Shielding our Smallest: Exploring the Impact of Infection Control Measures in NICU Care

18th Hot Topics in Neonatal Medicine
KFAFH Jeddah Feb 15th 2024

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Neonatal Sepsis

Neonatal sepsis is a serious and potentially life-threatening infection

Rapid progression of untreated infection may greatly increase morbidity or mortality in neonates

Neonatal sepsis is estimated to be responsible for 15% of all neonatal deaths globally

Causes significant morbidity including delayed enteral feeding, prolonged duration of mechanical ventilation and hospital stay and long-term disability, and the sequelae may extend well into childhood and last throughout life

There have been some practices are evidence-based for infection prevention in this population, other practices are controversial and require further investigation

Neonatal sepsis: a systematic review of core outcomes from randomized clinical trials Cían J. HenryPediatric Research 2022

Preterm Infant Infection Vulnerability

Extremely preterm infants are particularly vulnerable to systemic infections secondary to:

- Immature immune defenses
- Prolonged hospitalizations
- Delays in enteral feeding
- Early antibiotic exposure
- Need for life sustaining invasive interventions
- A lack of a well-formed stratum corneum as well as the vernix caseosa in preterm skin

Preterm Infants Environmental Exposure in the NICU

The preterm infant's **microbiome is largely driven by environmental exposures in the NICU**

- Repeated courses of antibiotics
- Choice of diet (formula or breast milk)
- Rupture of membrane
- Preterm labor with intact membranes
- Mode of delivery

Delivery Characteristics and the Risk of Early-Onset Neonatal Sepsis Dustin D. Flannery, DO, MSCE,a PEDIATRICS Volume 2022

Modifiable Factors

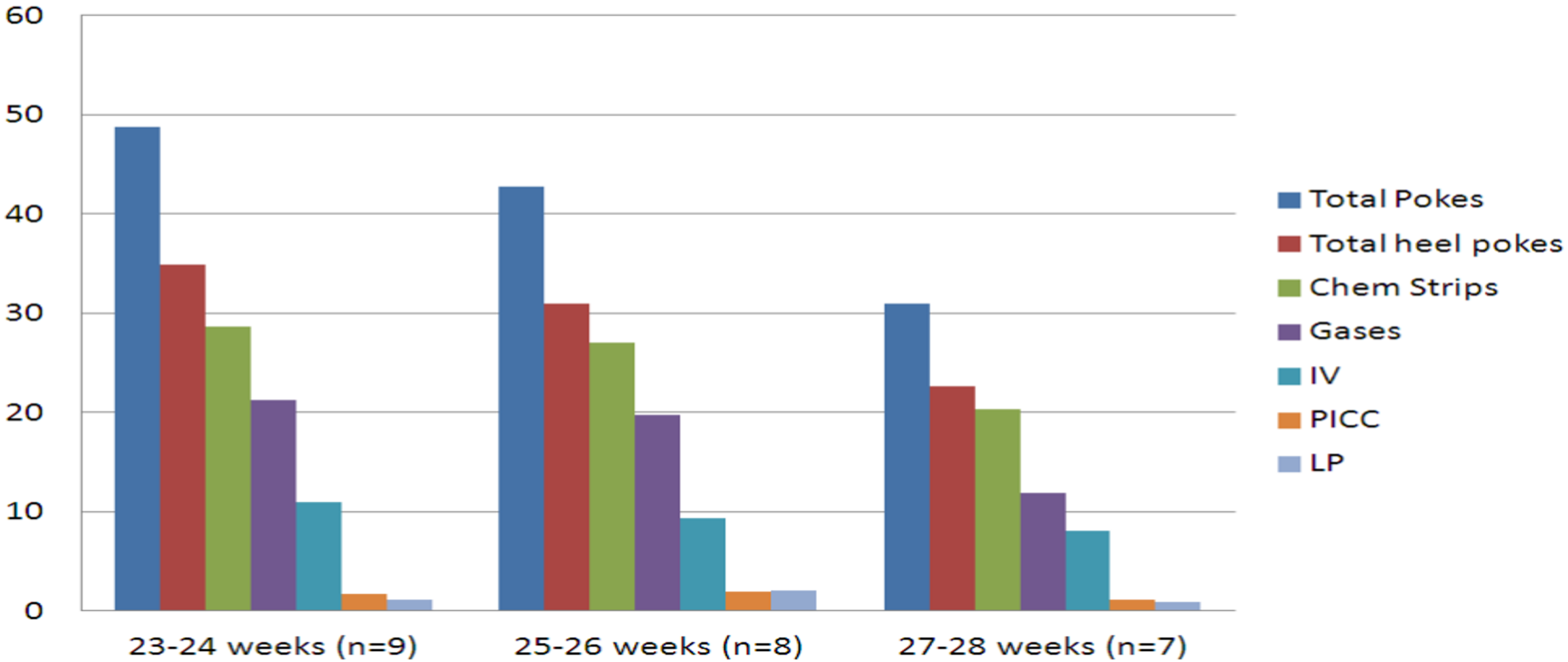
Drugs which suppress gastric acidity have been shown to alter the microbiome and potentially increase the risk of LOS and NEC in very low birthweight infants

Antibiotics for early-onset sepsis

- Intrapartum antibiotic prophylaxis has been shown to alter the microbiome for months postnatally
- prolonged treatment with antibiotics for early-onset sepsis has been associated with an increased risk of necrotizing enterocolitis and late onset sepsis
- Proton pump inhibitors alter the composition of the gut microbiota Matthew A BMJ 2016

Dynamics of the preterm gut microbiome in health and disease Alain Cuna American Journal of Physiology-Gastrointestinal and Liver Physiology 2021

Total Skin Breaks by Gestation- First 3 weeks of life



Taxonomy of Infection Related Diseases

- EOS
- LOS: CNN Definition- **Late Onset Sepsis** is defined as any positive blood and/or cerebrospinal fluid culture after 2 days
- Central line associated bloodstream infections (CLABSI) and BSI
- VAP
- MRSA MSSA Colonization
- Localized infection: skin, eye, …
- Meningitis
- Infectious related Disease Process NEC

Renée E. Mobley Central line-associated bloodstream infections in the NICU: Successes and controversies in the quest for zero Seminars in Perinatology 2017

Taxonomy of Infection Related Diseases

Common Non-Bacterial Infection

- Herpes Simplex Virus
- Enterovirus and Parechovirus
- Candida
- Syphilis
- COVID-19

Neurodevelopmental Outcomes Following Neonatal Late-Onset Sepsis and Blood Culture-Negative Conditions

Infants with LOS had **higher risk of death**, but not NDI compared with infants with LOCNC.

Surviving Infants with LOCNC had **higher risk of NDI** compared with unaffected infants.

Neurodevelopmental outcomes following neonatal late-onset sepsis and blood culture-negative conditions

(Mukhopadhyay, Arch Dis child Fetal Neonatal 2021)

Clinical Manifestation

- **Subtle symptoms** to **profound septic shock**
  - The signs and symptoms of neonatal sepsis are subtle, nonspecific and are clinically indistinguishable from various noninfectious conditions such as RDS, PDA and maladaptation
  - It is important to **identify neonates with risk factors** for sepsis and to have a high index of suspicion for sepsis when an infant deviates from his or her usual pattern of activity or feeding

Julia Eichberger et al Diagnosis of Neonatal Sepsis: The Role of Inflammatory Markers, Front. Pediatr., 2022

EOS According to GA & BW

According to GA

-GA <25 weeks – 3.5%

-GA < 25 to 28 weeks – 1.9 %

-GA ≥29 weeks – 1 %

According to BW

-BW 501 to 750 g – 2.2%

-BW 751 to 1000 g – 1.9%

-BW 1001 to 1250 g – 1.5%

-BW 1251 to 1500 g – 0.8 %

These estimated rates are based on data from the **National Institute of Child Health and Human Development (NICHD)**

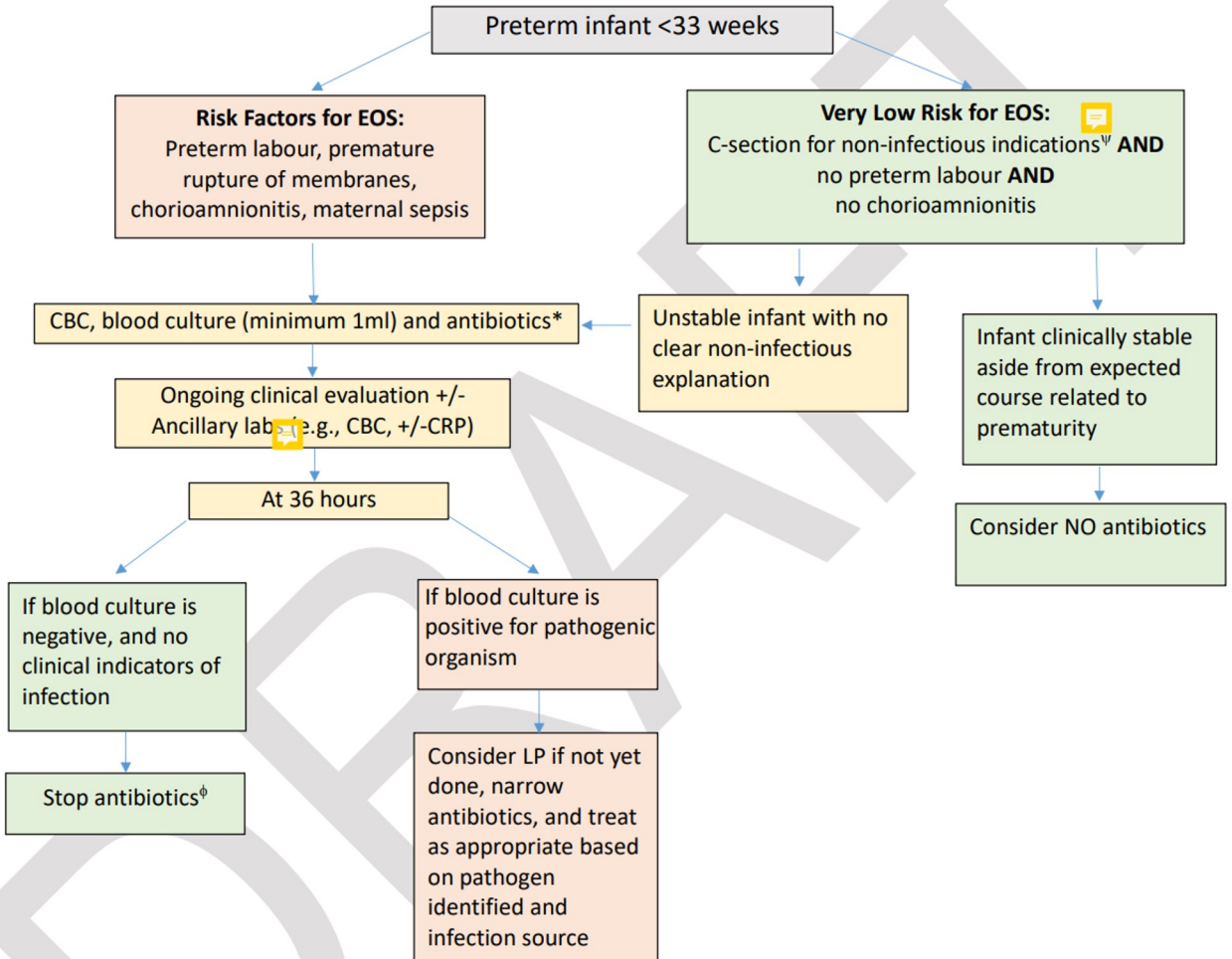
Early Onset Sepsis Guideline for Preterm Infants

PURPOSE:

- Reduce unnecessary antibiotic exposure in preterm infants at very low risk of early onset sepsis (EOS).

RATIONALE:

1) Higher antibiotic utilization in preterm infants, particularly in first week of life, is associated with higher morbidity, mortality, and longer lengths of stay[1, 2].
2) Preterm infants delivered for maternal/fetal indications without infectious risk factors are at low risk for EOS[3].
3) Blood culture volumes should be optimized (minimum 1mL) to reduce false negative results.



CNN neonatal infection committee draft guideline unpublished

- C-reactive protein in early-onset neonatal sepsis – a cutoff point for CRP value as a predictor of early-onset neonatal sepsis in term and late preterm infants early after birth Nati Friedman EUR Jour Inf dis 2021

TABLE 2: PRETERM INFANTS LESS THAN 34 WEEKS GESTATION

Clinical Presentation	Laboratory Investigations	Management
Unwell infant with clinical signs suggestive of sepsis		
	• **CBC** • **Blood Culture** • **LP** • **(CXR)**	Immediate initiation of empiric antibiotics: Ampicillin and Aminoglycoside
Culture: positive sepsis	• **LP if not already done**	Treatment guided by susceptibility profile of organism and site of infection Consider ID consult
Culture: negative sepsis	• **LP for clinical indications (If not already done)**	Duration of antibiotic therapy-recommend a maximum of 5 days. Consider ID consult Consider SCM automatic Stop Order after 5 days
Infant treated for "Rule out sepsis" where risk is low or other condition present (e.g. RDS)		
	• **CBC** • **Blood Culture**	Initiate empiric antibiotics: Ampicillin and Aminoglycoside Depending on clinical course can discontinue antibiotics after 48 hr • **24 hr "antibiotic time-out" review** • **SCM automatic Stop Order at 48 hr**
Infant born following a planned C/Section with no labour		
No signs of contractions No signs of ROM (e.g. C/Section for IUGR, maternal hypertension)	• **CBC-non-sepsis reasons only**	• **Risk of EOS is extremely low.** • **Antibiotics not recommended.**

LOS According to GA & BW

According to GA

-GA <25 weeks – 41%

-GA < 25 to 28 weeks – 21%

-GA 29 to 32 weeks – 10%

According to BW

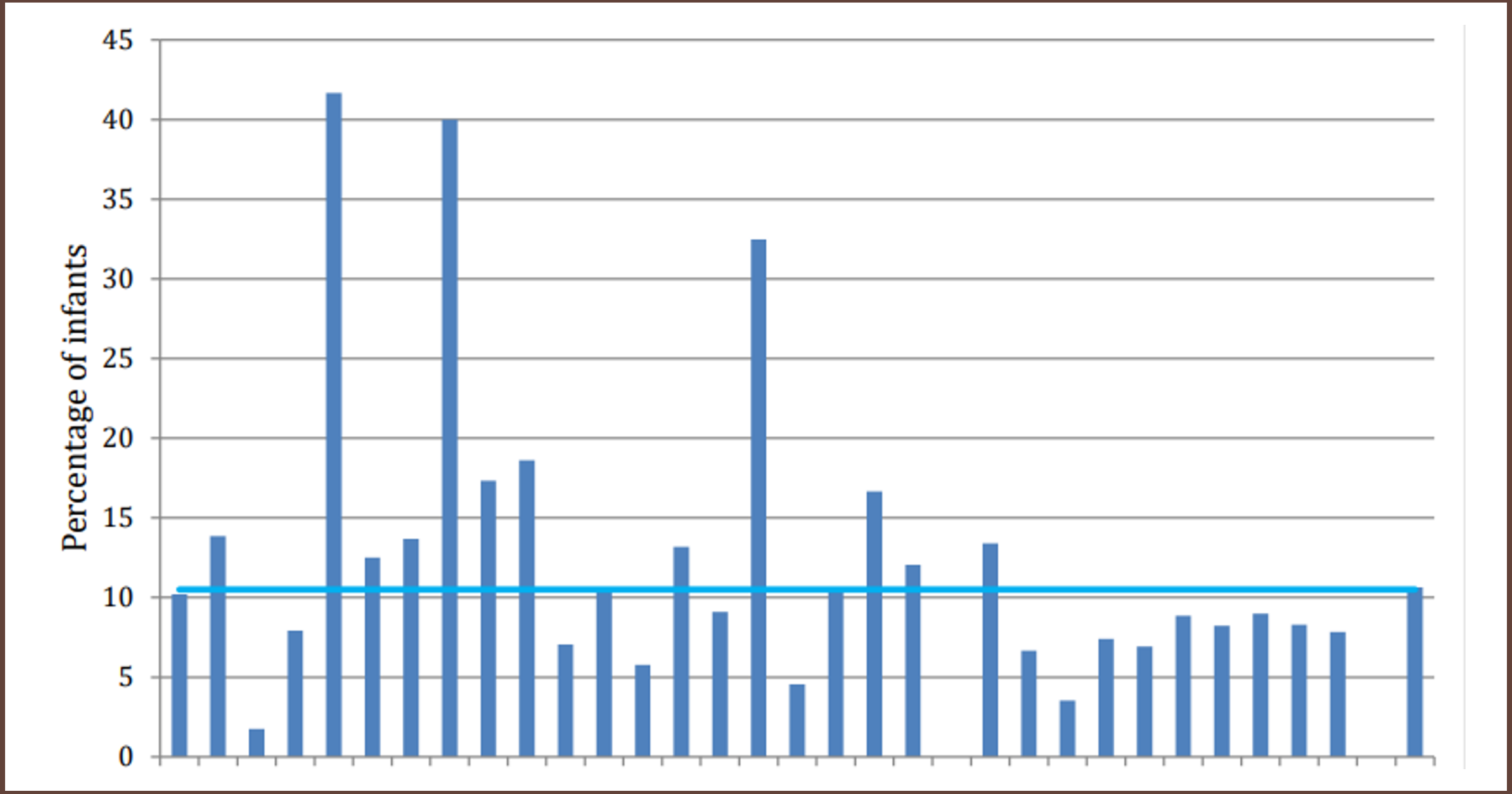
-BW 501 to 750 g – 43%

-BW 751 to 1000 g – 28%

-BW 1001 to 1250 g – 15%

-BW 1251 to 1500 g – 7 %

These estimated rates are based on data from the **National Institute of Child Health and Human Development (NICHD)**


45
40
35
30
25
20
15
10
5
0
Percentage of infants

What Bugs Our Kids

Bacterial pathogens in neonatal sepsis and focal neonatal infections

	Common pathogens*	Some less common pathogens*
Early onset¶		
Term and late preterm infants (GA ≥34 weeks)	▪ GBS ▪ *E. coli*	▪ *Enterobacter*, *Enterococcus*, *Klebsiella*, *Listeria*, nontypeable *H. influenzae*, other enteric gram-negative bacilli, *S. aureus*, viridans streptococci
Preterm infants (GA <34 weeks)	▪ *E. coli* ▪ GBS	▪ CoNS, *Enterobacter*, *Klebsiella*, *Listeria*, other enteric and nonenteric gram-negative bacilli, *S. aureus*, viridans streptococci
Late onset¶		
Term and late preterm infants (GA ≥34 weeks)	▪ *E. coli* ▪ GBS ▪ Additional pathogens seen in the NICU setting – *S. aureus*, CoNS	▪ *Enterobacter*, *Klebsiella*, *Listeria*, *N. meningitidis*, other enteric and nonenteric gram-negative bacilli, *Salmonella*, *S. pneumoniae*, viridans streptococci ▪ Additional pathogens seen in the NICU setting – *Citrobacter*, *Enterococcus*, *Pseudomonas*, *Serratia*
Preterm infants (GA <34 weeks)	▪ CoNS ▪ *S. aureus* ▪ *E. coli* ▪ *Klebsiella* ▪ GBS	▪ *Citrobacter*, *Enterobacter*, *Enterococcus*, *Listeria*, other enteric and nonenteric gram-negative bacilli, *Pseudomonas*, *Salmonella*, *Serratia*, viridans streptococci

Bundle Implementation to Prevent Infection in Preterm Infants

Domain
Hand Hygiene
Feeding
Line Insertion
Line Management & Maintenance
Line Removal Education & Documentation
Equipment & Environment Considerations Review of Infection by Team

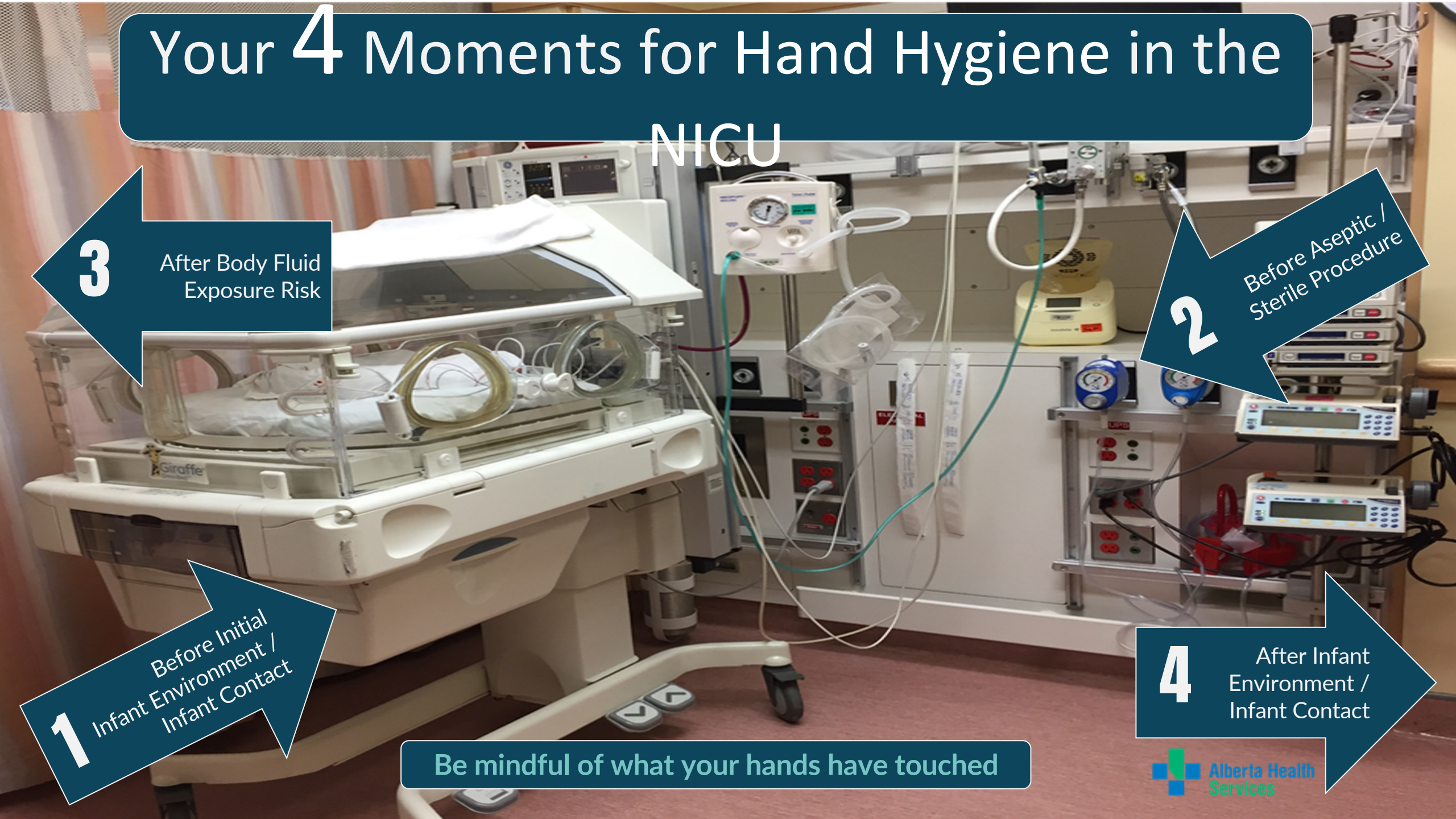
NICU Environment: Set the Tone

Disinfect with AHS approved disinfectant wipes

- Cell phone
- Pager
- Name Badges
- Pens

- One minute hand wash to the elbows
- Bare to the elbows (remove rings, watches, bracelets)
- No nail polish or artificial nails
- Loose hair tied back
- No lanyards, bags, or coats
- Sealed water bottles only (no food or other drink)

Your 4 Moments for Hand Hygiene in the NICU

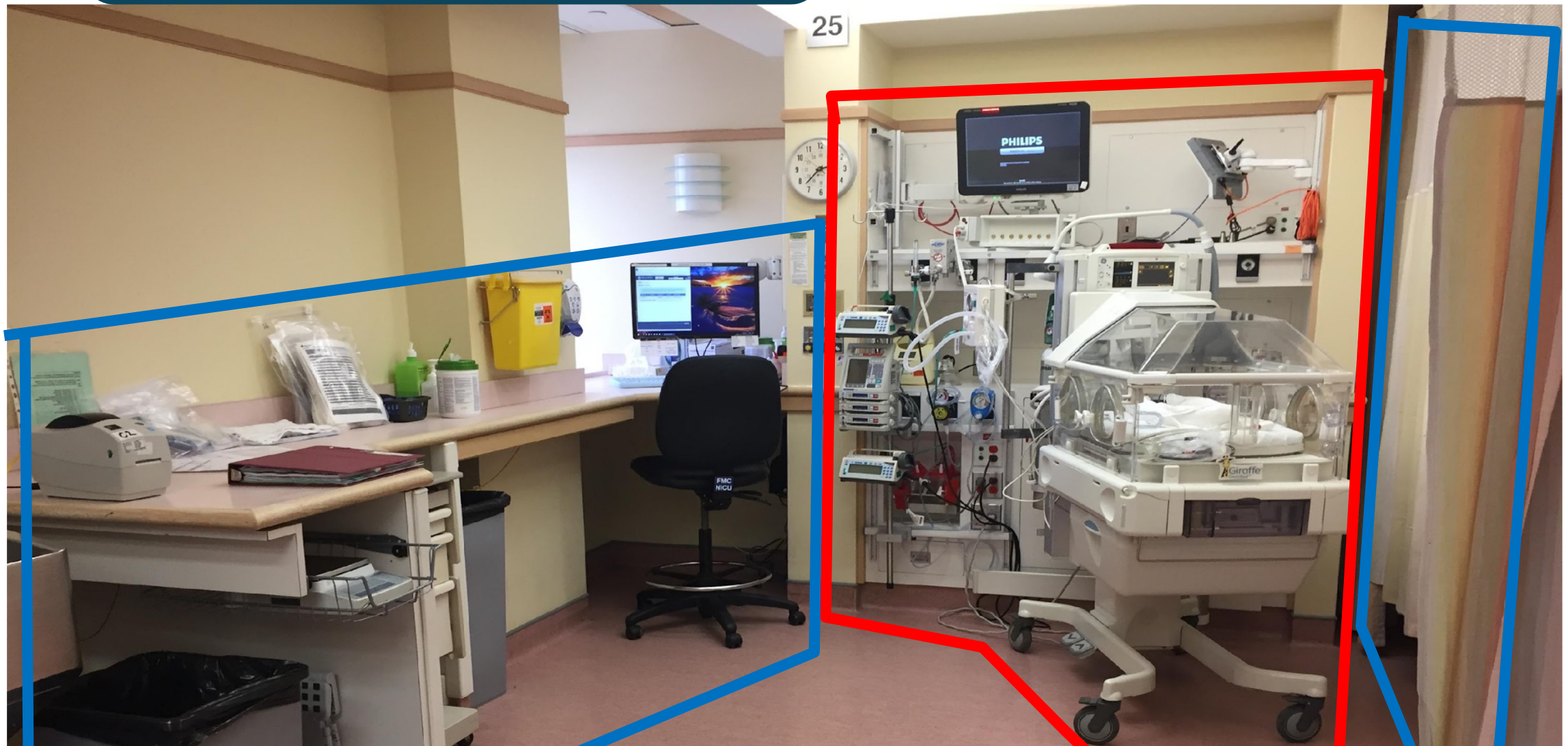


Health Care Environment

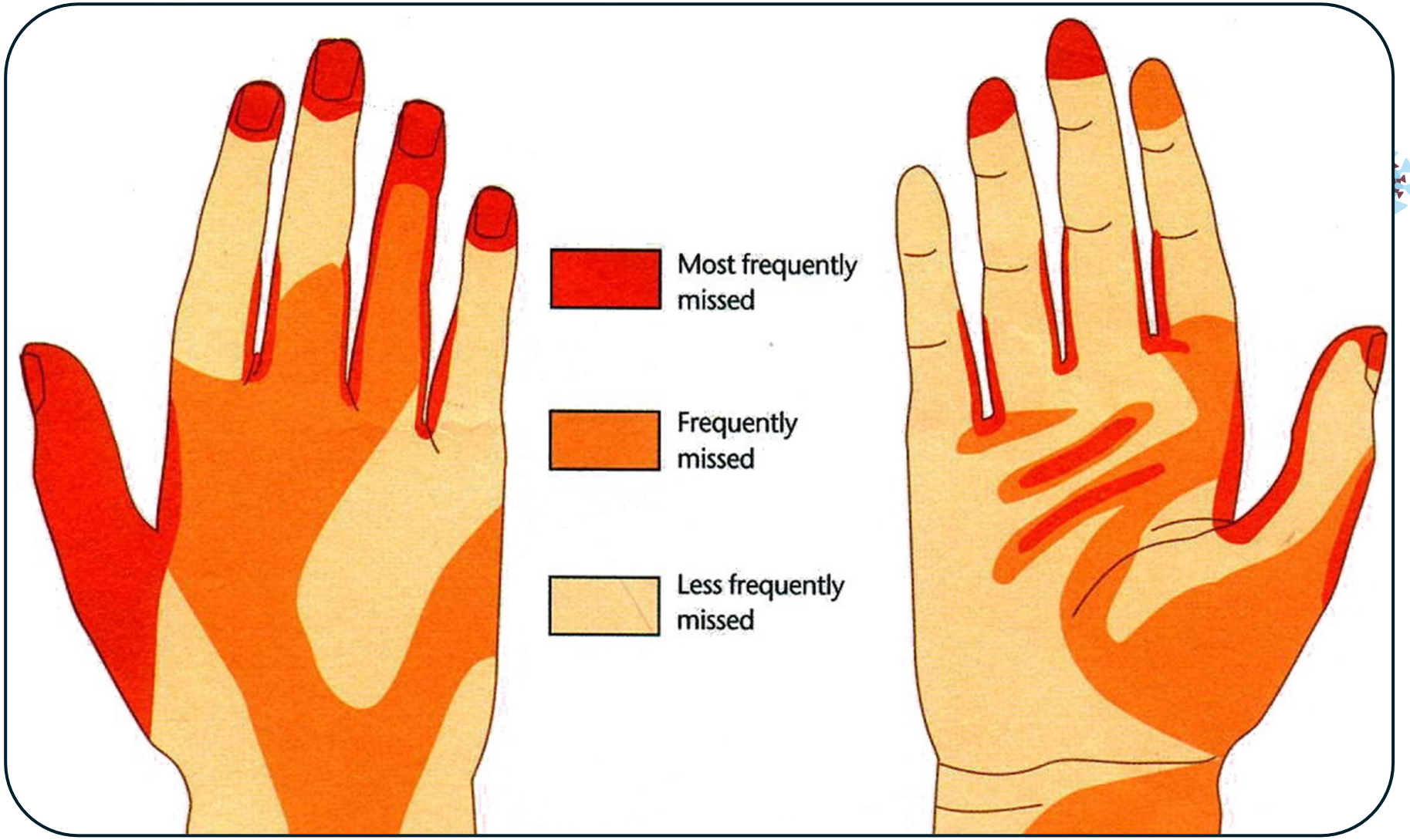
Curtains, Counters, Computer, Chart, Bedside Cart

Infant Environment

Isolette / warmer / cot, Monitor, Respiratory & IV Equipment, Emergency Equipment



Hand Hygiene: Technique is Key



Hand Hygiene

Interventions

1. ABHR at every bedside
2. **Bare to the elbows policy** ✓
3. AHS 4 Moments of HH
4. Unit approved ABHR
5. Culture of Safety
6. Monthly HH audits
7. Hospital grade skin moisturizers
8. Healthcare vs. Patient Environments

b) No lab coats, outer wear, briefcases/knapsacks/purses should be carried into the unit – consult the unit clerk for appropriate storage options

c) Long-sleeved warm-up jackets/sweaters must be removed prior to providing **direct patient care**. Upon removal of the long-sleeved warm-up jacket/sweater, hand hygiene of the hands and arms below the elbows must be performed before patient interaction

d) Arms should be bare to the elbows when providing **indirect patient care** in the patient "zone"

e) Jewelry may not be worn below the elbow (including wedding bands)

f) Fingernails are to be trimmed short

g) Nail polish, gel polish or artificial fingernails are NOT allowed

h) No lanyards may be worn around the neck

i) Hair must be contained or tied back such that it cannot dangle in the infant's space, and so it does not require manipulation or touching while providing patient care

Feeding

Interventions

1. Obtain colostrum for OIT ✓
2. NICU Mother's pumping within 6 hours ✓
3. Feed exclusively with mother's milk ✓
4. Use banked human milk if no MOM available ✓
5. Minimal enteral feedings on DOL 1 ✓
6. Standardized feeding guidelines ✓
7. Non-water based approach for milk warming ✓

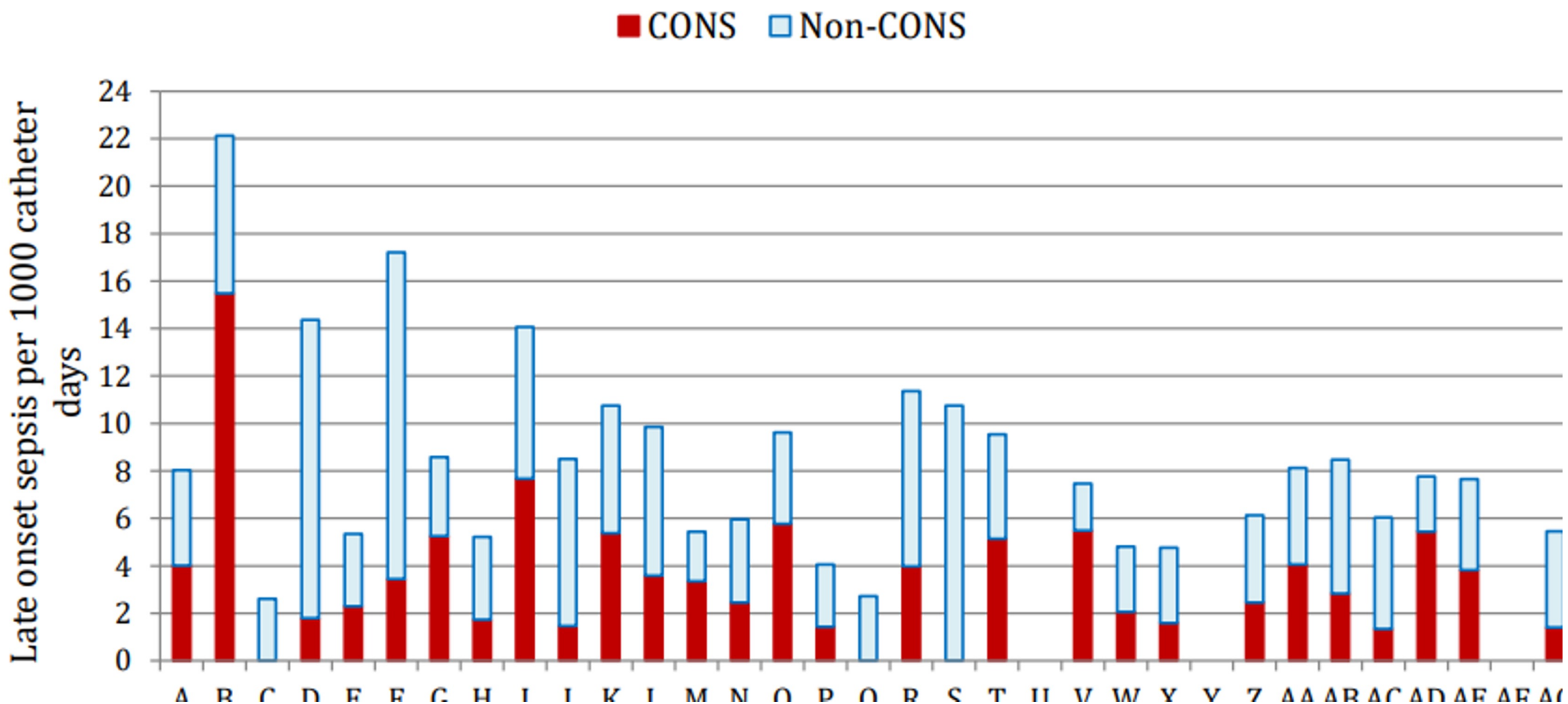
3. Physiologically Stable Infants: Birth Weight 750 – 999 grams

Day of Feeding	Feeds in mL/kg/day	Feed interval
1	10	Q4h
2	↑ to 20 over 24 hours	Q2h
3	↑ to 40 over 24 hours	Q2h
4	↑ to 60 over 24 hours	Q2h
5	↑ to 80 over 24 hours	Q2h
6	↑ to 100 over 24 hours	Q2h
7	↑ to 120 over 24 hours	Q2h
8	↑ to 140 over 24 hours	Q2h
9	↑ to 160 over 24 hours	Q2h

Central Line Associated Bloodstream Infections

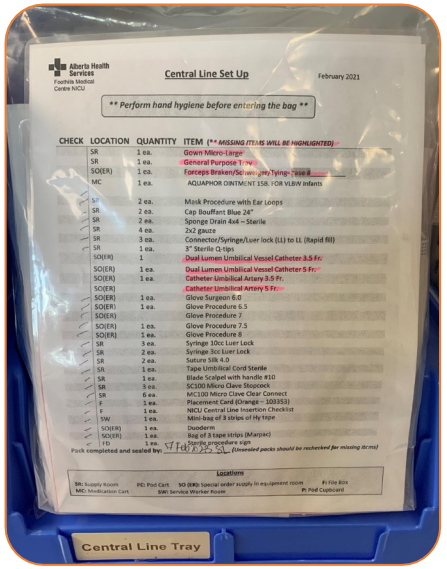
- Care bundles are an “all-or-nothing” approach of evidence-based practices, that when implemented simultaneously improve outcomes.
- In the case of CLABSI prevention bundles, there are a few key best practices that require full compliance:
  - Focus on sterile barrier precautions during PICC insertion (mask, sterile gown, sterile gloves and large sterile drapes)
  - Hand hygiene
  - Skin preparation with an antiseptic , Dressing changes when dressing becomes bloody, soiled or no longer occlusive
  - Daily review of line necessity with immediate removal of unwarranted lines

Central Line-Associated Bloodstream Infections per 1000 central line* days:
GA < 33 weeks: Site specific crude rates



Line Insertion

PICC Cart & Umbilical Line Kits



Alberta Health Services

NICU Central Line Insertion Checklist

Patient ID Label

Date: _____ Gestational Age at Birth: _____

Please circle Y for done and N for not done, or N/A if not applicable

Site: ACH FMC PLC RGH SHC

Type of line: Upper Limb PICC Lower Limb PICC Umbilical Central Line

1. Preparation

Y / N Assistant/Observers within one meter don hat and mask during the procedure
Y / N Observers and learners limited at the bedside
Y / N Curtains drawn

Inserter appropriately:
Y / N Completes hand hygiene
Y / N Dons mask and hat
Y / N Scrubs
Y / N Dons gown and gloves

Cleaning and Draping:
Y / N Patient draped as per policy with head and face visible
Y / N N/A Aquaphor/drain sponges used as appropriate (umbilical lines)
Y / N N/A For infants less than 32 weeks gestation and less than 2 weeks of age clean the umbilicus and/or skin with 0.5% chlorhexidine with 70% alcohol
Y / N N/A For infants at or greater than 32 weeks gestation, or more than 2 weeks of age, clean the umbilicus and/or skin with 2% chlorhexidine with 70% alcohol
Y / N N/A Drain sponges changed as appropriate

2. Insertion

Y / N Inserter uses sterile technique throughout the procedure. If No: Y / N Was procedure paused until inserter/field sterile again
Y / N N/A Inserter/assistant maintains sterile technique for blood collection and return
Y / N N/A Inserter/assistant maintains sterile technique for IV medication administration
Y / N Assistant maintains aseptic technique for line attachment: scrub the hub for 15 seconds and dry for 30 seconds

3. Post Insertion

Y / N Aseptic technique maintained during x-ray
Y / N Was line adjusted following x-ray
Y / N N/A Aseptic technique maintained for post x-ray adjustments
Y / N X-ray reviewed by physician/NNP prior to line completion (while inserter remains sterile)

For PICC lines:
Y / N N/A Optimal limb position for x-ray
Y / N N/A For lower limb PICC lines **both** AP and Lateral views obtained

For Umbilical Lines:
Y / N N/A UVC Tip T9-10 on x-ray. If No Tip location:_____
Y / N N/A UAC Tip T6-10 on x-ray. If No Tip location:_____

December 2018 PDSA Cycle 5

*** PLEASE RETURN COMPLETED FORM TO QI RN***

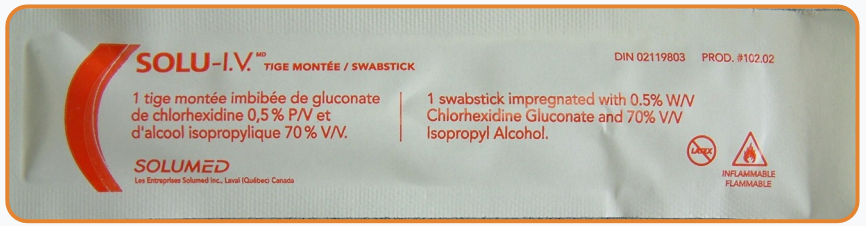
Line Insertion

2% CHG with 70% Alcohol

- All line maintenance
- Skin prep >32 weeks & > 2 weeks of age

0.5% CHG with 70% Alcohol

- Skin prep < 32 weeks & < 2 weeks of age, or
- Any baby with skin in poor condition

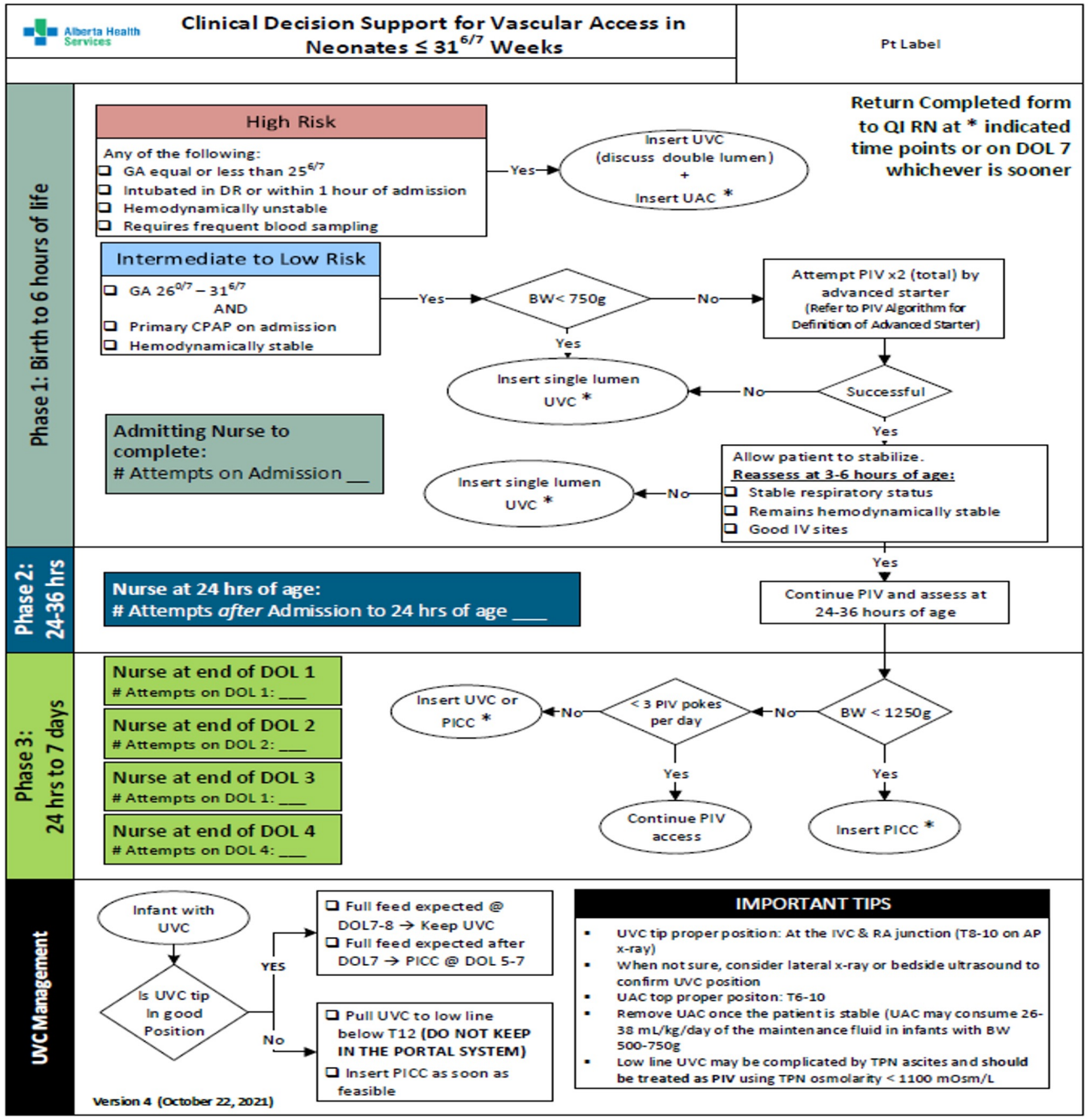


Line Maintenance Line Prep

Line Insertion

Vascular Access Tool

- Additional tool for infants born ≤ 31 6/7 weeks gestation
- Decision making for Peripheral vs. Central IV Access
- Aims:
  - Optimize line access
  - Avoid central lines when clinically indicated
  - Minimize skin pokes
  - Avoid malpositioned umbilical lines



Line Management & Maintenance

Line Maintenance – Instruction Sheet

Central & Peripheral BSI Prevention

Purpose

- To describe the steps for line priming, and TPN/Medline/Continuous Infusion line changes using **aseptic non-touch technique** (ANTT)

Major Steps	Key Point(s) & Rationale

Line Maintenance Checklist

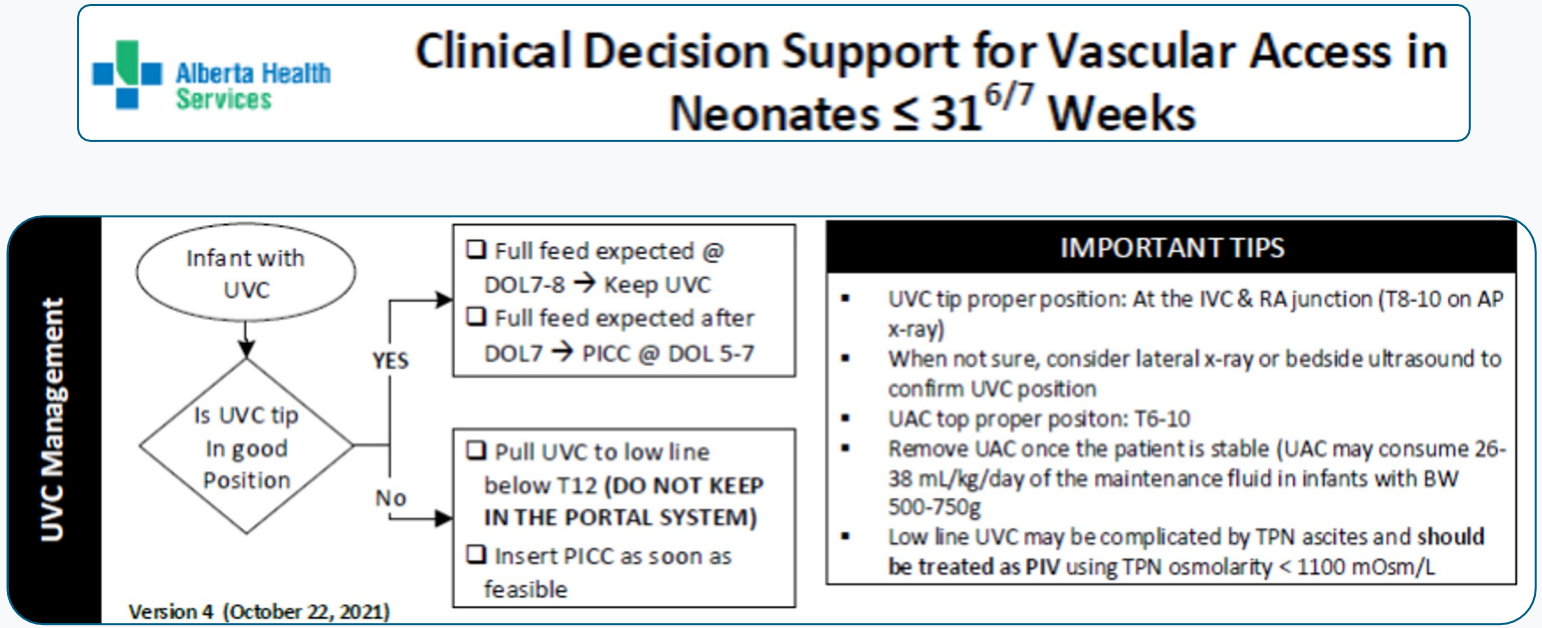
Patient Label

Self-Assessment Audit Tool

Line Practice Audit		
1. Team discussed line necessity or potential duration today?	Yes	No
2. Is the dressing dry and intact?	Yes	No
3. Is line entry minimized? • Blood sampling from UAC grouped (if applicable) • Can IV medications change to PO	Yes	No

Line Maintenance Audit		
1. Hand Hygiene	Yes	No
2. Prepare supplies and clean environment with unit approved cleansing wipes	Yes	No
3. Hand Hygiene	Yes	No
4. CHG cloth under elevated lines, all connections scrubbed for 15 seconds and allowed to dry on CHG cloth	Yes	No
5. Hand Hygiene	Yes	No
6. Don Sterile Gloves; set up sterile field (gloved individual picks items out of package one at a time)	Yes	No
7. Prime lines gently with no touch fluid path technique • Do not over prime • Medline, Continuous infusions (if applicable), Amino Acid/Dextrose, Lipids • Sterile field remains dry	Yes	No
8. 2x2's saturated in 2% CHG and 70% Alcohol	Yes	No
9. Lines into isolette maintaining sterility	Yes	No
10. Use gauze to clamp lines; disconnect, scrub hub for 15 seconds and allow to dry completely (new 2x2 for each hub)	Yes	No
11. Remove gloves	Yes	No
12. Hand Hygiene	Yes	No
13. Wipe down patient area	Yes	No
14. Hand Hygiene	Yes	No

Line Removal



	1400
UVC Double Lumen 22/02/23	
Properties	Placed: 22/2/
Site Assessment	No complications
Lumen 1 Description	Blue
Lumen 1 Status	Infusing
Lumen 2 Description	White
Lumen 2 Status	Locked
Measured External Length (cm)	4
Line Care	
Securement Type	Bridge Tape/ H...
Dressing Type	
Dressing Status	
Dressing Intervention	
Dressing Change Tolerance	
Dressing Change Due	
Line Necessity Reviewed?	Yes
Line Necessity	Yes, meets crite...
Line Necessity Reviewed With	Charge RN C....

- Fortification @ 80 – 100 mL/kg/day
- Line removal when enteral 100 – 120 mL/kg/day

VAP Prevention Bundle

Ventilator Circuit

- Minimal disconnection/disruption
- If disconnected, cover circuit "Y" to keep clean
- Minimize condensation
- Drained/angled away from the patient
- If needed, drain onto sterile gauze
- Provide enough slack
- Change circuit Q30D + PRN

Respiratory Equipment Care

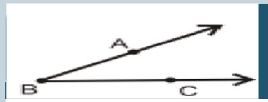
- Cover resuscitation bagging equipment when not in use
- Change NeoPuff circuit / resuscitation bag Q30D + PRN
- Do not routinely instill saline for suctioning
- Always use in-line suction catheter (change Q7D)

Intubation

- Use new ETT for every attempt
- Use sterile gloves
- Keep equipment clean; do not place directly on patient's bed or tuck equipment under mattress
- Daily assessment of patient's readiness for extubation

Mouth Care Q2-4 hrs

- Oral suction and/or OIT
- Thoroughly suction mouth before every handle / reposition
- Neosuckers / oral airway suction device change Q1D + PRN



Head Of Bed Elevated 10° - 30°

- Keep Head Of Bed (HOB) elevated unless contra indicated
- Helps with condensation staying away from patient
- Thoroughly suction mouth before lowering HOB
- Support patient from sliding down the bed

Hand Hygiene

4 moments for Hand Hygiene :

- Before entering pt room
- Before pt handle / procedure
- After pt handle / procedure
- Before leaving pt room

Human Milk Feedings for Prevention of NEC

- Human milk contains a variety of antimicrobial factors and immunomodulating agents (Bifidobacterium and Lactobacillus)
- use of human milk is considered an evidenced based strategy to reduce the incidence of NEC
- Recent RCT of Extremely Preterm Infants Fed Donor Milk or Preterm Infant showed decrease rate of NEC by 50% with no significant difference in neurodevelopment outcome

NEC

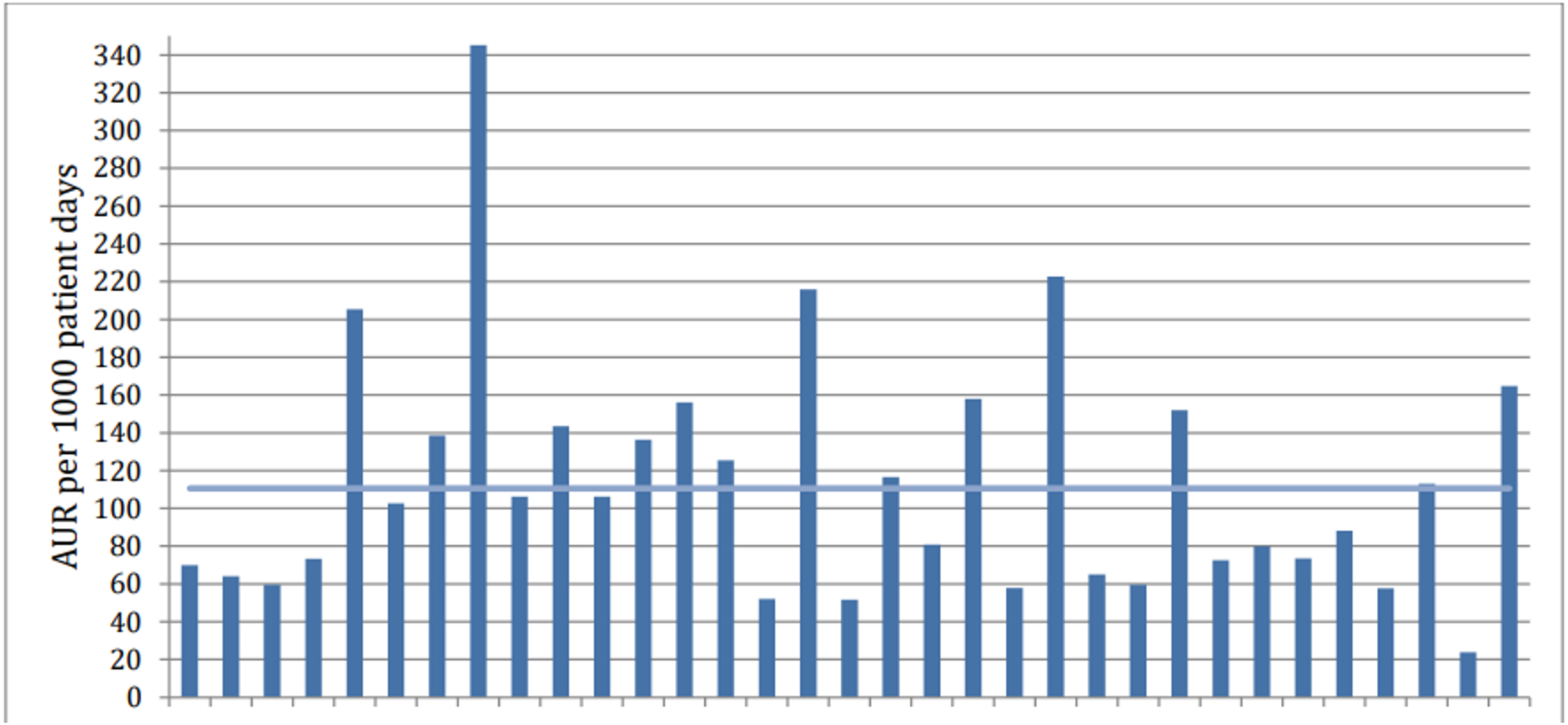
- All meta-analyses demonstrated a reduction in the incidence of NEC with donor milk compared with preterm formula
- There is no difference in all-cause mortality in infants fed formula vs. donor milk.
- No long-term differences in neurodevelopment or growth have been demonstrated
- There is no evidence that human milk (donor or maternal) decreases the risk of late onset sepsis.

Infection Prevention During COVID

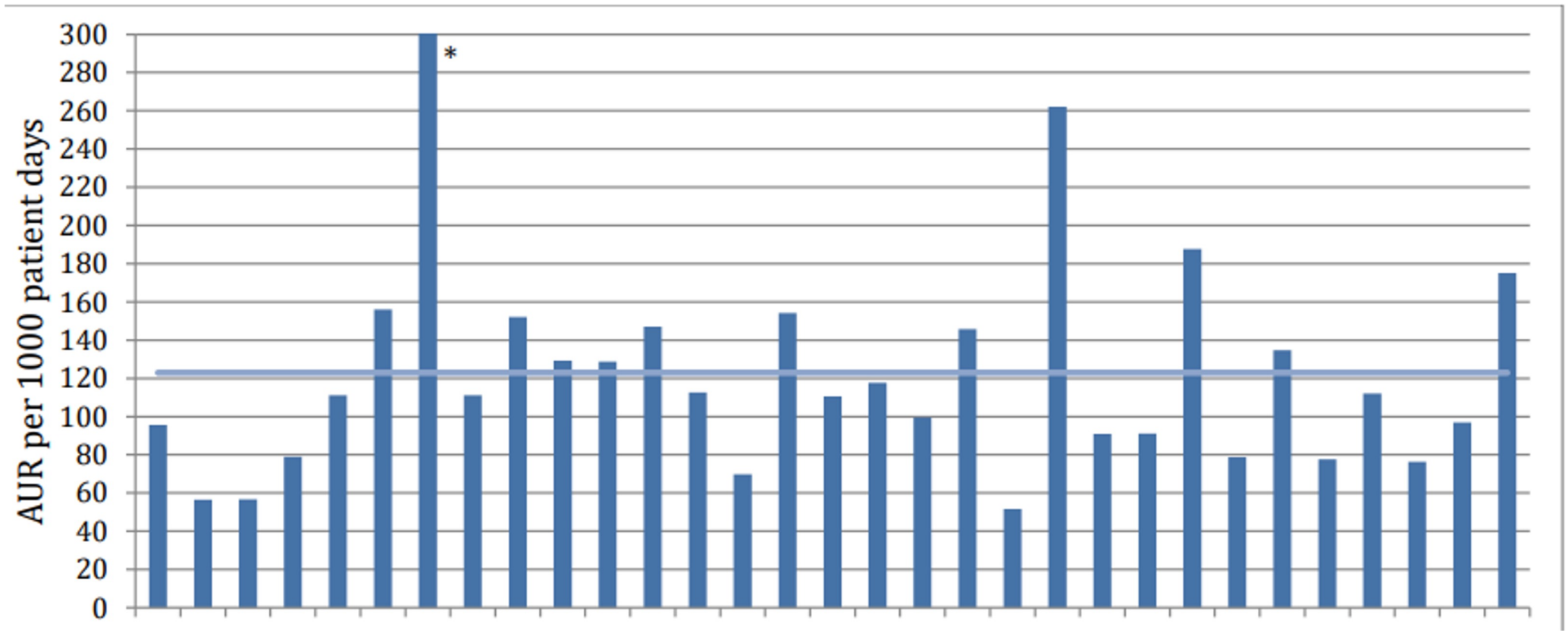
- Infection prevention strategies (visitor restrictions, hand hygiene, environmental disinfection, and donning of personal protective equipment).
- Vertical transmission
- Horizontal transmission

Antibiotics Stewardship

Days of antimicrobial use per 1000 patient days among neonates who did not develop NEC, early-onset sepsis or late onset sepsis: GA <33 weeks*



Days of antimicrobial use per 1000 patient days among neonates who did not develop NEC, early-onset sepsis or late onset sepsis: GA <29 weeks*



ABS


Core Elements of Hospital Antibiotic Stewardship Programs
Hospital Leadership Commitment
Dedicate necessary human, financial, and information technology resources.
Accountability
Appoint a leader or co-leaders, such as a physician and pharmacist, responsible for program management and outcomes.
Pharmacy Expertise (previously "Drug Expertise"):
Appoint a pharmacist, ideally as the co-leader of the stewardship program, to help lead implementation efforts to improve antibiotic use.
Action
Implement interventions, such as prospective audit and feedback or preauthorization, to improve antibiotic use.
Tracking
Monitor antibiotic prescribing, impact of interventions, and other important outcomes, like C. difficile infections and resistance patterns.
Reporting
Regularly report information on antibiotic use and resistance to prescribers, pharmacists, nurses, and hospital leadership.
Education
Educate prescribers, pharmacists, nurses, and patients about adverse reactions from antibiotics, antibiotic resistance, and optimal prescribing.

Role of IP&C Committee in the NICU

- Education
- Review
- Reporting both locally and nationally
- Liaise with ID and other committees
- Audit
- Research

Addressograph:

Alberta Health Services
Foothills Medical Centre NICU

EPIQ
Evidence-based Practice for Improving Quality

LOS Review

Step 1 Review Elements: The attending Neonatologist is to complete the following review elements for the case (*engage members of MDT for starred elements)

Intravascular Device Info	
Type of line(s) insitu at time of positive culture (include lines removed in last 48 hrs):	Insertion Date:
☐ UVC (single/double):	
☐ UAC	
☐ PICC	
☐ PIV	
☐ PAL	
☐ Other	
☐ No Lines	
If line(s) removed in last 48 hours, Date/Time of removal:	

Line Insertion*		
Was the insertion checklist used?	Yes	No
Were there any breaks in procedure noted? If Yes:	Yes	No
• Were corrective actions taken to maintian sterility?	Yes	No
Were there multiple attempts?	Yes	No

Line Maintenance*		
Was there daily discussion of line necessity?	Yes	No
# of line entries in previous 72 hrs: • Include: Line changes, intermittent medicaitons, new infusions, heparin locks, blood samples (UAC/PAL)		
# of skin breaks in previous 72 hrs: • Include: heel pokes, venepuncture, PIV/Central line attemtps/insertions,		
Were line maintenance audits regularly completed?	Yes	No

Catheter Related Complications*		
Were there any of the following line related complications in previous 72 hrs?		
• Leakage (including Trifuse filter leaks)	Yes	No
• Infiltration	Yes	No
• Occlusion	Yes	No
• Dressing change	Yes	No
• Breakage/Disconnection	Yes	No
Was line removed/replaced due to any of the above complications?	Yes	No

Positive Culture Details		
Type of Culture: ☐ Blood ☐ CSF		
Culture date & time:		
Organism Identified:		
Time to positivity (hrs):		
Collection Method: ☐ Venepuncture ☐ PIV Start ☐ LP ☐ Other:_____		
Repeat Culture Sent?	Yes	No

Other Cultures		
Were there other positive cultures in the past 7 days? If Yes: Type: ☐ETT ☐Sputum ☐Urine ☐Other: Organism(s) Identified:	Yes	No
Has the patient been colonized with any organisms at any time prior to positive culture? If Yes: Organizim(s) Identified:	Yes	No

Patient Demographics		
Date & Time of Birth:		
Birth GA:	BW:	grams
DOL:		
PMA at time of culture:		
Date of Review:		

Clinical Course Details In 72 hrs prior to positive culture		
Was the baby on respiratory support? If Yes: ☐ Invasive ☐ Non-Invasive	Yes	No
Was there a chest tube in situ?	Yes	No
Was there any surgical procedure? If Yes: Surgery Type:	Yes	No
Was there a diagnosis of NEC ≥ Stage 2 in the last week? If Yes, date:	Yes	No

Unit Specific Factors		
Were unit Hand Hygiene rates above 90% in the past month?	Yes	No
Has there been a unit infection spike/ outbreak in the past 2 weeks?	Yes	No
Was there an increase unit census or acuity in the past 2 weeks?	Yes	No
Were there significant staffing challenges in the past 2 weeks?	Yes	No

Additional Comments:

CORE

THANK YOU