Tennessee's Tiniest Babies: Prevention of Severe Intraventricular Hemorrhage (sIVH)

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]. While the IMR has decreased for both Black and White infants, the rate of infant mortality is still 50% higher for Black infants in Tennessee compared to White infants. 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].

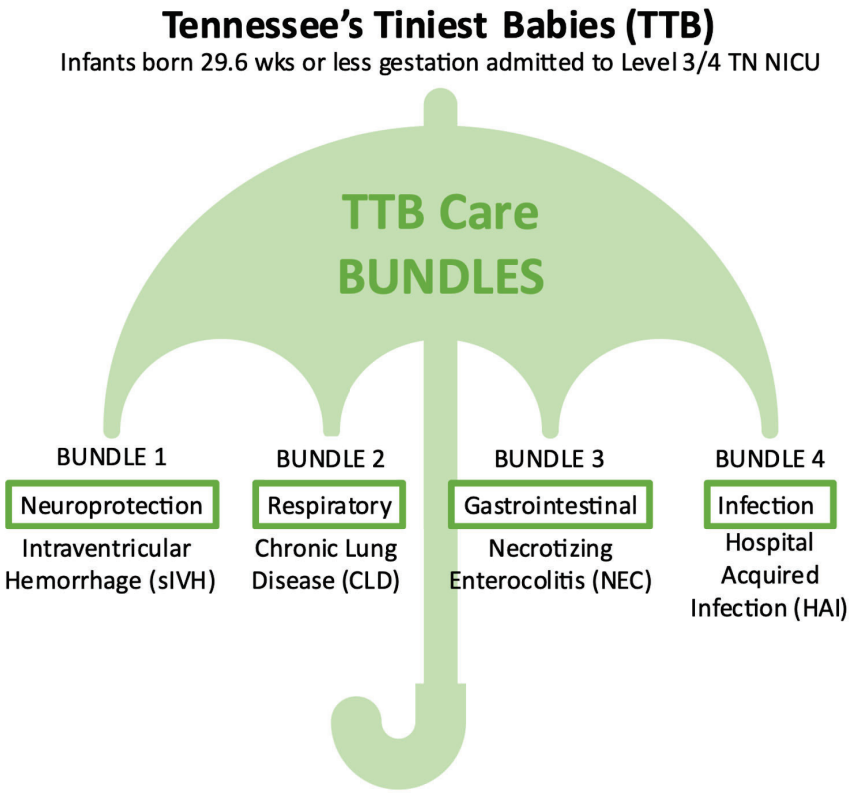
Tennessee has thirteen level 3 and 4 NICUs across the state who care for infants <32 weeks and a birth weight <1500g. In 2020, 1,352 babies, or 1.7% of live births, were born very preterm in Tennessee and cared for at these facilities[3]. Statistically, this group of infants represents approximately one-third of our state's infant deaths which include differences 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 (*what*)

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 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 2025. 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 severe Intraventricular Hemorrhage (sIVH) care bundle.* The project is proposed to end in Q4 2026.

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 your 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 your 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 ELBW team comprising 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 units across the country have developed small baby units dedicated to provide 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 unit should assess its own capability /resources to develop specialized protocols/guidelines to care for their smallest babies.

Of note, sIVH is only one of the many forms of preterm brain injury. Periventricular leukomalacia, reduced gray matter volume, decreased as well as abnormal neuronal pathways and connections are some others. Thus, neuroprotective care should not be limited only to strategies to decrease IVH but should also address the environment in which a preterm infant is nursed as this has a huge impact on the overall neurodevelopmental outcomes of these babies.

Rationale (*why*)

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. Thirteen 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 in an attempt 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[15]. 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.

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.

Aim Statement

The aim of the overarching TTB 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.

<u>The aim of this sIVH care bundle is:</u>

- 25% relative reduction (over last 3 years institutional baseline) in severe intraventricular hemorrhage (Grade III & IV) in infants less than or equal to 29.6 weeks gestational age in participating TN NICUs by March 2024

The proposed aims of the forthcoming care bundles are:

- 25% relative reduction (over last 3 years institutional baseline) in *chronic lung disease* in infants less than or equal to 29.6 weeks gestational age in participating TN NICUs by September 2024
- 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 March 2025
- 25% relative reduction (over last 3 years institutional baseline) in *hospital acquired infections* in infants less than or equal to 29.6 weeks gestational age in participating TN NICUs by September 2025

Summary of Evidence: *Prevention of Severe Intraventricular Hemorrhage (sIVH)*

One of the most devastating complications of the very preterm infant is a sIVH (Grade 3 or 4). This can occur in 15–45% of all very low birth weight, preterm infants and will be fatal in up to 20 percent[23] [24]. If the preterm infant survives the hemorrhage, there are profound consequences which can include: seizures, cerebral palsy, blindness, deafness, and/or learning disabilities. A sIVH can also lead to post-hemorrhagic hydrocephalus which may require surgical management and the potential complications related to this treatment. The burden of this complication of prematurity lasts a lifetime.

More than 90% of sIVH will occur within the first week of life and as many as 50% of cases will occur in the first 6 to 8 hours of life[24–28]. Thus, the first hours and days of life are a critical period where a bundle of PBPs can be developed so that care for these high risk neonates can be improved. Travers et al. developed a "Golden Week" at UAB which implemented targeted neuroprotective PBPs on 820 infants who were 22.0 to 27.6 weeks' gestation with a birth weight ≥400 g. They were able to reduce the rate of sIVH or death in the first week of life from the baseline rate of 27.4% to 15.0%. The rate of sIVH decreased from a baseline rate of 16.4% to 10.0%. While many PBPs were deployed in the hope of a "dose response", they noted that the change in the rate of sIVH specifically corresponded with increased compliance with delayed cord clamping, expanded use of indomethacin prophylaxis, and decreased use of sodium bicarbonate in the first 72 hours[16]. A subsequent report from UAB evaluating the impact of their PBPs on the incidence of sIVH or early death in very preterm infants born at 27.0 to ≤ 29.6 weeks found the primary composite outcome dropped from 11.1% (pre-intervention) to 0% (post-intervention)[22].

The NICU at the University of California in San Francisco (UCSF) has also reported a significant reduction in rates of sIVH with the implementation of a bundle of PBPs. Baseline review of data from their level 4 NICU in comparison to the Vermont Oxford Network (VON) database, showed that the UCSF NICU's rate of sIVH in the extremely preterm population (< 28 weeks or < 1000 grams) was significantly higher at 14% vs. ~8%. With the development of a QI bundle using various targeted interventions such as nursing PBPs, promotion of early noninvasive ventilation, consistent use of rescue antenatal betamethasone, and risk-based indomethacin prophylaxis, they were able to reduce the rates of sIVH in their center from 14% to 1.2 % over a 3-year period. Mortality also decreased by 50% during the same time period[23]. Improvement in clinical outcomes of this magnitude is further impetus that targeted bundles can reduce the incidence of sIVH and decrease mortality and morbidity in our most vulnerable patient population.

The ability to demonstrate sustained improvements is an important component of a successful QI project. A recent publication from the University of Florida reported on their success with implementation and sustainment of PBPs targeted at reducing sIVH. Their NICU was able to reduce the rate of sIVH from 25% and then sustain a low rate of sIVH over 4 years at 9.7%. Similar to UAB's "Golden Week," this project implemented PBPs found to be important to improve

care in the first week of life. Additionally, the program provided focused education to staff along with reminders of the PBPs at the bedside and in the delivery room. This focused effort allowed them to surpass the planned reduction of sIVH which had been 11%. As the project went into sustainment, continued improvement, and maintenance of the low rate of sIVH occurred[29]. For TIPQC's project to be successful, PBPs need to be easily sustained and part of a culture of change.

Evaluation of the existing literature indicates that development and implementation of PBPs can effectively decrease sIVH and reduce mortality in the population that TIPQC is targeting for this project. Review of the 2021 data reported to the VON database by 1044 hospitals revealed a median hospital rate of Grade 3 and Grade 4 sVIH to be 2.5% and 5.0%, respectively, for infants 22-29 weeks' gestational age. Ten centers from TIPQC report data to the VON database and an analysis of these hospitals found median hospital rates of Grade 3 sIVH to be 4.3% and of Grade 4 sVIH of 6.5% [30]. A concerted and collaborative approach amongst Tennessee's level 3 and 4 NICUs to improve care and prevent sIVH and death in "Tennessee's Tiniest Babies'' is clearly warranted.

Potentially Better Practices for the Prevention of sIVH

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 sIVH, TIPQC's experts have recommended that all participating NICUs implement all of these PBPs at a minimum. The relative decrease of sIVH when a bundle of PBPs has been adopted has been reported to be 24.5–91%[16–23]. 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.

Antenatal Steroids & Magnesium

- ***All eligible mothers with pregnancies at 22 weeks and above who present with preterm labor should be given betamethasone and magnesium.***
    - **Antenatal steroids:** TIPQC has identified this as a PBP since current evidence has shown that corticosteroid administration before anticipated preterm birth is one of the most important antenatal therapies available to improve newborn outcomes[1–5]. Furthermore, the American College of Obstetricians and Gynecologists (ACOG) has stated that a single course of corticosteroids is

recommended for pregnant women between 22 0/7 weeks and 33 6/7 weeks of gestation who are at risk of preterm delivery within 7 days[6].

- A **single repeat course** should be considered in women who are less than 34 0/7 weeks of gestation at risk of preterm delivery within 7 days, and whose prior course of antenatal corticosteroids was given more than 14 days previously[6].
- A multicenter observational cohort in 2018 and a systematic review and meta-analysis in 2021 found that antenatal corticosteroids improved survival among the 22 0/7 and 22 6/7 weeks gestation infants that received antenatal steroids[7] [8]. Because of this, if resuscitation is expected or requested at 22 0/7, antenatal steroids should be administered at 21 5/7, if possible.
- Numerous studies have shown no long-term evidence of harm, particularly for the single course of corticosteroids given to the less than 34 0/7 weeks gestation [9,10]

References

[1]Periviable birth. Obstetric Care Consensus No.4. American College of Obstetricians and Gynecologists. Obstet Gynecol 2016;127:e157–69.

[2]Carlo, W. A., McDonald, S. A., Fanaroff, A. A., Vohr, B. R., Stoll, B. J., Ehrenkranz, R. A., & et al. (2011). Association of antenatal cortico- steroids with mortality and neurodevelopmental outcomes among infants born at 22 to 25 weeks' gestation. Eunice Kennedy Shriver National Institute of Child Health and Human Development Neonatal Research Network. *JAMA*, 306, 2348–58.

[3]Mori, R., Kusuda, S., & Fujimura, M. (2011). Antenatal corticosteroids promote survival of extremely preterm infants born at 22 to 23 weeks of gestation. Neonatal Research Network Japan. *J Pediatr*, 159, 110–114.e1.

[4]Chawla, S., Natarajan, G., Rane, .S, Thomas, R., Cortez, J., & Lua, J. (2010). Outcomes of extremely low birth weight infants with varying doses and intervals of antenatal steroid exposure. *J Perinat Med*, 38, 419–23.

[5]Chawla, S., Bapat, R., Pappas, A., Bara, R., Zidan, M., & Natarajan, G. (2013). Neurodevelopmental outcome of extremely premature infants exposed to incomplete, no or complete antenatal steroids. *J Matern Fetal Neonatal Med*, 26, 1542–7.

[6]American College of Obstetricians and Gynecologists' Committee on Obstetric Practice (October 2016, reaffirmed 2020). *Antenatal corticosteroid therapy for fetal maturation* (Committee Opinion # 713). American Academy of Obstetricians and Gynecologists.

[7]Backes, C. H., Rivera, B. K., Pavlek, L., Beer, L. J., Ball, M. .K, Zettler, E. T. &,et al. (2021). Proactive neonatal treatment at 22 weeks of gestation: a systematic review and meta-analysis. *Am J Obstet Gynecol,* 224, 158–74. doi: 10.1016/j.ajog.2020.07.051

[8]Ehret, D. E., Edwards, E. M., Greenberg, L. T., Bernstein, I. M., Buzas, J. S., Soll, R. F., & et al. (2018). Association of antenatal steroid exposure with survival among infants receiving postnatal life support at 22 to 25 weeks' gestation. *JAMA Netw,*1:e183235. doi: 10.1001/jamanetworkopen.2018.3235

[9]Roberts, D., & Dalziel, S. R. (2006). Antenatal corticosteroids for accelerating fetal lung maturation for women at risk of preterm birth. *Cochrane Database of Systematic Reviews,* 3. Art. No.: CD004454. DOI: 10.1002/14651858.CD004454

[10]Sotiriadis, A., et al. (2015). Neurodevelopmental outcome after a single course of antenatal steroids in children born preterm: A systematic review and meta-analysis. *Obstet Gynecol.,* 125(6), 1385-1396.

- **Magnesium**: Prenatal magnesium has been recognized to reduce the risk of cerebral palsy[1].
- Studies have shown that magnesium sulfate given for neuroprotection reduced the total occurrences of death and cerebral palsy[2-4] None of these trials showed significant pregnancy prolongation and found minor maternal complications were more common with the magnesium sulfate.
- Also, three major randomized clinical trials showed a reduction in the risk of cerebral palsy for magnesium sulfate given before delivery of early preterm infants. [5-7]
- As these two interventions are done on the obstetrical side, participating NICUs are advised to discuss antenatal steroids and antenatal magnesium administration with their obstetrical team.

References

[1]American College of Obstetricians and Gynecologists' Committee on Obstetric Practice (Reaffirmed 2020). *Magnesium sulfate before anticipated preterm birth for neuroprotection* (Committee Opinion #455). American Academy of Obstetricians and Gynecologists.
[2]Doyle, L. W., Crowther, C. A., Middleton, P., Marret, S., & Rouse, D. (2009). Magnesium sulfate for women at risk of preterm birth for neuroprotection of the fetus. Cochrane Database of Systematic Reviews, 1. Art. No.: CD004661 . DOI: 10.1002/14651858.CD004661.pub3.
[3]Conde-Agudelo, & A., Romero, R. (2009). Antenatal magnesium sulfate for the prevention of cerebral palsy in preterm infants less than 34 weeks' gestation: A systematic review and meta- analysis. Am J Obstet Gynecol, 200, 595–609.
[4]Costantine, M. M., & Weiner, S. J. (2009). Effects of antenatal exposure to magnesium sulfate on neuro- protection and mortality in preterm infants: a meta-analysis. Eunice Kennedy Shriver Na- tional Institute of Child Health and Human Development Maternal-Fetal Medicine Units Network. Obstet Gynecol., 114, 354–64.
[5]Crowther, C. A., Hiller, J. E., Doyle, L. W., & Haslam, R. R. (2003). Effect of magnesium sulfate given for neuroprotection before preterm birth: A randomized controlled trial. Australasian Collaborative Trial of Magnesium Sulphate (ACTO Mg SO4) Collaborative Group. JAMA, 290, 2669–76.
[6]Marret, S., Marpeau, L., Zupan-Simunek, V., Eurin, D., Leveque, C., Hellot, M. F., & et al. (2007). Magnesium sulfate given before very-preterm birth to protect infant brain: The randomized controlled PREMAG trial. PREMAG trial group. BJOG, 114, 310–8.
[7]Rouse, D. J., Hirtz, D. G., Thom, E., Varner, M. W., Spong, C. Y., Mercer, B. M., & et al. (2008). A randomized,controlled trial of magnesium sulfate for the prevention of cerebral palsy. Eunice Kennedy Shriver NICHD Maternal-Fetal Medicine Units Network. N Engl J Med, 359, 895–905.
https://www.acog.org/clinical/clinical-guidance/committee-opinion/articles/2010/03/magnesium-sulfate-before-anticipated-preterm-birth-for-neuroprotection

Cardiopulmonary Resuscitation Simulation Training

- ***Participating NICUs should use simulation training to optimize cardiopulmonary resuscitation in the target group. This would involve honing skills such as: better team communication, improved use of the T-piece resuscitator, and intubation by the most experienced provider.***
    - Delivery room cardiorespiratory resuscitation is vital to the well-being of infants and their outcomes. Poor communication and teamwork were found to be the most common causes of potentially preventable infant deaths in the delivery room[1]. Infants with cardiopulmonary resuscitation for more than 10 minutes after birth are at high risk for neurodisability as well as mortality[2]. It is important to have effective communication. In a NICU in Indiana, it was shown that 3 interrelated practices were essential for successful teamwork during neonatal resuscitations: getting tasks done well, communicating well, and working well together[3].
    - Teaching team behaviors in conjunction with a skills-based curriculum such as the Neonatal Resuscitation Program (NRP) can significantly improve teamwork and quality of care[4].
    - Optimal resuscitation is advised as per the Neonatal Resuscitation Program (NRP) 8th edition Including, antenatal counseling, team debriefing, equipment check and NRP resuscitation steps[1]

References
[1]Weiner, G. M., Zaichkin, J., & Kattwinkel, J. (2021). *Textbook of Neonatal Resuscitation*, 8th edition. American Academy of Pediatrics.
[2]Foglia, E. E., Weiner, G., de Almeida, M. F. B., & et al. Duration of resuscitation at birth, mortality, and neurodevelopment: A systematic review. *Pediatrics*, 146(3), e20201449.
[3]Zeynep, N., Inanc Salih, M. D. & Draucker, C. B. (2019). Facilitators of and barriers to successful teamwork during resuscitations in a neonatal intensive care unit. *J Perinatol*., 39(7), 974–982. doi:10.1038/s41372-019-0380-3
[4]Edwards, E. & et al. (2015). Identifying improvements for delivery room resuscitation management: Results from a multicenter safety audit. *Maternal Health, Neonatology, and Perinatology*, 1(1). https://doi.org/10.1186/s40748-014-0006-xv

Optimal Cord Clamping (OCC)

- ***Each participating NICU should seek to increase the rate of the clamping of the umbilical cord to at least 60 seconds. Each unit should target a rate of at least 70% of OCC in this population; stretch goal would be 90%.***
    - A Cochrane Analysis has found that a delay in cord clamping can reduce the incidence of mortality in preterm infants by nearly a third. The number needed to treat to prevent one death is 30-50 infants and the number needed to treat to prevent a death in infants less than 1500 grams is only 20 infants. The study also concluded that "early cord clamping probably causes harm." Benefits for this population include a decreased need for blood transfusions by increasing blood volume and hemoglobin concentration at birth, a decreased risk of intraventricular hemorrhage, and a decreased risk of late-onset sepsis.
    - Optimal cord clamping in this population has been shown to increase intravascular volume, thus leading to a decreased need for saline boluses and vasopressors which are known to increase the risk of sIVH.
    - TIPQC has developed an Optimal Cord Clamping Project designed for all infants born in Tennessee. Further information on Optimal Cord Clamping and how to improve your rates can be obtained in the TIPQC toolkit for this project[1].
    - The time after birth when the umbilical cord was clamped should be documented in the electronic medical record. If clamped before 60 seconds, the reason for early clamping should be noted.

References
[1]Guthrie, S., Scott, P. A., Lerro, A., Barker, B. & Scott, T., A. (2022). *Optimal cord clamping*. Tennessee Initiative for Perinatal Quality Care Toolkit. https://tipqc.org/wp-content/uploads/2022/07/TIPQC-OCC-Toolkit-final-REVISED-05.17.2022-PDF.pdf

Thermoregulation

- ***Each participating NICU should put into place specific interventions to help maintain appropriate temperature in the target population.***

Thermoregulation is of paramount importance to the newly born preterm infant as hypothermia has been shown to increase mortality among the low-birthweight infants after birth[1]. One study showed that a decrease in admission temperature by 1 degree Celsius below 36 degrees Celsius was associated with a mortality increase of 28%[2]. The American Academy of Pediatrics advocates for a goal temperature between 36.5 and 37.5C right after birth, through admission, and stabilization for newly born babies[3].

- Preparation for delivery:
    - Perform delivery and admission pre-brief, prewarm incubator, prewarm sterile drapes, and set up line tray
- Delivery:
    - Prewarm incubator, use a blanket covered chemical mattress, raise delivery room ambient temperature to 74-77°F, wrap the baby in clear plastic and apply the hat as soon as possible[3]
- Admission:
    - Perform rapid collaboration assessment on admission (attending could perform in DR)
    - Stabilize airway and respiratory support
    - Place baby on a blanket covered chemical mattress in preheated incubator, place leads, perform weight, keep the baby wrapped in the clear plastic wrap, and perform right upper extremity blood pressure
    - Administer surfactant, if indicated and not already given (within first 1- 2 hours)
    - Vascular access secured by 60 minutes from birth
    - Closure of incubator by 60 minutes from birth

- Daily:
  - Time routine daily collaborative examinations with q 6h hands-on care
  - Wrap the baby in clear plastic during procedures (echo, lines, head ultrasound)
  - Warm fluids by placing them in the infant's incubator 30 minutes before their use to avoid heat loss by conduction[4]

References
[1] Singh, T. S. , Skelton, H., & et al. (2022). Improvement in thermoregulation outcomes following the implementation of a thermoregulation bundle for preterm infants. *Journal of Pediatrics and Child Health*, 58, 1201–1208.
[2]Laptook, A. R., Salhab, W., & Bhaskar, B., Neonatal Research Network. (2007). Admission temperature of low birth weight infants: Predictors and associated morbidities. *Pediatrics*, 119, e643–9.
[3]Weiner, G. M., Zaichkin, J., & Kattwinkel, J. (2021). *Textbook of Neonatal Resuscitation*, 8th edition. American Academy of Pediatrics.
[4]Gomella's Neonatology: Management, Procedures, On-Call Problems, Diseases, and Drugs – 8th edition
Editors – Gomella, T.L., Eyal, F.G., & Bany-Mohammed, F.
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Unit specific guidelines

- ***Optimal care to be delivered by medical personnel (MD/DO/NNP/PA) caring for this population.***
  It is important to *r*ecognize that repeated handling for assessments and procedures can decrease the hemodynamic stability and compromise neurodevelopmental status. Each participating unit should develop specific guidelines to deliver quality therapeutic and supportive care to the infants in the least stressful manner with the goal of limiting unnecessary handling and overstimulation of the baby [1-2]. The following PBP should be incorporated in guidelines [3-5]:
  - Perform collaborative examination on admission
  - Time routine examinations with the q 6h scheduled hands-on care schedule in order to minimize handling
  - Time routine lab sampling and X-rays with scheduled hands-on care times
  - Any hemodynamically unstable baby who needs frequent blood pressure monitoring should have an arterial line placed. This should also be strongly considered in all babies < 27 weeks GA
  - No routine cuff pressure if a working arterial line is present
  - In hemodynamically stable babies, when unable to obtain the arterial lines, cuff blood pressure monitoring should be limited to every 6 hours in hemodynamically stable babies

References
[1]Blackburn, S. (1998). Environmental impact of the NICU on developmental outcomes. *J Pediatr Nurs.,* 13(5), 279-289.
[2]Santos, J., Pearce, S. E., & Stroustrup A. (2015). Impact of hospital-based environmental exposures on neurodevelopmental outcomes of preterm infants. *Curr Opin Pediatr.,* 27(2), 254-260.
[3]Murthy, P., Zein H., Thomas, S., Scott, J. N., Abou Mehrem, A., Esser, M. J., Lodha, A., Metcalfe, C., Kowal, D., Irvine, L., Scotland, J., Leijser, L., & Mohammad, K. (2020). Neuroprotection care bundle implementation to decrease acute brain Injury in preterm infants. *Pediatr Neurol*., Sep (110), 42-48. doi: 10.1016/j.pediatrneurol.2020.04.016. Epub 2020 May 1. PMID: 32473764.
[4]Chiriboga, N., Cortez, J., Pena-Ariet, A., Makker, K., Smotherman, C., Gautam, S., Trikardos, A. B., Knight, H., Yeoman, M., Burnett, E., Beier, A., Cohen, I., & Hudak, M. L. (2018). Successful implementation of an intracranial hemorrhage (ICH) bundle in reducing severe ICH: A quality improvement project. *J Perinatol*., Jan;39(1), 143-151. doi: 10.1038/s41372-018-0257-x. Epub 2018 Oct 22. PMID: 30348961
[5] Kramer, K. P., Minot, K., Butler, C., Haynes, K., Mason, A., Nguyen, L., Wynn, S., Liebowitz, M., & Rogers, E. E. (2022). Reduction of severe intraventricular hemorrhage in preterm infants: A quality improvement project. *Pediatrics,* 149(3), e2021050652. doi: 10.1542/peds.2021-050652. PMID: 35229127

Avoid specific therapies

- ***Medical personnel (MD/DO/NNP/PA) need to avoid therapies that can cause a rapid fluctuation in the intracerebral pressure.***
  The preterm brain lacks the ability to auto regulate the cerebral blood flow in response to changes in systemic blood pressure, thus defined as pressure passive. Thus, fluctuations in the systemic blood pressure will directly reflect upon the cerebral blood flow increasing the risk for IVH[1]. Interventions to avoid rapid fluctuations in blood pressure include:
  - Avoid rapid blood draws[2].
    - Drawing of blood samples from arterial lines with subsequent flushing should be performed slowly (1.5 mL/30 sec) to avoid blood pressure fluctuations.
  - Consider using placental blood for initial sampling if large quantities of blood required (example for genetic testing, blood cultures, blood group and type, newborn screens)
  - Limit the use of normal saline boluses unless there is concern for hypovolemia [3-4]. When bolus is needed- consider smaller volumes and slow delivery over 60 minutes. 10 mL/kg of NS over 60 minutes, or, draw 1 mL per 30 seconds.
  - The use of sodium bicarbonate is not recommended as this can cause sudden increase in the osmolarity and increase risk for IVH[5].
  - Vasopressors should be used judiciously with the goal to improve end organ perfusion and not just the blood pressure numbers [6-7]. Traditionally, the GA at birth has been used as a surrogate marker for lower limits of mean arterial blood pressure. However, this does not reflect end organ perfusion[8-9]. When making decisions to use vasopressors, one must assess the organ perfusion using markers such as increased oxygen requirement, persistent metabolic acidosis, decrease urine output, skin perfusion. Studies have shown that infants treated with vasopressors have a significantly higher incidence of IVH, PVL and poor neurodevelopmental outcomes [7; 10-11] . This is likely due to the sudden change in cerebral blood flow due pressure passive circulation in the sick infants in the setting of systemic hypotension. Thus, one must be very careful when starting vasopressor therapy for treating hypotension. When indicated, always start at low dose and titrate the dose up slowly as needed.
  - Hypercarbia/hypocarbia is an important risk factor for IVH [4-6]. Thus, it is important to closely monitor the $PaCO_2$ levels.

References-
[1] Milligan, D. W. (1980). Failure of autoregulation and intraventricular haemorrhage in preterm infants. *Lancet*, 26;1(8174), 896-8. doi: 10.1016/s0140-6736(80)90836-3. PMID: 6103257
[2] Travers, C. P., Gentle, S., Freeman, A. E., Nichols, K., Shukla, V. V., Purvis, D., Dolma, K., Winter, L., Ambalavanan, N., Carlo, W. A., & Lal, C. V. (2022). A quality improvement bundle to improve outcomes in extremely preterm infants in the first week. *Pediatrics*, 149(2), e2020037341. https://doi.org/10.1542/peds.2020-037341
[3]Sankaran, J., Brandsma, E., & Kushnir, A. Section on Neonatal-Perinatal Medicine Program. (2018). Effect of administration of normal saline bolus on intraventricular hemorrhage in preterm neonates. *Pediatric*s, 141.
[4]Murthy, P., Zein H., Thomas, S., Scott, J. N., Abou Mehrem, A., Esser, M. J., Lodha, A., Metcalfe, C., Kowal, D., Irvine, L., Scotland, J., Leijser, L., & Mohammad, K. (2020). Neuroprotection care bundle implementation to decrease acute brain Injury in preterm infants. *Pediatr Neurol*., Sep (110), 42-48. doi: 10.1016/j.pediatrneurol.2020.04.016. Epub 2020 May 1. PMID: 32473764.
[5]Levene, M. I., Fawer, C., L., & Lamont, R. F. (1982). Risk factors in the development of intraventricular haemorrhage in the preterm neonate. *Arch Dis Child,* 57(6), 410–417.
[6]Travers, C. P., Gentle, S., Freeman, A. E., Nichols, K., Shukla, V. V., Purvis, D., Dolma, K., Winter, L., Ambalavanan, N., Carlo, W. A., & Lal, C. V. (2022). A quality improvement bundle to improve outcomes in extremely preterm infants in the first week. *Pediatrics*, 149(2), e2020037341. https://doi.org/10.1542/peds.2020-037341
[7]Synnes, A. R., Chien, L. Y., Peliowski, A., Baboolal, R., & Lee, S.K. (2001). Variations in intraventricular hemorrhage incidence rates among Canadian neonatal intensive care units. *J Pediatr.,* 138(4), 525-531.
[8]Dempsey, E. M. & Barrington, K. J. (2006). Diagnostic criteria and therapeutic interventions for the hypotensive very low birth weight infant. *J Perinatol.,* 26(11), 677-681.
[9] Alderliesten, T., Lemmers, P. M., van Haastert, I. C., & et al. (2014). Hypotension in preterm neonates: Low blood pressure alone does not affect neurodevelopmental outcome. *J Pediatr.,* 164(5), 986-991.
[10]Fanaroff, J. M., Wilson-Costello, D. E., Newman, N. S., Montpetite, M. M., & Fanaroff, A. A. (2006). Treated hypotension is associated with neonatal morbidity and hearing loss in extremely low birth weight infants. *Pediatrics,* 117(4), 131-1135.

[11] Heuchan, A. M., Evans, N., Henderson Smart, D. J., & Simpson, J. M. (2002). Perinatal risk factors for major intraventricular haemorrhage in the Australian and New Zealand Neonatal Network, 1995-97. *Arch Dis Child Fetal Neonatal Ed.,* 86(2), F86-90.

Additional References:Evaluating the Effect of a Neonatal Care Bundle for the Prevention of Intraventricular Hemorrhage in Preterm Infants, Maximilian Gross 1,*, Corinna Engel 2 and Andreas Trotter

Schulz G, Keller E, Haensse D, Arlettaz R, Bucher HU, Fauchère JC. Slow blood sampling from an umbilical artery catheter prevents a decrease in cerebral oxygenation in the preterm newborn. Pediatrics. 2003 Jan;111(1):e73-6. doi: 10.1542/peds.111.1.e73. PMID: 12509598.

Education and training

- All staff who provide bedside care (RN, RT, PT/OT) may need additional training and resources. TIPQC suggests hospital leadership provide resources and support staff time to complete a training/course focusing on key care components which can optimize care for this population. (Example: SYNAPSE Small Baby Course.) Education should include important interventions such as the need to:
    - Limit noxious stimuli
        - Handle gently
            - 2 person (four hands) or side-lying position for diaper changes with gentle lifting of legs to minimal height needed to complete the activity (this prevents rapid fluctuations in BP) with gentle lifting of legs to minimal height needed to complete the activity (this prevents rapid fluctuations in BP)[1, 2, 3, 4]
            - Slow transfers using containment techniques[4]
        - Limit suctioning and other painful procedures such as heelsticks and suctioning[1, 2, 4, 5]
            - Consider using 2 caregivers for painful procedures[2 4]
        - Position the head in a midline position for the first 72 hours of life in supine or side lying (side lying provides a variation of positioning for pressure relief with the head sustained in midline position) in supine or side lying (side lying provides a variation of positioning for pressure relief with the head sustained in midline position)[3, 5, 6]
        - Elevate the HOB 15-30 degrees
        - Decrease light and noise
            - Cycled lighting starting at 28-32 weeks ~ 200 lux during day, <10 lux during the night[2, 3, 4, 7, 8]
            - Cover the incubator or cover eyes to avoid bright lights[2, 3, 4, 7, 8]
            - Avoid setting items on the incubator[2, 3, 4, 7, 8]
            - Background noise < 45 dB, 1 second maximum < 70 dB[2, 3, 4, 7, 8]
            - Silence alarms quickly or adjust alarm levels depending on NICU set-up[2, 3, 4, 7, 8]
            - Set phones and pagers to the vibration setting[2, 3, 4, 7, 8]
            - For babies needed HFJV, consider the use of ear protection (ex-muffs) due to excessive noise from the patient box inside the incubator, which gives constant auditory stimulation at approximately 55 decibels
            - For babies needing HFV, consider the use of ear protection (ex-muffs) due to excessive noise from the patient box inside the incubator, which gives constant auditory stimulation at approximately 55 decibels
        - Minimal stimulation
            - Adhere to touch times limited to every 6 hours during the first 72 hours of life[1, 4, 7, 8]
    - Ensure developmentally appropriate care
        - Kangaroo care/skin-to-skin during the 1st 72 hours of life[1, 2, 3, 8, 9]
        - Appropriate developmental positioning – nesting, facilitated tucking and containment[2, 3, 4, 8]

- Positioning aids may assist with proper positioning[2, 3, 8]

o Parental involvement and engagement[1, 2, 3, 4]

o Developmental team with the goal of neuroprotection[2]

References:

[1]Esser, M., Dore, S., Fitzgerald, F., Kelley, K., Kuller, J., Ludwig, S., & Peterman, D. (2018). Applying developmentally supportive principles to diapering in the NICU: What we know. *Neonatal Network*, 37(3).

[2]Knudsen, K., McGill, G., Waitzman, K. A., Powell, J., Carlson, M., Shaffer, G., & Morris, M. (2021). Collaboration to improve neuroprotection and neuropromotion in the NICU: Team education and family engagement. *Neonatal Network*, 40(4).

[3]McGrath, J., Diallo, A. F., Paquette, R. J., & Samra, H. (2014). *Developmentally supportive and family-centered care* (R. Bissinger & D. J. Annibale, Eds.). Golden Hours Care of the Very Low Birth Weight Infant. National Certification Corporation.

[4]Spruill, C. T. (2021). *Developmental support* (M. T. Verklan, M. Walden, & S. Forrest, Eds.). Core Curriculum for Neonatal Intensive Care Nursing (6th ed.). Elsevier.

[5] Crowell, B., & Annibale, D. J. (2014). *Intraventricular hemorrhage in golden hours care of the very low birthweight infant* (R. Bissinger & D. J. Annibale, Eds.). Golden Hours Care of the Very Low Birth Weight Infant. National Certification Corporation.

[6]De Bijl-Marcus, K., Brouwer, A. J., De Vries, L. S., Groenendaal, F., & Wezel-Meijler, G. V. (2020). Neonatal care bundles are associated with a reduction in the incidence of intraventricular haemorrhage in preterm infants: A multicenter cohort study. *Arch Dis Child Fetal*, 105(4), 419-424.

[7]Ditzenberger, G. (2021). *Neurologic disorders* (M. T. Verklan, M. Walden, & S. Forrest, Eds.). Core Curriculum for Neonatal Intensive Care Nursing (6th ed.). Elsevier.

[8]Forrest S. (2021). *Care of the Extremely Low Birth Weight Infant (*M. T. Verklan, M. Walden, & S. Forrest, Eds.). Core Curriculum for Neonatal Intensive Care Nursing (6th ed.). Elsevier.

[9]Mino,t M., Kramer, K.P., Butler, C., Foster, M., Gregory, C., Haynes, K., Lagon, C., Mason, A., Wynn, S., Roger,s E. E., & Liebowitz, M. C. (2021). Increasing early skin-to-skin in extremely low birth weight infants. *Neonatal Network*, 40(4).

Use of Indomethacin

- ***Risk based use of indomethacin prophylaxis- In infants who fall under a high risk category, one dose of indomethacin (0.2mg/kg IV) should be given at 12 hours of age.***

Studies have shown that prophylactic indomethacin therapy, started within 24 hours in this population of preterm infants can result in decreased rates of sIVH[1.] However, given the clear benefits of significant reduction in sIVH, the use of prophylactic indomethacin should be considered under special circumstances which put the infant at a very high risk for IVH [3,4,5].

Prophylactic indomethacin should be strongly considered in:

1- All infants < 25 weeks GA

2- Between 25 - 27- prophylactic indomethacin should be used when:

The infant's mother did not receive an adequate course of antenatal steroids and/or

In all out born infants who required transport to a higher level NICU after birth.

Special considerations:

Infant should have voided before 12 hours of age

Evaluate the risk vs. benefit if postnatal steroid use is expected

References-

[1]Fowlie, P. W., Davis, P. G., & McGuire, W. (2010). Prophylactic intravenous indomethacin for preventing mortality and morbidity in preterm infants. *Cochrane Database of Systematic Reviews*, Issue 7. Art. No.: CD000174. DOI: 10.1002/14651858.CD000174.pub2. Accessed 11 July 2022.

[2]Schmidt, B., Davis, P., Moddemann, D., Ohlsson, A., Roberts, R. S., Saigal, S., Solimano, A., Vincer, M., & Wright, L. L. (2001). Trial of Indomethacin Prophylaxis in Preterms Investigators. Long-term effects of indomethacin prophylaxis in extremely-low-birth-weight infants. *N Engl J Med*., 28;344(26), 1966-72. doi: 10.1056/NEJM200106283442602. PMID: 11430325

[3]Kramer, K. P., Minot, K., Butler, C., Haynes, K., Mason, A., Nguyen, L., Wynn, S., Liebowitz, M., & Rogers, E. E. (2022). Reduction of severe intraventricular hemorrhage in preterm infants: A quality improvement project. *Pediatrics,* 149(3), e2021050652. doi: 10.1542/peds.2021-050652. PMID: 35229127

[4]Travers, C. P., Gentle, S., Freeman, A. E., Nichols, K., Shukla, V. V., Purvis, D., Dolma, K., Winter, L., Ambalavanan, N., Carlo, W. A., & Lal, C. V. (2022). A quality improvement bundle to improve outcomes in extremely preterm infants in the first week. *Pediatrics*, *149*(2), e2020037341.

[5]Singh, R., Gorstein, S. V., Bednarek, F., Chou, J. H., McGowan, E. C., & Visintainer, P. F. (2013). A predictive model for SIVH risk in preterm infants and targeted indomethacin therapy for prevention. *Sci Rep*,3:2539. doi: 10.1038/srep02539. PMID: 23995978; PMCID: PMC3759046

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.

Outcome measures

#1. Percent severe intraventricular hemorrhage (sIVH)) (among targeted infants)

- Grade 3 or 4 IVH confirmed by head ultrasound (HUS) on or before Day 14 of life

#2. Percent mortality by hospital discharge or 40 weeks corrected gestational age, whichever comes first (among targeted infants)

Both these Outcome measures will be calculated from the captured "TIPQC TTB-sIVH PROJECT CLINICAL CARE CHECKLIST" records – see "Data Collection" below.

Baseline data:

- Participating NICUs will retrospectively capture and report annual mortality and annual severe IVH rates (both among the target population) for the 3 years prior to the project start (2019, 2020, and 2021).
- This baseline data will serve as the "institutional baseline" from which they are trying to improve (planned 25% reduction)

Process measures

- Percent of mothers (of targeted infants) receiving at least 2 doses of antenatal steroids
- Percent of mothers (of targeted infants) receiving Magnesium Sulfate (MagSO4)
- Percent of targeted infants with cord clamped at least 60 seconds after birth
- Percent of targeted infants receiving Indomethacin within first 24 hours of life
    - Among those targeted infants that qualify for administration of Indomethacin (<25 completed weeks gestation; or 25-27 completed weeks gestation and outborn; or 25-27 completed weeks gestation and their mother did not receive 2 doses of antenatal steroids)
- Percent of targeted infants receiving ≥1 normal saline boluses within first 72 hours of life
- Percent of targeted infants receiving any vasopressors within first 72 hours of life
- Percent of targeted infants receiving Sodium Bicarbonate within first 72 hours of life

These Process measures will be calculated from the captured "TIPQC TTB-sIVH PROJECT CLINICAL CARE CHECKLIST" records – see "Data Collection" below.

In addition, participating NICUs will report the following Process measures *quarterly*:

- Provider education
    - Cumulative proportion of providers, including Neonatologists and NNPs, who have completed an education program on sIVH Prevention that includes the unit-standard protocols

        - Report estimate in 10% increments (0-9%, 10-19%, 20-29%, 30-39%, 40-49%, 50-59%, 60-69%, 70-79%, 80-89%, 90-100%)
- Nursing education
    - Cumulative proportion of neonatal nurses who have completed an education program on sIVH Prevention that includes the unit-standard protocols
        - Report estimate in 10% increments (0-9%, 10-19%, 20-29%, 30-39%, 40-49%, 50-59%, 60-69%, 70-79%, 80-89%, 90-100%)

Balancing measures

- Percent of targeted infant with 5-minute APGAR score ≤ 3
- Percent of hypothermic targeted infants on first temperature
- Percent of hypothermic targeted infants on admission to NICU
- Percent of targeted infants with any gastrointestinal (GI) perforations (including SIP and NEC) within first 7 days of life

These Balancing measures will be calculated from the captured "TIPQC TTB-sIVH PROJECT CLINICAL CARE CHECKLIST" records – see "Data Collection" below.

Structure measures

- *Frequency of collection & reporting*: quarterly
- Hospital policy & procedure - reviewed and updated in the last 2-3 years
- Guidelines & reminders available at the time of admission and at the bedside after infant admitted

Data Collection

Participating NICUs will capture data on each infant using the provided "TIPQC TTB-sIVH PROJECT CLINICAL CARE CHECKLIST" – see screenshots below. Each team will determine the process in which the data will be collected (eg, on paper at the bedside and from the targeted infant's EMR). A record for each targeted infant will be captured using TDH TIPQC instance of REDCap.

As mentioned, the defined Outcome, Process, and Balancing measures will be calculated from the individual targeted infant records captured in REDCap. Up-to-date data reports will be generated and distributed to the participating NICU teams monthly.

The two education Process measures and defined Structure measures will be collected quarterly using REDCap surveys. The surveys will be built and stored using the TDH TIPQC instance of REDCap. A unique survey link and response will be created for each participating NICU. Each participating NICU will be sent an email each quarter with their specific survey link and will be instructed to submit their data. The generated data reports will also include summaries of these Process and Structure measures.

--- TIPQC TTB-sIVH PROJECT ---
CLINICAL CARE CHECKLIST

Please capture a record for every infant born at 29.6 or less weeks gestation admitted to your NICU for care.

- *All inborns and outborns (transfers) admitted within 24 hours of birth should be captured.*
- *In the case of multiples (eg, twins), a record should be captured for each infant.*

FOR INTERNAL TRACKING ONLY: *Mother's MRN* _____ *(if delivered at your facility)*
Newborn's MRN _____
REDCap Record ID (assigned by REDCap) _____

(REQUIRED) **What data are you capturing in this record?**
O I have *no (0)* infants (inborn or outborn) that meet the inclusion criteria to capture this month
O I'm capturing data on an infant that meets the inclusion criteria

If "no (0) infants", **specify month & year (MM/YY)** _____ *and STOP here.*
If "capturing data on an infant", CONTINUE.

INFANT & MATERNAL DETAILS

Date of birth (MM/DD/YYYY) _____

Location of birth O Inborn / O Outborn
If Outborn,
REMINDER: capture records on only those outborns admitted ≤ 24 hours of life
Date of admission (MM/DD/YYYY) _____
Hours of life at admission _____

Birth weight (grams) _____

Gestational age, *completed* weeks _____ **Gestation age, days (0-6)** _____

Multiple birth? O No / O Yes – *number of infants delivered* _____ *(2-8)*

Mother's race O White / O Black or African American /
O Other (*includes other races (eg, Asian), unspecified/unknown and bi-/multi-racial)*

Mother's ethnicity O Hispanic / O Not Hispanic / O Unknown

Mother's insurance O Medicaid (includes CHIP and TennCare/Medicare) / O Private insurance
O Other public insurance (includes military insurance, HIS, other state or federal source)
O Uninsured (includes self-pay, those who are not charged for services, or other payer)

Mother received any antenatal steroids? O Yes / O No / O Unknown
If Yes, **mother received ≥2 doses of antenatal steroids?** O Yes / O No / O Unknown

Mother received antenatal Magnesium Sulfate (MagSO4)? O Yes / O No / O Unknown

Infant died in delivery room? O Yes / O No
If Yes, STOP here. If No, CONTINUE.

24 HOURS OF LIFE

5-minute APGAR score _____

Temperature at *first* temp (within first hour of life; in degrees centigrade to nearest 10th) _____

Temperature at *admission to NICU* (within first hour of admission; in degrees centigrade to nearest 10th)

_____

Cord clamped ≥60 seconds after birth? O Yes / O No / O N/A (not appropriate; contraindication)

Does infant qualify for administration of Indomethacin? O Yes / O No

The infant qualifies if they are (1) <25 completed weeks gestation; OR (2) 25-27 completed weeks gestation AND outborn; OR (3) 25-27 completed weeks gestation AND their mother did not receive 2 doses of antenatal steroids

If Yes, **Received Indomethacin within first 24 hours of life (to potentially prevent IVH)?**
O Yes / O No

72 HOURS OF LIFE

Received ≥1 normal saline boluses within first 72 hours of life? O Yes / O No

If Yes, **How many normal saline boluses?** _____

Received any vasopressors within first 72 hours of life? O Yes / O No

Received Sodium Bicarbonate (NaHCO3) within first 72 hours of life? O Yes / O No

7 DAYS OF LIFE

Any gastrointestinal (GI) perforations (including SIP and NEC) within first 7 days of life? O Yes / O No

14 DAYS OF LIFE

Head ultra-sound performed on or before Day 14? O Yes / O No

If yes, **Evidence of severe IVH (grade 3 or 4; sIVH)?** O Yes / O No

40 WEEKS CORRECTED GESTATIONAL AGE

Disposition at 40 weeks corrected gestational age

O Still inpatient / O Home / O Died / O Transferred to another hospital

If Died,

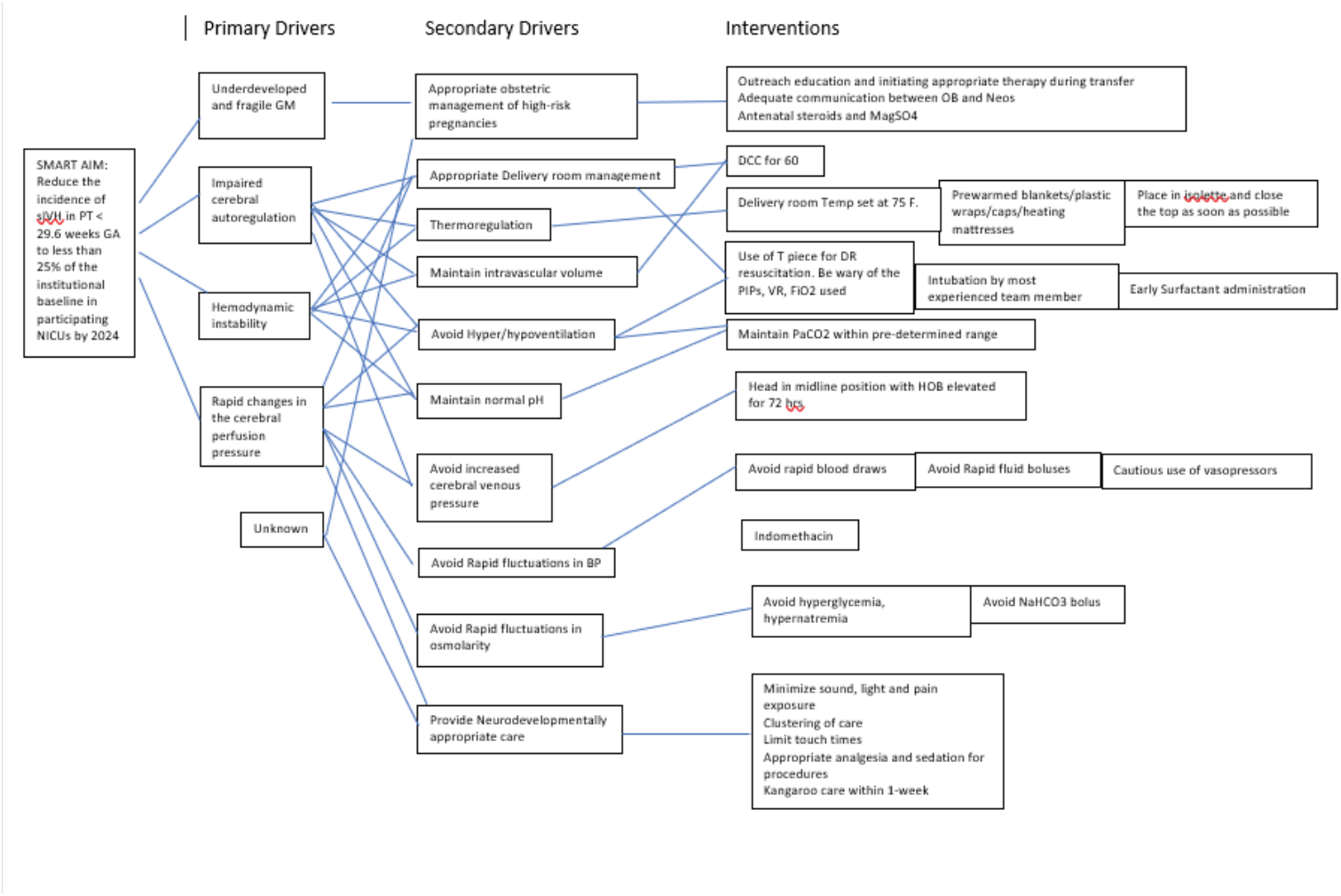
Died ≤ 24 hours of admission to your NICU? O Yes / O No

Date of death (MM/DD/YYYY) _____

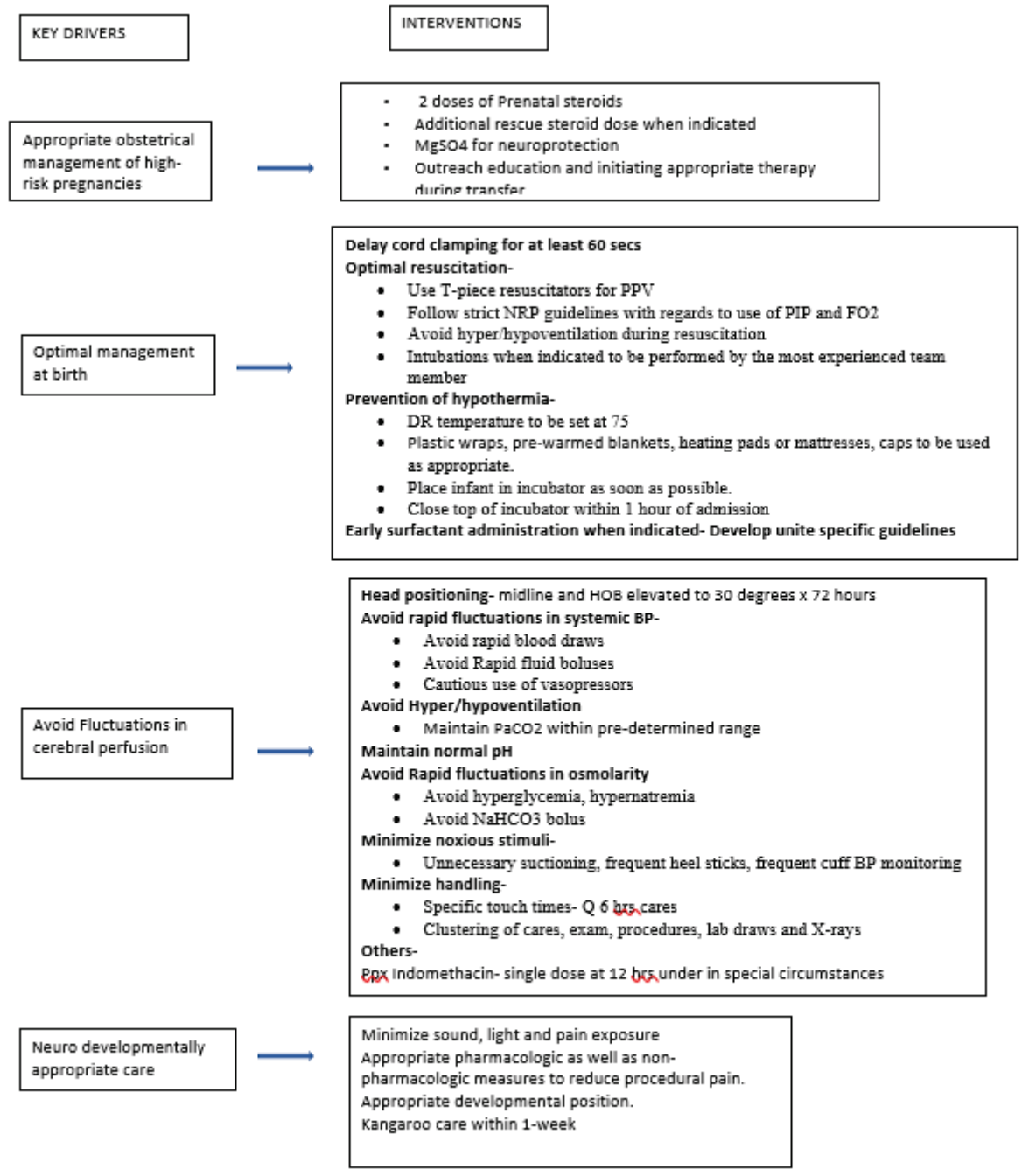
If Home or Transferred, **Date of discharge (MM/DD/YYYY)** _____

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.



Key Driver FLOW Diagram



References

[1]March of Dimes. *Report Card for Tennessee*. Premature birth report card. Retrieved July 6, 2022, from https://www.marchofdimes.org/peristats/tools/reportcard.aspx?frmodrc=1®=47
[2]Tennessee State Government - TN.gov. *Infant Mortality in Tennessee*. Retrieved July 6, 2022, from https://www.tn.gov/health/health-program-areas/tennessee-vital-signs/redirect-tennessee-vital-signs/vital-signs-actions/infant-mortality.html
[3]March of Dimes. *Infant Mortality Rates: Tennessee*. Retrieved July 6, 2022, from https://www.marchofdimes.org/peristats/
[4]Healthy People 2030. *Reduce the Rate of Infant Deaths*. Retrieved July 6, 2022, from https://health.gov/healthypeople/objectives-and-data/browse-objectives/infants/reduce-rate-infant-deaths-mich-02
[5]Gupta, R. & Froeb, K. (2020). Preterm birth. *The Journal of Perinatal & Neonatal Nursing*, 34(2), 99-103. doi: 10.1097/JPN.0000000000000469
[6]March of Dimes. *Preterm Birth: Tennessee, 2010-2020*. March of Dimes. Retrieved July 6, 2022, from https://www.marchofdimes.org/peristats/data?reg=99&top=3&stop=60&lev=1&slev=4&obj=1&sreg=47
[7]MacDorman, M. F., Martin, J. A., Mathews, T. J., Hoyert, D. L., Ventura, S. J. (2005). Explaining the 2001–02 infant mortality increase: Data from the linked birth/infant death data set. *Natl Vital Stat Rep.*, 53(12), 1–22.
[8]Callaghan, W. M., MacDorman, M. F., Rasmussen, S. A., Qin, C., & Lackritz, E. M. (2006). The contribution of preterm birth to infant mortality rates in the United States. *Pediatrics*, *118*(4), 1566–1573. https://doi.org/10.1542/peds.2006-0860
[9]Horbar, J. D., Badger, G. J., Lewit, E. M., Rogowsk,i J., & Shiono, P. H. (1997). Vermont Oxford Network. Hospital and patient characteristics associated with variation in 28-day mortality rates for very low birth weight infants. *Pediatrics*, 99(2), 149–156.
[10]Lee, S. K., McMillan, D. D., Ohlsson, A., & et al. (2000). Variations in practice and outcomes in the Canadian NICU network: 1996-1997. *Pediatrics*, 106(5), 1070–1079.
[11]Vohr, B. R., Wright, L. L., Dusick, A. M., & et al. (2004). Neonatal Research Network. Center differences and outcomes of extremely low birth weight infants. *Pediatrics*, 113(4), 781–789.
[12]Institute of Medicine - Committee on Quality of Health Care in America. (2001). *Crossing the quality chasm: A new health system for the 21st century*. National Academies Press.
[13]Aziz, K., McMillan, D. D., Andrews, W., & et al. (2005). Canadian Neonatal Network. Variations in rates of nosocomial infection among Canadian neonatal intensive care units may be practice-related. *BMC Pediatr*., 5(1), 22–34.
[14]Bell, E. F., Hintz, S. R., Hansen, N. I., Bann, C. M., Wyckoff, M. H., DeMauro, S. B., Walsh, M. C., Vohr, B. R., Stoll, B. J., Carlo, W. A., Van Meurs, K. P., Rysavy, M. A., Patel, R. M., Merhar, S. L., Sánchez, P. J., Laptook, A. R., Hibbs, A. M., Cotten, C. M., D'Angio, C. T., Winter, S., & et al. (2022). Eunice Kennedy Shriver National Institute of Child Health and Human Development Neonatal Research Network. Mortality, in-hospital morbidity, care practices, and 2-year outcomes for extremely preterm infants in the US, 2013-2018. *JAMA*, *327*(3), 248–263. https://doi.org/10.1001/jama.2021.23580
[15]Lapcharoensap, W., Bennett, M. V., Powers, R. J., Finer, N. N., Halamek, L. P., Gould, J. B., Sharek, P. J., & Lee, H. C. (2017). Effects of delivery room quality improvement on premature infant outcomes. *Journal of Perinatology*, *37*(4), 349–354. https://doi.org/10.1038/jp.2016.237
[16]Travers, C. P., Gentle, S., Freeman, A. E., Nichols, K., Shukla, V. V., Purvis, D., Dolma, K., Winter, L., Ambalavanan, N., Carlo, W. A., & Lal, C. V. (2022). A quality improvement bundle to improve outcomes in extremely preterm infants in the first Week. *Pediatrics*, *149*(2), e2020037341. https://doi.org/10.1542/peds.2020-037341
[17]Schmid, M. B., Reister, F., Mayer, B., Hopfner, R. J., Fuchs, H. &, Hummler, H. D. (2013). Prospective risk factor monitoring reduces intracranial hemorrhage rates in preterm infants. *Dtsch Arztebl Int*.,110, 489–96.
[18]de Bijl-Marcus, K., Brouwer, A. J., De Vries, L. S., Groenendaal, F., & Wezel-Meijler, J. V. (2020). Neonatal care bundles are associated with a reduction in the incidence of intraventricular haemorrhage in preterm infants: A multicentre cohort study. *Arch Dis Child Fetal*, 105, 419–24.

[19]Murthy, P., Zein, H., Thomas, S., Scott, J. N., Abou Mehrem, A., Esser, M. J., & et al. (2020). Neuroprotection care bundle implementation to decrease acute brain injury in preterm infants. *Pediatr Neurol*., 110, 42–8.
[20]Ferreira, D. M., Girao, A. L. A., Chaves, E. M. C., de Almeida, P. C., Freire, V. S., & et al. (2020). Application of a bundle in the prevention of peri-intraventricular hemorrhage in preterm newborns. *J Perinat Neonatal Nurs.,* 34, E5–E11.
[21]Wallau, C. A. K., Costa-Nobre, D. T., Leslie, A., & Guinsburg, R. (2021). Impact of bundle implementation on the incidence of peri/intraventricular hemorrhage among preterm infants: A pre-post interventional study. *Sao Paulo Med J.*, 139, 251–8.
[22]Shukla, V. V., Klinger, A., Yazdi, S. & *et al.* (2022). Prevention of severe brain injury in very preterm neonates: A quality improvement initiative. *J Perinatol*. DOI: 10.1038/s41372-022-01437-y
[23]Kramer, K. P., Minot, K., Butler, C., Haynes, K., Mason, A., Nguyen, L., Wynn, S., Liebowitz, M., & Rogers, E. E. (2022). Reduction of severe intraventricular hemorrhage in preterm infants: A quality improvement project. *Pediatrics*, *149*(3), e2021050652. https://doi.org/10.1542/peds.2021-050652
[24]Pfahl, S., Hoehn, T., Lohmeier, K., Richter-Werkle, R., Babor, F., Schramm, D., & et al.(2018). Long-term neurodevelopmental outcome following low grade intraventricular hemorrhage in premature infants. *Early Hum Dev.*, 117, 62–67.
[25]Volpe, J. J. (1979). Intracranial hemorrhage in the newborn: current understanding and dilemmas. *Neurology,* 29(5), 632-635.
[26]Mirza, H., Oh, W., Laptook, A., Vohr, B., Tucker, R. &, Stonestreet, B .S. (2013). Indomethacin prophylaxis to prevent intraventricular hemorrhage: Association between incidence and timing of drug administration. *J Pediatr.*, 163, 706–e701.
[27]Ment, L. R, Oh, W., Ehrenkranz, R. A., Philip, A. G., Schneider, K., Katz, K. H., & et al. (1993). Risk period for intraventricular hemorrhage of the preterm neonate is independent of gestational age. *Semin Perinatol.,* 17, 338–41.
[28]Al-Abdi, S. Y., & Al-Aamri, M. A. (2014). A Systematic Review and Meta-analysis of the Timing of Early Intraventricular Hemorrhage in Preterm Neonates: Clinical and Research Implications. *J Clin Neonatol.,* 3, 76–88.
[29]Chiriboga, N., Cortez, J., Pena-Ariet, A. & et al. (2019). Successful implementation of an intracranial hemorrhage (ICH) bundle in reducing severe ICH: A quality improvement project. *J Perinatol*., Jan 39(1), 143–151.
[30]Burlington (VT): Vermont Oxford Network. Nightingale Internet Reporting System. Accessed August 16, 2022; used with permission.