OBJECTIVES

At the conclusion of this educational activity, participants should be able to:

1. Identify evidence based practices for CLABSI prevention
2. Discuss the approach to the patient with central line occlusion
CATHETER-RELATED OCCLUSION*

- Thrombotic 58%
- Nonthrombotic or Mechanical 42%
- Episodes/Catheter year 0.071*

CAUSES OF CATHETER OCCLUSION

- Clot or thrombus
- Fibrin deposition
- Fat deposition
- Calcium-phosphorus precipitation
- Drug precipitation

Mechanical Causes

- Kinking of the catheter
- Catheter tip against venous wall
- Excessively tight suture

NON-THROMBOTIC CAUSES OF CVC OCCLUSION* 

1. Kinked catheter
2. Retaining suture too tight
3. Catheter clamped – slide or roller clamps left closed or partially closed
4. Catheter pinched+

*J Grant, JPEN 26:S21, 2002 (Coram HPEN Workshop)

NON-THROMBOTIC CAUSES OF CVC OCCLUSION (continued)

+ Pinch-Off Syndrome – blood return is only obtained when patient’s arm, on the same side as the catheter insertion site, is raised parallel to the shoulder. This indicates the catheter is compressed between the clavicle and the first rib. Pinch-Off Syndrome can lead to catheter fracture and embolism – remove catheter and place a new one lateral to the midclavicular line.

CAUSES AND MANAGEMENT OF CATHETER OCCLUSION

<table>
<thead>
<tr>
<th>Cause</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clot or thrombus</td>
<td>t-PA (Alteplase)</td>
</tr>
<tr>
<td>Fat deposition</td>
<td>70% ethanol</td>
</tr>
<tr>
<td>Calcium-phosphorus deposition</td>
<td>0.1 N Hydrochloric acid</td>
</tr>
<tr>
<td>Drug precipitation</td>
<td>0.1 N Hydrochloric acid or 0.1 N NaOH</td>
</tr>
</tbody>
</table>

WHAT IS ALTEPLASE?

- Genetically engineered human tissue-plasminogen activator
- Generic = alteplase (t-PA)
- Plasma half-life: 5 minutes (hepatic clearance)
- Tradename
  - 2 mg – Cathflo™ Activase ®
  - Catheter clearance
  - 50, 100 mg – Activase ®
- Acute MI, acute stroke, pulmonary embolism

CATHFLO ACTIVASE PEDIATRIC STUDY (CAPS)

- Determine catheter efficacy at 30 and 120 minutes
- Determine rates of SAE that occur within 48 hours of treatment
PATIENT CHARACTERISTICS

- Total Enrolled: 321
- Treated subjects: 310
- Subjects <2 years: 55
- Subjects >2 years: 255
- Gender: 174 M; 136 F
- Age (mean, SD): 7.2 years (5.1)
  Range (years): 0.04 to 18.3
- Weight (mean, SD): 30.3 kg (23.1)
  Range (kg): 2.2 to 107

CUMULATIVE RESTORATION RATES (Efficacy-Evaluable Subjects)

CONCLUSION

- Cathflo™ Activase® is safe in both patients <2 years of age as well as the general pediatric population <17 years of age.
- No ICH, Major Hemorrhage, Thrombosis, or Embolic Events observed.
- Incidence of protocol defined sepsis similar to that seen in COOL-2.
- High rate of efficacy similar to that seen in COOL-1 and COOL-2.
**OCCLUSION SECONDARY TO FAT DEPOSITION (“WAXY” BUILD-UP OF LIPIDS ON THE INTERNAL CATHETER)**

- Werlin (JPEN 19:416, 1995) – In Pediatrics: up to 3 mL EtOH (max. 0.55 mL/kg); 10 of 26 occlusions were secondary to lipid.

**CALCIUM-PHOSPHATE OR DRUG PRECIPITATION IN CHILDREN**

- Up to 3 mL of 0.1N HCl (up to 1 mL in infants between 1 and 3 kg.)
  - To syringes containing 0.5 ml connected to catheter hub and gentle push-pull motion applied to syringe plunger. If catheter did not clear, treatment remains in the line up to 1 hr; then aspirate
    - Werlin: JPEN 19:416, 1995 (mineral deposits n=3; medication ppts n=13)
    - Breaux: J Ped Surg 22:828, 1987 (Ca-Phos ppt. n=7)
  - Shulman JPEN 12: 509, 1988 – 0.2-1.0 mL HCl cleared 4/4 catheters
    a) Ca-Phos ppts. (2)
    b) Amikacin, piperacillin, vancomycin, heparin ppt.
    c) Etoposide ppt.

**DRUG PRECIPITATE**

- **ACIDIC DRUGS**
  (e.g., Vancomycin, Etoposide)
  Tx. With 0.1N HCl

- **BASIC DRUGS**
  (e.g., ticarcillin, oxacillin, heparin, phenytoin, imipenem)
  Tx. With sodium bicarbonate 1mEq/mL or 0.1N NaOH


• Compounding and storing of 0.1N HCl is now more complex due to USP <797> guidelines for sterile compounding – an alternative is needed

• L-cysteine pH 1 - 2.5
• CVC occlusion resolved in 10 of 16 episodes in 13pts.
• Dose: no more than 2mL (100mg; 50mg/mL)
• 2 that could not be cleared were from phenytoin admin. (has a basic pKa)

CLABSIs

• CLABSI rates for inpatient pediatric units
  • 0.5-1.9 per 1,000 catheter days

• CLABSI rates among pediatric IF
  • 8.0-10.2 per 1,000 catheter days
  • Proposed reasons
    – Relative immune-deficient state
    – Poor intestinal motility
    – Reduced barrier function
    – Frequency of line access/Line colonization

CLABSIs IN CHILDREN WITH INTESTINAL FAILURE

• Children with intestinal failure (IF) depend on central venous catheters (CVC) for total parenteral nutrition (TPN), placing them at high risk for central-line associated bloodstream infections (CLABSIs)
• Number of CLABSIs correlate with mortality and clinical outcome
• Unlike successful CLABSI reductions in other high-risk pediatric patients, children with IF continue to have high CLABSIs rates:

 8 - 26.4 CLA-BSI/1,000 catheter days
LOCKING SOLUTIONS

- Antimicrobial locking solutions
  - Expensive
  - Encourage resistant organisms

- Ethanol
  - Cheap
  - Antimicrobial
    - Kills bacteria, fungi, and viruses
  - Penetrates biofilms

ETHANOL’S ANTIMICROBIAL EFFECTS

- S. aureus and S. pyogenes are killed by 10 sec exposure to 60-95% EtOH
- P. aeruginosa, E. coli, and S. marcescens are killed by 10 sec exposure to 40-100% EtOH
- More time with EtOH ≥ 40% is needed to inhibit bacterial growth in established biofilms

EtOH AND PLASTIC-ADHERENT MICROORGANISMS

- Biofilm incubated for 40 hr
- Exposed to EtOH in varying concentrations for 8 hr
- Bactericidal effect from 30% to 90%
- No growth after 4, 6, or 24 hr of exposure to 70% EtOH
ELT - PRINCIPLES

- Ethanol concentrations above 40% required to inhibit bacterial growth in established biofilms
- Use 70% ethanol lock
  - Needed for at least 2 hrs to kill established biofilms
ETHANOL LOCK

- Ethanol is bactericidal and fungicidal
  - Nonspecifically denatures cell membrane proteins
- Inhibit bacterial growth and penetrates bacterial biofilm within the line
- Improves clearance of line infection
- May save the line from replacement
ETHANOL-LOCK FOR CATHETER SALVAGE

- 40 children/51 CVC-related infections
- EtOH 70%: 0.8 – 1.4 mL for 12-24 hr, then withdrawn
- Catheters removed: 0


After EtOH withdrawn, isotonic saline flush
Repeat EtOH for 5 consecutive days
Separate peripheral line for IV Abx.
With double lumen catheters
ethanol into 1 lumen for 24 hrs.,
while the other lumen used for infusion
Both lumens were alternately treated for 10 days


ETHANOL-LOCK FOR CATHETER SALVAGE

- Relapse: 12%
- 75% of polymicrobial isolates: no recurrence
- 94% of monomicrobial isolates successfully treated
- The treatments of 2 yeast isolates were also successful

ETHANOL LOCK

- Inexpensive, Readily available
- Bactericidal properties
  - 40% EtoH will inhibit bacterial growth in established biofilm
  - 70% EtoH with 4 hr dwell time leaves no viable plastic-adherent bacteria or fungi
- Protein denaturation
- No known resistance
- Limited experience in children with IF

1 Sisson et al, 1996
2 Chambers et al, 2006

Ethanol lock therapy to reduce the incidence of catheter-related bloodstream infections in home parenteral nutrition patients with intestinal failure: preliminary experience

Paul W. Wales a,b,⁎; Christina Kosar,⁎; Megan Carricato,⁎; Nicole de Silva,⁎; Karen Lang,⁎; Yaron Avitzur a,b

- 70% ethanol solution prepared by outpatient pharmacy in pre-loaded syringes
- >5 Kg with silicone CVC or PICC
- Parents instill ethanol solution at completion of PN cycle
- Minimum dwell time of 4 hours
- Solution flushed prior to re-starting PN
- Volumes vary based on CVC device (usually 1-1.5cc)

TOTAL CRBSI PRE AND POST ETHANOL LOCK THERAPY

<table>
<thead>
<tr>
<th></th>
<th>Pre-ELT</th>
<th>Post-ELT</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.2</td>
<td>0.9</td>
<td></td>
</tr>
</tbody>
</table>

p=0.005
CVC REPLACEMENTS PRE- AND POST- EtoH LOCK THERAPY

Per 1000 Catheter days

RESULTS: META-ANALYSIS
(a) Pooled mean difference of CRBSI rate

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Mean Difference</th>
<th>SD</th>
<th>Weight</th>
<th>95% CI Lower</th>
<th>95% CI Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 2010</td>
<td>-2.56</td>
<td>6.5</td>
<td>0.10</td>
<td>-7.67</td>
<td>2.55</td>
</tr>
<tr>
<td>June 2010</td>
<td>7.83</td>
<td>3.85</td>
<td>0.10</td>
<td>7.08</td>
<td>8.53</td>
</tr>
<tr>
<td>Nov 2010</td>
<td>7.79</td>
<td>3.82</td>
<td>0.10</td>
<td>6.95</td>
<td>8.63</td>
</tr>
<tr>
<td>Total (SRI CI)</td>
<td></td>
<td></td>
<td>0.51</td>
<td>7.08</td>
<td>8.53</td>
</tr>
<tr>
<td>Heterogeneity: $I^2 = 62.1$, $Q = 22.7$, $p = 0.04$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) Pooled relative risk of CRBSI rate

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Risk Ratio</th>
<th>95% CI Lower</th>
<th>95% CI Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 2010</td>
<td>0.63</td>
<td>0.42</td>
<td>0.93</td>
</tr>
<tr>
<td>June 2010</td>
<td>1.81</td>
<td>1.04</td>
<td>3.14</td>
</tr>
<tr>
<td>Nov 2010</td>
<td>1.83</td>
<td>1.04</td>
<td>3.18</td>
</tr>
<tr>
<td>Total (SRI CI)</td>
<td>1.89</td>
<td>1.03</td>
<td>3.35</td>
</tr>
<tr>
<td>Heterogeneity: $I^2 = 62.1$, $Q = 22.7$, $p = 0.04$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RESULTS: META-ANALYSIS
(c) Pooled mean difference of catheter replacements

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Mean Difference</th>
<th>SD</th>
<th>Weight</th>
<th>95% CI Lower</th>
<th>95% CI Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 2010</td>
<td>-2.13</td>
<td>3.85</td>
<td>0.10</td>
<td>-4.09</td>
<td>-0.17</td>
</tr>
<tr>
<td>June 2010</td>
<td>2.07</td>
<td>3.85</td>
<td>0.10</td>
<td>0.14</td>
<td>3.99</td>
</tr>
<tr>
<td>Nov 2010</td>
<td>2.07</td>
<td>3.85</td>
<td>0.10</td>
<td>0.14</td>
<td>3.99</td>
</tr>
<tr>
<td>Total (SRI CI)</td>
<td>1.61</td>
<td>0.89</td>
<td>0.10</td>
<td>0.14</td>
<td>3.99</td>
</tr>
<tr>
<td>Heterogeneity: $I^2 = 62.1$, $Q = 22.7$, $p = 0.04$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(d) Pooled relative risk of catheter replacements

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Risk Ratio</th>
<th>95% CI Lower</th>
<th>95% CI Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 2010</td>
<td>3.85</td>
<td>1.46</td>
<td>10.7</td>
</tr>
<tr>
<td>June 2010</td>
<td>1.23</td>
<td>0.59</td>
<td>2.60</td>
</tr>
<tr>
<td>Nov 2010</td>
<td>1.23</td>
<td>0.59</td>
<td>2.60</td>
</tr>
<tr>
<td>Total (SRI CI)</td>
<td>1.23</td>
<td>0.59</td>
<td>2.60</td>
</tr>
<tr>
<td>Heterogeneity: $I^2 = 62.1$, $Q = 22.7$, $p = 0.04$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**ETHANOL LOCK DATA**

**Clinical Research**

**Evaluation of Ethanol Lock Therapy in Pediatric Patients on Long-Term Parenteral Nutrition**

*Kathy F. Mouw, MD* | *Catherine Lopez, NP* | *Melody A. Thomas, MS* | *Marcela Garcia, MD* | *Melody Herritz, MD* | *William E. Bogart, MD* | *and Anna A. Smera, MD*  

- 73% Reduction in CABSIs  
- 77% Reduction in line replacements

---

**RESULTS: ADVERSE EVENTS**

<table>
<thead>
<tr>
<th>Source</th>
<th>Adverse Events (reported selectively for EL)</th>
</tr>
</thead>
</table>
| Mouw, 2008 | No adverse events reported by patients or health care providers  
1/10 CVC-related thrombus  
1/10 two episodes of culture-negative disseminated intravascular coagulations (full recovery without ICU admission)  
1/10 Loss of line integrity |
| Jones, 2010 | No adverse events  
1/10 CVC-related thrombus  
1/10 two episodes of culture-negative disseminated intravascular coagulations (full recovery without ICU admission)  
1/10 Loss of line integrity |
| Cober, 2010 | 1/10 CVC-related thrombus |
| Wales, 2011 | 2/10 CVC-related thrombus |

---

**ETHANOL LOCK DATA**

*14% Reduction in CABSI’s*  
*77% Reduction in line replacements*
ETHANOL LOCK EFFICACY AND ASSOCIATED COMPLICATIONS IN CHILDREN WITH INTESTINAL FAILURE

Ethan A. Mezoff, MD
Clinical Instructor
Division of Pediatric Gastroenterology, Hepatology, and Nutrition
Cincinnati Children’s Hospital Medical Center
Ethan.Mezoff@chmc.org

Coauthors: Lin Fei, PhD; Misty Troutt, MS, MBA; Kim Klotz, RN, MSN, CRNI; Samuel A. Kocoshis, MD; and Conrad R. Cole, MD, MPH, MSc
CCHMC ELT METHOD

- Determine ELT priming volume
- Educate caregiver
- Schedule dwell time
  - >2hrs up to length of window (12hrs)

1. Flush w/ NS
2. Instill priming volume of 70% Ethanol
3. Dwell (no access to CVC)
4. Withdrawal with small flash of blood
5. Flush line with >5 mL NS
6. Resume use

<table>
<thead>
<tr>
<th>Tunneled Catheter</th>
<th>Priming Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bard</td>
<td></td>
</tr>
<tr>
<td>2.7 Fr</td>
<td>0.15 mL</td>
</tr>
<tr>
<td>4.2 Fr</td>
<td>0.3 mL</td>
</tr>
<tr>
<td>6.6 Fr</td>
<td>0.7 mL</td>
</tr>
<tr>
<td>7.0 Fr DL Red</td>
<td>0.8 mL</td>
</tr>
<tr>
<td>7.0 Fr DL White</td>
<td>0.6 mL</td>
</tr>
<tr>
<td>Cook</td>
<td></td>
</tr>
<tr>
<td>3 Fr</td>
<td>0.3 mL</td>
</tr>
<tr>
<td>5 Fr</td>
<td>0.3 mL</td>
</tr>
<tr>
<td>4 Fr DL White</td>
<td>0.2 mL</td>
</tr>
<tr>
<td>4 Fr DL Blue</td>
<td>0.1 mL</td>
</tr>
<tr>
<td>5 Fr DL White</td>
<td>0.2 mL</td>
</tr>
<tr>
<td>5 Fr DL Blue</td>
<td>0.2 mL</td>
</tr>
</tbody>
</table>

DEMOGRAPHICS OF STUDY PARTICIPANTS

<table>
<thead>
<tr>
<th>Demographic Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Total Line Days</td>
<td>23,200</td>
</tr>
<tr>
<td>Of ELT 8,805 days</td>
<td>(median: 210)</td>
</tr>
<tr>
<td>On ELT 14,397 days</td>
<td>(median: 296)</td>
</tr>
<tr>
<td>Diagnoses</td>
<td></td>
</tr>
<tr>
<td>Total Line Days</td>
<td>23,200</td>
</tr>
<tr>
<td>Metabolic</td>
<td>15</td>
</tr>
<tr>
<td>Malignant</td>
<td>15</td>
</tr>
<tr>
<td>Infectious</td>
<td>11</td>
</tr>
<tr>
<td>Immune</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
</tr>
<tr>
<td>Post-multicellular transplant</td>
<td>9</td>
</tr>
<tr>
<td>Line Type</td>
<td></td>
</tr>
<tr>
<td>Total Line Days</td>
<td>23,200</td>
</tr>
<tr>
<td>Tunneled Central Venous Catheter</td>
<td>87</td>
</tr>
<tr>
<td>Peripherally Inserted Central Catheter</td>
<td>61</td>
</tr>
<tr>
<td>Port</td>
<td>8</td>
</tr>
</tbody>
</table>

BLOOD STREAM INFECTIONS

Events per 1,000 line days

- Difference significant (p<0.013) by Poisson regression modeling

*
**CONCLUSIONS**

ELT is a **SAFE** and **EFFECTIVE** method for reducing CLABSIs in the pediatric IF population.

- CLABSI rates are **reduced** with ELT (p<0.013)
- Central line perforations or breaks are **reduced** with ELT (p=0.006)
- Central line occlusion rates trended **downward** with ELT (p=0.056)
- Low rates are possible with fastidious line care

*Future Directions:*
- Be able to distinguish translocation from line infections
- Determine how antibiotic exposure changes the ability to grow
- Create a collaborative improvement network
CLABSI REDUCTIONS IN CHILDREN WITH INTESTINAL FAILURE THROUGH IMPLEMENTATION OF A PREVENTION BUNDLE: BROADENING QI INITIATIVES FROM THE HOSPITAL TO THE HOME

MI Ardura DO MSCS, J Lewis RN MBOE, JL Tansmore PharmD, P Harp RN, MC Dienhart MD, JP Balint MD

QI INITIATIVE

Goal: To evaluate whether implementation of a CLABSI prevention bundle that included the use of ethanol lock prophylaxis (ELP) in both the hospital and home settings could reduce total CLABSI rates in pediatric patients with IF.

Key driver specific aim: Decrease the CLABSI rate in children with IF by 50% by April 30, 2012 and sustain through December 31, 2013.

Secondary aims: safety assessments
- Central line replacement for any reason
- Central line repairs
- Number of hospitalizations

INCLUSION CRITERIA

- Child with intestinal failure
- weight ≥ 5 kg
- clinically stable
- requiring the CVC for at least 1 month
- Functional, silicone-based central venous catheter (CVC)
- No allergy to alteplase
- Not receiving citrate or metronidazole
- Parents were willing and able to comply with ELP in the home
BEST-PRACTICE CLABSI PREVENTION BUNDLE COMPONENTS

- Hospital QI bundles
- Daily dressing/site assessments
- Weekly sterile dressing changes
- Use of two, 15 second alcohol scrub/dry to the CVC hub with each line entry
- Use of alcohol impregnated disinfection caps
- Daily 70% ethanol lock prophylaxis (ELP)
- Clinical practice guideline

FIRST ELP PROCEDURE

- Performed in hospital or clinic by CVC nurse
- CVC is functional and volume was determined
  - child < 15 kg = 0.1 mL + CVC volume
  - child ≥ 15 kg: = 0.2 mL + CVC volume (max 3 mL)
- Instillation of alteplase for at least 2 hours
- Instilling the 70% ethanol as a lock
- Confirming parents were competent with the procedure

DAILY ELP

- 70% ELP was performed daily
  - Lumens were alternated daily in patients with double lumen CVCs
  - Heparin was removed from all TPN and medication orders
  - Individualized plan, minimizing catheter entry and longest ethanol dwell time
    - Ethanol dwell: 2 – 24 hours
  - Ethanol was removed at the end of the dwell and flushed with 5-10 mL of saline
**POST-CLABSI BUNDLE + ELP IMPLEMENTATION**

- **A:** ELP offered to patients with history of ≥2 CLABSI
- **B:** ELP offered to all eligible patients

**OTHER OUTCOMES**

<table>
<thead>
<tr>
<th>CLABSI (number)</th>
<th>Pre ELP</th>
<th>Post ELP</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLABSI rates (CLABSI/1,000 catheter days)</td>
<td>7.01</td>
<td>0.64</td>
</tr>
<tr>
<td>Total number of CLABSIs</td>
<td>34</td>
<td>3</td>
</tr>
<tr>
<td>Single organism</td>
<td>22</td>
<td>2</td>
</tr>
<tr>
<td>Gram positive</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>Gram negative</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>Polymicrobial</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>Bacteria + Candida</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Mixed bacterial</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>HA-CLABSI</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**SAFETY ASSESSMENTS**

- N=14 patients in whom ELP was used daily for ≥3 months

<table>
<thead>
<tr>
<th></th>
<th>Pre ELP</th>
<th>Post ELP</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLABSI rates</td>
<td>7.01</td>
<td>0.64</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td># catheter occlusions</td>
<td>0 [0-1]</td>
<td>0 [0-3]</td>
<td>0.25</td>
</tr>
<tr>
<td># of tPA or cysteine use</td>
<td>3 [0-9]</td>
<td>2 [0-5]</td>
<td>0.23</td>
</tr>
<tr>
<td># line repairs</td>
<td>0 [1-7]</td>
<td>1 [0-3]</td>
<td>0.22</td>
</tr>
<tr>
<td># central line insertions</td>
<td>3 [0-6]</td>
<td>0 [0-2]</td>
<td>0.001</td>
</tr>
<tr>
<td># hospitalizations</td>
<td>3.5 [0-20]</td>
<td>3.5 [1-9]</td>
<td>0.33</td>
</tr>
<tr>
<td>Duration of hospitalization (days)</td>
<td>66 [5-177]</td>
<td>12 [1-231]</td>
<td>0.13</td>
</tr>
<tr>
<td># hospitalizations for fever + CLABSI</td>
<td>2 [0-9]</td>
<td>0 [0-2]</td>
<td>0.003</td>
</tr>
</tbody>
</table>

*Wilcoxon matched pairs sign rank median [ranges]
CURRENT OVERALL CLABSI RATES IN IF PATIENTS

**0.68**
No additional safety concerns

SUMMARY
A best-practice CLABSI prevention bundle with ethanol lock prophylaxis in pediatric intestinal failure patients:
- Was **successfully implemented** in both the hospital and home settings,
- **Led to a statistically significant reduction in CLABSI rates**, 
- **CLABSI rate reduction was sustainable**, 
- **No significant increase in adverse events** attributable to daily 70% ethanol lock prophylaxis