Neonatal Skin Care: Evidence-Based Clinical Practice Guideline

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Disclosures

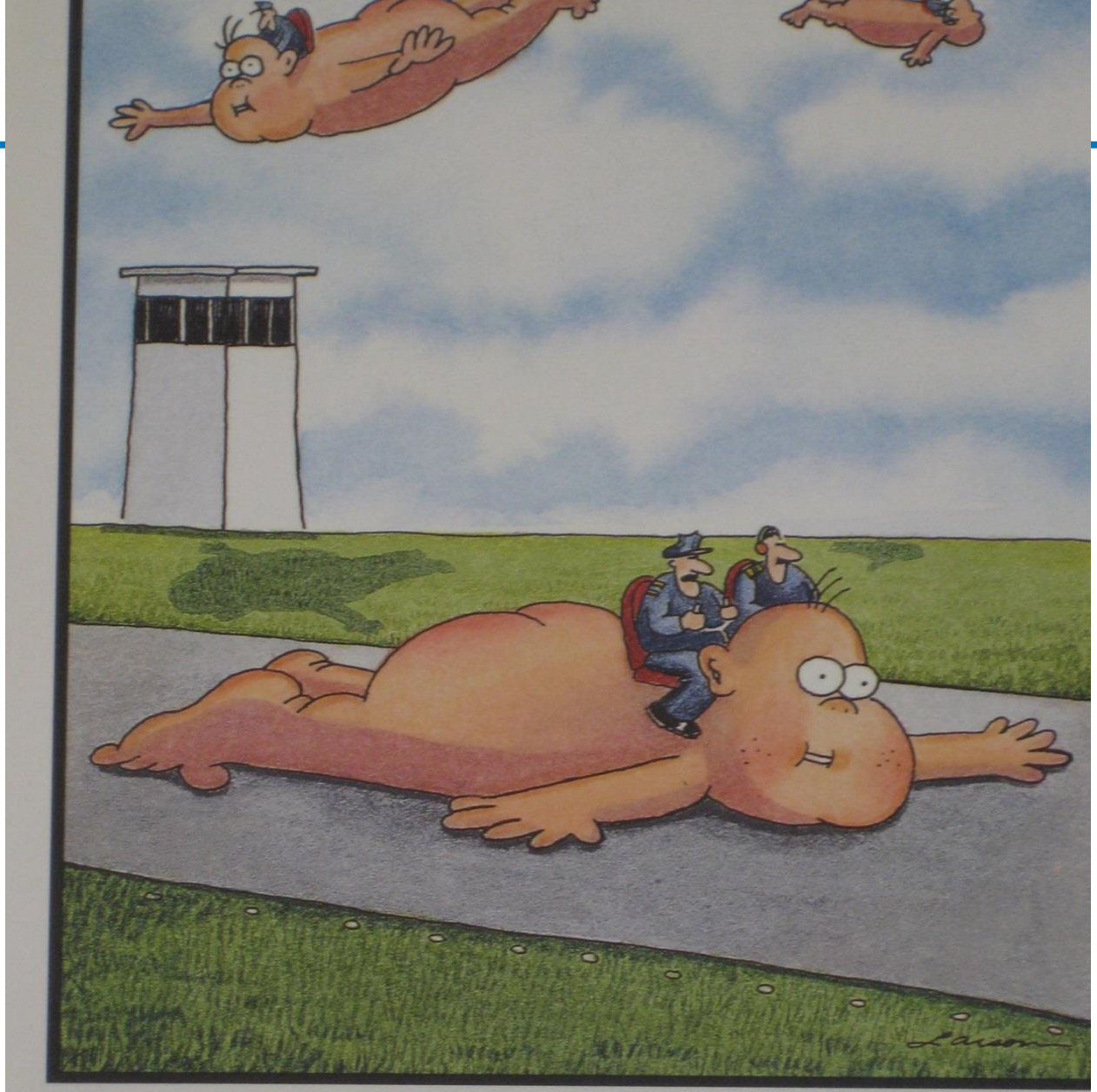
- Investigator-initiated grant from Johnson & Johnson Consumer Products to study the first bath in full term newborns, 2012–13

- I am honored and thrilled to be here!!

Session Objectives

By the end of this session, participants will be able to:

- Explain the basic science of baby skin and overview the fundamental differences between adult and baby skin
- Understand the role the Skin Barrier plays in the development of Atopic Dermatitis
- Identify the steps in management of IV Infiltration
- Highlight the evidence supporting best practices in baby skin care



"Fuel . . . check. Lights . . . check. Oil pressure . . . check. We've got clearance. OK, Jack — let's get this baby off the ground."

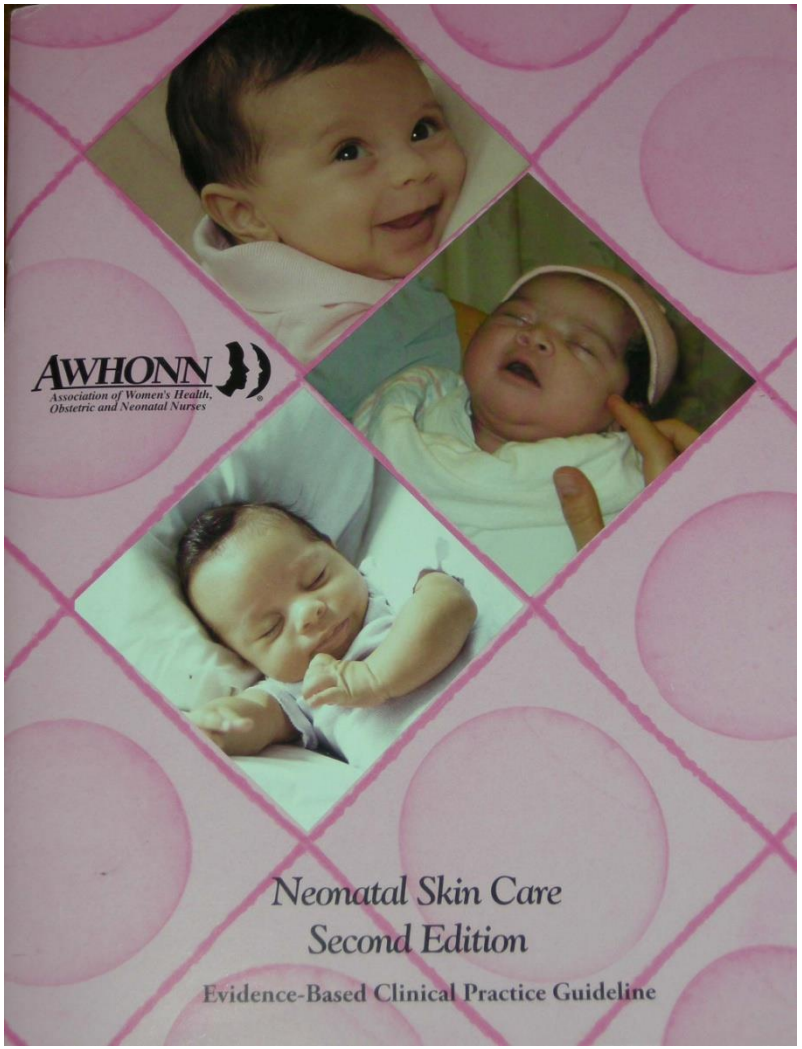
History of the Neonatal Skin Care Guideline

- Collaboration between two national nursing organizations in the US (AWHONN and NANN)
  - Included Canadian representation
  - Reviewed & scored over 200 research articles about neonatal skin and skin care

- First evidence-based, clinical practice guideline (2001) evaluated in 51 US nurseries
- 2nd edition of guideline 2007.
- 3rd edition of guideline 2013

2007 Edition of Neonatal Skin Care Guideline

- Newborn skin assessment
- Bathing
- Vernix
- Umbilical cord care
- Circumcision care
- Disinfectants
- Diaper dermatitis
- Medical Adhesives
- Emollients
- Transepidermal water loss in ELBW infants
- Skin breakdown
- Intravenous infiltration



2013 Neonatal Skin Care Guideline

- Includes new information on:
  - Product selection
  - Microbiome of the skin
  - Parent education
  - Atopic dermatitis

AWHONN International Adaptations

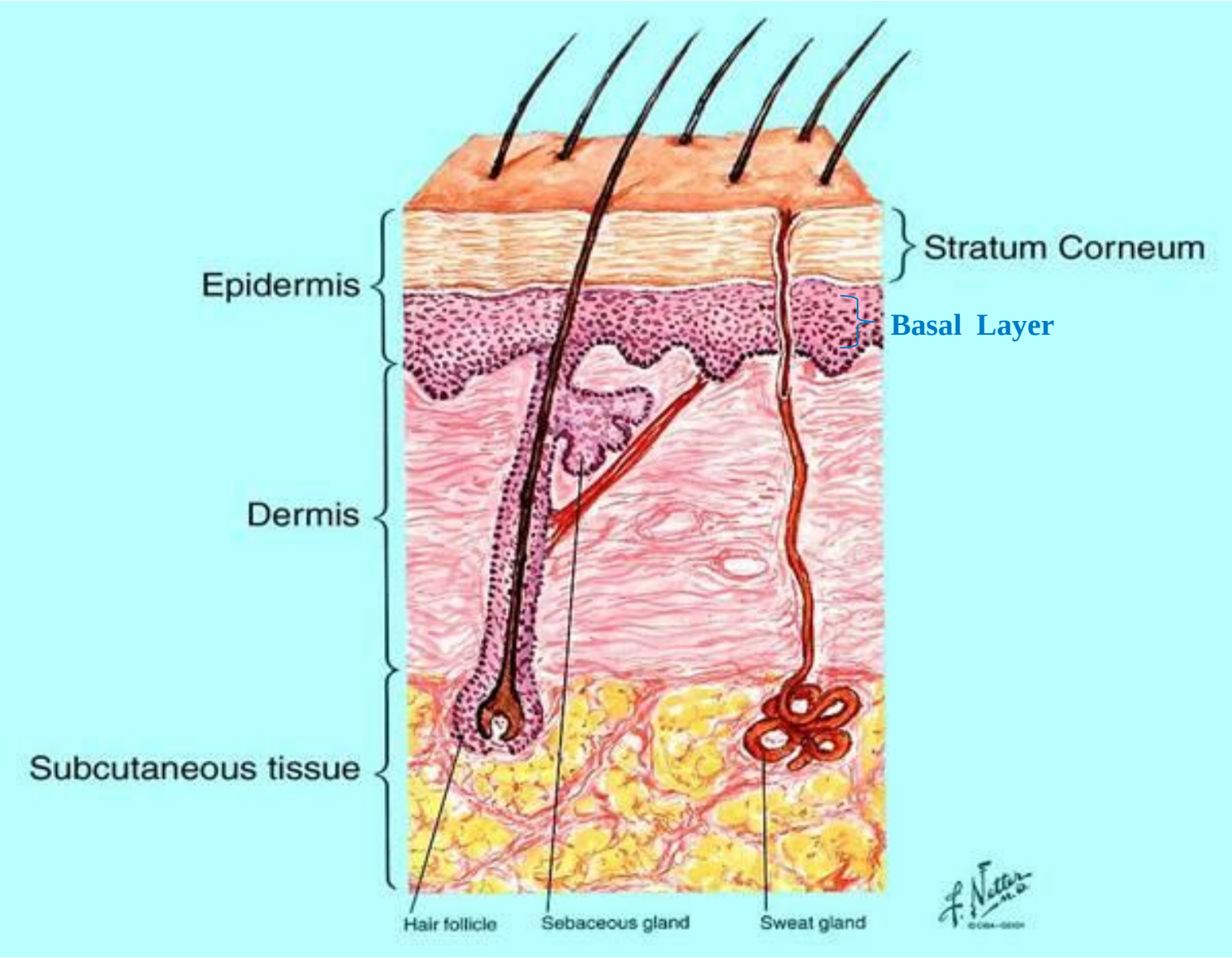
- China adaptation led by CMCHA – 2nd edition launch November, 2016.

- Philippines adaptation, 1st edition launch September , 2016.

- India adaptation – targeting early 2017.

- Additional programs implemented, or in planning, for Australia, Russia, Malaysia, Indonesia.

Skin Layers


Epidermis
Dermis
Subcutaneous tissue
Stratum Corneum
Basal Layer
Hair follicle
Sebaceous gland
Sweat gland

Stratum Corneum and TEWL

Adult SC

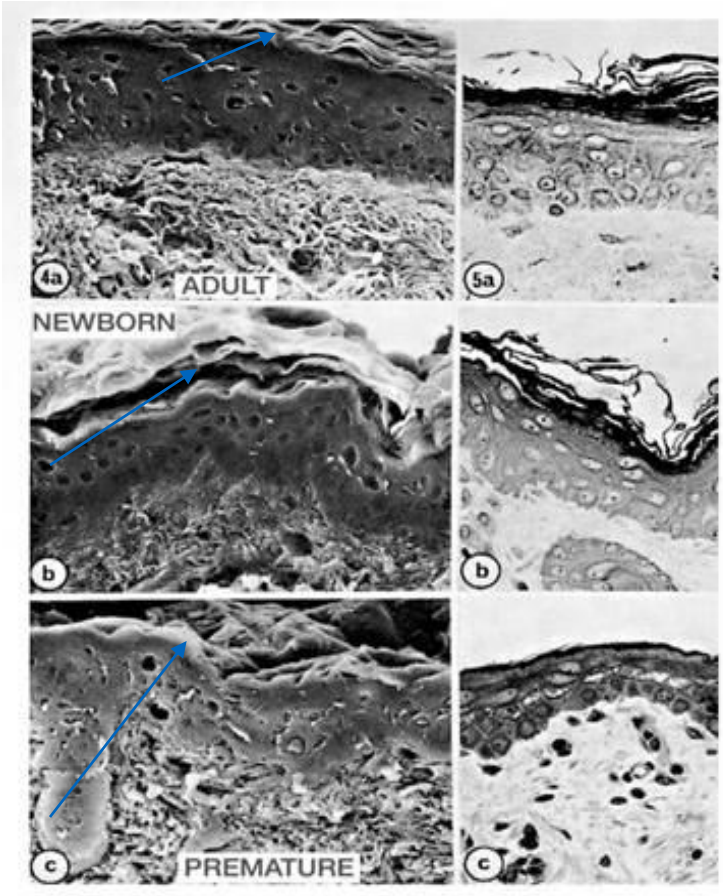
10-20 layers

Newborn SC

10-20 layers

Premature Infant

2-3 layers



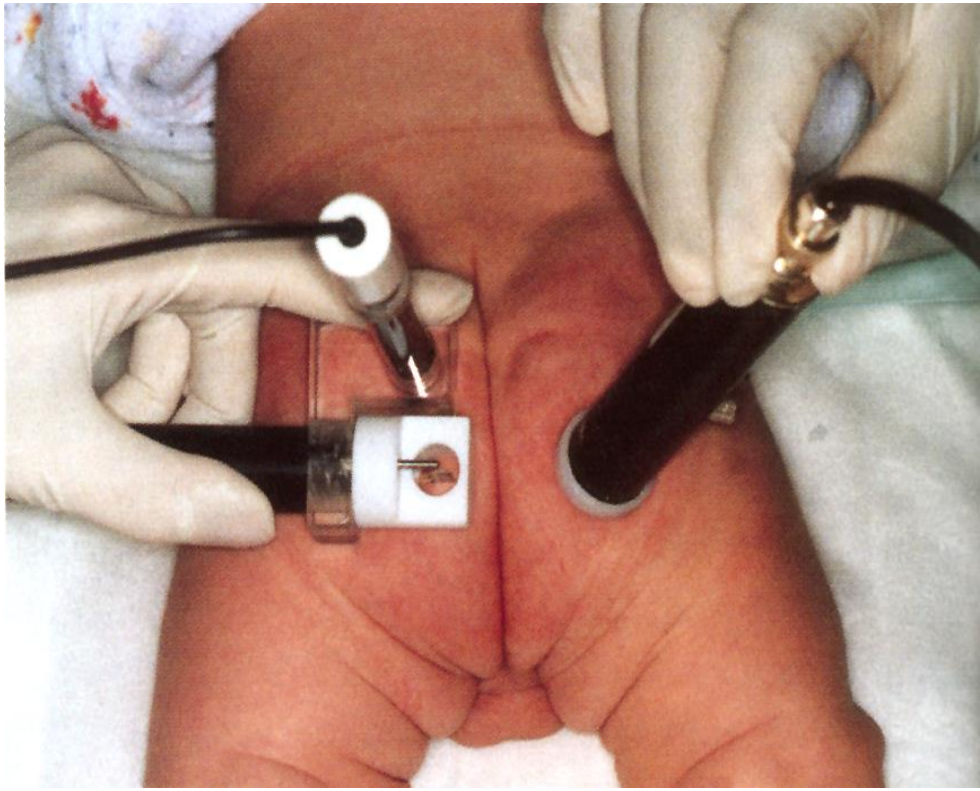
- 10-20 layers of stratum corneum in term infants and adults
- Far fewer layers in premature infants <30 weeks, increased fluid and heat losses
- Evaporimeter measures skin barrier function—TEWL (transepidermal water loss)
- 5-10 gms $H_20/m^2/hr$ in adults

Premature Infants and TEWL

- 23 weeks
  - 75 $gmH^20/m^2/hr$
- 26 weeks
  - 45 $gmH^20/m^2/hr$
- 29 weeks
  - 17 $gmH^20/m^2/hr$
- 32-40 weeks:
  - 5-10 $gmH^20/m^2/hr$
- Stratum corneum becomes mature at 30-32 weeks PCA

Measuring Skin Parameters

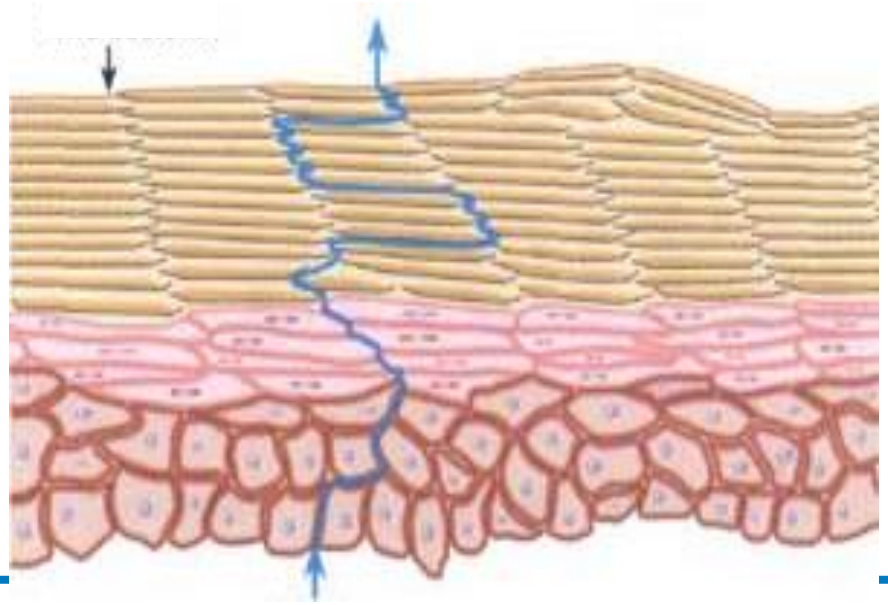
- TEWL
  - Transepidermal Water Loss
- pH
  - acid-base balance
- SCH
  - Surface hydration
- Colorimeter
  - erythema
- Visual Inspection Scales
- Skin cultures, PCR analysis



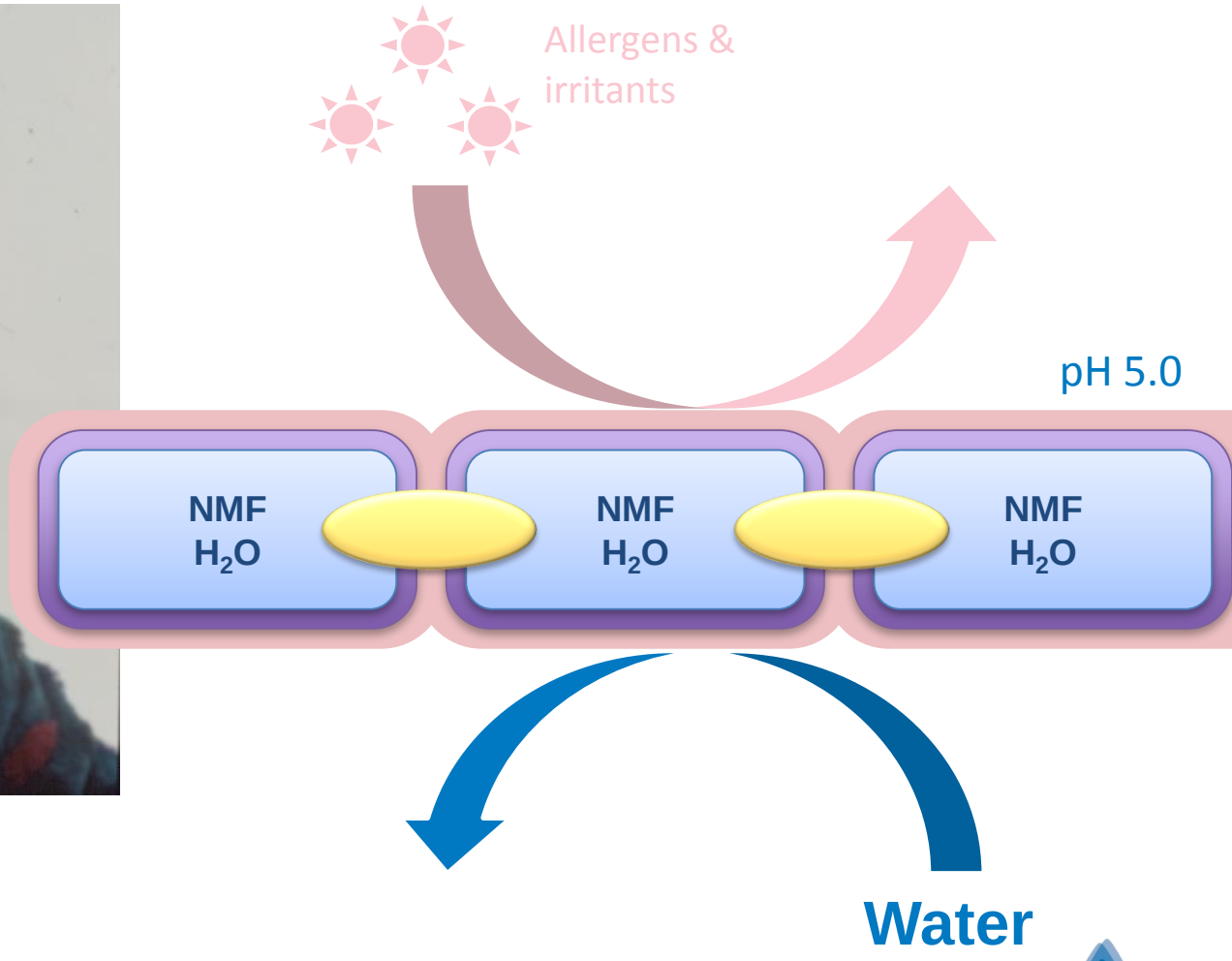
Davis,PediatrDermatol1989;6(2):102-8

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



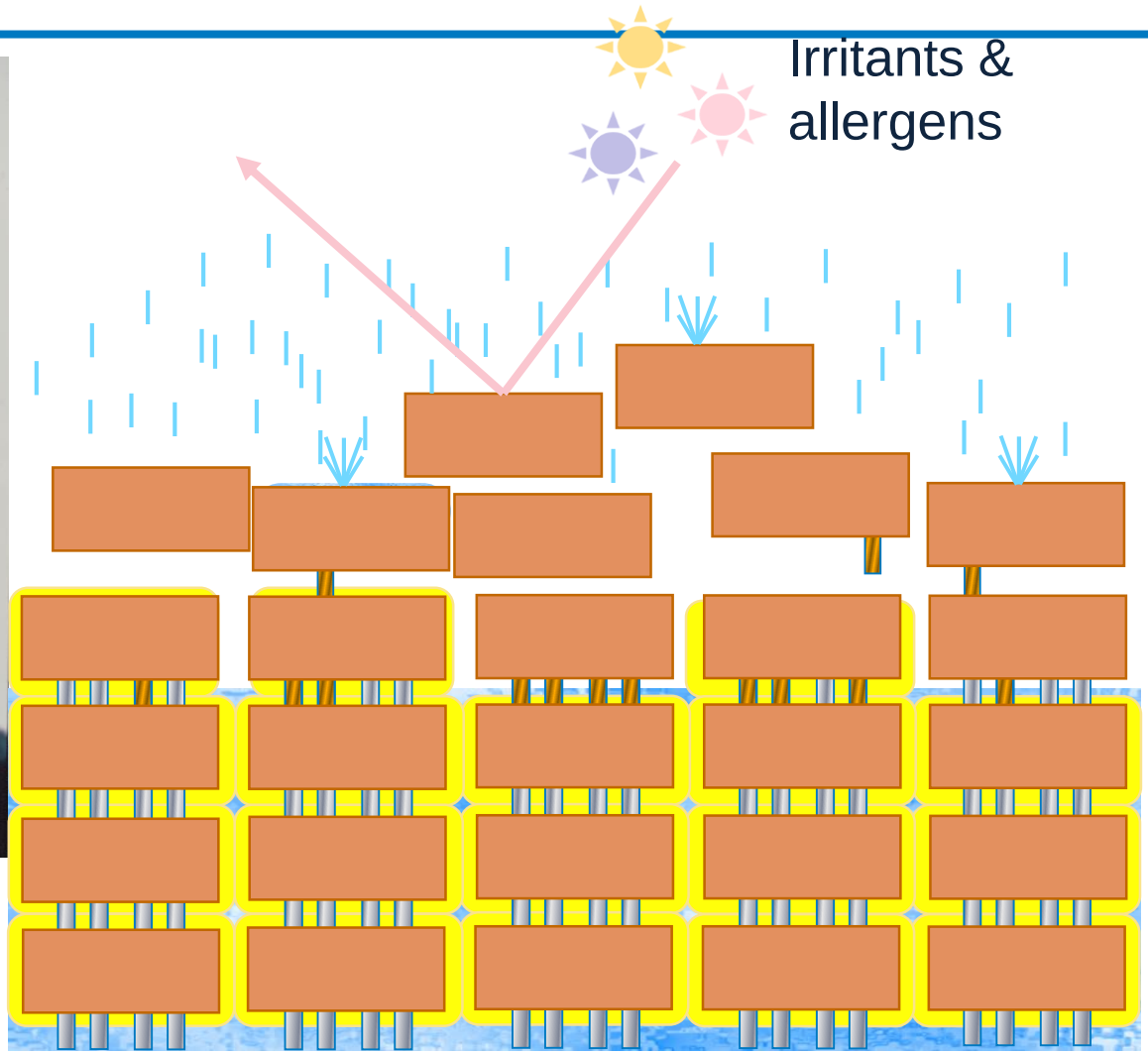
A Healthy Skin Barrier



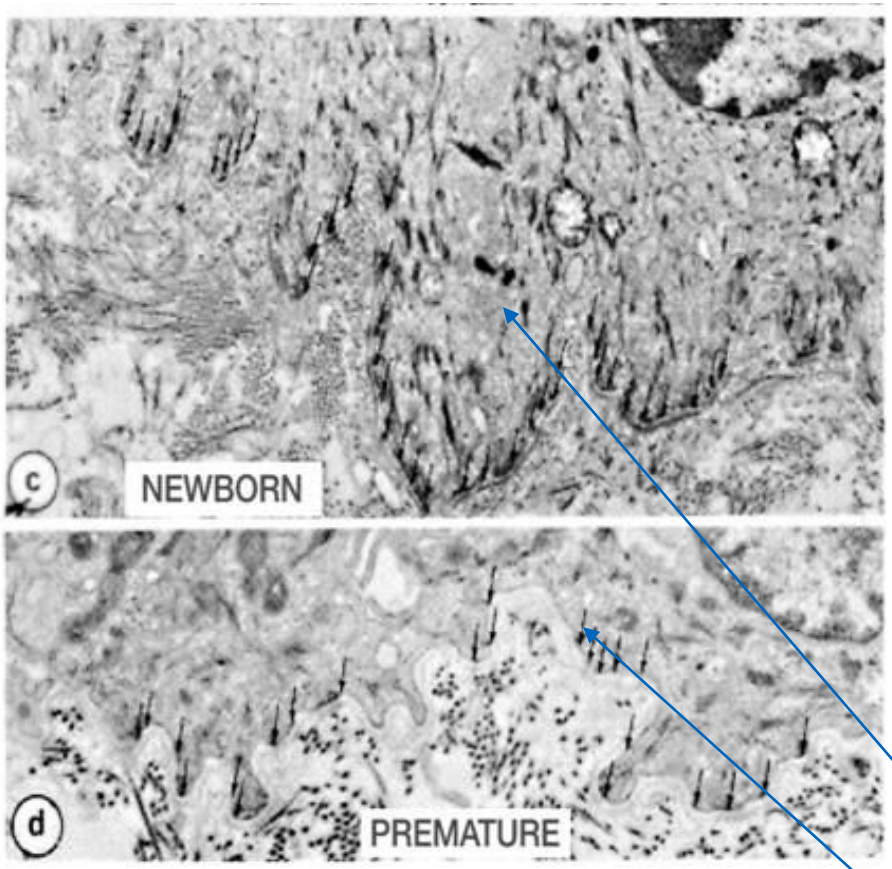
NMF = Natural moisturizing factor

Danby SG & Cork MJ, The Academic Unit of Dermatology Research, The University of Sheffield.

Brick Wall model of the Skin Barrier



Cohesion Between Epidermis and Dermis



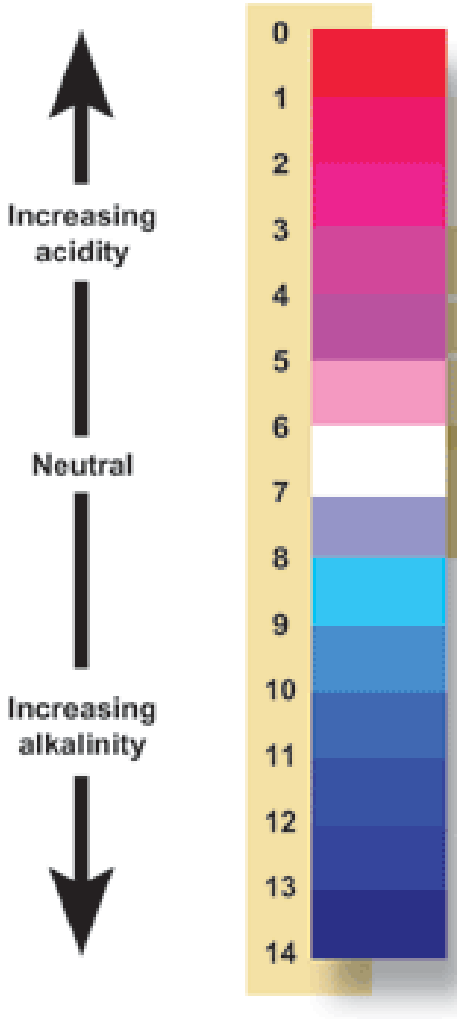
- Top two layers of skin connected by fibrils
- Fewer and further apart in premature infants
- Adhesives can attach more securely to epidermis than the epidermis is attached to the dermis

Fibrils

Skin pH

- pH >6.0 at birth, falls to <5.0 in 4 days
- Premature infants ≈ pH 5.5 after one week, ≈ pH 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 (staphylococcus epidermidis, micrococci, coryneforms, propionbacteria)
  - transient flora is inhibited (Escherichia coli; pseudomonas; gram positive staphylococcus; candida)
- Normal tap water increases pH for a while

More alkaline pH increases skin permeability



Unique Differences in Infant Skin

- Baby stratum corneum is 30% thinner than adult, epidermis is 20-30% smaller
- Keratinocyte cells smaller with higher cell turnover rate; explains faster wound healing in babies
- Dermis is also different; short collagen fibers, absent reticular layer, makes skin feel softer
- Baby skin contains less total lipids and less sebaceous lipids, confirming the decreased activity of glands

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

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

Kim et al (2010) Peds 125:e137

- 70-80% RH for week 1, 50-60% RH week 2 until 30-32 weeks
- ELBW infants using hybrid incubator w/humidity
  - ↓ fluid intake, urine output, weight loss, hypernaturemia
  - Improved growth rate
  - ↓ incidence severe BPD, duration of assisted ventilation

Hats and Wraps and Bags

Why is this important?

- Care practices for the hospitalized infant can place them at risk for compromising skin integrity
- Skin Breakdown can lead to systemic infection, increased morbidity, & increased cost of care

What is Atopic Dermatitis?

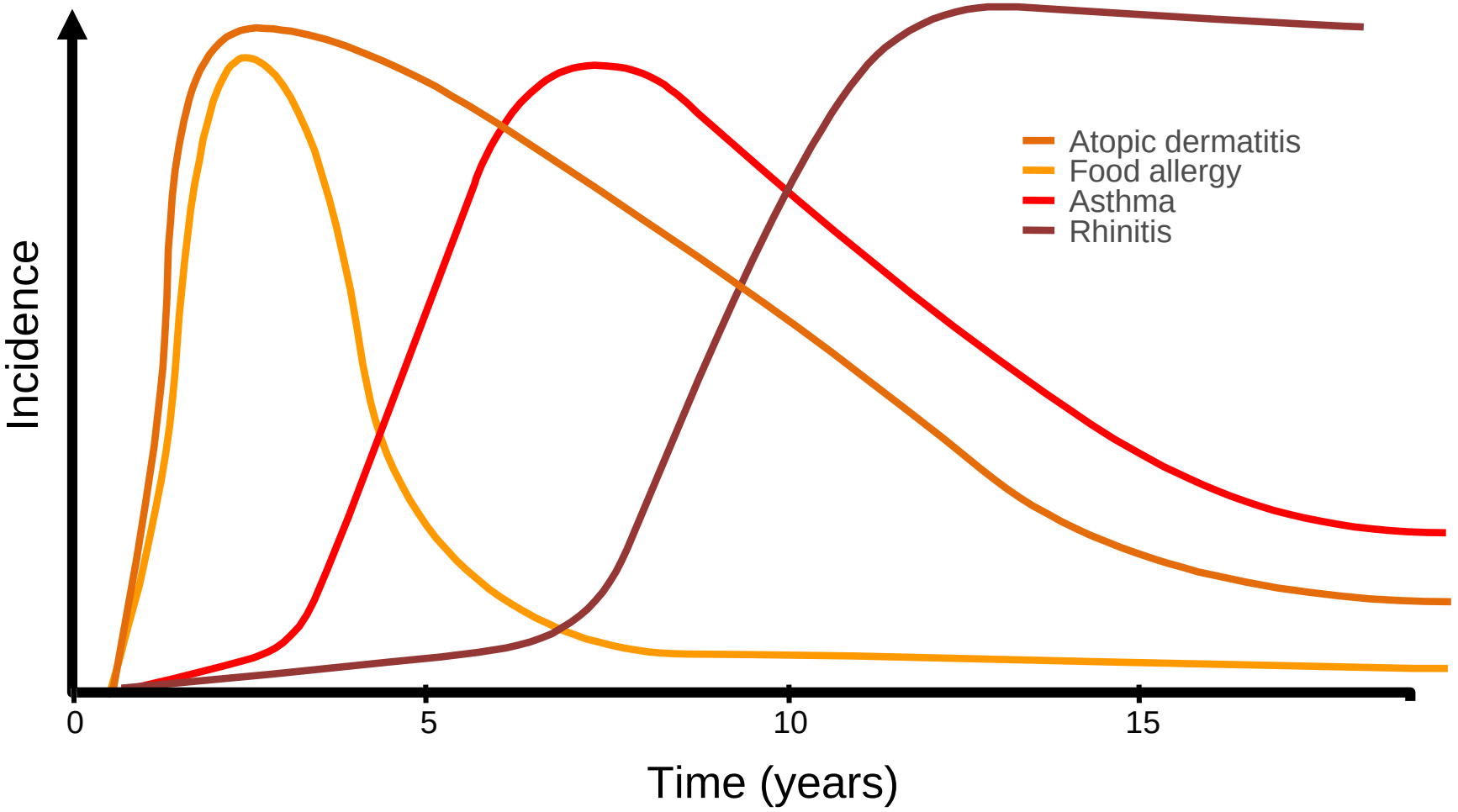
- Allergic inflammatory skin condition-results in dry, scaly skin
- Affects about 20% of children; 60% of those by their first birthday
- AD that arises in childhood is frequently a precursor of allergic asthma and allergic rhinitis
- Cause is a combination of genetic and environmental factors
- Altered TEWL, pH & skin microbiome is seen in AD
- Keeping skin barrier intact may possibly prevent disease progression by inhibiting entry of allergens and irritants
- BEEP study: Barrier Enhancement for Eczema Prevention

Preventing the Development of Atopic Dermatitis:

- A window of opportunity in the first few months after birth to change the environment to prevent the development of AD by changing the way we treat a babies skin

- Everything we put on a babies skin from birth should be designed to enhance the skin barrier rather than damage it

Atopic dermatitis: part of the ‘atopic march’



Barnetson RS & Rogers M. BMJ 2002; 324:1376–1379; & Weinberg EG. Curr Allergy Clin Immunol 2005; 18:4–5.

Emollients

- Preserve, protect, and enhance the skin barrier
- Petrolatum-based ointments are “gold standard” to retain surface hydration; highest oil-to-water ratio
- Considered first-line treatment for Atopic Dermatitis (AD)

Skin Disinfectants

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

What is Chlorhexidine?

- Topical antiseptic used since 1954
- Binds to cutaneous and mucosal protein (keratin)
- Concentrations: 0.5%-4%, with or without isopropyl alcohol or methanol
- Hand washing, skin prep, vaginal antisepsis, gingivitis, body washing
- Not effective against C. diff or non-enveloped viruses such as rotavirus, adenovirus, enterovirus

Milstone AM et al, Healthcare Epidemiology (2008), 46:274

Safety of Chlorhexidine Gluconate Used for Skin Antisepsis in the Preterm Infant

- Recent survey indicates that 61% of NICUs in the US use CHG

  -some restrict by weight, GA

  -adverse skin reactions reported, no systemic toxicity
- Skin irritation seen in preterm infants, even with aqueous CHG
- CHG absorption also a concern, seems to increase with repeated exposures

- Chapman, Aucott, Milstone (2012) J Perinat 32:4-9

A Systematic Review of Thyroid Dysfunction in Preterm Neonates Exposed to Topical Iodine

- 15 studies reviewed
- Incidence transient hypothyroidism, ↑TSH ranged from 12 to 33 per 100 infants
- Incidence in non-exposed infants was 0
- Premature infants more vulnerable
  - -Immature thyroid gland
  - -Increased permeability of skin
  - -Decreased renal clearance
- Maternal iodine levels ↑if prepped for C/S with PI

- Aitken J & Williams F (2014) Arch Dis Child Fet Neonat ED, 99:F21-F28

Efficacy of Disinfectants: Neonates

- Garland (1995): total of 765 peripheral IV catheters in neonates; colonization with bacteria in 4.7% with CHG, 9.3% with PI
- Linder (2004): retrospective study, PI or CHG; no differences in + blood cultures, true infections or contaminated cultures
- CDC (2011) : "No recommendation can be made for the safety or efficacy of chlorhexidine in infants aged < 2 months. Unresolved issue. Antiseptics should be allowed to dry according to the manufacturer's recommendation"

➢ *Central lines in neonates stay in longer; hub care, sterile tubing changes may be more important to prevent infection*

FDA Labeling (2013) for CHG/isopropyl alcohol agents

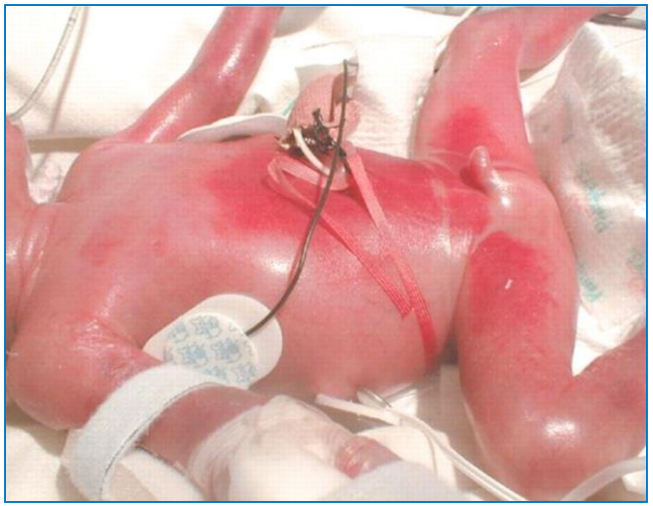
"Use with care in premature infants less than 2 months of age. These products may cause irritation or chemical burns."

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”

Disinfectant Summary

- 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

Preventing IV Infiltrates

- Insertion site clearly visible
- Check every hour
- Keep IV site out of swaddling blankets
- Tape at joint: knee for foot, elbow for hand
- Avoid tape or wraps that constrict venous return

IV Infiltrates/Extravasations

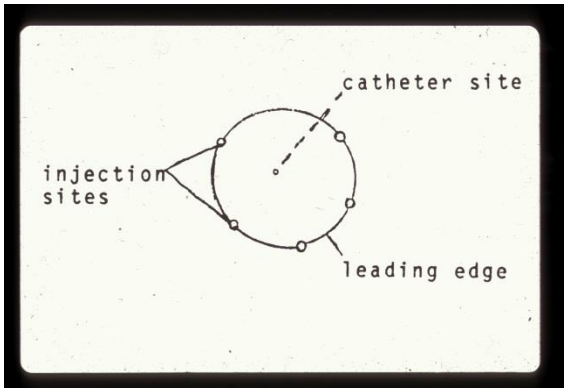
Immediate Care:

- Consider type of extravasated fluid: calcium-containing fluids, antibiotics, vasopressors
- Degree of injury: discoloration (blue, white), blistering, tightness of tissue
- Consider hyaluronidase, multiple puncture technique, hydrogel

IV Infiltrate Requiring Intervention

Hyaluronidase and Phentolamine

- Vitrase: www.istavision.com
- Amphadase: www.amphastar.com
- Hylenex: Baxter
- Doses 15-20 units, 1 cc volume injected at 5 sites around periphery
- Do not use for vasopressors; Phentolamine (Regitine) is antidote for Dopamine



Hyaluronidase + Puncture + Gel/Bag

- Hyaluronidase 15-20 units
- Deliver 0.2 ml in 5 sites around periphery of infiltrate
- No need to change needles

Multiple puncture technique

Hyaluronidase + Puncture + Gel/Bag

- Puncture to release extravasated fluid
- Use 23 gauge or greater
- Don’t be timid
- May repeat hyaluronidase, punctures
- Apply hydrogel, bag

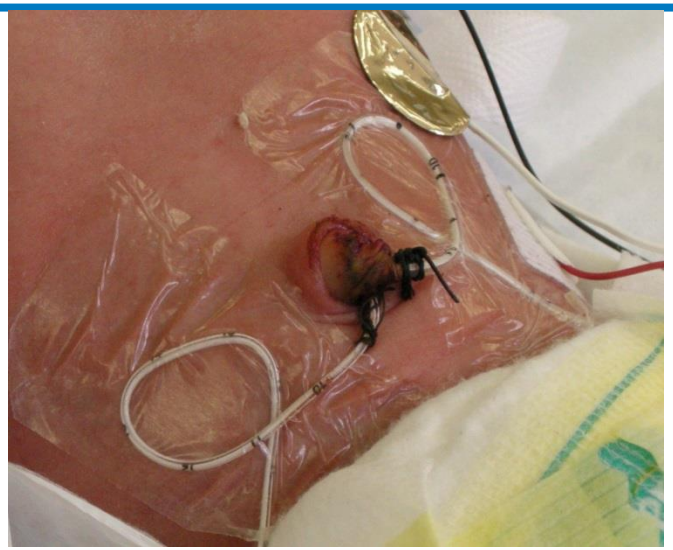
Hydrogel + Hydrocolloid Window

Medical Adhesives in the NICU

- Acrylates (Transpore, cloth)
- Zinc oxide (pink tape)
- Polyurethane (transparent drsgs)
- Hydrocolloids (pectin, duoderm)
- Hydrogel (electrodes)
- Silicone

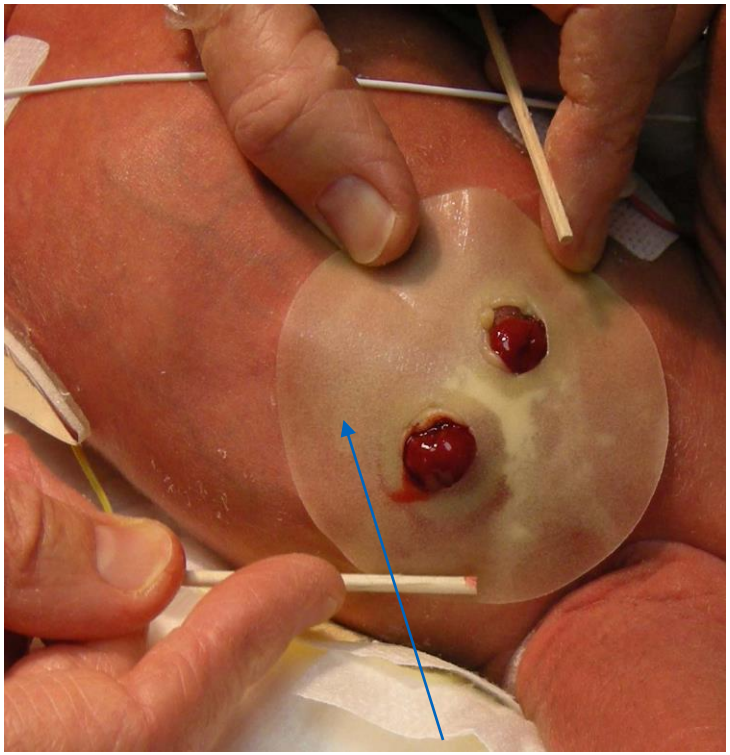
Transparent Adhesive Dressings

- Permeable to water vapor, O_2 and CO_2; allow skin to "breathe"
- Uses include wound coverings, securing IV devices, chest tubes, nasal cannulas, NG tubes



Hydrocolloid Products

Oral Endotraceal Tube Securement



Colostomy Skin Protection

Alternatives to Adhesive Pulse Ox Sensors

- Made of soft material
- Attaches with Velcro
- Stabilizing band to secure cable

Alternatives to Adhesives

- Adhesive circles have removable top layer
- Allows re-attachment of nasal cannula without adhesive removal

Silicone-Based Adhesives

- Several products have silicone-based adhesion
- Silicone dressings shown to cause less damage to wound, less discomfort when removed
- Silicone tapes have many uses in NICU patients

*Medical Adhesive-related Skin Injury

- Skin stripping
- Tearing
- Maceration
- Tension blisters

- Chemical irritation; contact dermatitis
- Sensitization; allergic response
- Folliculitis

***(MARSI)**

Adhesive Damage Hurts!

New Technology: Silicone Adhesives

Silicone Tape & Dressings

Barrier Films

- Plastic polymers 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 haven't approached FDA

Conclusions

- Goal is to protect neonatal skin and promote future skin health
- Care practices should promote Skin Barrier integrity

THE END…

THANK YOU!

THE END…

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

Misadventure in Neonatal Skin Care: Hexachlorophene

- Hexachlorophene was used to control outbreaks of *s. aureus* infection in nurseries
- Reports in 1970s of spongiform myelinopathy in LBW infants
- Anderson (1981):
  - Autopsied 27/97 infants (<1750 grams) who expired over 2 year period
  - HCP bath daily, and to diaper area with changes
  - 20 had brain myelinopathy on autopsy to varying degrees
  - Worst cases seen in infants who survived longer
  - Also saw brain abscesses from candida in one infant, E. coli meningitis in another

Increased Risk of Toxicity from Topical Agents

- 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 function
- Immature renal and hepatic function to excrete absorbed agents

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
- Significant reduction in bacteraemia in CHG group
  - 3.28 per 1000 days vs. 4.93 per 1000 days
- 1% of those bathed with CHG withdrew due to skin irritation

Milstone et al (2013);Lancet 381:1099-1106

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

Blood Concentration of CHG in Hospitalized Children Undergoing Daily CHG Bathing

- 12 subjects, 3 months – 17 years
- Mean # of daily baths 9 (range 1-30)
- 8 subjects had samples after at least 7 days CHG exposure
- Low concentrations of CHG
- No evidence CHG accumulation

Lee et al (2011) Inf control and Hosp Epidemiol 32:395-397

Chlorhexidine Gluconate Bathing?

- Daily baths in PICU reduced BSIs
- Safety in neonates?
- Influence on normal colonization, barrier function?

AHRQ Guideline: Daily Bathing of children in Critical Care Settings with CHG (2013)

- Best evidence statement from Cinncinati Children's

  "It is strongly recommended that patients (with intact skin) receiving care in an inpatient critical care setting receive a daily bath using 2% CHG to reduce the risk of bloodstream infection"

- Exclusions:
  - < 2 months
  - Indwelling epidural or lumbar drain
  - Known sensitivity to CHG

International Skin Science:

Topical Applications of Chlorhexidine for Prevention of Omphalitis and Neonatal Mortality in Southern Nepal

Mullaney LC, Darmstadt GL et al (2006) Lancet 367:910

- Community-based, cluster-randomised trial
  - 4934 infants- 4% CHG
  - 5107 infants- soap and water
  - 5082 infants- dry cord care
- Severe omphalitis reduced by 75%, neonatal mortality 24% lower with CHG
- If enrolled at <24 hours of age, mortality reduced by 34%