Antimicrobial Catheter Lock Solution for the Prevention of Hemodialysis Catheter-Related Bloodstream Infection

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Session Objectives

- Understand infection prevention techniques related to hemodialysis (HD) catheter infections
- Discuss antimicrobial catheter lock solutions as an additional technique to prevent catheter infections
- Demonstrate implementation and success of lock program at Henry Ford Health System

- No conflicts of interest. Discussion will include off-label uses.
Background

- Infection is the **2nd most common cause of death** in HD patients (20.2% in 2006), after cardiovascular disease

- Between 1993 and 2006, the rate of **hospitalization for vascular access infections** in HD patients more than doubled

- Infection rate is approximately 10 times higher for tunneled catheters than fistulas or grafts

When Fistula is Not First...

- Ongoing efforts to improve initiation of renal replacement therapy with increased access to pre-ESRD nephrology care and placement of arteriovenous fistula

- Still, 80% of ESRD patients in the US initiate HD with a central line

APIC 2010  http://www.apic.org/EliminationGuides

MMWR / March 1, 2011 / Vol. 60
http://www.fistulafirst.org/
**Benchmark Data**

**NHSN Data Summary for 2006**

- **Permanent catheter-related bloodstream infections**
  - **Best Practice is Zero**
  - Pooled mean: 3.1 per 100 patient months
  - 10<sup>th</sup> percentile: 0.0 per 100 patient months
  - 25<sup>th</sup> percentile: 0.6 per 100 patient months
  - 50<sup>th</sup> percentile: 2.4 per 100 patient months
  - 75<sup>th</sup> percentile: 4.5 per 100 patient months
  - 90<sup>th</sup> percentile: 6.3 per 100 patient months

*Klevans et al. Seminars in Dialysis. 2008—Vol 21, No 1, 24–28*
Dialysis Catheter Related BSI at HFHS 2008-2009

Catheter-Associated BSIs in Hemodialysis

Getting to Zero Infections at HFHS...

- Creation of the Fistula Improvement Team
  - More fistulas → less catheters

- Staff and patient education on basic prevention practices, catheter care

  Slow progress → Failure Mode and Effect Analysis
### Failure Mode Action

<table>
<thead>
<tr>
<th>Failure Mode</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM / Elderly / HF patients at increased risk of failure. Access site unavailable; AVF matures slowly</td>
<td>Venous mapping and vascular access data base, earlier PCP referral, better DM control</td>
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<tr>
<td>No insurance for access</td>
<td>Reduce barriers</td>
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<tr>
<td>Multiple sites used for access; IV catheter / PICC in potential vascular access site</td>
<td>Nursing and medical staff policies to preserve arm, unauthorized access</td>
</tr>
<tr>
<td>Vascular access infiltration; abandonment of fistula</td>
<td>Education and recertification educational assessment, redesign, assess competency</td>
</tr>
<tr>
<td>Catheter site maintenance</td>
<td>Biopatch; Antibiotic Lock System</td>
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<tr>
<td>Catheter clotting; pt sleeping on access arm</td>
<td>More tPA use, armboard; avoid excessive sedation; pt education</td>
</tr>
<tr>
<td>Hospitalization; precautions; CRBSI; competency</td>
<td>Educate and audit infection prevention practices</td>
</tr>
<tr>
<td>Patient factor: refusal to undergo vascular access surgery</td>
<td>Assess reasons for “refusal”; improve communication, education; facilitate early appt</td>
</tr>
<tr>
<td>Physician monitoring</td>
<td>Vascular Access DB; Unit Med Dir reviews each case where AVF is not being used</td>
</tr>
</tbody>
</table>

### Novel Prevention Strategies

- Recommended interventions to improve central-line maintenance can reduce bloodstream infection in hemodialysis patients and should be consistently implemented.

- Consider novel prevention strategies, such as measures to reduce central-line colonization in hemodialysis patients, to further reduce infection.

  - *Antimicrobial Catheter Lock solution*
Antimicrobial Catheter Lock Solution

- Bacterial biofilm develops rapidly in vascular catheters and is the major source of catheter-related bacteremia in hemodialysis patients.

- Bacteria in biofilm are relatively resistant to therapeutic plasma concentrations of antibiotics, but are susceptible to higher concentrations.

- Instillation of an antimicrobial solution into the catheter lumen will decrease catheter-related bacteremia.

M. Allon. AJKD 2008, 2: 165-168

Antimicrobial Lock vs. Heparin
Summary of Previous Studies

M. Allon. AJKD 2008, 2: 165-168
Possible Barriers to Implementation

- Lock solutions not currently marketed by large pharmaceutical companies and no solutions are currently FDA approved
- Extensive education and motivation required
- Potential adverse events
  - Development of antibiotic resistance
  - Antibiotic allergy
  - Systemic toxicity when solution leaks into circulation
- Lack of financial incentive
  - Solutions not directly reimbursed to dialysis center


Antibiotic Lock Protocol to Reduce Catheter-Related Bacteremia in Hemodialysis Patients: Scale Up and Spread

Greenfield Health Systems
Dialysis Management & Consulting
Aims of Antimicrobial Lock Project

- Reduce the incidence of CRBSI in HD patients to below the national benchmark of 3.1 infections per 100 patient months
- Protect patients from the morbidity and mortality associated with an episode of CRBSI
  - Infection-related hospitalization
  - Vascular access procedures

Implementation in Pilot Unit

- Lock Solution: Gentamicin/Citrate (320µg/mL/4%TSC)
- All patients dialyzing via catheter
- Protocol began October 1, 2009 in pilot unit

![Graph showing CRBSI rate over time](image-url)
Measurements

- **Primary Outcomes**
  - Rate of catheter-related BSI
  - Rate of infection-related hospitalization and vascular access procedures

- **Secondary Outcomes**
  - Mortality rate over time
  - Infection with gentamicin resistant organisms
  - Systemic levels of gentamicin

Results

Reduction in Catheter-Related Bacteremia

- Within 3 months of implementing change, infection occurred in **only 6%** of patients compared to **25% of patients before** the change, \( P < 0.001 \)

- When evaluating the rates of infection over time, use of antibiotic lock reduced infection from **5.3** per 100 patient months to **1.8** per 100 patient months in the pilot unit, \( P < 0.0001 \)
Results

Reduction in Healthcare Utilization

![Bar chart showing reduction in infection-related hospitalization and any vascular procedure post-lock. P-values indicate statistical significance.]

Results

Monitoring for Antibiotic Resistance

- No trends in gentamicin resistance identified

![Line chart showing counts of gentamicin resistant organisms over time. Pre-lock and post-lock periods are shown.]

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Scale Up and Spread

- Pilot protocol was spread to two other centers.
- Marked reduction in CRBSI to < 2/100 patient months and a 10-15% decrease in mortality in the entire dialysis population of over 1,700 patients.

![CRBSI Rate vs. Mortality](image)

Conclusion

- Using a prophylactic antibiotic lock significantly reduced the incidence of catheter-related bloodstream infection in a population experiencing a high rate of infection despite recommended efforts aimed at reduction.

- By reducing episodes of infection, we were able to reduce costly infection-related hospitalizations and vascular access procedures and have seen a reduction in mortality in this population.

- No adverse events (increase in antibiotic resistance, significant detectable levels of antibiotic in circulation) have occurred.
Summary

- Catheter-related bloodstream infection is a significant complication of hemodialysis.
- Antimicrobial lock prophylaxis is an effective and safe method to decrease infections, when basic measures are not effective.
- Implementation is a multidisciplinary effort; key players include: nephrology providers, dialysis unit administrators, pharmacy, infection prevention.

Acknowledgements

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Greenfield Health Systems

*Medical Management & Consulting*