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**3M**

**curos™**

Disinfecting Port  
Protectors



# Clinical Evidence Summary

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# Table of Contents

## PEER REVIEWED

### Effectiveness of disinfecting caps for intravenous access points in reducing central line-associated bloodstream infections, clinical utilization, and cost of care during COVID-19.

Hou Y, Griffin LP, Ertmer K, Bernatchez SF, Kärpänen TJ, Palka-Santini M. *Clinicoecon Outcomes Res.* 2023;15:477-486.



8

Population: Hospital Wide

### Antiseptic barrier caps to prevent central line-associated bloodstream infections: A systematic review and meta-analysis.

Gillis, Veerle ELM, et al. *American Journal of Infection Control.* 2023;51:7:827-835.



9

Population: Multiple Specialties

### Antiseptic barrier caps in central line-associated bloodstream infections: A systematic review and meta-analysis.

Tejada, Sofia, et al. *European Journal of Internal Medicine.* 2022;99:70-81.



10

Population: Multiple Specialties

### Antiseptic barrier cap effective in reducing central line-associated bloodstream infections: A systematic review and meta-analysis.

Voor in 't holt AF, Helder OK, Vos MC, et al. *Int J Nurs Stud.* 2017;69:34-40.



11

Population: Multiple Specialties

### Disinfection of vascular catheter connectors that are protected by antiseptic caps is unnecessary.

Fillman KM, Ryder JH, Brailita DM, et al. *Infect Control Hosp Epidemiol.* Published online 2023:1-5. doi:10.1017/ice.2023.148.



12

Population: Intensive Care & Acute Care

### A bundled approach to decrease the rate of primary bloodstream infections related to peripheral intravenous catheters.

Duncan M, Warden P, Bernatchez S, Morse D. *J Assoc Vasc Access.* 2018;23(1):15-22.



13

Population: Hospital Wide

### Strategies for the successful implementation of disinfecting port protectors to reduce CLABSI in a large tertiary care teaching hospital.

Beeler C, Kerley D, Davis C, et al. *Am J Infect Control.* 2019;47(12):1505-1507. doi:10.1016/j.ajic.2019.05.016



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Population: Hospital Wide

#### Outcomes Key



Infection and/or contaminated blood cultures



Compliance and/or patient/staff satisfaction



Staff time and/or length of stay



Cost

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## PEER REVIEWED

### Educational interventions alone and combined with port protector reduce the rate of central venous catheter infection and colonization in respiratory semi-intensive care unit.

Inchingolo R, Pasciuto G, Magnini D, et al. *BMC Infect Dis.* 2019;19(1):215.



15

Population: Respiratory Semi-Intensive Care

### Impact of universal disinfectant cap implementation on central line-associated bloodstream infections.

Merrill KC, Sumner S, Linford L, Taylor C, Macintosh C. *Am J Infect Control.* 2014;42:1274-1277.



16

Population: Multiple Specialties

### Use of alcohol containing caps for preventing bloodstream infections: A randomized controlled trial.

Taşdelen Öğülmen D, Ateş S. *J Vasc Access.* 2021 Nov;22(6):920-925. doi:10.1177/1129729820952961



17

Population: Intensive Care

### Port protectors in clinical practice: an audit.

Cameron-Watson C. *Br J Nurs.* 2016;25(8):S25-S31.



18

Population: Multiple Specialties

### Central venous catheter protective connector caps reduce intraluminal catheter-related infection.

Ramirez C, Lee AM, Welch K. *J Assoc Vasc Access.* 2012;17(4):210-213.



19

Population: Intensive Care

### Use of a central catheter maintenance bundle in long-term acute care hospitals.

Grigonis AM, Dawson AM, Burkett M, et al. *Am J Crit Care.* 2016;25(2):165-172.



20

Population: Long Term Acute Care

### Impact of alcohol-impregnated port protectors and needleless neutral pressure connectors on central line-associated bloodstream infections and contamination of blood cultures in an inpatient oncology unit.

Sweet MA, Cumpston A, Briggs F, Craig M, Hamadani M. *Am J Infect Control.* 2012;40(10):931-934.



21

Population: Hematology & Oncology

## Outcomes Key



Infection and/or contaminated blood cultures



Compliance and/or patient/staff satisfaction



Staff time and/or length of stay



Cost

# Table of Contents, Continued

Outcomes Key	
	Infection and/or contaminated blood cultures
	Compliance and/or patient/staff satisfaction
	Staff time and/or length of stay
	Cost

## PEER REVIEWED

### Efforts of a unit practice council to implement practice change utilizing alcohol impregnated port protectors in a burn ICU.

Martino A, Thompson L, Mitchell C, et al. *Burns*. 2017;43(5):956-964.

 22  
Population: Burn Intensive Care

### Reaching one peripheral intravenous catheter (PIVC) per patient visit with lean multimodal strategy: the PIV5Rights™ Bundle.

Steere L, Ficara C, Davis M, Moureau N. *J Assoc Vasc Access*. 2019;24(3):31-43. doi:10.2309/j.java.2019.003.004

 23  
Population: Intensive Care

### A quality improvement study on the reduction of central venous catheter-associated bloodstream infections by use of self-disinfecting venous access caps (STERILE).

Cruz-Aguilar R, Carney J, Mondaini V, et al. *Am J Infect Control*. 2021;49(5):586-592. doi:10.1016/j.ajic.2020.09.002

 24  
Population: Hematology & Oncology

### Reducing central line-associated bloodstream infections on inpatient oncology units using peer review.

Zavotsky KE, Malast T, Festus O, Riskie V. *Clin J Oncol Nurs*. 2015;19(6):655-658. doi:10.1188/15.CJON.655-658

 25  
Population: Oncology

### Alcohol-impregnated caps and ambulatory central line-associated bloodstream infections (CLABSIs): A randomized clinical trial.

Milstone AM, Rosenberg C, Yenokyan G, Koontz DW, Miller MR, CCLIP Authorship Group. *Infect Control Hosp Epidemiol*. 2021;42(4):431-439. doi:10.1017/ice.2020.467

 26  
Population: Pediatric Oncology & Hematology

### Microbial colonization of intravascular catheter connectors in hospitalized patients.

Hankins R, Majorant OD, Rupp ME, et al. *Am J Infect Control*. 2019;47(12):1489-1492. doi:10.1016/j.ajic.2019.05.024

 27  
Population: Intensive Care

## PEER REVIEWED – VETERINARY STUDY

### A comparative study of disinfecting catheter caps and their effectiveness in the reduction of equine IV catheter-related thrombophlebitis.

Fisk N. *Vet Nurs J*. 2018;33(3):74-78. doi:10.1080/17415349.2017.1414781

 28  
Population: Veterinary, Equine

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## ABSTRACTS

### Successful decrease of central line-associated bloodstream infections in an urban neonatal intensive care unit using a pediatric-specific interdisciplinary approach.

Karam-Howlin R, Fede A, Gibbs K, Bravo N, Wallach F, Patel G. *Am J Infect Control*. 2015;43(6):S58.



29

Population: Neonatal Intensive Care

### Systematic review on impact of use of disinfectant caps protectors for intravenous access ports on central line-associated bloodstream infections (CLABSI).

Jimenez A, Barrera A, Madhivanan P. *Open Forum Infectious Diseases*. 2015;2(1):281.



30

Population: Multiple Specialties

### A significant decline in central line-associated blood stream infections using alcohol-impregnated port protectors at a large non-profit acute care hospital.

Danielson B, Williamson S, Kaur G, Johnson N. *Am J Infect Control*. 2014;42(6):S16.



31

Population: Hospital Wide

### Alcohol-impregnated disinfectant caps reduce the rate of central-line associated bloodstream infections and nosocomial bacteremia.

Shelly M, Greene L, Brown L, Romig S, Pettis AM. *Open Forum Infect Dis*. 2014 Dec;1(Suppl 1):S248. doi:10.1093/ofid/ofu052.570



32

Population: Multiple Specialties

### Decreasing the incidence of central line-associated blood stream infections using alcohol-impregnated port protectors (AIPPS) in a neonatal intensive care unit.

Danielson B, Williamson S, Kaur G, Brooks C, Scholl P, Baker A. *Am J Infect Control*. 2013;41(6):S97-S98.



33

Population: Neonatal Intensive Care

### Decreasing CLABSI rates and cost following implementation of a disinfectant cap in a tertiary care hospital.

Sumner S, Merrill KC, Linford L, Taylor C. *Am J Infect Control*. 2013;41(6):S37.



34

Population: Hospital Wide

### Impact of alcohol-impregnated protectors on incidence of catheter-associated blood stream infections.

Mayfield J, Alasmari F, Kittur ND, et al. Presented at: IDWeek annual meeting; October 18, 2012; San Diego, CA.



35

Population: Oncology and Stem Cell Transplant

#### Outcomes Key



Infection and/or contaminated blood cultures



Compliance and/or patient/staff satisfaction



Staff time and/or length of stay



Cost

# Table of Contents, Continued

Outcomes Key	
	Infection and/or contaminated blood cultures
	Compliance and/or patient/staff satisfaction
	Staff time and/or length of stay
	Cost

## ABSTRACTS

### Reduction in central line associated bloodstream infection (CLABSI) in a neonatal intensive care unit with use of access site disinfection caps.

Pong A, Salgado C, Speziale M, Grimm P, Abe C. Presented at: Infectious Disease Society of America annual meeting; October 21, 2011; Boston, MA.



36

Population: Neonatal Intensive Care

### PTH-195 Curoc™ line caps are effective in reducing catheter related sepsis in inpatients receiving parenteral nutrition.

Wheatley DJ, Rowlands S, Chapman J, et al. *Gut*. 2015;64(Suppl 1):A495.1-A495. doi:10.1136/gutjnl-2015-309861.1083



37

Population: Inpatient Parenteral Nutrition

### 863 reduction in CLABSIs with alcohol port protectors.

Russo N, Gupta K, Tibert C, Strymish J. *Open Forum Infect Dis*. 2014;1(Suppl-1):S248. doi:10.1093/ofid/ofu052.571



38

Population: Multiple Specialties

## POSTERS

### Impact of disinfectant cap implementation on peripherally-inserted central catheter (PICC) associated bloodstream infection rates.

Cabahug T, Jie L, Meng QS, Tang M, Wang Y, Foo SY, Wu T. Poster presented at: APSIC Congress. 2019; Vietnam. Abstract available at: [https://www.researchgate.net/publication/333679803\\_Impact\\_of\\_disinfectant\\_cap\\_implementation\\_on\\_peripherally-inserted\\_central\\_catheter\\_PICC\\_associated\\_bloodstream\\_infection\\_rates](https://www.researchgate.net/publication/333679803_Impact_of_disinfectant_cap_implementation_on_peripherally-inserted_central_catheter_PICC_associated_bloodstream_infection_rates)



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Population: General Units

## SHORT COMMUNICATION

### Antiseptic cap protects stopcocks from internal bacterial contamination.

Guyot A, Lorf S, van Stein C, Hüniger F, Schaaf B. *J Hosp Infect*. 2021 Feb;108:212-214. doi:10.1016/j.jhin.2020.11.026



40

Population: Intensive Care

## ADDITIONAL RESOURCES

### Abstracts / Articles / Dissertations

41

# The use of 3M™ Curoso™ Disinfecting Port Protectors has proven highly effective in mitigating contamination risk, especially where the healthcare system is under significant strain or overloaded.

Hou Y, Griffin LP, Ertmer K, Bernatchez SF, Kärpänen TJ, Palka-Santini M. Effectiveness of disinfecting caps for intravenous access points in reducing central line-associated bloodstream infections, clinical utilization, and cost of care during COVID-19. *Clinicoecon Outcomes Res.* 2023;15:477-486.

## DESIGN

Retrospective review of data from the Premier Healthcare Database, focusing on 200,411 hospitalizations involving central venous catheters between January 2020 and September 2020—a period characterized by significant strain due to the COVID-19 pandemic.

## METHODS

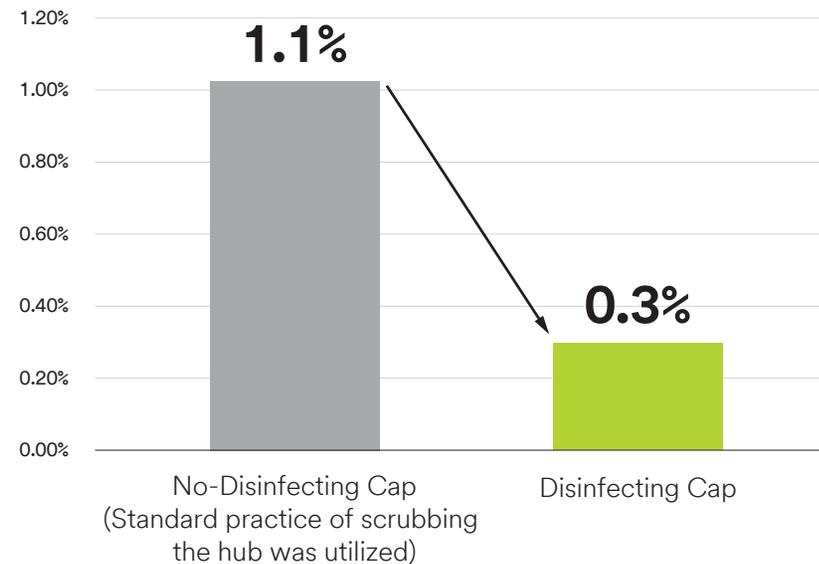
7,423 patients received a 3M™ Curoso™ Disinfecting Port Protector, while 192,988 patients did not receive any disinfecting caps and the standard practice of scrubbing the hub was used instead.



## RESULTS

### Central Line-associated Bloodstream Infection (CLABSI) Rate

73% decrease in CLABSI rates (p=0.0013)



The use of Curoso Disinfecting Port Protectors for reduction in the incidence of CLABSI has not been reviewed by the U.S. FDA.



There were **73% fewer** incidences of CLABSI



The Disinfecting Cap group exhibited a **0.5-day** reduction in hospital stay



The Disinfecting Cap group cost **\$6,703 less** per hospital stay

# "Antiseptic barrier caps are safe, highly-appreciated by healthcare workers for their ease of use, are timesaving in clinical practice and there are no disadvantages with their use."

Gillis, Veerle ELM, et al. Antiseptic barrier caps to prevent central line-associated bloodstream infections: A systematic review and meta-analysis. *American Journal of Infection Control*. 2023;51.7:827-835.

## DESIGN

Systematic review and meta-analysis

## METHODS

Primary outcome of this study was the rate of CLABSIs per 1,000 catheter days in patients using 3M™ Curo™ Disinfecting Port Protectors and SwabCap® Disinfecting Caps to manual disinfection. Secondary outcomes included safety, compliance, and costs of antiseptic barrier caps.

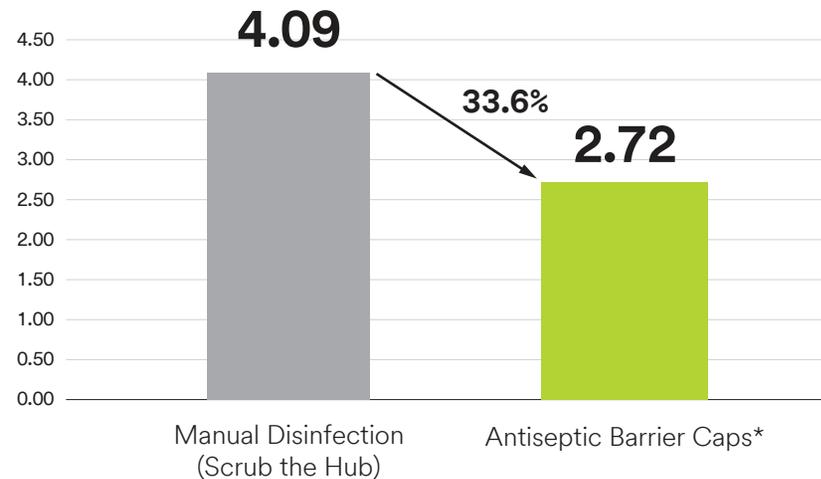
\*\*Calculation was based on data presented in Table 1 and Figure 3 – the relative change between was calculated as:  $(\text{Intervention Rate} - \text{Control Rate}) / (\text{Control Rate})$  where Intervention Rate and Control Rate are the weighted average CLABSI rates.

The use of Curo™ Disinfecting Port Protectors for reduction in the incidence of CLABSI has not been reviewed by the U.S. FDA.



## RESULTS

### Relative CLABSI Incidence per 1,000 Catheter Days\*\*



(p<0.0001)  
Total Intervention n>4630  
Total Control n>4681

Sixteen studies were included in the systematic review and fifteen within the meta-analysis.

\*Curo™ Disinfecting Port Protectors and SwabCap Disinfecting Caps

The risk of a CLABSI was found to be

**41%**

lower with the use of 3M™ Curo™ Disinfecting Port Protectors p<0.0001



**Increased compliance, ease of use and simple monitoring** because of the green-colored antiseptic barrier caps



Average cost savings

**\$41,000**

per 1,000 catheter days



# "Antiseptic barrier cap use appears to be effective and delivers cost savings."

Tejada, Sofa, et al. Antiseptic barrier caps in central line-associated bloodstream infections: A systematic review and meta-analysis. *European Journal of Internal Medicine*. 2022;99:70-81.

## DESIGN

Systematic review and meta-analysis

## METHODS

Observational studies and randomized controlled trials (RCTs) on hospitalized patients of any age that compared 3M™ Curoc™ Disinfecting Cap for Needleless Connectors and SwabCap® Disinfecting Caps to manual disinfection on the incidence of central line associated bloodstream infection (CLABSI) per 1,000 catheter days were included.

Additional outcomes were compliance with antiseptic cap use, total length of stay, and reported economic differences.

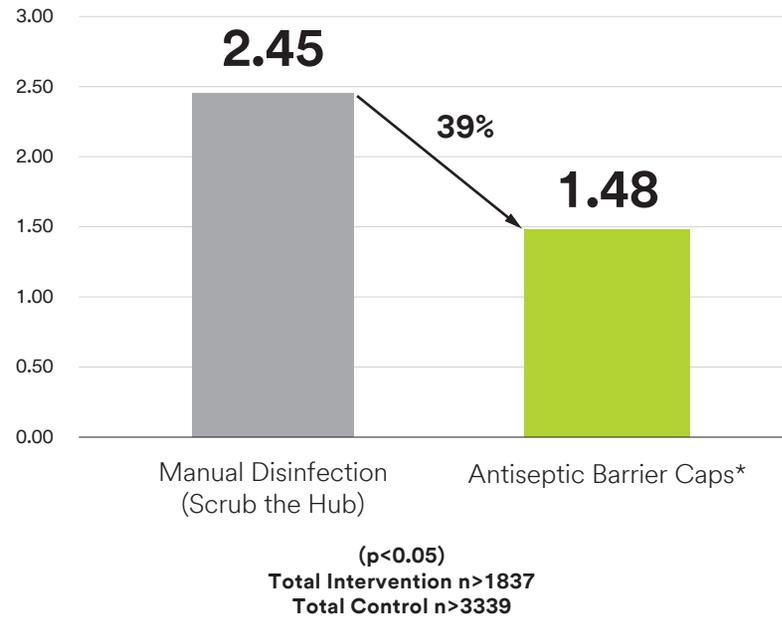
\*\*Calculation was based on data presented in Figure 3 – the relative change between was calculated as:  $(\text{Intervention Rate} - \text{Control Rate}) / (\text{Control Rate})$  where Intervention Rate and Control Rate are the weighted average CLABSI rates.

The use of Curoc Disinfecting Port Protectors for reduction in the incidence of CLABSI has not been reviewed by the U.S. FDA.



## RESULTS

### Central Line-associated Bloodstream Infection (CLABSI) Rate per 1,000 Catheter Days



\*Curoc Disinfecting Port Protectors and SwabCap Disinfecting Caps

14 studies were included in the systematic review and 9 within the meta-analysis.

**39% fewer**

incidences of CLABSI per 1,000 catheter days with the use of the antiseptic barrier cap\*\*



Median cost savings  
**\$21,890**  
per CLABSI



# “...use of the antiseptic barrier cap can lower the occurrence of CLABSIs and is cost saving.”

Voor in 't holt AF, Helder OK, Vos MC, et al. Antiseptic barrier cap effective in reducing central line-associated bloodstream infections: a systematic review and meta-analysis. *Int J Nurs Stud.* 2017;69:34-40.

## DESIGN

Systematic review and meta-analysis

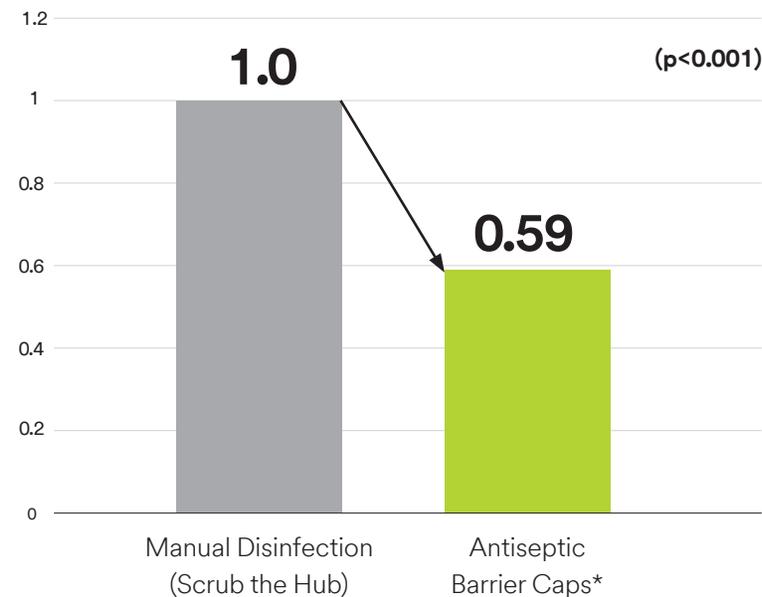
## METHODS

Studies conducted in the hospital setting that compared 3M™ Curoc™ Disinfecting Cap for Needleless Connectors and SwabCap® Disinfecting Caps to manual disinfection on the incidence of central line associated bloodstream infection (CLABSI) per 1000 catheter days were included.



## RESULTS

**Relative Pooled CLABSI Incidence (per 1000 catheter days)**



Nine studies were included in the systematic review and seven within the meta-analysis.

\*Curoc Disinfecting Cap for Needleless Connectors and SwabCap Disinfecting Caps



There were **41% fewer** CLABSIs associated with use of the antiseptic barrier cap (IRR = 0.59, 95% CI = 0.45-0.77 p < 0.001)



Overall median rate of compliance with barrier cap = **82.5%**



Net cost savings ranged from **\$39,050 – \$3,268,990**

# "Use of an antiseptic-containing cap reduces the risk of catheter connector colonization independent of an alcohol scrub."

Fillman KM, Ryder JH, Brailita DM, et al. Disinfection of vascular catheter connectors that are protected by antiseptic caps is unnecessary. *Infect Control Hosp Epidemiol*. Published online 2023:1-5. doi:10.1017/ice.2023.148.

## DESIGN

Quality improvement study over five days to assess whether vascular catheter disinfecting antiseptic-containing caps alone are effective at decreasing microbial colonization compared to antiseptic-containing caps plus a 5-second alcohol manual disinfection.

## METHODS

### Standard-of-care Group

165 catheter connectors with 3M™ Curox Jet™ Disinfecting Cap for Needleless Connectors cleaned with a 5-second alcohol wipe scrub prior to culture

### Comparison Group

165 catheter connectors with 3M™ Curox Jet™ Disinfecting Cap for Needleless Connectors without a 5-second alcohol wipe scrub prior to culture

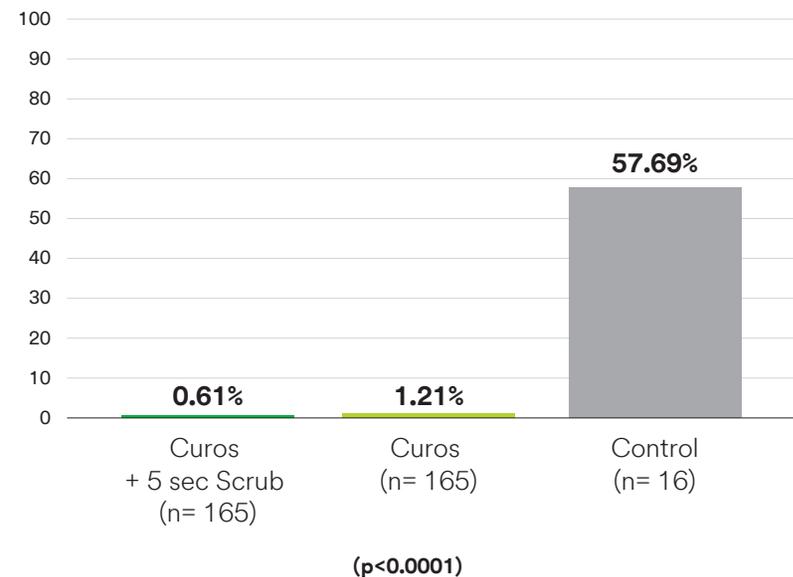
### Control Group

26 catheter connectors without an antiseptic-containing cap



## RESULTS

### Colonization of Catheter Connectors (Percentage)



The authors concluded that the 5-second alcohol-wipe disinfection step is unnecessary when an antiseptic-containing cap is in place and that the use of an antiseptic-containing cap helps reduce the risk of catheter connector colonization independent of an alcohol scrub.

Contamination rates were statistically not different between the Standard-of-care Group and Comparison Group  $P = .0063$



# “Using a PIV maintenance bundle including disinfecting caps and tips can effectively lower the rate of primary bloodstream infections attributable to PIV lines.”

Duncan M, Warden P, Bernatchez S, Morse D. A bundled approach to decrease the rate of primary bloodstream infections related to peripheral intravenous catheters. *J Assoc Vasc Access.* 2018;23(1):15-22.

## DESIGN

Before and after intervention study comparing hospital wide peripheral line-associated bloodstream infections (PLABSI) and intervention compliance.

## METHODS

**Pre-Intervention:** Primary bloodstream infection and IV catheter data collected

**Intervention:** PIV bundle implemented. 3M™ Curox Tips™ Disinfecting Cap for Male Luers added to existing Central Line-Associated Bloodstream Infection (CLABSI) bundle for all disconnected IV tubing. Compliance monitored for PIV and CLABSI bundles.

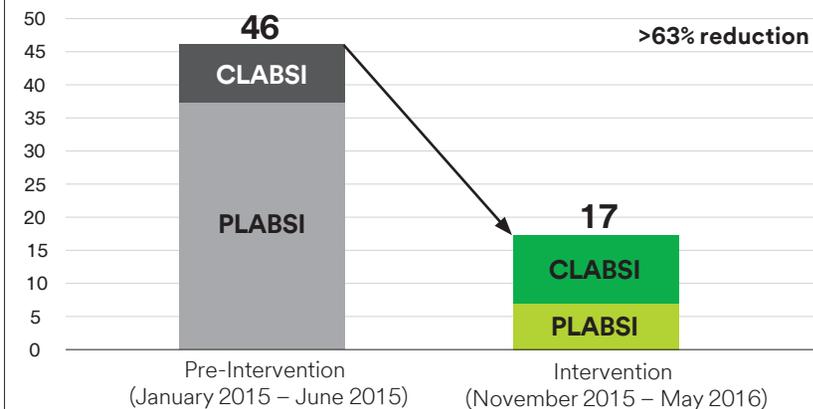
### PIV Bundle elements:

- Prohibit disconnecting IV tubing for convenience
- 3M™ Curox™ Disinfecting Cap for Needleless Connectors on all ports for all patients
- 3M™ Curox Tips™ Disinfecting Cap for Male Luers on all disconnected tubing
- Assessment of IV site, removing IV catheters with indication of phlebitis
- Assessment of dressing, changing if nonocclusive or blood is present

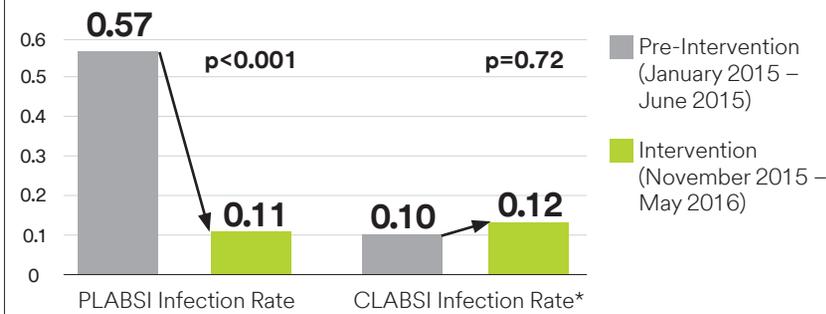


## RESULTS

### # of Primary Bloodstream Infections



### Average BSI Rate for Peripheral and Central Lines (per 1000 patient days)



\*Because CLABSI bundle was implemented prior to study, no significant change to CLABSI rate was anticipated or observed during study time period.

Compliance with protecting all needleless connectors was near

**90%**



Compliance with protecting male ends of disconnected IV tubing was near

**90%**



# “Inclusion of the alcohol impregnated disinfecting port protectors (AIDPP), as a component of the CLABSI bundle, hardwired adherence by audit accountability.”

Beeler C, Kerley D, Davis C, et al. Strategies for the successful implementation of disinfecting port protectors to reduce CLABSI in a large tertiary care teaching hospital. *Am J Infect Control.* 2019;47(12):1505-1507. doi:10.1016/j.ajic.2019.05.016

## DESIGN

Quasi-experimental study comparing hospital-wide central line-associated bloodstream infection (CLABSI) rates at a 1009-bed tertiary hospital using an evidence-based, multidisciplinary approach.

## METHODS

### Pre-Intervention:

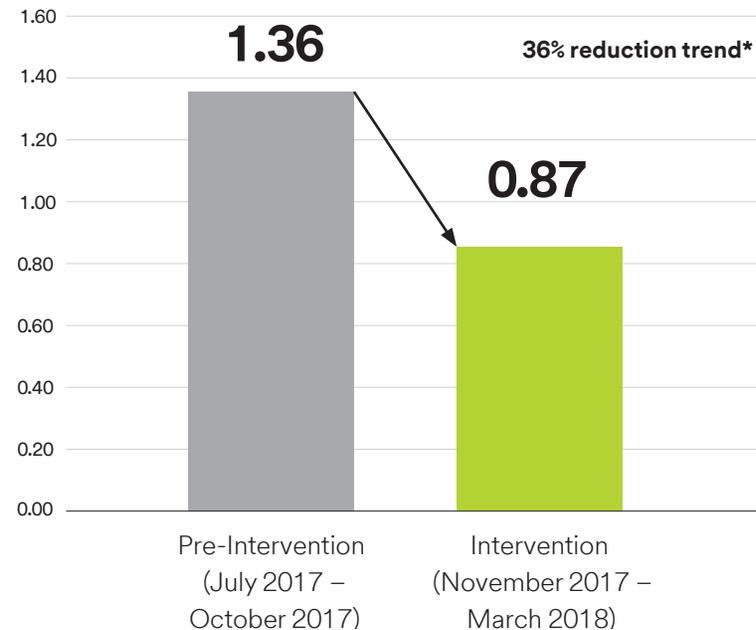
Standard central line bundle of care

### Intervention:

- Standard central line bundle of care
- 3M™ Curores™ Disinfecting Port Protectors implementation plan
- Curores Disinfecting Port Protectors 21-Day Challenge
- 3M™ Curores Jet™ Disinfecting Cap for Needleless Connectors
- 3M™ Curores™ Stopper Disinfecting Cap for Open Female Luers
- 3M™ Curores Tips™ Disinfecting Cap for Male Luers

## RESULTS

### CLABSIs (per 1000 device days)



\*The authors did not statistically test if the reduction in CLABSI was significant between the periods.

Reduction of  
**1.36 to 0.87**

CLABSIs per 1000  
device days



Used 21-Day Challenge to  
increase adherence rate from

**67% to 94%**



Potentially saved an adjusted

**\$1.6M**

in eight months, accounting  
for added cost of  
port protectors



# 3M™ Curoso™ Disinfecting Cap for Needleless Connectors combined with educational interventions led to zero rate of CLABSIs.

Inchingolo R, Pasciuto G, Magnini D, et al. Educational interventions alone and combined with port protector reduce the rate of central venous catheter infection and colonization in respiratory semi-intensive care unit. *BMC Infect Dis.* 2019;19(1):215.

## DESIGN

Prospective randomized study, assessing the rate of CLABSIs, central venous catheter (CVC) colonizations and contaminated blood cultures before and after introduction of educational interventions alone and combined with Curoso Disinfecting Cap for Needleless Connectors.

## METHODS

### Pre-Intervention:

Standard central line bundle of care (n=86)

### Intervention:

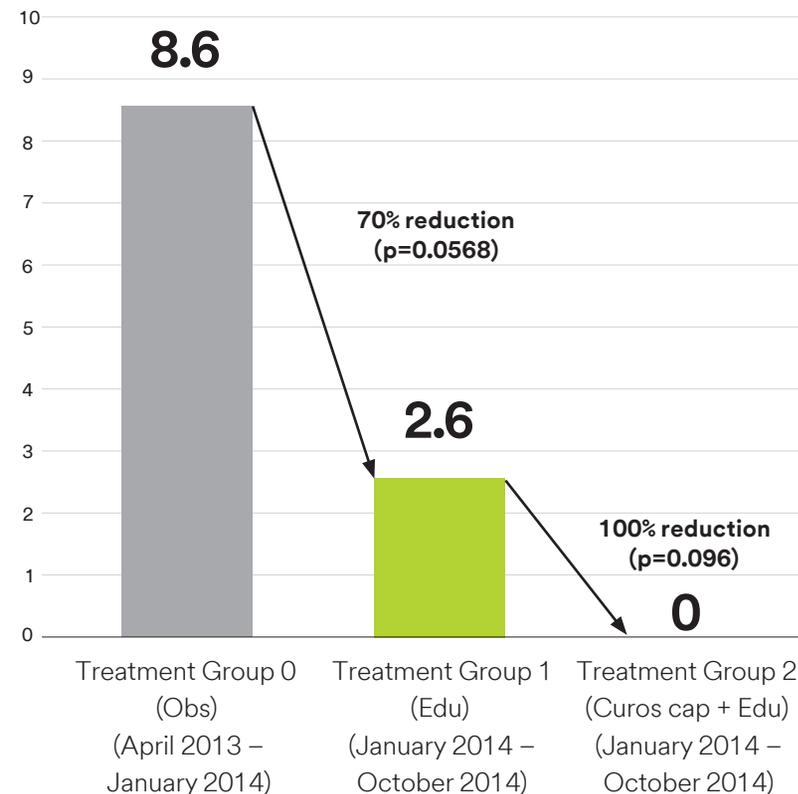
Randomized patients into two groups:

- Group 1: Educational intervention (n=25)
- Group 2: Curoso Disinfecting Cap for Needleless Connectors plus educational intervention (n=21)



## RESULTS

### CLABSI Rate (per 1000 central line days)



Contaminated blood cultures decreased to

# ZERO

with Curoso Disinfecting Cap for Needleless Connectors plus educational interventions



# 67%

reduction of CVC colonizations with Curoso Disinfecting Cap for Needleless Connectors plus educational interventions



# “Disinfectant cap use was associated with an estimated savings of almost \$300,000 per year in the hospital studied.”

Merrill KC, Sumner S, Linford L, Taylor C, Macintosh C. Impact of universal disinfectant cap implementation on central line-associated bloodstream infections. *Am J Infect Control*. 2014;42:1274-1277.

## DESIGN

Before and after intervention study comparing CLABSI rates and estimated costs in patients (newborn to adult) with CVCs and PIVs from 13 units at a Level 1 Trauma Center.

## METHODS

### Pre-Intervention:

Standard central line bundle of care

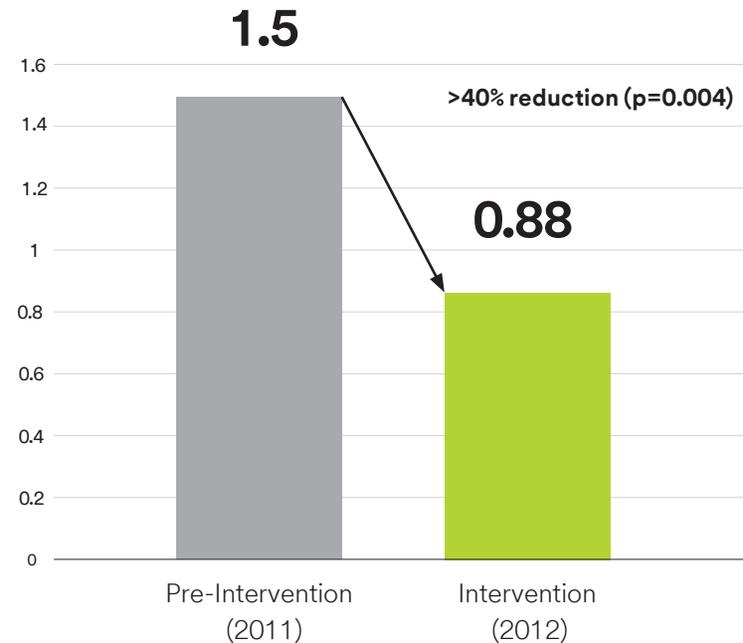
### Intervention:

3M™ Curoc™ Disinfecting Cap for Needleless Connectors placed on central, peripheral and IV tubing needleless connectors



## RESULTS

### Mean CLABSI Rate (per 1000 catheter days)



**10%**

Increase in compliance was associated with

**7%**

drop in infection rates



Estimated decrease of

**68**

patient hospital days after cap implementation



Estimated annual savings =

**\$282,840**



# Alcohol containing caps were found to be a beneficial addition to a bundle helping to prevent CLABSI.

Taşdelen Ögülmén D, Ateş S. Use of alcohol containing caps for preventing bloodstream infections: A randomized controlled trial. *J Vasc Access*. 2021 Nov;22(6):920-925. doi:10.1177/1129729820952961

## DESIGN

Randomized controlled trial investigating the effect of disinfecting caps on CLABSI in ICU patients with jugular or subclavian catheters.

## METHODS

95 patients between July and December 2018 who met inclusion criteria were in the study.

### CVC insertion:

2% chlorhexidine in IPA skin prep, gauze and/or chlorhexidine-impregnated dressing

### Pre-Intervention:

Sterile end caps and active disinfection with 70% IPA wipes (not explicitly stated in study, per author clarification)

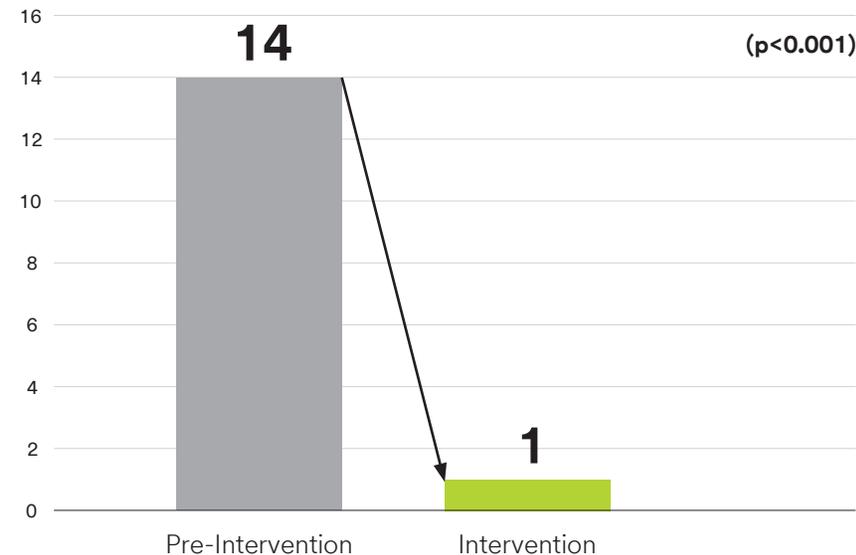
### Intervention:

Addition of needleless connectors were covered with 3M™ Curoc™ Disinfecting Cap for Needleless Connectors



## RESULTS

### Number of CLABSIs



Pre-intervention group (n=48)

Intervention group (n=47)

Infection risk in the pre-intervention group was

**13.7x**

higher than in the intervention group



Significant difference between groups regarding

**fever (p<0.001)**  
and  
**chills distribution (p=0.016)**



# The number of vascular access device (VAD) related bacteraemias was reduced by 69% when compliance with Curoso™ cap placement was 80% or more.

Cameron-Watson C. Port protectors in clinical practice: an audit. *Br J Nurs*. 2016;25(8):S25-S31.

## DESIGN

Before and after intervention study comparing VAD related bacteraemia for CVCs, PIVs and arterial lines from four wards at two hospital sites.

## METHODS

### Pre-Intervention:

Scrub the hub using CHG/IPA wipes prior to IV access

### Intervention:

3M™ Curoso™ Disinfecting Cap for Needleless Connectors placed on all needleless devices

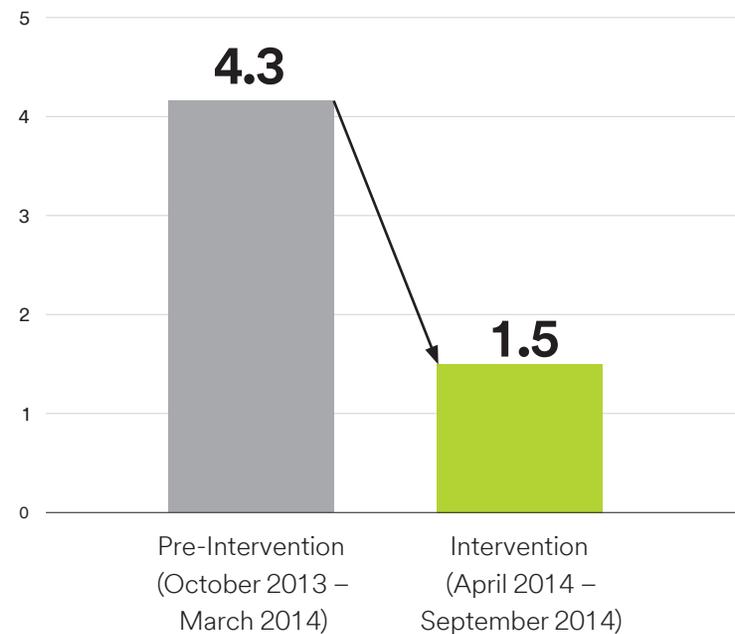
### Post intervention:

Scrub the hub protocol resumed



## RESULTS

### Catheter-related Bloodstream Infections (per 1000 line days)



Infection rates began to increase when scrub the hub was resumed in the post-intervention period (October 2014 – March 2015).

Compliance to protocol increased from

**27% to 80%**

during the intervention period

**100%** of staff surveyed preferred disinfecting caps

**92%** of patients provided positive feedback



Estimated potential time savings from passive disinfection compared to scrub the hub equated to

**82.4**

working days/yr



Estimated cost savings with passive disinfection =

**£387,366.22**



# “The implementation of the port protector cap system resulted in lower infection rates compared with an alcohol swab technique.”

Ramirez C, Lee AM, Welch K. Central venous catheter protective connector caps reduce intraluminal catheter-related infection. *J Assoc Vasc Access.* 2012;17(4):210-213.

## DESIGN

Before and after intervention study comparing CLABSI rates in patients with CVCs from two ICUs.

## METHODS

### Pre-Intervention:

Scrub the hub protocol

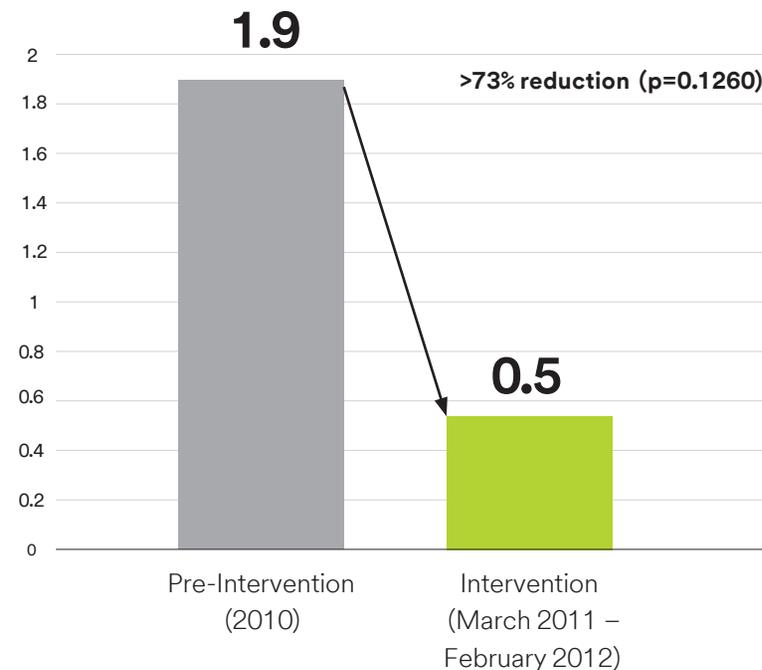
### Intervention:

3M™ Curoc™ Disinfecting Cap for Needleless Connectors placed on all CVC and IV tubing needleless connectors



## RESULTS

### CLABSI Rate (per 1000 catheter days)



Compliance increased from **63% to 80%** after moving from single caps to multiple cap strips to hang on IV pole for bedside access



The trial resulted in a calculated net savings of **\$39,050**



# “Application of the bundle resulted in a significant and sustained reduction in CLABSI rates in long-term acute care hospitals (LTACHs) for 14 months.”

Grigonis AM, Dawson AM, Burkett M, et al. Use of a central catheter maintenance bundle in long-term acute care hospitals. *Am J Crit Care*. 2016;25(2):165-172.

## DESIGN

Before and after intervention study comparing CLABSI in patients with CVCs from 30 LTACHs.

## METHODS

### Pre-Intervention:

No formal standardized CVC maintenance protocol in place

### Intervention:

Implementation of CVC maintenance bundle and care team trained on CVC care

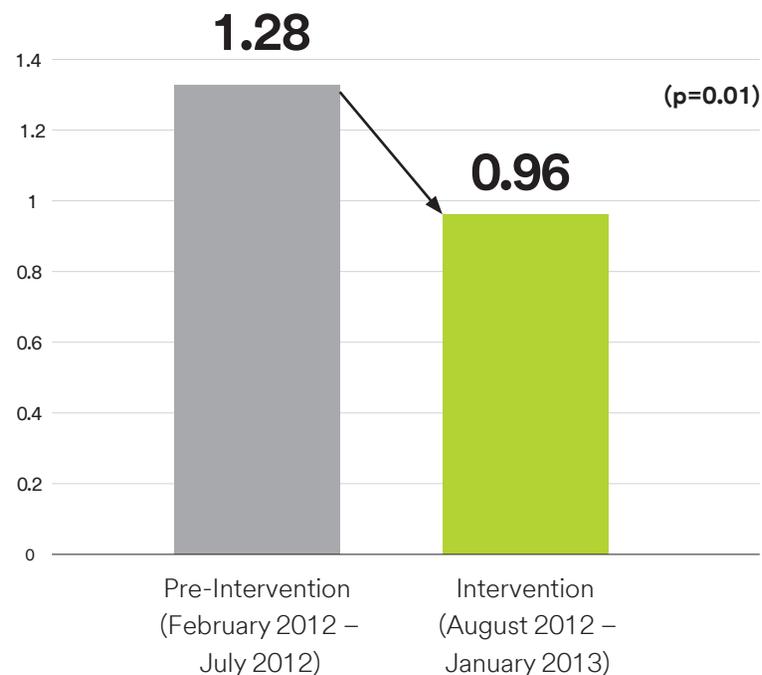
### CVC bundle:

- CDC guideline recommendations
- Mandatory use of 3M™ Curoc™ Disinfecting Cap for Needleless Connectors on all IV needleless connectors
- Chlorhexidine gluconate dressings



## RESULTS

### CLABSI Standardized Infection Ratio (SIR)



The number of central line days was 120,137 before and 119,412 after bundle implementation.

The study concluded that the mean number of CLABSIs per LTACH decreased by 4.5 in the 14 months after the intervention. The infection reduction could have potentially saved

**20**

patients' lives.\*

\*assuming a 15% mortality rate



Estimated potential savings of approximately

**\$3.7 million**

for the LTACHs studied



# Implementation of port protectors and needleless neutral pressure connectors was associated with a significant reduction in the rate of CLABSI and contaminated blood cultures (CBCs).

Sweet MA, Cumpston A, Briggs F, Craig M, Hamadani M. Impact of alcohol-impregnated port protectors and needleless neutral pressure connectors on central line-associated bloodstream infections and contamination of blood cultures in an inpatient oncology unit. *Am J Infect Control*. 2012;40(10):931-934.

## DESIGN

Before and after intervention study comparing CLABSI and CBC rates in adult hematology and oncology patients with CVCs.

## METHODS

### Pre-Intervention:

Scrub the hub protocol

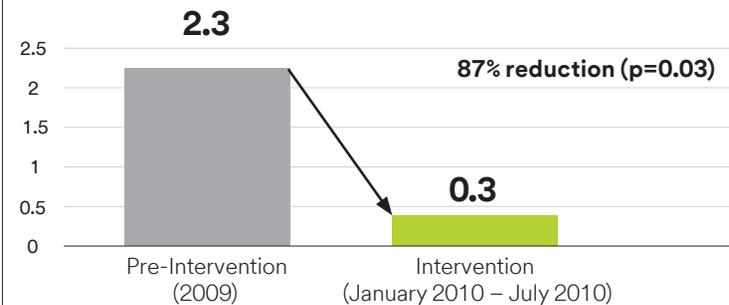
### Intervention:

Needleless neutral pressure connectors and 3M™ Curoc™ Disinfecting Cap for Needleless Connectors placed on CVC hubs

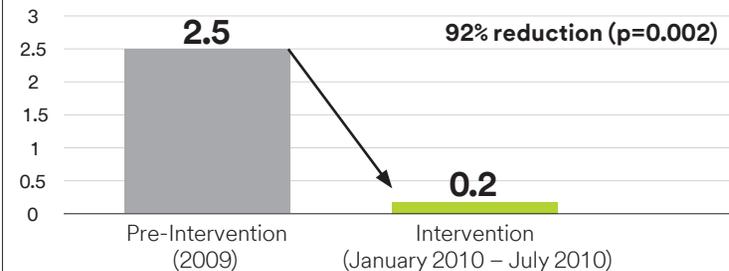


## RESULTS

### CLABSI Rate (per 1000 catheter days)



### CBC Rate (f)



The number of central line days was 6,851 in the pre-intervention and 3,005 in the intervention period

Compliance to the intervention =  
**85.2%**



# “Following implementation of the caps, the rates of CLABSI within the burn ICU were significantly reduced...”

Martino A, Thompson L, Mitchell C, et al. Efforts of a unit practice council to implement practice change utilizing alcohol impregnated port protectors in a burn ICU. *Burns*. 2017;43(5):956-964.

## BACKGROUND

Despite > 90% compliance to the CVC bundle, the CLABSI rate in the burn ICU was higher than benchmark.

## DESIGN

Prospective before and after intervention study comparing CLABSI rates in burn patients with CVCs.

## METHODS

### Pre-Intervention:

CDC recommended CVC bundle and scrub the hub protocol

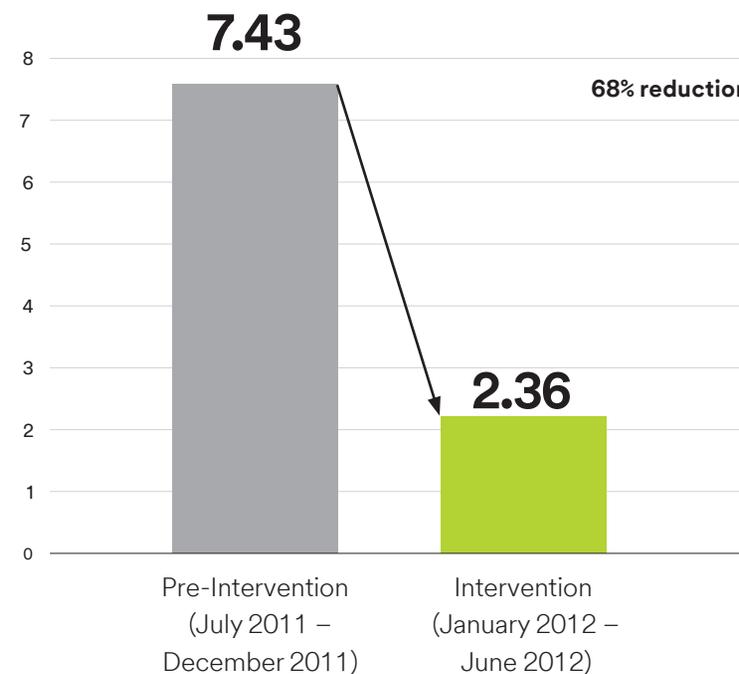
### Intervention:

3M™ Curoc™ Disinfecting Cap for Needleless Connectors added to CVC bundle as a standard of care January 2012



## RESULTS

### CLABSI Rate (per 1000 central line days)



“... ease of use with the caps simplified daily tasks, leading to higher compliance.”



The number of central line days was 673 in the pre-intervention and 1272 in the intervention period.

# “Reducing the number of IV attempts and extending the functionality of a PIVC without complications are keys to reducing waste, improving efficiency, and increasing patient satisfaction of services.”

Steere L, Ficara C, Davis M, Moureau N. Reaching one peripheral intravenous catheter (PIVC) per patient visit with lean multimodal strategy: the PIV5Rights™ bundle. *J Assoc Vasc Access.* 2019;24(3):31-43. doi:10.2309/j.java.2019.003.004

## DESIGN

A prospective comparator single-center study compared peripheral intravenous catheter (PIVC) outcomes and dwell time in adult patients in a medical surgical unit.

## METHODS

**Control (Group 1):** Staff nurses inserting PIVCs, no ultrasound, variability in placement location and supplies/technology including: neutral needleless connectors

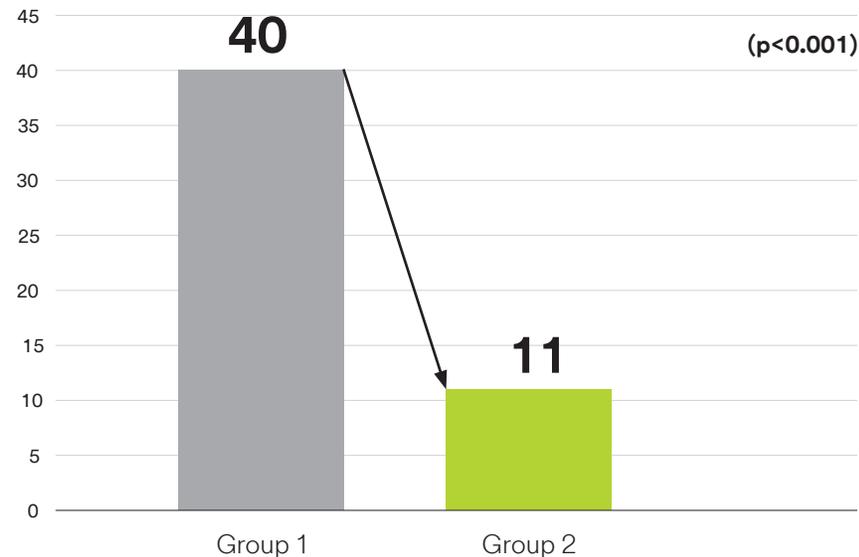
**Intervention (Group 2):** Infusion team nurses inserting PIVCs, using ultrasound as needed, preferred insertion site was in forearm, and supplies/technology included:

- IV kit
- CHG/alcohol skin prep
- 22g catheter
- Anti-reflux needleless connector
- Antimicrobial bordered securement dressing
- 3M™ Curores™ Disinfecting Cap for Needleless Connectors and 3M™ Curores Jet™ Disinfecting Cap for Needleless Connectors



## RESULTS

### Complication Rate (%)



Group 1: 94 PIVCs  
Group 2: 113 PIVCs



## 89%

of Group 2 PIVCs reached end of treatment, while only

## 15%

reached end of treatment in Group 1  
( $p < 0.001$ )



Group 2 had an average daily increased dwell time of

## 66.7%

(more than twice as long as Group 1 dwell times)  
( $p < 0.001$ )



Group 2 had a

## 71% reduction in cost

per bed per year, or \$3,376 per bed savings

# Introduction of 70% alcohol-impregnated antiseptic barrier catheter caps (ABCs) led to a non-statistically significant decrease in CLABSI incidence rates in a high-risk hematology and oncology population.

Cruz-Aguilar R, Carney J, Mondaini V, et al. A quality improvement study on the reduction of central venous catheter-associated bloodstream infections by use of self-disinfecting venous access caps (STERILE). *Am J Infect Control*. 2021;49(5):586-592. doi:10.1016/j.ajic.2020.09.002

## DESIGN

Before and after single center intervention study comparing CLABSI rates in high-risk hematology and oncology patients with jugular, femoral, or subclavian central venous catheters (CVCs).

## METHODS

### Control:

Standard catheter caps

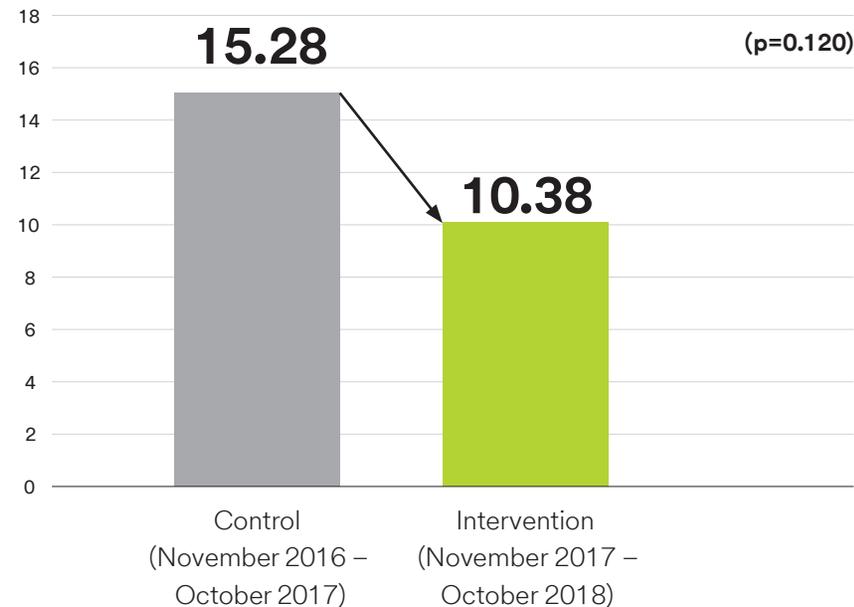
### Intervention:

3M™ Curosurf™ Stopper Disinfecting Cap for Open Female Luers placed on all CVC catheter hubs



## RESULTS

### CLABSI Rate (per 1000 catheter days)



The pre-intervention group had 309 patients with 443 catheters (4,189 catheter days) and the intervention group had 289 patients with 431 catheter placements (4,818 catheter days)

A decrease in CLABSI rate was demonstrated; however, in the Cox proportional hazard model the effect of ABCs on the CLABSI incidence was not statistically significant



# “The data show overall reduction in CLABSI, improvements in patient outcomes, and increased staff satisfaction.”

Zavotsky KE, Malast T, Festus O, Riskie V. Reducing central line-associated bloodstream infections on inpatient oncology units using peer review. *Clin J Oncol Nurs*. 2015;19(6):655-658. doi:10.1188/15.CJON.655-658

## BACKGROUND

The CLABSI rate in the Oncology Service was rising and prompted a performance improvement strategy and interventions.

## METHODS

### Pre-Intervention:

Standard central line bundle of care

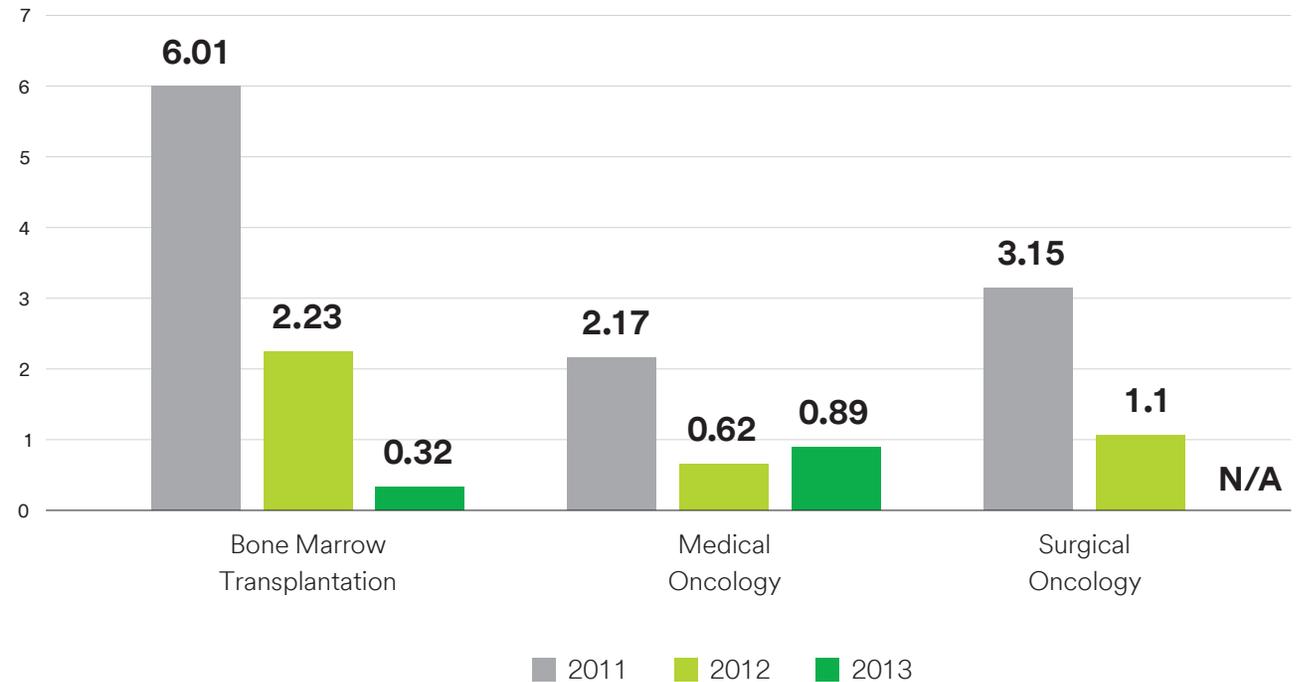
### Intervention:

- Staff education related to standards of insertion, dressing changes and maintenance
- Use of 3M™ Curosurf™ Disinfecting Cap for Needleless Connectors on all CVC needleless connectors
- Oncology central line management checklist
- Peer-to-peer program



## RESULTS

### CLABSI Rate (per 1000 patient days)



# Use of isopropyl alcohol-impregnated caps, as part of a care bundle, led to a statistically significant reduction in positive blood cultures in a per protocol analysis.

Milstone AM, Rosenberg C, Yenokyan G, Koontz DW, Miller MR, CCLIP Authorship Group. Alcohol-impregnated caps and ambulatory central-line-associated bloodstream infections (CLABSIs): A randomized clinical trial. *Infect Control Hosp Epidemiol.* 2021;42(4):431-439. doi:10.1017/ice.2020.467

## DESIGN

24-month, cluster-randomized, two period, crossover trial comparing ambulatory CLABSI rates at 16 pediatric hematology-oncology clinics.

## METHODS

### Control:

Standard central-line maintenance care bundle per institutional policy

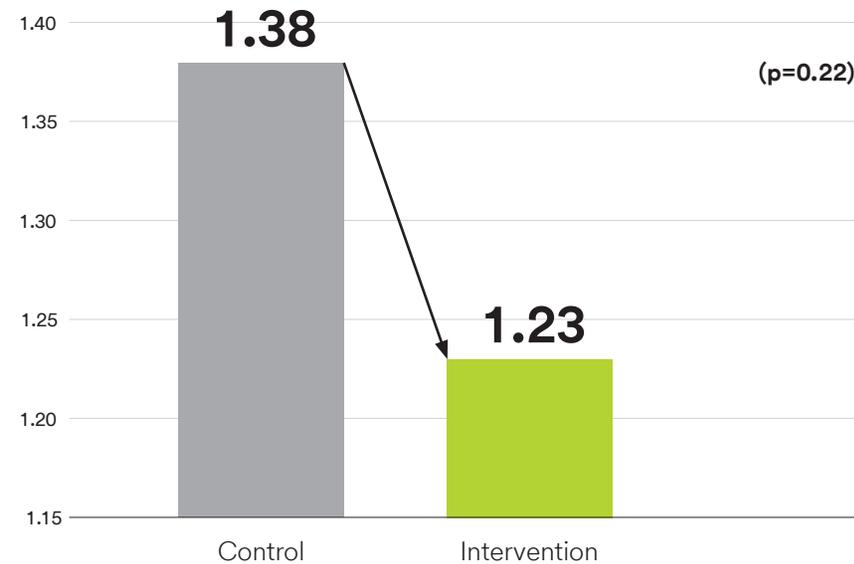
### Intervention:

3M™ Curoc™ Disinfecting Cap for Needleless Connectors placed on all external central line needleless connectors (Hickman, Broviac, central PICC, or non tunneled central lines)



## RESULTS

### CLABSI Rate (per 1000 at-risk days)



123 CLABSI events occurred in Control Clinics

109 CLABSI events occurred in Intervention Clinics

In the per protocol analysis, the incidence of positive blood cultures decreased by

**28%**  
(p=0.045)



# Switching from a split septum IV connector to a luer lock connector and passive alcohol disinfecting cap reduced colonization rates.

Hankins R, Majorant OD, Rupp ME, et al. Microbial colonization of intravascular catheter connectors in hospitalized patients. *Am J Infect Control*. 2019;47(12):1489-1492. doi:10.1016/j.ajic.2019.05.024

## DESIGN

Prospective, two phase, quality improvement study to assess colonization of catheter connector systems in adult patients receiving active infusions through peripheral or central catheters.

## METHODS

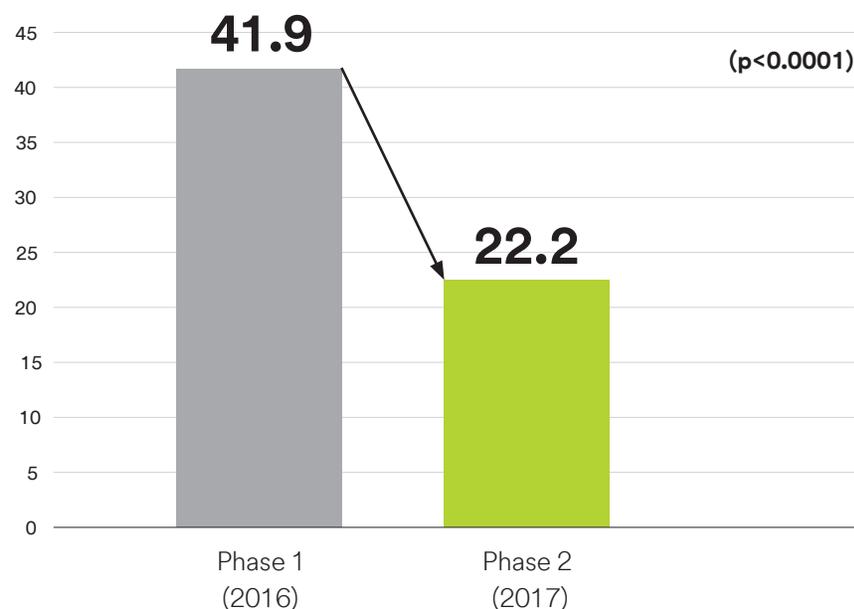
### Intervention:

- Phase 1: Split septum IV connector
- Phase 2: Luer lock needleless connector with 3M™ Curoc™ Disinfecting Cap for Needleless Connectors



## RESULTS

### Catheter Colonization (%)



Phase 1: Total of 234 catheter connectors cultured, of which 98 were colonized

Phase 2: Total of 243 catheter connectors cultured, of which 54 were colonized

# Reduction, not statistically significant, in occurrence of thrombophlebitis in equine patients when using disinfecting catheter caps.

Fisk N. A comparative study of disinfecting catheter caps and their effectiveness in the reduction of equine IV catheter-related thrombophlebitis. *Vet Nurs J.* 2018;33(3):74-78. doi:10.1080/17415349.2017.1414781

## DESIGN

Retrospective pilot study comparing the incidence of catheter-related thrombophlebitis in equine (horse) patients with indwelling over-the-wire catheters.

## METHODS

### Control:

14-gauge polyurethane over-the-wire catheters and needleless connector without disinfecting cap

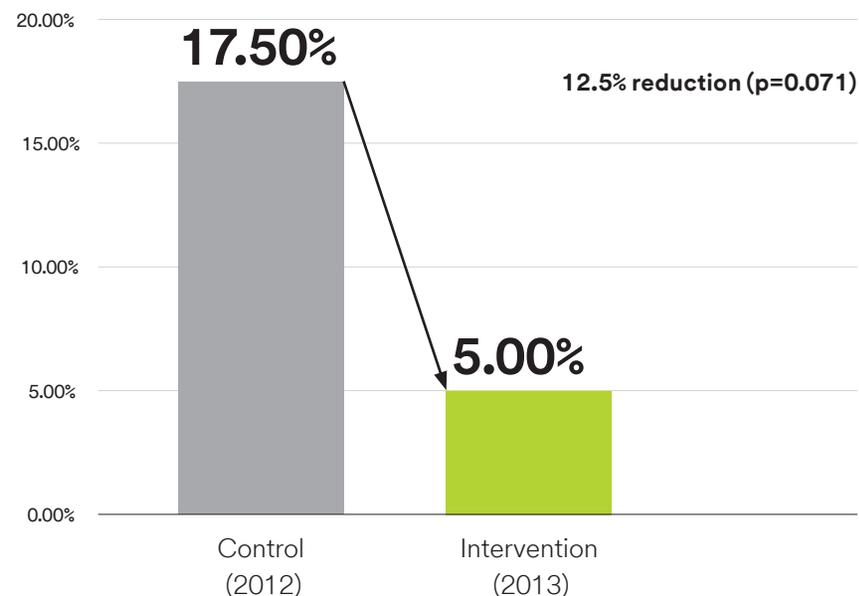
### Intervention:

Addition of 3M™ Curoc™ Disinfecting Cap for Needleless Connectors



## RESULTS

### Percent of Thrombophlebitis Cases



Data was collected via electronic randomization of data from 40 equine patients recorded during the pre-intervention and 40 equine patients during the intervention period.

# Post intervention CLABSI rate improved from 5.2 to 0.4 per 1000 line days in 2014 (p<0.05).

Karam-Howlin R, Fede A, Gibbs K, Bravo N, Wallach F, Patel G. Successful decrease of central line-associated bloodstream infections in an urban neonatal intensive care unit using a pediatric-specific interdisciplinary approach. *Am J Infect Control*. 2015;43(6):S58.

## DESIGN

Before and after intervention study comparing CLABSI in NICU patients.

## INTERVENTION

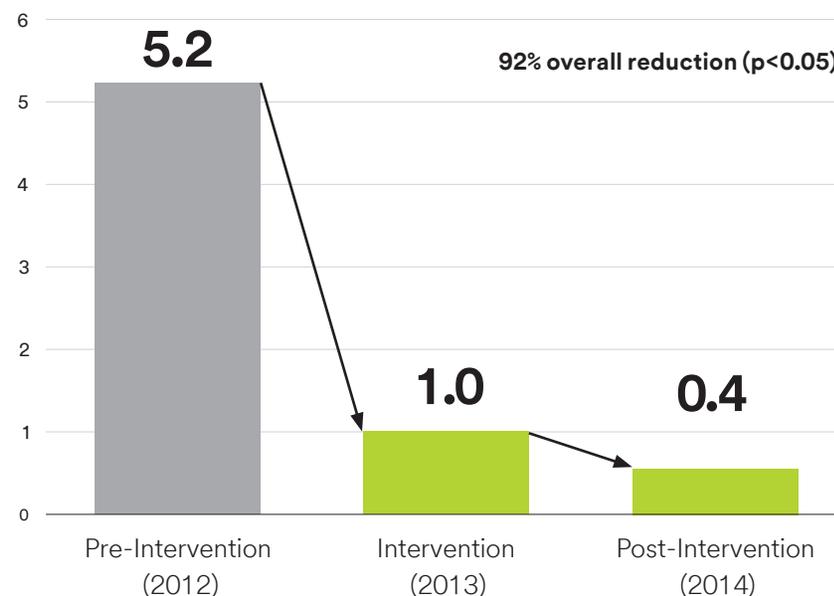
Implementation of an interdisciplinary pediatric CLABSI committee and multiple interventions including:

- Insertion checklist, placement of non-emergent lines in dedicated procedure room
- Daily assessment of line necessity
- Daily assessment of dressing, exit site and presence of 3M™ Curosur™ Disinfecting Cap for Needleless Connectors



## RESULTS

### CLABSI Infections (per 1000 line days)



# By utilizing disinfecting caps, compliance is more accurate and a significant reduction can be seen in the burden of CLABSIs.

Jimenez A, Barrera A, Madhivanan P. Systematic review on impact of use of disinfectant caps protectors for intravenous access ports on central line-associated bloodstream infections (CLABSI). *Open Forum Infectious Diseases*. 2015;2(1):281.

## DESIGN

Systematic review

## METHODS

A systematic review was conducted according to the MOOSE guidelines using MEDLINE, EMBASE, CINAHL, Scopus and the Cochrane Database without any limits. Searches were conducted to identify articles needing inclusion criteria and were independently screened by the authors.



## RESULTS

CLABSI reduction ranged from

**30% – 87%**

**in the nine studies included in the systematic review.**

Nine quasi-experimental studies examining the effect of 3M™ Curoc™ Disinfecting Cap for Needleless Connectors and Swabcap® Disinfecting Caps on CLABSI were included.

# Implementation of disinfecting caps was associated with a reduced rate of hospital wide CLABSI, cost savings and increased nursing satisfaction.

Danielson B, Williamson S, Kaur G, Johnson N. A significant decline in central line-associated blood stream infections using alcohol-impregnated port protectors at a large non-profit acute care hospital. *Am J Infect Control*. 2014;42(6):S16.

## DESIGN

Before and after intervention study comparing hospital wide CLABSI standardized infection ratios (SIR).

## METHODS

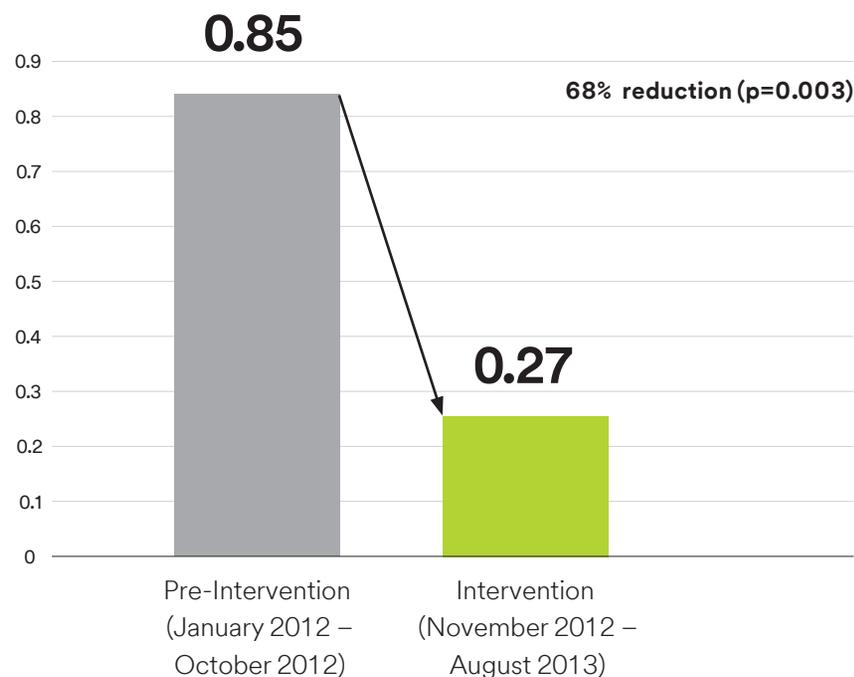
**Pre-Intervention:** 15 second scrub the hub protocol

**Intervention:** Implemented 3M™ Curoc™ Disinfecting Cap for Needleless Connectors hospital wide



## RESULTS

### Adult CLABSI SIR



# “When disinfectant caps were used on all IV ports, the rate of both CLABSI and nosocomial BSI fell significantly.”

Shelly M, Greene L, Brown L, Romig S, Pettis AM. Alcohol-impregnated disinfectant caps reduce the rate of central-line associated bloodstream infections and nosocomial bacteremia. *Open Forum Infect Dis.* 2014 Dec;1(Suppl 1):S248. doi:10.1093/ofid/ofu052.570

## DESIGN

Before and after intervention study comparing CLABSI and nosocomial bloodstream infections (BSI) in four hospital units (ICU, step down, two med/surg units).

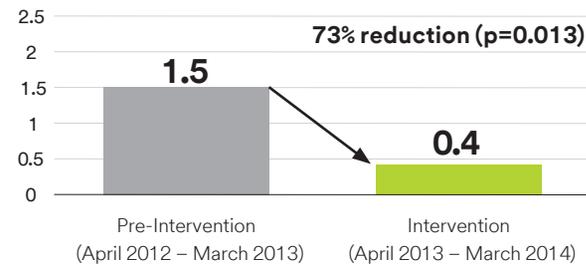
## INTERVENTION

3M™ Curoc™ Disinfecting Cap for Needleless Connectors or Swabcap® Disinfecting Caps placed on all needleless IV access ports of peripheral and central lines.

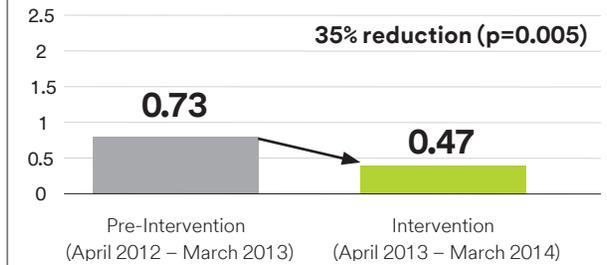


## RESULTS

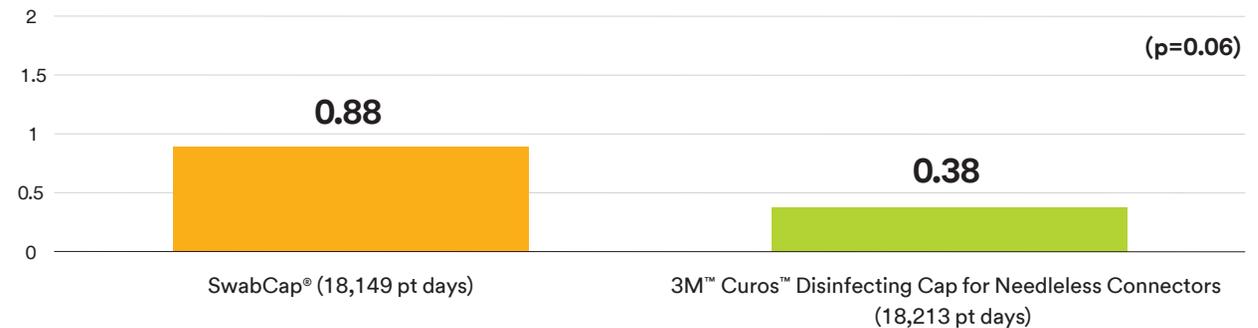
### CLABSI Rate (per 1000 line days)



### Nosocomial BSI Rate (per 1000 patient days)



### Nosocomial BSI Rate (per 1000 patient days)



The number of line days was 10,441 in the baseline and 9,536 in the intervention period.

In units that did not implement disinfectant caps, there was no significant difference in CLABSI or nosocomial BSI rates.

# A significant decline in the incidence of CLABSIs was observed after the addition of Curoso™ disinfecting caps to an existing central line bundle.

Danielson B, Williamson S, Kaur G, Brooks C, Scholl P, Baker A. Decreasing the incidence of central line-associated blood stream infections using alcohol-impregnated port protectors (AIPPS) in a neonatal intensive care unit. *Am J Infect Control*. 2013;41(6):S97-S98.

## DESIGN

Before and after intervention study comparing CLABSI standardized infection ratios (SIR) in level 3 NICU patients.

## METHODS

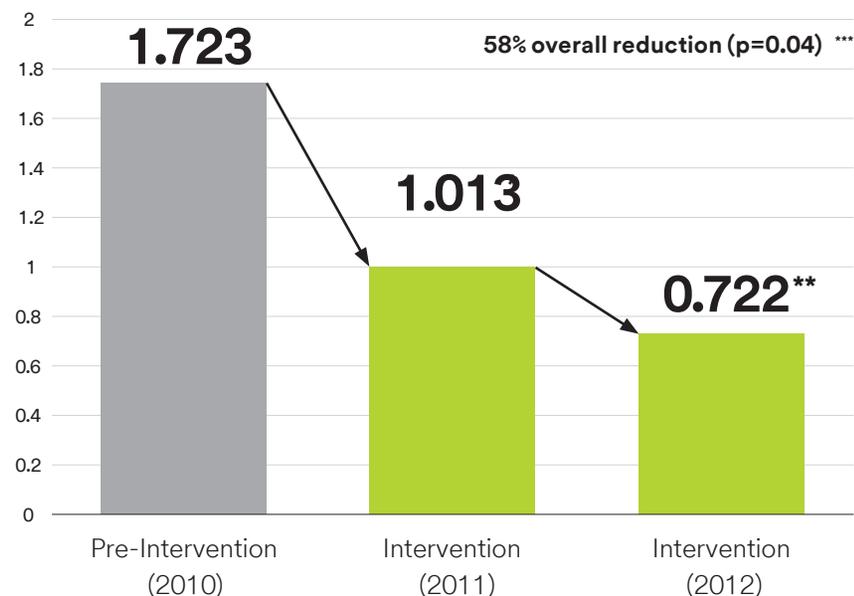
**Pre-Intervention:** Evidence-based central line bundle including 15 second scrub the hub protocol

**Intervention:** Implemented 3M™ Curoso™ Disinfecting Cap for Needleless Connectors on IV access ports



## RESULTS

### CLABSI SIR



\*Intervention began Q1 2011; Results included Q4 2011 when Curoso disinfecting cap not in use

\*\*Use of Curoso disinfecting cap resumed January 2012

\*\*\*Comparison is between 2010 and 2012

# “The use of a disinfectant cap is effective in reducing the rate of CLABSI and contaminated blood cultures and provides a substantial cost savings.”

Sumner S, Merrill KC, Linford L, Taylor C. Decreasing CLABSI rates and cost following implementation of a disinfectant cap in a tertiary care hospital. *Am J Infect Control.* 2013;41(6):S37.

## DESIGN

Before and after intervention study comparing CLABSI and nursing compliance in a Level I Trauma Center.

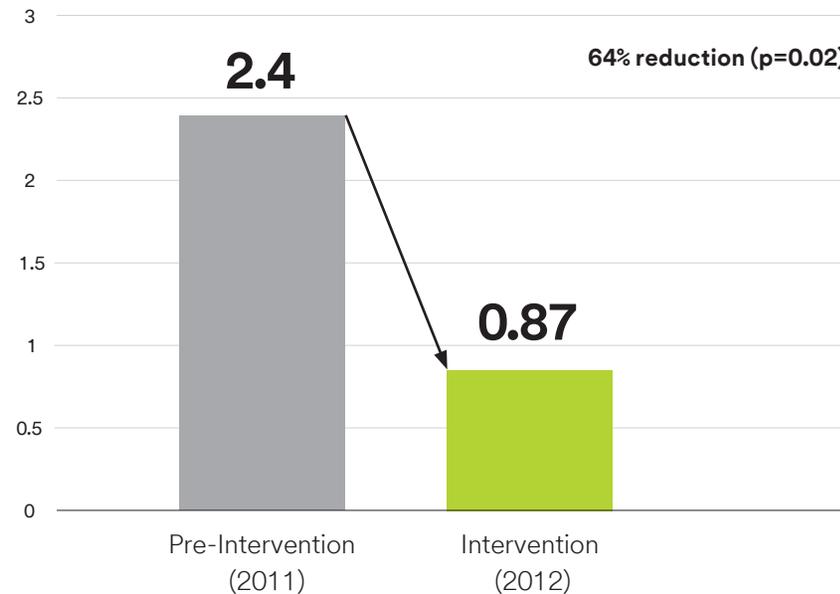
## METHODS

**Pre-Intervention:** Baseline data found that 55% of nurses scrub the needleless connector for less than five seconds

**Intervention:** 3M™ Curoc™ Disinfecting Cap for Needleless Connectors implemented on all central and peripheral needleless connectors in all inpatient departments (excluding women’s services)

## RESULTS

CLABSI Rate (per 1000 line days)



There was a non-significant decrease in contaminated blood cultures from **2.5%** before to **1.4%** after intervention

Nursing compliance to the disinfecting cap increased significantly from **73% to 88%** during the study (p=0.01)

Total estimated cost savings per month  
**\$95,000**

# Following discontinuation of disinfecting caps, the CABSI rate returned to the pre-intervention rate.

Mayfield J, Alasmari F, Kittur ND, et al. Impact of alcohol-impregnated protectors on incidence of catheter-associated blood stream infections. Presented at: IDWeek annual meeting; October 18, 2012; San Diego, CA.

## DESIGN

Before and after intervention study comparing catheter-associated bloodstream infection (CABSI) between a control and intervention unit caring for acute leukemia and stem cell transplant patients.

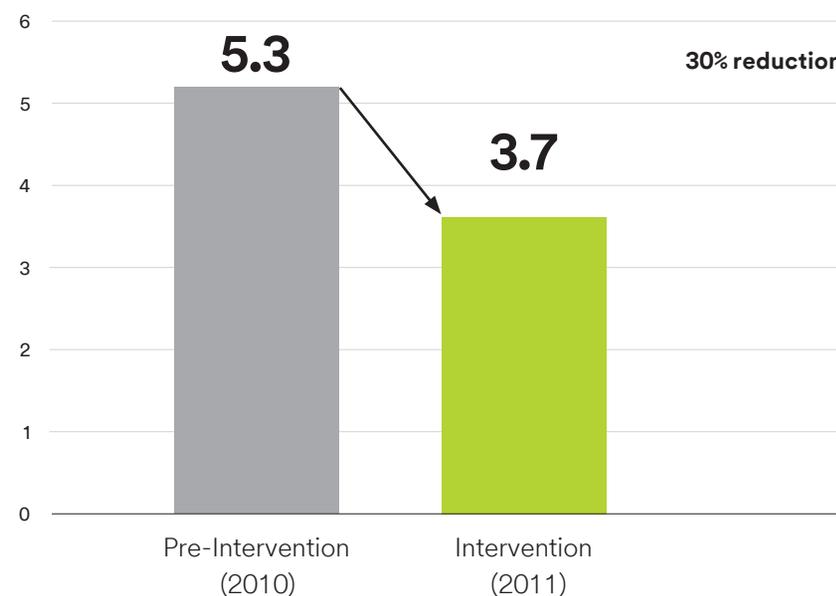
## INTERVENTION

Implementation of 3M™ Curoc™ Disinfecting Cap for Needleless Connectors on CVC needleless connectors



## RESULTS

### Median CABSI Rate (per 1000 central line days)



The number of central line days was 20,126 in the pre-intervention and 20,206 in the intervention period.

Analysis of CABSI rates in a control unit during the same time periods were 5.6 (2010) and 5.4 (2011) per 1000 central line days.

# The CLABSI rate decreased 68% the first year after implementation of Curoso™ disinfecting cap, used in conjunction with other CLABSI prevention measures.

Pong A, Salgado C, Speziale M, Grimm P, Abe C. Reduction in central line associated bloodstream infection (CLABSI) in a neonatal intensive care unit with use of access site disinfection caps. Presented at: Infectious Disease Society of America annual meeting; October 21, 2011; Boston, MA.

## DESIGN

Before and after intervention study comparing CLABSI and blood culture contaminants in level 4 NICU patients.

## METHODS

**Pre-Intervention:** CLABSI prevention measures in place:

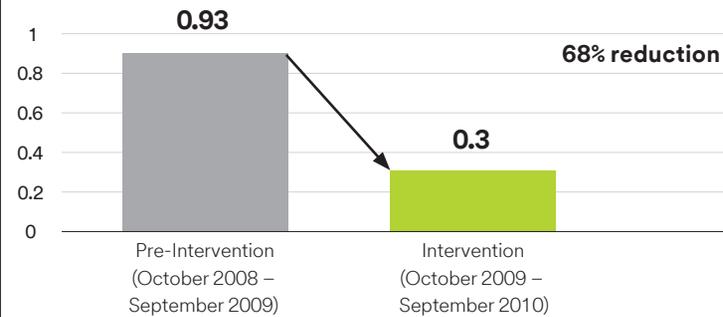
- Sterile insertion technique
- Hand hygiene
- Hub cleansing with access
- Standards for dressing and tubing changes
- Prompt catheter removal

**Intervention:** 3M™ Curoso™ Disinfecting Cap for Needleless Connectors added to all CVC needleless connectors

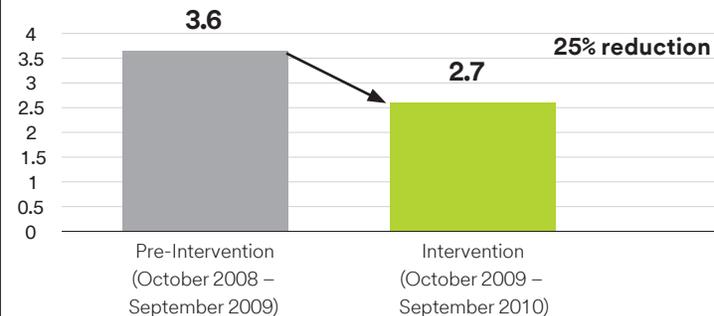


## RESULTS

### CLABSI Rate (per 1000 line days)



### Contaminated Blood Culture Isolates (per 1000 line days)



The number of central line days was 7,533 in the pre-intervention and 6,782 in the intervention period.

# Clinically significant fall in Catheter Related Sepsis (CRS) rates related to Parenteral Nutrition (PN) following introduction of a disinfecting cap.

Wheatley DJ, Rowlands S, Chapman J, et al. PTH-195 Curoso™ line caps are effective in reducing catheter related sepsis in inpatients receiving parenteral nutrition. *Gut*. 2015;64(Suppl 1):A495.1-A495. doi:10.1136/gutjnl-2015-309861.1083

## DESIGN

Before and after intervention study comparing CRS rates in inpatients receiving PN through either a PICC or dedicated port of a CVC.

## METHODS

### Pre-Intervention:

Standard aseptic non-touch technique

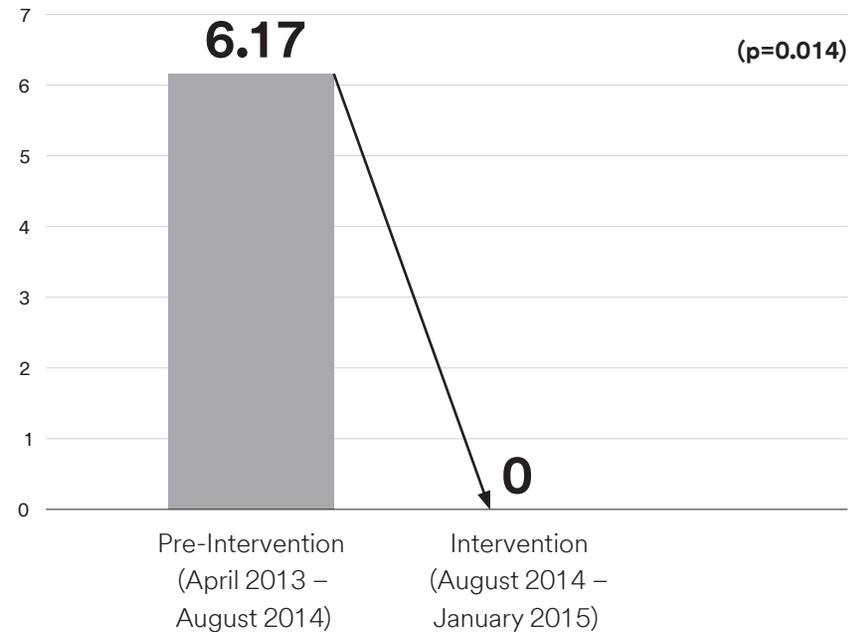
### Intervention:

Addition of 3M™ Curoso™ Disinfecting Cap for Needleless Connectors (implemented on Aug. 9, 2014)



## RESULTS

### Catheter Related Sepsis (events per 1000 catheter days)



Pre-intervention (no Curoso Disinfecting Cap for Needleless Connectors) total PN days: 1617

Intervention group (Curoso Disinfecting Cap for Needleless Connectors) total PN days: 521

# The introduction of 3M™ Curoso™ Disinfecting Cap for Needleless Connectors, in a care bundle with CHG bathing, was associated with a significant reduction in CLABSI.

Russo N, Gupta K, Tibert C, Strymish J. 863 reduction in CLABSIs with alcohol port protectors. *Open Forum Infect Dis*. 2014;1(Suppl-1):S248. doi:10.1093/ofid/ofu052.571

## DESIGN

Before and after intervention study comparing infection rates in multiple levels of care (acute care, ICU, and a community living center) for patients with peripheral and central catheters.

## METHODS

### Pre-Intervention:

CVC best practice bundle

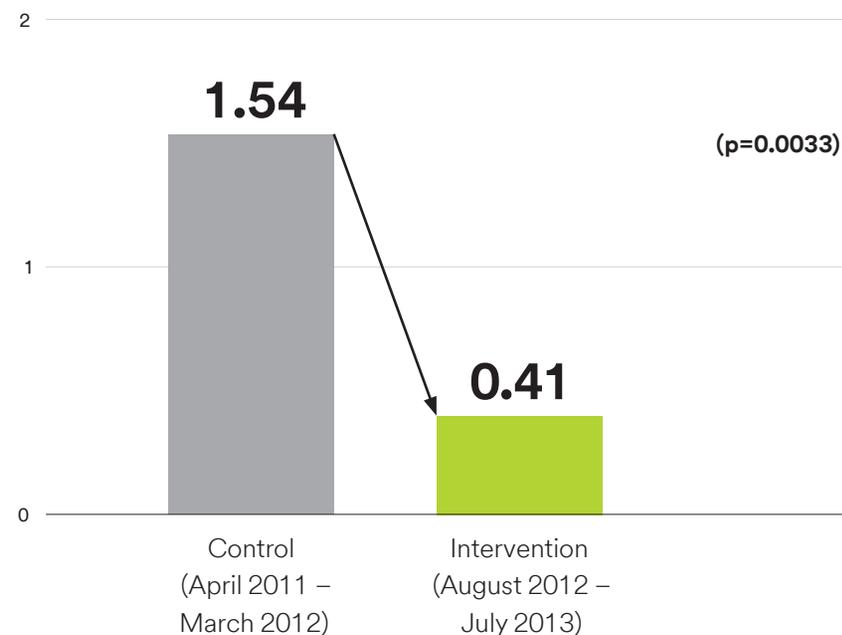
### Intervention:

- Use of Curoso Disinfecting Cap for Needleless Connectors on central and peripheral line needleless connectors
- Added chlorhexidine bathing in ICUs in November 2012



## RESULTS

### CLABSI Rates (per 1000 line days)



Pre-intervention: 22 infections, 14,308 line days

Intervention group: 5 infections, 12,263 line days

# Sustained compliance with disinfecting protocol seen with intervention implementation.

Cabahug T, Jie L, Meng QS, Tang M, Wang Y, Foo SY, Wu T. Impact of disinfectant cap implementation on peripherally-inserted central catheter (PICC) associated bloodstream infection rates. Poster presented at: APSIC Congress. 2019; Vietnam. Abstract available at: [https://www.researchgate.net/publication/333679803\\_Impact\\_of\\_disinfectant\\_cap\\_implementation\\_on\\_peripherally-inserted\\_central\\_catheter\\_PICC\\_associated\\_bloodstream\\_infection\\_rates](https://www.researchgate.net/publication/333679803_Impact_of_disinfectant_cap_implementation_on_peripherally-inserted_central_catheter_PICC_associated_bloodstream_infection_rates)

## DESIGN

Prospective study assessing the impact of implementing disinfecting caps on CLABSI rates for PICC lines in four inpatient wards.

## METHODS

### PICC Maintenance Bundle Education:

- Insertion site care
- Dressing recommendations
- Application of CHG disk (BIOPATCH®)

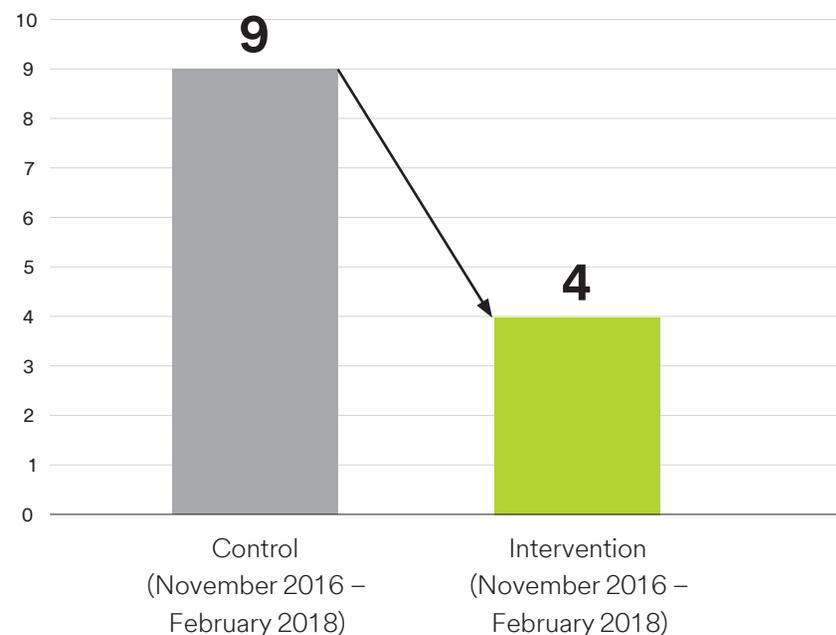
### Intervention:

- PICC maintenance bundle education
- Addition of 3M™ Curoc™ Disinfecting Cap for Needleless Connectors to PICC line needleless connectors



## RESULTS

### Number of CLABSIs\*



Control group (infection rate of 1.11/1000 catheter days)

Intervention group (infection rate of 0.74/1000 catheter days)

\*Not statistically significant

Compliance with use of disinfecting caps

**≥95%**

for 15 out of the 16 months tracked



# Use of antiseptic caps on CVC main stopcocks demonstrated protection from contamination and increased compliance over standard practice.

Guyot A, Lorf S, van Stein C, Hüngrer F, Schaaf B. Antiseptic caps protect stopcocks from internal bacterial contamination. *J Hosp Infect.* 2021 Feb;108:212-214.

doi:10.1016/j.jhin.2020.11.026

## DESIGN

A cluster randomized trial assessed the contamination rates of stopcocks and incidence of CLABSI in an ICU.

## METHODS

### Pre-Intervention:

Manual disinfection of stopcock hubs, which included the use of Octeniderm® spray and use of Combi-Stopper caps

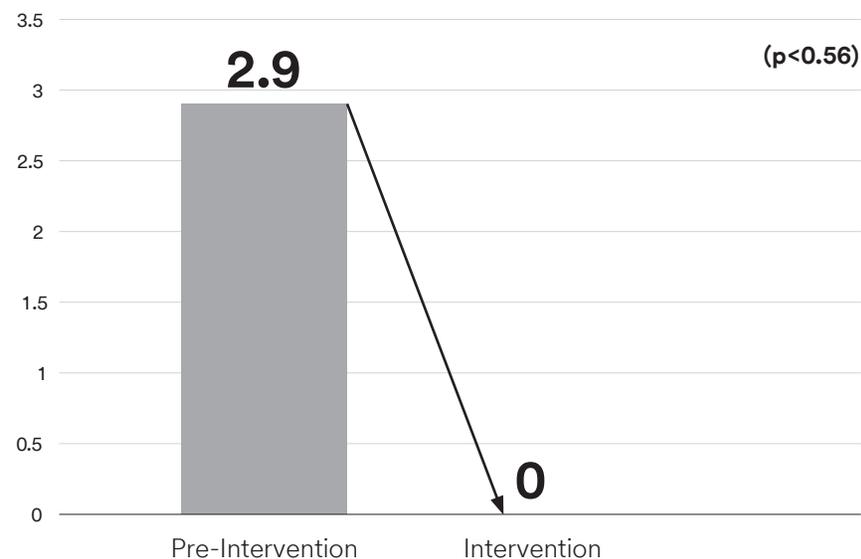
### Intervention:

3M™ Curoc™ Stopper Disinfecting Cap for Open Female Luers placed on all primary IV infusion stopcocks



## RESULTS

### CLABSI Rate (per 1000 CVC days)



The mean dwell time in the pre-intervention was 10.6 days and 12.7 days in the intervention.

Contamination rates of stopcocks dropped from

**15.9% to 5.6%**

during the study ( $p < 0.03$ )



Compliance rates to disinfecting caps was

**98%**

compared to

**60%**

for standard disinfection



# Additional Resources

## ABSTRACTS

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# Additional Resources, Continued

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