Immediate Pre-operative Decolonization Therapy Reduces Surgical Site Infections: A multidisciplinary quality improvement project

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Dr. Titus Wong
on behalf of
the VGH decolonization team

Surgery and Orthopaedics Combined Grand Rounds
12 December, 2012
The Team

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Patient Safety: Linda Dempster

Ondine Biomedical: Shelagh Weatherill et al

Special Thanks: microbiology technologists, and perioperative staff
Overview

• Relationship between surgical site infections, patient flora, and decolonization strategies

• VGH SSI infection reduction decolonization quality improvement project

• Findings from the project: Surveillance period, microbiologic efficacy, safety, compliance, integration findings, cost-effectiveness, effect on SSI, program impact

• Final thoughts / discussion
SSIs, Patient Flora and Decolonization Strategies

• Most SSIs arise from the patient’s own flora including skin and head/neck distant from wound
• Decreasing the bacterial load prior to surgery can decrease risk of SSIs
• Traditional decolonization strategies consist of chlorhexidine (CHG) +/- intranasal mupirocin
SSI reduction with pre-operative decolonization: CHG / Mupirocin

• **Bode LGM NEJM 2010;362:9-17**
  – CHG/M group 3.4% SA infection rate vs 7.7% placebo group in 6771 pts admitted

• **Eiselt Orthop Nurs 2009;28:141-5**
  – Reduction in SSI rate by 50% with CHG no-rinse cloths to replace PI skin antiseptic in ortho pts [3.19% to 1.59%]

• **Cochrane Review**
  – Nine RCTs in 3396 participants. A significant reduction in rate of SA infection associated with intranasal mupirocin

• **Kluytmans, JA et al. Inf Control Hosp Epidem 1996**
  – Nasal mupirocin reduced SSI in cardiac surgery

• **Cimochowski GE et al. Ann Thorac Surg 2001**
  – Nasal mupirocin in cardiac surgery reduces SSIs
SSI reduction with pre-operative decolonization: CHG / Mupirocin

- **Perl TM et al. Surgery 2003**
  - RCT: nasal mupirocin reduced nasal colonization of *S. aureus*, and overall hospital infections, but not SSI
  - when general surgery cases removed, the reduction in SSIs was significant for all *non-general surgery* cases
  - mupirocin resistance found

- **Miller MA et al. ICHE 1996**
  - Mupirocin resistance increased from 3% to 65%

- **Anderson DJ. ID Clinics of NA 2011**
  - “Thus many experts recommend that decolonization be limited to specific high risk populations...”
Traditional pre-operative decolonization uses CHG / Mupirocin

Outpatient decolonization

– compliance to chlorhexidine + mupirocin range from poor to mediocre

Caffrey et al. ICHE 2011

– gave preoperative patients comprehensive education, but compliance was only 31%
VGH SSI reduction decolonization
QI project

Wanted:

• Consistent pre-operative decolonization program in high risk surgeries
• High degree of compliance with program
• Minimal risk of antibiotic resistance
• Must be effective
Overview

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Our Novel Approach

• Nasal Photodisinfection using MRSAid

• Chlorhexidine impregnated washcloths
Chlorhexidine Washcloths

• Alcohol-free washcloth impregnated with CHG
• FDA and Health Canada approved
• Used *below the neck* day of or night prior to surgery
• Left on the skin (not rinsed off)
• Equivalent to 4% CHG on skin

http://www.sageproducts.com/lit/20778C.pdf
Conditions for PDT

Photodynamic Therapy

- Selectivity

Photosensitizer

Light

Oxygen
How Photodisinfection works

**Treatment Site**
Tissue Colonized with Pathogenic Bacteria

**Irrigation**
Apply Photosensitizer that binds to bacterial surfaces

**Illumination**
Illuminate the Treatment Site Using Non-Thermal Light Energy

**Eradication**
“Activated” Photosensitizer creates reactive oxygen species, killing bacteria
Advantages of PDT

- **Fungi**
- **Bacteria**
- **Parasites**
- **Virus**

**Antibiotics**

**PDT**

- **Practical**
  - Safe for human tissue
  - Inexpensive, instant results
  - No patient compliance
  - Versatile
  - Systemic antibiotics cannot get into dead or damaged tissue
  - Even if antibiotics work they take several days

- **Effective**
  - Broad therapeutic window
  - Eradicates pathogens in biofilms
  - Eliminates development of resistance
  - Destroys secreted virulence factors

From: Photodynamic therapy for localized infections—State of the art Tianhong Dai\textsuperscript{a, b}, Ying-Ying Huang\textsuperscript{a, b, c}, Michael R. Hamblin, PhD\textsuperscript{a, b, d}. Photodiagnosis and photodynamic Therapy 2009;6:170-188
Other uses of PDT

- Treatment of infections: periodontitis, sinusitis, ventilator associated pneumonia, catheter related urinary tract infections
- Treatment of skin conditions: psoriasis, eczema, fungal infections
- Cancer therapy
Further study required

- Accurate doses of photosensitizer and light
- Appropriate illumination device(s)
- Type of delivery system e.g. topical, interstitial, injection, aerosolization
- Stability and ease of application
- Patient acceptibility
- Safety profile of light/photosensitizer combinations
- Role of PDT in stimulating the host immune system
1. Connect nasal illuminator tips to laser cable port via fiber-optic connector
2. Illuminate for 2 minutes with tips placed as shown above (directed into inner tip of nose for 1\textsuperscript{st} cycle and posterior for 2\textsuperscript{nd} cycle)
Advantages of this Approach

• Horizontal infection control strategy
• Eradicate antibiotic resistant bacterial strains
• No generation of bacterial resistance
• No/minimal effect on human tissues
• Rapid action – maximally effective in minutes
• Increased compliance
VGH SSI reduction decolonization QI project

Objectives:

1. To determine if immediate preoperative decolonization using nasal photodisinfection therapy + CHG wipes reduces SSI rates in elective non-general surgeries.

2. To assess the feasibility of integration of a decolonization program in the pre-operative area

Target Population: all elective surgical procedures that were normally followed for SSI as part of the Infection Prevention and Control surveillance program
Limitations

• not a RCT

• cannot sort out incremental benefit of CHG and PDT therapy
Decolonization Protocol

Surgeries included:
- cardiac, thoracic, ortho-recon, ortho-trauma, vascular, neuro/spine, and breast cases.

Surgeries excluded:
- open fractures, dirty/contaminated cases, duplicate cases, cases in 6 week introductory period.
Overview

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• Findings from the project: Surveillance period, microbiologic efficacy, safety, compliance, integration findings, cost-effectiveness, effect on SSI, program impact

• Final thoughts / discussion
Results to be presented today

1. Microbiological efficacy, safety, compliance of nasal photodisinfection therapy (June 1/2011 to Aug 31, 2012)
2. Optimal period of follow-up for SSI surveillance
3. SSI data (Sept 1, 2011 to Aug 31, 2012)
4. Potential impact of SSI decolonization program
5. Evidence for expanding the program
The Project Timeline

April 15th
Project Starts

June 1st
Formal Evaluation Begins

September 1:
All services participating

October 1st
Business Case Complete

November 30:
Follow-up period ends

Final Outcome Analysis Sept to Aug

Preliminary Data for BC: Jun 1 to May 31
1. Microbiological Efficacy, Safety, and Compliance

• Microbiological Efficacy:
  – determine the ability of PDT in decreasing the bioburden of *S. aureus* nasal colonization
    • pre-PDT nasal swab
    • post-PDT nasal swab
    • growth categorized
      – no growth, scant, moderate, heavy

  – due to logistical/financial reasons, did not assess CHG’s ability to decrease *S. aureus* body colonization
1. Microbiological Efficacy, Safety and Compliance

- Microbiological Efficacy

Baseline Colonization:
- MRSA: 1.28%
- MSSA: 23.37%

Records during study period N=6090

- PDT treated N= 5691
- PDT not treated N= 399

Colonized with MRSA N = 56/4370 (1.28%)
Colonized with MSSA N = 1315/5627 (23.37%)
Not Colonized MRSA: (98.72%) MSSA: (76.63%)
1. Microbiological Efficacy, Safety, and Compliance

• Microbiological Efficacy

<table>
<thead>
<tr>
<th>Growth</th>
<th>MSSA reduction n = 1286 (%)</th>
<th>MRSA reduction n=51 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy</td>
<td>105/109 (96.3%)</td>
<td>8 /10 (80%)</td>
</tr>
<tr>
<td>Moderate</td>
<td>348/383 (90.9%)</td>
<td>13/16 (81.3%)</td>
</tr>
<tr>
<td>Scant</td>
<td>598/794 (75.3%)</td>
<td>18/25 (72%)</td>
</tr>
<tr>
<td>Total</td>
<td><strong>1051/1286 (81.7%)</strong></td>
<td><strong>39/51 (76.4%)</strong></td>
</tr>
</tbody>
</table>

*unpaired data was excluded

** reduction defined as complete or partial bioburden reduction
1. Microbiological Efficacy, Safety, and Compliance

• Safety:
  – All adverse events were tracked and reported
  – 7 cases of transient, mild burning sensation in throat after application of methylene blue
  – Total adverse event rate of 7/5691 = 0.123%
1. Microbiological Efficacy, Safety and Compliance

- Compliance:
  - Complete Tx: 5566, (91%)
  - CHG only: 303, (5%)
  - PDT only: 125, (2%)
  - No Tx: 96, (2%)
## 2. Optimal Period for SSI Surveillance

<table>
<thead>
<tr>
<th>Service</th>
<th>1 month (n)</th>
<th>3 months (n)</th>
<th>6 months (n)</th>
<th>9 months (n)</th>
<th>12 months (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cardiac</strong></td>
<td>86% (177)</td>
<td>92% (189)</td>
<td>96% (198)</td>
<td>97% (200)</td>
<td>100% (205)</td>
</tr>
<tr>
<td>(n=205)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ortho</strong></td>
<td>79% (107)</td>
<td>86% (116)</td>
<td>94% (127)</td>
<td>99% (133)</td>
<td>100% (135)</td>
</tr>
<tr>
<td>(n=135)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Neuro</strong></td>
<td>75% (52)</td>
<td>88% (61)</td>
<td>93% (64)</td>
<td>99% (68)</td>
<td>100% (69)</td>
</tr>
<tr>
<td>(n=69)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Spinal</strong></td>
<td>92% (302)</td>
<td>97% (317)</td>
<td>99% (323)</td>
<td>99% (324)</td>
<td>100% (327)</td>
</tr>
<tr>
<td>(n=327)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Thoracic</strong></td>
<td>83% (33)</td>
<td>95% (38)</td>
<td>98% (39)</td>
<td><strong>100% (40)</strong></td>
<td><strong>100% (40)</strong></td>
</tr>
<tr>
<td>(n=40)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Vascular</strong></td>
<td>83% (93)</td>
<td>97% (109)</td>
<td><strong>100% (112)</strong></td>
<td><strong>100% (112)</strong></td>
<td><strong>100% (112)</strong></td>
</tr>
<tr>
<td>(n=112)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>86% (764)</strong></td>
<td><strong>93% (830)</strong></td>
<td><strong>97% (863)</strong></td>
<td><strong>99% (877)</strong></td>
<td><strong>100% (888)</strong></td>
</tr>
<tr>
<td>(n=888)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How long is long enough? Determining the optimal surgical site infection surveillance period. Infect Control Hosp Epidemiol 2012 33:1178-9
3. SSI Data - Extraction

- Total Eligible for SSI surveillance: N = 3264
  - Cases treated preop with PDT: N = 3068
  - Cases not treated: N = 196
- Not eligible for SSI surveillance: N = 1912

Total cases during study period and study hours: N = 5176

Total cases eligible for SSI surveillance: N = 3264
Cases not treated: N = 196
### 3. SSI Data - Determining 4-yr Historical SSI Rate

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>CARDIAC</th>
<th>NEURO</th>
<th>ORTHO</th>
<th>SPINAL</th>
<th>THORACIC</th>
<th>VASCULAR</th>
<th>TOTALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007/08</td>
<td>866</td>
<td>507</td>
<td>515</td>
<td>334</td>
<td>231</td>
<td>262</td>
<td>2715</td>
</tr>
<tr>
<td>2008/09</td>
<td>818</td>
<td>492</td>
<td>647</td>
<td>287</td>
<td>316</td>
<td>291</td>
<td>2851</td>
</tr>
<tr>
<td>2009/10</td>
<td>776</td>
<td>532</td>
<td>815</td>
<td>271</td>
<td>282</td>
<td>257</td>
<td>2933</td>
</tr>
<tr>
<td>2010/11</td>
<td>874</td>
<td>621</td>
<td>867</td>
<td>714</td>
<td>528</td>
<td>284</td>
<td>3888</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>3334</td>
<td>2152</td>
<td>2844</td>
<td>1606</td>
<td>1357</td>
<td>1094</td>
<td><strong>12,387</strong></td>
</tr>
</tbody>
</table>

**Average Historical SSI Rate:**

\[
\frac{339 \text{ infections}}{12,387} = 0.027
\]
### 3. Comparing SSI rates: Treated and Historical*

<table>
<thead>
<tr>
<th>Specialty</th>
<th>Treated</th>
<th></th>
<th></th>
<th>4 year Historical</th>
<th></th>
<th>P-value</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SSI</td>
<td>Procedures</td>
<td>SSI Rate</td>
<td>SSI (Avg)</td>
<td>Procedures</td>
<td>SSI Rate</td>
<td></td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>18</td>
<td>628</td>
<td>0.029</td>
<td>21</td>
<td>833.5</td>
<td>0.025</td>
<td>0.5830</td>
</tr>
<tr>
<td>Neuro</td>
<td>2</td>
<td>502</td>
<td>0.004</td>
<td>7.75</td>
<td>538</td>
<td>0.014</td>
<td>0.0764</td>
</tr>
<tr>
<td>Orthopedics</td>
<td>5</td>
<td>892</td>
<td>0.006</td>
<td>12.5</td>
<td>711</td>
<td>0.018</td>
<td>0.0141</td>
</tr>
<tr>
<td>Spine</td>
<td>19</td>
<td>475</td>
<td>0.04</td>
<td>34</td>
<td>201.5</td>
<td>0.085</td>
<td>0.0015</td>
</tr>
<tr>
<td>Thoracic</td>
<td>2</td>
<td>431</td>
<td>0.005</td>
<td>3.5</td>
<td>1357</td>
<td>0.010</td>
<td>0.2884</td>
</tr>
<tr>
<td>Vascular</td>
<td>4</td>
<td>140</td>
<td>0.029</td>
<td>6.25</td>
<td>1273.5</td>
<td>0.023</td>
<td>0.6747</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>50</td>
<td>3068</td>
<td>0.016</td>
<td>85</td>
<td>3097</td>
<td>0.027</td>
<td><strong>0.0005</strong></td>
</tr>
</tbody>
</table>

(1) CHG/mupirocin program in place previously (2) CHG bathing program in place previously (3) CHG/mupirocin used variably

* Statistics done on the four year total numbers rather than the average
# 4. Impact: SSI Case Reduction

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSIs/total treated patients (rate)</td>
<td>50/3068 (0.016)</td>
</tr>
<tr>
<td>Projected number of SSIs if all eligible patients (n=3264) treated</td>
<td>0.0016 x 3264 = 52</td>
</tr>
<tr>
<td>Four year historical average number of SSIs</td>
<td>85</td>
</tr>
<tr>
<td>Potential cases avoided if all patients treated</td>
<td>33 (39% reduction)</td>
</tr>
</tbody>
</table>
## 4. Impact: Financial

<table>
<thead>
<tr>
<th>Service</th>
<th>Cases Avoided</th>
<th>Case Cost*</th>
<th>Cost Avoidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurosurgery</td>
<td>6</td>
<td>$25,000</td>
<td>$150,000</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>3</td>
<td>$30,000</td>
<td>$90,000</td>
</tr>
<tr>
<td>Orthopedics</td>
<td>8</td>
<td>$33,000</td>
<td>$264,000</td>
</tr>
<tr>
<td>Spine</td>
<td>15</td>
<td>$30,000</td>
<td>$450,000</td>
</tr>
<tr>
<td>Vascular</td>
<td>2</td>
<td>$20,000</td>
<td>$40,000</td>
</tr>
<tr>
<td>Thoracic</td>
<td>1</td>
<td>$10,000</td>
<td>$10,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>35</strong></td>
<td><strong>$1,040,000</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Case Cost provided by A. Karpa Financial Planning and Business Support
**Cases are rounded up for Neuro and Orthopedics
## 4. Impact: Readmissions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>April 1/2012 to Sept 2012</th>
<th>Average 09/10 and 10/11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg number of readmissions/Fiscal period</td>
<td>1.25/pd</td>
<td>4.04/pd</td>
</tr>
<tr>
<td>Average days stay</td>
<td>16.5</td>
<td>16.5 days</td>
</tr>
<tr>
<td>Projected Readmissions for this fiscal year</td>
<td>15</td>
<td>48.5</td>
</tr>
<tr>
<td>Days Stay x Cost/dy</td>
<td>15 x 16.5 x $500/dy = $123,750</td>
<td>48.5 x 16.5 x $500/dy = $400,125</td>
</tr>
<tr>
<td>Cost Avoidance</td>
<td>$276,375</td>
<td></td>
</tr>
</tbody>
</table>
5. Impact: Cost Avoidance

1. LPNs able to treat 5176 patients/yr
2. 3608 were cases routinely followed for SSI outcomes
3. If remaining 1912 cases had a similar SSI rate reduction (0.016), 31 additional infections prevented.
4. $20,000/SSI x 31 = $611,840 avoided costs

Total Cost Avoidance: $1,040,000 + $276,375 + $611,840 = $1,928,215
6. Comparison of treated and not treated patients

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Treated (n=3068)</th>
<th>Not Treated (n=196)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>1393/1496 (93.1%)</td>
<td>103/1496 (6.95%)</td>
<td>0.0546</td>
</tr>
<tr>
<td>Age</td>
<td>61.7</td>
<td>58.1</td>
<td>0.006</td>
</tr>
<tr>
<td>ASA 3-5</td>
<td>1834/3050</td>
<td>125/194</td>
<td>0.2661</td>
</tr>
<tr>
<td>Scheduled Surgery</td>
<td>2861/3068 (93.3%)</td>
<td>165/196 (84.2%)</td>
<td>0.00003</td>
</tr>
</tbody>
</table>
7. Treated vs Not Treated Patients
Sept 1, 2011 – Aug 31 2012
(Cases routinely followed for SSIs)

<table>
<thead>
<tr>
<th>SSI Status</th>
<th>Txd</th>
<th>Not Txd</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSI</td>
<td>50</td>
<td>18</td>
</tr>
<tr>
<td>No SSI</td>
<td>3018</td>
<td>178</td>
</tr>
</tbody>
</table>

\[ p<0.00001 \text{ OR } 6.1038 \]

*Treated vs Not Treated groups may not have comparable risk factors for infection*
### 4. SSIs with *S. aureus*

<table>
<thead>
<tr>
<th>Specialty</th>
<th>Treated</th>
<th>Not Treated</th>
<th>p</th>
<th>OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiovascular</td>
<td>4/18</td>
<td>2/3</td>
<td>0.0948</td>
<td>10.000</td>
</tr>
<tr>
<td>Neuro</td>
<td>1/2</td>
<td>1/2</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Ortho (all)</td>
<td>2/5</td>
<td>0/4</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Spine</td>
<td>8/19</td>
<td>7/7</td>
<td>0.0490</td>
<td>20.2941</td>
</tr>
<tr>
<td>Thoracic</td>
<td>0/2</td>
<td>0/1</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Vascular</td>
<td>1/4</td>
<td>1/3</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>16/50 (32%)</td>
<td>11/18 (61%)</td>
<td>0.0235</td>
<td>3.6667</td>
</tr>
</tbody>
</table>

*Note that these groups are not necessarily comparable re risk factors*
### Not Treated Patients: Reasons

<table>
<thead>
<tr>
<th>Reason for Not Treated</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Staffed</td>
<td>32 (16%)</td>
</tr>
<tr>
<td>After Shift</td>
<td>20 (10%)</td>
</tr>
<tr>
<td>Dr/Nurse – Not enough time</td>
<td>40 (20%)</td>
</tr>
<tr>
<td>Technical Reasons</td>
<td></td>
</tr>
<tr>
<td>- No illuminators</td>
<td>5 (3%)</td>
</tr>
<tr>
<td>- Straight to OR from unit</td>
<td>21 (11%)</td>
</tr>
<tr>
<td>- Allergic/Patient refused</td>
<td>10 (6%)</td>
</tr>
<tr>
<td>- No information</td>
<td>38 (19%)</td>
</tr>
<tr>
<td>- Miscellaneous</td>
<td>12 (6%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>196</strong></td>
</tr>
</tbody>
</table>

*percentage of ‘not done’ cases range from 3.4% - 8.3% among surgical subspecialties

** No substantive differences between surgical subspecialties
Conclusions

• Nasal photodisinfection therapy is **microbiologically effective**

• Decolonization therapy **reduces surgical site infections**

• Decolonization programs **can be integrated** into perioperative work flow

• Nasal and skin decolonization have **high degree of compliance** when performed (98.8%)

• **Decreases patient morbidity and is cost effective**
Thank you!

The Patients
Surgery
Perioperative Services
Infection Control
Medical Microbiology
Patient Safety
Operations and Senior Leaders
Ondine Biomedical

Special Thanks: Study LPNs, data clerks, data analysts, microbiology technologists, and perioperative staff

Special Thanks: UBC- VGH Hospital Foundation

Team Awards:
AMMI 2012
Innovation Academy Award
Discussion / Questions?

Our vision
We will be leaders in promoting wellness and ensuring care by focusing on quality and innovation.

Our mission
We are committed to supporting healthy lives in healthy communities with our partners through care, education and research.