Standardizing Skin Care for the Micro-Premature Infant

Carolyn Lund RN, MS, FAAN

Disclosures

- Member task force developing consensus statements for Medical Adhesives and Patient Safety; funded by an unrestricted educational grant from 3M
- Member of professional advisory panels for Johnson & Johnson Consumer Companies, Inc. and 3M.
- Sponsored by 3M to provide professional education to nurses.

Im mature Skin

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

Measuring TEWL: Evaporimeter

Premature Infants and TEWL

- 23 weeks
  - 75 gmH2O/m2/hr
- 26 weeks
  - 45 gmH2O/m2/hr
- 29 weeks
  - 17 gmH2O/m2/hr
- 32-40 weeks:
  - 5-10 gmH2O/m2/hr
  - Stratum corneum becomes mature at 30-32 weeks PCA

(Neonatal Skin: Structure and Function, 1982)
Standardizing Skin Care for the Micro-Premature Infant
Carolyn Lund RN, MS, FAAN

### TEWL in Infants Born at 24 and 25 Weeks


<table>
<thead>
<tr>
<th>DOL</th>
<th>TEWL (gm/m2/hr)</th>
<th>Fluid loss 24 h (ml/kg/day)</th>
<th>Humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>58.4</td>
<td>165</td>
<td>50%</td>
</tr>
<tr>
<td>3</td>
<td>43.8</td>
<td>123</td>
<td>50%</td>
</tr>
<tr>
<td>7</td>
<td>36.1</td>
<td>10</td>
<td>50%</td>
</tr>
<tr>
<td>28</td>
<td>24.2</td>
<td>66</td>
<td>50%</td>
</tr>
</tbody>
</table>

### Development of Skin Barrier Function in Premature Infants


- 10 infants, 23-32 weeks gestational age, <7 days of age
- Measured barrier function using two methods: TEWL (evaporimeter) and impedance spectroscopy
- Barrier matures at 200-230 days (30-32 weeks)

### Thermoregulation and the ELBW Infant

- Premature infants < 30 weeks predominately lose heat via evaporation because stratum corneum is deficient
- Thermoregulation must primarily address heat loss from evaporation
- Prevent evaporative losses rather than trying to make up for them

### Strategies to Decrease TEWL and Evaporative Heat Loss

- Plastic wrap or bags
- Supplemental conductive heat (heated mattress)
- Incubator rather than radiant heater
- Humidity >70%
- Transparent adhesive dressings
- Emollients

### Hats and Wraps and Bags

- Occlusive Bags Prevent Heat, Fluid Loss in ELBW Infants
  - Vohra (1999): RCT comparing bag to standard care; bag infants' temperature 1.9⁰C higher when admitted to NICU; benefit only seen if <28 weeks
  - Knobel (2005): bag infants' temperature 0.5⁰C higher, delivery room kept at higher temperatures
  - Vohra (2004): bag infants had higher temperatures when admitted to NICU, but at one hour same as controls
  - Caglar (2014): vinyl isolation bags better than wrapping with polyethylene stretch wrap
Occlusive Bags and Wraps: Unanswered Questions

• Best material?
  – Polyethylene, polypropylene, vinyl
• Sterile or non-sterile?
• Best head covering?
• Preventing hyperthermia?
• Skin maceration, effects of colonization?

Radiant Warmer vs. Incubator

• Kjartansson (1995): TEWL determined by water vapor pressure in air surrounding infant; radiant warmer dries the air more; “microclimate”
• Meyer (2001): better temperature control with radiant warmer, but increased fluid intake, more problems with serum Na levels >150
• Maayan-Metzger (2004): TEWL similar in both warmer and incubator; humidity levels 34% radiant warmer, 38% incubator

Supplemental Conductive Heat Reduces Radiant Heater Output

Humidity and TEWL

Increasing Humidity Reduces TEWL

High Humidity for ELBW Infants

Humidity Studies

- **Harpin (1985):** 80-90% RH for 33 premature infants, compared to historic controls; TEWL decreased by half, stopped added RH at 5-7 days due to concerns for infection.
- **Gaylord (2001):** 85 premature infants with mean BW 750 grams, 26 weeks; compared to 70 historic controls; mean RH 64% had decreased fluid intake, fewer Na, K problems, no increase in infection.

Improved Care and Growth Outcomes by Using Hybrid Humidified Incubators in Very Preterm Infants

- Retrospective study of 182 infants <1000g.
- Conventional incubator (CI) group (n=87) admitted to RW, moved to CI with no added humidity, 2002-2003.
- Hybrid incubator (HI) group (n=95) used radiant heat mode at first, then 70-80% RH for week 1, 50-60% RH week 2 until 30-32 weeks.

Humidity and Skin Barrier Maturation in Extremely Preterm Infants

- 27 infants, 23-27 weeks.
- 85% humidity during the first week.
- Randomized to 75% or 50% at 7 days.
- Measured TEWL, fluids, serum Na.
- At 28 days, infants in 75% humidity had less mature skin barrier compared to infants in 50% humidity.

CHO Humidity Guidelines

- High humidity (>70%) for first 7 days:
  - 23-26 weeks -- 85%
  - 27-30 weeks -- 70-75%
- Avoid flexion (skin-on-skin contact, no diapers) for first week.
- Decrease to 50% after first week, d/c added humidity after one month.
Standardizing Skin Care for the Micro-Premature Infant

Carolyn Lund RN, MS, FAAN

Transparent Adhesive Dressings and TEWL

- Four studies (1989-1995) studied transparent dressings effect on TEWL
- TEWL decreased by more than half with dressings
- Mancini (1995): transparent dressings accelerate maturation of stratum corneum

Transparent Dressings and Clinical Outcomes

- Donohue (1996): transparent dressings improved skin integrity, no effect on fluid intake, weight loss or serum Na levels (prospective study)
- Bhandari (2005): transparent dressings associated with lower fluid intake, fewer serum Na problems; treated infants had less BPD, mortality (retrospective study, only 30 in treatment group)
- Biggest problem with transparent dressings: skin breakdown when removed!

Emollients in Premature Infants

- Lane & Drost (1993): Eucerin cream treated infants had better appearance, no difference in barrier function (TEWL)
- Nopper (1996): Aquaphor treated infants had improved barrier function, appearance; fewer infections (60 infants, not a big enough sample to prove this)
- Pabst (1999): 19 infants, 26-30 weeks, <24 hours old received Aquaphor BID or standard care; no difference in fluid intake, NA levels, weight, skin microflora; skin condition better with Aquaphor

Effect of Prophylactic Ointment Therapy on Nosocomial Sepsis Rates and Skin Integrity in 501-1000g Infants

VON Skin Care Study Group, Peds 2004; 113:1195-1203

- 1191 subjects, randomized to prophylactic Aquaphor (BID) vs "routine skin care" in first 14 days of life
- No difference in combined outcomes (sepsis or death)
- Prophylactic group had increase sepsis w/CONS (25.8% vs 20.4%), more septic work-ups (highest in <750 g)
- No increase in gram negative or fungal sepsis
- 34% of "routine treatment" group received Aquaphor ointment for up to 4 days
- Prophylactic group had better skin scores

Effects of Topical Emollient Therapy on Infants at or less than 27 weeks gestation

- Retrospective chart review, ≤ 27 weeks
- Aquaphor every 6 hours for 2 weeks including head and face
- Compared to controls, treated infants:
  - Lower fluid intake
  - Better urine output
  - Less fluctuations in sodium
  - Bilirubin levels lower

Effectiveness of No-Sting Skin Protectant and Aquaphor on Water Loss and Skin Integrity in Premature Infants


- 69 infants, mean GA 28.5 weeks, birthweight means 1117-1215 g
- Randomized to Aquaphor BID or sprayed with No-Sting once a week for 2 weeks
- Both equally effective in reducing TEWL
- Skin condition score better with Aquaphor
- Used high humidity as well
Standardizing Skin Care for the Micro-Premature Infant

Carolyn Lund RN, MS, FAAN

Skin Breakdown in the ELBW Infant

- Medical adhesive skin injury
- Chemical burns (disinfectants)
- Infection
- Diaper dermatitis
- IV extravasation

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

Medical Adhesives in the NICU

- 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

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

Silicone Adhesives

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

Silicone Tape and EEGs

Silicone Tape in High Humidity

Silicone Barrier Films

Sprayed or wiped on skin to protect from trauma
Alcohol-free products less irritating to skin
Cavilon is FDA approved in infants >30 days as diaper dermatitis treatment
Other manufacturers do not need FDA label, covered under the original patented product
Standardizing Skin Care for the Micro-Premature Infant
Carolyn Lund RN, MS, FAAN

Silicone Barrier Films

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
  - Safest medical adhesive remover

Silicone Adhesive Removers

Bonding Agents
- Tincture of Benzoin, Mastisol
- Used to enhance adhesion of wound closure tapes
- Not recommended in newborns, can increase epidermal stripping

Anetoderma of Prematurity
- Atrophic patches, result from thinning of dermis, biopsy shows absence of dermal elastic tissue
- Extremely premature infants, lengthy stay in NICU
- Absent at birth, develop between 6-10 weeks
- Usually anterior trunk, limbs

Anetoderma of Prematurity

November 1, 2014
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

Factors in Premie Diaper Dermatitis?
Breastmilk fortifiers?
  - Powder
  - Liquid

Treating Skin Breakdown in ELBW Infants

- Surface injury most common
- Ointments facilitate healing
- Silicone dressings + ointment

Healing from Marsi

Healing from Extravasation
Cutaneous Lesions

Invasive Fungal Dermatitis in the <1000 gram neonate

- Series of 16 premature, 474-855 grams
- Fungal dermatitis in first 2 weeks of life
- Ulcerative, corrosive lesions
- Skin portal of entry: early colonization, immature barrier
- Often associated with systemic involvement

Invasive Fungal Dermatitis

Approach to Fungal Dermatitis

- Culture, gram stain or KOH prep of any skin breakdown
- If yeast present, evaluate for systemic symptoms such as thrombocytopenia, hypotension, acidosis
- Send blood culture, urine for hyphae
- Consider systemic antifungal therapy before blood culture is positive
- Topical antifungal ointment (not cream or powder)
- Some times it isn’t yeast!

Fungal Prophylaxis

- Used variably in NICUs; study in 2006 showed 34%
- Drugs include oral or IV fluconazole, oral nystatin
- Cochrane Review (2010): use of prophylaxis for prevention of mortality due to fungal infection not supported by research
- Side effects include liver toxicity (fluconazole), NEC, bowel perforation (oral nystatin)

Approach to the Neonates with Ecchymoses and Crusts

- Risk factors: premature, immunocompromised infants, corticosteroids, broad spectrum antibiotics, hospital construction, adhesive injury
- Opportunistic fungal and yeast infections include candidiasis, aspergillosis, rhizopus, fusarium
- Biopsy may be indicated, possible surgical resection for aspergillosis, zygomycosis
Conclusions

• Control of TEWL is necessary for premature infants less than 30 weeks gestation.
• Skin injury from medical adhesives may be reduced using some of the newer products.
• Other sources of skin breakdown include chemical burns from disinfectants, IV extravasations, infection, diaper dermatitis
• Ointments, silicone dressings effective treatments for skin breakdown