Improving Neonatal Skin Care

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Objectives

- Review neonatal bathing literature in regards to timing of the first bath, immersion bathing.
- Discuss controversies related to chlorhexidine gluconate bathing in NICU patients.
- Describe problems, challenges and new technologies related to medical adhesives in the NICU.
- Identify devices in NICU that are at risk for development of pressure ulcers.

Disclosures

- Professional advisory panel member for 3M and Johnson & Johnson Consumer Co.
- Investigator-initiated grant to study impact of the newborn’s first bath on skin parameters and microbiome, Johnson & Johnson Consumer Co.

Newborn Skin: Colonization with Microorganisms

What we thought:
After C/S, skin thought to be sterile
In utero, fetal skin not colonized (except PROM, selected organisms such as group B strep, candida)
“...skin flora resembles that of adults after the first few weeks...”

What we are learning:
- Skin, GI, respiratory tract colonized with thousands of microorganism species
- 9/10 cells are microbial
- "Microbiome" based on DNA sequencing (PCR)
- Most are commensal ("good bacteria")
- Imbalance may lead to disease states

Delivery Mode Shapes Initial Microbiota in Newborns

Partial Restoration of the Microbiota of Cesarean-born Infant Via Vaginal Microbial Transfer

- Concerns that C-section delivery alters skin and other body regions microbiome, possibly increasing risk for immune, metabolic disorders
- Sterile gauze placed in vaginal tract for 1 hour prior to delivery (no vaginosis, pH <4.5)
- After delivery, infant swaddled with the gauze
- Samples from oral, skin, anal areas obtained over the first moth show partial restoration of typical vaginal microbiome
### Vernix Caseosa

- Cheesy substance composed of sebum from sebaceous glands, broken-off lanugo, desquamated cells—unique to humans
- Primarily water (80%), lipids, protein
- Production begins end of 2nd trimester, most accumulated 36-38 wks
- Vernix detaches from skin as levels of pulmonary surfactant rise
- Vernix contains LL-37 and lysozymes, have antibacterial effects against pathogens (E. coli)

### Vernix Caseosa in Neonatal Adaptation


- Accumulation of vernix peaks at 36-38 weeks, covers >50% of skin surface
- Vernix naturally detaches as pregnancy progresses towards 40 weeks, covers <25% of skin surface
- When bathed, the neonates with >50% vernix had improved skin pH, better skin hydration
- Bathing does not reduce positive effects of vernix if not deliberatively removed

### First Bath: Wait for 8 (or 12 or 24?)

- Studies show newborns bathed as soon as 1 hour after delivery will maintain their temperature if they begin with normal temperature (Behring 2003, Varda 2000, Penny-MacGillivray 1996)
- Nako (2000): traditional early bathing in Japan “mokuyoku” 2-5 minutes after birth; study shows better temperature in this group compared to “dry care”
- AWHONN Guideline: Vital signs, temperature stable 2-4 hours
- WHO: wait at least 6 hours
- Late preterm infants: wait 24 hours (AWHONN 2010, Loring 2012)
- Delayed bathing improves breastfeeding rates (Preer 2013)

### How to Give the First Bath?

- Sponge bath
- Under the faucet
- Small tub
- Large tub “immersion bath”
- Swaddle bath

### Tub or Immersion Bathing Studies

- 100 babies randomized to first bath with water alone or water with liquid baby wash
- 50 vaginal birth, 50 C/S
- All babies immersed and swaddled in the bath
- Pre and Post-Bath:
  - pH
  - TEWL
  - stratum corneum hydration
  - Skin microbiome (baby, mom)
  - Baby’s temperature
  - Water pH, hardness

### Our “First Bath” Study (2012-13)
Swaddled Bathing

Skin pH

- pH > 6.0 at birth, falls to < 5.0 in 4 days
- Premature infants—pH 5.5 after one week, 5.1 after one month
- Diapered areas—pH 6.0
- pH of adult skin 4.7 (24 hours after bathing)
- Acid mantle is protective—at pH 4.7:
  - resident flora grow (staph-epi, micrococci, coryneforms, propionbacteria)
  - transient flora is inhibited (gram negative such as E. Coli, pseudomonas; gram positive staph; candida)
- Normal tap water increases pH for awhile

Skin Permeability in Neonates

- Fewer layers of stratum corneum in premature infants
- Stratum corneum “visibly mature” in full term infants but is 30% thinner
- Functional maturity of skin barrier takes months
- Permeability varies in different body sites
  - Forearm more permeable than trunk
  - Intertriginous area (skin on skin contact)
- pH and hydration of stratum corneum are other factors that influence permeability
  - Diaper area more permeable because of occlusion with diaper, change in skin pH
- Larger surface area (compared to body weight)—increased risk of toxicity from topical agents!

Chlorhexidine Gluconate Bathing

- Being used daily in adult and pediatric intensive care units, patients with CVCs
- Most commonly using 2% CHG wipes
- Is it safe in neonates?
- What are the effects on normal skin colonization, barrier function?
Daily CHG Bathing to Reduce Bacteraemia in Critically Ill Children
Mistone et al (2010); Lancet 381:1099-1106

- PICU patients > 2 months of age in 5 US units
- Randomized by unit type (cardiac, medical, surgical)
- Daily bath with CHG vs soap/water or bath cloth
- 4072 pts; randomized to standard care or CHG per protocol
- Significant reduction bacteraemia in “Per Protocol” group
  - 36% reduction
  - 3.28 per 1000 days vs. 4.93 per 1000 days
- Median time in PICU 3 days (range 1-119)
- 3% patients with CHG bathing had skin reactions

Chlorhexidine Baths for Newborns

*Da Cunha (2009)*: RCT of 94 full term newborns
- baby cleanser vs. 0.25% CHG
- staph aureus colonization reduced at 24 hours
- 36.7% with baby cleanser vs 13.6% with CHG

*Sankar (2009)*: RCT of 60 premature infants 28-36 wks
- 0.25% CHG, saline, no cleansing
- CHG reduced colonization by half in the axilla at 24 hours
- No difference in the groin at 24 or 72 hours
- Skin scores not changed

Chlorhexidine bathing in a tertiary care NICU:
impact on CLABSI

- Historical controls compared to CHG wipes
  - Infants with BW<1000 g and < 28 days excluded
  - Infants >1000 g had CHG bath (wipe) 2x week, QOD or daily depending on BW and postnatal age
- 195 infants >1000 g and 24 infants <1000g but >28 days included in analysis
- Reduced CLABSI from 6 to 1.92/1000 CVC days
- During study period fewer device days
  - More aggressively removing CVCs?
  - Fewer CLABSI?

Misadventures in Neonatal Skin Care

- 1968-1980: Hexachlorophene (Phisohex)
  - used to control outbreaks of S. aureus infection in nurseries
- Initial bath after birth, then every 1-2 days
- Autopsy of 20 premature infants <1750 grams
  - *Journal of Clinical Pathology* 1981; 34:25-29
- 4 infants had spongiform myelopathy
- Brain tissue contained hexachlorophene (HCP)
- 9 other infants had measurable amounts HCP, no myelopathy
- Length of survival was main determinant of HCP toxicity
  - If survived 22 days → myelopathy
  - If survived 7.5 days → detectable HCP,
    - If survived ≤ 2 days → no HCP
- One affected infant had brain abscesses with candida, one had *E. coli* meningitis

Cohesion Between Epidermis and Dermis

- Top two layers of skin connected by fibrils
- Fewer and further apart in premature infants
- Adhesives can attach more securely to epidermis than the epidermis is attached to the dermis

(Neonatal Skin: Structure and Function, 1982)
Medical Adhesives

- Acrylates (Transpore™, cloth)
- Zinc oxide (pink tape)
- Hydrocolloids (Duoderm™)
- Hydrogel (electrodes)
- Polyurethane (transparent dressings)
- Silicone

Disruption of Barrier Function Associated With Adhesive Removal


- 30 infants, 26-40 weeks, <7 days of age
- Significant alteration in skin barrier (TEWL, color, visual assessment) after removal of acrylate-based tape and hydrocolloid
- Hydrogel fell off in 7 infants before 24 hours
- Changes seen in big as well as small babies

Adhesive Damage Hurts!

The MARSI Project

- Consensus statements published in JWOCN in July 2013 about the risk of skin injury from medical adhesives
- In 2001, an evidence-based practice project evaluating the first Neonatal Skin Care Clinical Practice Guideline found:
  Adhesive removal was primary cause of skin breakdown

Medical Adhesive-related Skin Injury: MARSI

- Skin Stripping

Medical Adhesive-related Skin Injury: MARSI

- Skin Tears
Medical Adhesive-related Skin Injury: MARSI

- Contact Dermatitis

Options for Contact Dermatitis

Switch to another brand or type of adhesive product (Opsite, Tegaderm HP, Bioclusive)

Use silicone tape as “platform” instead of hydrocolloid

“Re-design” products without adhesive

Silicone Adhesives

Adhere well to skin, hair
Gentle when removed, can be replaced
Don’t stick well to plastic!

Silicone Tape and EEGs
Silicone Tape in High Humidity

Silicone Barrier Films

Silicone Adhesive Removers

Bonding Agents

Tincture of Benzoin, Mastisol
Used to enhance adhesion of wound closure tapes
Can increase epidermal stripping

Adhesive Removers

Alcohol/organic-based solvents
- Contain hydrocarbon derivatives or petroleum distillates
- Toxicity
- Case report of skin injury and hemorrhage in premature infant after exposure to Detachol

Oil-based solvents
- Paraffin-based (mineral oil), some citrus-based
- Leave oily residue, cannot replace adhesive

Silicone-based removers
- Probably the safest medical adhesive remover

Adhesive for critical tubes and lines:
adheres well in moist settings
Healing from MARSI

Thoughts about Pressure Ulcers in Neonates and Infants

• Risk assessment is not the same as skin assessment
• Braden Q does not predict device-related pressure ulcers, is not the same as a skin assessment
• “There are no studies to date to suggest that use of risk assessment tools reduces the number of new pressure ulcers that develop.” – Moore Z, Cowman S. (2014) Cochrane Review
• Term “Pressure Injury” can encompass multiple categories of iatrogenic tissue damage to the skin
• In one study of 247 neonates, 31.2% had “pressure injuries”, medical devices most common risk factor

Newborn and Infant Dermis

• Fetal and neonatal dermis has less structure with high cell turnover rate
• Low total collagen which increases rapidly during first 2 months, then decreases by 2 years
• Dermal elastin fibers not fully developed until 12-24 months
• Lower biologic elasticity has implications for skin damage from mechanical forces; ie, pressure injuries

Pressure Injury:
Be aware of “non-blanching” erythema when examining occiput, especially after long surgery

Pressure Injury Requiring Plastic Surgery
Preventing Pressure Injuries

- Gel pillows
- Special beds, surfaces
- Frequent turning, “off loading”
- Change location of monitoring devices (pulse oximeter, NIRS) every 8-12 hours, if possible
- Vigilant inspection

Device-Related Pressure Injuries

Soft silicone foam dressings to reduce pressure injuries from

Device-related Pressure Injuries

Preventing Injuries

Device-Related Pressure Ulcers

Diaper Dermatitis

Irritant contact diaper dermatitis (IDD)

Candida (fungal) diaper dermatitis

Combination
Factors in Irritant Diaper Dermatitis

Wetness:
Macerates epidermis, impairs skin barrier

Friction:
Trauma from skin-to-diaper contact

Urine and feces:
Fecal ureases release ammonia, ↑ skin pH
Activates proteases and lipases, disrupts epidermis

Risk factors:
Malabsorption (short bowel syndrome, NAS)
Fecal incontinence (Hirschsprung's, lack sphincter tone)
Atopic dermatitis (altered barrier function)
Wearing diapers!

Factors in Premie Diaper Dermatitis

Premie diapers?
- Occlusive
- Alters barrier that is already compromised

Breastmilk fortifiers?

Preventing Diaper Dermatitis

- Frequent diaper changes in first month
  - q 1-3 hours
- Superabsorbant disposable diapers offer some benefit, keep surface drier
- Bathing shown to restore acid skin pH (Visscher 2002)
- Diaper holiday
- Role of petrolatum ointment?
- Wipes?

Diaper Wipes

- Visscher (2009):
  - 130 NICU infants, 23-41 weeks, 30-51 weeks when studied
  - RCT: wipe A, wipe B or cloth/water
  - TEWL, erythema better with wipes; pH lower with wipe B (acidity as preservative)
- Lavender (2012)
  - 280 full term neonates, measurements at 48 hours and 4 weeks
  - randomized to wipes vs. cotton wool/water
  - No difference in SCH, TEWL, pH
  - Mothers reported more “napkin rash” in the water group

Contact Irritant Diaper Dermatitis: Create a Barrier “like frosting-on-a-cake”

Diaper Dermatitis Treatments
Diaper Dermatitis Remedies

- Affected skin is more permeable, ingredients may be absorbed
- Fewer ingredients better
- Some ingredients can cause contact dermatitis or sensitize as a potential allergen
- Mixing a bunch of products together is not better!
- Vigorous efforts to remove diaper rash agents can also injure skin that is trying to heal

Candida Diaper Rash

- Fiery red, satellite lesions
- Distributed on thigh, perineum
- Treat with antifungal agents

Combination Diaper Rash

- Antifungal powder
- Seal powder on with skin protectant
- “Crusting” technique
- Can then apply thick layer of moisture barrier paste

Treat the Underlying Cause!

- Diarrhea from malabsorption, opiate withdrawal, infection
- May need change in formula to reduce frequency of stooling

Beginning at the Bottom: Evidence-based Care of Diaper Dermatitis

Survey at a children’s hospital showed 24% infants had diaper dermatitis
- Nurses were inconsistent with treatment, not evidence-based
- Protocol recommends frequent diaper changes, super-absorbent diapers
- Visual chart with grading system, treatment options for consistency among nurses
- Using products correctly!
Conclusions

- Newborns are at risk for toxicity from topical agents for a number of reasons
- Safety of daily bathing with CHG is not known
- Prevention of medical adhesive related skin injury is possible
- "Pressure injuries" from devices are a concern in the NICU patient population
- Consistent approach to diaper dermatitis can improve outcomes

References