Strategies to Prevent Hospital-Onset Staphylococcus aureus Bloodstream Infections and an Ongoing Collaborative Implementing These Approaches

David "Cal" Ham, MD, MPH

Medical Officer, Antimicrobial Resistance Team

Prevention and Response Branch

Division of Healthcare Quality Promotion

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Objectives

- Describe *S. aureus* background information and surveillance data
- Review key findings from an investigation of hospital-onset MRSA bloodstream infections
- Provide an overview of the ongoing Tennessee and Kentucky Hospital-onset MRSA Bloodstream Infection Learning Collaborative
- Review Strategies to Prevent Hospital-onset *Staphylococcus aureus* Bloodstream Infections in Acute Care Facilities

Background

Staphylococcus aureus (SA)

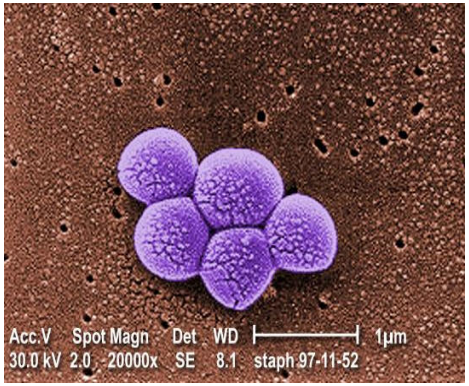


*Image courtesy of CDC and Public Health Image Library

- Common in healthcare settings
- Causes variety of infections including skin and soft-tissue, pneumonia, and bloodstream infections (BSIs)
- Can lead to severe complications including sepsis and death
- Methicillin-sensitive *Staphylococcus aureus* (MSSA)
- Methicillin-resistant *Staphylococcus aureus* (MRSA)
  - Resistant to many commonly used first-line antibiotics

SA as Cause of Healthcare-associated Infections (HAIs)

- *Staphylococcus aureus* pathogen rank by adult HAI type as reported to National Healthcare Safety Network (NHSN), 2015-2017
  - Central line-associated bloodstream infections (CLABSI) #2
  - Ventilator-associated pneumonias (VAP) #1
  - Surgical site infections (SSI) #1
  - Catheter-associated urinary tract infections (CAUTI) #11
  - Overall #2

- 56% *S. aureus* HAIs in Acute Care Hospitals (ACH) were MSSA

*Weiner-Lastinger LM, et al, Infection Control and Hospital Epidemiology, 2020,41; (1):1-18

S. aureus Bloodstream Infection National Estimates

- Total *S. aureus* BSIs in 2017: 119,832*
- In 2017 there were an estimated 19,832 deaths (inpatient) associated with *S. aureus* bloodstream infections nationally
- Associated in-hospital mortality from 2012 to 2017 was 18%*

*Premier and Cerner Electronic Health Record databases (2012–2017)

S. aureus Bloodstream Infection National Estimates

- Associated in-hospital mortality from 2012 to 2017: 18% overall
  - **Hospital-onset MRSA BSIs: 29%**
  - **Hospital-onset MSSA BSIs: 24%**
  - Community-onset MRSA BSIs: 18%
  - Community-onset MSSA BSIs: 14%

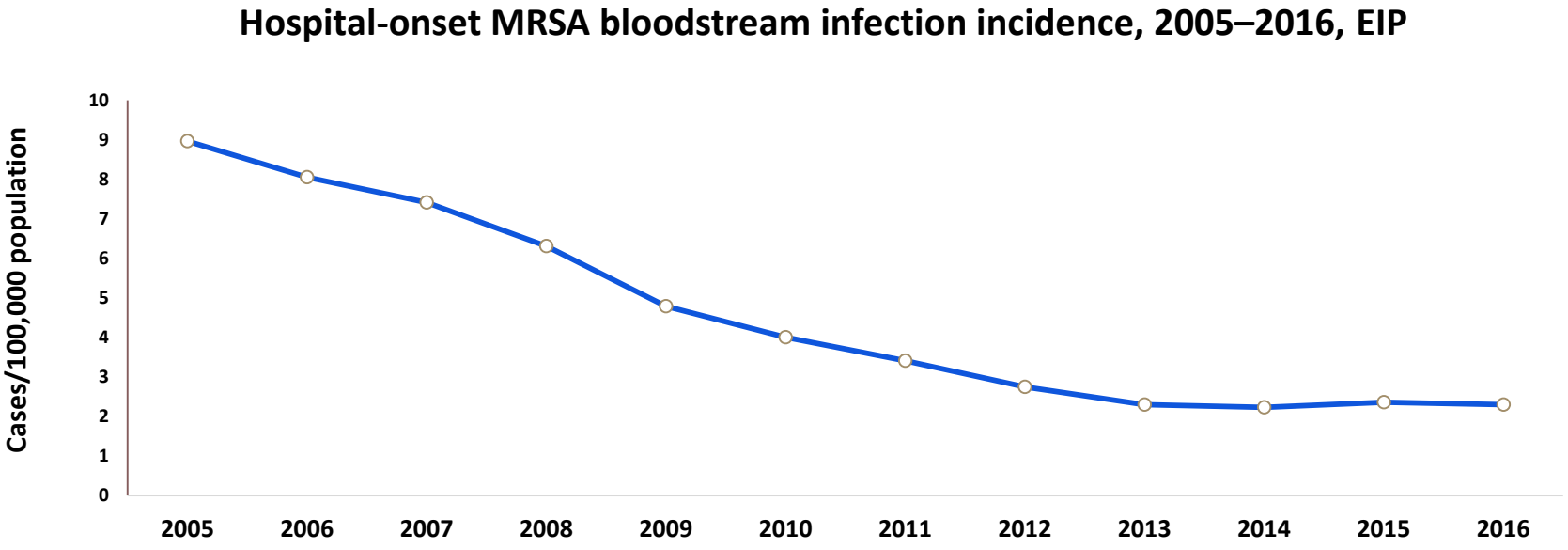
- Hospital-onset: culture obtained on or after day 4 of hospitalization
- Community-onset: culture was obtained from an outpatient or during the first 3 days of hospitalization

*Premier and Cerner Electronic Health Record databases (2012–2017)

MRSA Surveillance in NSHN

- 2018 NHSN HAI Progress Report
  - 8,222 hospital-onset MRSA bloodstream infections (HO MRSA BSIs)
  - Standardized infection ratio (SIR): # observed infections/# predicted infections
    - 2020 reduction target for HO MRSA BSIs is 0.5 (compared to 2015 baseline)
  - 2018 National HO MRSA BSI SIR: 0.840
    - Kentucky HO MRSA BSI SIR: 1.001

MRSA Surveillance Emerging Infections Program (EIP)



*Continuously reporting counties only

Investigation of Hospital-onset MRSA Bloodstream Infections (HO MRSA BSIs) at Acute Care Facilities in Two States, 2016

Objective

- We reviewed cases of HO MRSA BSIs in order to describe the epidemiology at high-burden short-stay acute care hospitals (SSACH) to inform prevention efforts

- How do we target interventions for greatest impact?

Methods

- Cases of HO MRSA BSIs from 2016 at SSACHs in two states were investigated by medical record abstraction

- Reviewed:
  - Demographics, hospitalization details, social and past medical histories, microbiology results, central venous catheters (CVCs) and other indwelling devices, dialysis receipt, surgeries and invasive procedures, wounds, and potential sources of BSI

Methods: Case Identification and Case Definition

- Cases identified from clinical laboratory microbiology records

- Case definition:
  - Isolation of MRSA from a blood specimen collected in 2016 on hospital day 4 or later from inpatient units
  - No MRSA positive blood specimen in the 14 days prior
  - Only a patient's first HO MRSA BSI in 2016 was reviewed

- Consensus review for likely clinical source(s) of HO MRSA BSIs
  - Each case reviewed by 2 CDC physicians
    - Selected clinically reasonable primary source(s) of MRSA BSIs

Results

- 8 SSACHs
  - 195 eligible HO MRSA BSI cases from 2016; abstracted 186 (95%)
- Male (63%); Median age 53 years (range 4 days to 92 years)
- Most common units of attribution: ICU (47%), Step Down (20%)
- In 2 weeks prior to HO MRSA BSI:
  - CVC present (72%)
  - Wound documented (79%)
  - Underwent surgical procedure (33%)
  - Received dialysis (18%)
    - Of these 56% were acute dialysis

Clinical Source Review Results (N=186)

- Percent agreement for likely source(s) of HO MRSA BSIs
  - Agreed: 152 (81.7%)
  - Disagreed: 34 (18.3%)

- No source identified: 9 (4.8%)

Clinical Source Review Results, Top Sources (N=186)

Source Type	Lower Bound , Number (%)	Upper Bound , Number (%)
CVC	49 (26.3%)	86 (46.2%)
Pneumonia (VAP)	2 (1.1%)	21 (11.3%)
Pneumonia (non VAP)	9 (4.8%)	24 (12.9%)
SSI	15 (8.1%)	30 (16.1%)
Wounds	19 (10.2%)	32 (17.2%)

- Device and procedure associated infections (CAUTI, CVCs, SSIs, and VAP) accounted for between 37% and 60% of infections

Tennessee and Kentucky HO MRSA BSI Learning Collaborative

TN and KY HO MRSA BSI Learning Collaborative

- 7 SSACHs that participated in 2016 investigation in TN and KY

- Aim: To develop and implement interventions to reduce Hospital-Onset Methicillin-resistant Staphylococcus aureus Bloodstream Infections (HO MRSA BSIs) at Short-Stay Acute Care Hospitals (SSACHs) in order to inform best practices and prevention strategies

- Kickoff meeting held in March 2019

Time Frame and Key Components

- Time Frame: March 2019 to August 2020
  - Quarter 1 of Evaluation Period: August- October 2019
- Development of a prevention intervention list with targeted implementation by facilities
- Unit and facility-level data reports with results from the 2016 HO MRSA BSI investigation
- Ongoing feedback using NHSN data (quarterly)
- Monitoring of impact
- Sharing of lessons learned via webinars and recurring phone calls

Post Kick-off Meeting

- Monthly Webinars
  - Combination of presentations by experts on specific prevention topics and group discussions to share lessons learned

- Weekly office hours

- Recurring individual facility calls to select interventions, discuss implementation, and review cases

Outcome Measures

- **Primary Goal:** reduce HO MRSA BSI rates by 25% in 75% of participating facilities (NHSN)
- **Primary Outcomes:** Change in HO MRSA BSI rates, and SIR (NHSN)
- **Secondary Outcomes:** Change in all-cause CLABSI rates, SIR (NHSN), and change in HO MSSA BSIs
- **Process Measures** including adherence to primary interventions

- Results, key findings, and lessons learned will be disseminated by CDC and state health departments pending facility approval

Strategies to Prevent Hospital-onset *Staphylococcus aureus* Bloodstream Infections in Acute Care Facilities

https://www.cdc.gov/hai/prevent/staph-prevention-strategies.html

Healthcare-associated Infections (HAI)
HAI Data +
Types of Infections +
Diseases and Organisms +
Preventing HAIs -
Staph BSI Prevention Strategies
CDI Prevention Strategies
Urine Culture +

CDC > Healthcare-associated Infections (HAI) > Preventing HAIs

Strategies to Prevent Hospital-onset *Staphylococcus aureus* Bloodstream Infections in Acute Care Facilities

Introduction

Purpose:

This document provides information about interventions for prevention of *hospital-onset Staphylococcus aureus Bloodstream Infections (HO SA BSIs)* in acute care facilities. The strategies are intended to facilitate implementation of HO SA BSI prevention efforts by state and local health departments, quality improvement organizations, hospital associations, and healthcare facilities. The interventions are not intended for use in response to an outbreak.

Purpose

- Provide a framework of evidence-based interventions to prevent HO *S. aureus* BSIs (HO SA BSI) in acute care settings
  - Intended for use primarily in adult inpatient units

- Facilities should select interventions for implementation that are feasible and most likely to impact HO SA BSI rates

- Interventions are not intended for use in response to an outbreak

- CDC subject matter experts available for consultation

Background

- Interventions are divided into core and supplemental strategies
  - **Core strategies** are strongly supported by published literature and should form the foundation of HO SA BSI prevention
  - **Supplemental strategies** are generally supported by less evidence and should be considered for use when reduction goals are not met after implementation of core interventions or when facilities wish to implement a more aggressive prevention strategy

Outline of Framework

- Core Infection Control Practices
- Reduction of Priority Healthcare-associated Infections (HAIs)
- Source Control Strategies for High Risk Patients During High Risk Periods
- Interventions to Prevent MRSA Transmission
- Infrastructure to Support HO SA BSI Prevention

Core Infection Control Practices

- **Core Strategies:**
  - Provide ongoing competency-based training and adherence monitoring
    - Hand Hygiene
    - Environmental Cleaning and Disinfection
    - Personal Protective Equipment (PPE)
  - Core Infection Prevention and Control Practices for Safe Healthcare Delivery in All Settings – Recommendations of the Healthcare Infection Control Practices Advisory Committee. 2017.
    - https://www.cdc.gov/hicpac/pdf/core-practices.pdf

Core Infection Control Practices

- Implement CDC Core Elements of Hospital Antibiotic Stewardship Programs
  - https://www.cdc.gov/antibiotic-use/healthcare/implementation/core-elements.html

Interventions to Reduce HAIs Associated with HO SA BSIs

- **Core Strategy:** Follow evidence-based guidance for the prevention of priority HAIs associated with HO SA BSIs
  - CLABSI (SHEA and CDC)
  - VAP (SHEA)
  - SSI (SHEA and CDC)
  - Hemodialysis BSI Prevention (CDC)

Resources

- CDC Guidelines for the Prevention of Intravascular Catheter-Related Infections, 2011: https://www.cdc.gov/hai/pdfs/bsi-guidelines-2011.pdf
- CDC Guidance on use of chlorhexidine-impregnated dressings: https://www.cdc.gov/infectioncontrol/guidelines/bsi/c-i-dressings/index.html
- SHEA Strategies to Prevent Central Line–Associated Bloodstream Infections in Acute Care Hospitals, 2014 Update: https://www.cambridge.org/core/journals/infection-control-and-hospital-epidemiology/article/strategies-to-prevent-central-lineassociated-bloodstream-infections-in-acute-care-hospitals-2014-update/CB398EB001FEADE0D9B4FF1A096ECA52
- CDC Guidelines for the Prevention of Surgical Site Infection, 2017: https://www.cdc.gov/infectioncontrol/guidelines/ssi/index.html
- SHEA Strategies to Prevent Surgical Site Infections in Acute Care Hospitals: 2014 Update: https://www.cambridge.org/core/journals/infection-control-and-hospital-epidemiology/article/strategies-to-prevent-surgical-site-infections-in-acute-care-hospitals-2014-update/EE4D1EC09206F231C69CB0E1A3F4EAC9
- American Society of Health-System Pharmacists antimicrobial prophylaxis in surgery: https://academic.oup.com/ajhp/article/70/3/195/5112717?searchresult=1

Resources

- CDC Approach to BSI Prevention in Dialysis Facilities: https://www.cdc.gov/dialysis/PDFs/Dialysis-Core-Interventions-5_10_13.pdf
- SHEA Strategies to Prevent Ventilator-Associated Pneumonia in Acute Care Hospitals: 2014 Update: https://www.cambridge.org/core/journals/infection-control-and-hospital-epidemiology/article/strategies-to-prevent-ventilatorassociated-pneumonia-in-acute-care-hospitals-2014-update/2D8A9D3BFD8BC8A68E04906B5C2CEF66
- CDC Strategies to Prevent Hospital-onset Staphylococcus aureus Bloodstream Infections in Acute Care Facilities: https://www.cdc.gov/hai/prevent/staph-prevention-strategies.html

Source Control Strategies for High Risk Patients During High Risk Periods

- Colonization: presence of an organism without signs of clinical infection
  - Transmission may occur from colonized patients
  - Colonized patients may progress to clinical infection
  - Nares are the major site of *S. aureus* colonization

- Source Control: the use of antimicrobials or antiseptics to reduce the burden of colonization in patients
  - Also referred to as decolonization

Source Control for *S. aureus*

- Typically done using an intranasal antistaphylococcal agent + topical antiseptic
  - Intranasal agent options
    - Mupirocin (antibiotic)
      - Most evidence to support
      - Resistance can occur
    - Iodophor (antiseptic)
    - Alcohol-based agents (antiseptic)
  - Topical antiseptic: Chlorhexidine Gluconate (CHG)

- Most Common Source Control Regimen for *S. aureus*
  - Intranasal mupirocin twice a day to each nare for 5 days + topical chlorhexidine wash or wipes daily for 5 days

Source Control: REDUCE MRSA Trial

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 JUNE 13, 2013 VOL. 368 NO. 24

Targeted versus Universal Decolonization to Prevent ICU Infection

Susan S. Huang, M.D., M.P.H., Edward Septimus, M.D., Ken Kleinman, Sc.D., Julia Moody, M.S., Jason Hickok, M.B.A., R.N., Taliser R. Avery, M.S., Julie Lankiewicz, M.P.H., Adrijana Gombosev, B.S., Leah Terpstra, B.A., Fallon Hartford, M.S., Mary K. Hayden, M.D., John A. Jernigan, M.D., Robert A. Weinstein, M.D., Victoria J. Fraser, M.D., Katherine Haffenreffer, B.S., Eric Cui, B.S., Rebecca E. Kaganov, B.A., Karen Lolans, B.S., Jonathan B. Perlin, M.D., Ph.D., and Richard Platt, M.D., for the CDC Prevention Epicenters Program and the AHRQ DECIDE Network and Healthcare-Associated Infections Program*

- Cluster-randomized trial of source control among ICU patients at 43 acute care hospitals

Source Control: REDUCE MRSA Trial

- 3 Arms:
  - *Universal source control*: Twice daily intranasal mupirocin for 5 days **plus** daily CHG baths for duration of ICU stay for all ICU patients
    - Contact precautions and isolation for known MRSA carriers, but no active screening
  - *Targeted source control*: Screening on admission to ICU (nares) with MRSA +'s receiving twice daily intranasal mupirocin for 5 days **plus** daily CHG baths for duration of ICU stay
    - Contact precautions and isolation for known MRSA carriers and those who screened +
  - *Screening and isolation*: Screening on admission to ICU (nares) with MRSA +'s being placed on contact precautions and isolation along with known +'s
- Primary outcome: MRSA positive clinical cultures (compared rates to pre-intervention baseline period)

Source Control: REDUCE MRSA Trial

- Results
  - Universal: 37%* reduction in MRSA clinical infections; 44%* reduction in BSIs (all cause)
  - Targeted: 25%* reduction in MRSA clinical infections; 22%* reduction in BSIs
  - Screening and isolation: 8% reduction in MRSA clinical infections; 1% reduction in BSIs

- Universal source control resulted in significantly greater reductions in the rate of BSIs than either targeted source control or screening and isolation

*Indicates statistically significant reduction

Source Control: ABATE, Lancet 2019

Chlorhexidine versus routine bathing to prevent multidrug-resistant organisms and all-cause bloodstream infections in general medical and surgical units (ABATE Infection trial): a cluster-randomised trial

Susan S Huang, Edward Septimus, Ken Kleinman, Julia Moody, Jason Hickok, Lauren Heim, Adrijana Gombosev, Taliser R Avery, Katherine Haffenreffer, Lauren Shimelman, Mary K Hayden, Robert A Weinstein, Caren Spencer-Smith, Rebecca E Kaganov, Michael V Murphy, Tyler Forehand, Julie Lankiewicz, Micaela H Coady, Lena Portillo, Jalpa Sarup-Patel, John A Jernigan, Jonathan B Perlin, Richard Platt, for the ABATE Infection trial team

- Cluster-randomized trial of source control among non-ICU patients at 53 acute care hospitals

Source Control: ABATE, Lancet 2019

- Facilities were randomized to routine care or daily skin cleansing with CHG (all patients) + twice daily intranasal mupirocin for 5 days (known MRSA carriers)

- Primary outcome: MRSA/VRE clinical cultures (compared rates to pre-intervention baseline period)

Source Control: ABATE, Lancet 2019

- Results
  - Overall 21% reduction in MRSA/VRE clinical cultures in intervention facilities compared to 13% reduction in routine care facilities (p=0.17)
  - Among patients with indwelling devices (CVCs, Midline Catheters, and Lumbar Drains)
    - 37% greater reduction in MRSA/VRE clinical cultures in intervention facilities (p<0.001)
    - 30% greater reduction in MRSA clinical cultures (p=0.01)
    - 32% greater reduction in BSIs (all cause) (p=0.003)
    - Patients with indwelling devices were 10% of the population, but accounted for 37% of MRSA/VRE cultures and 56% of BSIs

Source Control Strategies

- **Core Strategy:** Pursue a source control strategy to reduce carriage of *S. aureus* among all patients admitted to ICUs
  - Apply intranasal mupirocin twice a day to each nare for 5 days in conjunction with daily chlorhexidine bathing for duration of ICU admission
    - Intranasal iodophor could be considered as an alternative

- Universal ICU Decolonization: An Enhanced Protocol. Agency for Healthcare Research and Quality (AHRQ)
  https://www.ahrq.gov/professionals/systems/hospital/universal_icu_decolonization/index.html

Source Control

- **Supplemental Strategy:** Pursue a source control strategy to reduce carriage of *S. aureus* for patients hospitalized with CVCs, midline catheters, or lumbar drains outside the ICU
  - Apply intranasal mupirocin twice a day to each nare for 5 days in conjunction with daily chlorhexidine bathing while CVC, midline catheter, or lumbar drain is present
    - Intranasal iodophor could be considered as an alternative

Source Control Strategies for SSI Prevention

- **Core Strategy:** For patients undergoing **high risk surgeries** (e.g. cardiothoracic (CT), orthopedic, and neurosurgery), use an **intranasal antistaphylococcal** antibiotic/antiseptic (e.g. mupirocin or iodophor) and **chlorhexidine wash or wipes prior to surgery**
  - Possible Regimens
    - Intranasal antistaphyloccal agents
      - Mupirocin twice daily to each nare for the 5 days prior to day of surgery

        OR

      - 2 applications of Iodophor (at least 5%) to each nare within 2 hours prior to surgery

        PLUS

    - Topical chlorhexidine gluconate (CHG)
      - Daily chlorhexidine wash or wipes for up to 5 days prior to surgery

Source Control Strategies for SSI Prevention

- **Supplemental Strategy:** Consider chlorhexidine bathing or wipes for up to 5 days prior to surgery for all surgical patients, not just those undergoing high risk surgeries

Summary of Source Control Strategies by Patient Type and Setting

	Unit Type	
Patient Type	ICU	non-ICU
Indwelling Device Present*	CHG + Intranasal antistaphyloccal agent (Core)	CHG + Intranasal antistaphyloccal agent (Supplemental)
No Indwelling Device Present	CHG + Intranasal antistaphyloccal agent (Core)	none (unless meets criteria for high -risk surgery)
High-risk Pre-op Surgical Patients**	CHG + Intranasal antistaphyloccal agent (Core)	CHG + Intranasal antistaphyloccal agent (Core)

*Indwelling devices include CVCs, midline catheters, and lumbar drains
** High risk surgeries include orthopedic, cardiothoracic, and neurosurgery
***Intranasal antistaphyloccal agents such as mupirocin or iodophor
****CHG= topical chlorhexidine gluconate

Resources

- REDUCE MRSA Universal ICU Source Control Protocol and Training Resources: https://www.ahrq.gov/hai/universal-icu-decolonization/index.html

- CHG bathing protocol from SHIELD Orange County: http://www.ucihealth.org/-/media/files/pdf/shield/hospital/hospital-step-3-protocol-bed-bath-with-chg-cloths-pdf.pdf?la=en

- CHG Cloth Skills Assessment and Checklist: http://www.ucihealth.org/-/media/files/pdf/shield/hospital/hospital-step-6-chg-cloth-skills-assessment-checklist-pdf.pdf?la=en

Interventions to Prevent Transmission of MRSA

- **Core Strategies**
  - Place patients known to be infected or colonized with MRSA on contact precautions (CP) and in private rooms
    - CDC continues to recommend CP for known MRSA carriers:
      - https://www.cdc.gov/mrsa/healthcare/inpatient.html
      - Use dedicated or disposable patient equipment whenever possible
      - If cannot use dedicated or disposable equipment, clean and disinfect such equipment before use on another patient
  - Place patients with excessive wound drainage on CP and in private rooms regardless of MRSA status
  - Regular competency-based training on use of PPE and monitor adherence

Interventions to Prevent Transmission of MRSA

- **Supplemental Strategy**
  - Active surveillance testing (screening) for MRSA on admission to acute care facilities
    - Screening could be limited to high risk patients (e.g., prior healthcare exposure) or admission to high risk settings (e.g., ICU)
    - Place those who screen positive on CP and in private rooms
  - Screening could be combined with source control strategies for high risk patients (i.e. ICU patients and those outside the ICU with CVCs, Midline Catheters, or Lumbar Drains)

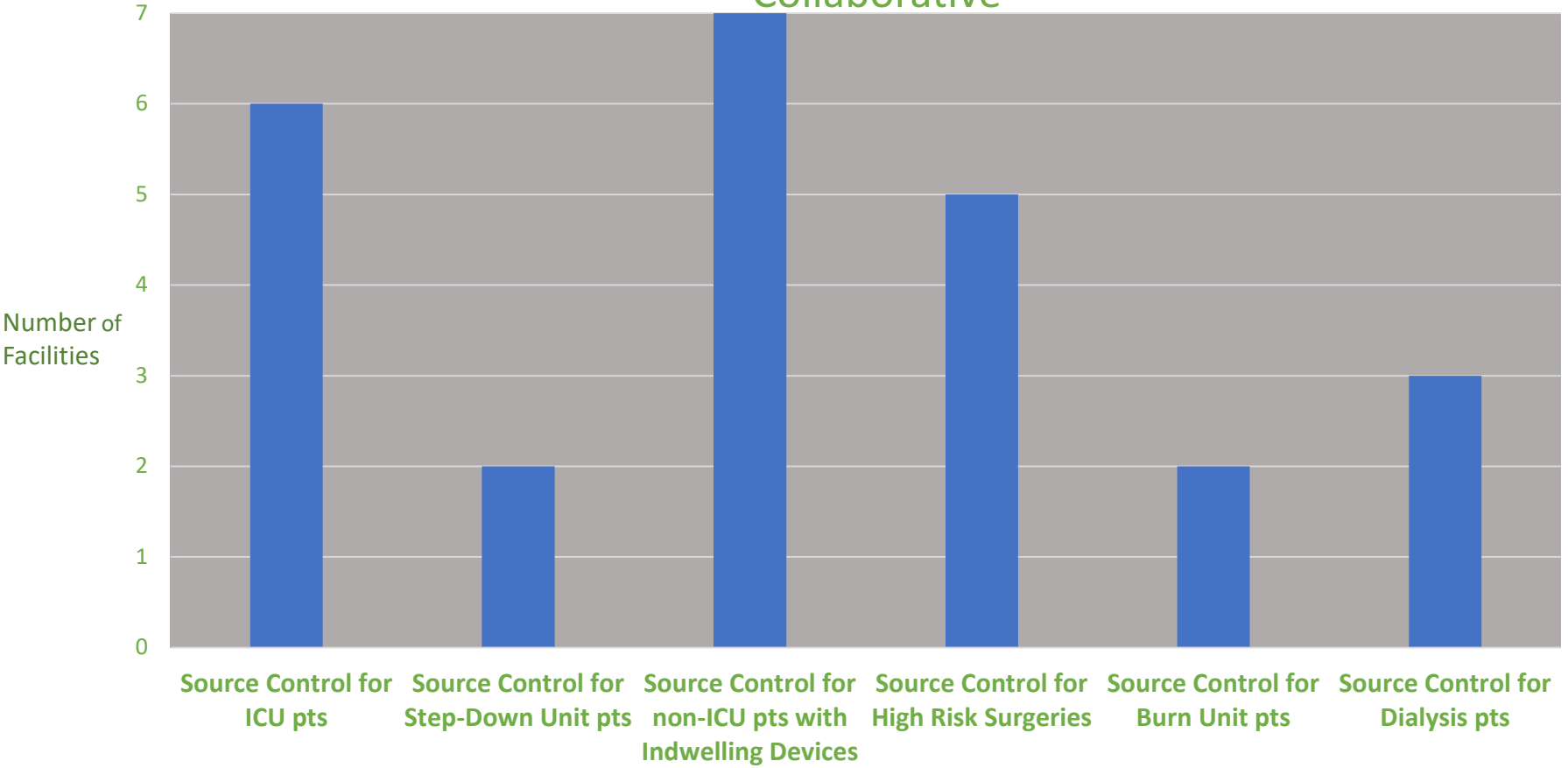
Infrastructure to Support HO SA BSI Prevention

- **Core Strategies**
  - Incorporate reduction of HO SA BSIs into HAI prevention program
    - Develop a multidisciplinary team: nursing, environmental services, and infection prevention
  - Monitor facility HO SA BSI events, and target units with highest burden of HO SA BSIs for evaluation and intervention
    - Consider using the LabID event reporting through NHSN which can identify high-burden units to target interventions towards
    - Review individual HO SA BSI episodes to assess preventability and to identify gaps

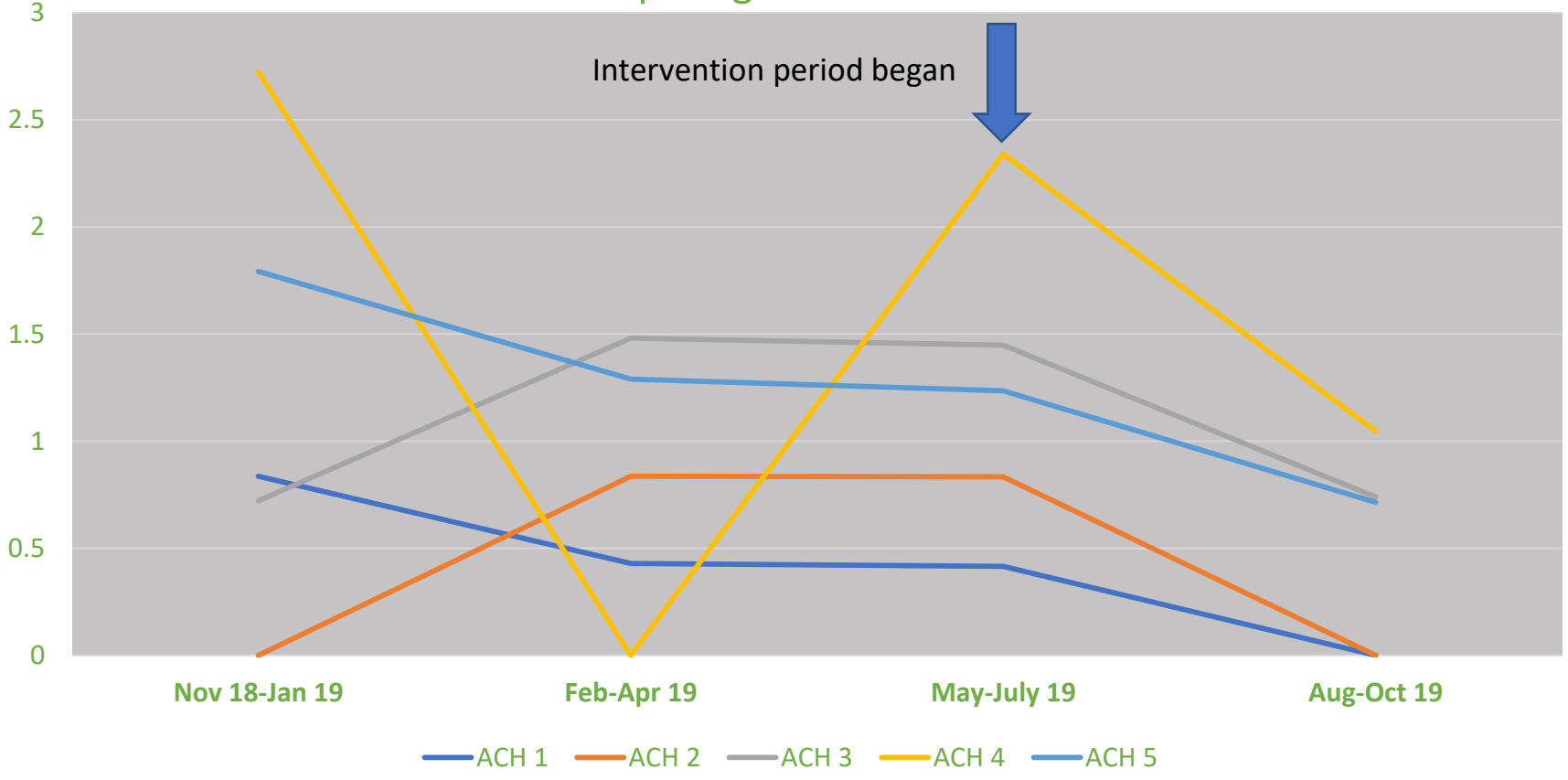
Infrastructure to Support HO SA BSI Prevention

- **Core Strategies**
  - Provide routine education and competency-based training to all healthcare personnel on:
    - Prevention practices for HO SA BSI and
    - Core infection control practices including hand hygiene, PPE use, Standard Precautions, Contact Precautions, and environmental cleaning and disinfection
  - Conduct routine audits and conduct competency-based assessments with feedback for
    - Adherence to hand hygiene, Standard Precautions, and Contact Precautions
    - Adequacy of room cleaning and environmental services

Primary Interventions Selected by Facilities in TN and KY MRSA Collaborative



HO MRSA BSI Rates per 10,000 patient days Among KY Hospitals Participating in Collaborative



Lessons Learned

- Implementation of interventions is a team effort
  - Establish a multidisciplinary team with a project champion responsible for coordination
  - Infection Prevention, Infectious Disease Department, ICU leadership, C-Suite, IT, and other involved departments/units

- Engage frontline staff
  - Buy-in is critical to success
  - Education, reach out, and solicit input

Lessons Learned

- High adherence to source control interventions requires a sustained and concerted effort
  - Education and training
  - Skills assessments
  - Adherence monitoring with feedback
  - Proper application of CHG is critical

- Work with IT early to assist with building adherence reports and order sets

Lessons Learned

- Success can be achieved and resources are available

- Reach out to Kentucky Department for Public Health, Kentucky Hospital Association, and CDC
  - Andrea Flinchum: Andrea.Flinchum@ky.gov
  - Deborah Campbell: dcampbell@kyha.com
  - Cal Ham: Ink4@CDC.gov

Thank you

For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov