SPECIALIZED CARE FOR THE VERY LOW BIRTH WEIGHT INFANT

Delinda Castillo, BSN, RN

Jennifer Gallegos, MSN, NNP-BC
OVERVIEW OF AFTERNOON:

• Session 1 (1:45-2:45)
  • Background Information
  • Delivery Room Management
  • Admissions Process/Checklist

• Session 2 (3-4)
  • Respiratory Management
  • Neuroprotection
  • Developmental Positioning

• Session 3 (4:15-5:15)
  • Importance of skin care for ELBW infants
  • Infection Control Practices
WHY START A SMALL BABY PROGRAM?

• Preterm birth rate still increasing in the US
• Increasing survival rates for ELBW infants
• Variation in outcomes
• Variation in practices amongst providers

SMALL BABY UNIT IMPROVES QUALITY AND OUTCOMES IN EXTREMELY LOW BIRTH WEIGHT INFANTS

MORRIS, M., CLEARY, J.P., & SOLIMAN, A. PEDIATRICS 2015; 136; E1007
ONE UNIT’S QUALITY IMPROVEMENT PROJECT RESULTS

- Reduction in chronic lung disease
- Successful extubation in the first week of life
- Increase use of CPAP alone as primary respiratory support
- Reduction in hospital acquired infection
- Improved growth
- Reduction in resource utilization
- Increase in staff satisfaction

- Consistent and uniform practice informed by best evidence
IMPLEMENTATION OF SMALL BABY PROGRAM AT TEXAS CHILDREN’S HOSPITAL
MISSION, VISION AND VALUES

Mission
To foster evidence-based care of ELBW infants in a family centered environment

Vision
To have the best clinical outcomes possible for ELBW infants born in our newborn center, as determined by key performance measures tracked by the Vermont Oxford Network

Values
Respect, Teamwork, Excellence
We have completed the guidelines for the program and are currently hosting education sessions. This program will focus on preterm infants ≤ 28 weeks or ≤ 1000 g. A focused program to care for ELBW infants to improve key outcome measures (VON definitions).
IMPLEMENTATION

• Goal of the SBP
  • consistent and uniform practice informed by best evidence

• Baylor neo guidelines relevant to ELBW infants

• Nursing/RT guidelines related to nursing/RT care.

• Guidelines and checklists to be uploaded to SBP teamsite.

• Committees:
  • Guidelines
  • Workflow Process
  • Educational Committee
WORKFLOW AND PROCESS COMMITTEE

• MD’s, RN’s, NNP’s, Fellows, Unit Educators

• What does it mean for a baby to be in the Small Baby Program?

Receive **consistent care** according to SBP guidelines and protocols by a specially educated clinical team including a dedicated group of PFW nurses working with **all 3 PFW teams** composed of residents, NNPs, fellows and attendings and with assistance from regular PFW clinical and support staff.
WORKFLOW AND PROCESS

- Physical location and overflow if needed
- Specific team structure
  - Providers:
  - Nursing:
    - Subset of PFW nursing will care for SBP patients including receiving SBP education
      - Group of 12-15 bedside nurses per shift
      - All charge nurses & Neo Response nurses
    - Staffing: Goal of 1:1 for first 72h of life and 72h after extubation to CPAP
  - RTs: Current PFW NICU staffing
  - Ancillary Staff:
    - Pharmacists, Nutritionists, SW, PT/OT:
    - Nutritionists:
GRADUATION FROM SBP

• Graduation
  • 32 weeks and 1250 grams

• Patient Flow
  • Continue current protocol of transferring out of PFW to WT Level 4 and Level 2
  • Graduate to different room in PFW
  • If transfers to level 2 or 4 prior, will be out of the program although guidelines should still be followed
# SBP TIMELINE

<table>
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<th>Dec 2018</th>
<th>Jan 2019</th>
<th>Feb 2019</th>
<th>March 2019</th>
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<td>Workflow</td>
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<td><strong>Neuro-dev</strong></td>
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<td>Compliance</td>
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<td>Outcomes</td>
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**OFFICIAL LAUNCH DATE – Wednesday, Feb 27, 2019**
OUTCOME MEASURES

• **Infant outcomes**
  - VON composite measure of survival without specified morbidities, specific morbidities

• **Evaluation of resource utilization**
  - the average number of laboratory tests and radiographs per patient

• **Improve family satisfaction**
  - consistency of care
  - providing a unique environment for families who experience similar lengths of hospitalization, complications, and outcomes

• **Increase staff satisfaction**
  - consistent care will be delivered by a dedicated team.

• **Staff perception**
  - of the quality of care delivered to this fragile population and team collaboration will be assessed via periodic surveys.
Hosted initial educational sessions to multidisciplinary team members

Responsibly for continued education as needed

Team composed of RN, Educators, CNS, NNP, MD’s

Collated all information and developed flow of educational sessions
DELIVERY ROOM MANAGEMENT
CONSIDERATIONS IN THE DELIVERY ROOM

- Pre-Brief
- Set-up
- Thermoregulation
- IV Access
- Family Centered Care
- Neuroprotection
- Infection Control

THERMAL REGULATION

- In delivery room, core temp may fall 2°C within 15 min
  - Increase temperature of OR or labor suite to at least 75 degrees 30 minutes prior
- Place in Giraffe with humidity 80% during first week of life
- Servo temp
  - 36.2 °C - 36.5 °C
- Consider keeping plastic wrap in place until goal humidity reached
- Rewarming of hypothermic infant (<36 °C): No evidence for slow vs fast rewarming
  - See Neo Guidelines for recommendations (radiant warmer with servo 36.5 °C, frequent temp checks)
• https://bcm.box.com/s/5ccsosin691266jxd97uhbvkrageyld8
DELAYED CORD CLAMPING

What is it?

• Infants < 37 weeks gestation

• Clamping of umbilical cord at 60 seconds of life

• Placental transfusion

• Baby kept at level of introitus or on mother’s abdomen
DELAYED CORD CLAMPING

How is it helpful?

• Increase in oxygen carrying capacity and oxygen saturation

• Maintain cardiac output, oxygenation, and arterial blood pressure while establishing breathing
DELAYED CORD CLAMPING

What are the outcomes?

- **DECREASES**
  - Hospital mortality
  - Number of blood transfusions given to infants

- **INCREASES**
  - Hematocrit
  - Polycythemia
  - Hyperbilirubinemia

TRANSPORT

• Wrap baby in warm blankets
• Ensure chemical mattress is on transport isolette to maintain thermoregulation
• Avoid drastic changes in movement
• Move baby in transport isolette to see mom
ADMISSION PROCESS & CONSIDERATIONS

The admitting nurse’s role
ADMISSION

• Ensure Respiratory Support is ready
• Ensure an isolette is warmed to 36.5
• Ensure humidity has been started
• Ensure that a provider is ready to place lines if needed
ADMISSION CHECKLIST

Small Baby Program (SBP)

ADMISSION CHECKLIST:

1. Shuttle used to transport patient to NICU: YES or NO
   a. If no, why not:__________________________

2. Surfactant administered: YES or NO

3. If so, what was P102 before administration: ____________

4. Umbilical Lines Place: UVC UAC [circle what apply]

5. Umbilical Lines Place: IN NICU [circle what apply]

6. Father/support person updated on admission: YES or NO

7. Admitted to: BCPAP ETT [circle what apply]

8. If ETT placed in NICU [on DOL 1], how many attempts: _______

9. Time of 1st antibiotic dose:__________________________

10. Time of umbilical cord was first closed: ____________

11. Was humidity started (80%) in 1st hour of life: YES or NO

12. How many times the baby touched in 1st 6 hours: _______

13. Once closed, was the top popped in the first 6 hours: YES or NO
   a. If so, why:__________________________

14. Started a Research Study: YES or NO
   a. If so, which one:__________________________

Patient Label

Small Baby Program (SBP)

MY FIRSTS:

1. Mother’s 1st visit and updated by RN: _________ [time]

2. Blood Transfusion Consent Signed: _________ [time]

3. Assent for Donor EBM obtained: _________ [time]

4. EOC/Infection control letter completed [DOL 3-7]: _________ [time]

5. My first ‘Hand Hugs’ with mom or dad: _________ [time]

6. My first Bath: _________ [not before DOL 7] [time]

7. My first oral care with colostrum: _________ [time]

8. My first Kangaroo care: _________ [time]
   a. If before DOL 7 or after DOL 14, why:__________________________

First bed change due (time): _________ [DOL 7] Done:

Humidity weaned to 75% (time) _________ at 0900 [DOL 7] Done:

Humidity weaned to 70% (time) _________ at 2100 [DOL 7] Done:

Humidity weaned to 65% (time) _________ at 0900 [DOL 8] Done:

Humidity weaned to 60% (time) _________ at 2100 [DOL 8] Done:

Humidity weaned to 55% (time) _________ at 0900 [DOL 9] Done:

Humidity weaned to 50% (time) _________ at 2100 [DOL 9] Done:

Humidity discontinued (time) _________ at 0900 [DOL 14] Done:

Second bed change due (time) _________ [DOL 14] Done:

Please place patient label on back and post in patient’s room until completed [approximately DOL 14].

Turn in to failure in charge nurse once done completed.

Texas Children’s Hospital
ADMITTING NURSE

• Take temperature prior to moving to isolette
• Carefully transfer the patient avoiding any sudden moves
• Leave patient in the plastic cover until temperature is stable
• Ensure humidity is started within 1 hour of life
• Complete assessment and any procedures within the 1st hour of life to close the top of the isolette
CONSISTENCY OF CARE

All providers should be practicing the same care regardless of discipline:

- RNs
- MDs
- Respiratory Therapists
- Radiology Techs
HOW DO I ENSURE CONSISTENCY OF CARE

- Good Communication amongst the team
- RN Admission Checklist
- MD Guidelines
- Respiratory Therapist
- Radiology Techs
STAFFING CONSIDERATIONS FOR VLBW INFANTS

• Admission on CPAP <32 weeks gestation

• Extubation to CPAP
  • 1:1 Nursing care
  • For 1st 72 hours
Why do premature infant deteriorate rapidly?

- Smaller airways
- Increased metabolic demands
- Decreased respiratory reserves
- Inadequate compensatory mechanisms
- Inadequate surfactant levels
  - A deficiency of pulmonary surfactant in preterm infants causes poor lung expansion, inadequate gas exchange, and a gradual collapse of the lungs (atelectasis).
HOW CAN WE SUPPORT THESE INFANTS?

• Non-invasive
  • Bubble CPAP
  • NIPPV

• Invasive
  • Mechanical Ventilation
BCPAP has been shown to:

- Help maintain functional residual capacity (FRC)
- Improve oxygenation
- Conserve surfactant
- Prevent atelectasis
- Reduce upper airway resistance
- Improve lung compliance
- Distend or stabilize the airway
BCPAP Check List

- Right sized mask in place?
- Is the hat snug?
- Is mepilex cut into either a triangle or V shape under the mask?
- Is a chin strap needed?
- Is the infant positioned well?
- Is bubbling present?

A well fitted hat – should be able to slide a finger under the brim. Measure the patient’s FOC to get the correct size hat.

The circuit should be parallel to the patient.

Mask should be sized correctly so that it does not fit over the mouth or go into eyes. Use the sizing guide included in the interface packaging.

Mouth is closed. Use of a pacifier or chin strap if needed.

Use of positioning aids to support the infant.
BCPAP SKIN BREAKDOWN IS PREVENTABLE!!!

It is EVERYONE’s job to assess and re-assess for CPAP prong size and position!!
NIPPV
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PHYSIOLOGIC BENEFITS OF NIPPV

• Exact mechanism by which NIPPV works is unclear
• Postulated hypothesis
  • Increases pharyngeal dilation
  • Improves respiratory drive
  • Increases Mean airway pressure
  • Increases TV and MV (c)
  • Maintain FRC in surfactant deficient alveoli of preterm infants
  1. Augmenting spontaneous respiratory effort
  2. Improving minute ventilation (a)
  3. Reducing work of breathing(b)
NIPPV VS CPAP AS PRIMARY SUPPORT

- Data from 4 trials
- NIPPV group needed intubation less frequently and decreased incidence of BPD
- NIPPV groups had lower failure rate, no difference in BPD
- No significant difference in failure rates in first 24-28 hours, but 24-72 hours NIV remained extubated longer compared to CPAP
- NIPPV group with fewer infants progressing to mechanical ventilation
NIPPV VS. CPAP AS SECONDARY SUPPORT

• NIPPV group with fewer reintubations by DOL 7 and lower rates of BPD

• No significance between NIPPV and CPAP and outcome of death before 36 weeks of PMA or survival with BPD at 36 weeks PMA

• NIPPV group associated with lower rate of extubation failure and need for reintubation within 48 hours to 7 days (compared to CPAP)
# NIPPV SETTINGS

<table>
<thead>
<tr>
<th>NIV Settings</th>
<th>Primary NIPPV</th>
<th>Secondary NIPPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIP</td>
<td>22-24</td>
<td>2 above PIP reached on Vent</td>
</tr>
<tr>
<td>Peep</td>
<td>5-6</td>
<td>Same as on vent</td>
</tr>
<tr>
<td>Rate</td>
<td>20-30</td>
<td>20</td>
</tr>
<tr>
<td>Ti</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Slope</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Flow</td>
<td>Start at 10, may go to 20</td>
<td>Start at 10, may go to 20</td>
</tr>
<tr>
<td>FiO2</td>
<td>As needed to maintain targeted goal oxygen saturations</td>
<td>As needed to maintain targeted goal oxygen saturations</td>
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</tbody>
</table>
MECHANICAL VENTILATION
INSURE

What is it?

- INtubate, SURfactant, Extubate

- Combined strategy to minimize lung injury in newborns with RDS

- Early CPAP with rescue surfactant

- Reduces repeat dosing of surfactant, oxygen requirement, and mechanical ventilation
MINIMIZING LUNG INJURY

How can we do it?

• Mechanical ventilation – Volume targeted = volume guarantee

• Pressure control $\rightarrow$ volume not controlled!

• Stretching, inflammatory response, capillary permeability

• Overdistension-induced injury can appear in just a few inflations
1 Day on Mechanical Ventilation

- Vt 4.5ml/kg, PEEP 5, Rate 30
- 1800 breaths in 1 hour
- 43,200 breaths in 24 hours
VENTILATOR-INDUCED LUNG INJURY

Volutrauma
- Overdistention

Atelectrauma
- Repeated recruitment and collapse

Bio trauma
- Inflammatory mediators

Barotrauma
- High-pressure induced lung damage

Oxygen toxic effect
- FiO2

Atelectrauma:
Repetitive alveolar collapse and reopening of the under-recruited alveoli

Dreyfuss: J Appl Physiol 1992

Volutrauma:
Over-distension of normally aerated alveoli due to excessive volume delivery

# VENTILATOR-INDUCED LUNG INJURY

## How can we help?

When a baby is ready, **EXTUBATE!!!**

<table>
<thead>
<tr>
<th></th>
<th>AC-VG</th>
<th>SIMV-VG</th>
<th>SIMV-PC</th>
<th>AC-PC</th>
</tr>
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<tbody>
<tr>
<td><strong>Tidal Volume or PIP</strong></td>
<td>4-5 ml/kg (generating PIP &lt;25)</td>
<td>4-5 ml/kg (generating PIP &lt;25)</td>
<td>20</td>
<td>20</td>
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<tr>
<td><strong>Mean Airway Pressure</strong></td>
<td>8-10</td>
<td>8-10</td>
<td>8-10</td>
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<tr>
<td><strong>PEEP</strong></td>
<td>5-6</td>
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<tr>
<td><strong>Rate</strong></td>
<td>Spontaneous breathing above back up rate of 30</td>
<td>20-25</td>
<td>20-25</td>
<td>Spontaneous breathing above back up rate of 30</td>
</tr>
<tr>
<td><strong>FiO₂</strong></td>
<td>≤ 30%</td>
<td>≤ 30%</td>
<td>≤ 30%</td>
<td>≤ 30%</td>
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<tr>
<td>Respiratory Care</td>
<td>Unplanned Extubations</td>
<td>Oxygen</td>
<td>Kangaroo Care</td>
<td>Extubation Readiness</td>
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If Lungs Could Talk

THANK YOU!
NEUROLOGIC CARE IN THE SMALL BABY PROGRAM
Rebeca Cavazos, MD
BRAIN DEVELOPMENT

- Neurons are born in the ventricular zone
- Migrate up to form cortex between 12-24 weeks gestation
- Late migration continues to cortex until 5 mo. postnatal age
- Third trimester is a time of massive brain tissue accumulation
NEUROSENSORY DEVELOPMENT

An Accelerated View of Brain Development

15 1/2 wks  22 weeks  23 weeks  ~25 weeks

27 weeks  Full term brain  Adult

http://medstat.med.utah.edu
NEUROSENSORY DEVELOPMENT

- Premature neonates are at risk for neurosensory impairment
  - Vision loss
  - Hearing loss
  - Learning impairment
  - Autism spectrum disorder
  - ADHD
  - Cerebral palsy
- Infants born prematurely have smaller total brain tissue volume than term equivalents

MIMIC THE WOMB
SENSORY DEVELOPMENT CONSIDERATIONS

Protect the ears! (Sound: 23-25 wk)
- Soft sounds around baby

Protect from pain! (Touch: 8 wk)
- Use pharmacologic and non-pharmacologic pain reduction measures

Protect the eyes! (Sight: 11 wk)
- Cover eyes with light exposure
- No pupillary light reflex until 30 WGA

SENSORY DEVELOPMENT CONSIDERATIONS

Avoid noxious odors! (Smell: 29 wk)
- Smell may be present by 29 WGA
- Avoid strong perfumes, alcohol

Introduce colostrum care when able! (Taste: 26 wk)
- Parents or staff
- As soon as available
- Even if NPO!
MINDFUL OF PREEMIES

Neuro-Protection Protocol for infants <32 weeks and <1,500 grams in the first week of life

**M**aintain neutral head positioning; minimize stimulation with clustered care

**I**ncline or elevate head of the bed by 30° to 45°

**N**ever position infant with head rotated or turned to the side

**D**o not place prone; avoid frequent suctioning - discuss with physician/NNP

**F**amily can perform kangaroo care with physician/NNP approval

**U**se gentle techniques for procedures

**L**og roll technique should be utilized when repositioning infant
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KANGAROO CARE

Assess readiness and ability to adapt during the first week of life.

Encourage a minimum of 2-3 hours in stable ELBW infants.

Support and teach parents “containment” or “hand hugs” during the first 72 hours.
KANGAROO CARE

• Adaptation: all physiological parameters return to baseline and stay there for 3 minutes after routine handling

• Prior to transfer
  • Assessment, diaper change, and cover with a blanket
  • Simulation of transfer is encouraged

• Considerations
  • Umbilical arterial catheters
  • Umbilical venous catheters
  • Chest tube
  • Recent destabilization
DEVELOPMENTAL CARE

Stephanie Bates, PT, CNT
WHY IS PROPER POSITIONING IMPORTANT

- Improved physiological stability – If a baby remains stressed in the motor system they will decompensate into the autonomic system.

- Decreased stress and agitation – Allows for longer periods of deep sleep and brain development.

- Decreased energy expenditure – improved growth
Consequences of Improper Positioning
Forces of gravity before musculoskeletal maturation Leads to Flat, extended, and asymmetrical resting posture causing gross motor delay
Restrictive positions due to surgery, lines, intubation, or HFOV  

Leads to

Skeletal deformation, muscle shortening, restricted joint mobility
Consistent supine positioning or supine with head to one side

**Leads to**
Plagiocephaly (asymmetrical flattening of occiput)
Consistent side to side or prone positioning

Leads to

Scaphocephaly (narrowing or elongation of the skull)
Arms in “W” position

**Leads to**
Scapular adduction with shoulder external rotation causing asymmetry, arching, lack of hands to midline, fine motor delays

Legs in “frog legged” position

**Leads to**
iliotibial band shortening and ankle eversion causing delays in walking and poor balance in standing
Proper Positioning
MIDLINE MATTERS

• Mindful Protocol
  • <32 weeks gestation
  • <1500 grams
  • 7 days of life

• Position supine
• Provide 360 degrees of containment
• Facilitate a pelvic tuck
• Provide a cranial boundary and foot bracing
• Maintain midline position by logrolling
POSITIONING
SIDELYING

- Provide 360 degrees of containment
- Facilitate pelvic tuck
- Use t-shirt roll to support shoulder rounding and midline
ATTEMPTING SIDELYING VS. DOING SIDELYING WELL

- Provide 360 degrees of containment
- Facilitate pelvic tuck
- Use a t-shirt roll to support shoulder rounding and midline
POSITIONING
PRONE

- After day of life 7
- Provide 360 degrees of containment
- Prone pillow needs to be no wider than the nipples and end at the umbilicus
- Shoulders should be forward, arms resting gentle at sides, pelvic tucked, and legs flexed
ATTEMPTING PRONE VS. ACHIEVING PRONE

- Shoulders are rounded
- Pelvic tuck with legs flexed
- T-shirt roll lies between the nipples and above the umbilicus
POSITIONING DEVICES

- Blanket rolls & t-shirts
- Z-flo
- Dandle-roo
- Gel pillows
- Snuggle ups
NEONATAL SKIN PHYSIOLOGY

Monika Patil, MD
REVIEW: MATURE SKIN

- Epidermis consists of 4 distinct layers:
  - Deepest layer - basal layer
  - Spinous layer
  - Granulous layer
  - Most superficial - stratum corneum
Body surface is already covered by basal cells and a layer of superficial “periderm” cells

Periderm sloughs, Epidermis contains 4-5 layers of cells, Definitive elastin fibers can be found in the dermis

Keratinization starts occurring in the skin appendages, Papillary and reticular dermal boundary is distinct

Intermediate layer forms and Dermis/subcutaneous boundary becomes distinct

Keratinization starts occurring in epidermis
First stratum corneum layer is forming

Further generation of granular and stratum corneal layers
Cornified layers increase

Fetal Age (Weeks)
PREMATURE SKIN: OVERVIEW

- All layers of the skin (epidermis, dermis, and subcutaneous fat) are thinner
- Stratum corneum only starts forming on the fetal epidermis at 23-24 weeks
- At birth, more premature babies have fewer corneified layers, increased permeability, high risk for skin damage, delayed skin maturation, and more risk for infection
- Dermis layer is deficient in structural proteins. Mechanical properties of dermis are poor, and skin is easily torn
- Vernix is not present <28 weeks gestation
PREMATURE SKIN: OVERVIEW

All skin Barrier Functions are Immature, leaving the preterm newborn vulnerable to:

- Mechanical Injury - Poor dermal development
- Infection - Poor epidermal barrier, much slower development of the acid mantle
- Immunosurveillance - Possibly poor antigen presenting/registering ability of Langerhans cells - further studies needed
- Light Injury (UV) - ↓ melanin to absorb UV, ↓ SC to reflect light, ↓ enzyme activity to combat free radicals, ↓ mechanisms for cellular or DNA repair
- Water loss - Immature stratum corneum – high transepidermal water loss
- Poor thermal regulation - High evaporative heat loss, inability to cool down when overheated (no eccrine function)
- Abnormal Neurocutaneous responses - in preemies 'globalized' responses to overstimulation by touching lead to A/B/Ds

NEWBORN CENTER
# Premature Skin: Comparisons

<table>
<thead>
<tr>
<th>Component</th>
<th>~30 weeks</th>
<th>Full Term</th>
<th>Adult</th>
<th>Significance</th>
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<tbody>
<tr>
<td>Epidermis</td>
<td>~27mm thickness</td>
<td>~50mm thickness</td>
<td>~50mm</td>
<td>Premature: increased permeability &amp; water loss</td>
</tr>
<tr>
<td>Dermis</td>
<td>Greatly decreased</td>
<td>Moderately decreased collagen</td>
<td>Normal</td>
<td>Term: decreased elasticity, premature: even greater decreased elasticity with tendency to be damaged and blister</td>
</tr>
<tr>
<td></td>
<td>collagen elastic</td>
<td>elastic fibers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melanosomes</td>
<td>1/3 of Normal</td>
<td>Slightly fewer than normal</td>
<td>Normal</td>
<td>Premature: more photosensitive</td>
</tr>
<tr>
<td>Eccrine (Sweat)</td>
<td>Complete anhidrosis</td>
<td>Decreased activity for 1st week,</td>
<td>Normal</td>
<td>Term: Decreased response to stress</td>
</tr>
<tr>
<td>glands</td>
<td></td>
<td>decreased neurologic control for up to 3 years</td>
<td></td>
<td>Premature: Complete absence of sweat</td>
</tr>
<tr>
<td>Sebaceous glands</td>
<td>Greatly decreased</td>
<td>Moderately decreased secretions</td>
<td>Normal</td>
<td></td>
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<tr>
<td></td>
<td>secretions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hair</td>
<td>Lanugo</td>
<td>Decreased terminal hair</td>
<td>Normal</td>
<td>Helps determine gestation</td>
</tr>
<tr>
<td>Surface area to</td>
<td>Significantly</td>
<td>Moderately increased</td>
<td>Normal</td>
<td>Increased transcutaneous penetration of topical agents</td>
</tr>
<tr>
<td>volume ratio</td>
<td>increased</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PREMATURE SKIN

- 23 weeks gestation
  - Stratum corneum is essentially absent. Transepidermal water loss is very high (~75g/m²/hr)
- 26 weeks gestation
  - There are a few corneified layers, and transepidermal water loss is ~45g/m²/hr
- 29 weeks gestation
  - Transepidermal water loss is ~17g/m²/hr
- Term gestation
  - Transepidermal water loss is ~4-6 g/m²/hr
## Skin Barrier Maturation: Modifying Factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Effect on Transepidermal Water Loss (TEWL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreasing Gestational Age</td>
<td>Increased TEWL (proportional to Gestational age)</td>
</tr>
<tr>
<td>Increasing Postnatal Age</td>
<td>TWEL decreases towards mature rate &lt;1000g, mature by 4-8 weeks &gt;1000g, mature by 2-4 weeks</td>
</tr>
<tr>
<td>Increasing Ambient Temperature</td>
<td>Increased TEWL, proportional to increase in temperature</td>
</tr>
<tr>
<td>Increasing Ambient Humidity</td>
<td>Decreased TEWL, proportional to increase in humidity</td>
</tr>
<tr>
<td>Radiant Warmer</td>
<td>Increased TEWL (by 40-100%)</td>
</tr>
<tr>
<td>Incubator Warmth and Humidity</td>
<td>Increased TEWL (by 20-40%)</td>
</tr>
</tbody>
</table>
SKIN BARRIER: PERCUTANEOUS ABSORPTION

Newborns, and especially premature newborns have higher percutaneous absorption capacity. The same factors that allow for higher TEWL in preterm infants make them more susceptible to absorption of topical compounds. In addition, premature skin is more vulnerable given the thinner epidermis.
## SKIN BARRIER: PERCUTANEOUS ABSORPTION

<table>
<thead>
<tr>
<th>Compound</th>
<th>Source</th>
<th>Toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nystatin</td>
<td>Topical Antifungal</td>
<td>Nephrotoxicity</td>
</tr>
<tr>
<td>Isopropyl Alcohol</td>
<td>Topical Antiseptic</td>
<td>Skin necrosis, Neurotoxicity</td>
</tr>
<tr>
<td>Povidone- iodine</td>
<td>Betadine Antiseptic</td>
<td>Skin necrosis, Hypothyroidism</td>
</tr>
<tr>
<td>Prilocaine</td>
<td>Topical Anesthetic (EMLA)</td>
<td>Methemoglobinemia</td>
</tr>
<tr>
<td>Epinephrine</td>
<td>Topical Vasoconstriction</td>
<td>High output failure</td>
</tr>
<tr>
<td>Corticosteroid</td>
<td>Topical corticosteroids</td>
<td>Adrenal Suppression</td>
</tr>
<tr>
<td>Silver Sulfadine</td>
<td>Topical antibiotic (Silvadine)</td>
<td>Kernicterus, agyria</td>
</tr>
</tbody>
</table>
SKIN: THE PRIMARY CARE INTERFACE

• Care of the preterm newborn involves multiple skin surface interactions
  • Temp probe
  • Adhesive tapes
  • Cardiorespiratory monitors
  • Diapers/Bedding
  • Intravenous catheters and securement
  • Pulse oximeters
  • Nasogastric and endotracheal tube securement
  • Transcutaneous gas monitors

• Aspects of the skin as a primary care interface
  • Soaps, disinfectants, bacteria
  • Support for tapes/adhesives
  • Interface for bedding/clothing, environment
  • Surface for wound/ostomy care
  • Site of action of topical anesthetics
  • Transdermal drug delivery
  • Site of lab draws
  • Platform for percutaneous catheters
  • Boundary for non-invasive monitoring
  • Medium for KMC, massage therapy
  • Basis for initial clinical evaluation and patient appearance (well-being)
AVOIDING INJURY IN ELBWS

• Medical adhesive-related skin injuries (MARSIs)
  • manifest as tension blisters, skin tears, and de-nudement
  • epidermis is separated from the dermis

• MARSIs MARI incidence/significance can be improved with:
  • Gentle adhesives, such as silicone tape and hydrogel adhesives
  • Consider these for nonlife lines or devices that require frequent site rotation
  • More aggressive adhesives, such as silk, paper tapes, and clear film dressings may be used for
    critical tubes and lines, such as endotracheal tubes and central lines
SKIN INJURY IN ELBWs

- One long-lasting consequence to adhesives in ELBW is **anetoderma of prematurity**
- Permanent atrophic patches of skin with altered pigmentation and/or texture
- May be flat, depressed, or outpouched skin
- These appear between several weeks to 5 to 10 months of age
- Caused by subclinical dermal injury due to long-term traction and pressure
PREVENTION MEASURES

• Possible preventative measures include avoiding traction on affixed lines and wires

• Minimizing prolonged pressure by not allowing infants to lie on electrodes and also by using low-profile electrodes

• If possible, position electrodes off areas of cosmetically sensitive areas, such as the breast area

• Hydrogel electrodes and silicone-backed adhesives may help to reduce both subclinical, and visible, skin injury
  • Ultimately these will reduce the potential for long term skin changes
Skin care practices in the NICU often have “risk versus risk”

For example: antiseptic skin preparation to reduce the risk of bloodstream infections before central line placement places the infant at risk for chemical dermatitis and/or absorption of potential toxins.

Another example: Routinely applied skin emollients may enhance barrier function and decrease TEWL, but may increase the chances of a hospital-acquired infection.

What’s the right answer?!!
REDUCING INFECTION: SKIN PREP

- Central line-related bloodstream infections (CLABSIs) in the NICU - 25% mortality
- The concentration of skin flora at the insertion site is huge risk factor for CLABSI
  - Skin antisepsis is crucial
- ‘Best’ skin prep is chlorhexidine (CHG), but it can cause chemical burns in ELBW and has high toxicity from skin absorption in ELBW <2 weeks old
- One alternative is povidone-iodine
  - ELBW are at higher risk for iodine overload from skin absorption
- Gentle application can be done to decrease friction-related skin breakdown
- Do not allow product to pool on skin surfaces, especially skin creases to decrease the risk of chemical burns
- Use sterile water or saline to clear off the residual (reduces absorption related toxicity)
REDUCING INFECTION: EMOLLIENTS

• Topical emollients can improve the neonatal skin condition

• However, topical emollients in the NICU have been associated with an increased risk for hospital-acquired infection

• Cochrane Review:
  • Topical emollients increased the risk for CONS infection by 31%
  • Also an increased risk of 20% for all hospital acquired infections (bacterial and fungal)
**REDUCING INFECTION: BATHING**

- Routine bathing is beneficial to reducing the overall number of microbes.
- However, bathing premature infants is more tricky—has detrimental physiologic effects.
- Skin needs time to acidify after birth to provide an infection barrier function. If the skin is more alkaline than it should be, this will support the growth of Staphylococcus aureus and Candida albicans.
- Any skin cleansers should be pH balanced as a way to protect premature infants from infection.
  - Consider cleaning ELBW's skin with only sterile water (no cleansers) during the first 2 weeks of life.
- Non-skin risks of bathing include hypothermia and worsening respiratory distress.
  - Bathing premature infants should be approached with caution and should only be done 2 to 3 times per week and clinically stable.
SKIN CARE RECOMMENDATIONS

• Inspect and assess daily
• Minimize adhesive and tape use to prevent epidermal stripping
  • Adhesive products should be removed with an approved adhesive remover
• After chlorhexidine or povidone-iodine, use sterile saline to remove the residual to avoid toxicity from absorption and chemical burns
• Emollients should not be used routinely
• Bathe ELBWs with warm sterile water during the first few weeks of life
REFERENCES

- Fowler, Joseph. Understanding the Role of Natural Moisturizing Factor in Skin Hydration. Practical Dermatology July 2012
INFECTION CONTROL PRACTICES
INFECTION PREVENTION

What
Prevents hospital acquired infections (HAIs) in patients, and reduces occupational exposures

Why
- Patient safety
- Employee safety
- Length of stay
- Cost

1 neonatal CLABSI increases length of stay by an average 31.5 days

Penalties must be paid to Medicaid for hospital acquired infections effective Jan. 1, 2019

Cost of 1 CLABSI in a neonate = $90,000

LEARNING OBJECTIVES

Hand Hygiene
✓ Describe the 5 moments and the “nest” concept

Environment
✓ State family/visitor guidelines
✓ Verbalize isolette change frequency

Patient Hygiene
✓ Articulate rationale for patient hygiene guidelines

Line Maintenance
✓ Describe the elements of the Central Line Maintenance Bundle and strategies for line associated blood stream infection prevention
WHO’S 5 MOMENTS OF HAND HYGIENE

1. Before touching a patient or their surroundings
2. Before a clean/aseptic procedure
3. After contact with body fluids
4. After touching a patient
5. After touching patient surroundings
MOMENT 1: BEFORE TOUCHING PATIENT OR SURROUNDINGS, OR BEFORE DONNING GLOVES

- Activities
  - Physical exam
  - Device assessment
  - Assisting with mobility
- Surroundings
  - Monitors
  - Bedside table
  - Bed/crib rails
MOMENT 2: BEFORE A CLEAN/ASEPTIC PROCEDURE

- Inserting/removing IV
- Dressing change
- Drawing labs
- Inserting/removing Foley
- Before preparing and giving medications
- Before accessing any line or device
MOMENT 3: AFTER CONTACT WITH BODY FLUIDS

- Diaper changes
- Insertion or removal of lines or devices
- Airway suctioning
- Bathing/oral hygiene
- Wound care
MOMENT 4: AFTER TOUCHING A PATIENT OR AFTER REMOVAL OF GLOVES

- Physical exam
- Greetings: handshake, hug, fist-bump
- Transfers/moves/lifts
- Patient ambulation
- Clinical patient care
HAND HYGIENE

- Hand washing with soap and water
  - Performed when hands are visibly soiled, after exit of a Special Contact Isolation room, & after using the restroom
  - Minimum 15 second vigorous scrub to all areas of the hands/wrists
  - Use paper towels to turn off faucet

- Hand rub with alcohol based product
  - Used when hands are not visibly soiled
  - Most common and preferred method of hand hygiene
  - Requires adequate amount of product to fully cover hands/wrists
  - Rub the product in until it dries – no fanning/waving, drying hands with paper towels or clothes
GLOVES

- Hand hygiene should be performed before donning gloves, and after removal.

- If a new moment of hand hygiene is encountered while wearing gloves, you should remove gloves, perform hand hygiene, and don a new pair of gloves.

Remember: Gloves are not foolproof. You should always inspect gloves upon donning.
NEST CONCEPT
Includes the baby and everything close to or attached to the baby
- Incubator
- Monitor
- Ventilator
- Counter Tops
- Cabinets
Areas Most Often Missed During Hand Washing

- Most Often Missed
- Often Missed
- Less Often Missed

Taylor, L., Nursing Times, 74, 54 (1978)
ENVIRONMENT
• Personal linens must be changed/washed daily
• Only hospital bath soap and lotion can be used
• Windows, window sills, and countertops must be kept clear of belongings to allow for proper cleaning
• No food is allowed in the unit, and drinks must be in spill-proof containers
ENVIRONMENT OF CARE

- Q 7 day isolette change
  - Benchmarking with other institutions revealed most change these beds every 7 days
- Q 7 isolette cover change
  - More covers have been ordered to support this practice
- No more than 2 small stuffed animals
- Clean work area with hospital approved disinfectant wipes
LINE MAINTENANCE
HOW DOES BACTERIA ENTER THE BLOOD THROUGH AN INTRAVENOUS CATHETER?

- **Line access/Hub care**
- **Insertion/Dressing**

Skin organisms:
- Endogenous
- Skin flora
- Extrinsic
- HCW hands
- Contaminated disinfectant

Contaminated catheter hub:
- Endogenous
- Skin flora
- Extrinsic
- HCW hands
- Contaminated disinfectant

Contaminated infusate:
- Extrinsic
- Fluid
- Medication
- Intrinsic
- Manufacturer

Hematogenous from distant infection:
- Fibrin sheath, thrombus
- Vein
CENTRAL LINE CARE – BUNDLE ELEMENTS

- Daily necessity discussed
- Dressing assessment
- Accessing the central line
- Labeling the tubing
- Cap change
- Dressing change
SCRUB THE HUB

No Interruptions and watch the clock

- Scrub 15 Seconds
- Dry 15 Seconds
SCRUB THE HUB – PIV AND CENTRAL LINES

WHY
To prevent bacteria from entering the line and causing bloodstream infections in our patients

HOW
• Gather supplies; perform hand hygiene; don clean gloves
• Scrub the hub for at least 15 seconds, and allow to dry for at least 15 seconds
• Do not contaminate your gloves

WHEN
Anytime the line is accessed
• Medication admin
• Blood transfusion
• Tubing changes
ADDITIONAL STRATEGIES TO PREVENT LINE ASSOCIATED BLOOD STREAM INFECTIONS

• Treat PIVs and PALs with the same care as central lines
• Utilize steri-drape (“mud flap”) on all femoral lines to protect from bodily fluids
  - Utilize on upper extremity lines as needed
• Ensure tubing does not touch the floor
• Position tubing away from diaper area
INFECTION CONTROL POLICY

• No watches or hand jewelry
  • 1 plain band
• Artificial nails or artificial nail products should not be worn
  • Chipped polish is not allowed
• Healthcare workers should use a barrier when holding patients, and remove it prior to contact with other patients
• Long sleeves should be pulled above the elbow and lab coats removed
• Hair should be secured to avoid direct patient contact
Shweta Parmekar, MD
Rita Shah, MD
OBJECTIVES

• Understand the pathophysiology that supports patient practices

• Review evidence based medicine that has contributed to patient care guidelines

• Know current and NEW practice updates as part of the SBP
HEADLINE (UPPERCASE)
FONT: CALIBRI BOLD, 32PT, RED

ANY MEDIA – LARGE
(i.e. Photography, Pie Charts, Bar Graphs, Etc.)

Suggested area dimensions:
9” W x 3.5” H

Font: Calibri, 14pt, Black
MYTH

Most Common Reason for Anemia is Frequent Blood Draws
ANEMIA

How much blood is that?

- POC Blood Gas – 0.25ml
- CBC – 0.5ml
- Chem 10 – 0.6ml
- LFTs – 0.6ml
- TFTs – 0.6ml
- Blood culture – 1ml
- Neonatal Profile – 2ml
- DIC Panel – 3.7ml

BW 500 grams
- Blood volume: 40ml

BW 750 grams
- Blood volume: 60ml

BW 1000 grams
- Blood volume: 80ml
Impaired Erythropoietin Production

- Produced by liver and kidney in response to hypoxia
- Does not cross placenta
- Increases with gestational age
- EPO administration not widely accepted
ANEMIA

Reduced RBC Life Span

- Newborn term infants: 60-80 days
- ELBW infants: 45-50 days
- Increased susceptibility to oxidant injury
## ANEMIA

### Transfusion Guidelines

<table>
<thead>
<tr>
<th>Clinical Status</th>
<th>Hematocrit trigger levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe cardiopulmonary disease (mechanical ventilation or NCPAP requiring high FiO₂, hypotension)</td>
<td>35%-40%</td>
</tr>
<tr>
<td>Anemia with unexplained tachycardia, frequent apnea, poor weight gain with adequate nutrition, or unexplained lethargy.</td>
<td>30%-35%</td>
</tr>
</tbody>
</table>
MYTH

Most Common Reason for Anemia is Frequent Blood Draws
MYTH

Extubation Trials Can Lead to IVH
Why does it happen?

- Fragility of germinal matrix vasculature
- Fluctuation in cerebral blood flow
- Platelet and coagulation disorder
IVH

What are the risk factors?

- Acidosis
- Hypoxia
- Hypercarbia
- Patent ductus arteriosus (PDA)
- Rapid infusion of sodium bicarbonate
- Sepsis
- Dehydration
- Thrombocytopenia
- Coagulopathy
- High vent support
- Hypertension
How can we prevent it?

- Antenatal steroids
- Minimal handling and suctioning
- Gentle ventilation
- Prophylactic Indomethacin: BW ≤ 800g, GA ≤ 26 weeks
  - Contraindications
    - Corticosteroids
    - Bleeding or platelet count < 50,000
    - Urine output < 0.5-0.6ml/kg/hr

MYTH
Extubation Trials Can Lead to IVH
BUSTED!
MYTH

Premedication for Non-Emergent Intubation Increases Apnea
PREMEDICATION FOR NON-EMERGENT INTUBATION

What is it?

BCM/Texas Children’s Hospital Newborn Center
Premedication for Non-Emergent Intubation Algorithm

- Bag and mask ventilation as needed
  - RN, RT, clinician, medications, and equipment to bedside

IV Access Present?

YES

Administer (in order):
1. IV Atropine 0.02 mg/kg IV PUSH (no minimum dose)
2. IV Fentanyl 2 mcg/kg*
3. IV Vecuronium 0.1 mg/kg IV PUSH

*IF Chest Wall Rigidity Occurs:
Administer Vecuronium 0.1 mg/kg/dose IV push (can repeat doses if symptoms persist)

Intubation Attempt(s)

If Unsuccessful:
- Consider repeat doses
- Consider GOAT

NO

OFF algorithm
Resuscitation,
Delivery, Airway
Anomaly

Notify Attending

NOTE: IV placement is PREFERRED method

Intranasal Route:
Fentanyl 1.5 mcg/kg/dose
IF needed may use:
Midazolam 0.2 mg/kg/dose

*IF Chest Wall Rigidity Occurs:
Administer Naloxone 0.1 mg/kg/dose IV push (if symptoms persist)
PREMEDICATION FOR NON-EMERGENT INTUBATION

How is it helpful?

PREMEDICATION FOR NON-EMERGENT INTUBATION

What are the outcomes?

• Reduces adverse effects of PAIN, bradycardia, and some studies have suggested oral trauma

• Increased success rate and reduced duration of attempt*

• *Gaps in knowledge of IDEAL medication regimen and long-term effects

PREMEDICATION FOR NON-EMERGENT INTUBATION

What are the risks?

- May cause delays in an intubation
  - NOTE: If during premedication, intubation becomes EMERGENT then premedication does **NOT** have to be completed

- Chest wall rigidity
  - Treatment:
    - FIRST-muscle relaxant-Vecuronium 0.1mg/kg
    - SECOND-2\textsuperscript{nd} dose of vecuronium/naloxone
  - IF patient is on opioids, naloxone administration may cause seizures due to rapid withdrawal
MYTH

Premedication for Non-Emergent Intubation Increases Apnea

BUSTED!
MYTH

Stevie Wonder was Born Premature
MYTH

Stevie Wonder
- 34 weeks
- Retinopathy of Prematurity
- Retinal Detachment
- Oxygen toxicity
NAME THAT PREMIE !!!

Wayde van Niekerk
29 weeks
2016 Rio Olympics
South Africa’s 1st Gold medal, 400m event and World Record
MYTH

Stevie Wonder was Born Premature
AUTHORS

• Rebecca Cavasos, MD and Neurodevelopmental Committee
• Shweta Parmekar, MD
• Rita Shah, MD
• Nathan Sundgren, MD and Delivery Room Team
• Mohan Pammi, MD
• Kellie Kainer, RNC
• Suzanne Iniguez, RT
• Sasha Galen, RT
• Monika Patil
• Stephanie Bates, PT, CNT
COMMENTS/QUESTIONS?