Preventing ICU Complications

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Overview

- Catheter related bloodstream infection
- Ventilator associated pneumonia
- Pressure ulcers
Catheter Related Blood Stream Infection
Epidemiology of CRBSI

- > 5 million central venous catheters inserted each year (15 million CVC days)
- CRBSI occurs with 3-5% of catheters and affects more than 250,000 patients per year in the US (5.3 per 1000 catheter days)
- Prolong hospitalization by 7 days
- Mortality: 5-35%
  - 2500 to 20,000 deaths per year
- UCSF cost $80,000/CRBSI
CRBSI Prevention Bundle

- Hand hygiene
- Maximal barrier precautions (mask, gown, gloves and full barrier drapes)
- Chlorhexidine skin antisepsis
- Optimal catheter site selection, with subclavian vein as the preferred site for non-tunneled catheters in adults
- Ultrasound guidance
- Daily review of line necessity with prompt removal of unnecessary lines

Institute for Healthcare Improvement
An Intervention to Decrease Catheter-Related Bloodstream Infections in the ICU

Peter Pronovost, M.D., Ph.D., Dale Needham, M.D., Ph.D., Sean Berenholtz, M.D., David Sinopoli, M.P.H., M.B.A., Haitao Chu, M.D., Ph.D., Sara Cosgrove, M.D., Bryan Sexton, Ph.D., Robert Hyzy, M.D., Robert Welsh, M.D., Gary Roth, M.D., Joseph Bander, M.D., John Kepros, M.D., and Christine Goeschel, R.N., M.P.A.

108 ICU’s in Michigan

Interventions:

Handwashing, full barrier precautions, chlorhexidine prep, avoiding femoral lines, asking about removal on rounds
## CRBSI Prevention

Pronovost et al, NEJM 2006

### Table 2. Baseline Data.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No. of ICUs</th>
<th>No. of Infections</th>
<th>Catheter-Days</th>
<th>No. of Infections per 1000 Catheter-Days</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>median (interquartile range)</td>
<td></td>
</tr>
<tr>
<td>All hospitals</td>
<td>55*</td>
<td>2 (1–3)</td>
<td>511 (220–1091)</td>
<td>2.7 (0.6–4.8)</td>
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<tr>
<td>Teaching status</td>
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<td></td>
<td></td>
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<tr>
<td>Teaching</td>
<td>33</td>
<td>2 (1–4)</td>
<td>744 (377–1134)</td>
<td>2.7 (1.3–4.7)</td>
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<tr>
<td>Nonteaching</td>
<td>22</td>
<td>1 (0–2)</td>
<td>306 (194–608)</td>
<td>2.6 (0–4.9)</td>
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<tr>
<td>No. of beds</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;200</td>
<td>13</td>
<td>1 (0–1)</td>
<td>247 (75–377)</td>
<td>2.1 (0–3.0)</td>
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<tr>
<td>200–299</td>
<td>12</td>
<td>2 (1–6)</td>
<td>595 (338–1670)</td>
<td>3.2 (0.3–4.3)</td>
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<tr>
<td>300–399</td>
<td>12</td>
<td>2 (1–3)</td>
<td>902 (184–1376)</td>
<td>2.7 (1.7–5.8)</td>
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<tr>
<td>≥400</td>
<td>18</td>
<td>2 (1–3)</td>
<td>616 (424–1102)</td>
<td>2.0 (1.3–4.7)</td>
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</table>
# Reduction in CRBSI

Pronovost et al, NEJM 2006

<table>
<thead>
<tr>
<th>Study Period</th>
<th>No. of ICUs</th>
<th>No. of Bloodstream Infections per 1000 Catheter-Days</th>
<th>&lt;200 Beds</th>
<th>≥200 Beds</th>
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<tr>
<td></td>
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<td>Overall</td>
<td>Teaching Hospital</td>
<td>Nonteaching Hospital</td>
</tr>
<tr>
<td></td>
<td></td>
<td>median (interquartile range)</td>
<td>median (interquartile range)</td>
<td></td>
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<tr>
<td>Baseline</td>
<td>55</td>
<td>2.7 (0.6–4.8)</td>
<td>2.7 (1.3–4.7)</td>
<td>2.6 (0–4.9)</td>
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<tr>
<td>During implementation</td>
<td>96</td>
<td>1.6 (0–4.4)†</td>
<td>1.7 (0–4.5)</td>
<td>0 (0–3.5)</td>
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<tr>
<td>After implementation</td>
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<td></td>
<td></td>
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<tr>
<td>0–3 mo</td>
<td>96</td>
<td>0 (0–3.0)‡</td>
<td>1.3 (0–3.1)†</td>
<td>0 (0–1.6)†</td>
</tr>
<tr>
<td>4–6 mo</td>
<td>96</td>
<td>0 (0–2.7)‡</td>
<td>1.1 (0–3.6)†</td>
<td>0 (0–0)‡</td>
</tr>
<tr>
<td>7–9 mo</td>
<td>95</td>
<td>0 (0–2.1)‡</td>
<td>0.8 (0–2.4)‡</td>
<td>0 (0–0)‡</td>
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<tr>
<td>10–12 mo</td>
<td>90</td>
<td>0 (0–1.9)‡</td>
<td>0 (0–2.3)‡</td>
<td>0 (0–1.5)‡</td>
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<tr>
<td>13–15 mo</td>
<td>85</td>
<td>0 (0–1.6)‡</td>
<td>0 (0–2.2)‡</td>
<td>0 (0–0)‡</td>
</tr>
<tr>
<td>16–18 mo</td>
<td>70</td>
<td>0 (0–2.4)‡</td>
<td>0 (0–2.7)‡</td>
<td>0 (0–1.2)†</td>
</tr>
</tbody>
</table>
CRBSI Prevention at UCSF

- CVC insertion checklist
- Routine use of ultrasound guidance
- Daily antibiotic review by pharmacy team
- Daily review of CVC necessity with prompt removal of unnecessary catheters (Daily Goals)
Daily Screening for CVC Indications

- Critical Care RNs are responsible for assessing.
  Indication for CVC:
  - Monitoring (i.e. hemodynamics)
  - Therapies (i.e. medications requiring CVC or long term administration >14 days, TPN, dialysis/pheresis)
  - Unable to obtain alternate IV access
- If none of the above criteria are present, RN should contact team to discuss plan for central line removal
CVC Rounds by ICU Leadership Teams

- Patient care managers, clinical nurse specialists and educators conduct daily rounds
- Reinforce CRBSI prevention strategies and current CVC maintenance procedures
- Visually inspect CVC system with the nurses
- Rounding template to engage nurses in dialogue about indications for CVC use and maintenance standards
Maintaining a Closed CVC System

Minimizing access to system

- Manifold use based on experience from oncology population
- If central line is accessed more than 2x/day, set up a maintenance line
- If more than 2 intermittent infusions ordered, use upper manifold to avoid repeated entry into CVC system
CRBSI Reduction at UCSF

- In 2004: 19,536 patient days, 12,052 line days
  - CRBSI rate = 3.7/1000 line days, 47 CRBSI’s
  - Attributable deaths => 16

- Program implemented in 2005

- In 2006: 24,408 patient days, 12,769 line days
  - CRBSI rate = 1.7/1000 line days, 22 CRBSI’s
  - Attributable deaths => 8

- Estimated 8 lives saved

2004: 47 CRBSI’s x $80K = $3,760,000
2006: 22 CRBSI’s x $80K = $1,760,000

estimated savings = $2,000,000
Indicator C09: Other: CVC bloodstream infection - adult

Number of Cases

- Other: CVC bloodstream infection - adult
- Trend line (Least Squares method)
Ventilator Associated Pneumonia
Ventilator Associated Pneumonia

- A leading cause of death among hospital acquired infections
- Increased length of time on ventilator, LOS in both the ICU and hospital.
- Mortality with VAP 46% versus 32%
- Estimated cost is > $40,000 (2004)
Ventilator Bundle

- Elevation of the Head of the Bed
- Daily "Sedation Vacations" and Assessment of Readiness to Extubate
- Peptic Ulcer Disease Prophylaxis
- Deep Venous Thrombosis Prophylaxis

Institute for Healthcare Improvement
HOB Interventions Implemented

- Made a “standing order” on ICU admission
- Incorporated assessment of HOB and intervention into the Adult Critical Care Standards of Care
- Utilized data: HOB gauge vs. visual assessment
- Documentation/Flowsheet prompt added
- Signage added
- Intensivist, RCP & RN focus on ICU rounds
- Monitored compliance
- Reinforced practice

Nurse/Therapist-Driven Weaning Protocols

- Randomized, controlled trial of 300 patients
- Physician order versus RN and RT driven weaning trials
- Duration of mechanical ventilation and cost were both lower
- Less complications in intervention group
- Fewer reintubations

Daily Interruption of Sedative Infusions

- 128 mechanically ventilated patients
- Intervention: Daily interruption of sedative infusions
- Duration of mechanical ventilation: 4.9 days vs 7.3 days (p=0.004)
- ICU median LOS: 6.4 days vs 9.9 days (p=0.02)

Other components of the bundle

- Peptic Ulcer Prophylaxis
  - Five fold increase in mortality for patients with GI bleed
  - Address the subject
- DVT prophylaxis
  - Higher incidence of venous thrombosis in sedentary patients
- When all four components of bundle implemented, demonstrated significant reduction in VAP rates.
Oral decontamination

- 2007 meta-analysis
  - 11 trials, 3242 patients
- VAP reduced by oral mouthwash only
- Less VAP, same mortality same length of ventilation
- Chlorhexidine most extensively studied oral antiseptic
- Safe, cheap and easy to apply

Chan, E et al. BMJ 2007 334: 889-900
Micro-Aspiration

- Aspiration still occurs despite having endotracheal tube, as secretions channel through folds in cuff.
- Experiments with cuff profile
  - Taper shaped cuff
  - Cuff material is minimized
- Limited pathway for aspiration

Cuff Technology

- Unique tapered shape
- Reduction in folds and channels
- Even lower occlusive pressures (20% lower)
- Improvement in quality of seal (reducing microaspiration by 95%)
- Not 100% occlusive
Subglottic secretion drainage with integrated suction line
Continuous aspiration of subglottic secretions

- Continuous aspiration of subglottic secretions (CASS)
- 5 studies, 896 patients intubated
  - Continuous aspiration
  - Halved incidence VAP
  - Reduced length of ICU stay
  - Reduced antibiotic use

Continuous Aspiration of Subglottic Secretions

- Requires intubation with special tube
- Separate dorsal lumen that opens into subglottic area
- Aspiration may be continuous or intermittent
- Requires frequent monitoring
- Cost is approximately 25% higher than standard endotracheal tubes
UCSF VAP Performance (80 ICU Beds)
Pressure Ulcers
Incidence and Cost

- Incidence ranging from 0.4% to 38%
- 2.5 million patients treated annually in US acute care facilities for pressure ulcers related complications
- Once pressure ulcer develops, mortality is increased by 2-6 fold with 60,000 deaths
- Total annual cost $11 billion
Pressure Ulcers

- **Definition:** Localized injury to the skin and/or underlying tissue usually over a bony prominence, as a result of pressure or in combination with shear or friction.

- Identifying patients at risk and identifying early skin changes can allow early intervention to prevent a pressure ulcer from developing.
Function of both time and pressure (hyperbolic curve)

- 32 mmHg sufficient to disrupt blood flow
- 70 mmHg pressure for two hours produces irreversible injury
Staging

Clinical appearance

Stage 1
Skin intact
Non-blanchable erythema

Stage 2
Partial loss of dermis
Shallow open ulcers

Stage 3
Full thickness skin loss
Fat exposed

Stage 4
Full thickness skin loss
Exposed bone, muscle, or tendon

Unstageable
Covered with slough or eschar
Depth undetermined

Suspected deep tissue injury
Purplish skin discoloration
Potential for deeper tissue damage

Normal
Sites

- **Sacrum** - most common site (30%)
  - Slouching in bed or chair
  - Higher risk in incontinent pts

- **Heels** - 2nd most common (20%)
  - Immobile or numb legs
  - Higher risk with PVD & diabetes neuropathy

- Trochanter

- Device related
Pressure Ulcer Bundle

- Conduct a pressure ulcer admission assessment for all patients
- Reassess risk for all patients daily
- Inspect skin of at-risk patients daily
- Manage Moisture
- Optimize nutrition/hydration
- Minimize pressure

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Risk identification

- Norton: 1-4 point scoring system rating patients (physical condition, mental status, activity, mobility, and incontinence) – score of 14 or less indicates risk of PU development.

- Braden: 1-4 point scoring system rating patients (sensory perception, moisture, activity, mobility, nutrition and friction/shear) – score of 18 or less indicates risk PU development.
# Braden Scale

<table>
<thead>
<tr>
<th>Factor</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensory Perception</td>
<td>Completely Limited</td>
<td>Very Limited</td>
<td>Slightly Limited</td>
<td>No Impairment</td>
</tr>
<tr>
<td>Moisture</td>
<td>Constantly Moist</td>
<td>Very Moist</td>
<td>Occasionally Moist</td>
<td>Rarely Moist</td>
</tr>
<tr>
<td>Activity</td>
<td>Bedfast</td>
<td>Chairfast</td>
<td>Walks Occasionally</td>
<td>Walks Frequently</td>
</tr>
<tr>
<td>Mobility</td>
<td>Completely immobile</td>
<td>Very Limited</td>
<td>Slightly Limited</td>
<td>No Limitation</td>
</tr>
<tr>
<td>Nutrition</td>
<td>Very Poor</td>
<td>Probably Inadequate</td>
<td>Adequate</td>
<td>Excellent</td>
</tr>
<tr>
<td>Friction &amp; Shear</td>
<td>Problem</td>
<td>Potential Problem</td>
<td>No Apparent Problem</td>
<td></td>
</tr>
</tbody>
</table>
Braden Scores:

- < 9 indicates severe risk
- 10-12 indicates high risk
- 13-14 indicates moderate risk
- 15-18 indicates mild risk
Minimize pressure

- Frequent small position changes (every 1.5 to 4 hrs)
- Keep reclining chair and bed below 30 degree angle to decrease pressure load
- Sitting: may need hourly position changes
- Increase mobility/Consult PT/OT
Minimize pressure
(Support surfaces)

- Order air mattress if turning protocols are ineffective
- Reposition off of any known ulcers
- Use pillows to pad bony prominences
- Float heels with pillow lengthwise under calves
Minimize friction and shear

- Use draw sheet under patient to assist with moving
- Do not drag over mattress when lifting up in bed
- Avoid mechanical injury - use slide boards, turn sheet, trapeze, corn starch
Manage Moisture

- Cleanse skin at time of soiling and use absorbent
- Provide a non-irritating surface
- Barrier ointments and pads
- Utilize appropriate fecal/urinary collection devices
Nutrition/hydration

- Skin condition reflects overall body function
- Skin breakdown may be evidence of general catabolic state
- Increase hydration & caloric needs
- Nutritional goals: ↑ protein intake 1.2-1.5 gm/kg body weight daily—unless contraindicated
- Consider vitamin supplementation
Education and Quality Initiatives

- Prospective cohort study
- Implemented prevention guidelines
- Educate all players
- Multidisciplinary approach
- Timely transfer to a specific pressure reducing device
- 40% reduction in pressure ulcers

Pressure Ulcers
Prevention Teamwork

RN’s

Patients

MD’s

Others