BSI: Addressing Clinical Challenges with Catheter Maintenance
Disclosure

- Marc J. Molitor, MSN, RN, VA-BC, CIC
  - Employed by 3M as a Clinical Specialist
- Presentation will mention brands as this is how it was presented in the literature
Learning Objectives

1. Identify sources of contamination that can lead to bloodstream infection (BSI)
2. Describe recommended practices and evidence based interventions for catheter maintenance to reduce BSI risk
3. Discuss clinical challenges associated with catheter maintenance that can impact outcomes
4. Identify solutions to address these challenges and clinical studies that support these solutions
Vascular Access and Bloodstream Infection (BSI)

60% of all hospital-acquired bloodstream infections (BSIs) originate from some form of vascular access.

Risk of BSIs vary and may be due to intrinsic or extrinsic factors:

<table>
<thead>
<tr>
<th>Catheter-related</th>
<th>Operator-related</th>
<th>Patient-related</th>
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</thead>
</table>
| • Intravascular device | • Experience and education of the individual who inserts the catheter, and/or Use of proven preventative strategies | • Characteristics of the catheterized patient:  
  ▪ Patient age  
  ▪ Severity of underlying illness  
  ▪ Patient nutrition  
  ▪ Poor skin integrity, and  
  ▪ Immunocompromised |
| • Type of and intended use for the catheter | | |
| • Insertion site | | |
| • Frequency with which the catheter is accessed, and/or | | |
| • Duration of catheter placement | | |
Terminology

Bloodstream Infection (BSI)

- Central Line Associated Bloodstream Infection (CLABSI)
- Catheter Related Bloodstream Infection (CRBSI)
CLABSI

Improvements made: CLABSI decreased by 58% in hospital ICUs since 2001\(^7\)

An estimated 65-70\% of CLABSIs are preventable\(^8\)

Goal 7
Reduce risk of HAI

07.04.01
Evidence-based practice to prevent CLABSI

78,000 bloodstream infections affect central line patients each year (2009)\(^7\)

Number of CLABSIs

- 47\% (37,000) ICU Patients
- 30\% (23,000) Other Acute Hospital Areas
- 23\% (18,000) Outpatient Dialysis
Patient Impact

HAIls account for a large proportion of the harm to patients caused by health care\(^9\)

1.27 cases per 1000 device-days\(^9\)

Incidence rate estimated for hospitalized adult populations at risk for CLABSI.

1.57 times higher risk of mortality in critically ill adults\(^10\)

CRBSIs are significant contributors to preventable hospital deaths.\(^2\)

12-24 more hospitalization days

Real world evidence has demonstrated an increase in hospital resources - and associated cost - required to treat morbidities due to CRBSIs\(^11-15\)

Patients who contract CLABSI die\(^7\)

1 in 4
Cost to Treat

CLABSI is the most costly HAI on a per-case basis\(^9\)

- **$45,814** Cost per CLABSI for adult inpatients
- **$1.85 billion** CLABSI annual cost to US healthcare system

![CLABSI LENGTH OF STAY\(^9\)](chart)

- ICU days: 6.9 days
- Total LOS: 10.4 days
The majority of CR-BSIs emanate from either the insertion site or the hub\textsuperscript{16-19}

Organisms on the skin gain access to the bloodstream via migration along the external surface of the catheter or catheter hub; both important routes of catheter-related bloodstream infections\textsuperscript{17-21}

Soon after insertion, the \textit{extraluminal route} or insertion site is the predominate source of infection\textsuperscript{17,22-23}

Whereas the \textit{intraluminal route} (primarily the hub) predominates after a more extended dwell time\textsuperscript{24-25}
The use of bundles
Evidence-based recommendations and performance improvement initiatives or strategies are bundled together to improve compliance\textsuperscript{26}

<table>
<thead>
<tr>
<th>Central Line Insertion Bundles\textsuperscript{26-29}</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔ Hand Hygiene</td>
</tr>
<tr>
<td>✔ Skin antisepsis using &gt;0.5% chlorhexidine in alcohol solution</td>
</tr>
<tr>
<td>✔ Maximal sterile barrier precautions (Mask, cap, sterile gown, large sterile drape and sterile gloves)</td>
</tr>
<tr>
<td>✔ Avoid the femoral vein for CVC placement</td>
</tr>
</tbody>
</table>
Maintenance includes many interventions
After catheter insertion, maintenance bundles have been proposed to ensure optimal catheter care\textsuperscript{29}

### Maintenance Bundles\textsuperscript{26-29}

- ✔ Assess need for catheter daily
- ✔ Perform hand hygiene before manipulation of IV system
- ✔ Dressing change recommendations and guidelines based on dressing type
- ✔ IV tubing administration set, secondary set and add-on device change guidelines based on medication or product infused
- ✔ Disinfect IV access ports with appropriate disinfectant for a period of time
ALL vascular access devices = BSI risk

Central venous catheters (CVC): Internal jugular, subclavian, femoral

Peripherally inserted central catheter (PICC)

Arterial line catheter (ART)

Peripherally inserted catheter (PIV)
References


References cont.


Extraluminal Contamination
The majority of CRBSIs emanate from either the insertion site or the hub\textsuperscript{1-3}

Organisms on the skin gain access to the bloodstream via migration along the external surface of the catheter or catheter hub; both important routes of catheter-related bloodstream infections\textsuperscript{4-6}

Soon after insertion, the extraluminal route or insertion site is the predominate source of infection\textsuperscript{2,31-32}

Whereas the intraluminal route (primarily the hub) predominates after a more extended dwell time\textsuperscript{33-34}
## Best Practice Guidelines: Dressings

**Strategies to Prevent Central Line-Associated Bloodstream infections in Acute Care Hospitals (2014)\(^8\)**

- Use chlorhexidine-containing dressings for CVCs in patients over 2 months of age (quality of evidence: I).

- If applicable, chlorhexidine-impregnated sponge dressing (1B) or chlorhexidine-impregnated dressing can be used. If a chlorhexidine-sponge dressing is used, it is oriented correctly and changed as the same time as the transparent dressing.

**Infusion Therapy Standards of Practice (2016)\(^9\)**

- Standard 41: Practice Criteria J: Use chlorhexidine-impregnated dressings over CVADs to reduce infection risk... (I)

- Practice Criteria C: Assess the catheter-skin junction site and surrounding area for redness, tenderness, swelling, drainage by visual inspection and palpation (V).

- Chlorhexidine-impregnated dressings with an FDA cleared label that specifies a clinical indication for reducing CRBSI or CABSI are recommended to protect the insertion site of short-term, non-tunneled central venous catheters. (Category IA)

**Guide to Preventing Central-Line Associated Bloodstream Infections (2015)\(^10\)**

- Chlorhexidine-containing dressings for CVCs in patients over 2 months of age (quality of evidence: I).

- If applicable, chlorhexidine-impregnated sponge dressing (1B) or chlorhexidine-impregnated dressing can be used. If a chlorhexidine-sponge dressing is used, it is oriented correctly and changed as the same time as the transparent dressing.

**Updated Recommendations on the Use of Chlorhexidine-Impregnated Dressings for Prevention of Intravascular Catheter-Related Infections (2017) [CDC website link]**

*According to CDC, due to a lack evidence, the use of CHG-impregnated dressings on patients younger than 18 years of age is an unresolved issue.*
### Intravascular (IV) devices mean BSI rates\(^3,27\)

**Short Term (<10-14 days)**
- Peripheral IV catheters
- Peripheral arterial catheters
- Central venous catheters (CVC)
  - Non cuffed
  - Not tunneled

**Long Term (>10-14 days)**
- Subcutaneous central venous ports
- Peripherally Inserted Central Venous Catheter (PICC)
- Central venous catheters
  - Tunneled
  - Cuffed

<table>
<thead>
<tr>
<th>Device Type</th>
<th>BSI Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIVs</td>
<td>0.6 BSI /1000 catheters days</td>
</tr>
<tr>
<td>Arterial</td>
<td>2.9 BSI/1000 catheters days</td>
</tr>
<tr>
<td>CVCs</td>
<td>2.3 BSI/1000 catheter days</td>
</tr>
<tr>
<td>Ports</td>
<td>0.2 BSI/1000 catheter days</td>
</tr>
<tr>
<td>PICCs</td>
<td>0.4 BSI/1000 catheter days</td>
</tr>
<tr>
<td>Tunneled-HPN</td>
<td>1.2 BSI/1000 catheter days</td>
</tr>
<tr>
<td>Dialysis</td>
<td>Cuffed: 1.1 Noncuffed: 2.8/1000 cd</td>
</tr>
</tbody>
</table>
Beyond the guidelines: Clinical considerations for VAD site maintenance
**Maintenance is for the life of the line**

**Insertion** - the procedure represents only one aspect of the risk for CRBSI\(^8\)

**Maintenance** - the risk of CRBSI extends to all aspects of nursing care and maintenance during the CVC dwell time\(^8\)
## Skin preps: Which is more effective?^{11}

<table>
<thead>
<tr>
<th></th>
<th>10% PI</th>
<th>70% alcohol</th>
<th>2% CHG</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N</strong></td>
<td>N = 227</td>
<td>N = 227</td>
<td>N=214</td>
</tr>
<tr>
<td><strong>CRI/100 cd</strong></td>
<td>9.3</td>
<td>7.1</td>
<td>2.3</td>
</tr>
<tr>
<td><strong>CR Bacteremia</strong></td>
<td>2.6</td>
<td>2.3</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Infected Catheters</strong></td>
<td>7</td>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>

Skin microbes and preps

CHG prep reduces skin microbes, but some remain

Despite prep, skin flora regrow in 24 hours

In-Vivo Suppression of Microbe Regrowth

<table>
<thead>
<tr>
<th>Time</th>
<th>Mean Log count ( \log_{10} ) CFU/CM(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>3.0</td>
</tr>
<tr>
<td>Post-Prep</td>
<td>0.1</td>
</tr>
<tr>
<td>Day 1</td>
<td>0.5</td>
</tr>
</tbody>
</table>

CRBSI: Most Common Pathogens

Usability: Medical device errors

Consistent Application

The International Organization of Standards promote the importance of medical device design to support correct use, patient safety, user satisfaction and to reduce medical device-related errors.


Site assessment

<table>
<thead>
<tr>
<th>Source</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDC⁷</td>
<td>Recommends the use of transparent dressings because they permit continuous visual inspection of the catheter site.</td>
</tr>
<tr>
<td>Gauze or sponges⁹</td>
<td>Some dressing materials may obstruct site visibility and reduce securement.</td>
</tr>
<tr>
<td>INS⁹</td>
<td>INS 2016 Standard 41 recommends assessment of the VAD catheter-skin junction site and surrounding area for redness, tenderness, swelling, and drainage by visual inspection and palpation.</td>
</tr>
</tbody>
</table>
Phlebitis is related to bloodstream infection

Peripheral Vein Phlebitis
- Related to the incidence of peripheral catheter bloodstream infection (ratio 1 catheter related bloodstream infection for every 320 episodes of peripheral vein phlebitis)

Peripheral Catheters
- The most used catheter CVC to PVC = 1:90
- Peripheral catheters cause 19% of all CRBSIs
- Peripheral catheters are the leading source of S. aureus BSI

Dressing Disruption

CRBSI Risk

>10x risk of infection with 2+ unscheduled dressing changes\textsuperscript{16}

INS 2016

Do not rely on standard (non-bordered) VAD dressings as a means of stabilization… (I).\textsuperscript{9}

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Sutures

**Microbes**
Able to colonize the catheter and cause CRBSI.\(^7\)

**Needle-stick Injury**
CDC and INS recommend the use of sutureless securement devices to reduce the risk of catheter movement, dislodgement and needlestick injury.\(^7,9\)
The difference is clear: Solving the site maintenance challenge
CHG Effectiveness

- **1st Synthesized & Marketed in 1950s**
  - Over 55 years of efficacy and safety experience by chlorhexidine as a topical antimicrobial

- **Efficacy**
  - Broad-spectrum activity against gram-positive and gram-negative bacteria, anaerobes and aerobes, yeasts, and some lipid-envelope viruses. Not sporicidal. Demonstrated effectiveness against *S. epidermidis*, MRSA, VRE, *K. pneumoniae*, *C. albicans*
  - **Bacterial Susceptibility**
    - After 50 years of research and experience, still no development of bacterial resistance against CHG
    - A large multitude of genes will need to evolve to fend off CHG
CHG Gel: Tested against 37 microbial strains

**Bashir (2012) Am J Infect Control**

**CHG Gel Securement Dressing Results**

**DESIGN:** Randomized controlled trial comparing suppression of microbe regrowth chlorhexidine prep vs. CHG gel vs CHG disk dressings.

**METHODS:**
- All patients treated with CHG skin prep
- Randomized to either:
  - Transparent film dressing (control)
  - CHG gel dressing
  - CHG disk + transparent film dressing

**RESULTS:**
- n = 32 healthy subjects
- The CHG gel dressing demonstrated significantly greater microbial suppression than CHG disk on day 7 (p = 0.01).


A Different Experience with Two Different Chlorhexidine Gluconate Dressings for use on Central Venous Devices

CHG Gel Securement Dressing Results

**DESIGN:** Clinical audit: correct application

**METHODS:**
- Staff re-educated on both products
- Evaluated application of CHG gel dressing in 2012, and CHG disk in 2009

**RESULTS:**
- n = 248 dressing applications
- CHG disk placed incorrectly 64%
- CHG gel pad of the CHG dressings placed correctly 100%

CHG Gel: Site visibility to assess complications

- Erythema
- Catheter movement
- Infiltration
- Catheter Damage
- Extravasation
- Phlebitis
- Bleeding
Securement

CHG Gel Securement Dressing Results

**DESIGN:**
- In-vivo mean pull force test
- Inserted CVC catheters with ESDs

**RESULTS:**
- 3M™ ESD + CHG gel securement dressing required significantly higher pull force than sutures + dressing or a competitive securement dressing.

Mean Pull Force Required to Dislodge Inserted CVC Catheter

- **3M™ ESD + CHG gel securement dressing:** 9.2 pounds
- **Sutures (3-0) Silk Tegaderm™ I.V. Film Dressing:** 6.2 pounds
- **Competitive Securement Dressing:** 3.9 pounds

Independent Lab in vivo testing: EM-05-012908 (Synchrony labs, Durham, NC.)
Karpanen (2016) Am J Infect Control

Clinical evaluation of a chlorhexidine intravascular catheter gel dressing on short-term central venous catheters

**CHG Gel Securement Dressing Results**

**DESIGN:** Prospective, cross-over, comparative, non-blinded, single center study.

**METHODS:**
- Microbial analysis of suture material, suture skin sites, CVC insertion sites and CVC tip sections after removal of antimicrobial CVC and either:
  - Standard IV dressing
  - CHG Gel IV dressing

**RESULTS:**
- Significant reduction of microbes at all sites using CHG gel dressing compared to standard dressing (p<0.001).

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CRBSI Clinical Studies
Safdar (2014) Crit Care Med
Chlorhexidine-impregnated dressing for the prevention of CRBSIs: A meta-analysis

**Meta-analysis: CHG Dressings**

**DESIGN:** Meta-analysis

**METHODS:**
- Included RCTs evaluating effectiveness of CHG disk or CHG gel dressing or a non-CHG dressing on CRBSI

**RESULTS:**
- CVC and arterial catheters
- 6,067 patients
- 5,586 catheters (CHG group)
- 5,628 (conventional group)
- Catheter dwell: 5.6 – 71.5 days
- Low incidence of contact dermatitis

**Graph:**
- Catheter Colonization (% of catheters) & CRBSI (% of patients)
- Control vs. CHG
- Catheter Colonization: Control 14.3%, CHG 6.8% (p < 0.001)
- CRBSI: Control 2.1%, CHG 1.1% (p = 0.009)
Timsit (2012) Am J Respir Crit Care Med

Randomised controlled trial of chlorhexidine dressing and highly adhesive dressing for preventing CRBSIs in critically ill adults

CHG Gel Securement Dressing Results

DESIGN: Randomised controlled trial comparing major CRI with or without CRBSI and catheter colonization rates

METHODS:
- Patients with CVC and/or arterial catheters randomized to:
  - CHG Gel IV Dressings
  - Non-chlorhexidine dressings
- 12 ICUs in France

RESULTS:
- 1,879 patients, 4,163 catheters, 34,339 catheter-days

Timsit (2012): CVC and Arterial Catheters

Results:

- **CRBSI Rate (per 1000 catheter days)**
  - Non CHG dressing: 1.3
  - CHG dressing: 0.5
  - 60% reduction
  - *P* = 0.02

- **Catheter Colonization Incidence (per 1000 catheter days)**
  - Non CHG Dressings: 10.9
  - CHG Dressings: 4.3
  - 61% reduction
  - *P* < 0.0001
A Crossover Intervention Trial Evaluating the Efficacy of a Chlorhexidine-Impregnated Sponge (BioPatch®) to Reduce Catheter-Related Bloodstream Infections in Hemodialysis Patients

**Hemodialysis Tunneled Catheters Study**

**DESIGN:** Prospective non-blinded cross-over intervention trial measuring CRBSI rates

**INTERVENTION:**
- Patients with tunneled HD catheters: Standard dressing or Standard dressing with CHG sponge.
- Two outpatient dialysis centers

**RESULTS:**
- n = 121 patients with tunneled HD catheters
- The use of the CHG-impregnated sponge dressing did not decrease CRBSI (p = 0.46)

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Righetti (2017) J Vasc Access

Tegaderm™ CHG dressing significantly improves catheter infection rate in hemodialysis patients

CHG Gel Securement Dressing Results

DESIGN: Prospective Randomized cross over trial measuring CRI and CRBSI rates in HD patients

METHODS:

- Patients with tunneled HD catheters randomized to either:
  - Standard dressing
  - Tegaderm™ CHG Dressing

RESULTS:

- n = 59
- Estimated annual savings of €237,940 with use of Tegaderm™ CHG Dressings

CRI & CRBSI Rate (per 1000 catheter days)

- CRI: Standard dressing 1.21, CHG 0.28 (p = 0.02)
- CRBSI: Standard dressing 0.65, CHG 0.09 (p = 0.05)
Apata (2017) J Vasc Access

Chlorhexidine-impregnated transparent dressings decrease catheter-related infections in hemodialysis patients: a quality improvement project

**CHG Gel Securement Dressing Results**

**DESIGN:** Prospective Before and After Intervention Measuring CRI Rates in Patients with Dialysis Catheters

**METHODS:**
- Patients with tunneled HD catheters: 3 outpatient units
  - Control: Dry gauze dressing with ointment changed 3x/week
  - Intervention: CHG Gel Dressing changed weekly

**RESULTS:**
- CHG-transparent gel dressing decreased CRI rates in patients with tunneled dialysis catheters

**CRI Rates (per 1,000 cd) per respective outpatient units**

- **EDN:** Pre-Intervention: 1.89, Intervention: 0.88, P < 0.05
- **EDG:** Pre-Intervention: 1.86, Intervention: 0.26, P < 0.05
- **EDC:** Pre-Intervention: 1.69, Intervention: 0.82, P < 0.05

A randomized trial on chlorhexidine dressings for the prevention of CRBSIs in neutropenic patients

DESIGN: Open-label randomized, multi-center trial measuring definite CRBSI within the first 14 days of CVC placement

METHODS:
- Patients with CVCs randomized to either: Standard dressing or CHG Gel Dressing
- 10 German hematological depts

RESULTS:
- n = 613
- dCRBSI: CHG 2.6% vs control 3.9% (p = 0.375)

Scheithauer (2016) Clin Infect Dis

Significant Reduction of External Ventricular Drainage–Associated Meningoventriculitis by Chlorhexidine-Containing Dressings: A Before-After Trial

CHG Gel Securement Dressing Results

**DESIGN:** Before and after intervention study comparing external ventricular drainage (EVD)-associated meningoventriculitis (MV)

**METHODS:**
- Pre-Intervention: Gauze dressing
- Intervention: CHG gel dressing

**RESULTS:**
- 5383 EVDs (Pre-intervention)
- 2512 EVDs (Intervention)
- No adverse events reported

EVD associated MV (per 1000 EVD days)

- Pre Intervention: 6.98
- Intervention: 1.70

*p = 0.005*
Use of a Central Catheter Maintenance Bundle in Long-term Acute Care Hospitals (LTACHs)

**Disinfecting Cap Study Results**

**DESIGN:** Before and after intervention study bundle in 30 LTACHs

**INTERVENTION:**
- Implemented central line bundle
- Bundle included: education, mandatory use of disinfecting caps on CVC and tubing, chlorhexidine gluconate dressings, and formation of central line team

**RESULTS:**
- Infection reduction translate to a savings of approximately $3.7 million annually for the 30 LTACHs
- Potentially saved 20 patients’ lives

**CLABSI Standardized Infection Ratio (SIR)**

Pre intervention (2/2012-7/2012) SIR = 1.28

Intervention (8/2012-1/2013) SIR = 0.96

25% reduction


Economic impact of Tegaderm™ CHG IV securement dressing in critically ill patients

Medical Adhesive-Related Skin Injury (MARSII)
Skin preparation Best Practice: protect skin with an alcohol-free barrier film


Central Vascular Access Device (CVAD) Stabilization
Standard 37, page S72-74

- Apply barrier solutions to skin exposed to adhesive dressing to reduce risk of Medical Adhesive-Related Skin Injury (Marsi). (Level I)

Best Practice: protect skin with an alcohol-free barrier film

- Forms a protective interface between the adhesive and skin
- Adhesive removal removes barrier film, not epidermal cells
So how do we prevent MARSI? Address causal factors

- **Type of adhesive**
- **Skin Preparation**
- **Application Technique**
- **Removal Technique**
What Does Some of the Evidence Tell Us?

A recent study evaluated skin condition in 100 patients with peripherally inserted central catheters. Without Cavilon NSBF, 20% of patients experienced skin complications such as rash, redness, peeling, maceration, and adhesive transfer. However, with the use of Cavilon NSBF, a significant decrease in local skin complications was demonstrated, reducing the percentage to 10% of patients.

Skin damage is a local complication that can lead to increased risk of colonization and infection. Skin protectant plays an important role in reducing the local complications in PICC lines.

% Patients with skin complications* (PICC lines)

- Without Cavilon NSBF
  - n=100
  - *rash/redness, peeling, maceration, adhesive transfer
- With Cavilon NSBF

* Significant decrease in local skin complications with use of Cavilon™ NSBF was demonstrated.

References:
Resources


CHG Clinical Study Summary Slide
Summary of Clinical Evidence

Reduce the risk of CRBSI

- CRBSI reduction 60%\(^\text{21}\)
- Catheter colonization reduction 61%\(^\text{21}\)
- CVC and arterial catheters\(^\text{21}\)

Reduce Cost

- More cost effective than standard dressing\(^\text{29}\)
- A group of 30 Long Term Acute Care Hospital (LTACHs) approximated annual savings of $3.7 million\(^\text{28}\)

Increase Compliance

- 100% compliance of CHG gel placement, compared with only 36% CHG disk\(^\text{14}\)
- CHG gel can be applied to a variety of different catheter types, sizes and locations.

Transparent

- CHG gel dressing meets transparent securement dressing recommendations for all types of VADs\(^\text{7,9}\)
BSI

- ALL vascular access devices increase the risk of BSI
- Contamination can be introduced into bloodstream via:
  - Extraluminal route
  - Intraluminal route
- Clinical considerations are important when implementing evidence based interventions to address catheter maintenance challenges
Reducing the risk of BSI
A comprehensive approach to maintenance is critical to reduce risk at all access points.
Thank you

Questions?
References


References cont.


18. Independent Lab *in vivo* testing: EM-05-012908 (Synchrony labs, Durham, NC.)


References cont.


27. Maki, Catheter BSI rates: *Clinical Infectious Diseases*, 2002; 34:1232-1262


3M™ Health Care Academy
References cont.


36. George M. Role of skin protectant in reducing the local complications in PICC lines. Poster presentation at the 2013 meeting of the Infusion Nursing Society


