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

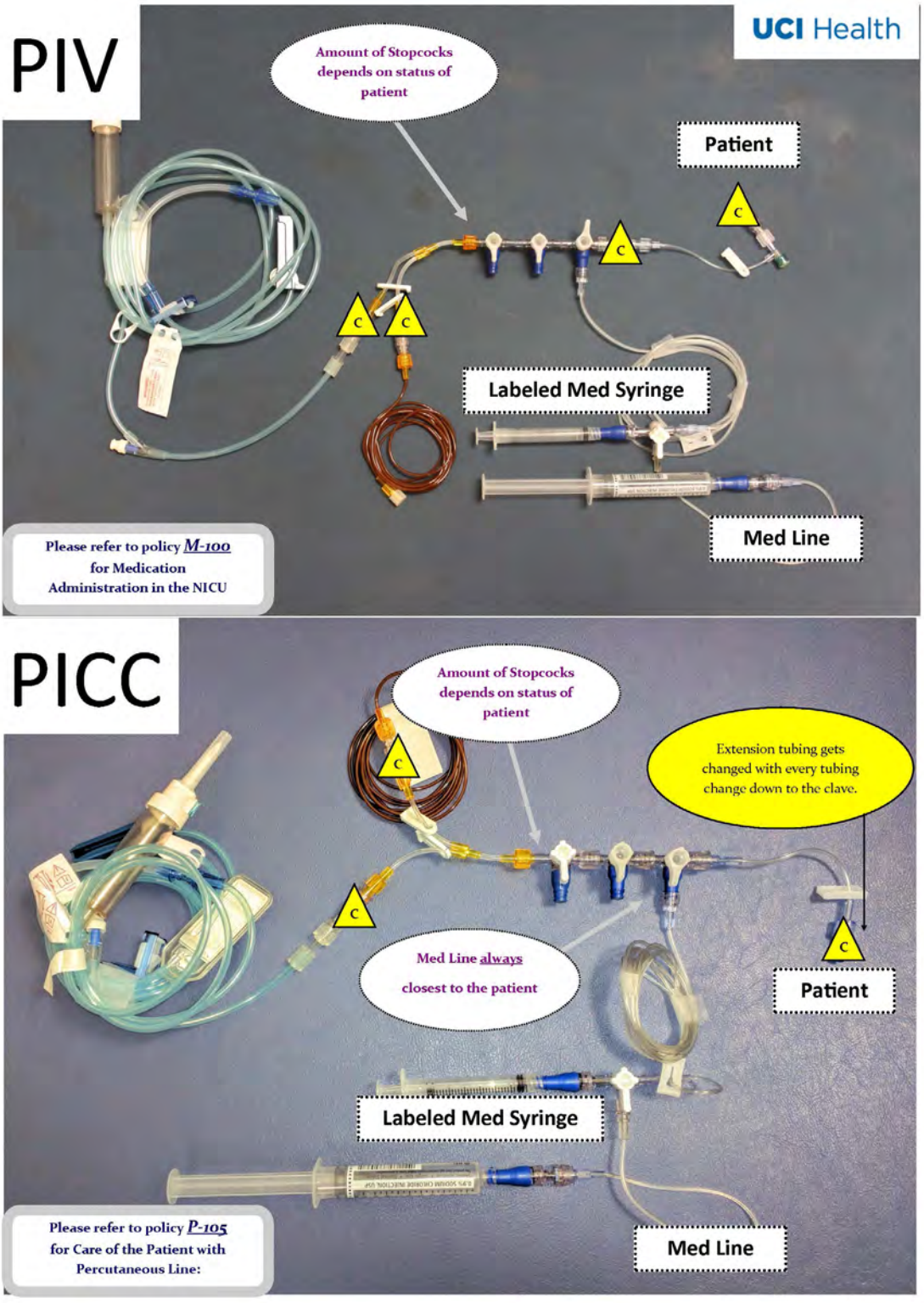
SOURCE: University of California, Irvine (UCI) Health

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			

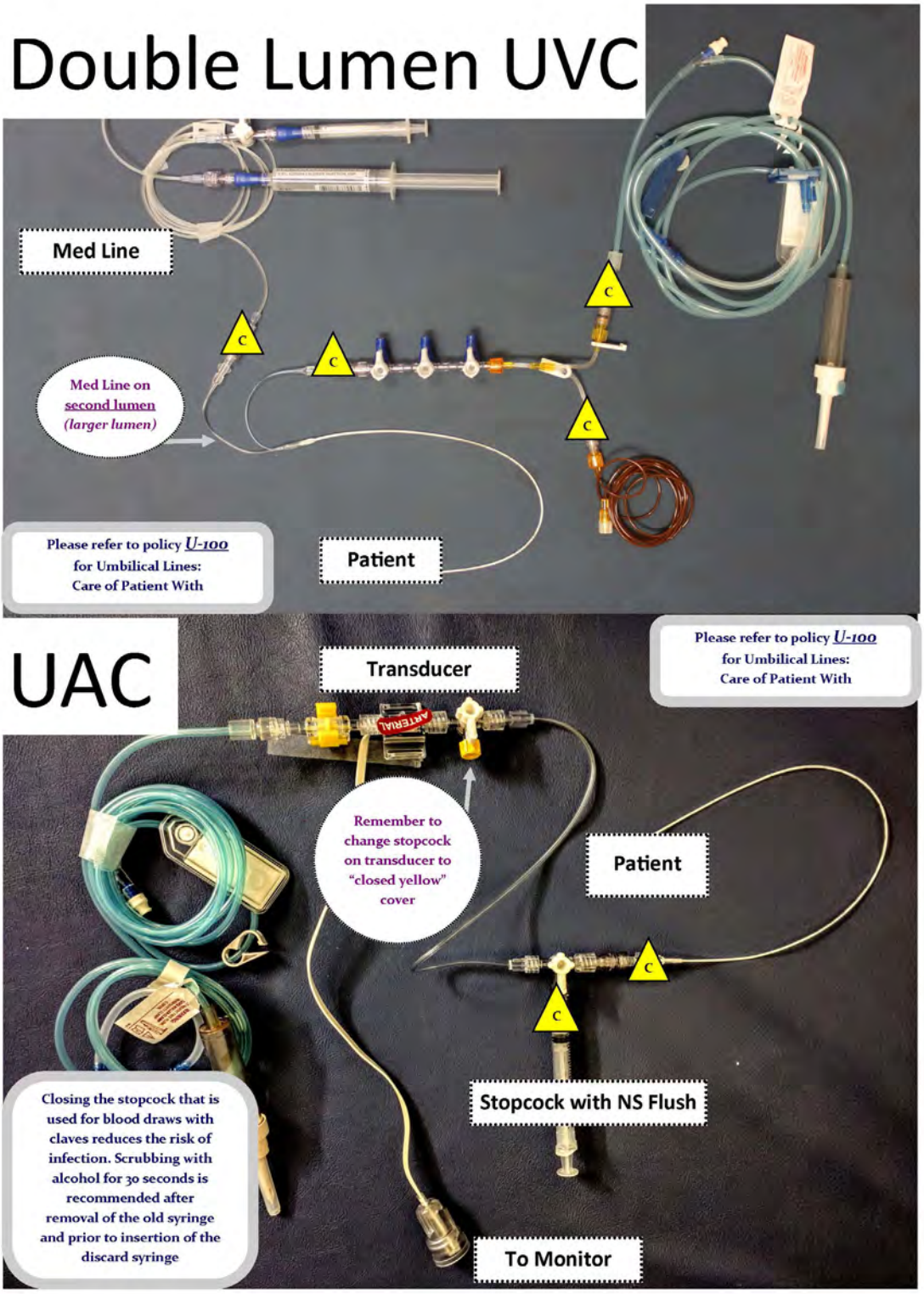
STANDARDIZED CENTRAL LINE TUBING VISUAL AID - PAGE 1

SOURCE: University of California, Irvine (UCI) Health



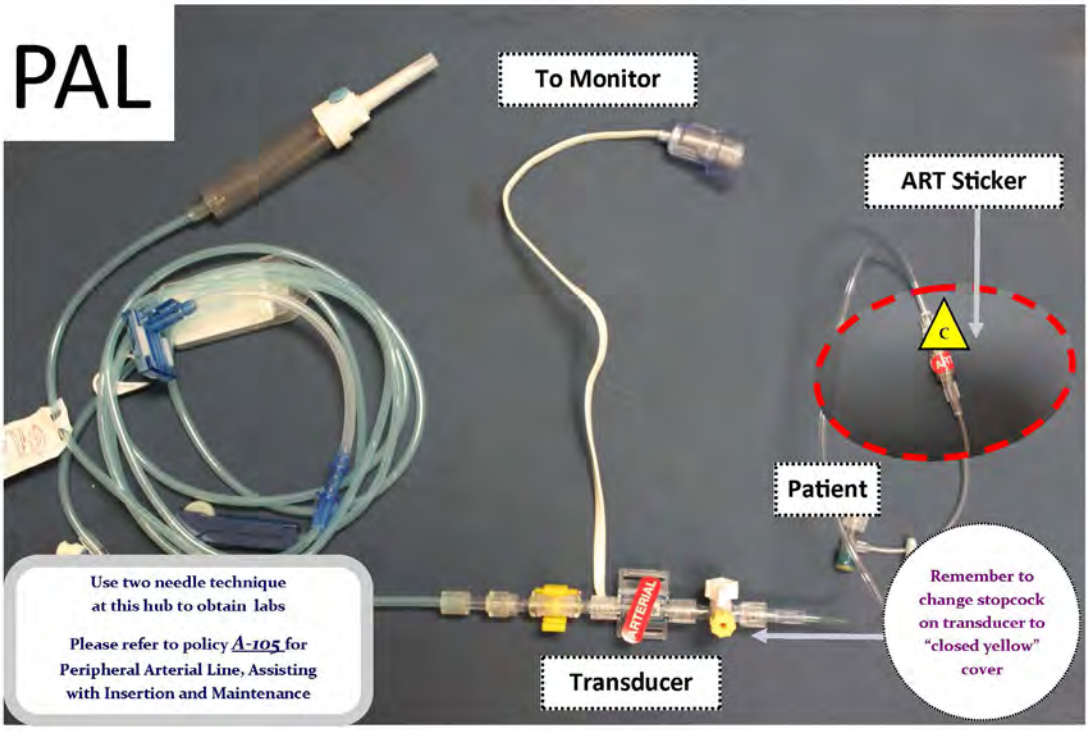
STANDARDIZED CENTRAL LINE TUBING VISUAL AID - PAGE 2

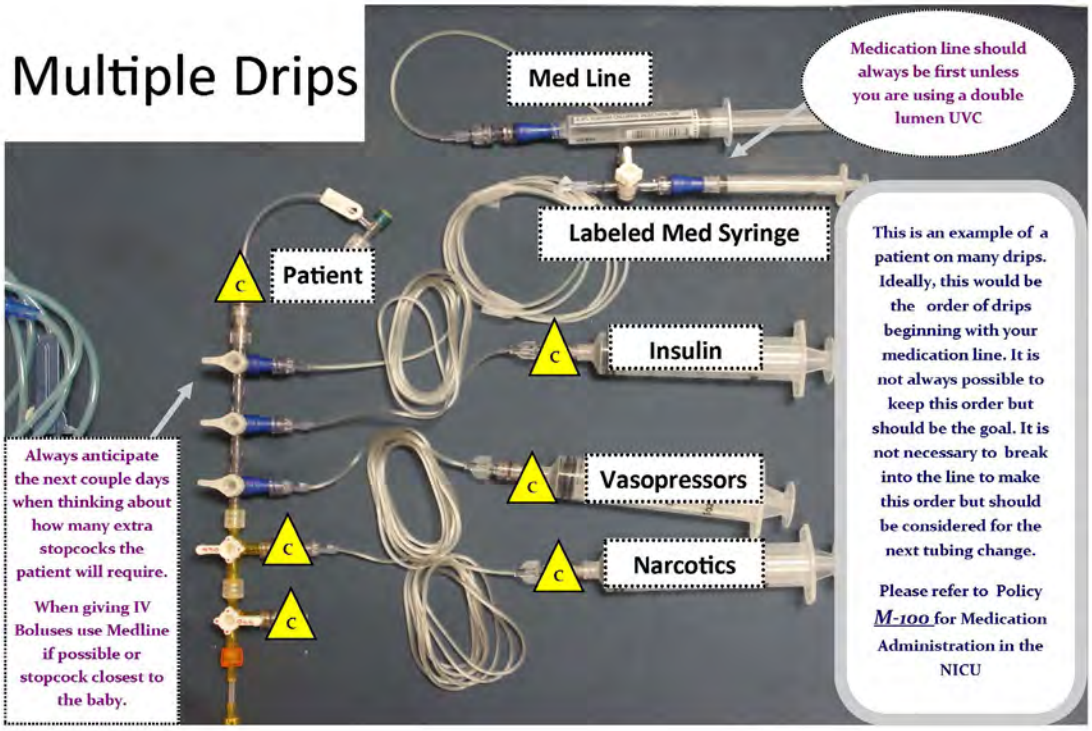
SOURCE: University of California, Irvine (UCI) Health



STANDARDIZED CENTRAL LINE TUBING VISUAL AID - PAGE 3

SOURCE: University of California, Irvine (UCI) Health





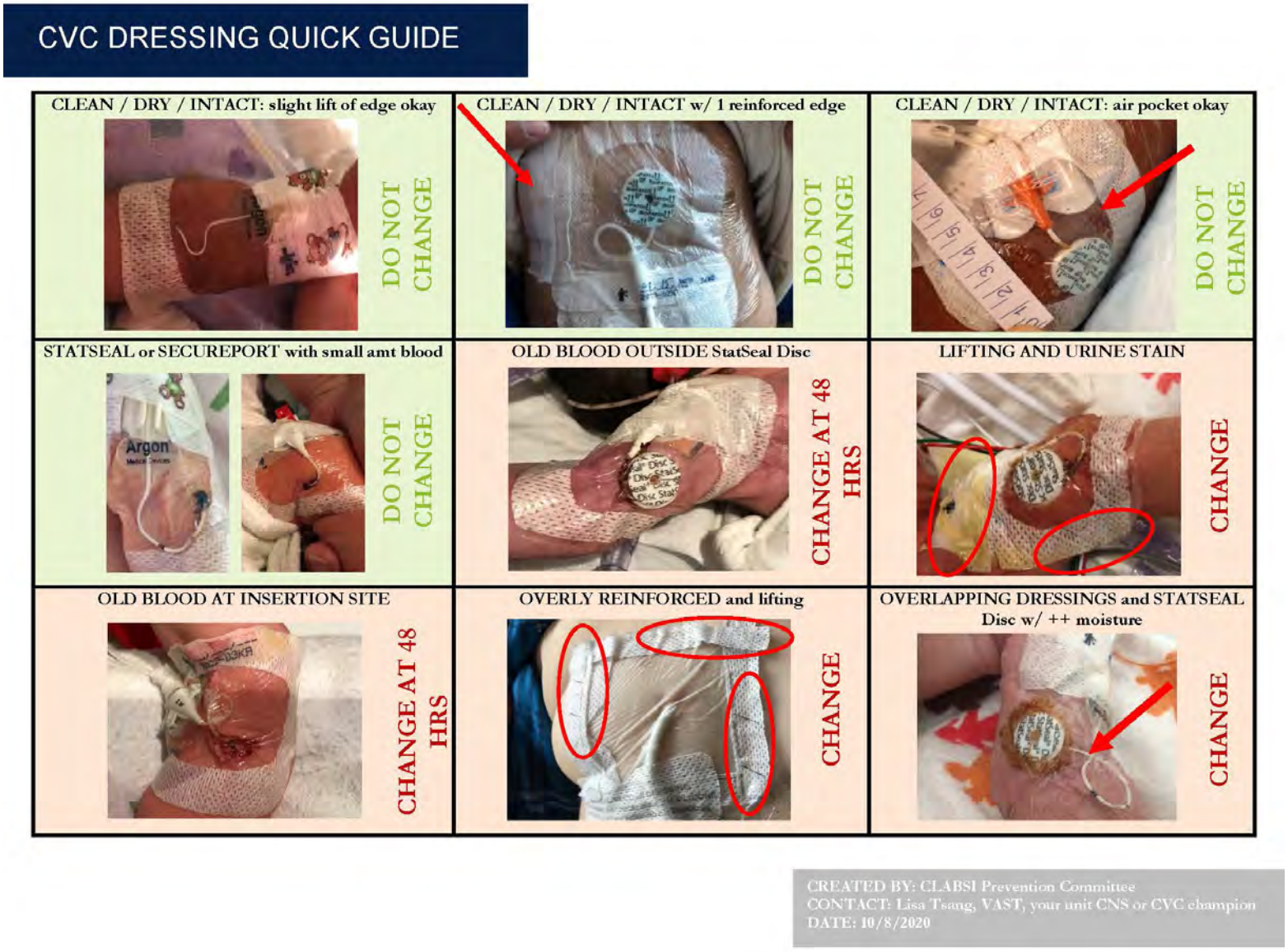
STANDARDIZED CENTRAL LINE TUBING VISUAL AID - PAGE 4

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 San Francisco



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 San Francisco

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 San Francisco

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 San Francisco

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	

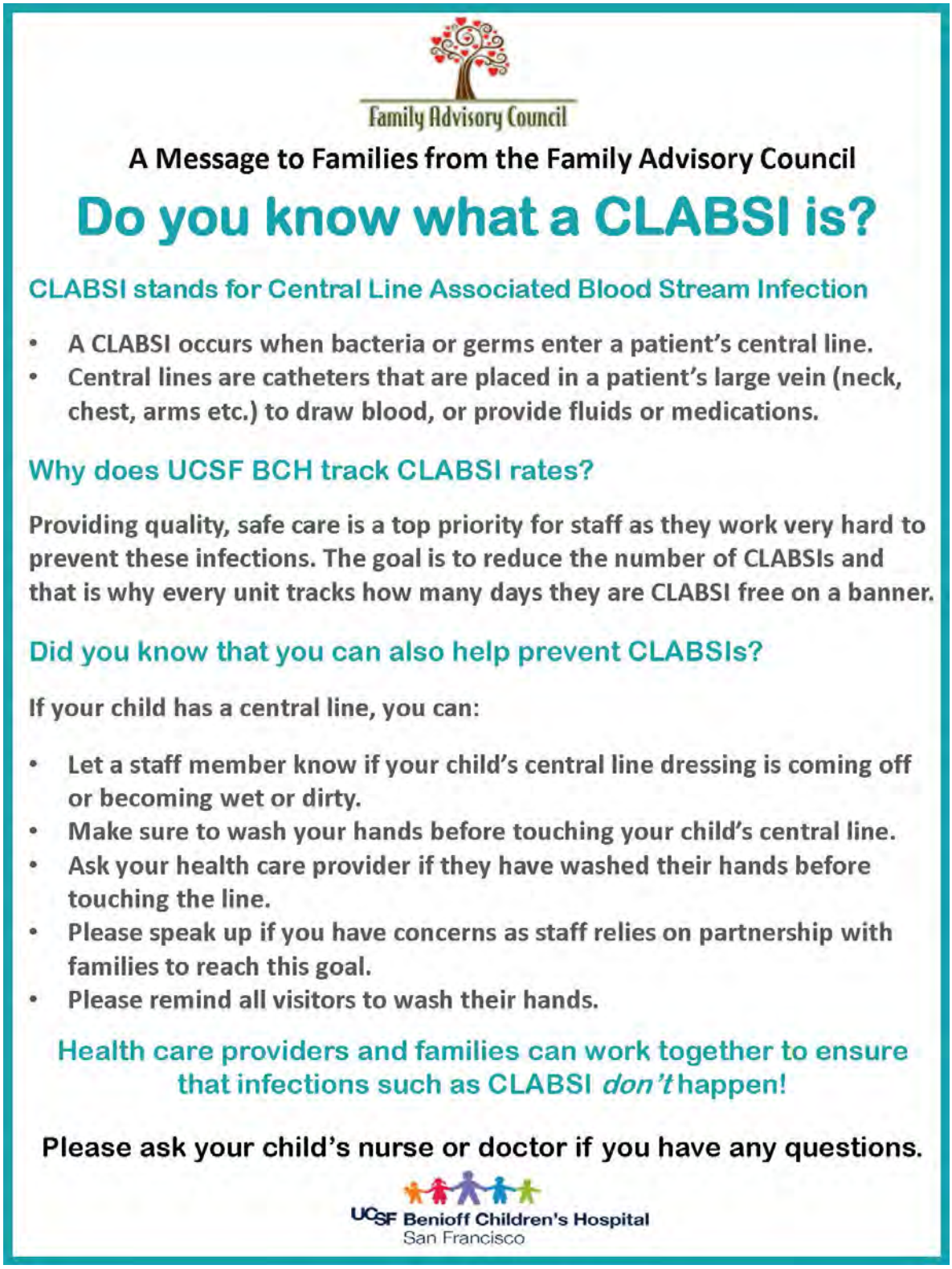
SUMMARY OF ACTION ITEMS:

Item	Owner

Draft 3
9/13/22

FAMILY CLABSI EDUCATION TOOL

SOURCE: UCSF Benioff Children's Hospital San Francisco



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 San Francisco

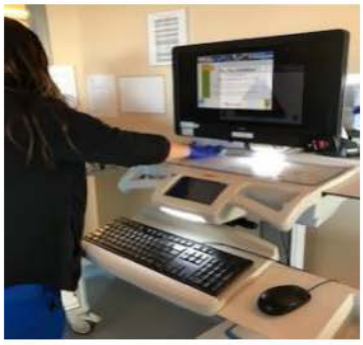
ENVIRONMENTAL CLEANLINESS FLYER FOR STAFF

SOURCE: UCSF Benioff Children's Hospital San Francisco

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