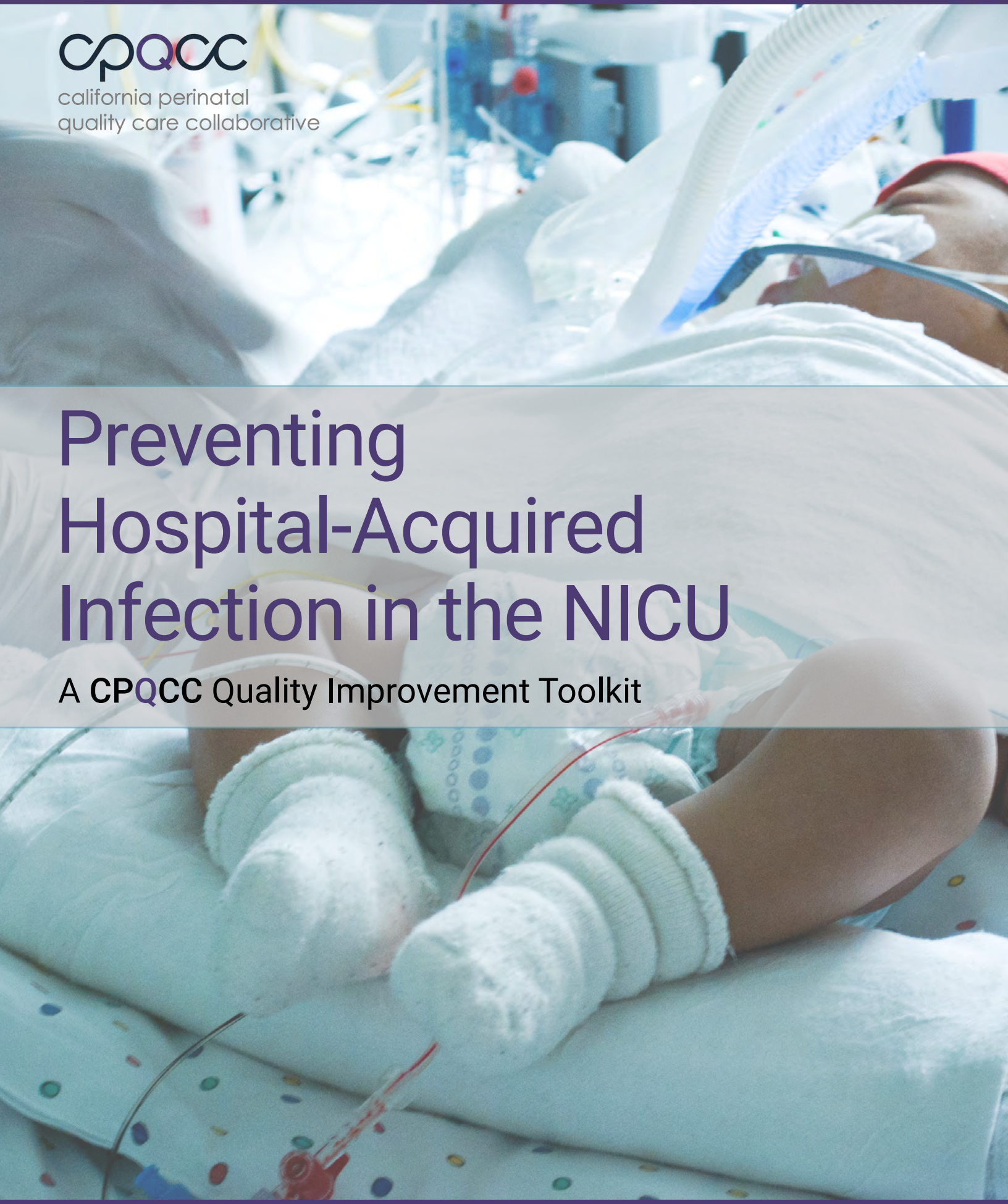

CPQCC
california perinatal
quality care collaborative

Preventing Hospital-Acquired Infection in the NICU

A CPQCC Quality Improvement Toolkit

NOVEMBER 2022

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A CPQCC Quality Improvement Toolkit

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Acronyms

AHRQ	Agency for Healthcare Research and Quality
AUR	Antibiotic Use Rate
CHG	Chlorhexidine Gluconate
CLABSI	Central Line Associated Blood Stream Infections
CPQCC	California Perinatal Quality Care Collaborative
CRE	Carbapenem Resistant Enterobacterales
CUSP	Comprehensive Unit-based Safety Program
CVC	Central Venous Catheter
DIVA	Difficult Intravenous Access
DOT	Days of Therapy
ELBW	Extremely Low Birthweight
EOS	Early-onset Sepsis
ESBL-E	Extended-spectrum beta-lactamases producing Enterobacterales
HAI	Hospital Acquired Infection
HCW	Healthcare Workers
HH	Hand Hygiene
HOB	Hospital-Onset Bacteremia
HRO	High Reliability Organizations
IHI	Institute for Healthcare Improvement
IVH	Intraventricular Hemorrhage
LOS	Late-onset Sepsis
MARSI	Medical Adhesive-related Skin Injury
MDR-GNR	Multi-Drug Resistant Gram-Negative Rods
MDRO	Multi-Drug Resistant Organisms
MRSA	Methicillin Resistant Staphylococcus aureus
NAE	Newborn Antibiotic Exposure
NEC	Necrotizing Enterocolitis
NHSN	National Healthcare Safety Network
NICU	Neonatal Intensive Care Unit
NPO	Nil per os (nothing by mouth)
PICC	Percutaneously Inserted Central Catheter
PICU	Pediatric Intensive Care Unit
QI	Quality Improvement
SAQ	Safety Attitude Questionnaire
SIR	Standard Infection Ration
TAD	Transparent Adhesive Dressing
TeamSTEPPS	Team Strategies and Tools to Enhance Performance and Patient Safety
TPN	Total Parenteral Nutrition
VAP	Ventilator Associated Pneumonia
VLBW	Very Low Birthweight
VON	Vermont Oxford Network
VRE	Vancomycin Resistant Enterococcus

Acknowledgments

The authors of the 2022 revision of the Preventing Hospital Acquired Infection (HAI) in the NICU Toolkit would like to thank the following individuals and groups:

- The **NICU leaders and clinicians** who shared unit-based HAI tools, checklists, and work processes to enhance this toolkit
- The **authors of the 2007 Preventing Hospital Acquired Infection in the NICU Toolkit** for creating a foundation upon which to build.

This toolkit includes and builds upon the following goal from the original toolkit:

> **This toolkit continues the effort to stimulate self-analysis as the basis for quality improvement efforts, by bringing together all of the essential elements of quality improvement: awareness of authoritative opinion, self-examination of one's own processes and results, and ready access to easily used means to enable change.**
>
> - David Wirtschafter, MD, 2007

Executive Summary

Over the past 20 years, through efforts of single and multi-center neonatal intensive care unit (NICU) quality improvement (QI) projects and collectively through state collaboratives, the rates of central line associated blood stream infections (CLABSIs) and subsequently, hospital acquired infections (HAI), in the NICU have been reduced.[1,2] Despite these improvements, HAI remains a persistent challenge in the NICU resulting in increased length of stay, morbidity, and mortality, and increased hospital costs.[3-5] Very low birthweight (VLBW) infants hospitalized in the NICU are at an increased risk for HAI. It is imperative that healthcare providers not only implement published evidence-based national and international guidelines, but consider additional safeguards, practices, and approaches to protect this high-risk population.

This toolkit was revised in 2022 to assist NICUs to not only evaluate and implement additional CLABSI prevention efforts, but to also consider evolving NICU care practices and approaches that may further reduce hospital acquired bacteremia. NICUs not performing at desired levels of HAI prevention, or which have set goals for "zero" HAI will find useful interventions and tools within this toolkit.

At its core, this toolkit supports NICU healthcare providers and leaders to evaluate current HAI prevention performance and practices, outlines potentially better practices, and provides examples of tools and checklists to assist HAI prevention efforts, including identifying focused opportunities for improvement. Several potentially best practices are explored within this toolkit under five categories, including:

1. Hand Hygiene: Hand hygiene is the foundation of HAI prevention and the first step in reducing HAI
2. NICU Quality Improvement and Culture: NICU work environment and the context in which care is provided is an important emerging aspect of HAI prevention
3. General Principles of HAI Prevention: Recent comprehensive and NICU-specific guidelines have been published guiding the insertion, care, and maintenance of central lines in the NICU. This toolkit does not duplicate these recommendations; instead, additional interventions are recommended to reduce the overall burden of HAI in the NICU.
4. Skin Considerations and HAI Prevention: The skin is an important barrier to infection and methods to reduce skin injury have become a central focus in HAI prevention
5. Antibiotic Stewardship/Multi-Drug Resistant Organisms (MDRO): Antibiotic stewardship activities are integral in HAI prevention; MDROs are an emerging issue in the NICU and affect HAI prevention efforts

A central focus for the authors was to include tools, checklists, visual displays, and other resources that may enhance HAI prevention QI efforts. We are hopeful that readers will find this toolkit a valuable resource in preventing HAI in the NICU.

Introduction

NICU clinical care practices continue to evolve, and NICU care is improving, with increasing survival rates of the youngest and smallest newborns.[2] Recent trends demonstrate a rapid increase in efforts to actively treat newborns 22-25 weeks of gestation, with the highest increase in active treatment of those infants at 22 weeks of gestation.[6] However, the burden of HAI in preterm infants remains high, with those with the lowest birthweight and gestational ages having the highest incidence.[7] Extremely preterm infants at the edge of viability have the highest risk of HAI and current care practices may not be sufficient to protect these infants from the burden of hospital acquired bacteremia. Risk factors for HAI include premature biologic systems (e.g., immature immune system, immature skin), prolonged lengths of stay, need for invasive tubes and lines, delayed enteral nutrition, and exposure to antibiotics.

Both the California Perinatal Quality Care Collaborative (CPQCC) and Vermont Oxford Network (VON) provide HAI data for participating NICUs. There is significant variation in infection rates across NICUs in California despite the availability of published evidence-based protocols and state-sponsored collaboratives. Importantly, Hispanic infants in California NICUs reporting infection rates to CPQCC have a significantly higher rates of HAI when compared to white infants.[7]

Hospital-Onset Bacteremia (HOB) or non-CLABSI blood stream infection may be a more clinically relevant and global marker of quality in intensive care units and NICUs may consider moving to this metric as a global method of quality measurement.[8] To provide comprehensive prevention efforts, NICU leaders' focus should include all potential sources of blood stream infections, such as the gut or skin.

The aim of this toolkit is to serve as a resource and road map for NICUs seeking additional HAI prevention strategies that may enhance existing practices or for those NICUs seeking to reduce their overall HAI rate. The authors avoided duplicating HAI prevention recommendations that are available via published national guidelines.[9-11]

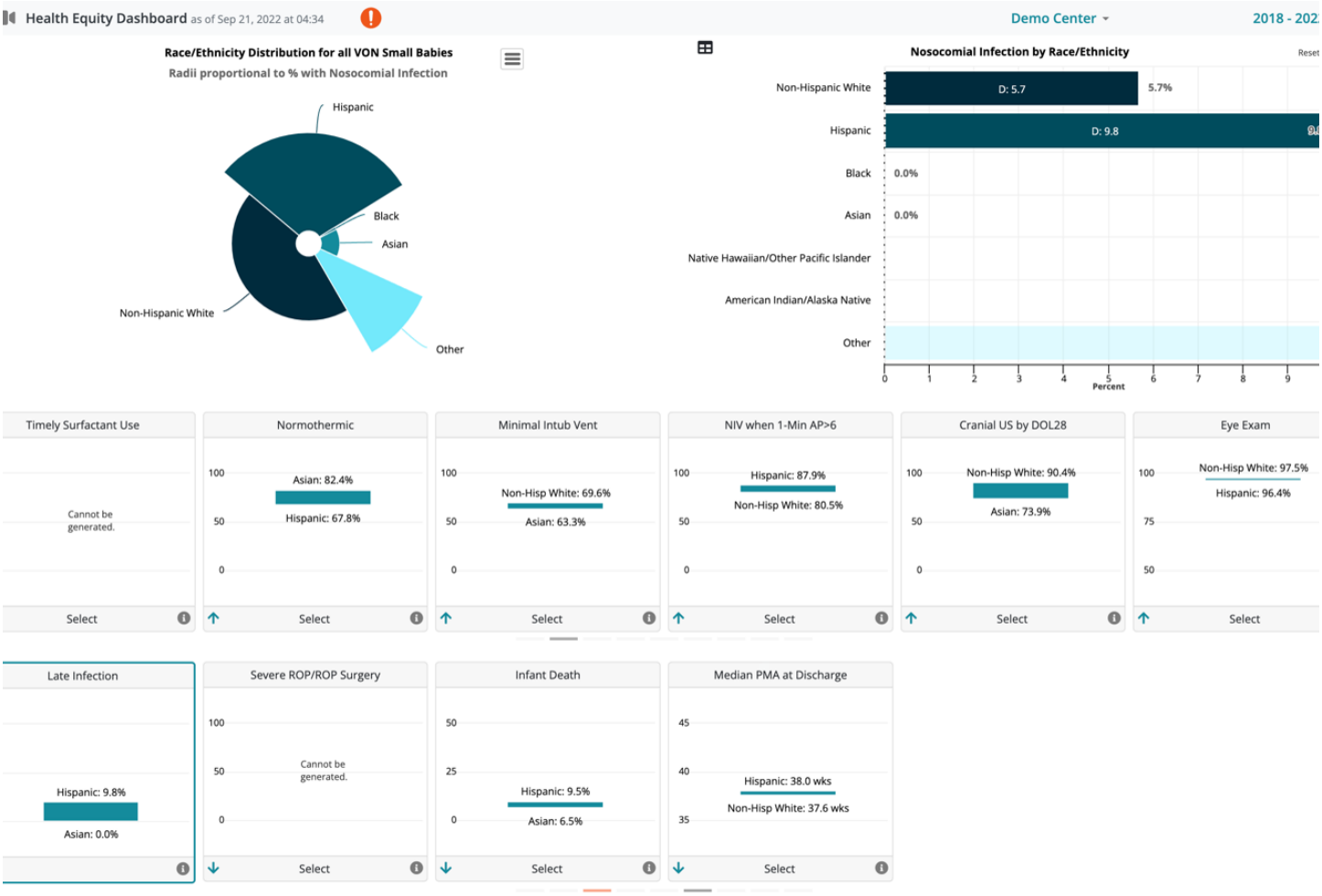
The following schematic displays the interplay of the different toolkit sections, with hand hygiene practices and compliance as the foundation from which to build a robust and comprehensive HAI prevention program in the NICU.

Family-Centered Care Considerations

Involving the family in NICU HAI prevention efforts has not been widely reported in the literature but may be an important lever in HAI mitigation. Family members may be helpful in providing hand hygiene reminders to all health care providers, assisting with "counting" the seconds of scrub-the-hub techniques used by NICU staff, or other procedures. Family advisory committees, if present in the NICU structure, can be used to develop and review parent centered HAI education programs and flyers.

Health Equity Considerations

CPQCC is committed to improving both the quality and the equity of care for vulnerable infants and their families. As such, it is vital to understand and address how disparities in clinical outcomes present in different NICU settings. As discussed above, the incidence of HAI is higher among Hispanic infants as compared to White infants across California NICUs. This can be seen in data collected by CPQCC and displayed on its Health Equity Dashboard, which is made available to all member NICUs (see image below). NICUs are encouraged to explore health equity data from their own unit – either by viewing the CPQCC Health Equity Dashboard or through other means – to better understand how to target HAI prevention efforts to improve outcomes for all patients.



QI Basics

Understanding the basic principles of QI is integral to improving HAI prevention efforts in the NICU. CPQCC has developed a self-paced, online quality improvement education course ("QI Fundamentals") designed to walk learners through the foundation of healthcare improvement in the NICU. The course is comprised of several modules of short video-based lessons, including instructional content and "deep dive" videos featuring CPQCC member NICUs explaining how they have used the concepts presented in the lesson as part of their unit's quality improvement journey. Lessons are accompanied by practical tools for learners to use to put the concepts into practice. Topics covered include: Understanding the Model for Improvement, Creating a Culture of Improvement, How to Form and Manage a QI Team, Planning for Sustainability, An Introduction to QI Tools, Learning from Run Charts and Control Charts and supplementary content on Building an Anti-Racist NICU and Using CPQCC Data and Reports for QI.

All California NICUs with membership in CPQCC are encouraged to complete the QI Fundamentals course as a foundation for their HAI prevention efforts. Readers of this toolkit who are not CPQCC members should seek out basic QI education through other sources, such as the Institute for Healthcare Improvement.

Implementation and Sustainability

This toolkit is designed to assist NICUs interested in reducing the incidence of HAI. Consider the following steps to get started:

1. Gather a multidisciplinary team (include a parent team member) to review unit-specific HAI rates and health-equity data (as available from CPQCC or other sources), current unit HAI prevention practices, and this toolkit's Potentially Better Practices

2. Develop team goals for HAI prevention, using QI tools and techniques from CPQCC's "QI Fundamentals" online course (or other QI educational resource) as well as section two of this toolkit. Develop, enhance, and sustain a unit culture in which HAI prevention is a priority and widely embraced by NICU staff.

3. Provide staff education centered on "the why" of HAI prevention such as reduced morbidity and mortality with reduced incidence of HAI and the need to provide further HAI protection for the extremely low birthweight infant at the edge of viability

4. Hand Hygiene (HH) is foundational to HAI and is a good starting point even if unit based HH compliance is high. Detailing in-room and while-giving-care HH requirements may reveal important opportunities

5. Review additional HAI prevention efforts included in sections 3, 4 and 5 and the included tools and example checklists

6. Throughout the team's work, consider methods that ensure sustainment of results, such as integrating audits and checklists into the electronic record as part of everyday charting, embedding all HAI practices as part of the onboarding of new staff, and sharing HAI data widely with NICU healthcare providers, such as during staff meetings, family advisory meetings, and hospital-wide committee meetings

References

1. Horbar JD, Edwards EM, Greenberg LT, et al. Variation in Performance of Neonatal Intensive Care Units in the United States. JAMA Pediatr 2017;171(3):e164396 doi: 10.1001/jamapediatrics.2016.4396[published Online First: Epub Date].
2. Bell EF, Hintz SR, Hansen NI, et al. Mortality, In-Hospital Morbidity, Care Practices, and 2-Year Outcomes for Extremely Preterm Infants in the US, 2013-2018. JAMA 2022;327(3):248-63 doi: 10.1001/jama.2021.23580[published Online First: Epub Date].
3. Lapcharoensap W, Kan P, Powers RJ, et al. The Relationship of Nosocomial Infection Reduction to Changes in Neonatal Intensive Care Unit Rates of Bronchopulmonary Dysplasia. J Pediatr 2017;180:105-09 e1 doi: 10.1016/j.jpeds.2016.09.030[published Online First: Epub Date].
4. Stoll BJ, Hansen NI, Bell EF, et al. Trends in Care Practices, Morbidity, and Mortality of Extremely Preterm Neonates, 1993-2012. JAMA 2015;314(10):1039-51 doi: 10.1001/jama.2015.10244[published Online First: Epub Date].
5. Mukhopadhyay S, Puopolo KM, Hansen NI, et al. Neurodevelopmental outcomes following neonatal late-onset sepsis and blood culture-negative conditions. Arch Dis Child Fetal Neonatal Ed 2021;106(5):467-73 doi: 10.1136/archdischild-2020-320664[published Online First: Epub Date].
6. Venkatesh KK, Lynch CD, Costantine MM, et al. Trends in Active Treatment of Live-born Neonates Between 22 Weeks 0 Days and 25 Weeks 6 Days by Gestational Age and Maternal Race and Ethnicity in the US, 2014 to 2020. JAMA 2022;328(7):652-62 doi: 10.1001/jama.2022.12841[published Online First: Epub Date].
7. Liu J, Sakarovitch C, Sigurdson K, Lee HC, Profit J. Disparities in Health Care-Associated Infections in the NICU. Am J Perinatol 2020;37(2):166-73 doi: 10.1055/s-0039-1688481[published Online First: Epub Date].
8. Rock C, Thom KA, Harris AD, et al. A Multicenter Longitudinal Study of Hospital-Onset Bacteremia: Time for a New Quality Outcome Measure? Infect Control Hosp Epidemiol 2016;37(2):143-8 doi: 10.1017/ice.2015.261[published Online First: Epub Date].
9. Muller M, Bryant KA, Espinosa C, et al. SHEA neonatal intensive care unit (NICU) white paper series: Practical approaches for the prevention of central line-associated bloodstream infections. Infect Control Hosp Epidemiol 2022:1-46 doi: 10.1017/ice.2022.53[published Online First: Epub Date].
10. Bryant KA. Recommendations for Prevention and Control of Infections in the Neonatal Intensive Care Unit Patients: Central Line-associated Blood Stream Infecitons. www.CDC.gov, 2022.
11. Committee HICPA. Core Infection Prevention and Control Practices for Safe Healthcare Delivery in All Settings-Recommendations of the Healthcare Infection Control Practices Advisory Committee (HIPAC). 2017.

In This Section

I. Hand Hygiene

Introduction

Hand Hygiene (HH) is the single most effective strategy to reduce HAI and serves as the foundation of this toolkit. HAI prevention efforts should begin with a detailed review of all NICU HH practices, protocols, and staff education efforts. HH is complex in the NICU and application of the WHO's "five moments for hand hygiene" may not be detailed enough for healthcare providers caring for NICU patients. Variations in NICU layout and the fragility of the infant during handling require detailed modifications to standard HH protocols and/or additional processes to assure HH is both robust and practical.

NICU design varies from open-bay concepts to single, individual rooms and hybrid layouts, all of which impacts hand hygiene practices and protocols. For example, in open-bay designs, the beginning of one bed space and the start of another may be unclear, making the requirement to ensure HH before/after room entry difficult to follow. NICUs are encouraged to adopt specific HH protocols that reflect their current physical layout and clearly communicate HH requirements to all healthcare providers.

Providing care to the infant in an isolette/bassinette, along with the fragility of the infant during handling, impacts HH protocols. HH during in-room care is complex as health care providers may touch multiple pieces of equipment while directly caring for and supporting the infant (e.g., oxygen blender, cardiorespiratory monitor, radiant warmer controls) and be physically unable to perform hand hygiene before and after contact with each piece of equipment. HH requirements while providing care should be detailed and standardized within each NICU, tailored to the unique in-room set up of equipment and supplies. The HH tools and protocols provided in this toolkit serve as examples of how other NICUs address these challenges.

POTENTIALLY BETTER PRACTICE

Establish hand hygiene standards and compliance monitoring as an integral component of a robust hospital acquired infection reduction program

Background, Rationale, and Goals

- Hand hygiene (HH) is the single most important factor in preventing the spread of pathogens and antibiotic resistance within healthcare settings.[19] Therefore, HH must be made a priority to reduce infections in the NICU.
- Studies have demonstrated a significant reduction in HAI rates when antiseptic hand washing was performed by personnel. However, HH compliance rates among healthcare workers (HCWs) remains problematic with some centers reporting compliance below 50%.[17]
- Many factors contribute to HH compliance among HCWs including provider role, hospital setting, shifts worked, use of gown and gloves, automated sinks, type of activities being performed, and number of patient care interactions[8]
- HCW self-report lack of adherence with HH recommendations related to skin irritation, inaccessible supplies, interference with worker-patient relation, patient needs perceived as priority, wearing gloves, forgetfulness, ignorance of guidelines, insufficient time, high workload, under staffing, and lack of scientific information demonstrating impact of improved hand hygiene on hospital infection rates[20]
- A multi-modal approach to HH improvement includes education, monitoring, and compliance. The use of formal and informal approaches to HH education with initial orientation as well as continuous intervals is effective. Formal HH education includes educating all levels of HCWs on both the importance of HH and the correct procedures.[1,5,23]
- The use of HH monitors can improve compliance through observing adherence to HH protocols, providing just in time peer to peer feedback, and promoting HH practices[12]

Recommended Guidelines and Algorithms

Select hand hygiene agents based on[10]:

- Efficacy of antiseptic agent
- Accessibility of the product
- Dispenser systems
- Acceptance of product by HCWs including factors such as:
  - Characteristic of product and ease of use
  - Skin irritation and dryness

Evidence-based hand hygiene guidelines in the NICU:

- All HCWs and families should perform an initial wash upon entry into the NICU as well as before and after patient contact
- Eliminate hand/wrist jewelry, artificial nails, and nail polish
  - Removal of jewelry has been shown to reduce HAI[11]
  - Natural nail tips should be kept to ¼ inch in length. Artificial nails should not be worn when having direct contact with high-risk patients including in the NICU environment[10]
- HH with non-antimicrobial or antimicrobial soap and water should be performed when hands are visibly dirty, contaminated, or soiled
- If hands are not visibly soiled, use of a 60-95% alcohol-based hand gel is recommended for routinely decontaminating hands[10,19]
- Healthcare personnel should use an alcohol-based hand rub or wash with soap and water:[7, 23]
  - Immediately before touching a patient
  - Before performing an aseptic task (e.g., placing an indwelling device) or handling invasive medical devices
  - Before moving from work on a soiled body site to a clean body site on the same patient
  - After touching a patient or the patient's immediate environment
  - After contact with blood, body fluids, or contaminated surfaces
  - Immediately after glove removal

Universal gloving in the NICU:

- The use of non-sterile gloves after hand hygiene, but before all patient contact, compared to hand hygiene alone to reduce HAI in the NICU is not recommended.[7]
  - A single randomized, non-blinded control study demonstrated a reduction in gram positive blood stream infections with the implementation of universal gloving in a subset of patients[15]
  - However, universal gloving has also been shown to increase infections among patients, particularly device related infections[4]
  - Universal gloving interferes with positive patient touch and interaction with patients. Positive patient touch may outweigh the perceived benefits of universal gloving.[18]

Family Integrated Care & HH:

- Parents in the NICU are an integral part of the team. Active patient and family empowerment may increase HH compliance among HCWs.[9, 13]
- Provide education to families on the importance and proper technique of HH
- Encourage families to be active participants in cross-monitoring HH in the NICU

Guidance on Quality and Process Improvement

- Review organizational and department HH policies and guidelines
- Implement a multidisciplinary program to improve adherence to recommended practices
- Standardize approach to hand hygiene (e.g., Targeted Solutions Tool, 5 Moments of Hand Hygiene)[21, 23]
- Provide staff education at all levels related to the importance of hand hygiene in reducing HAI in the NICU, appropriate HH technique, and isolation precaution standards. Use a variety of media and approaches to educate staff: rounding, return demonstration, signage/ infographics, staff newsletters, and posters. In addition, education may include use of products that demonstrate thoroughness of HH techniques. Refer to examples under Tools.
- Identify specific elements related to hand hygiene compliance to monitor and establish organizational goals
- Monitor HCW adherence with recommended hand hygiene practices through:
  - Direct observation with use of HH monitors/ champions. Refer to sample observation worksheet under Tools.
  - Provider surveys
  - Standardized compliance programs (e.g., the Targeted Solutions Tool from the Joint Commission[24])
- Select innovative strategies for providing feedback regarding hand hygiene:
  - Develop interdepartmental competitions and post results
  - Use electronic message boards to post compliance rates
  - Include HH in leadership and routine patient rounding
  - Report HH compliance feedback in staff meetings, unit huddles, and unit dashboards
  - Provide just in time peer to peer feedback/coaching
  - Implement signage as reminders of hand hygiene techniques (Refer to sample signage under Tools)
  - Use of immediate feedback systems [14,16]
  - To promote accountability, consider incentives and rewards for achieving HH compliance targets

Outcome, Balancing and Process Measures

- Monitor and record adherence to overall hand hygiene
- Monitor and record adherence to hand hygiene by discipline
- Monitor the volume of alcohol-based sanitizers used per 1,000 patient days
- Monitor adherence to department policies related to nails, jewelry, bare below the elbows
- Track method of hand hygiene
- Monitor adherence to posted isolation precautions
- Provide feedback to healthcare workers on individual performance

Refer to the Joint Commission's "Measuring Hand Hygiene Adherence" monograph for more information about these Outcome, Balancing and Process Measures.

Resources and Tools

Resources

CDC Resources

- https://www.cdc.gov/infectioncontrol/pdf/QUOTS/Neonatal-Intensive-Care-Unit-Suite-P.pdf

Joint Commission Resources

- https://www.jointcommission.org/-/media/tjc/documents/resources/hai/hh_monograph.pdf
- https://www.jointcommission.org/-/media/tjc/documents/resources/hai/jqps_1_15.pdf

World Health Organization Resources:

- https://www.who.int/teams/integrated-health-services/infection-prevention-control/hand-hygiene/tools-and-resources
- https://cdn.who.int/media/docs/default-source/integrated-health-services-(ihs)/hand-hygiene/monitoring/hhsa-framework-october-2010.pdf?sfvrsn=41ba0450_6
- https://cdn.who.int/media/docs/default-source/documents/health-topics/hand-hygiene-why-how-and-when-brochure.pdf?sfvrsn=9b52e145_2&download=true
- https://cdn.who.int/media/docs/default-source/integrated-health-services-(ihs)/infection-prevention-and-control/your-5-moments-for-hand-hygiene-poster.pdf?sfvrsn=83e2fb0e_16

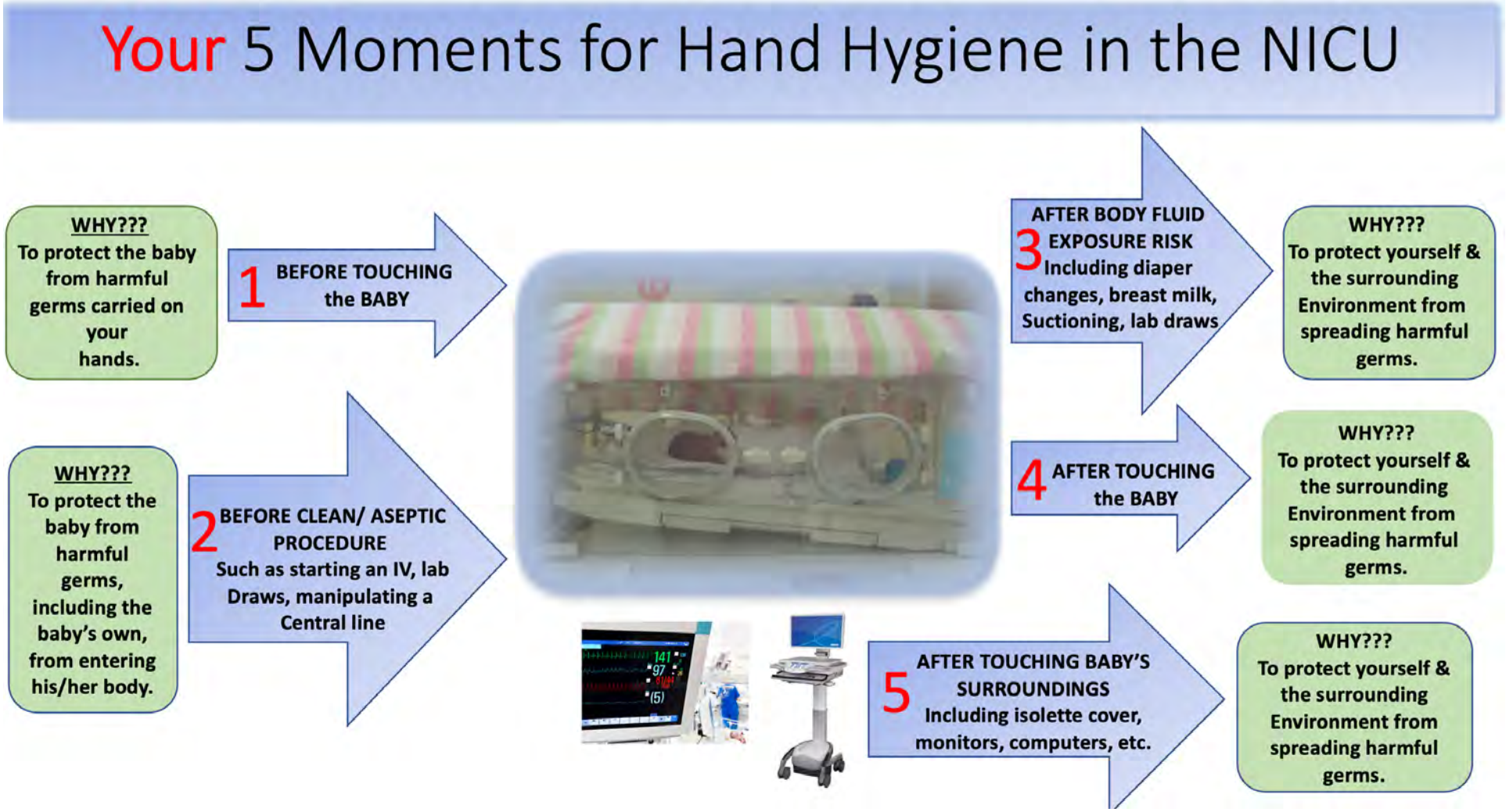
Tools

The following tools are included in this section:

1. Your 5 Moments for Hand Hygiene in the NICU - Example 1
2. Your 5 Moments for Hand Hygiene – Example 2
3. Hand Hygiene Audit
4. Standard Precautions: Observation of Hand Hygiene Provision of Supplies
5. Neonatal Environment: Observation of Nutritional Preparation Area
6. Hand Hygiene NICU Observation Tool
7. Hand Hygiene Sink Signage Example
8. Hand Hygiene Moments While Giving Care Tool

YOUR 5 MOMENTS FOR HAND HYGIENE IN THE NICU - EXAMPLE 1

SOURCE: Santa Clara Valley Medical Center



YOUR 5 MOMENTS FOR HAND HYGIENE IN THE NICU - EXAMPLE 2

SOURCE: World Health Organization (WHO)

1	BEFORE TOUCHING A PATIENT	WHEN?	Clean your hands before touching a patient when approaching him/her.
		WHY?	To protect the patient against harmful germs carried on your hands.
2	BEFORE CLEAN/ ASEPTIC PROCEDURE	WHEN?	Clean your hands immediately before performing a clean/aseptic procedure.
		WHY?	To protect the patient against harmful germs, including the patient's own, from entering his/her body.
3	AFTER BODY FLUID EXPOSURE RISK	WHEN?	Clean your hands immediately after an exposure risk to body fluids (and after glove removal).
		WHY?	To protect yourself and the health-care environment from harmful patient germs.
4	AFTER TOUCHING A PATIENT	WHEN?	Clean your hands after touching a patient and her/his immediate surroundings, when leaving the patient's side.
		WHY?	To protect yourself and the health-care environment from harmful patient germs.
5	AFTER TOUCHING PATIENT SURROUNDINGS	WHEN?	Clean your hands after touching any object or furniture in the patient's immediate surroundings, when leaving – even if the patient has not been touched.
		WHY?	To protect yourself and the health-care environment from harmful patient germs.

World Health Organization | Patient Safety — A World Alliance for Safer Health Care | SAVE LIVES Clean Your Hands

WHO acknowledges the Hôpitaux Universitaires de Genève (HUG), in particular the members of the Infection Control Programme, for their active participation in developing this material.

May 2009

ACCESSED FROM: https://www.who.int/campaigns/world-hand-hygiene-day

HAND HYGIENE AUDIT TOOL

SOURCE: Sharp Mary Birch Hospital for Women & Newborns

Hand Hygiene Audit

Objective: Observe another staff member's interaction with a patient and assess whether or not they are Adequately meeting the Center for Disease Control (CDC) hand hygiene guidelines.

The most accurate results will be achieved if your coworker has not been warned that you will be observing their behavior.

Person Observed: _____Initials
(Circle one) RCP RN MD Other

Date _____ Observer_____

	Indicator (5 Moments of Hand Hygiene)	Yes	No	N/A
1.	**Hand Hygiene completed prior to patient contact:** Appropriate methods: a. washing hands for 15 seconds covering all surfaces and fingers with soap and water (turns off faucet with paper towel if no foot pedals) b. use of alcohol-based waterless antiseptic agent (rub hands together covering all surfaces and fingers until dry.			
2.	**Before an aseptic task** Appropriate methods: a. washing hands for 15 seconds covering all surfaces and fingers with soap and water (turns off faucet with paper towel if no foot pedals) b. use of alcohol-based waterless antiseptic agent (rub hands together covering all surfaces and fingers until dry.			
3.	**After body fluid risk** Appropriate methods: a. washing hands for 15 seconds covering all surfaces and fingers with soap and water (turns off faucet with paper towel if no foot pedals)			
4.	**After patient contact** Appropriate methods: a. washing hands for 15 seconds covering all surfaces and fingers with soap and water (turns off faucet with paper towel if no foot pedals) b. use of alcohol-based waterless antiseptic agent (rub hands together covering all surfaces and fingers until dry.			
5.	**After contact with patient surroundings** Appropriate methods: a. washing hands for 15 seconds covering all surfaces and fingers with soap and water (turns off faucet with paper towel if no foot pedals) b. use of alcohol-based waterless antiseptic agent (rub hands together covering all surfaces and fingers until dry.			
	NICU only			
	Bare Below the Elbows (No jewelry below the elbow or long sleeves if providing direct patient care)			
	Before handling neonates in the NICU for the first time on a shift, personnel providing direct patient care/contact will wash their hands and arms to the elbow for at least 1 minute using liquid soap and water. The hands, wrists, and forearms are to be washed thoroughly.			

STANDARD PRECAUTIONS: OBSERVATIONS OF HAND HYGIENE PROVISION OF SUPPLIES

SOURCE: Center for Disease Control (CDC)

Standard Precautions: Observation of Hand Hygiene Provision of Supplies

NICU-2

Instructions: Observe patient care areas or areas outside of patient rooms. For each category, record the observation. In the column on the right, sum (across) the total number of "Yes" and the total number of observations ("Yes" + "No"). Sum all categories (down) for overall performance.

	Standard Precautions: Observation Categories	Room 1	Room 2	Room 3	Room 4	Room 5	Summary of Observations	
							Yes	Total Observed
1	Are functioning sinks readily accessible in the patient care area?	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No		
2	Are all handwashing supplies, such as soap and paper towels, available?	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No		
3	Is the sink area clean and dry?	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No		
4	Are any clean patient care supplies on the counter within a splash-zone of the sink?	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No		
5	Are signs promoting hand hygiene displayed in the area?	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No		
6	Are alcohol dispensers readily accessible?	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No		
7	Are alcohol dispensers filled and working properly?	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No	❑ Yes ❑ No		
	Total YES and TOTAL OBSERVED							

ACCESSED FROM: https://www.cdc.gov/infectioncontrol/pdf/QUOTS/Standard-Precautions-Hand-Hygiene-Supplies-P.pdf

NEONATAL ENVIRONMENT: OBSERVATION OF NUTRITIONAL PREPARATION AREA

SOURCE: Center for Disease Control (CDC)

Neonatal Environment: Observation of Nutritional Preparation Area

NICU-8

Instructions: Observe nutritional preparation area. Observe each practice below and answer Yes, No, or N/A. Sum all Yes and No responses. Divide by sum of "Yes" + "No".

Nutritional preparation area: Observation Categories				
1	Are surfaces in the nutrition preparation area visibly clean and free from clutter?	❑ Yes	❑ No	❑ N/A
2	If powdered formula is used, is sterile water provided for dilution or reconstitution?	❑ Yes	❑ No	❑ N/A
3	Thermometers in the breast milk storage refrigerator and freezer are easy to visualize and are within the range noted below?	❑ Yes	❑ No	❑ N/A
4	Are the breast milk storage refrigerator and freezer temperatures monitored and recorded every 4 hours?	❑ Yes	❑ No	❑ N/A
5	Is stored breast milk labeled with name, date, and time of pumping?	❑ Yes	❑ No	❑ N/A
6	Is breast milk stored in a manner that prevents misadministration (e.g., each mother's milk is in a dedicated tray?)	❑ Yes	❑ No	❑ N/A
7	Is the refrigerator/freezer in which breast milk is stored clean and dedicated to patient nutrition supplies only?	❑ Yes	❑ No	❑ N/A
8	Are waterless warmers used to thaw and warm breast milk (i.e., there is no evidence of thawing by immersion in tap water)?	❑ Yes	❑ No	❑ N/A
9	Are ready-for-use breast pumps clean, labeled as clean, and stored separately from breast pumps that have not been cleaned?	❑ Yes	❑ No	❑ N/A
TOTAL (Total YES and No Only)				

Refer to human milk storage guidelines table at https://www.cdc.gov/breastfeeding/recommendations/handling_breastmilk.htm

ACCESSED FROM: https://www.cdc.gov/infectioncontrol/pdf/QUOTS/Neonatal-Nutritional-Prep-Area-P.pdf

HAND HYGIENE NICU OBSERVATION TOOL

SOURCE: Doctors Medical Center Modesto

NICU Hand Hygiene Observation

Month of Observation: **Shift:**

Observer:

Directions: please collect 20 observations (20 rows). Please vary staff category if possible. Not all columns need to be completed. Due by the last day of the month. Place this form in Quality Binder, check yourself off.

#	Job Category RN	Before Patient Contact	After Patient Contact	After Removing Gloves	Before Invasive Procedure	No Jewelry During Care	Forearms Clear During Care	Comment: Indication for NO (see reference key)	Before Contact Clean Environ	After Contact Dirty Environ
1		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
2		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
3		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
4		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
5		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
6		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
7		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
8		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
9		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
10		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
	RCP	Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
1		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
2		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
3		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
4		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
5		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
	MD/NNP									
1		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
2		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
3		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
4		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
5		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
	Other									
1		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
2		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
3		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N
4		Y N	Y N	Y N	Y N	Y N	Y N		Y N	Y N

Reference Key: Performed the following activities without adequate HH. 2: phone 3: chart 4: touching self 5: Other (please list)

HAND HYGIENE SINK SIGNAGE EXAMPLE

SOURCE: University of California, Irvine (UCI) Health

HAND HYGIENE MOMENTS WHILE GIVING CARE TOOL

SOURCE: University of California, Irvine (UCI) Health

Clean vs Dirty

CLEAN items at head of bed
- Pacifier
- Suction equipment
- Bulb syringe/Neosucker

DIRTY items at foot of bed
- Rose bag/white chux to collect dirty items while giving care

General Guidelines
- Work head-to-toe (clean to dirty) when giving routine care
- Hand hygiene before entry to the isolette and immediately after exiting isolette
- Before/after performing a procedure (IV start, heelstick, etc.)
- Use a **clean white CHUX** during invasive procedures (heelstick, IV starts, etc.) to reduce contamination from bed linens
- All linen is changed **DAILY including any cover on top of isolette**
- Curtains are a part of the patient room; hand hygiene before/after touching

Hand Hygiene Moments During Cares

Before/After providing/handling feedings

Before/After respiratory care (NCPAP care, suctioning)

Before/After changing/handling diapers

Bathing Guidelines
Bathe every 3-4 days and PRN, stable infants and growing preterm infants

References

1. Akanji, J., Walker, J., & Christian, R. (2017). Effectiveness of formal hand hygiene education and feedback on healthcare workers' hand hygiene compliance and hospital acquired infections in adult intensive care units: a systematic review protocol. JBI Database System Rev Implement Rep, 15(5), 1272-1279.
2. American Academy of Pediatrics. (2017). Guidelines for Perinatal Care (8th ed). Elk Grove Village, Il: American Academy of Pediatrics and American College of Obstetrics and Gynecologists.
3. Arrowsmith VA, Taylor R. Removal of nail polish and finger rings to prevent surgical infection. Cochrane Database Syst Rev. 2014;8:CD003325.
4. Bearman GM, et al. A controlled trial of universal gloving versus contact precautions for preventing the transmission of multidrug-resistant organisms. American Journal of Infection Control. 2007; 35:650–655.
5. Boyce JM, Pittet D. Guideline for hand hygiene in healthcare settings: recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Am J Infect control 2002;30(8): S1–46.
6. https://www.cdc.gov/hicpac/recommendations/core-practices.html#anchor_1556561902
7. https://www.cdc.gov/infectioncontrol/guidelines/nicu-clabsi/index.html
8. https://www.cdc.gov/infectioncontrol/pdf/guidelines/NICU-saureus-h.pdf
9. Campbell, J.I., Pham, T.T., Le, T., Dang, T.H., Chandonnet, C.J. et al. (2020). Facilitators and barriers to family empowerment strategy to improve healthcare worker hand hygiene in a resource limited. Setting. American Journal of Infection Control, 48, 1485-1490. https://doi.org/10.1016/j.ajic.2020.05.030
10. CDC MMWR Morbidity and Mortality Weekly Report. Guideline for hand hygiene in health care settings. Recommendations of the healthcare infection control practices advisory committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. 2002; 51: No RR-16. https://www.cdc.gov/mmwr/PDF/rr/rr5116.pdf#page=19
11. Fagernes, M., Lingaas, E., & Bjark, P. (2007). Impact of a single plain finger ring on the bacterial load on hands of healthcare workers. Infect Control Hosp Epidemiol, 28, 1191-1195.
12. Goedken, C. C., Livorsi, D. J., Sauder, M., Vander Weg, M. W., Chasco, E. E., Chang, N., Perencevich, E., & Reisinger, H. S. (2019). "The role as a champion is to not only monitor but speak out and to educate": the contradictory roles of hand hygiene champions. Implementation Science 14(110). https://doi.org/10.1186/s13012-019-0943-x
13. Gorig, T., Dittmann, K., Kramer, A., Heidecke, C., Diedrich, S., & Hubner, N. (2019). Active involvement of patients and relatives improves subjective adherence to hygienic measures, especially self-reported hand hygiene. Antimicrobial Resistance and infection control, 8, 201. https://doi.org/10.1186/s13756-019-0648-6
14. Hong, T. S., Bush, E.C., Hauenstein, M. F., Lafontant, A., Li, C., Wanderer, J.P., & Ehrenfeld, J. M. (2015). A hand hygiene compliance check system: Brief communication on a system to. Improve hand hygiene compliance in hospitals and reduce infection. J Med Syst, 39, 69.
15. Kaufman DA, Blackman A, Conaway MR, Sinkin RA. Nonsterile glove use in addition to hand hygiene to prevent late-onset infection in preterm infants: Randomized clinical trial. JAMA Pediatrics. 01 Oct 2014;168(10):909-916. doi:http://dx.doi.org/10.1001/jamapediatrics.2014.953
16. McCalla, S., Reilly, M., Thomas, R., McSpedon-Rai, D., McMahon, L.A., Palumbo, M. (2018). An automated hand hygiene compliance system is associated with decreased rates of health care-associated infections. American Journal of Infection Control, 46, 1381-1886.
17. McGuckin M, Waterman R, Govednik J. Hand hygiene compliance rates in the United States – a one-year multicenter collaborative using product/volume usage measurement and feedback. Am J Med Qual 2009;24(3):205–13.

18. Nist MD, Pickler RH, Harrison TM. Gloving and Touch Practices of Neonatal Nurses. J Perinat Neonatal Nurs. 2022 Jan-Mar 01;36(1):86-92. doi: 10.1097/JPN.0000000000000626. PMID: 35089182.
19. Ramasethu J. Prevention and treatment of neonatal nosocomial infections. Matern Health Neonatol Perinatol. 2017; 3:5. Published 2017 Feb 13. doi:10.1186/s40748-017-0043-3 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5307735/
20. Sands, M. & Aunger, R. (2020). Determinants of hand hygiene compliance among nurses in US hospitals: A formative research study. PLoS ONE, 15(4): e0230573. https://doi.org/10.1371/journal.pone.0230573
21. Shabot, M.M., Chassin, M.R., France, A., Inurria, J., Kendrick, J., & Schmaltz, S.P. (2016). Using targeted solutions tool to improve hand hygiene compliance is associated with decreased health care-associated infections. The Joint Commission Journal of Quality and Patient Safety, 42(1).
22. Trick, W. E., Vernon, M. O., Hayes, R. A., Nathan, C. Rice, T. W., Peterson, B. J. et al. (2003). Impact of ring wearing on hand contamination and comparison of hand hygiene agents in a hospital. Clinical Infectious Disease, 36, 1383-1390.
23. World Health Organization. WHO guidelines on hand hygiene in health care: first global patient safety challenge. Clean care is safer care: a summary. 2009; [Internet]. Available from: http://www.who.int/gpsc/5may/tools/who_guidelineshandhygiene_summary.pdf
24. https://www.centerfortransforminghealthcare.org/improvement-topics/hand-hygiene/?_ga=2.108894656.399842706.1654057965-1554331285.1613416740

In This Section

II. Building the Foundation to Prevent Hospital Acquired Infections in the NICU

Targeting Zero Hospital Acquired Infections and Building a Quality Improvement Team Mindset

Introduction

Reduction and elimination of hospital acquired infections and specifically, central line associated blood stream infections (CLABSI), is possible; however, the task is more complex than the quest for the perfect bundle and NICU leaders need to widen their lens to build a quality improvement framework through which to ground the important work of preventing harm.[1] As neonatal care becomes increasingly complex and NICU patients more vulnerable, achieving zero harm requires teams to think about the work differently and to build interdependent teams and safer systems.

There are several alternative approaches which have yielded significant improvement, all of which are rooted in the understanding of team dynamics and error reduction. These include:

- Comprehensive Unit-based Safety Program (CUSP) - Agency for Healthcare Research and Quality (AHRQ)
- Team Strategies and Tools to Enhance Performance and Patient Safety (TeamSTEPPS) - Agency for Healthcare Research and Quality (AHRQ)
- High Reliability Methodologies - Institute for Healthcare Improvement (IHI)

High Reliability Organizations (HRO) are widely described as organizations that in performing complex tasks observe fewer than their expected share of unexpected outcomes. Although caring for neonates is not necessarily comparable to the work within the nuclear power or airline industries, humans functioning in complex systems tend to behave and succeed or fail in these systems in a similar manner. NICU leaders and work groups should standardize work whenever possible and create a team understanding of how human factors engineering impacts daily tasks. In doing so, teams should guide task-development by making it easy to do the right thing and hard to do the wrong thing. Examples of using human factors engineering in improving the daily work of NICU staff include avoiding the reliance on memory and developing and instituting visual aids, well designed checklists, and insertion and maintenance kits (which standardize supply utilization).

POTENTIALLY BETTER PRACTICE

Target Zero Hospital Acquired Infections

Background, Rationale, and Goals

- Although not all units have achieved zero hospital acquired infections, many units have demonstrated that zero is achievable
- Many adult and pediatric critical care units have achieved zero CLABSI, some for many years [2,3]
- An expectation of 'zero harm" leads to a change in mental model and a different level of accountability for each nosocomial event [4]
- Avoid common "group think" that HAIs are "unpreventable" as this perpetuates that given outcome
- Team's focus and goals should be zero HAI

Recommended Guidelines and Algorithms

- Post not only infection rates but "days since last infection."
- Share stories of units and institutions that have achieved zero with senior leaders and Board of Directors or other high-level leadership
- Ensure consistent Board/leadership messaging of zero as an achievable goal with sustained effort

Guidance on Quality and Process Improvement

- Monitor run charts with notation of significant interventions; examples of run chart measurements include hand hygiene compliance percentages and CLABSI rates over time. Consider a unit dashboard including all major HAI measures such as hand hygiene compliance, days between infection, and antibiotic utilization rate.
- Publish "days since last infection" in the unit

POTENTIALLY BETTER PRACTICE

Foster a Culture of Safety and Learning

Background, Rationale, and Goals

- The care provided in NICUs has become increasingly complex with significant potential for slips or lapses
- Teams increasingly are dependent on the expertise and awareness of other teammates
- Performance improvement efforts to reduce adverse outcomes necessitate an environment of trust and learning
- Creating a "just culture" is critical to drive safety reporting and crucial conversations; adopting a just culture approach to safety events may be foundational to reducing adverse events, improving communication of safety risks, and reducing patient harm. See the Just Culture Resources.
- Efforts to establish a culture of safety should form the foundation for all safety interventions [6]
- There is a strong correlation between a strong safety culture and reduced adverse events,[10] including CLABSI
- Units that execute plans to address Safety Attitude Questionnaire (SAQ) opportunities are more likely to decrease CLABSI [6]
- Staff working in an environment that does not feel safe are less likely to speak up, check one another or provide feedback, crippling efforts at standardization and compliance
- CLABSI reduction is highly correlated with improvements in "teamwork climate". A positive teamwork climate refers to the presence of open communication and cooperation between and among employees and is one piece of the context in which care is provided [5]
- Standardize expectations of team members to team check and to be checked; using staff as auditors of critical steps (such as central line tubing change) can offer both important compliance data along with promoting a team safety culture
- Foster a climate in which it is expected that assistance will be actively sought and offered

Recommended Guidelines and Algorithms

- Assess the status of safety culture in your unit with any of the available tools, paying particular attention to the elements of a teamwork climate
- If opportunities are identified, develop unit specific action plans to address concerns
- Ensure institutional commitment aligns to a culture of safety
- Consider using one of the following methodologies to teach team behaviors which have the potential to impact culture. Although there are differences with each, there are also great similarities, and it is important to consider which is most suitable to your unit and institution:
  - Team STEPPS
  - Healthcare Performance Improvement/High Reliability
  - Comprehensive Unit-based Safety Program

Guidance on Quality and Process Improvement

- Consider periodic assessment of unit specific questions to assess progress with addressing safety opportunities such as:
  - "In our unit we use error reporting as an opportunity for improvement"
  - "In the past week I have team checked/been team checked"

Outcome, Balancing and Process Measures

- At a minimum, conduct an annual survey of all staff about the safety culture, such as the SAQ or a similar tool, or ask questions on a standard survey specifically addressing safety culture
- Monitor error reporting as a proxy measure for staff "speaking up"

POTENTIALLY BETTER PRACTICE

Become a Highly Reliable Organization

Background, Rationale, and Goals

- High reliability organizations (HRO) are those organizations that operate in hazardous conditions and yet observe fewer than expected adverse outcomes, and in studies have been shown to share similarities in how they achieve reduced adverse events
- Application of high-reliability principles and practices can drive culture change [9]
- Integration of high-reliability principles strengthens evidence-based practice and reduces clinical variation [9,10]
- Institutional efforts toward high reliability integrates QI work into healthcare providers' everyday activities which

promotes standardized expectations and a singular focus on error prevention, resulting in sustainable improvement [11,12]

- A comprehensive approach to achieving high reliability (such as The Joint Commission's High Reliability Health Care Maturity Model and the Institute for Healthcare Improvement's Framework for Safe, Reliable, and Effective Care) has the potential to significantly reduce preventable harm [15]

Recommended Guidelines and Algorithms

- Share transformational testimonials of healthcare organizations that have undergone high-reliability transformation with unit and institutional leadership
- Review high reliability resources provided by the Institute for Healthcare Improvement (IHI), the Joint Commission, and AHRQ
- Review and share information from safety surveys with staff
- Evaluate unit preparation and readiness for cultural shift and transformation by conducting small focus groups consisting of all healthcare providers (e.g., RNs, MDs, Respiratory Therapists)

Guidance on Quality and Process Improvement

- Measure compliance with particularly relevant care bundle elements to assess reliability
- Monitor days since last preventable adverse event (i.e., serious safety event)
- Implement leadership rounding to assess reliability behaviors/challenges
- Develop and use tools to assess degree to which behaviors are hardwired which assists to build sustainability of the QI outcomes. Examples include sharing QI outcome data (such as CLABSI rates) openly with staff and creating a sense of awareness.

Outcome, Balancing and Process Measures

- Monitor serious safety event rate (per patient day) and days between events

POTENTIALLY BETTER PRACTICE

Understand the Impact of Human Factors Engineering and Make it Easier for Healthcare Providers to Do the Right Thing

Background, Rationale, and Goals

- Simplifying workflow can lead to a better understanding of potential failures and may improve efficiency
- Embedding human factors principles in work has the potential to increase compliance and decrease CLABSI [16, 17, 18]
- Establishment and reinforcement of standard work including formal line rounding has been shown to significantly reduce CLABSI [19]
- Human factors engineering can be utilized to significantly increase hand hygiene rates [20]
- Intervention strategies such as simulation and standardized kits have also been shown to significantly increase compliance and reduce CLABSI [21]

Recommended Guidelines and Algorithms

- Standardize processes (as well as when to deviate from standard processes) whenever possible
- Align policies to actual practice, which improves training and hard-wires rule-based behavior
- Prepare procedure/maintenance packs, kits, and carts, or locate supplies for line management in proximity
- Provide visual aids illustrative of expected workflow, supplies, and steps
- Design and implement electronic workflows that encourage the right decisions
- Consider adoption of peer audits performed in real time
- Survey front line staff as to barriers that reduce compliance

Guidance on Quality and Process Improvement

- Involve frontline staff in workflow development as well as in structure of audits
- Conduct "random audits" of care process bundle elements (central line care bundle, environmental cleaning) and provide feedback in real time
- Monitor compliance with measures such as hand hygiene, central line dressing change, and central line

entry
- Monitor if staff are using tools to reduce missing important elements of care processes.
- Consider use of simulation to evaluate effectiveness of interventions

Resources and Tools

Resources

IHI Resources
- Just Culture Resources

Tools

The following tools are included in this section:

1. “Days Between Infections" Signage Example
2. Leadership Walkrounds Tool

DAYS BETWEEN INFECTIONS SIGNAGE EXAMPLE

SOURCE: University of California, Irvine (UCI) Health

LEADERSHIP WALKROUNDS TOOL

SOURCE: Adapted Baker, S. (2010). Rounding for outcomes: An evidence-based tool to improve nurse retention, patient safety, and quality of care. Journal of Emergency Nursing, 36(2), 162-164.

PURPOSE: To gather information directly from staff about actionable information. Topics are focused on patient safety issues, what is working well and what is not, build relationships to enhance communication.

HOW TO USE: Choose a few of the following questions to focus the rounds; be consistent in both time of rounding and how questions are asked.

QUESTION EXAMPLES	AREA OF FOCUS
What is your biggest safety concern on your unit?	Safety
What is one thing that could happen today to improve safety on your unit?	Safety
What are the barriers to reporting a safety concern?	Safety
What is going well in this unit?	Staff Retention/Satisfaction
Who should I recognize for doing great work?	Staff Retention/Satisfaction
Do you have what you need to provide safe care?	Safety
What can I do to help?	Safety/Staff Retention/Satisfaction

ROUNDING LOG:

DATE/TIME AREA OF FOCUS	STAFF MEMBER	FEEDBACK ON AREA OF FOCUS	ACTIONS	NOTES

REFERENCES:

1. Wahl K, Stenmarker M, Ros A. Experience of learning from everyday work in daily safety huddles-a multi-method study. BMC Health Serv Res 2022;22(1):1101 doi: 10.1186/s12913-022-08462-9.

References

1. Pronovost P, Needham D, Berenholtz S, Sinopoli D, Chu H, Cosgrove S, Sexton B, Hyzy R, Welsh R, Roth G, Bander J Kepros J. An Intervention to Decrease Catheter Related Bloodstream Infections in the ICU. New England Journal of Medicine 2006;355;2725-2732.
2. Yaseen M, Al-Hameed F, Osman K, Al-Janadi M, Al-Shamrani M, Al-Saedi A, Al-Thaqafi A. A Project to Reduce the Rate of Central Line Associated Bloodstream Infection in ICU Patients to a Target of Zero. BMJ Open Quality 2016.
3. Erdei, C, McAvoy LL, Gupta M, Pereira S, McGowan EC. Is Zero Central Line Associated Bloodstream Infection Rate Sustainable? A 5 Year Perspective. Pediatrics 2015, 135 (6) e1485-1493.
4. Lin DM, Weeks K, Holzmueller CG, Pronovost PJ, Pham JC. Maintaining and Sustaining On the CUSP: Stop BSI Model in Hawaii. The Joint Commission Journal on Quality and Patient Safety 2013; 39:2:51-60.
5. Pronovost PJ, Sexton B. Assessing Safety Culture: Guidelines and Recommendations. BMJ Quality and Safety 2015; 14:231-233.
6. Thornton KC, Schwarz JJ, Gross AK, Anderson WG, Liu KD, Romig MC, Schell-Chaple H, Pronovost PJ, Sapirstein A, Gropper MA; Lipshutz AK. Zero Harm in the ICU-Building a Culture of Safety and Engaging Patients and Families. Critical Care Medicine 2017; 45:1531-1537.
7. Vigorito MC, McNicoll L, Adams L, Sexton B. Improving Safety Culture Results in Rhode Island ICUs: Lessons Learned from the Development of Action-Oriented Plans. The Joint Commission Journal on Quality and Patient Safety 2011; 37:509-514.
8. Richter JP, McAlearney AS. Targeted Implementation of the Comprehensive Unit-Based Safety Program Through an Assessment of Safety Culture to Minimize Central Line-Associated Bloodstream Infections. Health Care Management Review 2018; 43:42-49.
9. Oster CA, Deakins S. Practical Application of High-Reliability Principles to Quality and Safety Outcomes. The Journal of Nursing Administration. 2018; 1:50-55.
10. Shabot MM, Monroe D, Inurria J, Garbade D France AC. Memorial Hermann: High Reliability from Board to Bedside. The Joint Commission Journal on Quality and Patient Safety 2013; 39:253-257.
11. Day RM, Demski RJ, Pronovost PJ. Operating Management System for High Reliability: Leadership, Accountability, Learning and Innovation in Healthcare. Journal of Patient Safety and Risk Management 2018; 23:155-156.
12. Stalets E, Hausfeld J, Casper T, Demmel K, Cooks A. IHI ID 20 Sustaining System-Level High Reliability for CLABSI: Impacts of Standardization, Human Factors, and Direct Observation of Key Processes. BMJ Open Quality 2018;7: Suppl1.
13. McCraw B, Crutcher T, Polancich S. Preventing Central Line-Associated Bloodstream Infections in the Intensive Care Unit: Application of High-Reliability Principles. The Journal for Healthcare Quality 2018; 40:392-397.
14. Pham JC, Goeschel CA, Berenholtz SM, Demski R Lubomski LH, Rosen MA, Sawyer MD, Thompson DA, Trexler P, Weaver SJ, Weeks KR, Pronovost PJ. CLABSI Conversations: Lessons from Peer-to-Peer Assessment to Reduce Central Line-Associated Bloodstream Infections. Quality Management in Health Care 2016; 25:67-78.
15. Brilli RJ, McClead RE, Crandall WV, Stoverock L, Berry JC, Wheeler TA, Davis JT. A Comprehensive Safety Program Can Significantly Reduce Preventable Harm, Associated Costs and Hospital Mortality. The Journal of Pediatrics 2013; 163:1638-1645.
16. Jesse JT, Herwaldt LA, Durso FT. Preventing Healthcare-Associated Infections Through Human Factors Engineering. Current Opinion in Infectious Diseases 2018; 31:353-358.
17. Drews FA, Bakdash JZ, Gleed MS. Improving Central Line Maintenance to Reduce Central Line-Associated Bloodstream Infections. American Journal of Infection Control 2017; 45:1224-1230.
18. Bishop NB, Lee JI, Mahoney M, Genow B, Zadeh R, Capezuti E, Brown S, Jean-Marie S, Mathieu J, Osorio SN. A Human

Factors Approach to Central Line-Associated Bloodstream Infection Prevention and Safety Culture in the Pediatric Intensive Care Unit Pilot Report. Proceedings of the Human Factors and Ergonomics Society 2019 Annual Meeting.

19. Wilder KA, Wall B, Haggard D, Epperson T, Ikuta L, Zukowski K. CLABSI Reduction Strategy. Advances in Neonatal Care 2016; 16:170-177.
20. Drews FA, Visnovsky LC, Mayer J. Human Factors Engineering Contributions to Infection Prevention and Control. The Journal of the Human Factors and Ergonomics Society 2019; 61:693-701
21. Allen GB, Miller V, Nicholas C, Hess S. A Multitiered Strategy of Simulation Training, Kit Consolidation and Electronic Documentation is Associated with a Reduction in Central Line-Associated Bloodstream Infection. American Journal of Infection Control 2014; 42:643-648

In This Section

III. General Principles of HAI Prevention

Introduction

Published national guidelines are available to guide each NICU with central line insertion and maintenance practices. NICUs should use both published guidelines and findings from QI reports to establish evidence-based practice protocols that are associated with CLABSI reduction, and are applicable and practical within their specific NICU.

Each NICU should evaluate their current CLABSI and HAI rate over time, to determine if performance is improving, declining, or stagnant and compare to other like-NICUs as a method of benchmarking. Current unit-specific care practices and protocols should be evaluated against published guidelines to determine what next steps are needed to further reduce hospital-acquired bacteremia.

Detailed examination of the steps of care, such as central line tubing change, scrub the hub techniques, and environmental cleaning approaches are

encouraged as these efforts may further enhance the unit's current HAI prevention efforts. With HAI reduction work in the NICU, details matter.

POTENTIALLY BETTER PRACTICE

Review and Utilize Published National Guidelines for Central Line Insertion, Care, and Maintenance Practices

Background, Rationale, and Goals

- Hospital acquired bacteremia leads to prolonged hospitalization and worse neurodevelopmental outcomes[1]
- CLABSIs remain the most frequent hospital acquired infection in the NICU, leading to substantial morbidity and mortality
- CLABSI prevention efforts over the past decade have shown significant reduction of CLABSI events, however these improvements have plateaued despite published care bundles
- Published national guidelines delineate recommended bundle elements for insertion and maintenance of central lines for all patients[2], however NICU patients have specific and unique challenges that may not be addressed completely in published bundles. Additional safeguards and practices may need to be implemented to achieve zero HAI in the vulnerable NICU patient.
- A bundled approach to central line care practices in the NICU is associated with reduced CLABSI rates; however, there are a variety of practices included within each of these published NICU bundles, making comparisons of each intervention and its effect on CLABSI prevention difficult[3,4]
- Although published studies do not identify one central line care bundled element as more effective than another, methods to reduce central line entry along with "closed" methods of line entry (via needleless connectors) have been a central component of the majority of published NICU quality improvement CLABSI prevention projects[5] and are a recommended practice in published national guidelines for CLABSI prevention (refer to CDC guidelines below)

Recommended Guidelines and Algorithms

- CDC Recommendations for the Prevention and Control of Infections in Neonatal Intensive Care Unit Patients: Central Line-associated Blood Stream Infections (February 2022)
- SHEA neonatal intensive care unit (NICU) white paper series: Practical approaches for the prevention of central line-associated blood stream infections (March 2022)
- Infusion Nurses Society
- Solutions for Patient Safety (SPS) Prevention Bundles
- 2022 NANN Guidelines on Peripherally Inserted Central Catheters (4th edition)

Guidance on Quality and Process Improvement

- Review unit performance using national measurement standards including standard infection ratio (SIR) which is a risk-adjusted metric generated by the CDC using NICU-specific surveillance data reported to the National Healthcare Safety Network (NHSN)
- Utilizing a multidisciplinary group of healthcare providers involved with insertion, maintenance, and care of central lines, review published national guidelines and perform a gap analysis to identify areas of central line practice that can be changed, streamlined, or improved
- Review and analyze available compliance audit data related to all facets of central line care such as insertion steps, accessing a central line for medication administration, dressing changes,and IV tubing changes. If not currently auditing, consider adding audits to identify lapses in practice. Audits of care practices also assist with the sustainability of CLABSI prevention efforts.
- Standardize approach to care practices of all types of central lines in the NICU (umbilical, peripherally inserted, surgically placed) including securement, IV tubing configuration, medication administration, and blood sampling, to reduce variation
- CLABSI prevention is a continuous goal with care practices integrated and hardwired into all healthcare providers daily work, included in the onboarding of all new healthcare providers, and as part of yearly education efforts
- Although routine chlorhexidine (CHG) bathing is currently not recommended for all NICU patients with a central line, as safety concerns for systemic absorption have not been carefully evaluated, for select NICUs with CLABSI rates persistently above national thresholds, selected CHG bathing may be considered.[6,32] Detailed protocols should be developed, including a monitoring plan to track any local dermatitis or intolerance to CHG.

Outcome, Balancing and Process Measures

- CLABSI rates
- Audit results
- Incidence of skin reactions to CHG, tracked by gestational age

POTENTIALLY BETTER PRACTICE

Reaching Zero Hospital Acquired Bacteremia: Additional Interventions

Background, Rationale, and Goals

Promote the health of the gastrointestinal tract (GI) to reduce bacteremia acquired through bacterial translocation.[8] This includes:

- Adopting an exclusive human milk diet for all newborns in the NICU to reduce HAI.[9] Feeding preparation methods should follow established published national guidelines to reduce bacterial contamination during collection, storage and preparation.[33]
- The routine use of probiotics as a method to reduce late onset sepsis is currently not recommended [34]
- Although limited, published research identifies indwelling feeding tubes as a potential source of HAI through the development of a microbial biofilm along the feeding tube walls and end hole, creating potential gut microbiota disruption and colonization with drug resistant organisms.[10-13] Currently, there is a paucity of data in which to guide care of indwelling feeding tubes, including length of time in place and or flushing protocols that may reduce risk of HAI.
- Avoid use of an H2 blocker as they increase pH in the GI tract and may increase risk of bacterial translocation, late onset sepsis, and necrotizing enterocolitis (NEC).[14-17]

Implement families as partners for HAI prevention:

- Utilize families as active participants in HAI prevention practices, such as assisting with reminders for hand hygiene and counting the seconds of "scrub-the-hub" prior to line entry. Family participation has been included in CLABSI reduction bundles.[3,18,19]
- Partnering with families requires a culture shift within the NICU and must be carefully navigated to avoid undue stress for both families and healthcare providers [20]
- More research is needed on the impact of family empowerment and CLABSI reduction, especially as it relates to families with a preferred language other than English

Focus on reducing the bioburden in the NICU environment to reduce HAI:

- Consider implementation of robust environmental cleaning protocols to reduce bioburden; common NICU high-touch surfaces may serve as reservoirs for pathogenic bacteria and cleaning significantly reduces the total microbial load.[21,22] Computer keyboards and common surfaces (e.g. work stations, carts) are examples of high-touch areas.
- Identify NICU "orphan" equipment (equipment that is used in the NICU but not sent to a centralized area for cleaning, such as opthalmascopes, point-of-care ultrasound, additional light sources, transilluminators) and implement standardized cleaning processes. Collaborate with all departments that may be involved with using and cleaning NICU-dedicated equipment to clearly delineate roles (i.e. who cleans which equipment).
- Consider use of fluorescent gel markers (markers are only visible with ultraviolet light) as a tool to assess efficacy of cleaning protocols, such as discharge room cleaning and initial on-shift high-touch wipe down.[23,24] Provide immediate feedback to staff and share cleaning audit results regularly.

NICU culture and processes:

- Identify infants at highest risk for HAI including infants exposed to broad-spectrum antibiotics, Total Parenteral Nutrition (TPN), those with a prolonged need for central line and invasive ventilator support, and prolonged NPO. Consider performing daily audits (e.g. central line care audits and environmental cleaning) on this select group of infants to prospectively identify practice breaks.
- Perform a root cause analysis for any positive blood culture, regardless of source (e.g. CLABSI, gut bacterial translocation, urinary tract infection) to identify potential lapses in practice and presence of modifiable and unmodifiable risk factors. Track the data for trends and patterns to inform future clinical practice changes, identify barriers to meeting expected clinical standards, and needed staff education.
- The quality of the NICU work environment (such as adequacy of nurse staffing, presence of support personnel, unit organization) has been linked to multiple improvements in NICU outcomes including reduced HAI, improved breastfeeding rates, and reduced intraventricular hemorrhage (IVH).[25-29] Missed nursing care (care that is omitted or significantly delayed due to high nurse workload) is associated with high nursing workload.[30,31] Evidenced-based standards for NICU staffing are lacking and more research is needed in this area. Although published studies vary in methodologies

used, outcomes measured, and study sites (international vs. USA), common themes are emerging that may guide NICU leadership on methods to improve the NICU work environment. These include conducting an assessment of quality of the NICU work environment (contextual factors), benchmarking with peer institutions using national measures (such as the SCORE Survey and the Magnet Recognition Program), and using data to advocate for needed resources.

Recommended Guidelines and Algorithms

- High-touch cleaning protocol (see Tools section)
- Family "script" for active participation in HAI prevention

Outcome, Balancing and Process Measures

- Hospital acquired bacteremia, CLABSI incidence
- Rates of human milk at discharge from the NICU
- Results of all clinical practice audits (such as central line tubing change, equipment cleaning)

Resources and Tools

Tools

The following tools are included in this section:

1. Central Line Care Practice Audit Tool
2. Standardized Central Line Tubing Visual Aid
3. Securement/Dressing Visual Aid
4. Catheter Entry Observations Tool
5. Blood Culture Review Form
6. CLABSI Notification and Huddle Tool
7. Family CLABSI Education Tool
8. Environmental Cleanliness Flyer for Families
9. Environmental Cleanliness Flyer for Staff
10. Bedside Cleaning Routine Tool

CENTRAL LINE CARE PRACTICE AUDIT AND MONITORING TOOL

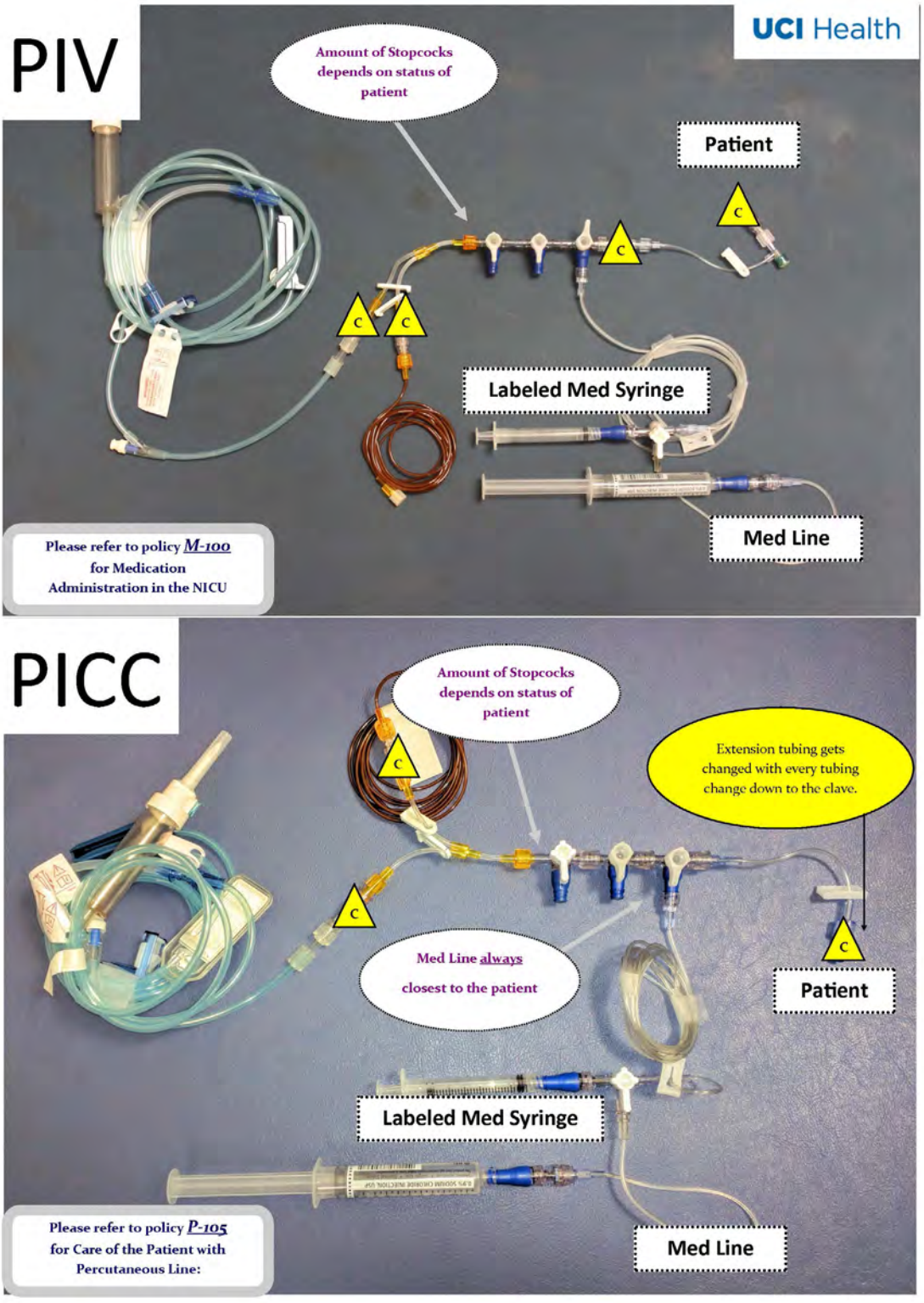
SOURCE: University of California, Irvine (UCI) Health

Central Line Care Monitoring Tool

	Step	Done	Not Done	Comments
Set-up	Performs hand hygiene			
	Gathers equipment			
	Checks TPN bag constituents against order for accuracy; checks constituents for safe dosing per KG			
	Washes work surface with disinfectant wipe			
	Opens packages maintaining sterility			
	Performs hand hygiene			
	Dons clean gloves			
	Connects necessary tubing in a clean manner avoiding contamination			
	Alcohol scrub the access site on IV bag, then spikes bag keeping end of tubing clean			
	Purges fluid through tubing keeping end of tubing sterile			
	Places tubing in isolette with end of tubing protected. Discards nonsterile gloves			
Patient Connection	Opens sterile gloves and drops alcohol wipe onto sterile glove packaging			
	Performs hand hygiene			
	Dons clean gloves			
	Places sterile 4x4 (or other sterile surface) underneath central line connection. Does not let IV tubing touch sterile surface			
	Vigorously scrubs old connection site with alcohol wipe for 30 seconds			
	Places IV tubing down on sterile 4X4 (or other sterile surface) to provide protection of connection site from bed linens			
	Performs hand hygiene			
	Dons sterile gloves and disconnects old tubing; uses alcohol wipe to vigorously scrub connection site for 30 seconds. Allows to dry			
	Attaches new IV tubing to central line			
Final Steps	Places tubing into IV pump			
	Begins infusion at ordered rate			
	Tubing labeled with "change date" sticker			

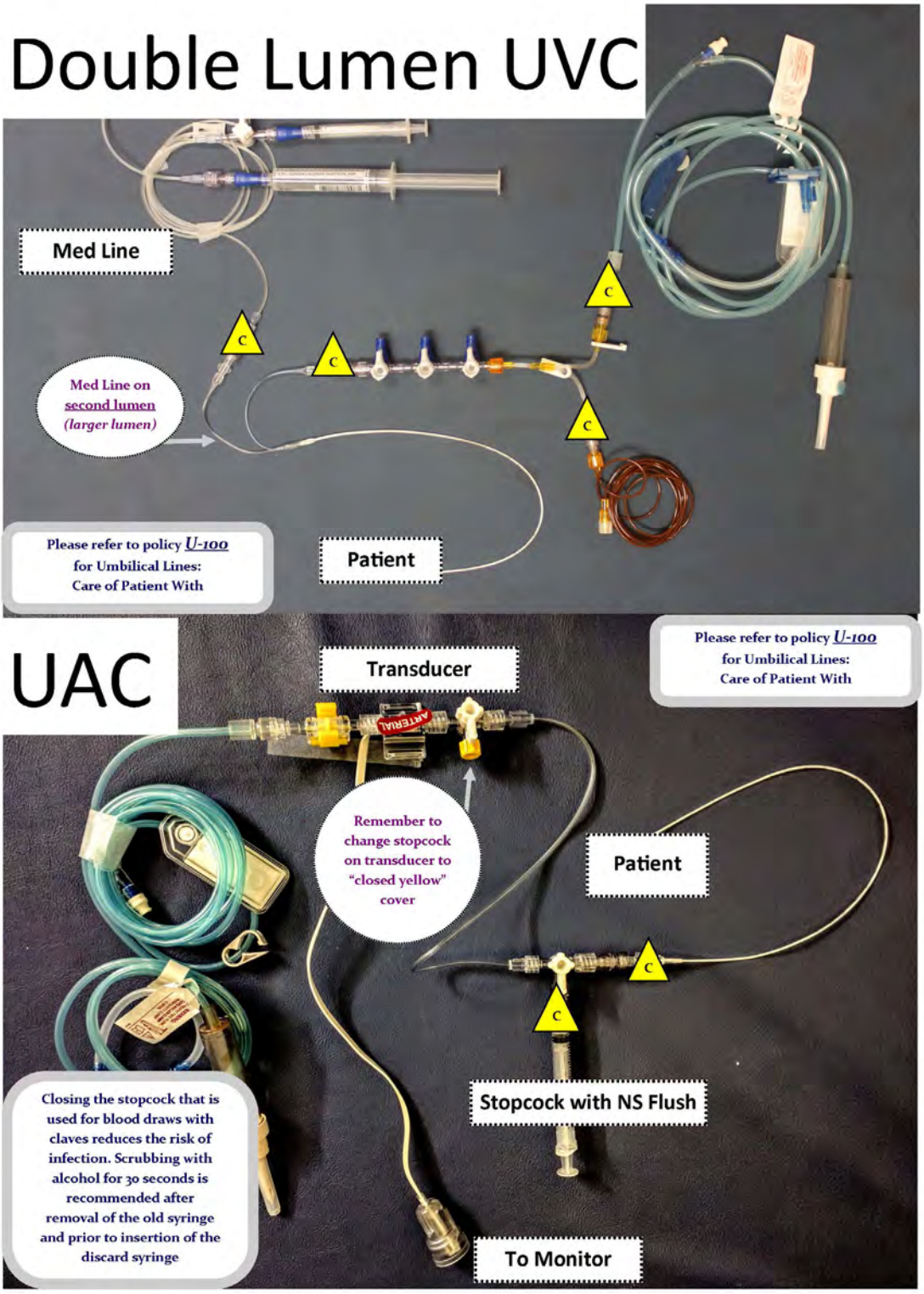
STANDARDIZED CENTRAL LINE TUBING VISUAL AID - PAGE 1

SOURCE: University of California, Irvine (UCI) Health



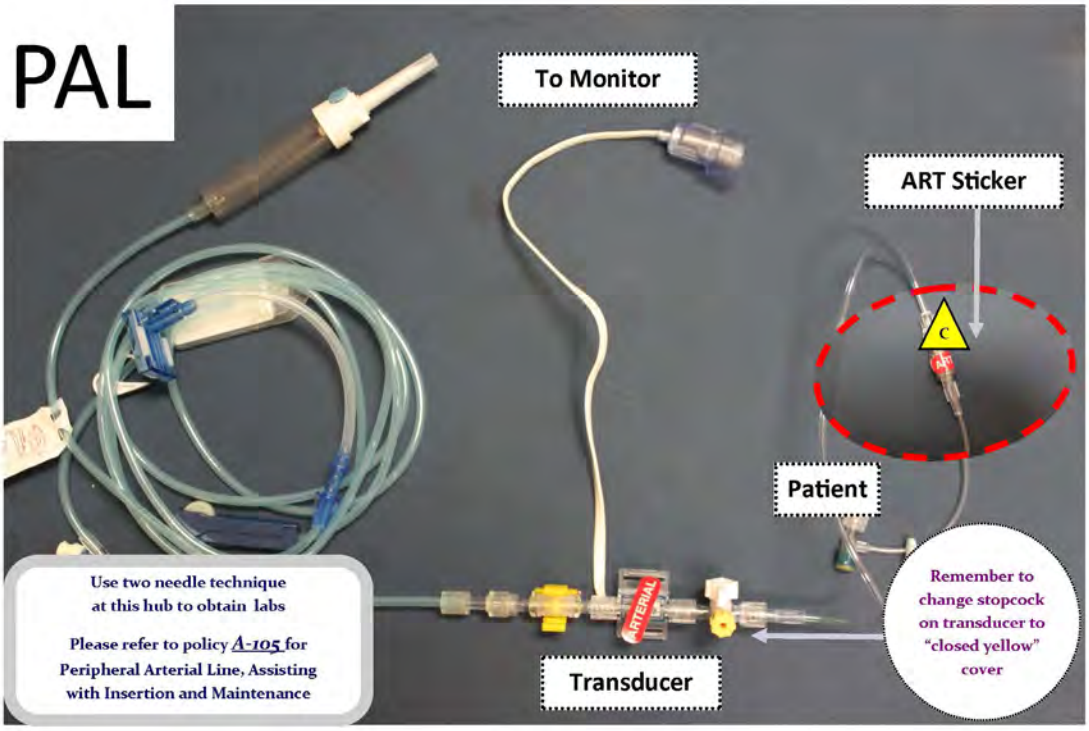
STANDARDIZED CENTRAL LINE TUBING VISUAL AID - PAGE 2

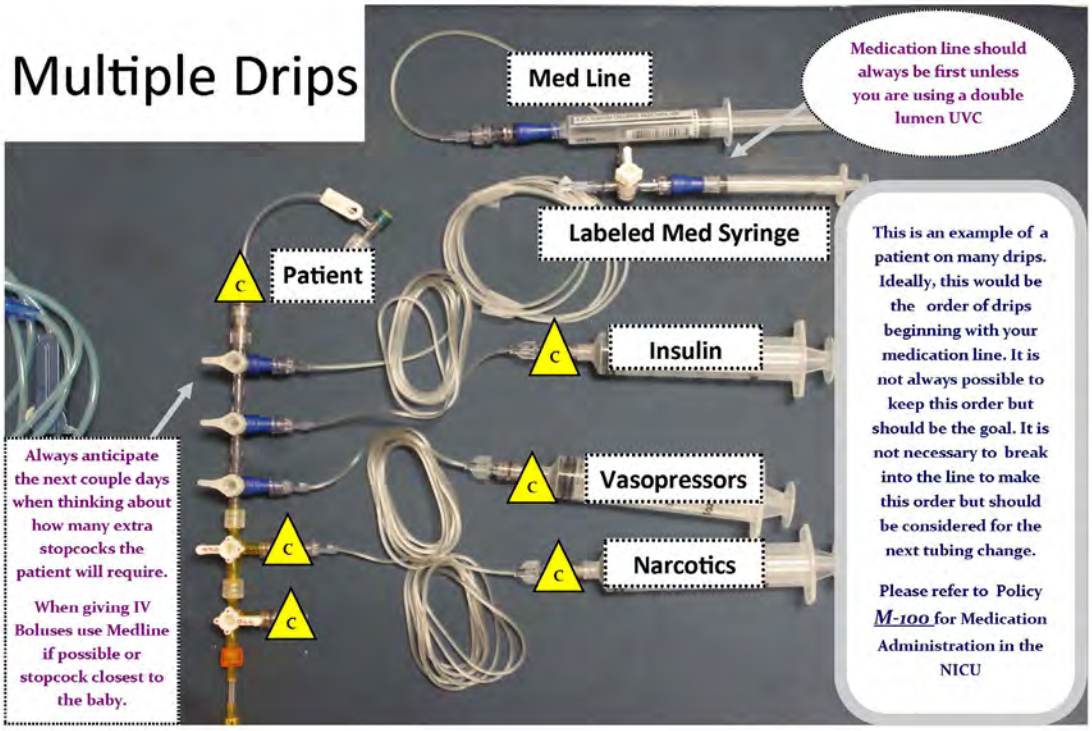
SOURCE: University of California, Irvine (UCI) Health



STANDARDIZED CENTRAL LINE TUBING VISUAL AID - PAGE 3

SOURCE: University of California, Irvine (UCI) Health





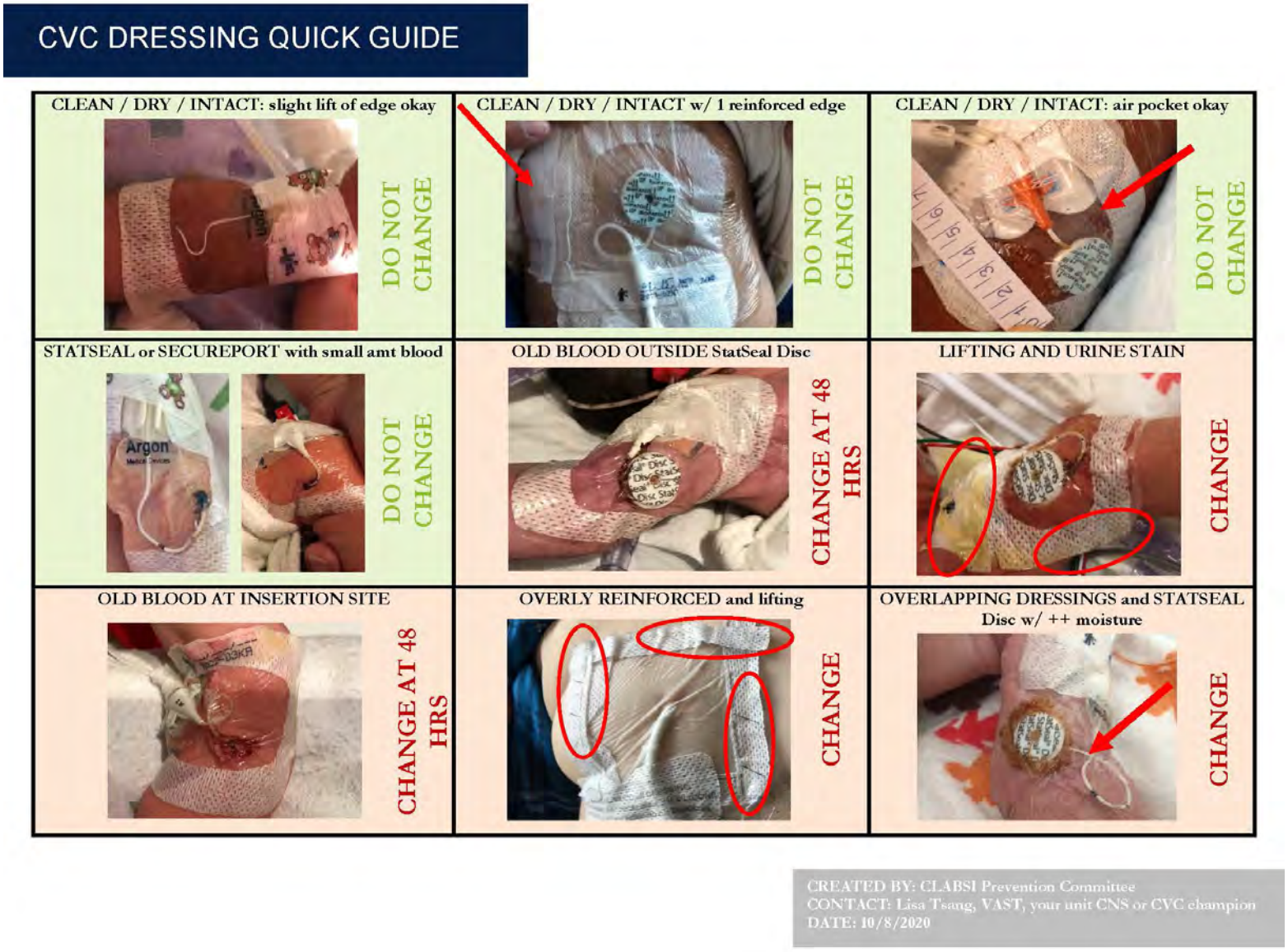
STANDARDIZED CENTRAL LINE TUBING VISUAL AID - PAGE 4

SOURCE: University of California, Irvine (UCI) Health

	Central Line Tubing Change Steps
Set-up	Checks TPN bag constituents against order for accuracy; checks constituents for safe dosing per KG
	Scan IV bag using KBMA system
	Performs hand hygiene ☆
	Gathers equipment
	Washes work surface with disinfectant wipe
	Opens packages maintaining sterility
	Performs hand hygiene ☆
	Dons clean gloves
	Connects necessary tubing in a clean manner avoiding contamination
	Alcohol scrub the access site on IV bag, then spikes bag keeping end of tubing clean
	Purges fluid through tubing keeping end of tubing sterile
	Places tubing in isolette with end of tubing protected. Discards nonsterile gloves
Patient Connection	Opens sterile gloves and drops alcohol wipe onto sterile glove packaging
	Performs hand hygiene ☆
	Dons clean gloves
	Places sterile 4x4 (or other sterile surface) underneath central line connection. Does not let IV tubing touch sterile surface
	Vigorously scrubs old connection site with alcohol wipe for 30 seconds
	Places IV tubing down on sterile 4X4 (or other sterile surface) to provide protection of connection site from bed linens
	Performs hand hygiene ☆
	Dons sterile gloves and disconnects old tubing; uses alcohol wipe to vigorously scrub connection site for 30 seconds. Allows to dry
	Attaches new IV tubing to central line
Final Steps	Places tubing into IV pump
	Begins infusion at ordered rate and chart fluids in EMR
	Tubing labeled with "change date" sticker

SECUREMENT/DRESSING VISUAL AID

SOURCE: UCSF Benioff Children's Hospital Oakland



CATHETER ENTRY OBSERVATION TOOL

SOURCE: Doctor's Medical Center Modesto

Catheter Entry Observations

Observer:

Observation #	Reason for entry: B=blood draw M=med administration T=Tubing change			Line Type PIV = PI P=PICC U=umbilical			Performed hand hygiene		Scrubbed port for 10 times using friction or alcohol port protector in place			Allowed disinfectant to dry unless alcohol port protector in place			Entered port without contaminating it		Performed hand hygiene (applies only if provider leaves patient)			All criteria met
1	B	M	T	PI	P	U	Y	N	Y	N	NA	Y	N	NA	Y	N	Y	N	NA	Y
2	B	M	T	PI	P	U	Y	N	Y	N	NA	Y	N	NA	Y	N	Y	N	NA	Y
3	B	M	T	PI	P	U	Y	N	Y	N	NA	Y	N	NA	Y	N	Y	N	NA	Y
4	B	M	T	PI	P	U	Y	N	Y	N	NA	Y	N	NA	Y	N	Y	N	NA	Y
5	B	M	T	PI	P	U	Y	N	Y	N	NA	Y	N	NA	Y	N	Y	N	NA	Y
6	B	M	T	PI	P	U	Y	N	Y	N	NA	Y	N	NA	Y	N	Y	N	NA	Y
7	B	M	T	PI	P	U	Y	N	Y	N	NA	Y	N	NA	Y	N	Y	N	NA	Y
8	B	M	T	PI	P	U	Y	N	Y	N	NA	Y	N	NA	Y	N	Y	N	NA	Y
9	B	M	T	PI	P	U	Y	N	Y	N	NA	Y	N	NA	Y	N	Y	N	NA	Y
10	B	M	T	PI	P	U	Y	N	Y	N	NA	Y	N	NA	Y	N	Y	N	NA	Y
Totals																				
Report Total Of Next 3 Columns As Observation Denominator>>>>				Total			Report Total This Column As Numerator Of Observations >>>>>>>>>>>>>>>>>>					Total								

BLOOD CULTURE REVIEW FORM

SOURCE: University of California, Irvine (UCI) Health

Positive Blood Culture Review

DOB:__/__/__ Birth WT:_____ (gm) GA:____._/7_wk &days/7 Date 1st + blood culture drawn: ___/___/___

Record below: **Risk factors *present* at time blood culture drawn & data about the positive blood culture**	
[Y/N] Compromised skin integrity [Y/N] Open body cavity [Y/N] Ostomy present [Y/N] Surgical site infection receiving Rx [Y/N] Other risk factors: (state)	[Y/N] NCPAP/Nasal cannula present [Y/N] Feeding tube present: [Y/N] Continuously indwelling; if so date last changed:__/__/__ Enteral fluids:~____ml/kg/d; Parenteral nutrition:~____ml/kg/d during last full day prior to sepsis workup [Y/N] Major surgery within past week Specify most recent major op:_____
Catheter Information:**Only relevant if line(s) present (or discontinued) within 48 hours prior to first blood culture**	
[ ] No deep line present [ ] PIV ____# days (if multiple sites, note only longest) Estimate # IV start attempts in last 72 hrs:_____ [ ] UAC_____# days present prior to 1st blood culture [ ] UVC_____# days present prior to 1st blood culture [ ] PICC_____# days present prior to 1st blood culture Site: _____ [ ] Other CENTRAL line _____# days present prior to 1st blood culture. Site: _____ _____Estimate total # times all lines accessed during the **last 72 hours** (including all meds/blood draws/ tubing changes, etc) Last date tubing changed: ___/___/___ Last date dressing changed: ___/___/___(applies only to umbilical & central lines)	[Y/N] Abnormal CL site appearance on day culture drawn [Y/N] Line-related phlebitis [Y/N] Compromised dressing [Y/N] Vomiting onto line dressing [Y/N] Stool/Urine onto line dressing [Y/N] Line repaired/exchanged in past 48 hours [Y/N] Line leaking events in past 48 hours [Y/N] Care by temporary staff in past 48 hours [Y/N] Care by non-NICU staff in past 48 hours [Y/N] Staffing difficulties for the NICU over past 48 hours [Y/N] Improper line set-up [Y/N] Tubing/infusate NOT changed appropriately (method/time) [Y/N] Any other unusual event: (specify):_____ [Y/N] Line discontinued ≤ 48 hrs prior to drawing blood culture
Infusates in Past 72 hours : [ ] TPN [ ] Lipids [ ] Blood products [ ] Steroids (3 x physiologic doses)	
Additional comments	[ ] BSI – source unknown [ ] BSI – NEC [ ] BSI –-VAP [ ] BSI – other source [ ] BSI – CLABSI suspected, but doesn't meet NHSN criteria [ ] CLABSI – pathogenic species [ ] CLABSI – CONS [ ] CLABSI – another common skin species other than CONS [ ] Contaminant
Findings from staff interviewed: [Y/N] Occlusion alarms [Y/N] Unexpected disconnections [Y/N] Leaking events: [Y/N] required exchange of tubing or connection [Y/N] Other:	
Comments and Lessons Learned:	

Adapted from 2008 CPQCC HAI Prevention Toolkit

CLABSI NOTIFICATION AND HUDDLE TOOL - PAGE 1

SOURCE: UCSF Benioff Children's Hospital Oakland

BCH CLABSI Notification and Unit Huddle Notes

GOALS:

a) **To increase unit engagement including of front line staff in CLABSI reduction efforts**
b) **To review possible CLABSI case and identify areas of improvement for CLABSI reduction**

1. **Preliminary CLABSI Huddle Notification**

Patient Name/MRN#	
Unit of Attribution	
Primary Service at time of event	
Secondary Service at time of event (if applicable)	
Date of admission	
Date of blood cultures	
Date of Initial Notification	
Date of Unit Huddle	
Attendees	

2. **Unit Huddle**

OVERVIEW:

Organism	
DTTP (positive, negative, not done)	

LINE INFORMATION:

Type of Line	
Location of Line	
When was the line placed? Dwell time?	
What was line used for?	
Was need for line discussed on daily rounds?	
What was discussed? (necessity, function, use, contamination)	
Was line removed as a result of infection?	
Does this patient need a CVC?	

Draft 3
9/13/22

CLABSI NOTIFICATION AND HUDDLE TOOL - PAGE 2

SOURCE: UCSF Benioff Children's Hospital Oakland

Could it have been removed earlier?	
Any known line issues including function, patency/TPA, recent breaks, lines dislodgement, or contamination (stool, emesis, bodily substances)?	
Any known dressing/CVC site issues (integrity, timely changes, localized symptoms)?	
Were there opportunities to change formulation of medications or lab frequency to decrease access of the CVC?	
Are there opportunities to change formulation of medications or lab frequency to decrease access of the CVC now?	
Was line accessed within the last 3 days by non-unit staff?	
Any additional issues?	

HYGIENE/ENVIRONMENT:

Was patient receiving CHG bathing daily as per policy? Any contraindications?	
Was the patient receiving oral care per policy?	
Was the linen changed daily as per policy?	
Was the qshift environmental cleaning performed?	
Other?	

HOST:

Other host contributors to bacteremia? Immunosuppression, poor skin integrity, poor GI integrity, broad spectrum antibiotics, TPN, etc.	
Did the patient receive blood products in the 48 hrs prior to the bacteremia?	
Other?	

OTHER:

Who will communicate with unit RNs? How will this information be communicated?	
Who will communicate with unit MDs? How will this information be communicated?	
Who will communicate with other important groups (consultants, procedural MD/RN, other?	

FAMILY DEBRIEF:

Draft 3
9/13/22

CLABSI NOTIFICATION AND HUDDLE TOOL - PAGE 3

SOURCE: UCSF Benioff Children's Hospital Oakland

Does the patient/family know about the bacteremia? Yes, no, do not know	
Is it appropriate to debrief about the CLABSI Huddle Discussion with them? Yes, no	
Will you debrief with the patient/family? Yes, no	

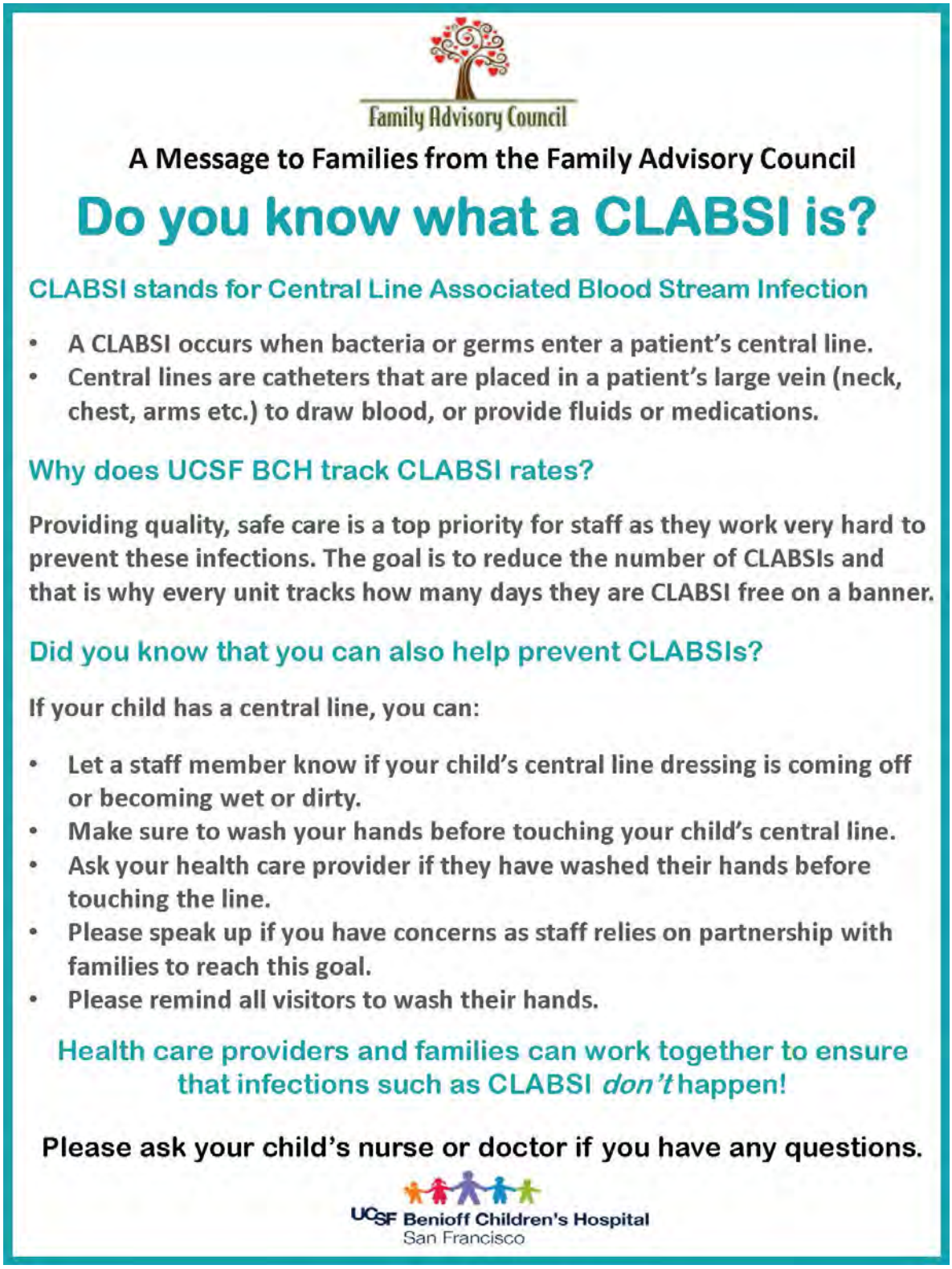
SUMMARY OF ACTION ITEMS:

Item	Owner

Draft 3
9/13/22

FAMILY CLABSI EDUCATION TOOL

SOURCE: UCSF Benioff Children's Hospital Oakland



Family Advisory Council

A Message to Families from the Family Advisory Council

Do you know what a CLABSI is?

CLABSI stands for Central Line Associated Blood Stream Infection

- A CLABSI occurs when bacteria or germs enter a patient's central line.
- Central lines are catheters that are placed in a patient's large vein (neck, chest, arms etc.) to draw blood, or provide fluids or medications.

Why does UCSF BCH track CLABSI rates?

Providing quality, safe care is a top priority for staff as they work very hard to prevent these infections. The goal is to reduce the number of CLABSIs and that is why every unit tracks how many days they are CLABSI free on a banner.

Did you know that you can also help prevent CLABSIs?

If your child has a central line, you can:

- Let a staff member know if your child's central line dressing is coming off or becoming wet or dirty.
- Make sure to wash your hands before touching your child's central line.
- Ask your health care provider if they have washed their hands before touching the line.
- Please speak up if you have concerns as staff relies on partnership with families to reach this goal.
- Please remind all visitors to wash their hands.

Health care providers and families can work together to ensure that infections such as CLABSI *don't* happen!

Please ask your child's nurse or doctor if you have any questions.

UCSF Benioff Children's Hospital
San Francisco

ENVIRONMENTAL CLEANLINESS FLYER FOR FAMILIES

SOURCE: UCSF Benioff Children's Hospital Oakland

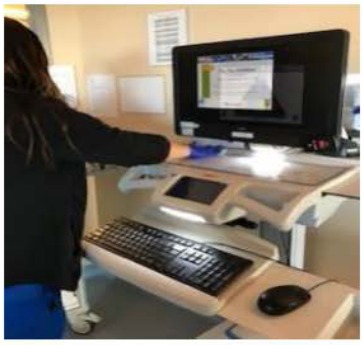
ENVIRONMENTAL CLEANLINESS FLYER FOR STAFF

SOURCE: UCSF Benioff Children's Hospital Oakland

Did you know?

Environmental Cleanliness

- **A clean environment is important for preventing infections**
- Daily room cleaning by Hospitality Services excludes:
  - Machines and cables attached to patients
  - Computer equipment
  - Moving patient/family belongings & medical equipment/supplies to clean the surfaces underneath
- **Every shift** use the hydrogen peroxide wipes to clean the following:
  (it only takes about 4 minutes!)
  - IV pumps and tubing
  - Cardio-respiratory monitors and cables
  - Feeding pumps and tubing
  - Computer keyboard, mouse, scanner, and surface
  - Crib rungs and side rails in an occupied bed/crib
  - Surfaces occupied with patient/family belongings & medical equipment/supplies
- Educate and encourage patients and families to consolidate items and take home items not being used



UCSF Benioff Children's Hospital
San Francisco

Preventing Hospital-Acquired Infection in the NICU
A CPQCC Quality Improvement Toolkit 55

BEDSIDE CLEANING ROUTINE TOOL

SOURCE: Doctor's Medical Center Modesto

DOCTORS MEDICAL CENTER NICU Manual Protocol	No. NICU.1.04 Document Owner: Director of Neonatal Services Approved: 6/26/19 Page 1 of 1 Next Review Date: 6/26/20
TITLE: **NICU.1.04 NICU Bedside Cleaning Routine**	

PURPOSE: To outline the nursing responsibility in providing a consistent practice for cleaning the neonate's bedside. The patient's bedside is defined as the following:

- Cardiac Monitor
- IV pumps & IV poles
- Medfusion pumps
- Feeding pumps
- Bedside counter
- Bedside drawers
- Computer keyboards/mouse
- Patient suction
- Stethoscope
- Mask and respiratory bag
- Patient Respiratory support equipment
- Any equipment taken from one patient and used on another patient

PROCEDURE:

1. The patient bedside will be cleaned with hospital-approved germicidal wipes (i.e. Saniwipes) at the beginning of every shift and as needed.
2. Equipment (i.e. swings, scales) will be cleaned with germicidal wipes after each patient use and allow to dry per manufacturer's recommendation.
3. Place the equipment in a clean area.
4. Pulse oximeter probes will be cleansed with bleach wipes only.
5. After the patient is discharged, perform a complete bedside cleaning including removal of linen from the patient drawer. Place the patients' dirty bed in the hallway, across from the charge nurse desk, to be cleaned by the environmental service staff.

Initiated: 8/10
Reviewed: 5/11, 2/19, 6/19
Approved: NICU Medical Director; 9/ 10, 7 / 11, Neonatology 4/16/19, PEDS 4/16/19, IP&T 5/16/19, Quality 5/28/19, MEC 5/31/19, BOG 6/26/19

References

1. Mukhopadhyay S, Puopolo KM, Hansen NI, et al. Neurodevelopmental outcomes following neonatal late-onset sepsis and blood culture-negative conditions. Arch Dis Child Fetal Neonatal Ed 2021;106(5):467-73 doi: 10.1136/archdischild-2020-320664
2. Ista E, van der Hoven B, Kornelisse RF, et al. Effectiveness of insertion and maintenance bundles to prevent central-line-associated bloodstream infections in critically ill patients of all ages: a systematic review and meta-analysis. Lancet Infect Dis 2016;16(6):724-34 doi: 10.1016/S1473-3099(15)00409-0
3. Fisher D, Cochran KM, Provost LP, et al. Reducing central line-associated bloodstream infections in North Carolina NICUs. Pediatrics 2013;132(6): e1664-71 doi: 10.1542/peds.2013-2000
4. Savage S, Hodge, D., Pickard, K., Myers, P., Powell, K., Cayce, J. Sustained reduction, and prevention of neonatal and pediatric central line-associated bloodstream infection following a nurse-driven quality improvement initiative in a pediatric facility. JAVA 2018;23(1):30-41
5. Aly H, Herson V, Duncan A, et al. Is bloodstream infection preventable among premature infants? A tale of two cities. Pediatrics 2005;115(6):1513-8 doi: 10.1542/peds.2004-1785
6. Muller M, Bryant KA, Espinosa C, et al. SHEA neonatal intensive care unit (NICU) white paper series: Practical approaches for the prevention of central line-associated bloodstream infections. Infect Control Hosp Epidemiol 2022:1-46 doi: 10.1017/ice.2022.53
7. Gorski LA, Hadaway L, Hagle ME, et al. Infusion Therapy Standards of Practice, 8th Edition. J Infus Nurs 2021;44(1S Suppl 1): S1-S224 doi: 10.1097/NAN.0000000000000396
8. Tarr PI, Warner BB. Gut bacteria and late-onset neonatal bloodstream infections in preterm infants. Semin Fetal Neonatal Med 2016;21(6):388-93 doi: 10.1016/j.siny.2016.06.002
9. Hair AB, Peluso AM, Hawthorne KM, et al. Beyond Necrotizing Enterocolitis Prevention: Improving Outcomes with an Exclusive Human Milk-Based Diet. Breastfeed Med 2016;11(2):70-4 doi: 10.1089/bfm.2015.0134
10. Mehall JR, Kite CA, Saltzman DA, Wallett T, Jackson RJ, Smith SD. Prospective study of the incidence and complications of bacterial contamination of enteral feeding in neonates. J Pediatr Surg 2002;37(8):1177-82 doi: 10.1053/jpsu.2002.34467
11. Singh NP, Choudhury DD, Gupta K, et al. Predictors for gut colonization of carbapenem-resistant Enterobacteriaceae in neonates in a neonatal intensive care unit. Am J Infect Control 2018;46(6): e31-e35 doi: 10.1016/j.ajic.2018.01.007
12. Hurrell E, Kucerova E, Loughlin M, Caubilla-Barron J, Forsythe SJ. Biofilm formation on enteral feeding tubes by Cronobacter sakazakii, Salmonella serovars and other Enterobacteriaceae. Int J Food Microbiol 2009;136(2):227-31 doi: 10.1016/j.ijfoodmicro.2009.08.007
13. Petersen SM, Greisen G, Krogfelt KA. Nasogastric feeding tubes from a neonatal department yield high concentrations of potentially pathogenic bacteria- even 1 d after insertion. Pediatr Res 2016;80(3):395-400 doi: 10.1038/pr.2016.86
14. Manzoni P, Garcia Sanchez R, Meyer M, et al. Exposure to Gastric Acid Inhibitors Increases the Risk of Infection in Preterm Very Low Birth Weight Infants but Concomitant Administration of Lactoferrin Counteracts This Effect. J Pediatr 2018; 193:62-67 e1 doi: 10.1016/j.jpeds.2017.09.080
15. Santana RNS, Santos VS, Ribeiro-Junior RF, et al. Use of ranitidine is associated with infections in newborns hospitalized in a neonatal intensive care unit: a cohort study. BMC Infect Dis 2017;17(1):375 doi: 10.1186/s12879-017-2482-x
16. Terrin G, Passariello A, De Curtis M, et al. Ranitidine is associated with infections, necrotizing enterocolitis, and fatal outcome in newborns. Pediatrics 2012;129(1): e40-5 doi: 10.1542/peds.2011-0796
17. More K, Athalye-Jape G, Rao S, Patole S. Association of inhibitors of gastric acid secretion and higher incidence of necrotizing enterocolitis in preterm very low-birth-weight infants. Am J Perinatol 2013;30(10):849-56 doi: 10.1055/s-0033-1333671

18. Chamblee TB, Miles DK. A Prospective Study of Family Engagement for Prevention of Central Line-associated Blood Stream Infections. Pediatr Qual Saf 2021;6(5): e467 doi: 10.1097/pq9.0000000000000467
19. Gilbert A, Cartwright CC. Enlisting Parents to Decrease Hospital-Acquired Central Line-Associated Infections in the Pediatric Intensive Care Unit. Crit Care Nurs Clin North Am 2021;33(4):431-40 doi: 10.1016/j.cnc.2021.08.004
20. Lyndon A, Wisner K, Holschuh C, Fagan KM, Franck LS. Parents' Perspectives on Navigating the Work of Speaking Up in the NICU. J Obstet Gynecol Neonatal Nurs 2017;46(5):716-26 doi: 10.1016/j.jogn.2017.06.009
21. Oh Y, Oh KW, Lim G. Routine scrubbing reduced central line associated bloodstream infection in NICU. Am J Infect Control 2020;48(10):1179-83 doi: 10.1016/j.ajic.2020.02.011
22. Bokulich NA, Mills DA, Underwood MA. Surface microbes in the neonatal intensive care unit: changes with routine cleaning and over time. J Clin Microbiol 2013;51(8):2617-24 doi: 10.1128/JCM.00898-13
23. Hung IC, Chang HY, Cheng A, et al. Application of a fluorescent marker with quantitative bioburden methods to assess cleanliness. Infect Control Hosp Epidemiol 2018;39(11):1296-300 doi: 10.1017/ice.2018.222
24. Rock C, Xie A, Andonian J, et al. Evaluation of environmental cleaning of patient rooms: Impact of different fluorescent gel markers. Infect Control Hosp Epidemiol 2019;40(1):100-02 doi: 10.1017/ice.2018.287
25. Lake ET, Hallowell SG, Kutney-Lee A, et al. Higher Quality of Care and Patient Safety Associated with Better NICU Work Environments. J Nurs Care Qual 2016;31(1):24-32 doi: 10.1097/NCQ.0000000000000146
26. Rochefort CM, Clarke SP. Nurses' work environments, care rationing, job outcomes, and quality of care on neonatal units. J Adv Nurs 2010;66(10):2213-24 doi: 10.1111/j.1365-2648.2010. 05376.
27. Cimiotti JP, Haas J, Saiman L, Larson EL. Impact of staffing on bloodstream infections in the neonatal intensive care unit. Arch Pediatr Adolesc Med 2006;160(8):832-6 doi: 10.1001/archpedi.160.8.832
28. Rogowski JA, Staiger D, Patrick T, Horbar J, Kenny M, Lake ET. Nurse staffing and NICU infection rates. JAMA Pediatr 2013;167(5):444-50 doi: 10.1001/jamapediatrics.2013.18
29. Beltempo M, Lacroix G, Cabot M, Blais R, Piedboeuf B. Association of nursing overtime, nurse staffing and unit occupancy with medical incidents and outcomes of very preterm infants. J Perinatol 2018;38(2):175-80 doi: 10.1038/jp.2017.146
30. Lake ET, Staiger D, Edwards EM, Smith JG, Rogowski JA. Nursing Care Disparities in Neonatal Intensive Care Units. Health Serv Res 2018;53 Suppl 1:3007-26 doi: 10.1111/1475-6773.12762
31. Pillay T, Nightingale P, Owen S, Kirby D, Spencer A. Neonatal nurse staffing and delivery of clinical care in the SSBC Newborn Network. Arch Dis Child Fetal Neonatal Ed 2012;97(3): F174-8 doi: 10.1136/adc.2011.300224
32. CDC Recommendations for the Prevention and Control of Infections in Neonatal Intensive Care Unit Patients: Central Line-associated Blood Stream Infections (February 2022)
33. Infant and Pediatric Feedings, Academy of Nutrition and Dietetics; Best Practice for Expressing, Storing, and Handling Human Milk, 2019.
34. Poindexter B, Cummings J, Hand I, et al. Use of probiotics in preterm infants. Pediatrics. 2021;147(6). doi:10.1542/peds.2021-051485

In This Section

IV. Skin Considerations and HAI Prevention

Introduction

The condition of the skin is an important consideration in the prevention of hospital acquired infection; especially for the extremely low birthweight infant as their skin is significantly underdeveloped and provides little protection from the surrounding environment. The burden of infection is inversely related to gestational age with the youngest and most immature infants experiencing a higher incidence of late onset infection.[32, 33]

The skin of premature and full-term neonates has several unique anatomic and functional differences that puts them at risk for injury from the skin disinfectants and medical adhesives used for insertion and securement of central venous catheters in the neonatal population. Although the full-term infant has sufficient barrier function provided by the stratum corneum and basal layer of the epidermis, this layer is not a fully formed compared to older children and adult skin. The dermis is also not fully formed.[1]
The premature infant has fewer layers of the uppermost layer of the

epidermis, the stratum corneum, resulting in increased evaporative heat and water loss. In addition, the entire epidermis is attached to the dermis with proteinaceous fibrils which are fewer in number and more widely spaced in the premature infant, placing them at risk for stripping of the epidermis from adhesive removal and potential chemical burns from skin disinfectants.[2]

Active treatment of infants born at 22-23 weeks increases the need for specific, evidence-based care protocols that reduce skin injury, improve skin barrier function, and reduce hospital acquired infection. [34-37]

POTENTIALLY BETTER PRACTICE

Disinfect skin surfaces before insertion of central venous and arterial catheters including umbilical catheters and percutaneously inserted central catheters (PICCs)

Background, Rationale, and Goals

- Central catheters risk development of hospital acquired bloodstream infections
- Infections arising from insertion and dressing changes are considered an extraluminal source of infection and can be prevented by careful skin preparation with disinfectants
- Infections from an intraluminal source can be prevented by strict adherence to aseptic technique for catheter hubs, caps, connectors, and IV tubing[4]

Outcome, Balancing and Process Measures

- Number of CLABSIs occurring within the first week from insertion (extraluminal course)

POTENTIALLY BETTER PRACTICE

Select a Disinfectant by Evaluating Risks and Benefits of Each Product Relative to Efficacy, Potential for Toxicity, and Skin Irritation

Background, Rationale, and Goals

- Available products include:
  - Chlorhexidine gluconate (CHG), usually mixed with 70% isopropyl alcohol (although an aqueous formulation is also available but not in single use packaging)
  - 10% povidone iodine
  - 70% isopropyl alcohol
- There is insufficient evidence to recommend a single product for all neonates[31]
- Isopropyl alcohol is the least effective disinfection compared to CHG or povidone iodine[5]
- CHG containing disinfectants have been shown to reduce contaminated blood cultures in pediatric patients[6]
- Systemic toxicity can occur if skin disinfectants are absorbed through the skin
- Povidone iodine has been shown to alter thyroid function in some premature infants, although this effect appears to be transient[7,8]
- CHG can also be absorbed, with some studies showing measurable levels of CHG in serum, although no toxicity has been reported at this time[9,10]
- Use of daily CHG wiping or bathing as a method to reduce HAI carries a risk of significant absorption and until it is known whether CHG crosses the blood/brain barrier, this practice has not been determined to be safe in neonates[11]
- Skin irritation, chemical burns or erosive contact dermatitis have been reported from skin disinfectants
- Reports are seen primarily with CHG preparations, generally with those that contain 70% isopropyl alcohol, but some injuries have also been reported with aqueous preparations[12-16]
- Infants born earlier than 32 weeks' gestation who require skin disinfectants in the first two weeks of life are at greatest risk for these skin injuries

Outcome, Balancing and Process Measures

- Report and track any skin injuries from skin disinfectants

POTENTIALLY BETTER PRACTICE

Standardize Dressings and Securement Techniques that Minimize Catheter Migration and Extraluminal Introduction of Microorganisms Along the Tract of the Catheter

Background, Rationale, and Goals

- Transparent adhesive dressings (TADs) allow for direct visualization of the insertion site, are semi-occlusive, and prevent catheter migration, especially when used to secure PICCs
- TADs should be changed when the dressing has lifted/detached on any border edge or within the transparent portion of the dressing[31,38, 39]
- For NICU patients, PICC dressings should be changed when dressing integrity is compromised, since dressing changes can result in catheter migration and cause skin disruption from adhesive removal[40]
- Dressing changes are best done by two people using standardized sterile technique; using a dressing change kit will facilitate the process and save time
- External catheter length measurements are advised to determine if catheter migration has occurred
- If there is bleeding at the insertion site, use a sterile hemostatic agent to promote adherence and prevent catheter migration. If the agent or blood obscures the insertion site, the dressing should be changed after 24 hours.
- Clear tissue adhesives formulated with cyanoacrylates can be applied to the insertion site prior to placement of the TAD. There is a paucity of published research on the use of tissue adhesives in the NICU population. Potential benefits of these products used in adult and pediatric patients include prevention of catheter migration, barrier to microorganisms at the insertion site, and hemostasis. These should be applied with initial dressing application and with dressing changes. [41]

Recommended Guidelines and Algorithms

- Standardize techniques for dressing changes to reduce variability. An example of a PICC dressing standardization visual aid is included under Tools.

Guidance on Quality and Process Improvement

- Audit central venous catheter (CVC) dressings regularly to improve adherence to standardized techniques.

POTENTIALLY BETTER PRACTICE

Use Products and Techniques to Minimize Risk for Medical Adhesive-Related Skin Injury (MARSI)

Background, Rationale, and Goals

- Injuries from medical adhesives include epidermal stripping, skin tears, blistering and contact dermatitis [17-21]
- To prevent skin stripping and skin tears use a silicone, non-alcohol skin protectant under TADs used as dressing for CVCs [22]
- Use a silicone based adhesive remover to facilitate removal of TADs and other medical adhesives [23]
- Avoid the use of adhesive enhancing “tackifiers” as these make the bond between epidermis and adhesive stronger than the bond between epidermis and dermis, increasing the likelihood of epidermal stripping [5]
- Remove TADs and other medical adhesives by pulling the adhesive parallel to the skin surface and gently holding the skin down during removal [5]
- Contact dermatitis can occur with some TAD products. Switching to a different product can resolve contact dermatitis in most cases.[19,21]
- Reduce the number of breaks in the skin from peripheral IV attempts as this may reduce the risk of HAI, especially in preterm infants for which the skin is a clear portal of entry for bacteria. Consider adopting a Difficult Intravenous Access (DIVA) tool or another algorithm to guide practice [42-45]

Guidance on Quality and Process Improvement

- Report all MARSI as unusual occurrences
- Report any MARSI related to CVC securement

POTENTIALLY BETTER PRACTICE

If Skin Injury is Evident and Physical Findings of Skin Infection are Present (Drainage, Redness) in Extremely Low Birthweight (ELBW) Patients with CVCs in the First Weeks of Life, Obtain Skin Culture to Identify Microorganisms that are Colonizing the Skin

Background, Rationale, and Goals

- If pathogens are present, consider sending a blood culture for bacteremia
- Topical antimicrobial and anti-fungal ointments or creams can be used on areas of skin breakdown, along with silicone dressings[5]
- Medical grade honey has anti-infective effects and can facilitate healing of skin breakdown[24-26]
- Dressings containing silver have been used for skin breakdown in premature neonates[27]
- If skin breakdown is excessive and colonized with candida albicans, consider systemic treatment with antifungal agent to prevent bacteremia[28,29]

Guidance on Quality and Process Improvement

- Early identification of microorganisms colonizing the skin may prevent systemic infection or guide antimicrobial selection when suspecting sepsis

Resources and Tools

Tools

The following tools are included in this section:

1. PICC Dressing Change Steps
2. Audit Tool for Dressing Integrity/Changing
3. Difficult Intravenous Access (DIVA) Policy and Pathway Tool

PICC DRESSING CHANGE STEPS

SOURCE: UCSF Benioff Children's Hospital Oakland

DRESSING CHANGE PROCEDURE

- If dressing is intact immediately and *completely* surrounding insertion site (and Biopatch or port needle):
  - It is acceptable to reinforce a non-intact edge with tape (e.g., Medipore H or Multipore Dry)
  - Application of Cavilon barrier film to the skin prior (except with IV Clear) will help with adhesion.
  - Do not add an additional layer of transparent dressing over original dressing. This will trap moisture and may result in skin irritation or breakdown.
- If dressing becomes soiled with emesis, urine, stool or secretions:
  - Clean off visible debris from dressing and surrounding area with dry or saline wipes, followed by CHG.
- Change dressing if it has become non-occlusive, damp or soiled as soon as possible (i.e., within the hour).
- If insertion site or surrounding skin is bleeding, oozing or weeping, change dressing (after being left intact for 2 days since last noted to bleed, ooze or weep).
  - If continues to significantly bleed, apply gauze with transparent dressing, then change every two days.
  - If a more minor bleed/ooze, apply hemostatic agent (e.g., StatSeal), and if dry but at risk for bleeding, consider using SecurePort IV tissue adhesive.

Type of Catheter	Dressing Components	Minimum Dressing Change Frequency
PICC (< 2 mos/48 wks corrected age)	Transparent dressing only	PRN
Tunneled, Non-Tunneled (all pt > 27 weeks GA, > 1000 gms & > 7 days of age) **PICC** (> 2 mos/48 wks corrected age)	Biopatch® and transparent dressing	Every 7 days
Tunneled, Non-Tunneled, PICC (all ages)	Gauze and transparent dressing	Every 2 days
Tunneled, Non-Tunneled, PICC (> 2 mos/48 wks corrected)	Transparent dressing only	Every 7 days
Implanted Vascular Access Port	Transparent dressing	Every 7 days (+ needle change)

AUDIT TOOL FOR DRESSING INTEGRITY/CHANGING

SOURCE: University of California, Irvine (UCI) Health

PICC Dressing Daily Audits

(✓) Dressing intact/per protocol (*) drsg not intact; see comments (education, redressed, not secure, etc.)

June

Pt. Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Totals																															

Comments:

(✓): transparent dressing intact/not lifting

DIFFICULT INTRAVENOUS ACCESS (DIVA) POLICY AND PATHWAY TOOL - PAGE 1

SOURCE: UCSF Benioff Children's Hospital Oakland

TITLE: DIVA (Difficult Intravenous Access)	
BCHO NICU PATIENT CARE STANDARDS	**NICU PROTOCOL**
POLICY OWNER(S): Manager, NICU	**LAST APPROVAL:**
RESPONSIBLE OFFICE: NICU Nursing	**EFFECTIVE DATE:** April 2021
SCOPE: BCHO NICU Registered Nurses (RNs), BCHO Vascular Access Team	

PURPOSE

To outline the NICU Nursing practice of objectively assessing the potential for successfully PIV placement in NICU patients. To reduce the number of potential painful procedures during hospitalization.

LEVEL

Interdependent (*requires provider order)

CRITICAL POINTS

1. Establishing intravenous access in the neonatal population is a challenge for the NICU nurse.
2. Treatment delay, infiltration or inadequate intravenous access may result from the inability to properly assess and place the appropriate access in a patient.
3. These issues may be compounded by such factors as age, underlying disease, and disease chronicity.
4. The DIVA (Difficult Intravenous Access) Scoring system was first introduced to assist nurses in emergency departments to identify and assess patients who may be more difficult to access. It is now a clinically proven tool used to assess difficult intravenous access (DIVA) in both the adult and pediatric populations.

HISTORY of BCHO NICU DIVA Trial

- **Phase I:** To review factors that may predict difficult intravenous access (DIVA) in the neonatal population in the NICU at UCSF Benioff Children's Hospital Oakland and to develop a simple scoring tool that clinically identifies a neonate with difficult intravenous access.
- **Phase II:** Following development and validation of the BCHO Neonate DIVA Scoring Tool, an IV Access Pathway will be developed.
- **Goal:** Implementation of the BCHO Neonate DIVA Scoring Tool will increase the success rate of IV placement by the NICU nurses and decrease the number of venipuncture attempts to the patient.
- **Outcome:** The BCHO NICU DIVA Tool was adapted from the DIVA score studied in pediatric emergency departments. After four months of trialing the DIVA Tool, it proved to be a welcome approach for NICU nurses. Fewer unsuccessful attempts at placing IVs resulted in better neurodevelopmental NICU care and the preservation of veins in NICU patients.

DIFFICULT INTRAVENOUS ACCESS (DIVA) POLICY AND PATHWAY TOOL - PAGE 2

SOURCE: UCSF Benioff Children's Hospital Oakland

PROCEDURE

1. **IV ACCESS REQUIRED**
    a. Establish and confirm the need for PIV access.
2. **CONSIDER ALTERNATIVES to PLACING PIV:**
    a. PO route
    b. NG placement
    c. SQ/IM route
    d. E-PIV
    e. PICC/TCVC
3. **ASSESSMENT**
    a. Previous attempts
    b. Pre-op needs
    c. Length of treatment:
    d. E-PIV(5-7days)
    e. PICC/TCVC (>7 days)
    f. Frequent Blood Draws
    g. Hydration Status
    h. Analgesia Requirements
4. **CALCULATE DIVA SCORE:** Assign 0-2 points per predictor
    a. Visible Vein:
        i. Visible = 0
        ii. Not Visible = 2
    b. Palpable Vein:
        i. Palpable = 0
        ii. Not palpable = 2
    c. Length of Stay:
        i. 0-3 months = 0
        ii. 3-6 months = 1
        iii. >6 months = 2
    d. Current Weight:
        i. <1000 gm = 0
        ii. 1000 - 3000 gm = 1
        iii. >3000 gm = 2

DIFFICULT INTRAVENOUS ACCESS (DIVA) POLICY AND PATHWAY TOOL - PAGE 3

SOURCE: UCSF Benioff Children's Hospital Oakland

5. **TOTAL** the points for EACH of the four predictors:
    a. **DIVA SCORE = 0**
        i. RN **max 2** attempts
        ii. RN Superuser **max 2** attempts
        iii. Notify Neo/NNP & consider alternatives
        iv. Neo/NNP consult V.A.T.
    b. **DIVA SCORE = 1-2**
        i. RN Superuser **#1 max 2** attempts
        ii. RN Superuser **#2 max 2** attempts
        iii. Notify Neo/NNP & consider alternatives
        iv. Neo/NNP consult V.A.T.
    c. **DIVA SCORE ≥3**
        i. RN Superuser assess and considers NO attempts; or **max 2** attempts
        ii. Notify Neo/NNP & consider alternatives
        iii. Neo/NNP consult V.A.T.
6. **PLAN PAIN MANAGEMENT**: consider the following
    a. Oral Sucrose
    b. ELMAX > 6 mo.
    c. Child Life
    d. Procedural Sedation
7. CONSIDER **TOOLS FOR SUCCESS**:
    a. Ultrasound
    b. Vein Finder
    c. Transillumination
    d. Warm compress
    e. Movement
    f. Proper analgesia
    g. Proper sized catheter
8. Consult as indicated:
    a. DIVA Resource Champion
    b. RN PIV Superuser or PICC Inserter
    c. Provider
    d. Member of the Vascular Access Team

DIFFICULT INTRAVENOUS ACCESS (DIVA) POLICY AND PATHWAY TOOL - PAGE 4

SOURCE: UCSF Benioff Children's Hospital Oakland

DOCUMENTATION

- Document the DIVA Score in the IV Sticky Note.

RESOURCES

- **DIVA Resource Champions**:
  - NICU RNs with in depth knowledge of the tool. DIVA Resources participated in the DIVA trial and the education of NICU RNs in the use of the DIVA tool.
  - Vascular Access Team:
    - Lora Johnson, Anna Liang and Nina Rosche.
  - NICU RNs:
    - Kelly Keefe, Victoria Vetterli, Karen Simarro, Alison Gray, Mary Jane Levy, Vernaliza Largaespada, Jaime Croff, Kayla Hawkins, Mayra Gonzalez
- **RN PIV Superusers**:
  - Experienced NICU RNs with demonstrated competence in successfully placing IVs in NICU patients.

REFERENCES

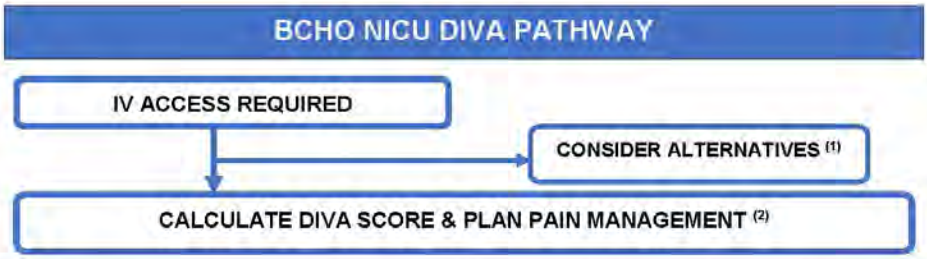
- Addendum: BCHO NICU DIVA PATHWAY
- Riker, M. Validation and Refinement of the Difficult Intravenous Access Score: A Clinical Prediction Rule for Identifying Children with Difficult Intravenous Access. Academic Emergency Medicine. 2011: 18: 1129-1134. https://onlinelibrary.wiley.com/doi/full/10.1111/j.1553-2712.2011.01205.x
- https://cham.org/File%20Library/Global%20Navigation/For%20Health%20Professionals/Clinical%20Pathways/IV-pathway.pdf
- https://www.pediatricnursing.org/article/S0882-5963(17)30338-X/pdf
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4845841/
- https://journals.sagepub.com/doi/pdf/10.5301/jva.5000558
- https://connect.springerpub.com/content/sgrnn/20/5/33.full.pdf
- https://journals.lww.com/advancesinneonatalcare/FullText/2014/12000/Peripheral_Intravenous_and_Central_Catheter.13.aspx

PROTOCOL HISTORY

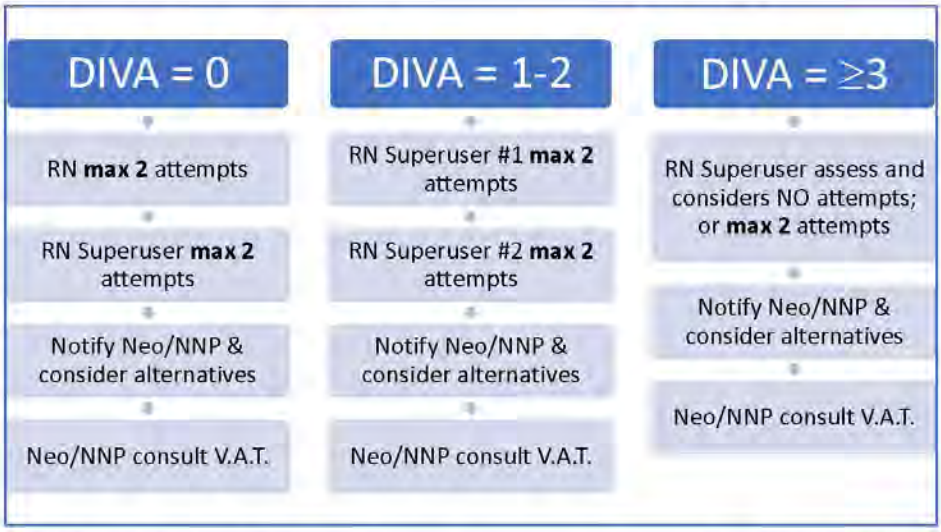
Originated/Approved:	Pam Koch RNIII & Vascular Access Team January 2021
Revised:	
Next Revision:	
Author:	Pam Koch RNIII & Lora Johnson PNP
Distribution:	NICU Nursing
Revision History:	

DIFFICULT INTRAVENOUS ACCESS (DIVA) POLICY AND PATHWAY TOOL - PAGE 5

SOURCE: UCSF Benioff Children's Hospital Oakland



Predictor	0 Points	1 Point	2 Points
Visible Vein	Visible	-	Not Visible
Palpable Vein	Palpable	-	Not Palpable
Length of Stay	0-3 months	3-6 months	> 6 months
Current Weight	<1000 gm	1000-3000 gm	>3000 gm
Total the points for EACH of the four predictors.		***DIVA SCORE =***	



(1) CONSIDER ALTERNATIVES	(2) PAIN MANAGEMENT	ASSESSMENT	TOOLS FOR SUCCESS

• PO route
• NG placement
• SQ/IM route
• E-PIV
• PICC/TCVC
	• Oral Sucrose
	• ELMAX > 6 mo.
	• Child Life
	• Procedural Sedation
		• DIVA Score
		• Previous attempts
		• Pre-op needs
		• Length of treatment:
		  ○ E-PIV(5-7days)
		  ○ PICC/TCVC (>7 days)
		• Frequent Blood Draws
		• Hydration Status
		• Analgesia Requirements
			• Ultrasound
			• Vein Finder
			• Transillumination
			• Warm compress
			• Movement
			• Proper analgesia
			• Proper sized catheter

** Adapted From: Riker, M. Validation and Refinement of the Difficult Intravenous Access Score. A Clinical Prediction Rule for Identifying Children with Difficult Intravenous Access. Academic Emergency Medicine. 2011:18: 1129-1134 and Children's Hospital at Montefiore IV Access Pathway*

BCHO NICU DIVA PROTOCOL

References

1. Stamatas, G., Nikolovski, J, Luedtke, M, Kollias, N & Wiegand, B. (201) Infant skin microstructure assessed in vivo differs from adult skin in organization and at the cellular level. Pediatric Dermatology, 27, 125-131. https://doi.org/10.1111 /j.1525-1470.2009.00973.
2. Holbrook, K. (1982). A histological comparison of infant and adult skin. In H. I. Maibach & K. Boisits (Eds.), Neonatal skin: Structure and function (1st ed., pp. 3-31). New York: Marcel and Dekker.
3. Sathiyamurthy, S., Banerjee, J., & Godambe, S. V. (2016). Antiseptic use in the neonatal intensive care unit—A dilemma in clinical practice: An evidence-based review. World Journal of Clinical Pediatrics, 5, 159–171. https://doi.org/10.5409/wjcp.v5.i2.159
4. Mermel, L. A. (2011). What is the predominant source of intravascular catheter infections? Clinical Infectious Diseases, 52, 211–212. https://doi.org/10.1093/cid/ciq108
5. AWHONN (2018). Neonatal Skin Care: Evidence-based clinical practice guideline.
6. Nuntnarumit, P., & Sangsuksawang, N. (2013). A randomized controlled trial of 1% aqueous chlorhexidine gluconate compared with 10% povidone-iodine for topical antiseptic in neonates: Effects on blood culture contamination rates. Infection Control and Hospital Epidemiology, 34, 430–432. https://doi.org/10.1086/669863
7. Aitken, J., & Williams, F. L. R. (2014). A systematic review of thyroid dysfunction in preterm neonates exposed to topical iodine. Archives of Disease in Childhood: Fetal &Neonatal Edition, 99(1), F21–F28. https://doi.org/10.1136/archdischild-2013-303799
8. Kieran, E. A., O'Sullivan, A., Miletin, J., Twomey, A. R., Knowles, S. J., & O'Donnell, C. P. F. (2018). 2% chlorhexidine–70% isopropyl alcohol versus 10% povidone–iodine for insertion site cleaning before central line insertion in preterm infants: a randomised trial. Archives of Disease in Childhood - Fetal and Neonatal Edition, 103(2), F101. https://doi.org/10.1136/archdischild-2016-312193
9. Chapman, A. K., Aucott, S. W., & Milstone, A. M. (2012). Safety of chlorhexidine gluconate used for skin antisepsis in the preterm infant. Journal of Perinatology, 32, 4–9. https://doi.org/10.1038/jp.2011.148
10. Garland, J. S., Alex, C. P., Uhing, M. R., Peterside, I. E., Rentz, A., & Harris, M. C. (2009). Pilot trial to compare tolerance of chlorhexidine gluconate to povidone-iodine antisepsis for central venous catheter placement in neonates. Journal of Perinatology, 29, 808–813. https://doi.org/10.1038/jp.2009.161
11. Milstone, A. M., Bamford, P., Aucott, S. W., Tang, N., White, K. R., & Bearer, C. F. (2014). Chlorhexidine inhibits L1 cell adhesion molecule-mediated neurite outgrowth in vitro. Pediatric Research, 75, 8–13. https://doi.org/10.1038/pr.2013.175
12. Beresford, D. (2015). MHRA report chlorhexidine solutions: Risk of chemical burn injury to skin in premature infants. Journal of Neonatal Nursing, 21, 47–49. https://doi.org/10.1016/j.jnn.2015.02.002
13. Bringué Espuny, X., Soria, X., Solé, E., Garcia, J., Marco, J. J., Ortega, J., … Pueyo, A. (2010). Chlorhexidine-methanol burns in two extreme preterm newborns. Pediatric Dermatology, 27, 676–678.
14. Kutsch, J., & Ottinger, D. (2014). Neonatal skin and chlorhexidine: A burning experience. Neonatal Network, 33, 19–23. https://doi.org/10.1891/0730-0832.33.1.19
15. Lashkari, H. P., Chow, P., & Godambe, S. (2012). Aqueous 2% chlorhexidine-induced chemical burns in an extremely premature infant. Archives of Disease in Childhood: Fetal and Neonatal Edition, 97, F64. doi:10.1136/adc.2011.215145
16. Neri, I., Ravaioli, G. M., Faldella, G., Capretti, M. G., Arcuri, S., Patrizi, A. (2017). Chlorhexidine gluconate-induced chemical burns in very low birth weight infants. Journal of Pediatrics, 191, 262-265.e2. doi: 10.1016/j.jpeds.2017.08.002
17. Dykes, P. J. (2007). The effect of adhesive dressing edges on cutaneous irritancy and skin barrier function. Journal of Wound Care, 16, 97–100.

18. Lund, C. H., Nonato, L. B., Kuller, J. M., Franck, L. S., Cullander, C., & Durand, D. J. (1997). Disruption of barrier function in neonatal skin associated with adhesive removal. Journal of Pediatrics, 131, 367–372.
19. McNichol, L., Lund, C., Rosen, T., & Gray, M. (2013). Medical adhesives and patient safety: State of the science. Journal of Wound, Ostomy and Continence Nursing, 40, 365–380. https://doi.org/10.1097/WON.0b013e3182995516
20. Breternitz, M., Flach, M., Prässler, J., Elsner, P., & Fluhr, J. W. (2007). Acute barrier disruption by adhesive tapes is influenced by pressure, time, and anatomical location: integrity and cohesion assessed by sequential tape stripping. A randomized, controlled study. British Journal of Dermatology, 156, 231–240. https://doi.org/10.1111/j.1365-2133.2006.07632.x
21. Broadhurst, D, Moureau, N, & Ullman, A. (2017). Management of central venous access device-associated skin impairment. J Wound Ostomy Continence Nurs. 43, 211-220. Doi: 10.1097/WON.0000000000000322.
22. Irving, V. (2001). Reducing the risk of epidermal stripping in the neonatal population: An evaluation of an alcohol-free barrier film. Journal of Neonatal Nursing, 7, 5–8.
23. Denyer, J. (2011). Reducing pain during the removal of adhesive and adherent products. British Journal of Nursing, 20, S28, S30–S35. https://doi.org/10.12968/bjon.2011.20.Sup8.S28
24. Amaya, R. (2015). Safety and efficacy of active Leptospermum honey in neonatal and paediatric wound debridement. Journal of Wound Care, 24, 95–103.
25. Boyar, V., Handa, D., Clemens, K., & Shimborske, D. (2014). Clinical experience with Leptospermum honey uses for treatment of hard to heal neonatal wounds: Case series. Journal of Perinatology, 34, 161–163. https://doi.org/10.1038/jp.2013.158
26. Esser, M. (2017). Leptospermum honey for wound care in an extremely premature infant. Advances in Neonatal Care, 17, 27–32. https://doi.org/10.1097/ANC.0000000000000331
27. August, D. L., Ireland, S., & Benton, J. (2015). Silver-based dressing in an extremely low-birth-weight infant: A case study. Journal of Wound, Ostomy, and Continence Nursing, 42: 290–293.
28. Darmstadt, G., Dinulos, J., & Miller, Z. (2000). Congenital cutaneous candidiasis: Clinical presentation, pathogenesis, and management guidelines. Pediatrics, 105, 438–444.
29. Kaufman, D. (2003). Strategies for prevention of neonatal invasive candidiasis. Seminars in Perinatology, 27, 414–424.
30. Van Rens M, Abdelghafar N, Nimeri N, Spencer T, et. al. (2022). Cyanoacrylate Securement in Neonatal PICC Use: A 4-Year Observational Study. Adv Neonatal Care, 22(3), 270-279.
31. Muller, et. Al, 2022, NICU white paper series: Practical approaches for the prevention of CLABSI, Infection Control & Hospital Epidemiology.
32. Paul AA, Hoffman KL, Hagan JL, Sampath V, Petrosino JF, Pammi M. Fungal cutaneous microbiome and host determinants in preterm and term neonates. Pediatric Research. 2019;88(2):225-233. doi:10.1038/s41390-019-0719-7
33. Shane AL, Sánchez PJ, Stoll BJ. Neonatal sepsis. The Lancet. 2017;390(10104):1770-1780. doi:10.1016/s0140-6736(17)31002-4
34. Mehler K, Oberthuer A, Keller T, et al. Survival among infants born at 22- or 23-weeks' gestation following active prenatal and postnatal care. JAMA Pediatrics. 2016;170(7):671. doi:10.1001/jamapediatrics.2016.0207
35. Mahgoub L, van Manen M, Byrne P, Tyebkhan JM. Policy change for infants born at the "cusp of viability": A Canadian NICU experience. Pediatrics. 2014;134(5). doi:10.1542/peds.2014-0904
36. Ishii N, Kono Y, Yonemoto N, Kusuda S, Fujimura M. Outcomes of infants born at 22- and 23-weeks' gestation. Pediatrics. 2013;132(1):62-71. doi:10.1542/peds.2012-2857
37. Rysavy MA, Mehler K, Oberthür A, et al. An immature science: Intensive care for infants born at ≤23 weeks of gestation. The Journal of Pediatrics. 2021;233. doi: 10.1016/j.jpeds.2021.03.006
38. 2021 Infusion Therapy Standards of Practice Updates. Journal of Infusion Nursing. 2021;44(4):189-190. doi:10.1097/nan.0000000000000436

39. Bryant K.; 2022. https://www.cdc.gov/infectioncontrol/guidelines/nicu-clabsi/index.html#print. Accessed September 2022.
40. Gorski LA, Hadaway L, Hagle ME, et al. Infusion therapy standards of practice, 8th edition. Journal of Infusion Nursing. 2021;44(1S). doi:10.1097/nan.0000000000000396
41. Kleidon TM, Ullman AJ, Gibson V, et al. A pilot randomized controlled trial of novel dressing and Securement techniques in 101 pediatric patients. Journal of Vascular and Interventional Radiology. 2017;28(11). doi: 10.1016/j.jvir.2017.07.012
42. Riker MW, Kennedy C, Winfrey BS, Yen K, Dowd MD. Validation, and refinement of the difficult intravenous access score: A clinical prediction rule for identifying children with difficult intravenous access. Academic Emergency Medicine. 2011;18(11):1129-1134. doi:10.1111/j.1553-2712.2011. 01205.x
43. Schults J, Rickard C, Kleidon T, Paterson R, Macfarlane F, Ullman A. Difficult peripheral venous access in children: An international survey and critical appraisal of assessment tools and escalation pathways. Journal of Nursing Scholarship. 2019;51(5):537-546. doi:10.1111/jnu.12505
44. Kleidon TM, Cattanach P, Mihala G, Ullman AJ. Implementation of a paediatric peripheral intravenous catheter care bundle: A Quality Improvement initiative. Journal of Paediatrics and Child Health. 2019;55(10):1214-1223. doi:10.1111/jpc.14384
45. Wilder KA, Kuehn SC, Moore JE. Peripheral intravenous and central catheter algorithm. Advances in Neonatal Care. 2014;14(6). doi:10.1097/anc.0000000000000125

In This Section

V. Antibiotic Stewardship and Preventing/Reducing Multidrug Resistant Organisms

Introduction to Antibiotic Stewardship

Antimicrobial stewardship efforts aim at optimizing use of antimicrobials by improving selection, dose, duration, and route of administration of antimicrobials.[1] It is important to recognize that the role of antimicrobial stewardship efforts is not always to discontinue antimicrobials, but to optimize their use weighing risks and benefits. Diagnostic stewardship means optimizing selection of the appropriate test for the appropriate patient that would improve management, including antimicrobial selection.[2,3] Antimicrobial and diagnostic stewardship and infection prevention complement each other. Prolonged and broad-spectrum antibiotic exposure is associated with increased risk of invasive candidiasis and infection with multidrug resistant bacteria in neonates.[4,5] Newborns, especially preterm newborns, are at high risk for infection, and antibiotics are the most commonly prescribed medications in the NICU;[6] Applying diagnostic stewardship to diagnose and treat hospital acquired infections improves accuracy of surveillance of these infections and use of appropriate therapy

when indicated. Lastly, antibiotic use has been found, in observational studies, to be associated with worse outcomes in extremely low birth weight infants including increased incidence of necrotizing enterocolitis and death.[7, 31, 32]

POTENTIALLY BETTER PRACTICE

Establish a Multidisciplinary Collaborative Approach to Diagnostic and Antimicrobial Stewardship

Background, Rationale, and Goals

- Creating a culture change in antimicrobial and diagnostic stewardship is important.[8]
- Empowering stewardship leadership style which is inclusive and enabling of frontline clinicians, compared to a controlling and supervision-driven style, results in decreased broad-spectrum antimicrobial use and decreased hospital acquired infections in the NICU and pediatric ICU (PICU).[9]
- Nursing involvement in stewardship efforts in critical care settings is essential and underutilized.10 The role of nurses in stewardship is likely more critical in NICU settings given nurses' distinct involvement in the direct care of neonates.[33]

Recommended Guidelines and Algorithms

- A multidisciplinary stewardship team involves representation from advanced practice providers, nurses, pharmacists and physicians[11]
- Multidisciplinary team members update colleagues on new policies and guidance and encourage adoption of stewardship practices and interventions
- Identify a team leader who is accountable for NICU outcome measures relating to stewardship efforts
- Multidisciplinary interventions may include the following:[11]
  - **Antimicrobial time-out**: Facilitate an antibiotic time-out during rounds. This includes revisiting the indication, choice, and duration of antimicrobials at a specific interval after initiating therapy.
  - **Assuring appropriate diagnostics**: Examples include obtaining blood cultures before empiric antibiotic therapy is started, and obtaining sterile urine samples for cultures

Guidance on Quality and Process Improvement

- Identify "stewardship champions" from each of the following disciplines: nursing, pharmacy, advanced practice providers and physicians
- Conduct meetings involving the multidisciplinary stewardship team at regular intervals to discuss stewardship outcome measures, opportunities for improvement, and future directions
- Create an Antibiotic Utilization Review Committee to review selected cases (criteria may be prolonged antibiotics or broad-spectrum antibiotics, as examples) as a methodology to learn from patient cases

Outcome, Balancing and Process Measures

- Administration of antibiotics within one hour after the order is placed

POTENTIALLY BETTER PRACTICE

Measure the Effectivness of Diagnostic and Antimicrobial Efforts in the NICU

Background, Rationale, and Goals

- Antimicrobial use is variable among California NICUs independent of proven infection[12]
- Measuring the success of diagnostic and antimicrobial stewardship could be achieved by tracking antimicrobial use as well as safety and quality metrics
- Measuring antimicrobial use is important not only to evaluate the present state of antimicrobial use in comparison to peers and the success of diagnostic and stewardship efforts, but also to discover potential areas of improvement
- All California Children's Services approved NICUs are required to report antimicrobial use rate (AUR) to CPQCC [12]
- All participating CPQCC NICUs are required to report newborn antibiotic exposure (NAE), NEC, and late-onset-sepsis[13]
- Days of therapy (DOT) per 1000 patient days is another measure of antimicrobial use that is widely utilized in pediatrics[14]

Recommended Guidelines and Algorithms

- Measure at least one metric of antimicrobial use, such as AUR, NAE and/or DOT and post data for all healthcare providers to view
- Compare antimicrobial use metric to other NICUs of similar size and level of care
- Measure and follow the specific antimicrobial use of high-impact antimicrobials. This could include broad-spectrum, nephrotoxic, or high-cost antimicrobials.
- Compare antimicrobial use metric over time to determine the effectiveness of a targeted diagnostic or antimicrobial stewardship effort
- Consider measuring quality metrics that could potentially be affected by stewardship efforts such as nosocomial infections with multidrug resistant organisms,[15] acute kidney injury,[16] or NEC[7,17]
- Evaluate safety outcomes and balancing measures related to diagnostic or antimicrobial stewardship efforts such as mortality from newborn sepsis, hospital readmission and rate of restarting antimicrobials[17]

Outcome, Balancing and Process Measures

- AUR is the total number of patient-days that infants were exposed to one or more antibacterial or antifungal agents (antivirals are not included) administered intravenously or intramuscularly per 100 patient-days in the reporting NICU, expressed as a percentage[12,13]
- NAE is the number of newborns who received at least one dose of intravenous or intramuscular antibacterial or antifungal agents per 100 newborns. Both the numerator and denominator include all admitted newborns after maternal delivery, including those born outside the hospital but who received their initial medical evaluation at the hospital in question and newborns taken care of in mother/baby units[13]
- DOT per 1000 patient days is the number of days a patient receives a certain antimicrobial, or a group of antimicrobials divided by the number of hospital days. The numerator usually captures each antibiotic separately; for example, if a patient receives ampicillin and gentamicin for 7 days, she will have 14 DOTs. The denominator usually captures the census of a given population (for example: neonates) at 23:59.[14]
- Other safety and quality metrics may be related to diagnostic and antimicrobial stewardship efforts include: multidrug resistant nosocomial infections,[15] NEC rates,[7] hospital readmissions, rate of fungal late-onset sepsis, rate of restarting antimicrobials, mortality from newborn sepsis and episodes of acute kidney injury associated with nephrotoxic antimicrobials[16,18,19]

POTENTIALLY BETTER PRACTICE

Develop Antimicrobial and Diagnostic Stewardship Interventions

Background, Rationale, and Goals

- Consider multiple interventions to improve appropriate use of diagnostics and antimicrobials.[14,20] These interventions may include antimicrobial restriction, audits and feedback, provider education, optimizing diagnostics, development of clinical pathways, infection prevention efforts and antibiotic time-outs and automatic stop orders.[3,14,20,21]

Recommended Guidelines and Algorithms

- Define goals and opportunities for improvement by reviewing NICU-specific antimicrobials as compared to NICUs of similar size, at least annually
- Goals include optimizing antimicrobial use of a specific broad-spectrum or toxic antimicrobial, optimizing antimicrobial use for a specific indication, gestational age groups (example: >35 weeks) or timing of neonatal sepsis (early-onset or late-onset), or general reduction in antimicrobial use
- Consider prospective audits and feedback whenever resources are available[14,22,23]
- Consider preauthorization for targeting specific broad-spectrum, highly toxic and/or excessively used antimicrobials[14]
- Establish diagnostic criteria or guidelines when there are concerns for over diagnosis of a specific infection based on the rate of this infection in comparison to other NICUs[3,21]
- Establish treatment guidelines if there are concerns for prolonged treatment of specific diagnoses[17]
- Implement provider education as an adjunctive measure to other interventions[14,22,24]

Outcome, Balancing and Process Measures

- AUR and NAE in comparison to other NICUs within CPQCC

- DOT per 1000 patient days for specific antimicrobials or diagnoses
- NEC, ventilator associated pneumonia, CLABSI, urinary tract infection and coagulase negative *Staphylococcus* infection rates

POTENTIALLY BETTER PRACTICE

Develop Clinical Pathways and Guidelines for Common Neonatal Infections

Background, Rationale, and Goals

- Developing clinical pathways and guidelines is an effective strategy for improving diagnostic and antimicrobial stewardship[24–26]
- Clinical guidelines provide consistency in clinical practice, which might improve communication among medical providers and between medical providers and families. Consistency in clinical practice could also help detect adverse outcomes when care deviates from specific guidelines or practices.
- Higher blood volumes obtained for blood culture correlate with higher sensitivity and lower contamination rates[27]

Recommended Guidelines and Algorithms

- Develop unit-specific diagnosis and treatment guidelines to help standardize the approach to:
  - Early onset infection in the term and preterm infant
  - Late onset infection
  - Necrotizing enterocolitis
  - Culture negative sepsis and pneumonia[17]
  - Ventilator associated pneumonia[21]
  - Urinary tract infection
- Develop perioperative prophylaxis antibiotic guidelines specific to the NICU to reduce variability in prophylactic antibiotic choice and duration[28]
- Adopt a standardized blood culture process, including minimum blood volume for blood culture of **at least** 1 ml[3,27]
- Avoid routine endotracheal aspirate cultures to rule out sepsis when ventilator associated lower respiratory infection is not suspected based on other clinical considerations[21,29,30]
- Avoid a diagnosis of ventilator associated pneumonia (VAP) based on endotracheal aspirate cultures. Rather, use endotracheal aspirate culture results to support the diagnosis of VAP in inconclusive cases or to guide antimicrobial therapy for diagnosed VAP based on clinical and imaging criteria.[21,29,30]
- Use vancomycin for empiric antibiotic coverage for late onset sepsis only if methicillin resistant *Staphylococcus aureus* (MRSA) infection rates are high[3,24]
- Monitor blood culture contamination data and develop standardized approach to blood culture collection techniques[34-36]

Outcome, Balancing and Process Measures

- Compliance with unit-specific diagnosis and treatment guidelines
- Possible balancing measures could include mortality, surgical site infection, recurrent infection, or restarting antimicrobials

Introduction to Multidrug Resistant Organisms

Multidrug resistant organisms (MDROs) are microorganisms that are resistant to one or more antimicrobials.[1] Although most of these organisms are bacteria, including MRSA, vancomycin resistant Enterococcus (VRE), and multi-drug resistant gram-negative rods (MDR-GNR), they also include fungi such as *Candida auris*.[2] The causes of antimicrobial resistance, and the resultant spread of MDROs, are complex, but include increased antimicrobial use in the care of people, animals and crops.[3,4] MDROs cause more than 2.8 million infections and more than 35,000 deaths in the United States each year.[3] Further, MDROs can cause outbreaks in the NICU, resulting in significantly increased length of stay and cost of care.[5] *Staphylococcus aureus* outbreaks in the NICU are common and it is imperative that NICUs take precautions and develop policies to prevent spread.[20]

POTENTIALLY BETTER PRACTICE

Implement Measures to Recognize and Prevent Staphylococcus Aureus Infection in the NICU, Including Methicillin Resistant Staphylococcus Aureus (MRSA)

Background, Rationale, and Goals

- MRSA is *Staphylococcus aureus* with resistance to methicillin and other anti-staphylococcal penicillins due to a change in the structure of the penicillin binding receptor
- There are controversies and variations in practice regarding the requirement for MRSA screening upon admission for inborn NICU patients[6]
- Studies evaluating decolonization protocols for *Staphylococcus aureus* have mixed results for decreasing infection and colonization with *Staphylococcus aureus*.[7,8]
- It is likely that no one standalone intervention will decrease infection and colonization with *Staphylococcus aureus*; rather, a multi-intervention bundle, including ensuring compliance with basic and standard infection prevention practices, is required[9,10]

Recommended Guidelines and Algorithms

- There is no specific standard or guideline for frequency of active or periodic surveillance for *Staphylococcus aureus* if the rate of *Staphylococcus aureus* infection is low[21]
- NICU patients colonized with MRSA have an increased risk of developing MRSA infection and decolonization may reduce this risk. However, an optimal decolonization protocol for NICU patients has not been identified.[9, 22] Routine decolonization or active periodic surveillance for *Staphylococcus aureus* in non-outbreak settings is not recommended.[9]
- Recommendations for contact precautions on all neonates who are colonized with MRSA without evidence of infection are mixed.[11] However, these measures are commonly used as a part of a multi-intervention strategy to control healthcare associated MRSA transmission, during MRSA outbreaks, and especially in high-risk settings such as the NICU.[1,9,19, 22, 23]
- High levels of hand hygiene compliance may not be enough to stop the spread of MRSA; additional complimentary precautions such as cohorting, contact isolation, and decolonization are needed.[23, 24]
- Implement contact precautions for neonates with MRSA infection
- Other interventions recommended in cases of *Staphylococcus aureus* outbreaks or high infection rate:[7,9,19]
  - Focused hand hygiene interventions to assure and improve compliance
  - Cleaning and disinfection of NICU common areas and development of an ongoing cleaning protocol of high touch/common areas and equipment performed by NICU staff and/or combination of technicians and staff
  - Dedicated single-patient equipment (e.g., thermometer, blood pressure machine, mobile computer, diaper scale, etc.)
  - Contact precautions for neonates colonized with MRSA
  - Active surveillance of all NICU patients, consider weekly throughout hospitalization19
  - Decolonization of *Staphylococcus aureus* or, more specifically, MRSA
  - Staff cohorting and changing staffing ratios
  - Staff screening and decolonization may be considered; staff with chronic skin conditions may need special attention as they may continue to harbor S. aureus[24]
- If decolonization is used, mupirocin ointment, two nasal applications daily for five days, and selected patient bathing with chlorhexidine may be cautiously considered, based upon patient's risk of MRSA invasive disease.[7,8, 9, 19]
- Inform local public health partners of MRSA outbreaks and use their expertise for case identification and infection control

Outcome, Balancing and Process Measures

- Rate of MRSA colonization per admission or, if periodic screening is performed for outbreaks, over time per 1000 patient days
- Rate of *Staphylococcus aureus* and, more specifically, MRSA infections. This could be categorized by infection site such as bloodstream and skin and soft tissue infections.[7]

POTENTIALLY BETTER PRACTICE

Take Measures to Identify and Control Multidrug Resistant Gram-Negative Rods

Background, Rationale, and Goals

- Multidrug resistant Gram-negative rods (MDR-GNR) are a broad group of bacteria that includes, extended spectrum beta-lactamase producing Enterobacterales (ESBL-E), carbapenem resistant Enterobacterales (CRE), and other Gram negative bacteria that have inherent or acquired resistance to multiple classes of antibiotics[1]
- MDR-GNR infections are difficult to treat and associated with high morbidity and mortality[3]
- ESBL-E are ubiquitous and increasing in prevalence in the community and healthcare settings.[12,13] They are known to cause outbreaks in the NICU.[14]
- The role of surveillance and contact precautions for ESBL-E is controversial[13,15–17]

Recommended Guidelines and Algorithms

- For identification, define the different groups of MDR-GNR as follows:
  - **ESBL-E:** Enterobacterales resistant to at least one third generation cephalosporin[18]
  - **CRE:** Enterobacterales that are resistant to at least one carbapenem or producing a carbapenemase enzyme[18]
  - ***Burkholderia cepacia, Stenotrophomonas***

maltophilia,* and *Ralstonia pickettii are inherently resistant to broad antibiotics and are thus all considered MDROs[1]
    - **Other MDR-GNR such as *Acinetobacter baumannii*, *Pseudomonas aeruginosa* and Enterobacterales** that do not meet the above criteria: definition is variable between institutions depending on infection prevention and control policies
- Follow hospital policy regarding screening and contact precautions for ESBL-E. Controversies exist regarding optimal interventions to prevent the spread of ESBL-E.[13,15–17] These interventions should be reserved to outbreak settings given the high prevalence of ESBL-E as commensals,[12] and that evidence for surveillance and isolation comes from quasi-experimental studies which are inherently biased.[13]
- Contact precautions are recommended for all other MDR-GNRs as well as relying on the local infection prevention and control team for duration of isolation
- Inform the local public health partners of MDR-GNRs outbreaks and use their expertise for case identification and infection control

Guidance on Quality and Process Improvement

- Develop and implement a NICU-specific MDRO policy that outlines care practices including isolation requirements, treatment guidelines, and family activities
- Assure hospital systems are in place to identify and flag cultures that are positive for MDR-GNRs
- Review all infections due to MDR-GNRs to identify potential trends and commonalities
- In outbreak settings, review compliance with surveillance and control measures

Resources and Tools

Tools

The following tools are included in this section:

1. Obtaining a Blood Culture Checklist
2. Early-Onset Sepsis (EOS) and Late-Onset Sepsis (LOS) Algorithms
3. Antibiotic Time Out Sheet

OBTAINING A BLOOD CULTURE CHECKLIST - PAGE 1

SOURCE: University of California, Irvine (UCI) Health

UCI Health

Blood Culture Checklist

Peripheral Blood Culture

Obtain Supplies

23-25 gauge butterfly (depending upon size of patient)	alcohol prep pad	White chux (to protect from bed linens)
blood culture bottle and transfer device	Exidine (CHG) skin prep	sterile gloves
3-5 ml syringe (depends upon volume of other labs)	sterile 2X2	normal saline wipe

Steps

1	Verify MD Order	
2	Obtain oral sucrose for pain	
3	Check expiration on blood culture bottle	
4	Verify correct patient identification by comparing blood culture order to patient's medical record number and name on patient band	
5	Cleanse overbed table with disinfectant	
7	Open all sterile supplies using cleansed overbed table as work surface; pour small amount of Exidine onto sterile 2X2	
8	Wash hands and immobilize patient; protect eyes from exam light; obtain assistance (this is a two-person procedure)	
9	Place white chux underneath extremity to prevent contamination from bed linens	
10	Wash hands again	
11	Using sterile gloves, connect syringe to end of butterfly. Prep skin using sterile 2X2 with Exidine; apply using a forward, backwards and side to side cleaning motion. Allow to dry for 30 seconds.	
12	Perform venipuncture (or arterial stick); **obtain 1 mL for blood culture for ALL infants**	
13	After obtaining the sample, activate the safety needle device.	
14	Prior to inoculation, scrub top of blood culture bottle with alcohol wipe prior to transferring blood into blood culture bottle	
15	Hand syringe to assistant to inoculate blood into blood culture bottle.	
16	Transfer blood culture specimen to blood culture bottle using the blood transfer device	
17	Cleanse skin area with NS wipe to remove Exidine	
18	Dispose of all sharps in sharps container	
19	Gently invert bottle 2-3 times	
20	Label culture bottle using electronic lab collection system (Rhodes); alternatively, if electronic labeling system unavailable, label with patient sticker and note on sticker if collection site is peripheral or central and send with transmittal	
21	Document lab draw in EMR	

Place white chux underneath site to protect from contamination; cleanse using Exidine and allow area to dry before performing collection.

Connect the syringe to the end of the butterfly tubing to reduce contamination during sampling

After scrubbing the top of the blood culture bottle with alcohol swab, use the blood transfer device to inoculate the blood culture bottle

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OBTAINING A BLOOD CULTURE CHECKLIST - PAGE 2

SOURCE: University of California, Irvine (UCI) Health

UCI Health

Blood Culture Checklist

Central Line Blood Culture (PICC/Broviac)

Note: blood culture samples are not routinely drawn from umbilical lines as part of a late onset sepsis work-up; only use umbilical line for blood culture when the umbilical line is immediately placed

Obtain Supplies

Sterile Gloves	Alcohol prep pad X2	White chux (to protect from bed linens)
Blood culture bottle and transfer device	3-5 ml syringe	

Steps

1	Verify MD Order	
2	Check expiration on blood culture bottle	
3	Verify correct patient identification by comparing blood culture order to patient's medical record number and name on patient band	
4	Cleanse overbed table with disinfectant	
5	Open all sterile supplies using cleansed overbed table as work surface	
7	Turn IV pump to stand-by	
8	Place white chux underneath extremity or connection of clave to IV tubing to prevent contamination from bed linens	
9	Wash hands again	
10	Don sterile gloves: scrub the tubing vigorously with alcohol pad where the clave attaches to the main IV tubing; this is the area that will be disconnected (disconnect the IV tubing at the clave; do not remove clave to draw blood); scrub for 30 seconds.	
11	Disconnect IV tubing keeping IV tubing end protected (hand to assistant) and scrub end of clave with alcohol vigorously for 30 seconds. Assure the end of the IV tubing remains protected and sterile.	
12	Attach syringe to clave and withdraw 1 ml (no discard needed for any central line)	
13	Prior to inoculation, scrub top of blood culture bottle with alcohol wipe prior to transferring blood into blood culture bottle	
14	Hand syringe to assistant to inoculate blood into blood culture bottle.	
	Re-connect IV tubing to clave; no flush is required to the central line (PICC/Broviac) unless line is heparin locked. If heparin locked, flush line per MD order.	
15	Gently invert bottle 2-3 times	
16	Label culture bottle using electronic lab collection system (Rhodes); alternatively, if electronic labeling system unavailable, label with patient sticker and note on sticker if collection site is peripheral or central and send with transmittal	
17	Restart IV pump	
18	Document lab draw in EMR	
19		
20		

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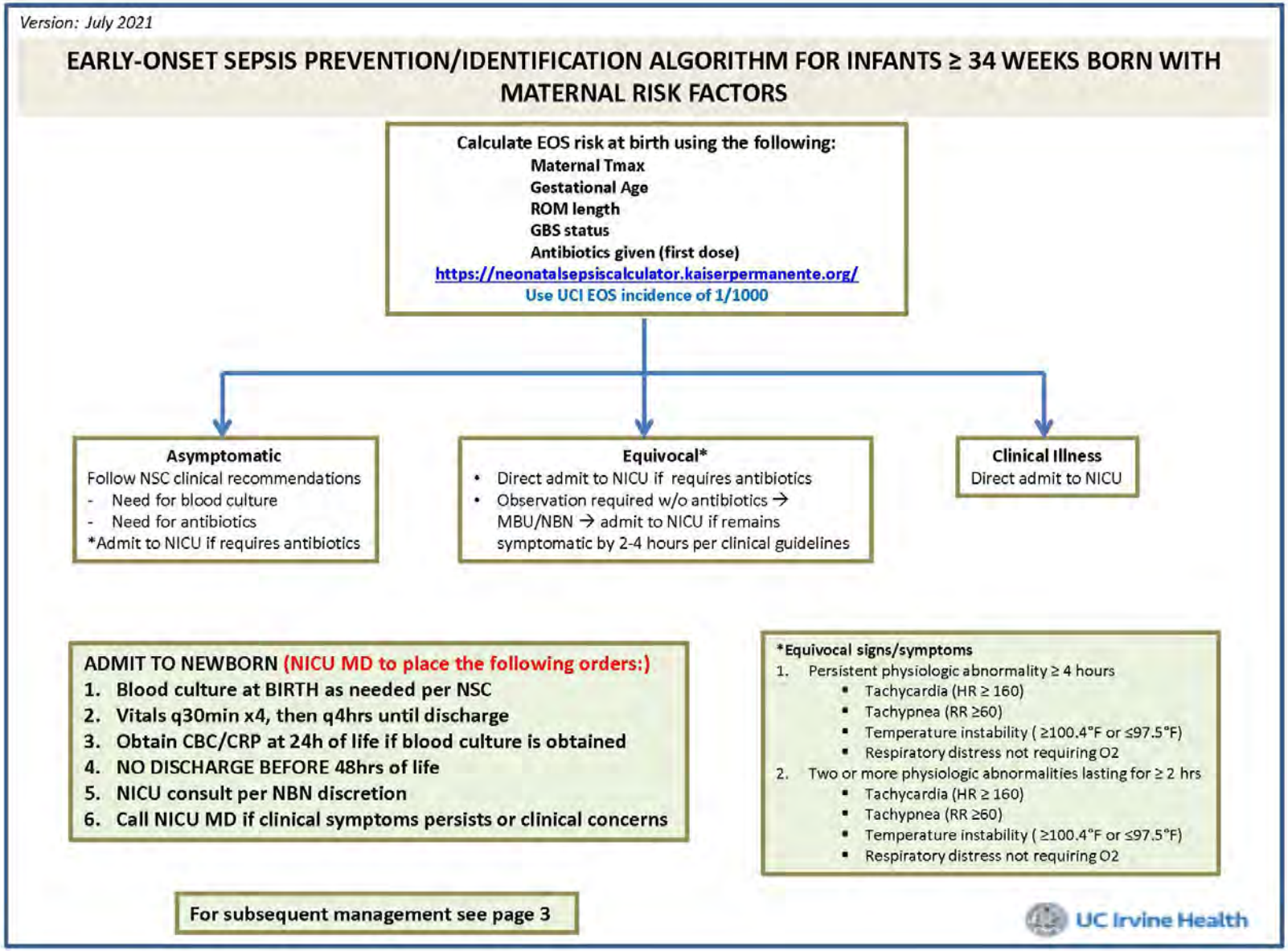
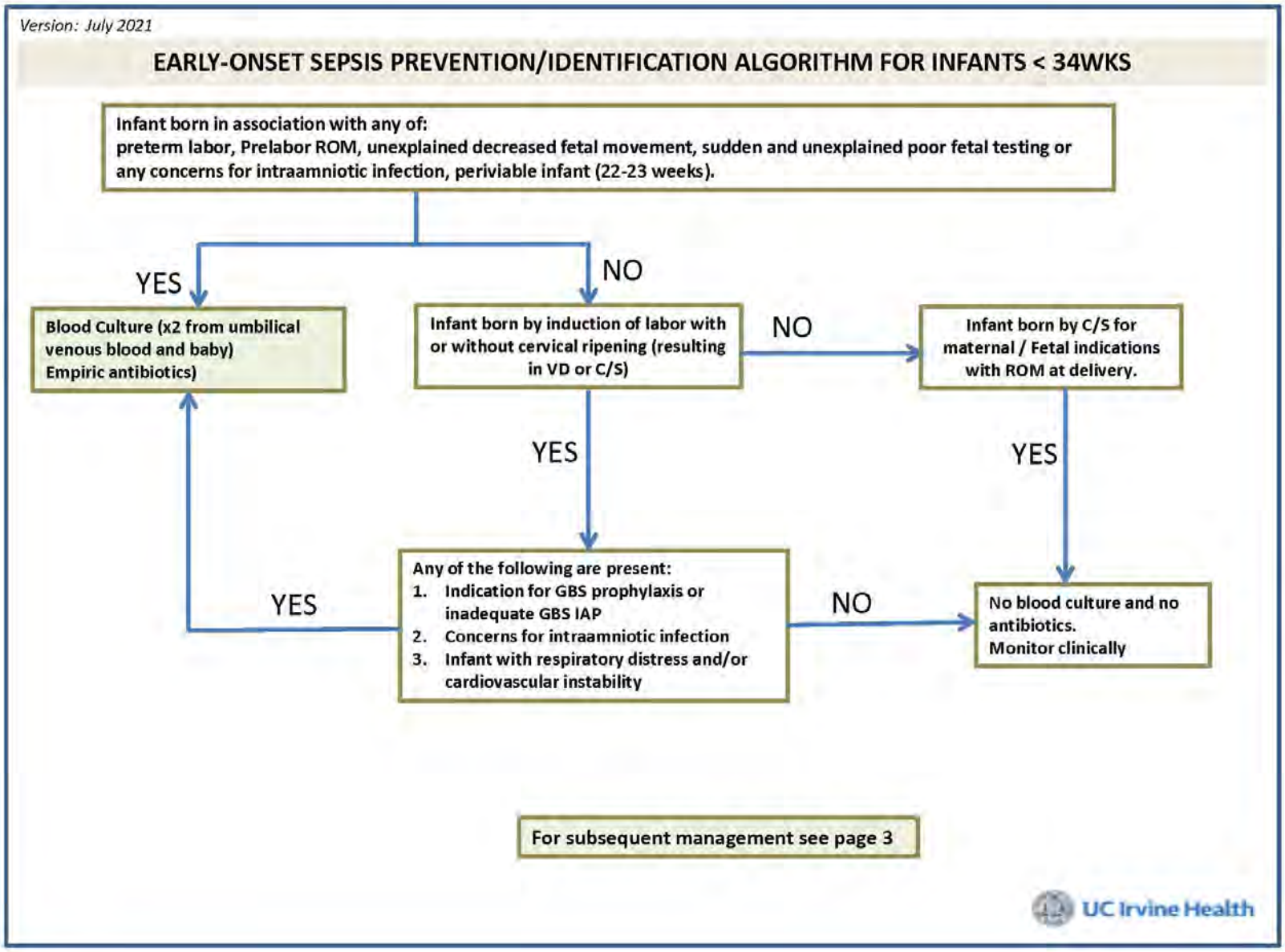
EARLY ONSET SEPSIS (EOS) ALGORITHM - PAGE 1

SOURCE: University of California, Irvine (UCI) Health



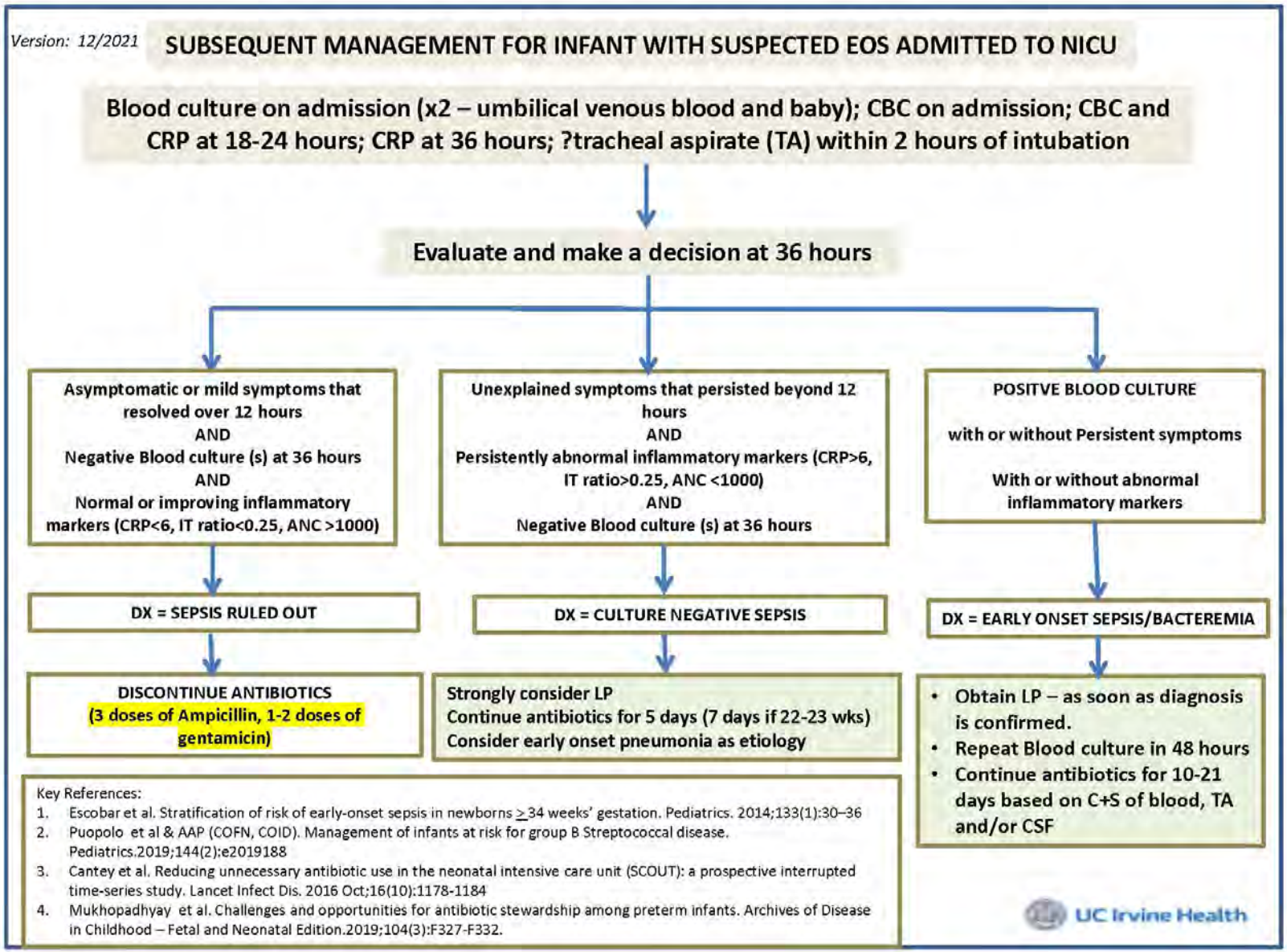
EARLY ONSET SEPSIS (EOS) ALGORITHM - PAGE 2

SOURCE: University of California, Irvine (UCI) Health



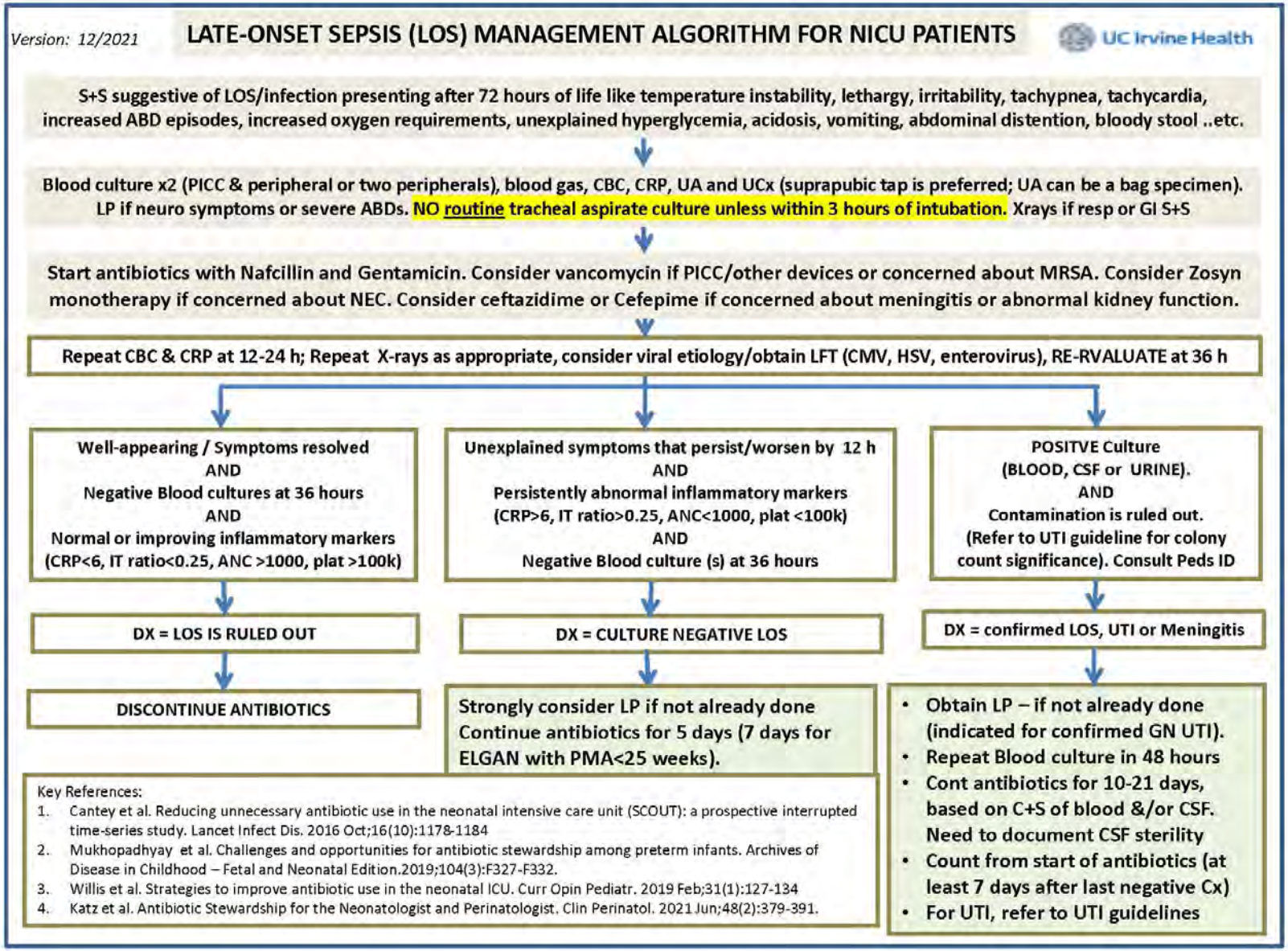
EARLY ONSET SEPSIS (EOS) ALGORITHM - PAGE 3

SOURCE: University of California, Irvine (UCI) Health



LATE ONSET SEPSIS (LOS) ALGORITHM

SOURCE: University of California, Irvine (UCI) Health



DAILY ANTIBIOTIC TIME OUT SHEET

SOURCE: University of California, Irvine (UCI) Health

Daily Antibiotic Time Out

Patient Name	Antibiotics Receiving/Dose/Frequency	Medical Plan for Antibiotics Guidelines Used	Interventions 1= clarifying indication for treatment 2= determining duration of treatment 3=Enter future stop dates 4= de-escalate 5=dosage adjustment/drug levels

References

Antibiotic Stewardship

1. Fishman N. Policy Statement on Antimicrobial Stewardship by the Society for Healthcare Epidemiology of America (SHEA), the Infectious Diseases Society of America (IDSA), and the Pediatric Infectious Diseases Society (PIDS). Infect Control Hosp Epidemiol. 2012;33(4):322-327.
2. Patel R, Fang FC. Diagnostic Stewardship: Opportunity for a Laboratory-Infectious Diseases Partnership. Clin Infect Dis. 2018;67(5):799-801.
3. Willis Z, De St Maurice A. Strategies to improve antibiotic use in the neonatal ICU. Curr Opin Pediatr. 2019;31(1):127-134.
4. Lee JH, Hornik CP, Benjamin DK, et al. Risk factors for invasive candidiasis in infants >1500g birth weight. Pediatr Infect Dis J. 2013;32(3):222-226.
5. Singh N, Patel KM, Léger MM, et al. Risk of resistant infections with enterobacteriaceae in hospitalized neonates. Pediatr Infect Dis J. 2002;21(11):1029-1033.
6. Clark RH, Bloom BT, Spitzer AR, Gerstmann DR. Reported medication use in the neonatal intensive care unit: Data from a large national data set. Pediatrics. 2006;117(6):1979-1987.
7. Michael Cotten C, Taylor S, Stoll B, et al. Prolonged duration of initial empirical antibiotic treatment is associated with increased rates of necrotizing enterocolitis and death for extremely low birth weight infants. Pediatrics. 2009;123(1):58-66.
8. Paskovaty A, Pflomm JM, Myke N, Seo SK. A multidisciplinary approach to antimicrobial stewardship: Evolution into the 21st century. Int J Antimicrob Agents. 2005;25(1):1-10.
9. Steinmann KE, Lehnick D, Buettcher M, et al. Impact of empowering leadership on antimicrobial stewardship: A single center study in a neonatal and pediatric intensive care unit and a literature review. Front Pediatr. 2018;6.
10. Olans RN, Olans RD, Demaria A. The Critical Role of the Staff Nurse in Antimicrobial Stewardship - Unrecognized, but Already There. Clin Infect Dis. 2016;62(1):84-89.
11. Summary of Core Elements for Hospital Antibiotic Stewardship Programs | Antibiotic Use | CDC.
12. Schulman J, Profit J, Lee HC, et al. Variations in neonatal antibiotic use. Pediatrics. 2018;142(3).
13. Improving the Quality of NICU Care Using State of the Art Collaborative Quality Improvement Methods CPQCC Network Database Manual of Definitions For Infants Born in 2017.; 2016.
14. Barlam TF, Cosgrove SE, Abbo LM, et al. Implementing an Antibiotic Stewardship Program: Guidelines by the Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America. 2016.
15. Carling P, Fung T, Killion A, Terrin N, Barza M. Favorable Impact of a Multidisciplinary Antibiotic Management Program Conducted During 7 Years. Infect Control Hosp Epidemiol. 2003;24(9):699-706.
16. Karino S, Kaye KS, Navalkele B, et al. Epidemiology of acute kidney injury among patients receiving concomitant vancomycin and piperacillin-tazobactam: Opportunities for antimicrobial stewardship. Antimicrob Agents Chemother. 2016;60(6):3743-3750.
17. Cantey JB, Wozniak PS, Pruszynski JE, Sánchez PJ. Reducing unnecessary antibiotic use in the neonatal intensive care unit (SCOUT): a prospective interrupted time-series study. Lancet Infect Dis. 2016;16(10):1178-1184.
18. Young J, Dahale D, Demmel K, et al. Reducing acute kidney injury in pediatric oncology patients: An improvement project targeting nephrotoxic medications. Pediatr Blood Cancer. 2020;67(8).
19. Patel SJ, Saiman L. Principles and Strategies of Antimicrobial Stewardship in the Neonatal Intensive Care Unit. Semin Perinatol. 2012;36(6):431-436.

20. Ricardo Araujo da Silva A, Marques A, Di Biase C, et al. Effectiveness of antimicrobial stewardship programmes in neonatology: a systematic review. Arch Dis Child. 2020;105:563-568.
21. Goerens A, Lehnick D, Büttcher M, et al. Neonatal Ventilator Associated Pneumonia: A Quality Improvement Initiative Focusing on Antimicrobial Stewardship. Front Pediatr. 2018;6:262.
22. Nzegwu NI, Rychalsky MR, Nallu LA, et al. Implementation of an antimicrobial stewardship program in a neonatal intensive care unit. Infect Control Hosp Epidemiol. 2017;38(10):1137-1143.
23. Ting JY, Paquette V, Ng K, et al. Reduction of Inappropriate Antimicrobial Prescriptions in a Tertiary Neonatal Intensive Care Unit After Antimicrobial Stewardship Care Bundle Implementation. Pediatr Infect Dis J. 2019;38(1):54-59.
24. Chiu CH, Michelow IC, Cronin J, Ringer SA, Ferris TG, Puopolo KM. Effectiveness of a guideline to reduce vancomycin use in the neonatal intensive care unit. Pediatr Infect Dis J. 2011;30(4):273-278.
25. Nzegwu NI, Rychalsky MR, Nallu LA, et al. Implementation of an antimicrobial stewardship program in a neonatal intensive care unit. Infect Control Hosp Epidemiol. 2017;38(10):1137-1143.
26. Lee KR, Bagga B, Arnold SR. Reduction of broad-spectrum antimicrobial use in a tertiary children s hospital post antimicrobial stewardship program guideline implementation. Pediatr Crit Care Med. 2016;17(3):187-193.
27. Bard JD, TeKippe EME. Diagnosis of bloodstream infections in children. J Clin Microbiol. 2016;54(6):1418-1424.
28. Laituri C, Arnold MA. A standardized guideline for antibiotic prophylaxis in surgical neonates ,. Semin Pediatr Surg. 2019;28(1):53-56.
29. Antoine J, Inglis GDT, Way M, O'Rourke P, Davies MW. Bacterial colonisation of the endotracheal tube in ventilated very preterm neonates: A retrospective cohort study. J Paediatr Child Health. 2020;56(10):1607-1612.
30. CDC, Oid, Ncezid, DHQP. Identifying Healthcare-associated Infections (HAI) for NHSN Surveillance. 2018.
31. Cantey JB, Pyle AK, Wozniak PS, Hynan LS, Sánchez PJ. Early antibiotic exposure and adverse outcomes in preterm, very low birth weight infants. The Journal of Pediatrics. 2018; 203:62-67. doi: 10.1016/j.jpeds.2018.07.036
32. Mukhopadhyay S, Puopolo KM, Hansen NI, et al. Neurodevelopmental outcomes following neonatal late-onset sepsis and blood culture-negative conditions. Archives of Disease in Childhood - Fetal and Neonatal Edition. 2021;106(5):467-473. doi:10.1136/archdischild-2020-320664
33. Shukla S, Cortez J, Renfro B, et al. Charge nurses taking charge, challenging the culture of culture-negative sepsis, and preventing central-line infections to reduce NICU antibiotic usage. American Journal of Perinatology. 2020;39(08):861-868. doi:10.1055/s-0040-1719079
34. El Feghaly RE, Chatterjee J, Dowdy K, et al. A Quality Improvement initiative: Reducing blood culture contamination in a children's Hospital. Pediatrics. 2018;142(4). doi:10.1542/peds.2018-0244
35. Rupp ME, Cavalieri RJ, Marolf C, Lyden E. Reduction in blood culture contamination through use of initial specimen diversion device. Clinical Infectious Diseases. 2017;65(2):201-205. doi:10.1093/cid/cix304
36. Clinical practice guideline: Prevention of blood culture contamination. Journal of Emergency Nursing. 2018;44(3). doi: 10.1016/j.jen.2018.03.019

Multi-Drug Resistant Organisms

1. Siegel JD, Rhinehart E, Jackson M, Linda ; Management of Multidrug-Resistant Organisms In Healthcare Settings, 2006.; 2006. https://www.cdc.gov/infectioncontrol/guidelines/mdro/. Accessed March 25, 2021.
2. Infection Prevention and Control for Candida auris | Candida auris | Fungal Diseases | CDC. https://www.cdc.gov/fungal/candida-auris/c-auris-infection-control.html. Accessed March 18, 2021.

3. U.S. Department of Health and Human Services C. Antibiotic Resistance Threats in the United States, 2019. 2019;(Atlanta, GA: U.S). doi:10.15620/cdc:82532
4. Manyi-Loh C, Mamphweli S, Meyer E, Okoh A. Antibiotic use in agriculture and its consequential resistance in environmental sources: Potential public health implications. Molecules. 2018;23(4). doi:10.3390/molecules23040795
5. Stone PW, Gupta A, Loughrey M, et al. Attributable Costs and Length of Stay of an Extended-Spectrum Beta-Lactamase-Producing Klebsiella pneumoniae Outbreak in a Neonatal Intensive Care Unit . Infect Control Hosp Epidemiol. 2003;24(8):601-606. doi:10.1086/502253
6. SB 1058 Senate Bill - CHAPTERED. http://www.leginfo.ca.gov/pub/07-08/bill/sen/sb_1051-1100/sb_1058_bill_20080925_chaptered.html. Accessed March 22, 2021.
7. Popoola VO, Colantuoni E, Suwantarat N, et al. Active surveillance cultures and decolonization to reduce staphylococcus aureus infections in the neonatal intensive care unit. Infect Control Hosp Epidemiol. 2016;37(4):381-387. doi:10.1017/ice.2015.316
8. Bozzella MJ, Soghier L, Harris T, Zell L, Short B Lou, Song X. Impact of decolonization on methicillin-resistant Staphylococcus aureus transmission and infection in a neonatal intensive care unit. Infect Control Hosp Epidemiol. 2019;40(10):1123-1127. doi:10.1017/ice.2019.217
9. Milstone AM, Elward A, Brady MT, et al. Recommendations for Prevention and Control of Infections in Neonatal Intensive Care Unit Patients: Staphylococcus aureus Centers for Disease Control and Prevention National Center for Emerging and Zoonotic Infectious Diseases Division of Healthcare Quality Promotion. 2020. doi:10.1017/ice.2020.51
10. Parente DM, Cunha CB, Mylonakis E, Timbrook TT. The Clinical Utility of Methicillin-Resistant Staphylococcus aureus (MRSA) Nasal Screening to Rule Out MRSA Pneumonia: A Diagnostic Meta-analysis With Antimicrobial Stewardship Implications. Clin Infect Dis. 2018;67(1):1-7. doi:10.1093/cid/ciy024
11. Kaushik A, Kest H, Zauk A, Debari VA, Lamacchia M. Impact of Routine Methicillin-Resistant Staphylococcus aureus (MRSA) Surveillance and Cohorting on MRSA-Related Bloodstream Infection in Neonatal Intensive Care Unit. Am J Perinatol. 2015;32(6):531-536. doi:10.1055/s-0034-1395481
12. Bezabih YM, Sabiiti W, Alamneh E, et al. The global prevalence and trend of human intestinal carriage of ESBL-producing Escherichia coli in the community. J Antimicrob Chemother. 2021;76(1):22-29. doi:10.1093/jac/dkaa399
13. Benenson S, Levin PD, Block C, et al. Continuous surveillance to reduce extended-spectrum β-lactamase klebsiella pneumoniae colonization in the neonatal intensive care unit. Neonatology. 2013;103(2):155-160. doi:10.1159/000343150
14. Oteo J, Cercenado E, Fernández-Romero S, et al. Extended-spectrum-β-lactamase-producing Escherichia coli as a cause of pediatric infections: Report of a neonatal intensive care unit outbreak due to a CTX-M-14-producing strain. Antimicrob Agents Chemother. 2012;56(1):54-58. doi:10.1128/AAC.05103-11
15. Cohen CC, Cohen B, Shang J. Effectiveness of contact precautions against multidrug-resistant organism transmission in acute care: A systematic review of the literature. J Hosp Infect. 2015;90(4):275-284. doi:10.1016/j.jhin.2015.05.003
16. Maechler F, Schwab F, Hansen S, et al. Contact isolation versus standard precautions to decrease acquisition of extended-spectrum β-lactamase-producing Enterobacterales in non-critical care wards: a cluster-randomised crossover trial. Lancet Infect Dis. 2020;20(5):575-584. doi:10.1016/S1473-3099(19)30626-7
17. Kluytmans-van den Bergh MFQ, Bruijning-Verhagen PCJ, Vandenbroucke-Grauls CMJE, et al. Contact precautions in single-bed or multiple-bed rooms for patients with extended-spectrum β-lactamase-producing Enterobacteriaceae in Dutch hospitals: a cluster-randomised, crossover, non-inferiority study. Lancet Infect Dis. 2019;19(10):1069-1079. doi:10.1016/S1473-3099(19)30262-2
18. Tamma PD, Aitken SL, Bonomo RA, Mathers AJ, van Duin D, Clancy CJ. Infectious Diseases Society of America Antimicrobial Resistant Treatment Guidance: Gram-Negative Bacterial Infections A Focus on Extended-Spectrum β-Lactamase Producing Enterobacterales (ESBL-E), Carbapenem-Resistant Enterobacterales (CRE), and Pseudomonas Aeruginosa with Difficult-to-Treat Resistance (DTR-P. Aeruginosa).

19. Akinboyo I, Zangwill K, Berg W. SHEA neonatal intensive care prevention. Infection Control and Hospital Epidemiology. 2020; 41:1251-1257.
20. Lake JG, Weiner LM, Milstone AM, Saiman L, Magill SS, See I. Pathogen distribution and antimicrobial resistance among pediatric healthcare-associated infections reported to the National Healthcare Safety Network, 2011–2014. Infection Control & Hospital Epidemiology. 2017;39(1):1-11. doi:10.1017/ice.2017.236
21. Akinboyo IC, Zangwill KM, Berg WM, Cantey JB, Huizinga B, Milstone AM. Shea Neonatal Intensive Care Unit (NICU) White Paper Series: Practical Approaches to staphylococcus aureus disease prevention. Infection Control & Hospital Epidemiology. 2020;41(11):1251-1257. doi:10.1017/ice.2020.51
22. Popoola VO, Budd A, Wittig SM, et al. Methicillin-resistant staphylococcus aureus transmission and infections in a neonatal intensive care unit despite active surveillance cultures and decolonization: Challenges for infection prevention. Infection Control & Hospital Epidemiology. 2014;35(4):412-418. doi:10.1086/675594
23. Goldstein ND, Eppes SC, Mackley A, Tuttle D, Paul DA. A network model of hand hygiene: How good is good enough to stop the spread of MRSA? Infection Control & Hospital Epidemiology. 2017;38(8):945-952. doi:10.1017/ice.2017.116
24. Quan KA, Sater MR, Uy C, et al. Epidemiology and genomics of a slow outbreak of methicillin-resistant staphyloccus aureus (MRSA) in a neonatal intensive care unit: Successful chronic decolonization of MRSA-positive healthcare personnel. Infection Control & Hospital Epidemiology. 2022:1-8. doi:10.1017/ice.2022.133

Concluding Remarks

Since the publication of CPQCC's first Preventing HAI in the NICU toolkit, CLABSI prevention has been a central focus of NICU HAI prevention efforts, resulting in an overall reduction of the incidence of CLABSI and HAI. Published QI reports and statewide collaborative efforts have produced a variety of NICU-focused central line care bundles with varying interventions. NICUs can now turn to national guidelines containing NICU-specific CLABSI prevention interventions. Unanswered questions remain, however, and more research is needed on NICU-specific central line care and maintenance techniques to more clearly delineate the specific interventions that are most effective at reducing CLABSI.

Despite these successful CLABSI prevention efforts, HAI persists and remains a significant burden for the youngest and smallest NICU patients. This toolkit builds upon CLABSI prevention efforts and shifts the focus toward a broader approach to HAI prevention by encouraging use of "hospital-acquired bacteremia" or "non-CLABSI bloodstream infection" incidence as an important and more global measurement of NICU quality. To that end, this toolkit addresses other potential sources of hospital acquired bacteremia, such as the skin and gut, and delineates potentially better practices to address these areas. Along with CLABSI prevention efforts, this wider approach to HAI prevention is needed to protect the youngest and smallest NICU patients. More research is needed to understand the mechanisms of hospital-acquired blood stream infections in the NICU patient along with effective prevention efforts.

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