**Principle of occupational health on infectious diseases**

- Health care personnel (HCP) at risk of acquiring infection through occupational exposure
- HCP also transmit infections to patients and other HCP
- Occupational health program in place to prevent and manage infections in HCP

Practical guidelines for infection control in health care facilities, WHO 2004

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**HCPs & ID risk by contact**

- Direct skin contact
  - Scabies, lice
  - *M. furfur*, dermatophyte
- Blood-borne pathogen
  - HIV, HBV, HCV
  - Ebola virus

**HCPs & ID risk by droplets**

- Respiratory: influenza, rhinovirus, diphtheria, pertussis
- Systemic: meningococcemia, rubella, CMV, parvovirus B19
- Misc: conjunctivitis, mumps, hand-foot-mouth disease (HFMD)
HCPs & ID risk by airborne

• Active tuberculosis in respiratory tract
• Varicella-zoster
• Measles

Infectious diseases harm among HCPs with pregnancy

• Increased maternal severity
  – Varicella
  – Hepatitis E
• Intrauterine fetal infection
  – Varicella
  – Rubella
  – Cytomegalovirus
  – Parvovirus B19

Infectious diseases harm among HCPs with pregnancy

• Initiate premature labor
  – Any IDs with associated febrile episode
• Teratogenic effect associated with antimicrobial agents
  – Ribavirin aerosolized in RSV
  – Pentamidine aerosolized in PCP

<table>
<thead>
<tr>
<th>Category</th>
<th>Attack rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influenza</td>
<td>45-60</td>
</tr>
<tr>
<td>RSV</td>
<td>42-56</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>20-50</td>
</tr>
<tr>
<td>Pertussis</td>
<td>43</td>
</tr>
<tr>
<td>Varicella</td>
<td>4.4-14.5</td>
</tr>
<tr>
<td>Rubella</td>
<td>13</td>
</tr>
</tbody>
</table>

Schwartzman: Can Med Assoc J, 1999;161;1271-7
### How contagious?

<table>
<thead>
<tr>
<th>Type of EID, RID</th>
<th>Reproduction rate (1: no of infected pt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measles</td>
<td>12-18</td>
</tr>
<tr>
<td>Pertussis</td>
<td>12-17</td>
</tr>
<tr>
<td>Diphtheria</td>
<td>6-7</td>
</tr>
<tr>
<td>Polio</td>
<td>5-7</td>
</tr>
<tr>
<td>Mumps</td>
<td>4-7</td>
</tr>
<tr>
<td>HIV</td>
<td>1-4</td>
</tr>
<tr>
<td>Ebola</td>
<td>1-4</td>
</tr>
</tbody>
</table>

### EID & transmission characteristics

<table>
<thead>
<tr>
<th>Type of Diseases &amp; Categories</th>
<th>Avian influenza A(H7N9) virus</th>
<th>Middle East Respiratory Syndrome Coronavirus (MERS-CoV)</th>
<th>Avian influenza A(H5N1) virus</th>
<th>SARS-CoV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human-to-human transmission</td>
<td>Some small clusters, No evidence of sustained spread</td>
<td>Several clusters (closed contact), but no evidence of widespread</td>
<td>Some small clusters, No evidence of sustained spread</td>
<td>Several hospital clusters and outbreaks, definite evidence of widespread</td>
</tr>
<tr>
<td>Hospital Outbreaks</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**WHO Global Alert & Response**

- Middle East respiratory syndrome coronavirus (MERS-CoV) – update 30 Aug 2013
- Human infection with avian influenza A(H7N9) virus – update 11 Aug 2013
- WHO/GIP, data in HQ as of 29 Aug 2013
**EID & mortalities**

<table>
<thead>
<tr>
<th>Categories</th>
<th>Ebola</th>
<th>H7N9</th>
<th>MERS-CoV</th>
<th>H5N1</th>
<th>SARS-CoV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab-confirmed cases</td>
<td>20,206</td>
<td>453</td>
<td>971</td>
<td>694</td>
<td>8,096 (probable)</td>
</tr>
<tr>
<td>Case Fatality Rate, no(%)</td>
<td>7,905 (39.1%)</td>
<td>175 (38.6%)</td>
<td>356 (36.6%)</td>
<td>402 (57.9%)</td>
<td>774 (9.6%)</td>
</tr>
</tbody>
</table>

**Topics**

- Infection control (IC) & patient safety
- Health-care associated infections (HAIs) & impacts on patient safety
- Impacts of IC on patient safety
- Conclusions

**The rationale of IC & patient safety**

- Health-care-associated infections (HAIs) affect millions of patients worldwide
- At least 50% are preventable with IC
- Improvements in patient safety associated with a comprehensive IC
- The goal of IC is to eliminate HAIs
- Effective IC programs reduce HAI rates and are also cost-effective
**Topics**

- Infection control (IC) & patient safety
- Health-care associated infections (HAIs) & impacts on patient safety
- Impacts of IC on patient safety
- Conclusions

### Health-care associated infections & impacts in different parts of the World

<table>
<thead>
<tr>
<th></th>
<th>Total population (millions)</th>
<th>HAIs (no/yr)</th>
<th>Mortality (no/yr)</th>
<th>Extra LOS (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU</td>
<td>500</td>
<td>4,500,000</td>
<td>37,000</td>
<td>16,000,000 (pt-days)</td>
</tr>
<tr>
<td>USA</td>
<td>200</td>
<td>1,700,000</td>
<td>98,000</td>
<td>10.4-13.1</td>
</tr>
<tr>
<td>Thailand</td>
<td>65</td>
<td>380,000</td>
<td>37,000</td>
<td>10-12.5</td>
</tr>
</tbody>
</table>


### IC Factors associated with NI reduction

*Haley AW, et al. Am J Epid 1985;121(2);182-205*

- US general hospitals in 1970-76
- Infection surveillance and control strongly associated with 32% reductions in rates of UTI, RTI, SSI & BSI
- Essential components included
  - Organized surveillance system
  - Infection control activities
  - a trained, infection control physician or an infection control nurse per 250 beds
  - SSI Feedback system to practicing surgeons
Key EU IC components 2015

- Organisation at the hospital level
- Bed occupancy, workload & staffing
- Access to materials, equipment and optimum ergonomics
- Appropriate use of guidelines
- Education and training


Key EU IC components 2015

- Auditing
- Surveillance and feedback
- Multimodal and multidisciplinary prevention programmes that include behavioural change
- Engagement of champions
- Positive organisational culture


IC Strategy Guidelines 2014

Sponsored by
- The Society for Healthcare Epidemiology of America (SHEA)
- The Infectious Diseases Society of America (IDSA)
- The American Hospital Association (AHA)
- The Association for Professionals in Infection Control and Epidemiology (APIC)
- The Joint Commission International (JCI)

A Compendium of Strategies to Prevent Healthcare-Associated Infections in Acute Care Hospitals: 2014 Updates

Deborah S. Yolken MD, MPH, DPhil; Deverick J. Anderson MD, MPH; Sean M. Berenholtz MD, MPH; David P. Callery MD, MS; Erik L. Dubberke MD, MPH; Katherine D. Ellerberg MD, PhD; Dale N. Gerding MD; Janet F. Haas PhD, RN, CIC; Keith S. Kaye MD, MPH; Michael Klompas MD, MPH; Evelyn Lo MD; Jonas Marshall MD, DDS; Leonard A. Mermel DO, ScM; Lindsey E. Nicolle MD; Cassandra D. Saagman MD, MS; Kristina Bryant MD; David Classen MD, MS; Katrina Crist MBA; Valerie M. Deloney MBA; Neil O. Fishman MD; Nancy Foster; Donald A. Goldmann MD; Eve Humphrey MBA, CAE; John A. Jernigan MD, MS; Jennifer Paulberg MPH; Trish M. Perl MD, MSc; Kelly Podgorsky DNP, MS, RN; Edward J. Septimus MD; Margaret VanAuringe MS; Tim Weaver DMD; Robert A. Weinstein MD; Robert Wise MD; Lisa M. Maragakis MD, MPH.
IC Strategy Guidelines 2014

- Hand hygiene
- Central line-associated blood stream infection (CLABSI)
- Ventilator-associated pneumonia (VAP)
- Surgical site infection (SSI)
- Catheter-associated urinary tract infection (CAUTI)

Strategies to prevent HAIs through hand hygiene

1. Basic practices for hand hygiene: recommended for all acute care hospitals
   1. Select appropriate products (quality of evidence: II).
2. Provide convenient access to hand hygiene equipment and products by placing them strategically and assuring that they are refilled routinely as often as required (quality of evidence: III).
4. Perform hand hygiene with an alcohol-based hand rub or, alternatively, an antimicrobial or nonantimicrobial soap for the following indications (quality of evidence: II).
5. Perform hand hygiene with antimicrobial or nonantimicrobial soap when hands are visibly soiled (quality of evidence: II).
6. Assess unit- or institution-specific barriers to hand hygiene with frontline HCP for the purpose of identifying interventions that will be locally relevant (quality of evidence: III).

Health-care associated infections & impacts of specific IC interventions

<table>
<thead>
<tr>
<th>Category</th>
<th>Type of intervention &amp; outcome</th>
<th>Pre-intervention</th>
<th>Post-intervention</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand hygiene</td>
<td>Alcohol HR &amp; NI rate</td>
<td>16.9</td>
<td>9.9</td>
<td>%</td>
</tr>
<tr>
<td>Isolation &amp; precaution</td>
<td>Gown/gloves &amp; VRE</td>
<td>19.6</td>
<td>9.1</td>
<td>per 1,000 ICU-days</td>
</tr>
<tr>
<td>Surveillance</td>
<td>VRE culture &amp; acquisition</td>
<td>2-27</td>
<td>1-10</td>
<td>%</td>
</tr>
</tbody>
</table>

Pazianik L, Clin Infect Dis 2002;35:18
Huang SS, J Infect Dis 2007;195:339
**How many ICNs needed in a hospital?**

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>1 ICN: beds</th>
<th>1 ICP: admission</th>
<th>1 Micro: beds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haley RW</td>
<td>1985</td>
<td>250</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>O’Boyle</td>
<td>2002</td>
<td>100-125</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Morrison J</td>
<td>2004</td>
<td>167</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Van de Broek</td>
<td>2007</td>
<td>178</td>
<td>5,000</td>
<td>806</td>
</tr>
<tr>
<td>Weiss</td>
<td>2009</td>
<td>100</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

**“CLABSI bundles”**

- Multifaceted CLABSI interventions
- Effective to decrease CLABSI rates
- Most likely to be successful in established patient safety culture
- Success rates depend on adherence

**CLABSI “CLABSI”**

- Chlorhexidine skin preparation
- Learning: Training for HCP
- Assessment daily of indication
- Barrier: maximum & sterile
- Scrub the hub, aseptic technic
- Inspection of cath site: q shift

**VAP “WHAP”**

- Weaning protocol
- Head of bed elevation
- Antiseptic oral care
- Personnel education/hand hygiene
**CAUTI “CAUTI”**

- Closed drainage system
- Aseptic technique
- Uroflow maintenance
- Training & hand hygiene
- Indication assessment OD

---

### Health-care associated infections & impacts of IC bundle interventions

<table>
<thead>
<tr>
<th>Category</th>
<th>Outcome measurement</th>
<th>Pre-intervention</th>
<th>Post-intervention</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAP</td>
<td>VAP rate</td>
<td>16.9</td>
<td>9.9</td>
<td>per 1,000 vent-days</td>
</tr>
<tr>
<td>CLABSI</td>
<td>CLABSI rate</td>
<td>14.0</td>
<td>1.4</td>
<td>per 1,000 cath-days</td>
</tr>
<tr>
<td>CAUTI</td>
<td>CAUTI rate</td>
<td>13.3</td>
<td>4.0</td>
<td>per 1,000 cath-days</td>
</tr>
</tbody>
</table>

**Pros Cons**

- **Effective, some settings reducing and maintaining their infection rates at zero**
- Zero CLABSI rates uncommon across bundle studies with poor to fair quality of evidence

- **Relatively inexpensive**
- Significant time and resources at the outset of the intervention

- **In Australian ICU study, bundle cost-effective if implementation costs over 18 mo below $24,880 per ICU**
- Nontrivial costs of monitoring and the education activities required to implement a bundle

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"Antimicrobial catheters": Pros & Cons

<table>
<thead>
<tr>
<th>Pro</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced CRBSI, (ARR 2%, 95% CI 3-1, RR 0.61, 95% CI 0.51-0.73, NNTB 50)</td>
<td>No different rates of clinical sepsis (RR 1.0 (95% CI 0.88 to 1.13)) &amp; all-cause mortality (RR 0.88 (95% CI 0.75 to 1.05))</td>
</tr>
<tr>
<td>Reduced CL colonization (ARR 10%, 95% CI 13-7%), RR 0.66, 95% CI 0.58-0.75, NNTB 10)</td>
<td>Risk of potential side-effects including anaphylaxis, etc.</td>
</tr>
<tr>
<td>No significant different rates of adverse effects, based on systematic review</td>
<td>Relatively expensive</td>
</tr>
</tbody>
</table>


A decade of investment in infection prevention: A cost-effectiveness analysis

<table>
<thead>
<tr>
<th>Category</th>
<th>Gain per ICU (CLABSI)</th>
<th>Gain per ICU (VAP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life-years (LYs)</td>
<td>15.55</td>
<td>9.61</td>
</tr>
<tr>
<td>Quality-adjusted LYs (QALYs)</td>
<td>10.84</td>
<td>6.55</td>
</tr>
<tr>
<td>Reductions in index admission ICU costs</td>
<td>$174,713.09</td>
<td>$163,090.54</td>
</tr>
<tr>
<td>Incremental cost-effectiveness ratios (ICERs)</td>
<td>$14,250.74 per LY</td>
<td>$23,277.86 per QALY</td>
</tr>
</tbody>
</table>


Conclusions

- Significant HAIs impacts on patient safety
- Significant proportions of HAIs preventable
- Significant effects & cost effectiveness of IC esp., multimodal approach, bundles on HAIs