The Modern Approach to Infection Control

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Lead, 1st Global Patient Safety Challenge,
World Health Organization (WHO) Patient Safety

Florence Nightingale, 1820 - 1907
from Notes on Hospitals published in 1863

The very first requirement in a hospital is that it should do the sick no harm

Ignaz Philipp Semmelweis
Maternal mortality rates, First and Second Obstetric Clinics, GENERAL HOSPITAL OF VIENNA, 1841-1850

Maternal mortality rates, First and Second Obstetric Clinics, GENERAL HOSPITAL OF VIENNA, 1841-1850

Semmelweis IP, 1861

Early times of infection control

1847
1863

Infection Control and Quality Healthcare in the New Millennium
Are there lessons to be learned?

Does infection control control infections?

Recognize Explain Act
**SENIC study**

Study on the Efficacy of Nosocomial Infection Control


<table>
<thead>
<tr>
<th>Relative change in NI in a 5 year period (1970-1975)</th>
<th>Without infection control</th>
<th>With infection control</th>
</tr>
</thead>
<tbody>
<tr>
<td>LRTI</td>
<td>-27%</td>
<td>9%</td>
</tr>
<tr>
<td>SSI</td>
<td>-35%</td>
<td>14%</td>
</tr>
<tr>
<td>UTI</td>
<td>-31%</td>
<td>19%</td>
</tr>
<tr>
<td>BSI</td>
<td>-35%</td>
<td>26%</td>
</tr>
<tr>
<td>Total</td>
<td>-32%</td>
<td>18%</td>
</tr>
</tbody>
</table>

Relative change in NI: 50%

**SENIC**

Study on the Efficacy of Nosocomial Infection Control

- 1 infection control nurse per 200 to 250 beds per 110 beds
- 1 hospital epidemiologist per hospital (1000 beds)
- Organized surveillance for nosocomial infections
- Feedback of nosocomial infection rates


**Approach to infection control**

1847
1863
1958
1970
1980

Pittel D, Am J Infect Control 2005, 33:258

**1st principle of infection prevention**

At least 35-50% of all healthcare-associated infections are associated with only 5 patient care practices:

- Use and care of urinary catheters
- Use and care of vascular access lines
- Therapy and support of pulmonary functions
- Surveillance of surgical procedures
- Hand hygiene and standard precautions

**Healthcare-Associated Urinary Tract Infection**

- Urinary tract infection (UTI) causes ~40% of hospital-acquired infections
- Most infections due to urinary catheters
- 25% of inpatients are catheterized
- Leads to increased morbidity and costs

Prevention of Catheter-Associated Urinary Tract Infection (CA-UTI)

Two main principles

- Avoid unnecessary catheterization
- Limit the duration of catheterization

Indications for the use of indwelling urethral catheters

- **Indications**
  - Perioperative 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

- Urinary incontinence is **not** an accepted indication for urinary catheterization
  - 21 to 50 percent of urinary catheters not indicated

Is one catheter better than another?

- No significant difference between latex and silicone catheters
- What about coated / impregnated catheters?
- The concept: prevention of biofilm formation

Antimicrobial-coated urinary catheters

<table>
<thead>
<tr>
<th>Study, Year (Reference)</th>
<th>Study Design</th>
<th>No. Group</th>
<th>Catheter Type</th>
<th>Urine Cult. (%)</th>
<th>Time Period</th>
<th>Proportion Developing Bacteriuria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nishimura et al. (2007)</td>
<td>Randomized trial</td>
<td>350</td>
<td>Coated silicone</td>
<td>6.3</td>
<td>2006-2007</td>
<td>0.52 vs 0.42 (NS)</td>
</tr>
<tr>
<td>Lo et al. (2008)</td>
<td>Randomized trial</td>
<td>40</td>
<td>Coated silicone</td>
<td>25</td>
<td>2003-2004</td>
<td>0.05 vs 0.05 (NS)</td>
</tr>
<tr>
<td>Morgan et al. (2009)</td>
<td>Randomized trial</td>
<td>18</td>
<td>Coated silicone</td>
<td>18</td>
<td>2009-2010</td>
<td>0.05 vs 0.05 (NS)</td>
</tr>
</tbody>
</table>

EM pictures of biofilms on silver coated catheters

Antimicrobial-coated urinary catheters are not recommended by any of the guidelines (insufficient evidence, costs ++)

Some effect, but studies mostly of poor quality

Useful in high-risk groups?

Catheter insertion and maintenance

- Practice hand hygiene (A-III)
  - Before insertion of the catheter
  - Before and after any manipulation of the catheter site

Your 5 moments for **HAND HYGIENE**

- Before touching the catheter
- During catheter insertion
- After touching the catheter
- Between touching different parts
- After removing the catheter

http://www.who.int/gpsc/tools/en/
### Catheter Insertion and Maintenance

- Insert catheters by use of aseptic technique and sterile equipment (A-III)
- Cleanse the meatal area with antiseptic solutions is unnecessary (A-I) - routine hygiene is appropriate
- Properly secure indwelling catheters after insertion to prevent movement and urethral traction (A-III)
- Maintain a sterile, continuously closed drainage system (A-I)
- Do not disconnect the catheter and drainage tube unless the catheter must be irrigated (A-I)


### What You Should Not Do to Prevent CAUTI

- Do not use (avoid) catheter irrigation (A-I)
- Do not use systemic antimicrobials routinely as prophylaxis (A-II)
- Do not change catheters routinely (A-III)


### Incidence of UTI, Before and After a Multimodal Intervention


<table>
<thead>
<tr>
<th>UTI</th>
<th>Pre-intervention period (n=280)</th>
<th>Post-intervention period (n=259)</th>
<th>RR (95%-CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N  ID*</td>
<td>N  ID*</td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>39  27.0</td>
<td>17  12.0</td>
<td>0.44 (0.24-0.81)</td>
</tr>
<tr>
<td>Orthopedic surgery</td>
<td>34  45.8</td>
<td>10  18.6</td>
<td>0.41 (0.20-0.79)</td>
</tr>
<tr>
<td>Digestive surgery</td>
<td>6  9.0</td>
<td>3  5.6</td>
<td>0.62 (0.14-2.50)</td>
</tr>
</tbody>
</table>

* ID: episodes per 1000 catheter-days

1st Principle of Infection Prevention


- Incidence density of UTI decreased by 60% after orthopedic surgery following a multimodal intervention
- Results were maintained after 2 years
- Less indwelling urinary catheters placed in the operating room
- Decrease UTI antibiotic-related consumption

1st principle of infection prevention

at least 35-50% of all healthcare-associated infections are associated with only 5 patient care practices:

- Use and care of urinary catheters
- Use and care of vascular access lines
- Therapy and support of pulmonary functions
- Experience with surgical procedures
- Hand hygiene and standard precautions
Sources of the catheter-associated bloodstream infection

- Intraluminal from tubes and hubs
- Hematogenous from distant sites
- Extraluminal from skin

Reported incidence rates of catheter-associated bloodstream infections in surveillance networks in ICUs:

- NHSN: 2.7 per 1000 catheter-days (1.5/1’000 – 6.8/1’000) National Healthcare Safety Network
- Michigan: 2.7 per 1000 catheter-days (median before intervention)
- Germany: 2.1 per 1000 catheter-days

18 developing countries: 8.9 per 1000 catheter-days International Nosocomial Infection Control Consortium (INICC) 2002-2007

Prevention of vascular access line infection in intensive care

Eggimann and Pittet Sepsis Monitor 2000

Education-based, multimodal prevention strategy of CRI


Prevention of vascular access line infection Medical intensive care unit

Incidence density episodes/1’000 patient-days

- 11.3 1996
- 8.2 1997

- 3.1 1996
- 3.8* -67% primary BSI
- 3.3* -68% clinical sepsis
- 2.6* -63% microbiologically doc. BSI
- 1.2* -64% insertion site infection

* P < 0.05


Education-based prevention of vascular catheter-associated bloodstream infection

Primary bacteremia / 1000 CVC-days

- 112 MICUs (NNIS)
- 146 SICUs (NNIS)

Average rate is not necessarily the best you can get

Sherrert Ann Intern Med 2000

Coopersmith et al. CCM 2002

Warren et al. CCM 2003

Eggimann et al. Lancet 2000


NNIS Am J Infect Control 1999
**Multimodal intervention strategies to reduce catheter-associated bloodstream infections:**

- Hand hygiene
- Maximal sterile barrier precaution at insertion
- Skin antisepsis with alcohol-based chlorhexidine-containing products
- Subclavian access as the preferred insertion site
- Daily review of line necessity
- Standardized catheter care using a non-touch technique
- Respecting the recommendations for dressing change

Eggimann P. Lancet 2000; 35: 290
Eggimann P. Ann Intern Med 2005

**Efficacy of multimodal intervention strategies:**

<table>
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<th>Baseline</th>
<th>Intervention</th>
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<tr>
<td>Eggimann 3.1/1000 catheter-days</td>
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<tr>
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<td>1.4/1000 catheter-days</td>
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<td>Zingg 3.1/1000 catheter-days</td>
<td>1.1/1000 catheter-days</td>
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*mean pooled CRBSI-episodes per 1’000 catheter-days

**Could we do better?**

Chlorhexidine gluconate-impregnated sponges

**Chlorhexidine-Impregnated Sponges and Less Frequent Dressing Changes for Prevention of Catheter-Related Infections in Critically Ill Adults**

Multi-centre randomized controlled trial

- 3'778 catheters
- 28'931 catheter-days
- Baseline rate of major catheter-related infections: 1.4/1000 catheter-days!

Timsit JF. JAMA 2009; 301: 1231

**Efficacy of multimodal intervention strategies:**

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Prevention of vascular access line infection

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Risk factors for Ventilator-Associated Pneumonia (VAP)

**Patient**
- Age
- Burns
- Coma
- Lung disease
- Immunosuppression
- Malnutrition
- Blunt trauma

**Devices**
- Invasive ventilation
- Duration of invasive ventilation
- Reintubation
- Medication
- Prior antibiotic treatment
- Sedation

Risk factors for VAP

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- Medication
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**General precautions**

- Staff education, hand hygiene, isolation precautions (I)
- Surveillance of infection and resistance with timely feedback (II)
- Adequate staffing levels (II)

Effect of staffing level in late onset VAP

Intubation and ventilation

- Avoid intubation and reintubation - I
- Prefer non-invasive ventilation - I
- Prefer orotracheal intubation & orogastric tubes - II
- Continous subglottic aspiration - I
- Cuff pressure > 20 cm H2O - II
- Avoid entering of contaminate condensate into tube/nebulizer - II
- Use sedation and weaning protocols to reduce duration – II
- Use daily interruption of sedation and avoid paralytic agents - II

Is there a role for oral antiseptics?

Oral decontamination

Chlorhexidine

VAP

<table>
<thead>
<tr>
<th></th>
<th>0.45 (0.16; 1.44)</th>
<th>0.20 (0.10; 1.10)</th>
<th>1.90 (0.22; 1.71)</th>
<th>3.90 (0.18; 1.44)</th>
<th>1.17 (0.71; 1.61)</th>
<th>0.30 (0.10; 1.10)</th>
<th>0.54 (0.19; 1.12)</th>
</tr>
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</table>

Mortality

<table>
<thead>
<tr>
<th></th>
<th>2.19 (0.96; 7.91)</th>
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Is there a role for oral antiseptics?

- Oral chlorhexidine application reduces VAP in one study but not for general use – I

Systemic and enteral antibiotics

- Selective decontamination of the digestive tract (SDD) reduces the incidence of VAP & helps to contain MDR outbreaks – I
- But SDD not recommended for routine use – II
- Prior systemic antibiotics helps to reduce VAP in selected patient groups but increases MDR – II
- 24-hour AB prophylaxis helps in one study but not for routine use - I

Stress bleeding, transfusion, hyperglycemia

- Trend towards less VAP with sucralfate (vs H2 blockers) but increased gastric bleeding > individual choice - I
- Prudent transfusion, leukocyte-depleted red blood cell transfusion - I
- Intensive insulin therapy to keep glucose 80 - 110 mg/dl - I

Aspiration, body position

- Semirecumbent position (30 - 45°) especially when receiving enteral feeding - I
- Enteral nutrition is preferred over parenteral because of translocation risk - I

ATS Guidelines 2005
A multifaceted program to prevent ventilator-associated pneumonia: Impact on compliance with preventive measures

Lila Bouadma, MD; Bruno Mourier, MD; Veronique Delier, RN; Bertrand Le Corre, RN; Isabelle Lusso, SS; Bernard Royer, MD; Michel Wolff, MD; Jean-Christophe Loot, MD, PhD

Crit Care Med 2010; volume 38 in Press

1. Adherence to hand hygiene
2. Adherence to glove and gown use
3. Backrest elevation maintenance
4. Correct tracheal-cuff maintenance
5. Orogastric tube use
6. Gastric overdistention avoidance
7. Good oral hygiene
8. Elimination of non-essential tracheal suction

2 year intervention study:
Compliance with preventive measures increased
VAP prevalence rate decreased by 51%

VAP Prevention

1. Hand hygiene before and after patient contact, preferably using alcohol-based handrubbing
2. Avoid endotracheal intubation if possible
3. Use of oral, rather than nasal, endotracheal tubes
4. Minimize the duration of mechanical ventilation
5. Promote tracheostomy when ventilation is needed for a longer term
6. Glove and gown use for endotracheal tube manip

VAP Prevention (con’t)

7. Avoid non-essential tracheal suction
8. Oral hygiene with chlorhexidine
9. Backrest elevation 30-45°
10. Maintain tracheal tube cuff pressures (>20) to prevent regurgitation from the stomach
11. Avoid gastric overdistention
12. Promote enteral feeding
13. Careful blood sugar control in patients with diabetes
14. SDD in selected cases

1st principle of infection prevention

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Strategies to prevent SSI

- Objectives
  - Reduce the inoculum of bacteria at the surgical site
  - Surgical Site Preparation
  - Antibiotic Prophylaxis Strategies
  - Optimize the microenvironment of the surgical site
  - Enhance the physiology of the host (host defenses)

- In relation to risk factors, classified as
  - Patient-related (intrinsic)
  - Pre-operative
  - Operative

Patient-related factors

- Diabetes - Recommendation (IDSA/SHEA)
  - Preoperative
    - Control serum blood glucose; reduce HbA1C levels to <7% before surgery if possible (A-II)
  - Post-operative (cardiac surgery patients only)
    - Maintain the postoperative blood glucose level at less than 200 mg/dL, (A-I)

- Smoking
  - Rationale
    - Nicotine delays wound healing
    - Cigarette smoking = independent RF for SSI after cardiac surgery
  - Studies: None
  - Recommendation
    - Encourage smoking cessation within 30 days before procedure
**Procedure-related risk factors**

- Hair removal technique
- Preoperative infections
- Surgical scrub
- Skin preparation
- Antimicrobial prophylaxis
- Surgeon skill/technique
- Asepsis
- Operative time
- Operating room characteristics

**Antimicrobial prophylaxis**

- Recommendations (A-I)
  
  - Administer within 1 hour of incision to maximize tissue concentration
  
  - Once the incision is made, delivery to the wound is impaired

**Antimicrobial prophylaxis**

- Duration of prophylaxis (A-I)
  
  - Stop prophylaxis
    
    - within 24 hours after the procedure
    
    - within 48 hours after cardiac surgery
  
  - To:
    
    - Decrease selection of antibiotic resistance
    
    - Contain costs
    
    - Limit adverse events


**Surgeon Skill and Technique**

- Excellent surgical technique reduces the risk of SSI (A-III)

- Includes
  
  - Gentle traction and handling of tissues
  
  - Effective hemostasis
  
  - Removal of devitalized tissues
  
  - Obliteration of dead spaces
  
  - Irrigation of tissues with saline during long procedures
  
  - Use of fine, non-absorbed monofilament suture material
  
  - Wound closure without tension
  
  - Adherence to principles of asepsis


**Active surveillance**

<table>
<thead>
<tr>
<th>Système</th>
<th>N patients</th>
<th>Période</th>
<th>Réduction ISO</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREZIES Geubbels, U QualiCare, 2006</td>
<td>21 920</td>
<td>5 ans</td>
<td>- 57%*</td>
</tr>
<tr>
<td>KISS Brandt, ICHE 2006</td>
<td>119 114</td>
<td>4 ans</td>
<td>- 25%*</td>
</tr>
<tr>
<td>INCISO Roux, JHI 2007</td>
<td>150 440</td>
<td>6 ans</td>
<td>- 50%**</td>
</tr>
</tbody>
</table>

* Courtesy: Astagneau, SPFH 2007
### Summary: Relative SSI reduction

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage Reduction</td>
<td>38%</td>
<td>27%</td>
<td>18%</td>
<td>13%</td>
<td>38%</td>
<td>41%</td>
<td>25%</td>
<td>58%</td>
<td>No Data</td>
</tr>
</tbody>
</table>

### Examples of Multimodal approach(es) to reduce SSI

**Timely antibiotic prophylaxis, strict glycaemia control, no shaving**

SSI 1.5% vs. 3.5% in controls


**100k lives campaign**

(antibiotic prophylaxis, glycaemia control, normothermia)

SSI from 2.3% to 1.7% (-27%)


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### 1st principle of infection prevention

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- Use and care of urinary catheters
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- Hand hygiene and standard precautions

---

**Handwashing ... an action of the past**

(except when hands are visibly soiled)

**Recognized**

**Explained**

**Act**

**Alcohol-based hand rub is standard of care**

Alcohol-based hand rub at the point of care

Before and after any patient contact
After glove use
In between different body site care
Results

**Hospital-wide nosocomial infections; trends 1994-1998**

- 12/94
- 12/95
- 12/96
- 12/97

Alcohol-based handrubbing
Handwashing (soap + water)

[Graph showing compliance with hand hygiene over time]

www.hopisafe.ch

**Success story – Key Parameters**

- System change
- Education of healthcare workers
- Monitoring and feedback of performance
- Administrative support
- Leadership and culture change
- Associated with reduction in cross-transmission and infection rates

The University of Geneva Hospitals (HUG), 8 years follow-up

Rub hands... it saves money

• The 5 core components of the WHO Multimodal Hand Hygiene Improvement Strategy

1. System change
   - Alcohol-based handrub at point of care
   - Access to safe, continuous water supply, soap and towels

2. Training and Education

3. Observation and feedback

4. Reminders in the hospital

5. Hospital safety climate

“A my 5 Moments for Hand Hygiene”

- Before touching a patient
- Before doing a procedure
- After touching a patient
- After doing a procedure
- After touching patient’s environment


“A multimodal strategy

- System change
- Education
- Monitoring performance + feedback
- Reminders
- Safety culture

Evolving to new challenges in infection control and patient safety

- Team and multidisciplinary team work
- Successful interventions
- Adaptability of actions
- Scaling up
- Sustainability of actions / interventions
- Leadership commitment / Governance

Infection Control and Quality Healthcare in the New Millennium

Multidisciplinary team approach

Infection Control and Quality Healthcare in the New Millennium

Where are we going?

Multidisciplinary team approach

1. Recognize
2. Explan
3. Act

Healthcare system:
- Hospitals
- Ambulatory services
- Nursing homes
- Long-term care facilities
- Home care delivery systems

State/country epidemiology program
International surveillance systems
Financing bodies
Patient safety promotion


Registered health-care facilities – May 2009 on…

Work in progress….

The global impact of SAVE LIVES: Clean Your Hands - Jan 2010

5996 health-care facilities from 126 countries

Aiming at… 10 000 registered health-care facilities by May 2010

SAVE LIVES: Clean YOUR Hands
5 May 2009-2020

A WHO Patient Safety Initiative 2009

Encourage health-care facilities to show their commitment by signing up now on:

http://www.who.int/gpsc/5may

The countdown has started!

SAVE LIVES
WHO Patient Safety
WHO Collaborating Centres
Country campaigns & activities
Facility campaigns & activities including evaluation and feedback

Patient Safety: the point of care - hand hygiene 5 moments
Infection Control

Making healthcare safer