Bathing and Beyond: New Data to Guide Newborn Skin Care

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In 2001, an evidence-based Neonatal Skin Care Clinical Practice Guideline, written by a science team including neonatal nurses and a pediatric dermatologist, was evaluated in 51 nurseries, involving 2820 neonates. Skin scores improved after the guideline was implemented.

The guideline was revised in 2007 and included in the National Guideline Clearinghouse.

The 2013 guideline revision won 3rd place in the AJN Book of the Year Awards in maternal-child nursing.


Disclosures

- Investigator-initiated grant to study the first bath in full term newborns, 2012-13 (Johnson & Johnson Consumer Products)
- Member of professional advisory panels for Johnson & Johnson Consumer Companies, Inc. and 3M.
- Sponsored by 3M to provide professional education to nurses.

Newborn Skin Assessment

- Bathing
- Vernix
- Umbilical Cord Care
- Circumcision Care
- Disinfectants
- Diaper Dermatitis
- Medical Adhesives
- Emollients
- Transdermal Water Loss in ELBW Infants
- Skin Breakdown
- Intravenous Infiltration

What is Skin Barrier Function?

- Ability of skin to protect and function as barrier to toxins, pathogenic organisms
- Can be measured by the skin’s ability to hold on to water (TEWL), stay hydrated (SCH); influenced by pH
- Immaturity, alterations in pH, skin injury or disease can result in impaired barrier function

Skin Layer

Epidermis

Dermis

Subcutaneous tissue

Stratum Corneum

Basal Layer

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Measuring Skin Barrier Function

- TEWL
  - Transepidermal Water Loss
- pH
  - acid-base balance
- SCH
  - Surface hydration

Stratum Corneum and TEWL

- 10-20 layers of stratum corneum in term infants and adults
- Far fewer layers in premature infants <30 weeks, increased fluid and heat losses
- Evaporimeter measures skin barrier function—TEWL (transepidermal water loss)
- 5-10 gms H₂O/m²/hr in adults

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

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

Increased Risk of Toxicity from Topical Agents in Newborns

- Newborn dermis is 40-60% the depth of adult dermis
- Larger surface area (compared to body weight) exposed to topical agent
- Stratum corneum maturity and integrity are factors, especially in premature infants
- pH of skin surface: more alkaline pH increases permeability
- Occlusion (ie, wearing a diaper) compromises stratum corneum, skin barrier

Misadventures in Neonatal Skin Care

- Aniline Dye and Methemoglobinemia
  - Link between outbreak of cyanosis in normal newborns and aniline dye used to print the hospital's name on cloth diapers due to methemoglobinemia
  - Implications for diaper dermatitis remedies in neonates
- Hexachlorophene (Phisohex)
  - used to control outbreaks of S. aureus infection in nurseries
  - Initial bath after birth, then every 2 days
  - Irreversible brain damage (vacuolar encephalopathy) found in premature infants washed 4 or more times

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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

Diversity of the Human Skin Microbiome Early in Life

Skin swabs from 31 infants
- Infant skin:
  - Firmicutes predominate (staph, strep, propionibacter)
- Adult skin:
  - Actinobacteria predominate (gram + organisms, mycobacteria, corynebacter)

Establishment of healthy skin microbiome may have role in denying access to infectious microbes, help to modulate inflammation

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Delivery Mode Shapes Initial Microbiota in Newborns

Dermal Microflora Transmission From Mother to Baby At Birth Correlates With Region of First Maternal Contact

Innate Immunity of Skin

- Symbiotic relationship between skin and skin flora: skin provides sebum (lipids), sweat (minerals), dead skin cells (protein) to resident flora
- Resident flora strengthens the skin’s first defense (acid mantle) by producing anti-bacterials which compete and prevent colonization with harmful bacteria
- Antimicrobial defense system in the skin is more than just a mechanical barrier

What is 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)

First Bath

- Studies indicate that newborns bathed as soon as 1 hour after delivery will maintain their temperature if they have a normal temperature to begin with
- AWHONN Guideline:
  - Vital signs, temperature stable 2-4 hours
  - Antiseptic cleaners not currently required by American Academy of Pediatrics, Center for Disease Control
  - Universal precautions until bathed
  - Not necessary to remove all vernix
- WHO: wait at least 6 hours
- Would they, or their mothers, choose to be bathed as early possible?
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How to Give the First Bath?
- Sponge bath
- Under the faucet
- Small tub
- Large tub “immersion bath”
- Swaddle bath

Tub Bathing vs. Sponge Bathing
- Hennigson (1981): 232 newborns, no infection or colonization problems, better temperature, less crying with tub bathing
- Hylen (1983): 618 newborns, rectal temperatures better with tub bathing, no difference in infection
- Anderson (1995): 20 newborns, pre-/post bath measurements, axillary temperatures better with tub bath, better for attachment and bonding
- Cole (1999): tub bath maintained temperature better, 70% remained drowsy or quiet alert vs 90% crying with sponge bath
- Bryant (2004): 162 newborns randomized to tub or sponge bath. Tub bath less temperature loss, no differences in umbilical cord healing, behavior more content, mothers rated more pleasurable
- Loring (2012): 100 infants (35-36 6/7 weeks) randomized to immersion tub bathing or sponge bathing, tub bathed infants had overall higher and less variability in body temperature

Swaddled Bathing

Water alone vs. Baby Wash Studies
- Gfatter (1997): RCT 40 infants; all bathing (water, liquid cleanser, bar cleanser, soap) caused transient ↑ pH, ↑ SCH; significant only with soap
- Hoeger (2002): 202 neonates, water only bath 2x/week; pH ↓, ↑ SCH over first 4 weeks, desquamation on cheeks, forehead
- Bartels (2010): RCT 60 neonates (water, gel wash, crème after water, crème after gel wash); TEWL, SCH better when emollients used
- Lavender (2013): RCT 307 neonates, water vs liquid baby wash; no difference in TEWL, pH, SCH at 2 and 4 weeks; moms preferred using baby wash

Our “First Bath” Study (2012-13)
- 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

Routine Bathing
- Use mild baby wash
  - Neutral or mildly acidic pH
  - Proven to have minimal impact on pH of skin
  - Proven ocular safety
  - Bathe every other day or less frequently, although this may be influenced by cultural factors
  - Avoid rubbing, use rinsing or immersion instead
  - Prematures < 32 weeks, use water only for first 2 weeks
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Emollients

- Preserve, protect, and enhance the skin barrier
- Role in healthy newborn skin care not clear
- Considered first-line treatment for Atopic Dermatitis: “soak and seal”
- Keeping skin barrier intact may possibly prevent disease progression by inhibiting entry of allergens and irritants
- BEEP study: Barrier Enhancement for Eczema Prevention

Bathing Premature Infants

- 2013 AWHONN Guideline:
  - For preterm infants less than 32 weeks of gestation, gently clean skin surfaces using warm water only during the first week of life.
  - Preterm infants should usually not be bathed daily.

Premie Bathing Studies

- **Quinn (2005):** 53 subjects 560-1950 grams; sponge or tub bath with Johnson & Johnson “soap” and gauze bath; 2 vs 4 days; bathing every 4 days does not result in increased skin colonization
- **Da Cunha (2005):** 73 subjects 800-1800 grams; sponge bath with water only or liquid soap and water; both decrease number of colonies of gram + and gram – bacteria
- **Sankar (2009):** 60 subjects 1001-2000 grams; a single skin cleansing with .25% CHG did not adversely affect skin condition or temperatures, reduces bacterial colonization axillary but not groin

Stress of Bathing

- **Peters (1998):** physiologic and behavioral disruption during sponge bathing
- **Tapia-Rombo (2003):** sponge baths cause stress in premies
- **Lee (2002):** sponge bathing causes stress in premies; they should be stable before you start
- **Liaw (2006):** tub bathing causes stress in premies

Premie Swaddle Bath

Should We Reconsider Antimicrobial Bathing?

- Concerns about community-acquired MRSA
- Newborns seen in emergency departments with cellulitis, skin infections due to MRSA
- Hospital-acquired infection
### Daily CHG Bathing to Reduce Bacteraemia in Critically Ill Children
- 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
- 4947 pts enrolled (ITT group); 4072 received the full protocol (PP group)
- Significant reduction bacteraemia in PP group
  - 3.28 per 1000 days vs. 4.93 per 1000 days
- 1% of those bathed with CHG withdrew due to skin irritation

### Chlorhexidine Baths for Newborns

**Da Cunha (2008):** RCT of 94 full term newborns, cleanser vs. 0.25% CHG; staph aureus colonization reduced at 24 hours (36.7% vs 13.6% with CHG)

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

### Chlorhexidine Gluconate Bathing
- Safety in neonates?
- Influence on normal colonization, barrier function?

### Chlorhexidine Disinfectants
- Chlorhexidine gluconate (CHG)
  - 2% CHG aqueous
  - 2%, 3.15% CHG in 70% isopropyl alcohol
  - 0.5% CHG in 70% isopropyl alcohol
- Povidone Iodine (PI)
- Isopropyl Alcohol (IA)

### What is Chlorhexidine?
- Topical antiseptic used since 1954
- Hand washing, skin prep, vaginal antisepsis, gingivitis, body washing
- Concentrations: 0.5%-4%, with or without isopropyl alcohol or methanol
- Low concentrations affect membrane integrity, high concentrations cytoplasmic (cell death)
- Some pseudomonas species, other non-fermenting gram negative organisms have high level resistance

### Safety of Chlorhexidine Gluconate Used for Skin Antisepsis in the Preterm Infant
- Hexachlorophene and CHG are phenol derivatives, but differ chemically; hexachlorophene is bacteriostatic, CHG is bactericidal
- CHG more strongly binds to protein in the SC, withstands removal by alcohol
- Recent survey indicates that 61% of NICUs use CHG
  - some restrict by weight, GA
  - report adverse skin reactions, no systemic toxicity
- Skin irritation seen in preterm infants, even with aqueous CHG
- CHG absorption also a concern, seems to increase with repeated exposures
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New FDA Labeling (2013) for CHG/isopropyl alcohol agents

“Use with care in premature infants less than 2 months of age. These products may cause irritation or chemical burns.”

Disinfectant Issues: Toxicity

- PI shown to cause thyroid abnormalities in premature infants
  - Smerdley (1989); Parravicini (1996); Mitchell (1991); Linder (1997)
- CHG toxicity: rare reports
  - Ocular and corneal damage
  - Reports of anaphylaxis in adults with impregnated catheters
  - Frequent surgical exposure

Disinfectant Issues: Efficacy

- Adults: CHG reduced risk for catheter-related blood stream infection by 49%; Chaiyakunapruk (2002)
  - CDC strongly recommends 2% CHG/70% isopropyl alcohol used for insertion of CVC, dressing changes
- CVCs in adults average 7-10 days duration
- Neonates: CHG reduces skin colonization, reduces contaminated blood cultures, no evidence for reducing blood stream infection Garland (2009)
  - CVCs in neonates have longer dwell times
  - Care of IV tubing, accessing IVs may be more important to prevent infection Mermel (2011)
- Isopropyl alcohol least effective at reducing bacterial colonization, very irritating Maki (1991)

Chemical Burns: Povidone-Iodine + Isopropyl Alcohol

Chemical Burns: 2% CHG with 70% Isopropyl Alcohol

Case Reports:

- CHG chemical burns, erosive contact dermatitis
  - Reynolds (2005)
    - 0.5% CHG/methanol
  - Mannan (2007)
    - 0.5%CHG/isopropyl alcohol
  - Espuny (2010):
    - 0.5% methanol
  - Anderson (2005):
    - 2% aqueous CHG caused erythema, breakdown in 4/36 infants <1000g, <48 hours of age
  - Kutsch & Ottinger (2014)
    - 2 cases using "a chlorhexidine solution"); "CHG liberally applied"
  - Weitz (2013):
    - Erosive contact dermatitis from CHG-impregnated gel dressings

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CHG Impregnated Dressings

• Garland (2001):
  – 705 VLBW infants
  – RCT: PI skin prep w/TAD vs. IA skin prep, CHG foam drsg
  – drsg changed weekly
  – ↓ colonization, no difference in CRBIs or BSIs without source
  – ELBW infants: 15% developed severe contact dermatitis, pressure necrosis

• Levy (2005):
  – 145 pediatric CVS patients; RCT
  – ↓ colonization, no difference CABSI

• What about silver impregnated dressings?
  – Safe?
  – Effective?

Skin Antisepsis in the Neonate: What Should We Use?


• No robust evidence to recommend any topical antiseptic over another
• Use caution to avoid pooling of antiseptics in preterm infants, which is associated with skin burns
• Large trials with clinically relevant endpoints are now underway
  – CHG vs PI prior to CVC insertion in preterm infants (European Medicines Agency)
  – Efficacy study comparing 2%CHG/IA vs. 2% aqueous CHG (NLM, Clinical Trials #NCT01270776)

Disinfectants

Remove with water or saline, although CHG may still have lingering effect

Avoid using isopropyl alcohol-containing disinfectants in ELBW infants (<1000 grams) in the first weeks of life

There is insufficient evidence to recommend a single disinfectant for use in all NICU patients, all invasive procedures

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
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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

Factors in Premie Diaper Dermatitis?

- Breastmilk fortifiers?
  - Powder
  - Liquid

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

Diaper Dermatitis Treatments

- 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

Diaper Dermatitis Remedies
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 Ilex 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
Heimall et al (2012); MCN 37:10-16
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
• Newborn skin is uniquely different than older children and adult skin
• Care of the skin involves promoting normal skin function and preventing later skin disorders
• Antimicrobial bathing has not been well studied in the NICU population
• Skin disinfection remains a problem
• Consistency in prevention and treatment of diaper dermatitis is possible