Development and Implementation of a Risk Assessment Tool for prevention of Surgical Site Infections (SSIs) after Joint Replacement Surgery

Rajan V. Nair

Faculty Advisor: Lilly Engineer, DrPH, MD, MBA
Site Preceptor: Susan Redmond, MBA (Director of Rehabilitation, Neurosurgery, and Orthopedic Service Lines; Salem Health)
INTRODUCTION AND DISCLOSURES

• Rajan ("Raj") V. Nair, MD FACS
  • General Surgeon; Salem, OR (1999 – present)
  • Founding Medical Director and Surgeon, Salem Health Bariatric Surgery Center (2006 – present)
  • iMPH candidate, May 2019
  • CQPSOR Certificate candidate, May 2019
  • PHI Certificate candidate, May 2019
• I have nothing to disclose
GOALS FOR PRESENTATION

• Implications of Surgical Site Infections (SSIs) in Joint Replacement Surgeries

• Conceptual framework to justify Negative Pressure Wound Therapy as an intervention to prevent SSIs

• Inherent tension between the costs of unrestricted use of an intervention vs the accruable benefits for an institution

• Process of developing an intervention to address SSIs

• Describe the ongoing implementation of workflow changes
Hospital acquired Conditions and Financial Implications

• February 2006: Deficit Reduction Act (DRA) of 2005: identified conditions that were:
  • high cost + high volume
  • present as secondary case to a DRG
  • were felt to be reasonably preventable

• As of October 2008, hospitals no longer reimbursed for the costs of these events (aka “hospital acquired conditions” or “HACs”)

• CMS: in order to fulfill quality measurement reporting requirements, data needed to be submitted quarterly to the National Healthcare Safety Network (NHSN)
Surgical Site Infections (SSIs)—General

• 2006 – 2008: SSI rate of 1.9%

• 2008 → 2014: 17% decrease in SSI rate for 10 select procedures

• Mortality rate: 3%

• Most costly HAI
  • SSI estimated annual cost: $3.3 billion
  • Approximately 1 million additional inpatient-days annually
Surgical Site Infections (SSIs)—Orthopedic Surgery

• Incidence (in joint replacements): overall = 0.7%
  • For hips: 0.3%
  • For knees: 1.1%

• Infected prosthetic joints usually require operative removal and subsequent revisional arthroplasty → high monetary cost to society
  • $320 M in 2001 → $566M in 2009
  • Projected to be $1.62B in 2020!

• Risk factors for postop complications (including SSIs):
  • Presence of DM
  • Smoking
  • BMI over 40
  • ASA score over 2
  • Postop atrial fibrillation
  • Age > 80

Aggarwal 2013
Pulido 2008
Belmont 2014
Salem Health (Hospital)

- One of 62 Acute care hospitals in Oregon
- Founded in 1896; not-for-profit
- Salem Health System: 2 hospitals (one critical access; one Level 2 Trauma Center—454 acute care beds)
- Busiest ED in Oregon (including OHSU in Portland): 109,131 visits in 2017
- Staff: 4,700 employees, 820 active medical staff
February 2012: first in Oregon to earn the Joint Commission’s Gold Seal of Approval for certification in total hip and knee replacements

- 7+ surgeons

- Average annual volumes:
  - 667 hips
  - 766 knees

- Preop patient and caregiver teaching

- Dedicated ward and specialty nurses

- Standardized clinical care pathways
SSIs in Orthopedic Surgery at Salem Health

Efforts 2011-2016: Hip
Conceptual Framework #1: 
Pathophysiology of SSIs in Joint Replacement Surgeries

Surgical trauma to the tissue

Creation of SQ “dead space”

Formation of wound fluid collection (seroma)

Persistent wound drainage
(if greater than 5 days, then 12.7-fold increased risk of PJI)

Peri-prosthetic wound infection
Negative Pressure Wound Therapy (NPWT)

“Negative pressure wound therapy (NPWT), also called vacuum-assisted wound closure, refers to wound dressing systems that continuously or intermittently apply subatmospheric pressure to the surface of a wound.”

-UptoDate

“Negative-pressure wound therapy is a therapeutic technique using a vacuum dressing to promote healing in acute or chronic wounds...”

-Wikipedia
Negative Pressure Wound Therapy (NPWT)

1. Macrodeformation:
2. Microdeformation:
3. Fluid removal:

**Pachowsky 2012:**
- PRCT THAs; standard dressing vs NPWT (Prevena)
- Ultrasound quantification of seroma volume @POD #10:
  - 90% of pts with std dressing had seromas vs 44% of pts with Prevena
  - $5.08 \pm 5.11 \text{ ml} \ vs \ 1.97 \pm 3.21 \text{ ml Prevena}$ ($p = 0.021$)
4. Stabilization of the environment
Negative Pressure Wound Therapy (NPWT) Success in Orthopedic Surgeries

**Hester 2015**: hip and knee revisions
- Standard dressing vs NPWT (Pico)
- Decreased wound complications (NSS)

**Cooper 2016**: hip and knee revisions
- Standard dressing (Aquacel) \([n=108]\) vs NPWT (Prevena) \([n=30]\); **selection by surgeon discretion**
- Overall wound complications: 6.7% (Prevena) vs 26.9% (Aquacel) \([p = 0.024]\)
- Total SSIs: 3.3% (Prevena) vs 18.5% (Aquacel) \([p=0.045]\)
Conceptual Framework #2: Structured use of NPWT to prevent SSIs in Joint Replacement Surgery

- Surgical trauma to the tissue
- Creation of SQ dead space
- Formation of wound seroma
- Persistent wound drainage (if greater than 5 days, then 12.7-fold increased risk of PJI)
- Peri-prosthetic wound infection
Salem Health Experience with Prevena NPWT

### 2016

<table>
<thead>
<tr>
<th>Prevena Use</th>
<th>Infected</th>
<th>Not infected</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>0</td>
<td>13</td>
<td>0/13 = 0%</td>
</tr>
<tr>
<td>No</td>
<td>22</td>
<td>1438</td>
<td>22/1460 = 1.5%</td>
</tr>
</tbody>
</table>

### 2017

<table>
<thead>
<tr>
<th>Prevena Use</th>
<th>Infected</th>
<th>Not infected</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>0</td>
<td>61</td>
<td>0/61 = 0%</td>
</tr>
<tr>
<td>No</td>
<td>18</td>
<td>1384</td>
<td>18/1402 = 1.2%</td>
</tr>
</tbody>
</table>

Prevena Use over time in Orthopedics

- **2016**: 0 Infected, 13 Not infected, 0/13 = 0%
- **2017**: 18 Infected, 1384 Not infected, 18/1402 = 1.2%
- **2018**: $$$
The Fundamental Tension: Cost vs Benefit

Financial Cost of the Intervention
(known cost of ~ $466/device)

Clinical (safety) benefit of the Intervention
(potentially fewer SSIs)

Economic Benefit of the Intervention
(potentially lower costs for treating SSIs, readmissions, etc.)
2016-2017 Joint Replacement Surgeries:
- 40 infections
- Infection-related readmission cost of $479,166 (roughly $500,000) over 2 years

**IDEAL SITUATION:**
- Breakpoint of $500,000 would allow us to place 1,000 devices in 2 years (or about 500 devices annually)
  
  \[ \frac{$500,000}{466 \text{ per device}} = 1,073 \text{ devices over 2 years} \]

**REALITY SITUATION:**
- Goal: save 50% of costs
- Then place about 250 devices annually in appropriately targeted patients
### Risk factors for complications in joint replacements: What does the literature say about odds ratios?

<table>
<thead>
<tr>
<th>For any postop complication</th>
<th>BMI &gt; 40 OR = 1.47&lt;sup&gt;(2)&lt;/sup&gt;</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>For major systemic complication</td>
<td></td>
<td>Age &gt; 80 OR = 2.63&lt;sup&gt;(2)&lt;/sup&gt;</td>
</tr>
<tr>
<td>For Mortality</td>
<td></td>
<td>Diabetes OR = 2.99&lt;sup&gt;(2)&lt;/sup&gt;</td>
</tr>
<tr>
<td>For Minor local complication</td>
<td>ASA &gt; 2 OR = 1.88&lt;sup&gt;(2)&lt;/sup&gt;</td>
<td>BMI &gt; 40 OR = 2.01&lt;sup&gt;(2)&lt;/sup&gt;</td>
</tr>
<tr>
<td>For Infection</td>
<td>ASA &gt; 2 OR = 1.95&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>BMI &gt; 40 OR = 3.23&lt;sup&gt;(1)&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

(1) Pulido 2008  (2) Belmont 2014
Risk factors for infections in joint replacements: What does the *OUR experience (2016 – 18)* say using unadjusted *odds ratios*?

| Odds Ratios for Infection | ASA > 2 OR = 3.06 | BMI > 35 OR = 2.44 | Diabetes (A1C between 5.7 and 7.5) OR = 1.35 | Acute hip fracture OR = 1.49 | Anticoagulation OR = 1.61 | Revision OR = 5.61 | Uncontrolled DM OR = 5.25 | Active smoker OR = 2.66 | Age > 80 OR = 2.20 |
Risk factors for *infections* in joint replacements:

What does the *OUR experience (2016 – 18)* say about *prevalence*?

<table>
<thead>
<tr>
<th>Prevalence of the Risk Factor in our Patients</th>
<th>ASA &gt; 2</th>
<th>BMI &gt; 35</th>
<th>Diabetes (A1C between 5.7 and 7.5)</th>
<th>Acute hip fracture</th>
<th>Anticoagulation</th>
<th>Revision</th>
<th>Uncontrolled DM</th>
<th>Active smoker</th>
<th>Age &gt; 80</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASA &gt; 2</td>
<td>49.5%</td>
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<tr>
<td>BMI &gt; 35</td>
<td>20.8%</td>
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<tr>
<td>Acute hip fracture</td>
<td>11.0%</td>
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<td></td>
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<tr>
<td>Anticoagulation</td>
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<td>Active smoker</td>
<td>1.3%</td>
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<tr>
<td>Age &gt; 80</td>
<td>16.4%</td>
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### Risk factors for infections in joint replacements:

**How do we reconcile risk and prevalence?**

<table>
<thead>
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<th>Odds Ratios for Infection</th>
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<td>ASA &gt; 2</td>
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<tr>
<td>OR = 5.25</td>
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<td>Active smoker</td>
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The Solution:

Balance prevalence and odds ratios for infection by combining risk factors using a real-time, point-of-care Risk Assessment Tool.
## Development of the Risk Assessment Tool: Narrowing down the Risk Factors

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Average predicted # of patients per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>All revisions</td>
<td>70</td>
</tr>
<tr>
<td>All uncontrolled diabetics</td>
<td>22</td>
</tr>
<tr>
<td>All active smokers</td>
<td>17</td>
</tr>
<tr>
<td>All acute hip fx pts <strong>AND</strong> with anticoagulation</td>
<td>11</td>
</tr>
<tr>
<td>All pts with ASA &gt;2 <strong>AND</strong> Age &gt; 80</td>
<td>121</td>
</tr>
<tr>
<td>“Poor soft tissue envelope/ Pannus overlying incision” (intraop surgeon judgment)</td>
<td>???</td>
</tr>
<tr>
<td><strong>Total ~ 241 patients</strong></td>
<td></td>
</tr>
</tbody>
</table>
**Conceptual Framework #3: How the Risk Assessment Tool Should be Deployed**

- **Patient evaluated by Orthopedic surgeon at clinic for joint replacement**
- **Clinical documentation of co-morbidities, ordering of tests**
- **Pre-surgery Screening (PSS) Nurses contact patient and input data into discrete fields in the EMR **

**Risk factor data compiled in EMR transferred into a Risk Assessment Tool**

**Risk Assessment Tool is presented to OR nurse prior to completion of case to determine if Prevena NPWT is required**
Implementation of the Risk Assessment Tool in the O.R.

Based on the Risk Assessment Tool:
This patient **SHOULD** have a Prevena NWPT device placed because of the following reasons:
- Revisional surgery
- ASA > 2 **AND** Age > 80

The Surgeon has chosen:
- **TO PLACE** a Prevena NPWT device
- **To NOT** place a Prevena NPWT device for the following reasons: ______________
Implementation of the Risk Assessment Tool in the O.R.

Based on the Risk Assessment Tool:
This patient **SHOULD NOT** have a Prevena NWPT device placed because of the following reasons:
- Does **NOT** meet any of the defined risk factor criteria

The Surgeon has chosen:
- **To NOT** place a Prevena device
- **TO PLACE** a Prevena device for the following reasons:
  - Poor soft tissue envelope
  - Pannus overlying the incision
  - Other: ________________
Next Steps

• Work with the IT department to build the EMR-embedded Risk Assessment Tool

• Work with the circulating nurses in the Orthopedic operating room to incorporate the tool into their workflow

  • There is already an “End-of-case Time out” which is performed

• Work with BI to systematically follow outcomes
Final Thoughts

• Facilitators:

  • *Salem Hospital has been a Lean hospital for over a decade*
    • QI projects overseen by the Quality Operations Committee: “...physician-led, patient-centered, and data-driven” projects

  • Persistent institutional focus on HAIs:
    • FY 2018 → “Hips/Knee infections”
    • FY 2019 → “Reduction of HAIs/SSIs”

  • *Immediate administrative oversight*
    • Susan Redmond, MBA: Manager of the Neuromuscular Service Line
    • Denise Hoover, MBA: VP of Surgical Services
Final Thoughts

• **Barriers:**
  - Physician group engagement: Mark Dolan, MD [physician champion]
  - Bandwidth to build the tool in the IT department

• **Lessons learned:**
  - The published literature is ONLY a “guide” to start QI projects; local historical data is the best factor for determining the final intervention
  - Communication with shareholders all along the way is critical (MDs, RNs, IPs, BI, IT, etc.)
GOALS FOR PRESENTATION, again...

• Implications of Surgical Site Infections (SSIs) in Joint Replacement Surgeries

• Conceptual framework to justify Negative Pressure Wound Therapy as an intervention to prevent SSIs

• Inherent tension between the costs of unrestricted use of an intervention vs the accruable benefits for an institution

• Process of developing an intervention to address SSIs

• Demonstrate the implementation of workflow changes
Comments/ Questions?
REFERENCES


