Tennessee's Tiniest Babies: The Prevention of Hospital Acquired Infections

Tennessee Initiative for Perinatal Quality Care

Inter-Institutional Quality Improvement Project

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Introduction: What are we trying to accomplish?

Problem

Tennessee's preterm birth rate is amongst the highest in the nation as approximately 11% of all births in Tennessee are preterm.[1] Deaths secondary to prematurity are one of the leading contributors to Tennessee's high infant mortality rate.[2] This has historically been approximately 7 deaths per 1,000 live births.[3] A stated national priority in the "2030 Healthy People" objectives is the reduction of the US infant mortality rate to 5 deaths per 1,000 live births.[4] For Tennessee to meet this goal, there will need to be a reduction of approximately 25% of the current infant mortality rate.

Preterm birth is a multi-factorial problem that, despite national and state efforts remains relatively unchanged.[5] [6] Specifically, an increase in the number of the earliest preterm births (infants with birth weights of <750 g and gestational age of <28 weeks) has been implicated as the primary contributor to infant mortality rates.[7] Very preterm births, defined as <32 weeks and birth weight <1500g, represented 33% of all infant deaths in one report. In this study, more than two thirds of deaths attributable to preterm birth occurred during the first day of life and 27% of deaths occurred within the next 27 days. [8]

Variation in outcomes among NICUs have also been reported.[9] [10] [11] Practice variation, even amongst providers in the same group, can be a contributing factor to these varied outcomes.[12] [13] We have fortunately witnessed significant progress in the care of preterm infants over the past few decades. These advances have gradually moved from new technologies and medicines to how we care for these infants. This has led to improved survival rates and outcomes by the centers who have focused on improving the delivery of care.[14]

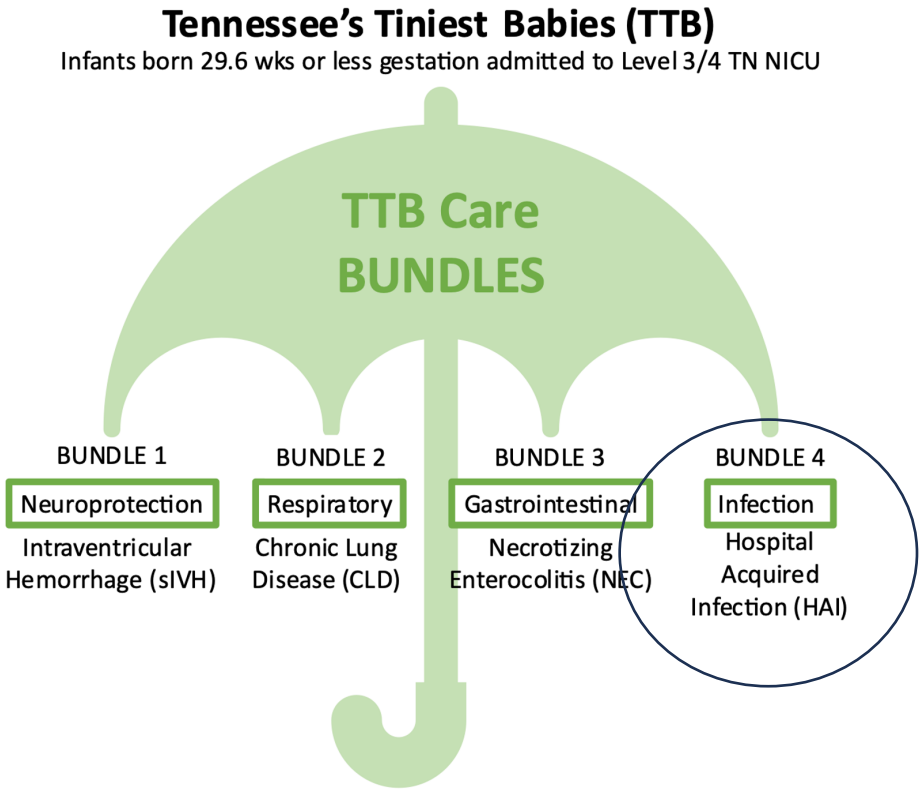
Tennessee has thirteen level 3 and 4 NICUs across the state who care for infants <32 weeks and a birth weight <1500g. In 2020, 1,352 babies, or 1.7% of live births, were born very preterm in Tennessee and cared for at these facilities.[3] Statistically, this group of infants represents approximately one-third of our state's infant deaths which include different outcomes amongst racial and ethnic groups. To lower Tennessee's infant mortality rate, meet the goal as put forth in the "2030 Healthy People" objectives, and improve care, a collaborative approach to the care along with the implementation of effective care strategies for Tennessee's Tiniest Babies should be undertaken.

Project Description

We are seeking to lower Tennessee's infant mortality rate to 5 deaths per 1,000 live births by focusing on the implementation of potentially better practices (PBPs) which can improve the survival rates and the outcomes of preterm infants born at less than 29.6 or less weeks gestation.

The development and implementation of the "Tennessee's Tiniest Babies'' (TTB) project will occur from Q3 2022 to Q3 2027. The project has been developed and will be launched in phases determined by specific care *bundles* – see Figure 1. The intent is to have participating hospitals implement the care bundles *cumulatively* – incorporating the potentially better practices from each bundle into their unit. *This toolkit is focused on the Hospital Acquired Infection (HAI) care bundle.* The project is proposed to end in Q2 2027, with data collection continuing through Q3 2027.

Figure 1: Tennessee's Tiniest Babies (TTB) Care Bundles



TIPQC agrees to the following:

- Provide a toolkit (see attachments) and other resources to participating teams.
- Offer monthly huddles, quarterly learning sessions, and annual statewide meetings.
- Facilitate the sharing between participating teams, allowing them to learn from each other.
- Facilitate capture of data metrics and provide reports to participating teams to show their progress towards improvement.
- Provide guidance and feedback to participating teams, facilitating their achievement of the project aim.

Participating teams will agree to the following:

- Hold regular, at least monthly, team meetings.
- Regularly review and revise team goals, current system, opportunities for improvement, and barriers.
- Plan and conduct tests of the recommended changes detailed in this toolkit.
- After successful testing and adaptation, implement the changes in their facility.
- Attend and actively participate in the monthly huddles, quarterly learning session, and annual statewide meetings.
- Capture and submit the defined project data as required (with minimal to no data lag).
- Submit a monthly report that includes data as well as information on changes being tested and/or implemented.
- Strive to achieve the project aim and the project's process and structure measure goals:
    - At least 90% compliance on all defined process measures.
    - Have all structures (defined by the structure measures) in place by the end of the project.

A dedicated extremely low birth weight (ELBW) team of staff (physicians, NNPs, nurses, respiratory therapist, speech/physical/occupational therapists, and lactation consultants) that have received special training in care of these

babies can have a big impact on overall care delivered. Many NICUs across the country have developed small baby units dedicated to providing care for the ELBW infants and have seen a significant reduction in mortality and morbidity in this population. Providing detailed guidelines to develop small baby units are out of scope for this project, but each NICU should assess its own capability /resources to develop specialized protocols/guidelines to care for their smallest babies.

Of note, success in the reduction of HAIs have been reported by NICUs who have implemented various quality improvement initiatives such as the use of central line insertion and maintenance bundles, standardized checklists, hand hygiene compliance monitoring, and multidisciplinary collaborative approaches, often achieving relative reductions in Central Line-associated Bloodstream Infection (CLABSI) rates of 60–80% and sustaining periods of zero infections in some units.[15]

Rationale

Despite early improvements with concerted efforts to improve the care of expectant mothers and infants, Tennessee's preterm birth rate and infant mortality rate have shown no significant, nor maintained, drop over the past decade. Twelve NICU's across the state care for infants which comprise approximately one-third of the state's infant mortality rate. No project has addressed the optimization of care in this population to improve the infant mortality rate despite this population's statistical importance.

There is a significant variation of care in the very preterm infant (29.6 weeks or less). Some NICUs in Tennessee have individually developed and implemented potentially better practices for the care of this population. Resources at other centers have made this difficult.

The California Perinatal Quality Care Collaborative (CPQCC) has previously demonstrated the impact a state's PQC can have on the mortality and morbidity in the very preterm infant population. CPQCC led a Delivery Room QI Collaborative which resulted in a reduction in mortality, severe intraventricular hemorrhage (sIVH), chronic lung disease (CLD), and retinopathy of prematurity (ROP) in infants 29.6 weeks or less.[16] As the state's perinatal care collaborative, TIPQC is poised to guide participating level 3 and 4 NICUs in the sharing of information and resources so that potentially better practices for this population can be developed and implemented across the network. Several of the participating hospitals already submit their data to the Vermont Oxford Network (VON).

Expected Outcomes and Benefits

Participating in this project will help participating centers improve the care of the very preterm infant (29.6 weeks or less) at their site. If successful, this project will (in turn) result in an improved survival rate with decreased morbidities in very preterm infants born in Tennessee. This will lead to meeting the "2030 Healthy People" objective. Ultimately, improving outcomes in Tennessee's Tiniest Babies should lead to decreased long term costs to the healthcare system.

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Aim Statement

The aim of the overarching TBB quality improvement (QI) project is:

- To reduce the mortality in infants less than or equal to 29.6 weeks gestational age by 25% of the Tennessee state baseline. There should be a dose response effect seen with the implementation of bundles which address broader global aims.

The aims of this HAI care bundle are:

- Primary aim: 25% relative reduction (compared to 2021-2023 institutional baseline data) in *hospital acquired infections** (HAIs) in infants less than or equal to 29.6 weeks gestational age in participating TN NICUs by Q2 2027, final data by Q3 2027.
    - *HAIs included in this project: positive blood cultures, CLABSI, Ventilator-Associated Pneumonia (VAP), and urinary tract infections (UTI)
    - Definitions for these HAIs can be found in the Measures section of this toolkit and in Appendix 1
- Secondary aim: 10% relative reduction in mortality of targeted infants by hospital discharge or 40 weeks corrected gestational age, whichever comes first (compared to 2021-2023 institutional baseline data) by Q2 2027, final data by Q3 2027.

The proposed aims and the results of the past care bundles were:

- The TIPQC Severe IVH (sIVH) Reduction Project (2023–2024), involving 12 Level III/IV NICUs, targeted a 25% relative reduction in sIVH for infants ≤29.6 weeks gestational age. While the primary sIVH outcome did not show reduction (baseline 9.0% to project mean 10.7%, potentially influenced by improved survival), the project achieved high engagement (98% data completion, 91% staff education) and secondary improvements in mortality (baseline 13.8% to 11.2%). Rates continue to be tracked, and practices are now in sustainment across participating units.
- The TIPQC Chronic Lung Disease (CLD) Reduction Project (2024–2025), involving 10 Level III/IV NICUs, targeted a 25% relative reduction in CLD for infants <30 weeks gestational age. Early results showed 60% of hospitals decreased overall CLD rates, with all hospitals reducing or maintaining severe (Grade 3) CLD and CLD-associated mortality (to 0% project mean). Rates continue to be tracked, and practices are now in sustainment across participating units.
- The TIPQC Necrotizing Enterocolitis (NEC) Reduction Project (2025-2026) is targeting a 25% relative reduction (over last 3 years institutional baseline) in *necrotizing enterocolitis* in infants less than or equal to 29.6 weeks gestational age in participating TN NICUs by Q2 2026, with final data expected by Q3 2026.

Summary of Evidence: *Prevention of Hospital Acquired Infections (HAI)*

Hospital-acquired infections (HAIs), also known as nosocomial infections, are a major cause of morbidity, mortality, prolonged hospitalization, and increased healthcare costs in neonatal intensive care units (NICUs). Premature and low-birth-weight infants are particularly vulnerable due to immature immune systems, fragile skin barriers, frequent invasive procedures (e.g., central lines, mechanical ventilation), and prolonged exposure to the hospital environment. Late-onset sepsis (LOS), defined as infection occurring after 72 hours of life, is predominantly hospital-acquired in NICU patients. The most common HAIs include central line-associated bloodstream infections (CLABSI), ventilator-associated pneumonia, and infections caused by multidrug-resistant organisms (MDROs). (See Appendix 1 for definitions.) CLABSI rates in NICUs vary widely, ranging from 3–22 per 1,000 central line days depending on unit practices and patient acuity, with higher rates in extremely low-birth-weight infants. Attributable mortality from CLABSI can reach 4–20%, and survivors often face neurodevelopmental impairments.

Significant variation exists across NICUs, with some achieving near-zero rates through sustained quality improvement efforts. According to Lapcharoensap et. al, Horbar et. al, and collaborative networks, such as the California Perinatal Quality Care Collaborative (CPQCC) and Vermont Oxford Network (VON), have demonstrated that targeted interventions can reduce CLABSI and overall HAI rates by 50–80%. In Tennessee, prior TIPQC initiatives focused on CLABSI reduction showed sustained improvements, highlighting opportunities for further progress in broader HAI prevention.

Evidence-based strategies, often implemented as "bundles," have proven effective in reducing HAIs and have included:

- **A Culture of Safety** helps create a learning environment and mindset to promote zero-HAI goals as a team
- **Hand hygiene** remains the cornerstone, with compliance monitoring and feedback leading to substantial reductions in infection transmission.
- **Environmental cleaning** (e.g., high-reliability practices, leadership rounds) support sustained zero-HAI goals
- **Central line insertion, maintenance, and removal bundles** (including maximal sterile barriers, chlorhexidine/alcohol antisepsis, and daily necessity reviews) consistently lower CLABSI rates https://www.cdc.gov/infection-control/hcp/nicu-clabsi/recommendations.html
- **Skin care and antisepsis protocols** tailored to preterm infants minimize skin injury while preventing entry of pathogens
- **Respiratory infection prevention** with equipment and visitation approaches
- **Family engagement, including exclusive human milk feeding** and avoidance of unnecessary acid suppression reducing non-device-related bacteremia
- **Antibiotic stewardship programs** (including diagnostic stewardship, guideline-based pathways, and antibiotic time-outs) decreasing unnecessary antimicrobial exposure, lower MDRO emergence, and reduce overall HAI rates without increasing adverse outcomes

Multifaceted quality improvement approaches, combining these potentially better practices with multidisciplinary teams, audits, and data feedback, have achieved dramatic and sustainable reductions. Targeting zero HAIs is realistic in many NICUs and our hope is that the recommendations in this toolkit will lead to that reality. Ongoing challenges include emerging MDROs and resource constraints, but collaborative statewide efforts like this TIPQC collaborative can drive meaningful improvements in Tennessee NICUs.

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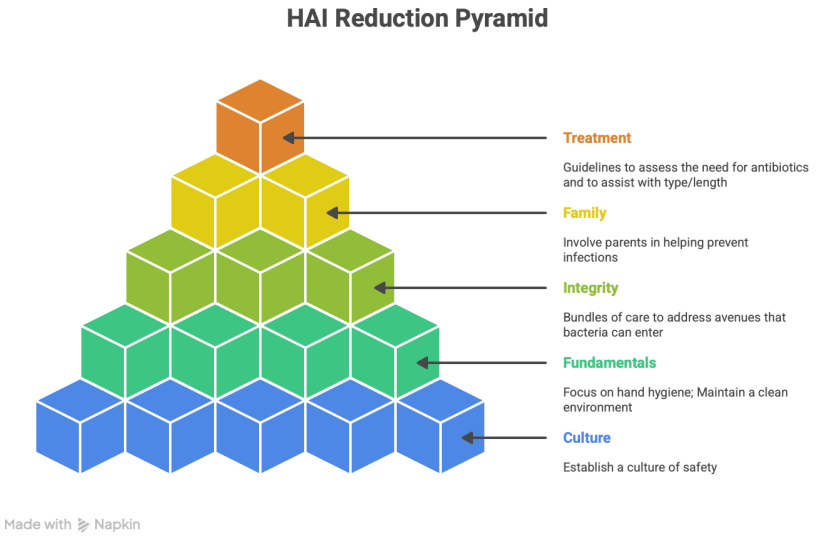

Potentially Better Practices for the Prevention of HAI

All improvement requires change. And while there are many kinds of changes that will lead to improvement, the specific changes are developed from a limited number of *change concepts*. As described in the Model for Improvement, "A change concept is a general notion or approach to change that has been found to be useful in developing specific ideas for changes that lead to improvement." These change concepts are used to design and run tests of change (i.e., Plan-Do-Study-Act (PDSA) cycles) to see if they result in improvement.

A similar idea to change concepts are *Potentially Better Practices* (PBPs), which are a set of clinical practices that have the potential to improve the outcomes of care. They are labeled 'potentially better' rather than 'better' or 'best' because until the practices are evaluated, customized, and tested in your own institution, you will not know whether the practices are truly 'better' or 'best' (or 'worse'). Depending on the circumstances in your facility, you may have to implement other practices or modify existing ones to successfully improve outcomes. The PBPs in this collection are not necessarily the only ones required to achieve the improved outcomes targeted. Thus, this list of PBPs is not exhaustive, exclusive, or all inclusive. Changes in practice, guided by these PBPs, will require testing and adaptation to your circumstances and context to achieve measured improvements in outcomes.

In designing this project and reviewing the evidence for practices that can reduce HAIs, TIPQC's faculty have recommended that all participating NICUs implement all these PBPs at a minimum. The relative decrease in CLABSI rates when a bundle of PBPs has been adopted has been reported to be 58–75%. It is vitally important that each NICU forms a multi-disciplinary team who can effectively implement these PBPs and possibly identify others which may be ideal for your facility and situation.

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Foster a Culture of Safety and Target Zero Hospital-Acquired Infections

Every NICU should foster a culture of safety and high reliability as a foundational element for targeting zero hospital-acquired infections (HAIs), using a multidisciplinary approach to prevention.

Adopting a goal of zero harm shifts the mindset from accepting HAIs as inevitable to recognizing them as preventable events. This expectation reinforces accountability and motivates staff to identify and mitigate risks at every opportunity.

A strong safety culture creates a learning environment where staff feel empowered to speak up, provide feedback, and raise concerns in real-time, regardless of role or discipline, without fear of blame. Emphasizing system improvements over individual fault (e.g., Just Culture principles) encourages reporting of near-misses and errors through occurrence reporting systems, enabling standardized learning and enhanced compliance.

Standardizing processes reduces human factors' variability and supports consistent performance of evidence-based practices. Multidisciplinary teams, leadership engagement (e.g., executive walk rounds), and tools like the Comprehensive Unit-based Safety Program (CUSP) promote high-reliability principles, teamwork, and sustained improvements.

- Form a multidisciplinary HAI prevention team including physicians, nurses, infection preventionists, pharmacists, respiratory therapists, and family representatives.
- Display and celebrate "days since last HAI" to reinforce the zero goal.
- Conduct regular safety huddles and debriefs after infections or near-misses.
- Implement leadership rounds to discuss barriers and recognize safe behaviors.
- When events happen, focus on system fixes rather than individual accountability.

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Establish Hand Hygiene Standards and Compliance Monitoring

Hand hygiene is the single most effective strategy for reducing hospital-acquired infections (HAIs) in the NICU. Multimodal interventions that improve hand hygiene compliance have led to significant reductions in nosocomial infections, including bloodstream infections.

Alcohol-based hand rubs are preferred for routine hand hygiene when hands are not visibly soiled, as they are more effective at removing transient flora and are less irritating to skin than soap and water.

A standard hand hygiene process should include the following:

- All healthcare workers and visitors should perform hand hygiene using the World Health Organization's "My 5 Moments for Hand Hygiene," adapted for the NICU environment.
- Upon unit entry, perform a full hand wash with soap and water (including under nails and up to elbows) or use alcohol-based hand rub if hands are not soiled.
- Use soap and water (15–20 seconds) when hands are visibly dirty, after restroom use, or during outbreaks involving Clostridioides difficile or norovirus.
- Perform hand hygiene:
    - Before entering the patient's space and touching the patient.
    - Before donning sterile gloves.
    - Before inserting invasive devices that do not require a surgical procedure such as indwelling urinary catheters, peripheral intravenous catheters, and lab draws.
    - Before an aseptic task or handling invasive devices.
    - Before moving from work on a soiled body site to a clean body site on the same patient.
    - After body fluid exposure risk or contact with blood, body fluids, or contaminated surfaces.
    - After touching a patient or the patient's immediate environment.
    - Immediately after glove removal.
    - When hands become soiled (e.g., after sneezing, coughing, or blowing your nose).
- All healthcare workers and visitors should be bare below the elbows (no jewelry, including wedding bands; no watches; short sleeves or sleeves rolled up).
- Natural nails should be kept short (less than ¼ inch long).
- Chipped nail polish is not permitted; if polish is allowed per hospital policy, it must be fresh and intact.
- Artificial nails or enhancements are prohibited for direct caregivers, as the subungual area harbors pathogens that cannot be adequately decontaminated.
- Gloves should be worn for anticipated contact with blood, body fluids, or non-intact skin.
- ***Routine universal gloving is not recommended for most patients in the NICU***, as evidence is unresolved for reducing infections and it may lead to reduced hand hygiene compliance. It is, however, not unreasonable to consider in infants <1000g during the first 7 days of life. Change gloves between patients or tasks on the same patient.

Compliance monitoring through direct observation (including secret shoppers) captures opportunities by moment and role, with regular feedback to improve performance. Other hospitals may have automated Hand Hygiene monitoring systems.

- Place alcohol-based hand rub dispensers at point of care and unit entry.

- Conduct regular audits and share results with staff.
- Educate families on hand hygiene upon entry.
- Integrate reminders and targets into daily huddles.

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Maintain a Clean and Sanitary Environment

Environmental contamination plays a significant role in the transmission of pathogens in the NICU, contributing to hospital-acquired infections. Regular cleaning of high-touch surfaces and equipment reduces microbial load and cross-contamination risks.

All patient care areas, equipment, and bed spaces should be thoroughly cleaned between patients using hospital-approved disinfectants effective against common NICU pathogens.

High-touch surfaces should be cleaned at least at the beginning of each shift and as needed. These include isolette handles, monitor controls, bedside carts, IV pumps, keyboards, door handles, and light switches. Consistent cleaning removes accumulated pathogens and minimizes transmission before new care activities begin.

Additional strategies to support a sanitary environment include the following:

- Use hospital-approved detergent/disinfectant solutions for routine equipment cleaning.
- Clean items contaminated with blood or body fluids immediately with an appropriate disinfectant.
- Cohort patients with MRSA (or those expected to remain on isolation/transmission-based precautions throughout hospitalization, in consultation with the Infection Prevention team) to reduce spread.
- When pairing isolated patients with non-isolated infants is unavoidable, prioritize pairing with non-surgical infants >1500 grams birth weight and with the fewest invasive devices.
- Increase frequency of surface cleaning in bedside areas for isolated patients.
- Use negative pressure rooms when appropriate for airborne precautions.
- Store extra linen in closed cabinets or covered areas.
- Prohibit stuffed animals at the bedside due to difficulty in cleaning.
- Place a barrier (such as a blanket or cover gown) between staff/parent clothing and the infant during holding or kangaroo care.

- Encourage regular cleaning of badges, keyboards, and personal devices: staff and parents should use germicidal wipes or UV devices to disinfect cell phones and other electronics before and after NICU entry/use, followed by hand hygiene before infant contact.
- Develop unit-specific cleaning checklists and assign accountability (e.g., shift-based responsibilities).
- Audit environmental cleaning compliance regularly with feedback.
- Educate staff and families on environmental hygiene roles.

Products to consider:

- Hospital-approved germicidal wipes safe for electronics (e.g., those without bleach or high alcohol content that could damage screens).
- UV-C mobile device sanitizers (e.g., CleanSlate UV for multi-device rapid cycles; PhoneSoap Med+/ExpressPro for healthcare settings).

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Standardize Central Line, Urinary Catheter, and Nasogastric/Orogastric Tube Placement, Maintenance, and Removal; Provide Cautionary Steps for Eye Care

Central line-associated bloodstream infections (CLABSIs) remain a leading cause of hospital-acquired infections in the NICU, with increased risk from prolonged catheter dwell time and non-standardized care. Urinary tract infections from indwelling catheters are less common but preventable through rigorous technique. Conjunctival colonization and infection can also occur in vulnerable preterm infants. Nasogastric/orogastric (NG/OG) feeding tubes, while essential for enteral nutrition, can become colonized with pathogens and contribute to non-device-related bacteremia if not managed properly.

Standardizing insertion, maintenance, and prompt removal practices using evidence-based bundles significantly reduces infection rates. Daily review of necessity and early enteral feeding advancement facilitate timely removal.

Central Line Practices

- Use maximum sterile barriers during insertion of umbilical and central venous lines (sterile gown, gloves, full drape, mask, and hat for all personnel).
- Restrain long hair to avoid contact with sterile fields or infants.
- Limit insertion and maintenance to trained healthcare workers educated in CLABSI prevention.
- Apply sterile occlusive dressings to PICC and tunneled catheter sites.
- Secure catheters to prevent migration, dislodgement, or pistoning, which can introduce pathogens. Consider use of cyanoacrylate glue at the insertion site in addition to engineered securement devices for enhanced fixation.

- For skin antisepsis in infants >28 weeks gestational age, use chlorhexidine-based solutions (e.g., ChloraPrep) unless contraindicated; alternatives include povidone-iodine or 70% alcohol for infants <28 weeks.
- Minimize system manipulations and accesses.
- Scrub hubs/ports with alcohol for 15–30 seconds (or per unit policy for shorter effective swipes) before access.
- Use single-use alcohol port protectors (e.g., alcohol port protector) on all injection ports.
- Change tubing at least every 96 hours (every 24 hours for lipids or intermittent infusions disconnected between uses); change all tubing with new insertions.
- Document maintenance using standardized bundle checklists.
- Review line necessity daily during rounds, document indication daily, and remove promptly when no longer required.
- Recommended dwell times for UVC's is 7-10 days, UAC's 5-7 days. If long term access is needed, consider early umbilical catheter removal at 4 days and PICC line placement.

Urinary Catheter Practices

- Perform insertion as a two-person sterile procedure with the inserter wearing sterile gloves.
- Utilize dedicated catheter insertion kits.
- Document maintenance using bundle checklists.
- Remove catheters as soon as clinically possible.

Eye Care Practices

- Monitor eyes routinely for signs of infection or abrasion.
- Clean exudate from inner to outer canthus using single-use saline-soaked cotton balls.
- Apply synthetic tears or lubricating ointment every 4–6 hours (or as needed) in infants with reduced eyelid function (e.g., extreme preterm, sedated, or paralyzed).
- Audit bundle compliance regularly with feedback to staff.

Nasogastric/Orogastric Tube Practices

- Secure tubes properly to prevent displacement.
- Verify placement before each use (inspection of gastric contents; auscultation with 1ml of insufflated air; radiographic confirmation if needed).
- While the optimal replacement schedule is not known at this time, we advise that routine scheduled replacement should be considered at 7 days due to concern for the contribution to an enteral infection.
    - Replace tubes when clinically indicated (e.g., clogged, dislodged, or soiled).
- Use aseptic technique for handling and administration of feeds to minimize contamination.
- Audit bundle compliance regularly with feedback to staff.

Products to consider:

- Chlorhexidine-based antiseptics (e.g., ChloraPrep).
- Alcohol port protectors (e.g., Curos caps).
- Engineered catheter securement devices (e.g., StatLock).

- Cyanoacrylate glue for insertion site securement (e.g., SecurAcath or similar tissue adhesives recommended for reducing dislodgement).
- Synthetic tear ointments or drops.

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Protect Fragile Skin with Disinfection, Cleansing, Dressing Securement, and Injury Prevention Measures

Preterm neonatal skin is immature, fragile, and highly permeable, increasing risks of injury, infection entry, and hospital-acquired pressure injuries. Standardized skin care, careful antisepsis, securement, and preventive measures preserve barrier function and reduce medical adhesive-related skin injury (MARSI) and pressure damage.

Perform and document a thorough head-to-toe skin integrity assessment each shift and with each cluster care time. Identify risk factors for skin breakdown, including gestational age ≤25 weeks (where skin is extremely thin and gelatinous; consider specialized protocols like burn sheets or humidified incubators).

Key Skin Care Practices

- Assess skin around IV sites (including central lines) and document hourly.
- Disinfect skin before central line insertion: use chlorhexidine-based solutions if >28 weeks gestational age unless contraindicated; alternatives include povidone-iodine or 70% alcohol for infants <28 weeks.
- Bathe stable patients every 3-4 days with mild soap and water or bath wipes.
- Consider chlorhexidine-impregnated wipes for targeted cleansing in patients with central lines, MRSA/MSSA colonization, or before surgery (use with caution per product labeling for infants <2 months; follow manufacturer directions).
- Have caregivers cleanse their hands/arms with hospital-approved wipes before skin-to-skin holding to reduce pathogen transfer.
- Utilize preventive measures to minimize MARSI and pressure injuries: apply skin barrier films, use silicone-based adhesives when possible, rotate device sites (e.g., saturation probes, temperature probes, CPAP interfaces),

ensure proper fit of CPAP hats/prongs/masks, and use gel mattresses or hydrocolloid dressings (e.g., Duoderm) under pressure points.

- Change patient position every 3–6 hours based on condition and tolerance.
- Change diapers during hands-on care and position changes.
- Develop unit-specific skin risk assessment tools and audit compliance.
- Consult dermatology or wound specialists for rashes or complex injuries.

MRSA/MSSA Screening and Management

- Routine universal active surveillance screening for MRSA colonization is not recommended in the absence of ongoing transmission or outbreaks.
- Consider active surveillance testing (e.g., nasal swabs) when there is evidence of increased MRSA incidence, ongoing healthcare-associated transmission, or during outbreaks, in consultation with the Infection Prevention team.
- Factors influencing implementation include unit structure (e.g., open pods vs. individual rooms), baseline MRSA rates, and cost considerations.
- Identified colonized infants should prompt contact precautions, cohorting where feasible, and potential targeted decolonization per unit policy.

Products to consider:

- Chlorhexidine-based antiseptics (e.g., ChloraPrep).
- Silver-based or chlorhexidine-impregnated wipes (for targeted use).
- Hydrocolloid dressings (e.g., Duoderm).
- Skin barrier films or sprays.

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Defend Against Respiratory Infections with Ventilator Maintenance and Visitation Guidelines

Ventilator-associated pneumonia (VAP) and other respiratory infections are significant risks in mechanically ventilated neonates due to immature immunity, endotracheal tubes bypassing natural defenses, and exposure to pathogens. Standardized equipment maintenance, oral care, and visitor screening can reduce microbial colonization and transmission.

Ventilator and Suction Equipment Maintenance

- Change ventilator tubing on a regular basis per manufacturer and unit guidelines.
- Change inline suction catheters (e.g., multi-access catheter) every other day for ventilated patients.
- Change all suction canisters and connecting tubing when grossly soiled or at least weekly; date and time when placed in service.
- Change nasal aspirators every 24 hours or as needed if unable to clear secretions.
- Clear suction lines with sterile water or saline after each suctioning event.
- Change bulb syringes regularly per unit policy.

Oral Care and Immune Therapy

- Provide routine oral care to intubated infants to maintain a clean mouth and reduce bacterial load.
- Consider oropharyngeal administration of mother's own colostrum (oral immune therapy) as early as possible, which has been associated with reduced incidence of VAP.

Visitation Guidelines

- Assess all visitors for signs of communicable disease upon entry (e.g., self-reported questionnaire or screening for fever, cough, sore throat, runny nose, vomiting/diarrhea, rash, or known exposure to chickenpox, measles, lice, or bed bugs).
- Communicate guidelines clearly through orientation materials, signage, and education for parents and visitors.
- During periods of high community respiratory virus circulation (e.g., flu, RSV, COVID-19), in collaboration with the Infection Prevention team:
    - Require masking for all staff.
    - Strongly recommend (but not mandate) masking for visitors, especially parents.
- Restrict visitors with active respiratory symptoms until resolved.
- Incorporate maintenance checks into daily workflows and audit compliance.
- Educate staff on early extubation readiness to minimize ventilation duration.

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Engage Parents and Families in Infection Prevention

While parent engagement is critical, encourage healthy non-ill family members to be involved in care.

Parents play a crucial role in preventing infections in the NICU by actively participating in their infant's care through infant- and family-centered developmental care (IFCDC). This approach emphasizes continuous parental presence, skin-to-skin contact (SSC), and breastfeeding, which collectively reduce the risk of late-onset sepsis and hospital-acquired infections.

SSC, often integrated into kangaroo mother care (KMC), allows parents to hold their infant against their cleansed skin, promoting the development of a diverse skin microbiome that mirrors the family's rather than the hospital environment's potentially harmful bacteria.

Breastfeeding, particularly with fresh, unpasteurized mother's own milk, provides essential probiotics, bioactive proteins, oligosaccharides, and immunoglobulins like secretory IgA and IgM, which bolster the infant's immune system and gut microbiome and offers protection against infections.

Additionally, oropharyngeal administration of colostrum (oral immune therapy) can further enhance immune defenses and reduce risks such as neonatal sepsis and necrotizing enterocolitis.

By engaging in care activities, parents can also improve overall safety and quality in the NICU, potentially leading to fewer invasive procedures like catheter placements or parenteral nutrition, which are risk factors for infections.

Continuous parental involvement, such as attending rounds and advocating for their infant, encourages staff to prioritize non-invasive practices and minimize unnecessary interventions.

Moreover, facilitating early discharge with adequate follow-up support allows parents to transition care responsibilities sooner. This will reduce prolonged exposure to the hospital environment and its associated infection risks.

Each NICU should evaluate the parental role and highlight the importance of empowering parents as key partners in infection prevention strategies.

- Support unlimited parental presence and participation in care when the parent is healthy.
- Educate parents on hand hygiene, skin cleansing before SSC, and signs of illness that preclude visits.
- Promote early and frequent SSC with proper barriers and hygiene.
- Provide lactation support for expression and provision of mother's own milk.
- Facilitate oropharyngeal colostrum administration when direct feeding is not possible.

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Use Antibiotics Appropriately

Antibiotic overuse in the NICU contributes to multidrug-resistant organisms (MDROs), gut dysbiosis, increased risk of necrotizing enterocolitis (NEC), and other adverse outcomes like prolonged hospitalization. Multidisciplinary stewardship programs reduce unnecessary exposure through standardized pathways, diagnostic stewardship (e.g., optimal culture volumes, biomarker use), metrics like antibiotic use rate (AUR) and days of therapy (DOT), and regular audits with feedback. These programs have safely lowered antibiotic use by 20–50% in NICUs without increasing sepsis-related morbidity or mortality.

TIPQC recommends that each NICU:

- Form a stewardship team including neonatologists, nurse practitioners, pharmacists, infection preventionists, nurses, respiratory therapists, and parents.
- Develop unit-specific pathways for early-onset sepsis (EOS), late-onset sepsis (LOS), and NEC based on local antibiograms and pathogen surveillance using the recommendations below.
- Monitor AUR/DOT monthly and target reductions through education, automatic antibiotic time-outs at 36 or 48 hours, and de-escalation protocols.
- Incorporate biomarkers (e.g., C-reactive protein, procalcitonin) for guided discontinuation in culture-negative cases. Please review our recommendations concerning how to effectively use these biomarkers below.

Early Onset Sepsis (EOS) Evaluation and Management

EOS, typically occurring within 72 hours of birth, is often due to maternal colonization or intrapartum factors. Risk stratification minimizes unnecessary antibiotics in low-risk preterm and term infants, supporting stewardship goals. Although the aim of this tool kit is geared towards infants <30 weeks gestation, antibiotic stewardship can be of benefit to all infants in the NICU. Below are guidelines for empiric antibiotic use for all gestations.

For infants ≤34 6/7 weeks gestational age:

- Lowest risk (e.g., maternal preeclampsia, placental insufficiency, cesarean delivery without labor): No routine laboratory evaluation or empiric antibiotics; perform blood culture and clinical monitoring if indicated.
- Highest risk (e.g., cervical incompetence, preterm labor, PROM >18 hours, intrauterine inflammation/infection, acute non-reassuring fetal status): Obtain CBC, blood culture (≥1 mL), and consider CSF if neurologic symptoms; initiate empiric antibiotics (ampicillin + gentamicin) promptly.

For infants ≥35 weeks gestational age:

- Use a sepsis calculator (e.g., Kaiser Neonatal Sepsis Calculator) to estimate risk.
- Clinically ill infants (those exhibiting signs consistent with Multisystem Organ Failure or those with Triple I): Obtain CBC, blood culture, and CSF if clinically indicated; start empiric antibiotics within 1 hour of being ordered.
- Maternal GBS colonization with inadequate IAP but no additional risks: Observe in hospital for 48 hours; no labs or antibiotics unless symptomatic.

C-reactive protein and procalcitonin are not recommended for routine EOS evaluation due to low specificity from perinatal confounders and leading to the potential for overtreatment. It is best to rely on risk stratification (e.g., calculators) and cultures for most EOS evaluations. The use of serial biomarkers could be used to effectively rule out and discontinue empiric therapy after 48 hours.

Empiric regimen: Ampicillin and Gentamicin remain the gold standard for early onset sepsis. Dosing and frequency are based on the most recent recommendations for use. For non-CNS involvement Ampicillin dosing for infants <34 weeks is 50 mg/kg/dose Q12h, infants 34 weeks and greater the dosing recommendation is 50 mg/kg/dose Q8h. For concerns of CNS involvement, Ampicillin should be increased to 100 mg/kg Q8h for all gestations. Gentamicin dosing for infants 29 weeks and less is 5 mg/kg/dose Q48h, infants 30-34 weeks is 4.5 mg/kg/dose Q36h, and infants 35 weeks and greater is 4 mg/kg/dose Q24h. Recommend customizing if maternal history suggests alternative coverage (e.g., recent urine culture).

Discontinue antibiotics at 36–48 hours if cultures are negative the infant is stable.

There is growing evidence supporting discontinuation of empirical antibiotics at **24 hours** in select low-risk scenarios. This approach is based on data showing that the vast majority (>95–99%) of true pathogenic bacterial growth in EOS blood cultures is detected within 24 hours, with very few additional positives between 24 and 48 hours. Antibiotics could be stopped at 24 hours if:

- The infant is **clinically well** (no signs of respiratory distress, temperature instability, hypotension, or other sepsis indicators).
- Blood culture shows **no growth** at 24 hours.
- **Low pretest probability** of EOS, quantified using a validated tool such as the Kaiser Permanente Neonatal EOS Calculator (risk <1–3 per 1,000 live births, depending on institutional threshold).
- Adequate intrapartum antibiotic prophylaxis (IAP) if maternal GBS-positive or other indications.
- No concerning maternal history (e.g., untreated chorioamnionitis) or abnormal ancillary labs (e.g., significant leukopenia, thrombocytopenia).
- This is primarily indicated in **term or late-preterm infants** (>34–35 weeks gestation); in very preterm or extremely low birth weight infants, caution is advised due to higher baseline risks and potential for atypical presentations.

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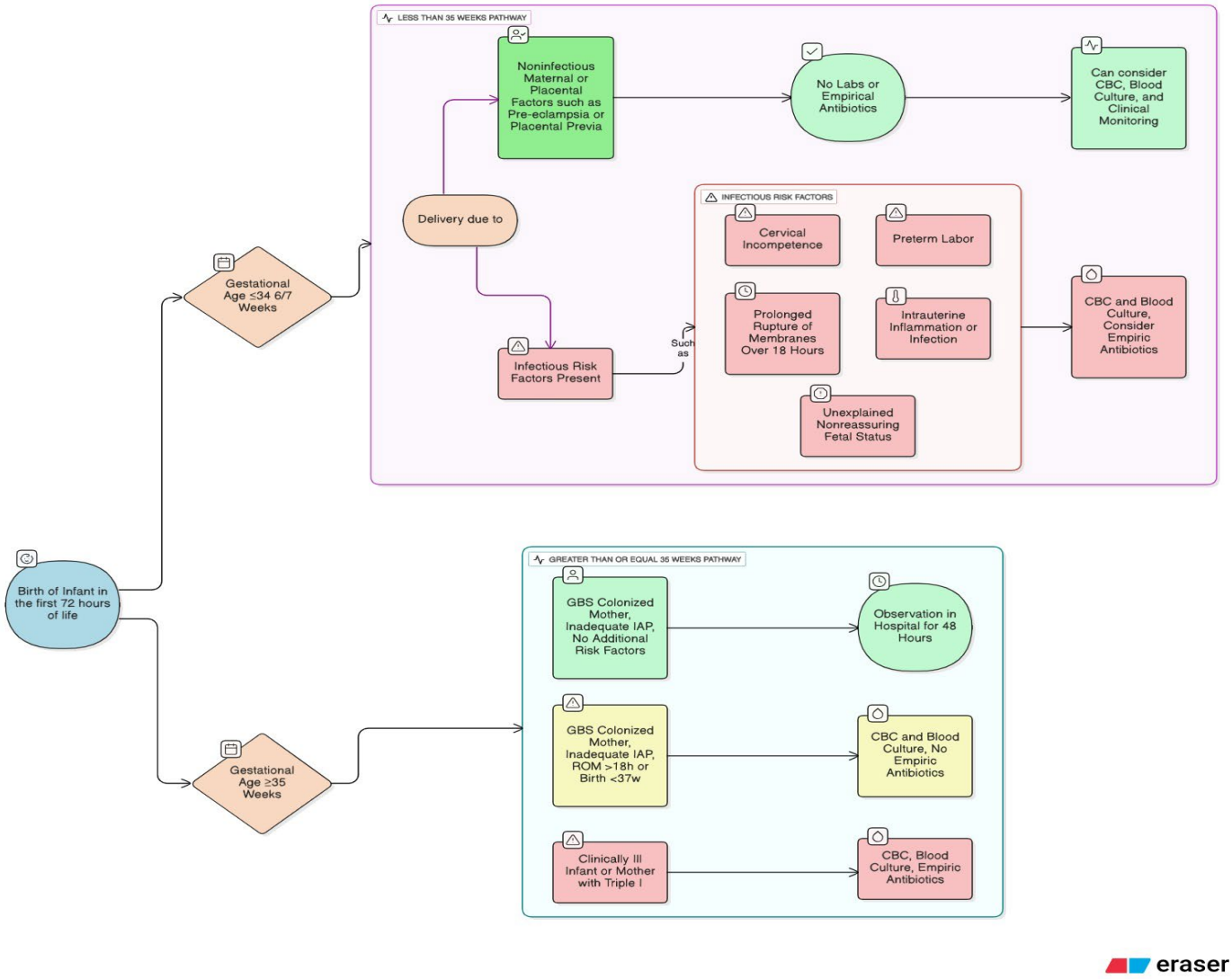

Late Onset Sepsis (LOS) Evaluation and Management

LOS, defined as infection after 72 hours of age, is predominantly hospital-acquired in preterm infants, with incidence peaking in the first weeks.

Clinical signs include temperature instability, lethargy, irritability, tachypnea, tachycardia, increased apnea/bradycardia, increased oxygen requirement, increased work of breathing, hypotonia, hyperglycemia, acidosis, vomiting, feeding intolerance, hypotension, abdominal distension, and bloody stools.

Diagnostic approach: Obtain cultures before antibiotics (blood ≥1 mL, urine via catheter/suprapubic aspiration (SPA), CSF if neurologic symptoms or severe apnea, tracheal aspirate if recently intubated, radiograph if respiratory/GI signs). Include CBC/differential and inflammatory markers (c-reactive protein or procalcitonin). Procalcitonin is preferred at presentation and serially (e.g., 12–24 hours) in suspected cases to guide initiation, de-escalation, and duration, especially in culture-negative scenarios, as this can support safe antibiotic reduction without compromising outcomes. If procalcitonin is unavailable, use c-reactive protein similarly. Always integrate with clinical assessment and local

guidelines for optimal use. If there is any concern that the pathogen may be HSV, then HSV cultures and PCRs should also be obtained.

For urine culture: Gold standard is single organism ≥50,000 CFU/mL via SPA/catheter; consider ≥10,000 CFU/mL with clinical indicators.

Empiric antibiotics: Reevaluate routine broad use (e.g., vancomycin for MRSA/central lines, gentamicin/cephalosporin for gram-negatives) based on local antibiograms (MRSA often <10% in LOS); consider narrower agents like oxacillin/nafcillin for gram-positives (e.g., CoNS). Omit ampicillin unless specific risks. Add acyclovir if HSV is a concern. Remind staff that antibiotics should be given within one hour of being ordered.

Continued evaluation: Repeat CBC/PCT or CRP at 12–24 hours, radiograph as needed; consider viral etiologies.

Discontinue antibiotics if well-appearing, symptoms resolved, cultures negative at 36 hours, and normal/improving markers.

For culture-negative sepsis with persistent symptoms: 5–7 days of treatment (longer for PMA <25 weeks), but shorten with normalizing PCT or CRP.

For positive cultures: Consult ID, obtain LP if not done, repeat blood culture at 48 hours, continue 10–21 days based on organism/susceptibility (e.g., 10 days gram-positive, longer for gram-negative/meningitis), document CSF sterility; days of treatment are counted starting with the first negative culture.

Fungal prophylaxis: Each participating NICU should review their internal data and current criteria for fluconazole prophylaxis as a subset of infants covered by this toolkit are high risk for invasive fungal disease.

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Necrotizing Enterocolitis (NEC) Management

Bacteria play a role in NEC pathogenesis, with concurrent bacteremia in many cases. Empiric antibiotics are broad, covering LOS pathogens plus anaerobes for advanced disease.

Standardize via algorithms correlated to Bell's stages or variations to reduce variation, NPO time, and antibiotic exposure without increasing morbidity. An example of the algorithm in use at Le Bonheur Children's Medical Center has been provided.

Tailor based on unit antibiogram; consider monotherapy like piperacillin-tazobactam for ≥IIA in some centers but prefer narrower regimens to minimize resistance.

Fungal prophylaxis should be added for prolonged exposure.

Stage	Classification	Systemic signs	Intestinal signs	Radiographic signs	NPO duration	Antibiotic	Feeds
IA	Suspected NEC	Perinatal stress, Temp instability, Apnea, bradycardia, lethargy	Abdominal distention, emesis, blood in stool	Normal or intestinal dilation, Mild ileus	24 to 48 hrs	48- 72 hrs Broad spectrum abx	Resume feeds at 50% volume and advance by 25% every 3rd feed to goal volume.
IB	Suspected NEC	Same as above	Blood in stool	Same as above	48 hrs with resolution of symptoms and screen negative.	48- 72 hrs Broad spectrum abx	Resume feeds at 50% volume and advance by 25% every 3rd feed to goal volume.
IIA	Proven NEC-Mild illness	Same as above	Same + +/- abdominal tenderness	Intestinal dilation, ileus, Pneumatosis intestinalis	Q12h KUB. NPO until resolution of Pneumatosis in 2 KUB (12hr apart) with documentation of Bowel sounds.	Ampicillin + Gentamicin 5 days	Feed at 20ckd until completion of antibiotics and advance by 25% every 3rd feed to goal volume.
IIB	Proven NEC Mod illness	Same as above + Mild metabolic acidosis, mild thrombocytopenia	Same as above + abdominal tenderness, abd cellulitis or RLQ mass	Same as IIA, Portal venous gas +/- ascites	Same as above + off pressors and improvement in metabolic acidosis & thrombocytopenia and decline in CRP	Ampicillin + Gentamicin 7 days	Trophic feeds at 20ckd until completion of antibiotics and advance by 25% of goal feeds Q12H to goal feeds.
IIIA	Advanced NEC-Severely ill, bowel intact	Same as IIB + hypotension, bradycardia, respiratory and metabolic acidosis, DIC and neutropenia	Same as above + peritonitis	Same as IIB, definite ascites	Resolution of pneumatosis /portal air in 2 KUB (12hr apart) + off pressors, improvement in metabolic acidosis &thrombocytopenia and after 7days NPO	Ampicillin + Gentamicin + Metronidazole 10 days	Trophic feeds 20ckd until completion of antibiotics and advance by 25% goal feeds Q12H.
IIIB	Advanced NEC-Severely ill bowel perforated	Same as IIIA	Same as above	Same as IIB plus Pneumoperitoneum	Until completion of ABX for NEC	Ampicillin + Gentamicin + Metronidazole 14 days	Refer to surgical NEC guidelines
SIP	Mild ill +Perforation	Mild, usually none	Benign	Pneumoperitoneum	Until completion of ABX for NEC	Ampicillin + Gentamicin + Metronidazole	Refer to surgical NEC guidelines

Source: Lebonheur Children's Guideline (with permission to use)

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Nursing Focus: Education & Nursing Care

Standard nursing education is needed. Suggestions for this education are included in Appendix 2.

Intraventricular Hemorrhage (IVH), Chronic Lung Disease (CLD), and Necrotizing Enterocolitis (NEC)

TIPQC has developed an Intraventricular Hemorrhage (IVH), Chronic Lung Disease (CLD), and Necrotizing Enterocolitis (NEC) Projects designed for all infants born in Tennessee. Further information on these projects and how to improve your rates can be obtained in the TIPQC toolkits for these projects.

References-

- TIPQC Tennessee Tiniest Babies: The Prevention of Necrotizing Enterocolitis. Available at: https://tipqc.org/nec/
- TIPQC Tennessee Tiniest Babies: The Prevention of Chronic Lung Disease. Available at: https://tipqc.org/project-chronic-lung-disease/
- TIPQC Tennessee Tiniest Babies: The Prevention of Severe Intraventricular Hemorrhage. Available at: https://tipqc.org/project-intraventricular-hemorrhageproject/

Measures: *How will we know that a change is an improvement?*

Target population

Infants born *29.6 or less weeks gestation* admitted to one of the participating NICUs for care.
This includes all infants including transfers admitted within 24 hours of birth. In the case of multiples (e.g. twins), a record should be captured for EACH infant. Infants that died in the delivery room or that died within 24 hours of admission to the NICU should be EXCLUDED. All infants transferred will stay with the receiving hospital UNLESS HAI occurs within 48 hours transfer.

Outcome measures

Outcome measures will be calculated from the captured "TIPQC TTB- HAI PROJECT MONTHLY CLINICAL CARE CHECKLIST" form and entered into the designated platform MONTHLY. See form for details. *Outcome measures #1 and #5 will be collected by race, ethnicity, and payor status.*

#1. Number of positive blood cultures (excluding admission blood cultures)^/Number of infants <29.6 weeks or less in NICU
#2. Number of Central Line-Associated Blood Stream Infections (CLABSI) cases*/Number of infants <29.6 weeks or less in NICU
#3. Number of Ventilator-Associated Pneumonia (VAP) cases**/Number of infants <29.6 weeks or less in NICU (Optional but strongly encouraged if feasible)
#4. Number of Urinary Tract Infection (UTI) cases***/Number of infants <29.6 weeks or less in NICU
#5: Mortality: Number of infants deceased/Number of infants <29.6 weeks or less in NICU

Baseline Data:

- Participating NICUs will retrospectively capture and report annual positive blood culture rates excluding admission blood cultures (both among the target population) for the 4 years prior to the project start (2022, 2023, 2024, and 2025).
- Participating NICUs will retrospectively capture and report annual CLABSI rates (both among the target population) for the 4 years prior to the project start (2022, 2023, 2024, and 2025).
- Participating NICUs will retrospectively capture and report annual VAP rates (both among the target population) for the 4 years prior to the project start (2022, 2023, 2024, and 2025).

- Participating NICUs will retrospectively capture and report annual UTI rates (both among the target population) for the 4 years prior to the project start (2022, 2023, 2024, and 2025).
- Participating NICUs will retrospectively capture and report annual mortality rates (both among the target population) for the 4 years prior to the project start (2022, 2023, 2024, and 2025).
- This baseline data will serve as the "institutional baseline" from which they are trying to improve (planned 25% reduction in CLABSI, VAP and 10% reduction in mortality).

These Baseline Data will be calculated from the captured "TIPQC TTB- HAI PROJECT BASELINE Data Collection Form" in SimpleQI.

Use the following definitions of Positive Blood Culture, Central Line-Associated Blood Stream infections (CLABSI), Ventilator-Associated Pneumonia (VAP), and Urinary Tract Infection (UTI) cases when capturing data on these Outcome Measures:

^Positive Blood Culture definition (non-admission): Any laboratory confirmed bacterial growth on a blood culture not obtained at birth or associated with confirming proper treatment of a congenital infection. If the positive blood culture is identified as a contaminant by the medical team, there will be a place to note this.

***Central Line-Associated Blood Stream Infections (CLABSI) definition:** A laboratory confirmed bloodstream Infection that is not secondary to an infection at another body site.

Types of Central Lines would include the following:

1. Permanent Central line:
    a. Tunneled catheters, including tunneled dialysis catheters
    b. Implanted catheters (including ports)
2. Temporary central line: A non-tunneled, non-implanted catheter
3. Umbilical catheter: A vascular catheter inserted through the umbilical artery or vein in a neonate. All umbilical catheters are central lines.

- *Refer to 4-3 and 4-6 of National Healthcare Safety Network (NHSN) Patient Safety Component Manual https://www.cdc.gov/nhsn/pdfs/pscmanual/pscmanual_current.pdf for detailed guidance.*

****Ventilator-Associated Pneumonia (VAP) definition** in a mechanically ventilated neonate (intubated >48 hours):

Clinical suspicion of VAP requires both of the following:

1. Radiographic changes: New or worsening infiltrates (consolidation, new/persistent infiltrate, or progression on serial chest imaging).

2. Clinical deterioration: At least 3 of the following signs/symptoms:

- Worsening gas exchange (increased FiO_2 or mean airway pressure requirements, recurrent desaturations)

- Temperature instability (>38.5°C or <36.5°C)

- Increased volume or purulent endotracheal secretions

- Apnea, tachypnea, or increased retractions

- Bradycardia or tachycardia

- Leukocytosis or leukopenia with left shift/bandemia

- Elevated inflammatory markers (e.g., CRP or procalcitonin rise from baseline)

  - *Refer to 6-3 of National Healthcare Safety Network (NHSN) Pneumonia (Ventilator-associated [VAP] and non-ventilator-associated Pneumonia [PNEU]) Event https://www.cdc.gov/nhsn/pdfs/pscmanual/6pscvapcurrent.pdf for detailed guidance.*

***Urinary Tract Infection (UTI) definition**:

Diagnosis is made on the basis of the presence of both pyuria and at least 50,000 CFU/mL of a single uropathogenic organism or a colony count between 10,000 and 50,000 CFU/mL with associated pyuria detected on urinalysis.

If the specimen was obtained by a suprapubic bladder aspiration, any growth ≥ 1,000 CFU/mL is diagnostic.

As a reminder, this data will differ slightly from data reported to NHSN which is dependent on weight and not gestational age dependent.

Process measures

- Total days on antibiotics (A day of therapy is any calendar day on which a patient receives at least one dose of a specific antibiotic. Example: if two different antibiotics are received on one day, that counts as two days of therapy.) (Reported Monthly)
- Percent compliance hand hygiene observations (either automated or direct observation) adherence (Reported Monthly)

Reported monthly. Numerator being measure and denominator being any infant born less than 29.6 weeks gestation admitted to hospital, including transfers admitted within 24 hours of birth.

- Provider & Nursing Education (Reported Quarterly)

Reported quarterly. Using the following increments (0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%), report quarterly, the % of providers that have completed HAI education. Example: Q1 2024 - 10% (total %) of staff have completed training - Numerator = 10 Example: Q2 2024 - 20% (total %) of staff have completed training - Numerator = 20

These Process measures will be calculated from the captured "TIPQC TTB- HAI PROJECT MONTHLY CLINICAL CARE CHECKLIST" form and "TIPQC TTB- HAI PROJECT QUARTERLY DATA ENTRY" form.

Balancing measures

- Number of skin injuries from skin disinfectants/Number of infants <29.6 weeks or less in NICU (Examples include: epidermal stripping, diaper dermatitis, extravasation injuries, pressure injuries based on esafes/hospital occurrence reports that staff submit.)

Reported monthly. Numerator being measure and denominator being any infant born less than 29.6 weeks gestation admitted to hospital, including transfers admitted within 24 hours of birth.

These Balancing measures will be calculated from the captured "TIPQC TTB- HAI PROJECT MONTHLY CLINICAL CARE CHECKLIST" form.

Structure measures

- Policy & Procedure
    - Hospital (handwashing, identify and control mdr gram-negative rods, recognizing *Staph Aureus*) policy and procedure (reviewed and updated in the last 2-3 years)?
    - Hospital guidelines for both early and late onset sepsis (EOS and LOS), and NEC
    - Annual survey of staff on safety culture
    - Audits on handwashing (automated or direct observation)
    - Safety huddle frequency
    - Terminal clean audit: percent of bed spaces passing ATP/fluorescent marker test
    - Antibiotic stewardship including pre-authorization protocol (including 48-hour "hard stop" active for all antibiotic)

Reported quarterly. Report your progress in the implementation of guidelines in percent increments (0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%) quarterly.

- Patient/Family Partner

Reported quarterly. Using the following increments (0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%), report quarterly, the % complete towards having a patient/family partner engaged in appropriate education and is actively participating on the improvement team.

An example for data collection is provided in the "TIPQC TTB- HAI PROJECT QUARTERLY DATA ENTRY" form.

Sustainment measures

- Number of CLD cases at 36 PMA per month/Number of infants <29.6 weeks or less in NICU
- Number of Grade 3 CLD cases at 36 PMA per month/Number of infants <29.6 weeks or less in NICU
- Number of sIVH cases per month/Number of infants <29.6 weeks or less in NICU
- Number of NEC cases per month/Number of infants <29.6 weeks or less in NICU

Reported monthly. Numerator being measure and denominator being any infant born less than 29.6 weeks gestation admitted to hospital, including transfers admitted within 24 hours of birth.

These Sustainment measures will be calculated from the captured “TIPQC TTB- HAI PROJECT MONTHLY CLINICAL CARE CHECKLIST” form monthly.

Data Collection

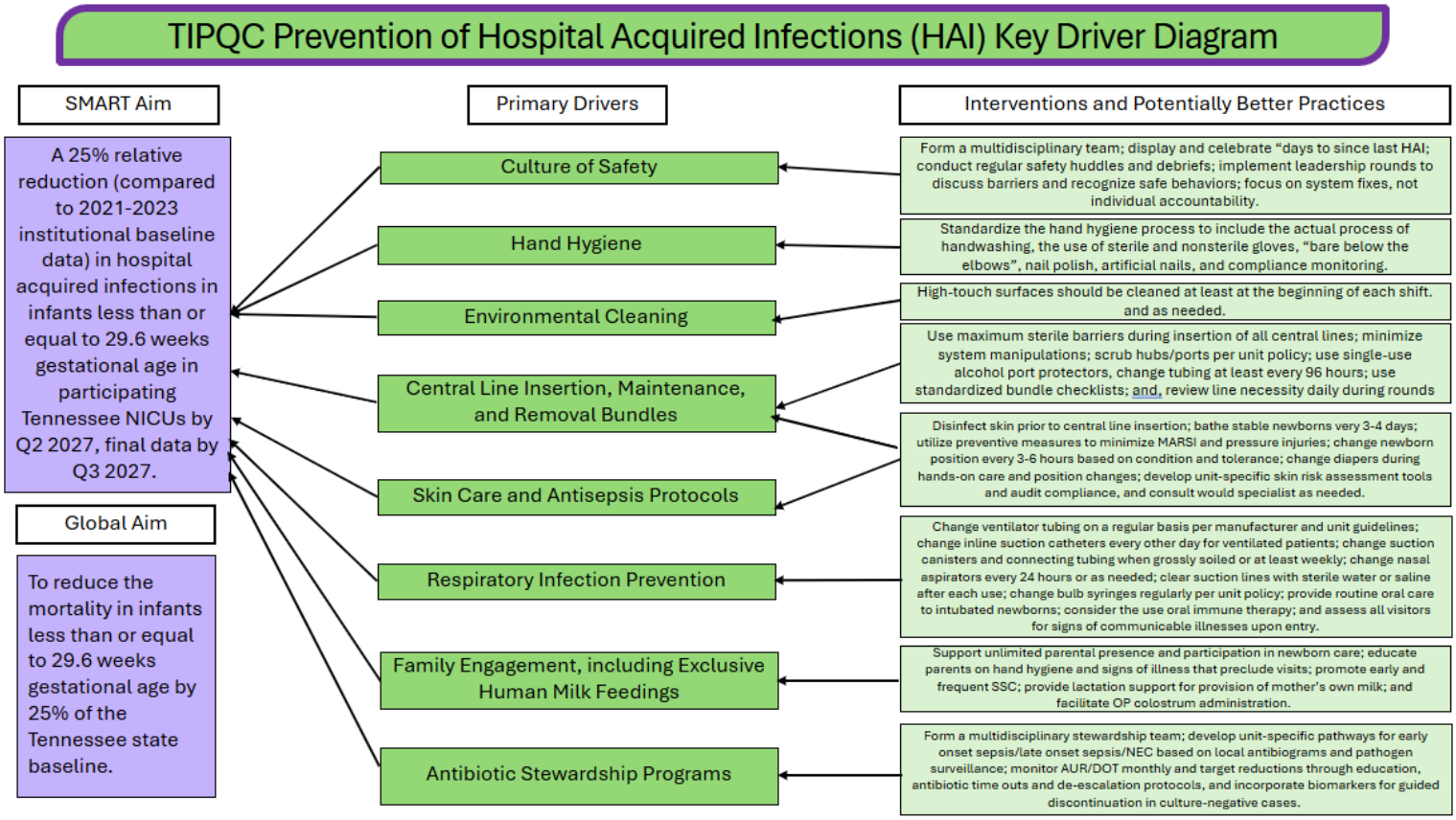
Participating NICUs will capture data on each infant using the provided “TIPQC TTB- HAI PROJECT MONTHLY CLINICAL CARE CHECKLIST” form.

As mentioned, the defined Outcome, Process, and Balancing measures will be calculated from monthly hospital records and reported. Up-to-date data reporting will be available to the participating NICU teams as data is entered.

The defined Structure and Process measures will be collected quarterly and entered in by hospital teams. An example for data collection is provided in the “TIPQC TTB- HAI PROJECT QUARTERLY DATA ENTRY” form. Each participating NICU will be sent an email each quarter as a reminder to submit their data. Generated data reports will also include summaries of these Process and Structure measures.

Key Driver Diagram

A driver diagram is a visual display of a QI collaborative's (or team's) theory of what "drives," or contributes to, the achievement of the project aim – that is, the project's "theory of change." The far-right column of the driver diagram lists the specific *change ideas to test* using PDSA cycles.



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Appendix 1 - Definitions

1. **Bacteremia:** The gold standard for detection of bacteremia in newborns is a positive blood culture.

2. **Bacterial Meningitis:** The gold standard for the evaluation of meningitis is the analysis of the CSF, this includes the white blood cell count, glucose and protein levels, gram stain, and culture. Isolation of a bacterial pathogen from the CSF and/or detection of a bacterial pathogen in the CSF with molecular methods (e.g. PCR testing) is considered diagnostic.
3. **Central Line-associated bloodstream infection (CLABSI) definition:** A Laboratory Confirmed Bloodstream Infection (LCBI) that is not secondary to an infection at another body site.
   Types of Central Lines would include the following

   A. Permanent Central line:
      a. Tunneled catheters, including tunneled dialysis catheters
      b. Implanted catheters (including ports)

   B. Temporary central line: A non-tunneled, non-implanted catheter

   C. Umbilical catheter: A vascular catheter inserted through the umbilical artery or vein in a neonate. All umbilical catheters are central lines.

4. **Colonization:** The presence of bacteria, viruses, or fungi in or on the newborn (skin, endotracheal, gastrointestinal) but they are not causing illness or an immune system response.

5. **Infection:** An infection can be caused by bacteria, viruses, candida, or fungi and can occur in several areas of the body. For example, a urinary tract infection, pneumonia, and cellulitis are examples of an infection. But the blood culture remains sterile.

6. **Late Onset Sepsis (LOS)**: infection after 72 hours of age, is predominantly hospital-acquired in preterm infants, with incidence peaking in the first weeks.

7. **Multi-Drug-Resistant Organisms (MDROs)**: microorganisms, predominantly bacteria, that are resistant to one or more classes of antimicrobial agents

8. **Urinary Tract Infection (UTI) definition:** Diagnosis is made based on the presence of both pyuria and at least 50,000 CFU/mL of a single uropathogenic organism or a colony count between 10,000 and 50,000 CFU/mL with associated pyuria detected on urinalysis. If the specimen was obtained by a suprapubic bladder aspiration, any growth $\geq$ 1,000 CFU/mL is diagnostic.

9. **Ventilator-Associated Pneumonia (VAP)** in a mechanically ventilated neonate (intubated >48 hours). Clinical suspicion of VAP requires both of the following:

   A. Radiographic changes: New or worsening infiltrates (consolidation, new/persistent infiltrate, or progression on serial chest imaging).
   B. Clinical deterioration: At least 3 of the following signs/symptoms:
      a. Worsening gas exchange (increased FiO_2 or mean airway pressure requirements, recurrent desaturations)
      b. Temperature instability (>38.5°C or <36.5°C)
      c. Increased volume or purulent endotracheal secretions
      d. Apnea, tachypnea, or increased retractions

e. Bradycardia or tachycardia
f. Leukocytosis or leukopenia with left shift/bandemia
g. Elevated inflammatory markers (e.g., CRP or procalcitonin rise from baseline)

C. Diagnostic Evaluation: Endotracheal Aspirate (ETA) Guidance: When VAP is clinically suspected based on the criteria above, consider the potential benefit to obtaining a non-bronchoscopic (blind) tracheal aspirate through the existing ETT for:
   a. Gram stain (to assess purulence: >25 polymorphonuclear leukocytes per low-power field ± intracellular bacteria)
   b. Aerobic bacterial culture with semi-quantitative or quantitative reporting
D. Key considerations regarding colonization and timing:
   a. Endotracheal tubes become colonized rapidly (often within 48 hours), predominantly with gram-negative organisms in prolonged intubation.
   b. A positive culture from an ETT in place >48 hours must be interpreted cautiously as it may reflect colonization rather than true infection.
   c. However, in the setting of high clinical suspicion, an ETA may be useful: purulent Gram stain, heavy growth, or pathogenic organisms can support targeted antimicrobial therapy, while a negative or light-growth result (in the absence of prior antibiotics) can aid de-escalation or discontinuation.
E. When to avoid ETA:
   a. Do not obtain routine surveillance ETAs (e.g., weekly or at fixed intervals), regardless of intubation duration. These have low specificity, frequently isolate colonizing flora (e.g., coagulase-negative staphylococci, Pseudomonas spp., Klebsiella spp.), and drive unnecessary antibiotic exposure.
   b. Do not obtain ETA if clinical suspicion is low based on the criteria outlined above.
   c. Special circumstance: If reintubation is planned (e.g., for ETT change) and VAP suspicion is high, obtain a fresh ETA shortly after placement of the new tube to reduce colonization artifact.

Appendix 2 - Nursing Focus: Education, Assessment, & Nursing Care

As front-line providers of bedside care, nursing staff play a critical role in the prevention of hospital acquired infections. In addition to providing meticulous attention to hand hygiene practices and environmental cleaning and following evidence-based guidelines for the prevention of HAIs, nurses also demonstrate these principles every day to other staff members and to the families of our patients. Parents often model the care that they see nurses provide so this is an opportunity to provide important patient education.

Four areas have been identified repeatedly in the literature as crucial to any efforts to decrease hospital acquired infections. These areas are hand hygiene, environmental cleaning, aseptic technique, and parent education. This information first has to be shared with the nursing staff. [1] Khan et al. found that before the implementation of their structured education program the rate of HAIs in their NICU was 10.8% and after the program it had decreased to 5% ($p<0.001$).[2]

Hand Hygiene: Alnadawy et al. evaluated 52 peer-reviewed studies that included over 50,000 patient cases from all healthcare settings and found that hand hygiene adherence led to a 35% reduction in HAIs.1 One of the potentially best practices in this toolkit is focused on hand hygiene. Important education points for staff include but are not limited to:

- The definition of a full hand wash and when to perform it
- The role of alcohol-based hand sanitizing products and when they can be used
- What does “Bare Below the Elbows” include
- Guidelines for fingernails - natural and artificial, nail polish
- When gloves should be worn
- The importance of compliance monitoring, even professionally correct colleagues when a breach in hand hygiene is witnessed in real time
- More details on each of these concepts can be found in the toolkit.

Environmental cleaning is also an important aspect of preventing hospital acquired infections. The same work mentioned above by Alnadawy et al. found that when staff were provided structured training in aseptic techniques to apply for invasive procedures correlated with a 40% reduction in infections related to central lines.[1] All patient care areas, equipment, and bed spaces should be thoroughly cleaned between patients using hospital-approved disinfectants effective against common NICU pathogens. But, high touch surfaces and objects should be cleaned at the beginning of each shift and as needed. Other important strategies include using the right solutions to clean the right objects, cohort patients appropriately, proper storage of linens, barriers between caregivers when holding the newborn, and the regular cleaning of personal devices, for example cell phones. More details can be found in the toolkit. [3]

Aseptic Technique is a crucial component of reducing infections, especially catheter-associated infections. Marschall et al. found in their work that hospitals benefited from a 40% in catheter-associated bloodstream infections when they implemented protocols related to aseptic technique. [4]

Catheter-associated blood stream infections are a significant source of hospital-acquired infections, it is important to remember that any indwelling device can be a source of infection. Examples include peripheral IVs, OG or NG tubes, urinary catheters, and chest tubes. Any of these indwelling devices can also be a source of non-device-related infection if they become colonized with pathogens. Reevaluating the need for any indwelling device daily is a best practice. The toolkit goes into much more detail but practices to incorporate include:

- Ensuring that all central lines are inserted with the use of maximum sterile barriers
- Minimize entries into the lines but when entry is necessary, scrub hubs/ports with alcohol per unit policy
- Change tubings and fluids per unit policy
- Bundles have been shown to be very effective for preventing these infections

Parent Education

As mentioned before, nursing staff models proper hand hygiene and aseptic technique to parent with every encounter. Discussions with parents regarding the rationale for these techniques will enhance their understanding and improve their compliance. Other activities that involve the parents and have been shown to decrease hospital-acquired infections include:

- Skin-to-skin holding with parents
- Breastfeeding
- Mother's Own Milk (MOM)
- Oral immune therapy for the days prior to feedings being initiated
- Details are included in the toolkit

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