

The Golden Hour and Beyond
Golden Opportunities in the Care of the Very Low Birthweight Infant

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Disclosures

- I am a current employee of Logan Health Medical Center
- I am a current employee of Prolacta Bioscience
- I have independently prepared this presentation
- Photos and diagrams in this presentation are for educational purposes only



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Objectives

- Describe the teams, roles and steps involved in the smooth transition from birth to NICU admission
- Discuss potential barriers to facilitating a smooth transition process and tips to overcome them
- Understand the most common morbidities associated with preterm birth and ways to promote positive outcomes through optimal NICU care

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Who Is This New Population Of Premature Infants?

- < 28 weeks gestation (fetuses?)
 - Limits of viability
 - Significant multiorgan prematurity
- Growth and development should be occurring within the intrauterine environment
- Severe complications including CLD, NEC, ROP, and late-onset sepsis are **IATROGENIC**
- Short and long-term costs staggering
 - Avg \$3500/day without morbidities
 - NEC \$74,000-198,000¹ (2021 adjusted)
 - Lifetime costs have been estimated at up to \$4 million



Uniformly treated ELBW infants have better survival than those treated on a more case-by-case approach (standardized protocols)

Genapatil V, Hay IW, Kim JH. Costs of necrotizing enterocolitis and cost-effectiveness of exclusively human milk-based products in feeding extremely premature infants. *Breastfeed Med*. 2012;7(1):29-37. doi.org/10.1089/bfm.2011.0002

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Mortality, Morbidity and 2 Year Outcomes for Extremely Preterm Infants (JAMA 2022)



10,877 infants
22-28 weeks gestation
19 academic medical centers

- 80% survival to discharge (30% @ 22 weeks)
 - 12% of infants had necrotizing enterocolitis (15)
 - 26% had late-onset infection (41)
 - 19% had severe retinopathy of prematurity (38)
 - 67% had severe bronchopulmonary dysplasia (84)
- Follow-up assessment at 2 years,
 - 49% had been re-hospitalized (65)
 - 42% had mod-severe neurodevelopmental impairment (69)

Bell EF, Hirtz SR, Hansen NJ, et al. Mortality, In-Hospital Morbidity, Care Practices, and 2-Year Outcomes for Extremely Preterm Infants in the US, 2013-2018. *JAMA*. 2022;327(13):248-263. doi:10.1001/jama.2021.23380

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The Importance of the Golden Hour

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The Golden Hour is 60 minutes of *team-oriented and task-driven protocols* that can mean the difference between life and death.

Focus:

- Resuscitation
- Thermoregulation
- Early administration of antibiotics for suspected sepsis
- Early parenteral nutrition
- Management of hypoglycemia
- Completed admission within one hour of life



Doyle, K., Bradshaw, W. 2012. Sixty golden minutes. Neonatal Netw. Sep-Oct;31(5):289-94. doi: 10.1891/0730-0832.31.5.289

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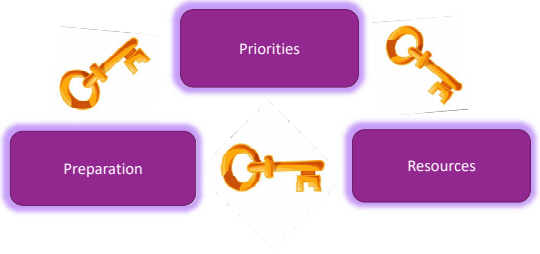
First Hour Goals

You will only be successful at meeting these goals if you are well prepared and have the help of a good team.

Appropriate respiratory support	Normothermia	Monitors on
Lines placed	Boluses as appropriate	TPN/fluids running
Initial lab work	X-rays	Admission medications given
Antibiotics given if indicated	Admission measurements as appropriate	Infant nested, isolette closed, humidity on, and walk away

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The Keys to Success



Preparation

Priorities

Resources

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What Are Your Delivery Room Priorities?

- Cardio-respiratory support
 - Ventilation and oxygenation
 - Lines and fluids
 - Resuscitation medications
- Thermoregulation
 - Prevent hypothermia
 - Minimize insensible water loss
- Transfer to the NICU
- Parent involvement

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What Resources Do You Need To Address The Priorities?

Leader: Neonatologist or NNP	Airway/Ventilation: RT
HR and Monitors: RN	Lines/Meds: Neo, NNP or RN
Thermoregulation: RN	Scribe/Timekeeper: RN or Tech
Runner: Tech	Family Liaison: RN or Social Worker

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Assign Delivery Room Roles – Be Specific!


Time	Neo/NNP	RN 1	RN 2	RT
Pre-delivery	<ul style="list-style-type: none"> ✓ Review maternal history ✓ Discussion with OB provider re: delayed cord clamping ✓ Discussion with family ✓ Pre-fill order sets ✓ Pre huddle with team 	<ul style="list-style-type: none"> ✓ Check delivery room setup ✓ Increase room temperature 	<ul style="list-style-type: none"> ✓ Prepare lines/fluids/meds 	<ul style="list-style-type: none"> ✓ Check BVM equipment ✓ Check intubation supplies ✓ Set up bedside support
0-10 minutes	<ul style="list-style-type: none"> ✓ Decision tree ✓ Direct team ✓ Intubation if needed 	<ul style="list-style-type: none"> ✓ Assess HR ✓ Apply monitors ✓ Initiate compressions as directed 	<ul style="list-style-type: none"> ✓ Thermal wrap ✓ Temperature ✓ Hat and thermal mattress as appropriate 	<ul style="list-style-type: none"> ✓ Assess resp status ✓ Initiate BVM as directed ✓ Adjust FIO₂ as needed
10-15 minutes	Stabilize and transport to NICU	Stabilize and transport to NICU	Stabilize and transport to NICU	Stabilize and transport to NICU

American College of Obstetricians and Gynecologists. 2017. Delayed umbilical cord clamping after birth. Committee Opinion Number 684.

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Prepare For Every Infant To Require Resuscitation

- Have all resuscitation equipment immediately available in sufficient quantity
- Always the same equipment in the same place
 - Warmer set up consistent
 - Trays for intubation, lines
 - Cart drawers for storage/organization



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Delivery Room Thermoregulation


- Prevent hypothermia
 - Associated with increased likelihood of 5 min Apgar score being <7
 - Associated with increase in IVH, sepsis, respiratory distress, and hypoglycemia
 - For every 1° C below 36° C on admission, mortality increases by 28%
- Turn up the heat in the DR or OR to 26-28° C (about 80° F)
- Prewarm everything
- Use plastic wrap or bag, plastic lined hat (stockinette is ineffective), chemical thermal mattress
- Warmed gases for resuscitation if <32 weeks gestation

Neonatal Resuscitation Program, 8th ed. American Academy of Pediatrics and American Heart Association. Weiner, G, Zaiciklin J. 2021. ISBN-13: 978-1-61002-524-9.

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Delivery Room Care - Resuscitation

- Immediate appropriate resuscitation
 - Avoid PPV unless necessary
 - CPAP, 4-6 cm
- Goals:
 - Decrease pulmonary vascular resistance
 - Promote blood flow into the lungs
 - Trigger normal transition to extrauterine life
- Start at 21-30% FiO2 for <35 weeks gestation (per NRP 8th ed.)



Neonatal Resuscitation Program, 8th ed. American Academy of Pediatrics and American Heart Association. Weiner, G, Zaiciklin J. 2021. ISBN-13: 978-1-61002-524-9.

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Target Saturation Goals in the Delivery Room

Avoid hyper- or hypo-oxygenation, both are detrimental

Minute of Life	Target SpO ₂ (Preductal)
1 min	60% - 65%
2 min	65% - 70%
3 min	70% - 75%
4 min	75% - 80%
5 min	80% - 85%
10 min	85% - 95%

- Preterm infants have reduced antioxidant defenses
- Hypoxia/hypoxemia can lead to tissue damage and organ failure

Neonatal Resuscitation Program, 8th ed. American Academy of Pediatrics and American Heart Association. Weiner G, Zachariah J. 2021. ISBN-13: 978-1-61002-524-9.

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Admission

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The Next 45 Minutes

Time	Neo/NNP	RN 1	RN 2	RT
15-45 minutes	<ul style="list-style-type: none"> Place umbilical lines Draw labs Complete orders 	<ul style="list-style-type: none"> String fluids – D₁₀W, PN Administer admit meds Administer boluses as needed Assist with x-rays 	<ul style="list-style-type: none"> Assess infant: weight, VS Obtain blood glucose Place PIV if indicated Monitor temperature Send labs 	<ul style="list-style-type: none"> Place on respiratory support Monitor/adjust FIO₂ Ensure securement of ETT if intubated
45-55 minutes	<ul style="list-style-type: none"> Interpret x-ray Adjust lines if needed 	<ul style="list-style-type: none"> Hang/start fluids Administer antibiotics as ordered 	<ul style="list-style-type: none"> Obtain temperature Obtain blood glucose Remove plastic wrap 	<ul style="list-style-type: none"> Monitor SpO₂ Obtain blood gases as indicated/ordered Adjust FIO₂ as needed
55-60 minutes	<ul style="list-style-type: none"> Update family 	<ul style="list-style-type: none"> Assure isolette temperature and humidity are set Hands off 	<ul style="list-style-type: none"> Nest infant Hands off 	<ul style="list-style-type: none"> Monitor SpO₂ Adjust FIO₂ as needed
61 minutes and beyond	<ul style="list-style-type: none"> Continue to monitor 		<ul style="list-style-type: none"> Continue to monitor Minimal handling 	<ul style="list-style-type: none"> Continue to monitor Adjust support as needed Minimal suctioning
Post-admission	Huddle with team	Huddle with team	Huddle with team	Huddle with team

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Respiratory Support

- Support normal gas exchange
- Use the least invasive, least aggressive support necessary

CPAP, nIPPV

Intubation if indicated


- Surfactant administration
 - Institution policy? (<29 wks?, <27 wks?)
 - INSURE if appropriate
- Inadequate respiratory effort

- Skin protection in place

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Thermal Regulation


- Temperature can drop 2-3°C in the first 30 min after delivery
- Hypothermia: temperature below 36.5 °C (WHO)
 - Impaired lung function and surfactant production
 - Increased risk of infection
 - Increased incidence of intraventricular hemorrhage
 - Increased risk of death
- Vermont Oxford data: 25% prevalence of hypothermia at NICU admission
- Laptook et al.: 28% increase in mortality and an 11% increase in late-onset sepsis for every 1 °C drop below 36 °C at admission



Pelleg, B., Gibbus, O., Granot, M. et al. "Golden Hour" quality improvement intervention and short-term outcome among preterm infants. *J Perinatol* 39, 387-392 (2019). <https://doi.org/10.1098/041372-018-0254-0>
 Elbaum, L., Skora, K. S., Damman, D., & Damman, C. E. (2021). Adverse events and outcomes of hypothermia at admission to the neonatal intensive care unit. *The Journal of Maternal-Fetal & Neonatal Medicine*, 24(1), 56-71. Laptook AR, Sabhu W, Bhaskar B, Neonatal Research Network. Admission temperature of low birth weight infants: predictors and associated morbidities. *Pediatrics*. 2007;119:6448-9

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Maintain Normothermia and Reduce Insensible Water Loss



- Heat and humidify supplemental respiratory gases as soon as possible
- Provide a humidified environment
 - Improves thermal regulation
 - Decreases insensible water loss
- No consensus on how much humidity to use or for how long
 - For the ELBW starting at 70-80% is most common
 - Start weaning at about 1 week of age if tolerated

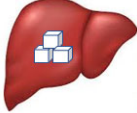
Hyperthermia is associated with respiratory depression, lung injury, acidosis, inflammation, and death

Wickoff, MN. 2014. Initial resuscitation and stabilization of the perinatal neonate: the Golden Hour approach. *Semin in Perinatol* Feb;38(1):12-6. doi:10.1053/j.semper.2013.07.003.

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Fluids- Hypoglycemia

- The preterm infant has minimal glycogen stores
- Substrates for gluconeogenesis are limited (protein, fat)
- Approx 60% of preterm infants develop hypoglycemia
- No consensus on the definition of hypoglycemia
 - Asymptomatic:
 - <4 hrs: <25 mg/dL
 - 4-24 hrs: <35 mg/dL
 - 24-48 hrs: <50 mg/dL
 - ≥48 hrs: <60 mg/dL
 - Symptomatic:
 - <48 hrs: <50 mg/dL
 - ≥48 hours: <60 mg/dL



Check blood sugar early (within the first 20-30 minutes of life), check often, and treat promptly.

Sharma A, Davis A, Shekhwat P5. Hypoglycemia in the preterm neonate: etiology, diagnosis, management and long-term outcomes. *Transl Pediatr*. 2017 Oct;6(4):335-348. doi: 10.2197/jp.2017.10.06. PMID: 29184814; PMCID: PMC5622372

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Fluids - Hypotension

- Fluid boluses
 - Perfusion vs blood pressure
 - Blood pressure is not very reliable in the ELBW infant
 - Color, cap refill, and response to resuscitation should help guide bolus decisions
- Normal saline vs blood products
 - Was there evidence of blood loss?
 - What is your protocol for getting neonatal blood products?
 - Emergent need?
 - Consent or decline – if declined how do you proceed in life & death situation?
- Keep it warm!

Fanaroff, A., Martin, R. 2015. Neonatal Perinatal Medicine: Diseases of the Fetus and Newborn. Elsevier/Saunders, Philadelphia, PA, pg 615-618.

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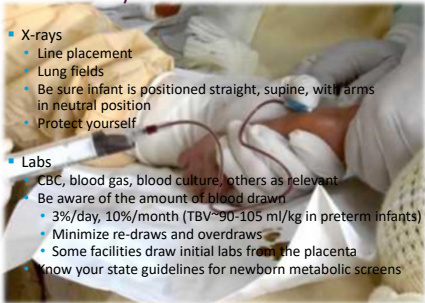
Early Nutrition: Parenteral

- Starter (vanilla) TPN should be available and at least room temperature before infant arrival
 - D10W for BW >1000 g, D5W for BW <1000 g
 - Needs to have amino acids: 3-3.5%
 - No electrolytes
 - Calcium may be added if a central line is in place
 - Start as soon as line placement is confirmed to decrease the time the infant is without a protein source – should be within 30 minutes of birth
- Initially 60-80 ml/kg/d
- Increasing needs in the first few days
- Total fluid requirements for an ELBW infant may be as high as 200 ml/kg/day to offset insensible water losses (humidity!)

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Lab Work and X-rays

- X-rays
 - Line placement
 - Lung fields
 - Be sure infant is positioned straight, supine, with arms in neutral position
 - Protect yourself
- Labs
 - CBC, blood gas, blood culture, others as relevant
 - Be aware of the amount of blood drawn
 - 3%/day, 10%/month (TBV ~90-105 ml/kg in preterm infants)
 - Minimize re-draws and overdraws
 - Some facilities draw initial labs from the placenta
 - Know your state guidelines for newborn metabolic screens



Fasaroff, A., Martin, R. 2015. Neonatal Perinatal Medicine: Diseases of the Fetus and Newborn. Elsevier/Saunders, Philadelphia, PA, p 1354.

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Medications


- Antibiotics
 - Antibiotic stewardship promotes less prophylactic use of antibiotics
 - Standardize your protocols for antibiotics
 - If started prophylactically discontinue within 48 hours unless indicated
- Admission medications
 - Eye prophylaxis - some facilities administer eye meds even if the eyelids are fused and repeat when eyes open
 - Vitamin K: ½ dose if infant is <1500 grams
 - Preterm infants are at higher risk of bleeding due to immature hepatic function

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That's A Lot To Accomplish in 60 Minutes
But You Can Do It!

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Barriers to Success



- Conflicting priorities
- Inadequate resources
- Inadequate preparation
 - Room was not warm as recommended
 - No use of hats or plastic bags on regular basis
 - No available T-piece for adequate ventilation in every work-station
 - Equipment was lacking and was not organized

Ning, B., Globus, O., Grant, M. et al. "Golden Hour" quality improvement intervention and short-term outcome among preterm infants. / *Perinatal* 39, 387-392 (2019). <https://doi.org/10.1018/41372-018-0214-0>

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Overcoming Barriers: Priorities

Is the Golden Hour Really a Big Deal?

- Prompt interventions can help lessen the severity of disease processes and reduce the risk of long-term complications
- Interventions during the first hour of life impact ongoing care
- Impress upon your team the importance of the Golden Hour through education (nursing, lab, radiology, ancillary staff, leadership)

"Decisions made and actions taken in the first hour of life can either support a smooth transition to extrauterine life or hasten and worsen maladaptation."

Bissinger, R., Amabile, D., 2014. Golden Hours: Care of the Very Low Birth Weight Infant. 2nd edition. National Certification Corporation, Chicago, IL.

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Overcoming Barriers: Resources

- Assign roles for delivery and admission
- Do you have the right number of the right people to do the job?
 - More is not always better
- If you feel you are frequently lacking in the right people gather facts and specifics before approaching the leadership team

Neonatal Resuscitation Program, 8th ed. American Academy of Pediatrics and American Heart Association, Welner, G. Zacharia, J. 2021. ISBN 11-978-1-61002-524-9.

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Overcoming Barriers: Preparation

- Develop and use checklists for delivery and admission set up
- Develop kits or designated cart drawers for all procedures
 - Intubation
 - Laryngoscopes, tubes, stylets, LMA, securement devices
 - Line placement
 - Trays, catheters, extensions, caps, transducers, restraints, PPE
 - Thermoregulation
 - Chemical mattress, plastic wrap, plastic lined or wool hat
- Have starter TPN immediately available

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Overcoming Barriers: Preparation

- Request pre-admission for all infants that will likely come to the NICU before delivery or prior to arrival if a transfer in
- Standardize protocols and order sets
- Have RT set up CPAP and have ventilator set up if this is a possibility. Better to have it and take it down than to wait while it calibrates
- Set up for any likely procedures
 - Intubation
 - Line placement or PIV supplies
 - Flush IV tubing - it will warm faster in the tubing than in the bag

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Beyond the First Hour

Continuing to Provide Care That Supports Good Outcomes

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Respiratory Support

- Try non-invasive support first
 - CPAP
 - nIPPV
 - Usually well tolerated
 - May not be synchronous with spontaneous breaths
 - Adequate stomach venting is critical and not easy
- Start caffeine early to prevent apnea of prematurity



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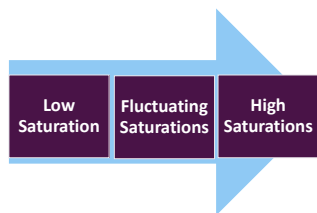
Respiratory Support

- If you *must* intubate
 - Minimize lung injury: Volume ventilation
 - High pressures have little adverse effect if not over-distending the lungs
- Extubate ASAP
 - Every day (several times/day) ask: does this baby still need the vent
 - Weaning to nIPPV has been shown to decrease extubation failure
- Use caffeine
 - Decreases extubation failure
 - Decreases apnea of prematurity
 - Decreases the incidence of BPD
 - Associated with improved neurodevelopmental outcomes

Mochino, L, Zivanovic, S, et al. Caffeine in preterm infants: where are we in 2020? ERI Open Research 2020 6:00330-2019. doi: 10.1183/23120541.00330-2019

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Be Vigilant About Oxygen Saturations



Cell/Tissue/Organ Injury




- Chronic Lung Disease/BPD
- Necrotizing Enterocolitis
- Patent Ductus Arteriosus
- Retinopathy of Prematurity
- Periventricular Leukomalacia

Trindade CP, Rugglo LMS. Free radicals and neonatal diseases. NeonReviews. 2007;8(12):e522-e532. doi:10.1542/neo.8-12-e522

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Sepsis Prevention

- Preterm infants are naturally set up for infection
- Antibiotic use or delayed enteral feedings may disrupt the gut microbiota
 - Predisposes the infant to delays in immune development and sepsis
- Humidified environment has been shown to increase risk in some studies but contradicted in others
- Attention to asepsis is paramount in every encounter
- Exposure to mother's milk helps develop the immune system
- Consider prophylactic fluconazole



Griff, E., Bhandari, V. 2015. The human neonatal gut microbiome: a brief review. *Frontiers in Pediatrics*. 3: 17. doi: 10.3389/fped.2015.00017
 DeSilva-Rios, J., Camargo, P. Fluconazole prophylaxis in preterm infants: a systematic review. *The Brazilian Journal of Infectious Diseases*. Volume 21, Issue 3, May-June 2017, Pages 333-338.

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Intraventricular Hemorrhage Prevention

- Risk factors


Prematurity	Sepsis
Respiratory distress syndrome	Hypoxemia
Hypothermia	Hypotension
Acidosis	Rapid changes in cerebral blood flow

- Antenatal steroids and magnesium sulfate administration have a protective effect
- Delayed cord clamping at delivery has been shown to help prevent IVH in the preterm infant

American College of Obstetricians and Gynecologists. 2017. Delayed umbilical cord clamping after birth. Committee Opinion Number 684.

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IVH Prevention



- Develop an IVH bundle and use it
- Midline head position for 72 hours
- Elevate the HOB 30° to promote venous drainage – avoid head down
- Avoid routine endotracheal suctioning
- Do not exceed 1 ml/min infusions or blood draws
- Minimal stimulation protocol

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Early Nutrition: Parenteral

- Approximately 50% of extra-uterine growth failure is related to fat and protein deficits
- Maintain protein intake of 3.5-4 g/kg/day (3-3.5?)
- Lipids at a minimum of 0.5-1.0 g/kg/day on dol 1
 - Increase to 3 g/kg/day (many units start at 3 g/kg/day)
 - Helps avoid essential fatty acid deficiency (EFAD)
 - EFAD can develop in less than 72 hours without adequate non-protein energy
 - May impede membrane development in the brain, resulting in potential abnormal neurodevelopment
 - Reluctance to use lipids due to concerns of increased risk of BPD, however meta-analysis showed no increased incidence

Bislinger, R, Amabile, D., 2014. Golden Hours, Care of the Very Low Birth Weight Infant. 2nd edition. National Certification Corporation, Chicago, IL.
 Robinson D.J, Cahill, K., Chen Y, Collier MP, Faniglia DL, Church DL, May J, McKeown L, Semelko T. Guidelines for parenteral nutrition in preterm infants: The American Society for Parenteral and Enteral Nutrition. *JPEN: A Practical Evidence-Based Nutr*. 2014;39(4):419-430. doi: 10.1007/s12019-014-0400-3

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Colostrum As Immunotherapy

- Colostrum is swabbed on the insides of the cheeks and also used for oral hygiene
 - Done with every cares
 - Sponge tipped applicators work better than cotton tipped
 - This is something parents should be encouraged to do for their baby
- As the name implies, this is mostly immunologic in nature
 - Introduction of immune cells and immunoglobulins
 - Natural prebiotics
 - Helps prevent ventilator associated pneumonia and should be part of your VAP bundle

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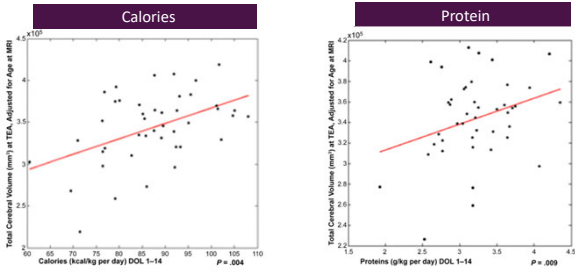
Early Nutrition: Enteral

- Begin trophic feeds with human milk within 24 hours of birth whenever possible
 - 15-20 ml/kg/day
 - Early enteral nutrition prevents gut atrophy and stimulates enzyme production
 - Formula should not be a back up for MOM if the infant is <1500 grams
- Have a feeding protocol and use it
- Human babies should have human milk
- Consider the use of an exclusive human milk diet for ELBW infants

AAP committee on nutrition. AAP section on breastfeeding. AAP committee on fetus and newborn. Donor human milk for the high-risk infant: preparation, safety, and usage options in the united states. *Pediatrics*. 2017;139(1):e20163446.

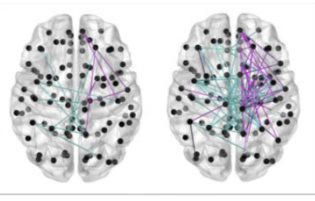
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Early Enteral Feeds and Neurodevelopment Outcomes



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Breastmilk Exposure Associated with Improved Markers of Brain Development and Connectivity in Preterm Infants



- Information processing hubs

Hub connections

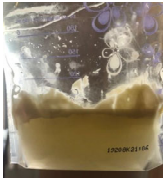
Data suggests that brain connections in preterm babies are improved with greater amounts of human milk (mom's or donor) in the weeks after birth

Bleca M, Sullivan G, Anbagan O, et al. Early breast milk exposure modifies brain connectivity in preterm infants. *NeuroImage*. 2019;184:431-439. doi:10.1016/j.neuroimage.2018.09.045

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Early Nutrition-Support Growth

- If using human milk, faster advancement (30-35 ml/kg/day) is tolerated, supports growth, and has not been shown to increase the risk of NEC
- Fortify early – if using human milk-derived fortifiers many facilities are starting fortification to 26 cal/oz at 60 ml/kg/day or earlier with good results
- When discontinuing TPN be sure macronutrients are still being met
 - About 15% of nutrients in enteral feedings are lost in digestion and fecal losses
 - May need additional fortification as TPN is being decreased/discontinued



Miller, M. 2017. Transitioning preterm infants from parenteral nutrition: A comparison of 2 protocols. *JPEN: J Parenter Enteral Nutr*. 2017 Nov;41(8): 1371-1379. doi: 10.1177/0148807116664560.

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Neurosensory Development



- The basic physical structure of the sensory receptors (eyes, ears, etc.) develop early in gestation
- Most neurosensory development occurs in the last sixteen weeks of pregnancy
- Preterm birth accelerates the maturation of the kidney, gastrointestinal, lung and cardiovascular systems
- Preterm birth **does not** alter the sequence or timing of neurodevelopment.

Green S, Brown J. Sensory development in the fetus, neonate, and infant: introduction and overview. *Newborn and Infant Nursing Reviews*. December 2008. <https://doi.org/10.1053/j.ninr.2008.10.007>

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Developmental Care



- Morbidity prevention
- Early attainment of full feedings/nutrient goals
- Appropriate parental involvement
- Attention to the environment
- Infant driven care

“Plasticity is a feature of the developing brain whereby it becomes highly adaptive and responsive to environmental stimulation.”

Church PT et al., Premature Infants: The Behavioral Phenotype of the Preterm Survivor, p. 106-121. In Needleman H & Jackson BJ (2018). *Follow Up for the NICU Graduate*. Springer Publishing.

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In Conclusion



**To a new human,
the first 60 minutes of
life are golden.**

**Never underestimate
your contribution.**

**What you do in that
hour and beyond
impacts a lifetime.**

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