that emit UV-C (254 nm range) can be placed in patient rooms after patient discharge and terminal cleaning had been performed

- Units can be set to kill vegetative bacteria or to kill spores
- Significantly reduce bacterial counts in patient rooms
- Easy to use and require relatively short cycle times

10/16/2011 97

Hydrogen Peroxide Vapor: HPV

- Ventilation ducts/doors must be taped shut
- HPV injected into empty room until defined dose delivered
- Catalytic converter converts HPV into oxygen & water vapor
- No toxic residuals
- Turn-around time for standard hospital room = ~ 2 hr 20 min
- Highly effective against Mtb, bacterial spores, fungi, viruses
- **Shown to reduce acquisition of *C. difficile* and VRE**

French GL et al. J Hosp Infect 2004;57:31
Boyce JM et al. Infect Control Hosp Epidemiol 200829:723
Otter JA et al. Infect Control Hosp Epidemiol 2009;30:574
Passaretti CL et al. 48th ICAAC, 2008, Abstr K-4214b

10/16/2011 98

Comparison of UV and HP

- UV
  - Faster decontamination (15 min)
    (longer times required for C.difficile ~50 min)
  - Room does not need to be sealed
  - No demonstrated clinical studies yet to demonstrate reduction in incidence of environmental pathogens
- HP
  - More effective at eliminating spore-forming bacteria, such as C. difficile
  - Demonstrated to reduce C.difficile incidence in a clinical study
  - Longer decontamination (3-5 hrs)
  - Room needs to be sealed

10/16/2011 99

Hydrogen Peroxide/Peracetic Acid

- **Altapure** system patented system – 15 month trial generously supported by a grant from the Methodist Health Foundation
- Produces a dense cloud of ultra-small/sub-micron aerosolized droplets of very dilute peroxides
  - **Deposited microfilm** comprised of 0.88% hydrogen peroxide and 0.18% peracetic acid
  - PAA + HP + H2O produces a residual of AA (faint vinegar smell)
- **Safety**: IUPUI environmental health formally asked to evaluate potential HCW exposures/air testing outside rooms
  - Air testing performed
  - EVS employee HP badges monitored
  - All levels significantly below the OSHA limits for HP and AA.
  - Additional recommendations provided to enhance protection of EVS workers and healthcare staff

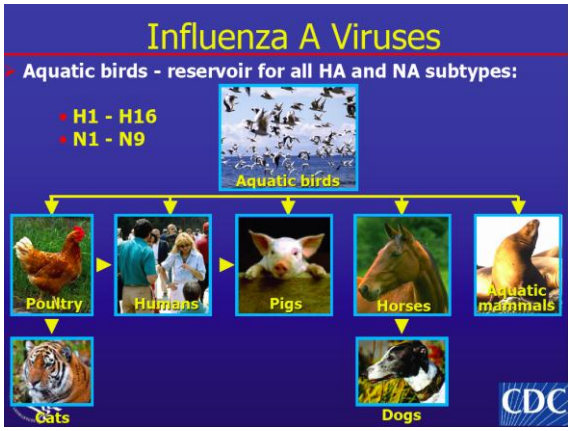
10/16/2011 100

10/16/2011 101

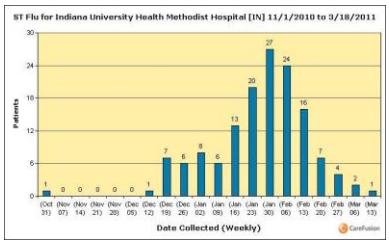
The Altapure HP/PAA intervention

- Potential advantage of Altapure HP/PAA system
  - Uses hydrogen peroxide (which has been demonstrated in clinical studies to reduce acquisition of C.difficile and VRE)
  - Shorter room turnaround than standard HP systems (45-90 minutes)
  - Unique submicron size particles containing HP/PAA likely allows better dissemination of active product
- How best to utilize this intervention?
  - Terminal cleaning of rooms on two adult ICUs at Methodist
    - Compare outcomes by nosocomial infection markers for
      - those patients housed in Altapure-cleaned rooms vs.
      - those patients not housed in Altapure-cleaned rooms
  - Targeted terminal cleaning of rooms occupied by patients with known C. difficile, MRSA, VRE or MDR-GNR infections (patients in contact isolation)
- Monitor safety/throughput issues

10/16/2011 102



Methodist Hospital Influenza 2010-2011



10/16/2011 104

Influenza Flu Bundle

- Vaccination to prevent!
- Stay home if you are ill!
- Cover your cough / respiratory etiquette
- Hand hygiene
- Isolation of suspected or confirmed influenza patients, consider antiviral medications
  - Mask patients as they enter healthcare facility
  - Private room, door closed
  - Surgical mask, standard precautions
  - N-95 for aerosol-generating procedures

10/16/2011 105

Patients at increased risk of complications from influenza

- Children younger than 5 yrs old
- Adults 65 yrs of age or older
- Persons with the following conditions
  - Chronic pulmonary, cardiovascular, renal, hepatic, hematologic, neurologic, neuromuscular, or metabolic disorders
  - Immunosuppression, including that caused by medication or HIV
  - Pregnant women
  - Persons younger than 19 yrs old who are receiving long-term aspirin therapy
  - Residents of nursing homes/chronic care facilities

Vaccine-Preventable Cases and Deaths in U.S. 1989 - 1998

Disease	Cases	Deaths
– Influenza	(millions)	~500,000
– Pneumococcal diseases	(millions)	~120,000
– Hepatitis A	282,650	1,013
– Hepatitis B	146,644	9,694
– Measles	60,189	132
– Mumps	24,075	7
– Rubella	4,412	21
– Pertussis	53,634	65
– Tetanus	486	77

- CDC. MMWR. 2006;55;511-515.
- Thompson W et al. JAMA. 2003;289:179-186
- Felkin D et al. Am J Public Health. 2000;90:223-229.

The Health Consequences of Influenza

- **Disease burden** due to influenza

  Each year, 5-20% of the US population becomes ill
  - Approx 200,000 hospitalizations in US yearly
- **Mortality** due to influenza
  - Approx 24-36,000 deaths in US yearly
    - Highest in adults > 65 and children < 2 yrs old and in those of any age who have medical conditions that put them at increased risk for complications.
  - Approx 500,000 deaths worldwide yearly
- **Healthcare expenditures** yearly due to influenza
  - $87 billion/$10 billion in direct medical costs (2003 estimates)
    - Work absenteeism, loss of productivity, and premature mortality
    - **Presentism** likely accounts for a significant proportion of this cost.

From Prevention and Control of Influenza with Vaccines; Recommendations of the ACIP 2010 CDC

Impact of Influenza Vaccine Strategies

Intervention/Study	Intervention Rate Pre %	Post %
• Declination		
– Polgreen et al	54	65
– Bertin et al	38	55
– Ribner et al	43	65
• Mandatory vaccination		
– **Virginia Mason Medical Center**	**30**	**98**
– **BJC Healthcare**	**71**	**99**
• Education/Promotion		
– Harbath et al	13	37
– Thomas et al	8	46
• Mobile Cart		
– Sartor et al	7	32
– Cooper et al	8	49
• Incentives (raffle)	38	42
• Educational letter from leadership	38	39
• On-site expert education	21	22

Those Implementing Mandatory Influenza Vaccination for HCWs

- Virginia Mason Medical Center
- Johns Hopkins Health System
- BJC Healthcare System
- Medstar Health System
- Hospital Corporation of America (HCA)
- Children's Hospital of Philadelphia
- University of Iowa Health System

Those Endorsing Mandatory Influenza Vaccines for HCWs

- National Patient Safety Foundation
- American Academy of Pediatrics
- American College of Physicians
- Infectious Disease Society of America
- Society for Healthcare Epidemiology of America
- Association for Practitioners in Infection Control
- American Hospital Association
- Department of Defense

Arguments in Favor of Mandatory Vaccination for HCWs

- Influenza is a serious disease
- HCWs transmit influenza to high-risk patients
- Vaccination saves money, prevents workplace disruption
- Vaccination is recommended by the CDC as a standard of care
- Education has had only a modest effect
- Requirements increase vaccination rates
- HCWs have a ethical and moral duty to protect their patients
- Joint Commission's proposed standard of hitting 90% HCW influenza vaccination rate
- CMS proposed plan to include HCW influenza vaccination rate in Value-Based Purchase Plan for 2015.

Inactivated Influenza Vaccine Efficacy

- 70-90% effective among healthy persons younger than 65 yrs of age
- 30-40% effective among frail elderly persons

- 50-60% effective in preventing hospitalization
- 80% effective in preventing death

  - ACIP/CDC/MMWR 2010;59(RR-8):1-68

Efficacy of Influenza Vaccine in HCWs

Condition in healthcare workers	Reduction documented
• Influenza infection	88%
• Sick days due to respiratory infection	28%
• Days lost from work	41%

Effect on patient population (cared for by healthcare workers)

• Patient mortality (Potter)	41%
• Patient mortality (Carman)	39%

– Talbot, ICHE 2005; Ferry, JID 1979; Saxen, PIDJ 1999; Wilde, JAMA 1999; Carmen, Lancet 2000; Potter, JID 1997

Inactivated Influenza Vaccine Adverse Reactions

• Local reactions	15-20% (mostly mild)
• Fever, malaise	not common
• Allergic reactions	rare
• Guillain-Barre syndrome	1 in 1,000,000 may be at risk
• Inactivated (TIV)	NEVER causes flu

• ACIP/CDC/MMWR 2010;59(RR-8):1-68

10/16/2011 115

Influenza in Healthcare Settings

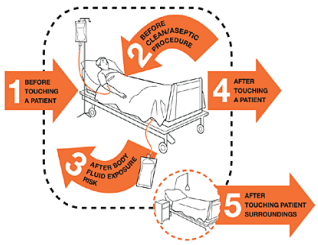
- ~25% of HCWs have serologic evidence of Influenza each year
  - ~50% of HCWs who have influenza infections are asymptomatic or have only minor symptoms
  - Both symptomatic and asymptomatic HCWs can transmit influenza
- Infected persons can shed virus 1 day before symptoms appear
- Nosocomial outbreaks lead to morbidity for patients and staff as well as increased costs for the institution
  - Attack rates of up to 54% reported
  - Mortality in NICUs up to 25%
  - HCW is the primary vector
- Vectors for transmission include staff, visitors, and patients
- Observational studies in healthcare settings indicate that direct and indirect contact and droplet transmission are primary means of spread

» Maltezou Scan Infect Dis 2010 online 1-9; Stott, Occup Med 2002; Talbot, ICHE 2005; Elder, BMJ 1996; Lester, ICHE 2003

10/16/2011 116

Expanding Hand Hygiene "Beyond the Door"…

WHO 5 Moments for Hand Hygiene



10/16/2011 117

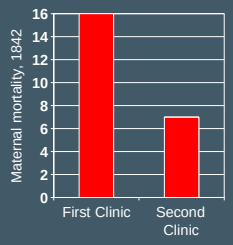
The 1847 Intervention:
Hand scrub with chlorinated lime solution

Hand hygiene basin at the Lying-In Women's Hospital in Vienna, 1847.

10/16/2011 118

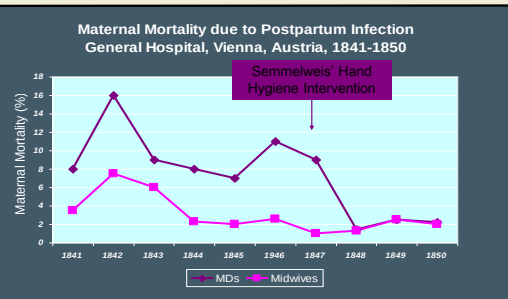
Ignaz Semmelweis, 1815-1865

- 1840's: General Hospital of Vienna
- Divided into two clinics, alternating admissions every 24 hours:
  - First Clinic: Doctors and medical students
  - Second Clinic: Midwives



10/16/2011 119

Hand Hygiene: Not a New Concept



– Hand antisepsis reduces the frequency of patient infections –

Adapted from: *Hosp Epidemiol Infect Control,* 2nd Edition, 1999.

10/16/2011 120

What are the "real" roots of hand hygiene and infection control?

- Ancient Egypt in 1500 B.C. was the most advanced society on earth. (Papyrus Ebers – an Egyptian manuscript translated in S.E. Massengill's: A Sketch of Medicine and Pharmacy)
  - Despite the advanced knowledge in engineering, **medical knowledge** was lacking and actually dangerous…
    - Infected splinter: apply ointment of the blood of worms mixed with dung of a donkey…
    - Hair loss: apply a solution composed of various fats from a horse, a crocodile, a cat, a snake, and a donkey's tooth crushed in honey…
    - Poisonous snake bite: "magical water" poured over an idol…
    - Constipation: zizyphus, gurma, cat's dung, sweet beer, wine…
    - Excessive crying baby: spn seeds mixed with fly dung from the wall made into a paste, strained, and drunk for 4 days…

What are the "real" roots of hand hygiene and infection control?

- The Jewish historian Flavius Josephus tells us (in his "Antiquities of the Jews") that Moses, prince of Egypt, was taught all that Egypt, the most advanced culture of the day, had to offer – including these medical remedies.
- However, in Exodus 15:26, Moses writes: "If you diligently heed the voice of the Lord you God and do what is right in His sight, give ear to His commandments and keep all His statutes, I will put none of the diseases on you which I have brought on the Egyptians. For I am the Lord who heals you."
  - Recorded by Moses 1491-1451 B.C.
- Of 613 Biblical commands found in the Torah, 213 were detailed medical or sanitation regulations!

What are the "real" roots of hand hygiene and infection control?

- FACT: The existence of germs and their methods of transmission were not known until the late 1800s, yet….
  - Leviticus 15:13, recommends the use of "**running water**" when dealing with those afflicted with infectious diseases
  - Leviticus 13:43, recommends the use of **quarantine** for management of leprosy or plague
  - Numbers 19:20, recommends the use of "water of **purification**" before returning to camp after being "unclean"
    - "water of purification" actually contained **antiseptic agents**: hyssop oil, carvacrol, which are actually effective antibacterial and antifungal compound, still used today……

What are the "real" roots of hand hygiene and infection control?

- Medical science did not know of the existence of germs and their methods of transmission until the late 1800s, yet....
  - Leviticus 4:11 recommends the use of **incineration** (outside of camp) to dispose of germ-filled waste of sacrificed animals
  - Deuteronomy 23:12 recommends the use of basic **sanitation** to bury human excrement/use of latrines
  - Leviticus 14:8, recommends the use of **isolation** – staying outside of his tent and camp for seven days after bathing, shaving all the hair off his head, beard, and eyebrows, and washing his clothes

- **Answer: the real roots of infection control are actually from the Bible!**

10/16/2011 124

Questions?

10/16/2011 125

10/16/2011 126