

Neonatal skin and wound care: the state of science in 2025.



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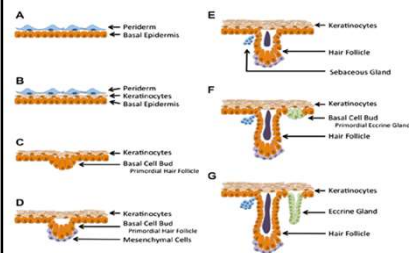
FANNP's National Neonatal Nurse Practitioner Symposium: Clinical Update and Review, 2025 ©

I have nothing to disclose as pertaining to this presentation

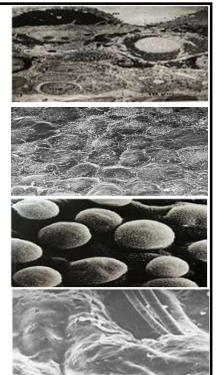
Learning Objectives:

- Describe the structure and function of skin; understand unique features of neonatal skin
- Discuss common cutaneous injuries and approach to wound healing
- Discuss safe and efficacious debriding agents, dressings, topical antimicrobial products and advanced biologics

Skin development



Holbrook et al., JGIM, 1975
Krid et al., 2013; McGrath et al., Textbook of Dermatology, 2010



Interventions	Therapist advice	Notes	Appropriateness to intervention – 1 = poor 2 = fair 3 = good 4 = excellent
1. Education	Education about the condition and its management	Education about the condition and its management	4
2. Behavioural (cognitive) CBT	Behavioural (cognitive) CBT	Behavioural (cognitive) CBT	4
3. Relaxation	Relaxation	Relaxation	4
4. Hypnotherapy	Hypnotherapy	Hypnotherapy	4
5. Self-help	Self-help	Self-help	4
6. Support groups	Support groups	Support groups	4
7. Medication	Medication	Medication	4
8. Surgery	Surgery	Surgery	4
9. Psychological (cognitive) CBT	Psychological (cognitive) CBT	Psychological (cognitive) CBT	4
10. Hypnotherapy	Hypnotherapy	Hypnotherapy	4
11. Self-help	Self-help	Self-help	4
12. Support groups	Support groups	Support groups	4
13. Medication	Medication	Medication	4
14. Surgery	Surgery	Surgery	4
15. Psychological (cognitive) CBT	Psychological (cognitive) CBT	Psychological (cognitive) CBT	4
16. Hypnotherapy	Hypnotherapy	Hypnotherapy	4
17. Self-help	Self-help	Self-help	4
18. Support groups	Support groups	Support groups	4
19. Medication	Medication	Medication	4
20. Surgery	Surgery	Surgery	4
21. Psychological (cognitive) CBT	Psychological (cognitive) CBT	Psychological (cognitive) CBT	4
22. Hypnotherapy	Hypnotherapy	Hypnotherapy	4
23. Self-help	Self-help	Self-help	4
24. Support groups	Support groups	Support groups	4
25. Medication	Medication	Medication	4
26. Surgery	Surgery	Surgery	4
27. Psychological (cognitive) CBT	Psychological (cognitive) CBT	Psychological (cognitive) CBT	4
28. Hypnotherapy	Hypnotherapy	Hypnotherapy	4
29. Self-help	Self-help	Self-help	4
30. Support groups	Support groups	Support groups	4
31. Medication	Medication	Medication	4
32. Surgery	Surgery	Surgery	4
33. Psychological (cognitive) CBT	Psychological (cognitive) CBT	Psychological (cognitive) CBT	4
34. Hypnotherapy	Hypnotherapy	Hypnotherapy	4
35. Self-help	Self-help	Self-help	4
36. Support groups	Support groups	Support groups	4
37. Medication	Medication	Medication	4
38. Surgery	Surgery	Surgery	4
39. Psychological (cognitive) CBT	Psychological (cognitive) CBT	Psychological (cognitive) CBT	4
40. Hypnotherapy	Hypnotherapy	Hypnotherapy	4
41. Self-help	Self-help	Self-help	4
42. Support groups	Support groups	Support groups	4
43. Medication	Medication	Medication	4
44. Surgery	Surgery	Surgery	4
45. Psychological (cognitive) CBT	Psychological (cognitive) CBT	Psychological (cognitive) CBT	4
46. Hypnotherapy	Hypnotherapy	Hypnotherapy	4
47. Self-help	Self-help	Self-help	4
48. Support groups	Support groups	Support groups	4
49. Medication	Medication	Medication	4
50. Surgery	Surgery	Surgery	4
51. Psychological (cognitive) CBT	Psychological (cognitive) CBT	Psychological (cognitive) CBT	4
52. Hypnotherapy	Hypnotherapy	Hypnotherapy	4
53. Self-help	Self-help	Self-help	4
54. Support groups	Support groups	Support groups	4
55. Medication	Medication	Medication	4
56. Surgery	Surgery	Surgery	4
57. Psychological (cognitive) CBT	Psychological (cognitive) CBT	Psychological (cognitive) CBT	4
58. Hypnotherapy	Hypnotherapy	Hypnotherapy	4
59. Self-help	Self-help	Self-help	4
60. Support groups	Support groups	Support groups	4
61. Medication	Medication	Medication	4
62. Surgery	Surgery	Surgery	4
63. Psychological (cognitive) CBT	Psychological (cognitive) CBT	Psychological (cognitive) CBT	4
64. Hypnotherapy	Hypnotherapy	Hypnotherapy	4
65. Self-help	Self-help	Self-help	4
66. Support groups	Support groups	Support groups	4
67. Medication	Medication	Medication	4
68. Surgery	Surgery	Surgery	4
69. Psychological (cognitive) CBT	Psychological (cognitive) CBT	Psychological (cognitive) CBT	4
70. Hypnotherapy	Hypnotherapy	Hypnotherapy	4
71. Self-help	Self-help	Self-help	4
72. Support groups	Support groups	Support groups	4
73. Medication	Medication	Medication	4
74. Surgery	Surgery	Surgery	4
75. Psychological (cognitive) CBT	Psychological (cognitive) CBT	Psychological (cognitive) CBT	4
76. Hypnotherapy	Hypnotherapy	Hypnotherapy	4
77. Self-help	Self-help	Self-help	4
78. Support groups	Support groups	Support groups	4
79. Medication	Medication	Medication	4
80. Surgery	Surgery	Surgery	4
81. Psychological (cognitive) CBT	Psychological (cognitive) CBT	Psychological (cognitive) CBT	4
82. Hypnotherapy	Hypnotherapy	Hypnotherapy	4
83. Self-help	Self-help	Self-help	4
84. Support groups	Support groups	Support groups	4
85. Medication	Medication	Medication	4
86. Surgery	Surgery	Surgery	4
87. Psychological (cognitive) CBT	Psychological (cognitive) CBT	Psychological (cognitive) CBT	4
88. Hypnotherapy	Hypnotherapy	Hypnotherapy	4
89. Self-help	Self-help	Self-help	4
90. Support groups	Support groups	Support groups	4
91. Medication	Medication	Medication	4
92. Surgery	Surgery	Surgery	4
93. Psychological (cognitive) CBT	Psychological (cognitive) CBT	Psychological (cognitive) CBT	4
94. Hypnotherapy	Hypnotherapy	Hypnotherapy	4
95. Self-help	Self-help	Self-help	4
96. Support groups	Support groups	Support groups	4
97. Medication	Medication	Medication	4
98. Surgery	Surgery	Surgery	4
99. Psychological (cognitive) CBT	Psychological (cognitive) CBT	Psychological (cognitive) CBT	4
100. Hypnotherapy	Hypnotherapy	Hypnotherapy	4
101. Self-help	Self-help	Self-help	4
102. Support groups	Support groups	Support groups	4
103. Medication	Medication	Medication	4
104. Surgery			

Functions	Structural Basis	Biochemical Mechanisms
Mechanical integrity/resilience	Comified envelope, cytosolic filaments	Crosslinked proteins (e.g., keratin, keratin filaments)
Xenobiotic defense	Lamellar bilayers, extracellular matrix	Acidic pH; free fatty acids; antimicrobial peptides
Antioxidant defense	Comycetes and extracellular matrix	Keratin; sebaceous gland-derived vitamin E and other antioxidants
Cytokine signaling	Comycocyte cytosol	Storage and release of interleukins; serine proteases
Permeability barrier	Lamellar bilayers	Hydrophobic lipids
Hydration	Lamellar bilayers, comycocyte cytosolic matrix	Sebaceous gland-derived cytokine; flagellin breakdown products (natural moisturizing factors)
Waterproofing/repellency	Lamellar bilayers	Keratinocyte and sebium-derived lipids
Cuticle/deaquamation	Comycocytes	Acidic pH; serine proteases
UV protection	Comycocytes	Structural proteins; uronic acid; light scattering/absorption

Figure 1 consists of four panels (a, b, c, d) illustrating the hydration of collagen.

(a) Hydration capacity vs. collagen age: A scatter plot showing Hydration capacity (g/g) on the y-axis (0 to 100) versus Collagen age (months) on the x-axis (0 to 40). The data points show a sharp decrease in hydration capacity as collagen age increases, with a significant drop between 0 and 10 months.

(b) Hydration capacity vs. probability: A bar chart showing Hydration capacity (g/g) on the y-axis (0 to 100) versus Probability (m) on the x-axis (1, 3, 7, 14, 28). The hydration capacity decreases as the probability increases. A horizontal line at 50 g/g is labeled "50% Ratio".

(c) Hydration capacity vs. time: A line graph showing Hydration capacity (g/g) on the y-axis (0 to 100) versus Time - Sec on the x-axis (0 to 12). Two data series are shown: "Cp weeks (1-300)" (blue line with circles) and "Cp weeks (1-100)" (black line with circles). The "Cp weeks (1-300)" series shows a rapid increase in hydration capacity, reaching a plateau around 80 g/g. The "Cp weeks (1-100)" series shows a much lower hydration capacity, remaining below 10 g/g. A horizontal line at 50 g/g is labeled "50% Ratio".

(d) Skin pH vs. day since delivery: A line graph showing Skin pH on the y-axis (5.0 to 6.5) versus Day Since Delivery on the x-axis (0 to 25). Two data series are shown: "Greater than 100g" (black line with circles) and "Less than 100g" (red line with circles). Both series show a rapid decrease in skin pH from approximately 6.4 at day 0 to around 5.2 by day 10, followed by a slight increase and then a gradual decline.

A bar chart showing Trans Epidermal Water Loss (TEWL) in g h⁻² h⁻¹ on the y-axis (0 to 80) against Postnatal age in days on the x-axis (0, 3, 7, 14, 28). The chart is divided into two groups by a vertical dashed line at day 7. The first group, 'All infants nursed at 85% RH', includes data for days 0, 3, and 7. The second group, 'Infants nursed at either 75% or 55% RH', includes data for days 14 and 28. For each day, there are two bars: a white bar for 85% RH and a grey bar for 75% or 55% RH. Error bars represent standard deviation. A horizontal line with an arrow indicates a significant difference (p < 0.05) between the two groups from day 14 onwards.

Postnatal age, days	85% RH (TEWL g h ⁻² h ⁻¹)	75% or 55% RH (TEWL g h ⁻² h ⁻¹)
0	~62	~61
3	~52	~51
7	~32	~33
14	~25	~18
28	~22	~12

- Which approach?
- Start where?
- Wean how?
- Discontinue when?
- Risks vs benefits

Agren et al., J of Pediatrics. 2006
Glass L, Adv Neonatal Care. 2021
Davies M et al., European J of Pediatrics. 2025

Reducing Excess Moisture

- Textiles



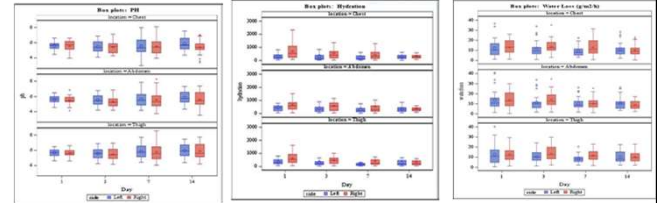
- Dressings



- Skin barrier film



Effects of non-alcohol skin barrier on skin maturation



Boyer V. JWOCN. 2023

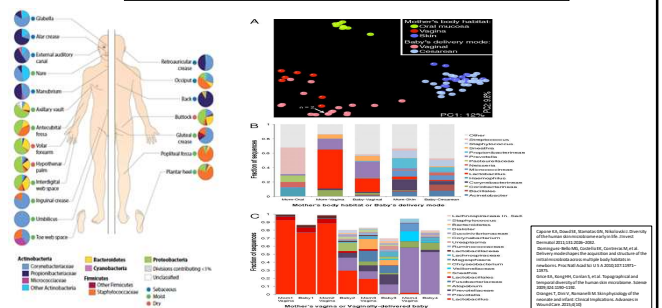
Biophysical skin differences: Skin pH



Wareham J et al. J of Perinatology, 1998

Delivery mode shapes the acquisition and structure of the initial microbiota across multiple body habitats in newborns

Maria B. Dominguez-Bello^{1,2,3}, Elizabeth K. Costello^{1,2,3}, Monica Contreras¹, Maple Magno¹, Gladys Hidalgo¹, Joseph J. B. (2010) and John A. (2010)

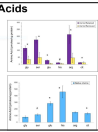


Vernix Caseosa

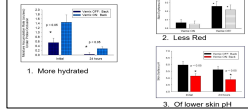
Components	Details
Water	80%
Infant lipid component and fetal ceramoglyc	10%
Proteins for structure and cellular function	10%
Cytokines	
Antimicrobial peptides	

Vernix & Free Amino Acids

- Vernix retained skin had significantly higher FAA levels versus infants with it removed.
- Free amino acids in vernix retained skin appear to originate from vernix itself.



Vernix Retained Skin



Martinez et al. Neonatology 2024
Vasquez et al. Pediatric Dermatology 2023
Vasquez et al. Pediatric Dermatology 2023
Nahata et al. J. of Clinical Research 2023
Tang et al. J. of Dermatology 2020
Brazner et al. J. of Dermatology 2020

Emollients...oils...or none?



Antiseptics: what should we use?

Skin antiseptics in the neonate: what should we use?
Hoskins M, et al. J. of Clinical Research 2023

Antiseptic use in the neonatal intensive care unit – a dilemma in clinical practice: An evidence based review
Hoskins M, et al. J. of Clinical Research 2023

Therapeutic Indices of Topical Antiseptics in Wound Care: A Systematic Review
Hoskins M, et al. J. of Clinical Research 2023

Pilot trial to compare tolerance of chlorhexidine gluconate to povidone-iodine antiseptics for central venous catheter placement in neonates
Hoskins M, et al. J. of Clinical Research 2023

Current Practices of Antiseptic Use in Canadian Neonatal Intensive Care Units
Hoskins M, et al. J. of Clinical Research 2023

Antiseptic use in the neonatal intensive care unit: a dilemma in clinical practice: An evidence based review
Hoskins M, et al. J. of Clinical Research 2023

- Isopropyl Alcohol
- Povidone Iodine
- Chlorhexidine Gluconate
- Other??

Antiseptics: CHG Gluconate

Antiseptic efficacy and plasma chlorhexidine levels following two different methods of application of 2% aqueous chlorhexidine gluconate for skin antiseptic in preterm neonates
Hoskins M, et al. J. of Clinical Research 2023

Aqueous chlorhexidine 1% versus 2% for neonatal skin antiseptic: a randomised non-inferiority trial
Hoskins M, et al. J. of Clinical Research 2023

Chlorhexidine gluconate for antiseptic in preterm neonates: A review of safety and efficacy
Hoskins M, et al. J. of Clinical Research 2023

Antiseptic efficacy and plasma chlorhexidine levels following two different methods of application of 2% aqueous chlorhexidine gluconate for skin antiseptic in preterm neonates: a randomised controlled trial
Hoskins M, et al. J. of Clinical Research 2023

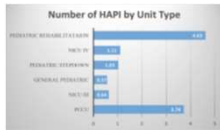
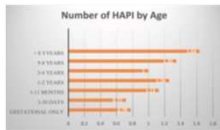
2% chlorhexidine gluconate antiseptic versus 2% aqueous chlorhexidine gluconate for skin antiseptic in preterm neonates: a randomised controlled trial
Hoskins M, et al. J. of Clinical Research 2023

Available formulations:
Aqueous: 0.2/0.1/0.05%
70% IPA: 4/3.15/2/0.5/.2 %
Conclusion: use lowest concentration single use packet, aqueous preferable as colonization, CLABSI or sepsis rates are similar

- Both aqueous and alcohol preparations are absorbed
- Measurable, significant systemic level 2-3 days later, even after removing w/ NS
- Removal w/ NS does not decrease plasma level significantly

- Occlusion matters
- How much and how applied matters
- Avoid rubbing

Who is at risk?



Pressure Injury Prevalence and the Rate of Hospital-Acquired Pressure Injury Among Pediatric Patients in Acute Care

ABSTRACT
PURPOSE: The purpose of this study was to describe the prevalence and rate of hospital-acquired pressure injury (HAPI) in pediatric patients.
DESIGN: Descriptive, secondary analysis of 2012 data on pressure injuries among pediatric patients from the National Database for Nursing Quality Indicators (NDNQI).
SUBJECTS AND SETTING: The sample included 30,884 patients 1 day to 18 years old from 678 pediatric acute care units (general pediatric, pediatric critical care, neonatal intensive care, pediatric step-down, and pediatric rehabilitation units) in 271 US hospitals that submitted pressure injury data to the NDNQI for at least 3 quarters during 2012.
RESULTS: The pressure injury prevalence was 1.4%, and the prevalence of HAPI was 1.1%. The rate of HAPI among males was 1.0%, and the rate among females was 1.4%. HAPI rates were highest among children ages 3 to 18 years (1.4%) and lowest among patients 1 to 30 days of age (0.7%). By unit type, HAPI were highest among pediatric critical care units (3.7%) and pediatric rehabilitation units (1.4%) and lowest in general pediatric units (1.2%). Most of the HAPI were Stage 1 and Stage 2 (85.6%), 14.3% were deep tissue pressure injuries and 10.1% were unstageable pressure injuries.
CONCLUSION: Accuracy of data on pressure injuries, including HAPI, Study findings provide data on HAPI from a large sample of hospitalized children and by pediatric unit type for comparison purposes.
KEYWORDS: Children, Neonate, Pressure Ulcer, Pressure Injury, Prevalence.

TABLE 1. Distribution of HAPI by Category/Stage

Category/Stage	HAPI, n (%)
Stage 1	214 (35.6)
Stage 2	180 (30.0)
Stage 3	24 (4.0)
Stage 4	4 (0.6)
DTPI	86 (14.3)
Unstageable	61 (10.1)
Indeterminate	37 (6.1)

Risk Factors

Device usage: ICU environment put our patients at a higher risk than normal.

More than 50% of pediatric PI are medical device-related

Monitors, leads, probes, tubing all put a degree of pressure on the skin

Skin Risk Assessment score

- Glasgow—scores 15 or higher
- NSARS (infants 0 to 20 days) at risk scores are 13 or higher
- Braden Q (21 days to 8 years) at risk scores are 22 or lower
- Braden (9 years+) at risk scores are 18 or lower
- Braden QD (infants 28 years) at risk scores are 12 or higher

Clinical Indications

- Oxygen requirement of any kind—need for respiratory equipment
- Limited mobility or activity; unable or unwilling to turn and reposition
- Sepsis, febrile activity
- Ventilator or hemodynamic support (ventilators, vasopressors, ECMO)
- Edema, drooling, sweating, leaking drains
- NPO, TN or enteral feedings
- ECMO
- Ostomies, tracheostomies, Central/Vascular access of any kind

Recommendations for assessment of equipment and patient risk for pressure injury:
 • Assess patient risk for pressure injury using a validated tool.
 • Assess equipment risk for pressure injury using a validated tool.
 • Assess patient and equipment risk for pressure injury using a validated tool.
 • Assess patient and equipment risk for pressure injury using a validated tool.

Equipment	Patient	Equipment + Patient
Bed	1	1
Bedding	1	1
Bedding + Patient	1	1
Bedding + Patient + Equipment	1	1
Bedding + Patient + Equipment + Patient	1	1
Bedding + Patient + Equipment + Patient + Equipment	1	1
Bedding + Patient + Equipment + Patient + Equipment + Patient	1	1
Bedding + Patient + Equipment + Patient + Equipment + Patient + Equipment	1	1

Braden QD

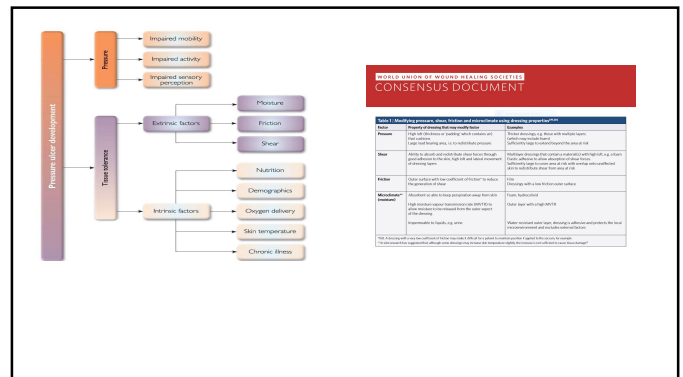
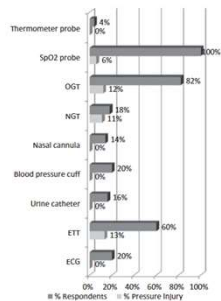
Braden QD	Score
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	1
9	1
10	1
11	1
12	1
13	1
14	1
15	1
16	1
17	1
18	1
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21	1
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89	1
90	1
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92	1
93	1
94	1
95	1
96	1
97	1
98	1
99	1
100	1

Medical-Device Related Pressure Injuries to Children in the Intensive Care Unit

DeWitt, M. L., Hsu, H. H., & Chen, D. (2017). Medical-Device Related Pressure Injuries to Children in the Intensive Care Unit. *Journal of Intensive Care Medicine*, 32(1), 1-10.

Table 3. The incidence rate of pressure injury in the perinatology and PICU, as measured by NSRAS and Braden Q.

Day	Pressure Injury	Mean	n
NSRAS	Yes	11.5	6
	No	11.08	36
2	Yes	11	1
	No	11.2	41
3	Yes	11	3
	No	11.1	39
Braden Q	Yes	19	1
	No	17.14	7
2	Yes	17.5	2
	No	17.8	6
3	Yes	17.5	2
	No	17.8	6



WORLD UNION OF WOUND HEALING SOCIETIES CONSENSUS DOCUMENT

Topic	Consensus Statement
Wound Assessment	Wound assessment is a critical component of wound care. It involves a systematic evaluation of the wound's location, size, depth, and characteristics. The assessment should be performed at every patient encounter and documented in the medical record.
Wound Classification	Wound classification is essential for determining the appropriate treatment. The most commonly used classification systems are the National Pressure Injury Advisory Panel (NPIAP) and the International Union of Wound Healing Societies (IUWHS) classification systems.
Wound Management	Wound management is a multidisciplinary approach that involves the use of various interventions to promote wound healing. These interventions include debridement, dressing selection, and the use of advanced wound care technologies.
Wound Prevention	Wound prevention is a proactive approach to reducing the risk of wound development. It involves the use of risk assessment tools, patient education, and the implementation of evidence-based practices.

Can we prevent PI?

Prevention Bundles

- Multicomponent interventions:
 - Health care staff education
 - Skin Care Champions
 - Risk Assessment tools
 - EMR reminders
 - PI Guidelines
 - Interventions bundles
- Single interventions:
 - Early mobilization
 - Repositioning
 - Support Surfaces
 - Barriers under devices
 - Skin Care
 - Nutrition

Meta-Analysis ▶ Int Wound J. 2019 Oct;16(5):1087–1102. doi: 10.1111/iwj.13147. Epub 2019 Jul 1.

Effectiveness on hospital-acquired pressure ulcers prevention: a systematic review

Sustana Gaspar^{1,2}, Miguel Peralta^{1,2,3}, Adilson Marques^{1,2,3}, Aglécia Budri⁴,
Margarida Gaspar de Matos^{1,2}

Outcomes of a Quality Improvement Program to Reduce Hospital-acquired Pressure Ulcers in Pediatric Patients

[illegible]

Neonatal and Pediatric skin is different

Journal of Tissue Viability 2017; 26: 57–60

 Taylor & Francis Group

 tissueviability
An International Journal of Wound, Ostomy and Tissue Care

Device-related pressure ulcers from a biomechanical perspective

Ayelet Levy^a, Kara Koppin^b, Amit Gefen^{a,b,c}

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 Published online: 12 February 2022

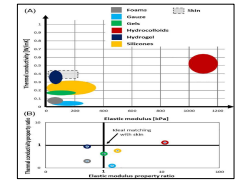
ORIGINAL RESEARCH

Alternatives and preferences for materials in use for pressure ulcer prevention: An experiment-reinforced literature review

Amit Gefen 



- Water %:Fat % ratio
- Quality of fat
- Quality of muscle
- Stiffness
- Deformability
- Extensibility



Comparative Study > *J Wound Ostomy Continence Nurs.* 2002 Sep;29(5):242-51.
doi: 10.1067/mjw.2002.127208.

Pressure Redistribution Crib Mattress
A Quality Improvement Project
Charleen Deo Ginn ♦ Noordenbos Schooling

► Adv Neonatal Care. 2008 Jun;8(3):176-84. doi: 10.1097/01.ANC.000032

Interface pressure comparison of healthy premature infants with various neonatal bed surfaces

- Foam Mattress/Overlay
- Air-filled
- Air-filled
- Water-filled
- Bead-filled
- Sheepskins
- Alternating Pressure
- Air Fluidized
- Low-air-loss beds

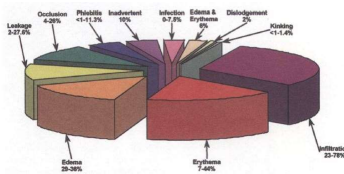
Outcome	n	Percent
Pressure-distributing mattress		
Pressure ulcer present	0/22	0
Non-pressure-distributing mattress		
Deep tissue injury	9/11	82
Stage 2 pressure injury	2/11	18

Schue RM, Langemo DK. Prevalence, incidence, and prediction of pressure ulcers on a rehabilitation unit. *J Wound Ostomy Continence Nurs.* 1999;26:121-129.

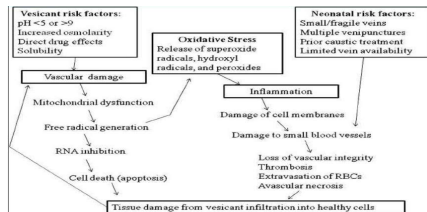
Ryan DW, Byrne P. A study of contact pressure points in specialized beds. *Inst Phys Sci Med.* 1989;10:331-335.

Jay R. Pressure and shear: their effects on support surface choice. *Ostomy/Wound Manage.* 1995;41:36-45.

Complications of PIVs



PIV extravasation



Solutions	Osmolality (mOsm/kg)	pH	Concentration (mg/mL)	Dilution	Osmolality (mOsm/kg)	pH	Isotonic/ Volume
Isotonic Solutions							
0.9% NaCl	285	5.0-7.0	0.9	100	285	5.0-9.0	Y
0.9% NaCl with 5% Dextrose	308	5.0-7.0	0.9	100	308	5.0-9.0	Y
Hypertonic Solutions							
0.45% NaCl	150	5.0-7.0	0.45	100	150	5.0-9.0	Y
0.33% NaCl	110	5.0-7.0	0.33	100	110	5.0-9.0	Y
0.22% NaCl	75	5.0-7.0	0.22	100	75	5.0-9.0	Y
0.11% NaCl	37.5	5.0-7.0	0.11	100	37.5	5.0-9.0	Y
0.055% NaCl	18.75	5.0-7.0	0.055	100	18.75	5.0-9.0	Y
0.0275% NaCl	9.375	5.0-7.0	0.0275	100	9.375	5.0-9.0	Y
0.01375% NaCl	4.6875	5.0-7.0	0.01375	100	4.6875	5.0-9.0	Y
0.006875% NaCl	2.34375	5.0-7.0	0.006875	100	2.34375	5.0-9.0	Y
0.0034375% NaCl	1.171875	5.0-7.0	0.0034375	100	1.171875	5.0-9.0	Y
0.00171875% NaCl	0.5859375	5.0-7.0	0.00171875	100	0.5859375	5.0-9.0	Y
0.000859375% NaCl	0.29296875	5.0-7.0	0.000859375	100	0.29296875	5.0-9.0	Y
0.0004296875% NaCl	0.146484375	5.0-7.0	0.0004296875	100	0.146484375	5.0-9.0	Y
0.00021484375% NaCl	0.0732421875	5.0-7.0	0.00021484375	100	0.0732421875	5.0-9.0	Y
0.000107421875% NaCl	0.03662109375	5.0-7.0	0.000107421875	100	0.03662109375	5.0-9.0	Y
0.0000537109375% NaCl	0.018310546875	5.0-7.0	0.0000537109375	100	0.018310546875	5.0-9.0	Y
0.00002685546875% NaCl	0.0091552734375	5.0-7.0	0.00002685546875	100	0.0091552734375	5.0-9.0	Y
0.000013427734375% NaCl	0.00457763671875	5.0-7.0	0.000013427734375	100	0.00457763671875	5.0-9.0	Y
0.0000067138671875% NaCl	0.002288818359375	5.0-7.0	0.0000067138671875	100	0.002288818359375	5.0-9.0	Y
0.00000335693359375% NaCl	0.0011444091796875	5.0-7.0	0.00000335693359375	100	0.0011444091796875	5.0-9.0	Y
0.000001678466796875% NaCl	0.00057220458984375	5.0-7.0	0.000001678466796875	100	0.00057220458984375	5.0-9.0	Y
0.0000008392333984375% NaCl	0.000286102294921875	5.0-7.0	0.0000008392333984375	100	0.000286102294921875	5.0-9.0	Y
0.00000041961669921875% NaCl	0.0001430511474609375	5.0-7.0	0.00000041961669921875	100	0.0001430511474609375	5.0-9.0	Y
0.000000209808349609375% NaCl	0.00007152557373046875	5.0-7.0	0.000000209808349609375	100	0.00007152557373046875	5.0-9.0	Y
0.0000001049041748046875% NaCl	0.000035762786865234375	5.0-7.0	0.0000001049041748046875	100	0.000035762786865234375	5.0-9.0	Y
0.00000005245208740234375% NaCl	0.0000178813934326171875	5.0-7.0	0.00000005245208740234375	100	0.0000178813934326171875	5.0-9.0	Y
0.000000026226043701171875% NaCl	0.00000894069671630859375	5.0-7.0	0.000000026226043701171875	100	0.00000894069671630859375	5.0-9.0	Y
0.0000000131130218505859375% NaCl	0.000004470348358154296875	5.0-7.0	0.0000000131130218505859375	100	0.000004470348358154296875	5.0-9.0	Y
0.00000000655651092529296875% NaCl	0.0000022351741790771484375	5.0-7.0	0.00000000655651092529296875	100	0.0000022351741790771484375	5.0-9.0	Y
0.000000003278255462646484375% NaCl	0.00000111758708953857421875	5.0-7.0	0.000000003278255462646484375	100	0.00000111758708953857421875	5.0-9.0	Y
0.0000000016391277313232421875% NaCl	0.000000558793544769287109375	5.0-7.0	0.0000000016391277313232421875	100	0.000000558793544769287109375	5.0-9.0	Y
0.00000000081956386566162109375% NaCl	0.0000002793967723846435546875	5.0-7.0	0.00000000081956386566162109375	100	0.0000002793967723846435546875	5.0-9.0	Y
0.000000000409781932830810546875% NaCl	0.00000013969838619232177734375	5.0-7.0	0.000000000409781932830810546875	100	0.00000013969838619232177734375	5.0-9.0	Y
0.0000000002048909664154052734375% NaCl	0.000000069849193096160888671875	5.0-7.0	0.0000000002048909664154052734375	100	0.000000069849193096160888671875	5.0-9.0	Y
0.00000000010244548320770263671875% NaCl	0.0000000349245965480804443359375	5.0-7.0	0.00000000010244548320770263671875	100	0.0000000349245965480804443359375	5.0-9.0	Y
0.000000000051222741603851318359375% NaCl	0.00000001746229827404022216796875	5.0-7.0	0.000000000051222741603851318359375	100	0.00000001746229827404022216796875	5.0-9.0	Y
0.0000000000256113708019256591796875% NaCl	0.000000008731149137020111083984375	5.0-7.0	0.0000000000256113708019256591796875	100	0.000000008731149137020111083984375	5.0-9.0	Y
0.00000000001280568540096282958984375% NaCl	0.0000000043655745685100555419921875	5.0-7.0	0.00000000001280568540096282958984375	100	0.0000000043655745685100555419921875	5.0-9.0	Y
0.000000000006402842700481414794921875% NaCl	0.00000000218278728425502777099609375	5.0-7.0	0.000000000006402842700481414794921875	100	0.00000000218278728425502777099609375	5.0-9.0	Y
0.0000000000032014213502407073974609375% NaCl	0.000000001091393642127513885498046875	5.0-7.0	0.0000000000032014213502407073974609375	100	0.000000001091393642127513885498046875	5.0-9.0	Y
0.00000000000160071067512035369873046875% NaCl	0.0000000005456968210637569427490234375	5.0-7.0	0.00000000000160071067512035369873046875	100	0.0000000005456968210637569427490234375	5.0-9.0	Y
0.000000000000800355337560176849365234375% NaCl	0.00000000027284841053187847137451171875	5.0-7.0	0.000000000000800355337560176849365234375	100	0.00000000027284841053187847137451171875	5.0-9.0	Y
0.0000000000004001776687800884246826171875% NaCl	0.000000000136424205265939235687255859375	5.0-7.0	0.0000000000004001776687800884246826171875	100	0.000000000136424205265939235687255859375	5.0-9.0	Y
0.00000000000020008883439004421234130859375% NaCl	0.0000000000682121026329696178436279296875	5.0-7.0	0.00000000000020008883439004421234130859375	100	0.0000000000682121026329696178436279296875	5.0-9.0	Y
0.000000000000100044417195022106170654296875% NaCl	0.00000000003410605131648480892181396484375	5.0-7.0	0.000000000000100044417195022106170654296875	100	0.00000000003410605131648480892181396484375	5.0-9.0	Y
0.0000000000000500222085975110530853271484375% NaCl	0.000000000017053025658242404460906982421875	5.0-7.0	0.0000000000000500222085975110530853271484375	100	0.000000000017053025658242404460906982421875	5.0-9.0	Y
0.00000000000002501110429875552654266357421875% NaCl	0.00000000000852651282912120223045349122109375	5.0-7.0	0.00000000000002501110429875552654266357421875	100	0.00000000000852651282912120223045349122109375	5.0-9.0	Y
0.000000000000012505552149377763271331787109375% NaCl	0.00000000000426325641456060111522674561046875	5.0-7.0	0.000000000000012505552149377763271331787109375	100	0.00000000000426325641456060111522674561046875	5.0-9.0	Y
0.0000000000000062527760746888816356658935546875% NaCl	0.000000000002131628207280300557613372805234375	5.0-7.0	0.0000000000000062527760746888816356658935546875	100	0.000000000002131628207280300557613372805234375	5.0-9.0	Y
0.00000000000000312638803734444081783294677734375% NaCl	0.0000000000010658141036401502788066864026171875	5.0-7.0	0.00000000000000312638803734444081783294677734375	100	0.0000000000010658141036401502788066864026171875	5.0-9.0	Y
0.000000000000001563194018672220408916473388671875% NaCl	0.00000000000053290705182007513940334320130859375	5.0-7.0	0.000000000000001563194018672220408916473388671875	100	0.00000000000053290705182007513940334320130859375	5.0-9.0	Y
0.000000000000000781597009336110204458236694296875% NaCl	0.000000000000266453525910037569701671600654296875	5.0-7.0	0.000000000000000781597009336110204458236694296875	100	0.000000000000266453525910037569701671600654296875	5.0-9.0	Y
0.0000000000000003907985046680551022291183471484375% NaCl	0.0000000000001332267629550187848508358003271484375	5.0-7.0	0.0000000000000003907985046680551022291183471484375	100	0.0000000000001332267629550187848508358003271484375	5.0-9.0	Y
0.00000000000000019539925233402755111455917357421875% NaCl	0.00000000000006661338147750939242541790016357421875	5.0-7.0	0.00000000000000019539925233402755111455917357421875	100	0.00000000000006661338147750939242541790016357421875	5.0-9.0	Y
0.000000000000000097699626167013775557279586787109375% NaCl	0.000000000000033306690738754696212708950081787109375	5.0-7.0	0.000000000000000097699626167013775557279586787109375	100	0.000000000000033306690738754696212708950081787109375	5.0-9.0	Y
0.0000000000000000488498130835068877786397933935546875% NaCl	0.0000000000000166533453693773481063544750408935546875	5.0-7.0	0.0000000000000000488498130835068877786397933935546875	100	0.0000000000000166533453693773481063544750408935546875	5.0-9.0	Y
0.00000000000000002442490654175344388931989669677734375% NaCl	0.00000000000000832667268468867405317723750204477734375	5.0-7.0	0.00000000000000002442490654175344388931989669677734375	100	0.00000000000000832667268468867405317723750204477734375	5.0-9.0	Y
0.000000000000000012212453270876721944659948348388671875% NaCl	0.00000000000000416333634234433702658861875022388671875	5.0-7.0	0.000000000000000012212453270876721944659948348388671875	100	0.00000000000000416333634234433702658861875022388671875	5.0-9.0	Y
0.0000000000000000061062266354383609723299741741	0.00000000000000208166817117216851329430937501119444						

Nutrients that may affect wound healing

Micronutrients:

Vitamin A
Vitamin C
Vitamin D
Carotenoids:
B-carotene
Lycopene
Lutein
Polyphenol
Riboflavin-B2
Niacin-B3
Pyridoxine
Calcium
Minerals: Zinc
Copper
Iron
Selenium

Macronutrients:

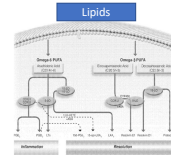
Proteins/Amino Acids/Collagen
Lipids/Essential fatty acids
Carbohydrates

Wound Ther. (Lond). 2019 May; 29(9): 249-261.
Published online 2019 May 1. doi: 10.1080/09637446.2019.1611111
Role of Micronutrients in Skin Health and Function

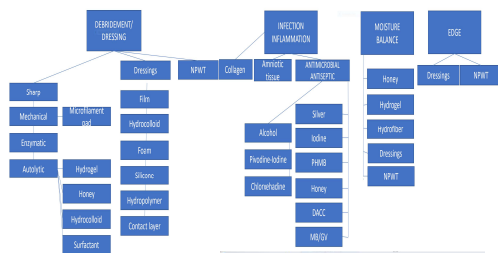
Priglas A, Netherl J, and Jellu 2019
Rosen K, Phillips J, Nutrition and wound healing 2020
Rosen K, Phillips J, 2020
Park, Rennie, 2019, 2021

Protein is imperative for: Hypermetabolic/Hypercatabolic state/injury

Glycogen depletion
Cortisol production
Protein catabolism
AA mobilization
Hepatic glucose production
Activated inflam/immune responses:
IL-1-6
TNF-alfa
CRP
Fibrinogen
Protein S
Decreased albumin/prealbumin



Micronutrient	Notes
Vitamin A	<ul style="list-style-type: none"> Modulates proliferation of epidermal keratinocytes and dermal fibroblasts (Clement et al., 1991A). Prevents UV irradiation-mediated skin damage (Gallus et al., 1997). Useful for the prevention and treatment of psoriasis (Gallus et al., 2011; van de Kerkhof, 2005). Methoxen (van't Hof-Grootenboer, 2003), skin cancer (Gallus, 2003), and skin (Kijewski, 1997).
Vitamin C	<ul style="list-style-type: none"> Supports UV irradiation-induced production of free radicals, protecting cells from oxidative stress (Chakrabarti et al., 2004). Attenuates UV irradiation-mediated damage in the skin (Chakrabarti et al., 2002; Stewart et al., 2004). Prevents cutaneous wound healing (Gallus et al., 1996). Increases epidermal moisture content, improving skin hydration (Campbell et al., 2004).
Vitamin D	<ul style="list-style-type: none"> Improves tissue integrity (through stimulation of collagen synthesis and epidermal growth factor production) (Gallus et al., 2005). Modulates inflammation, angiogenesis, wound healing (Gallus et al., 1997; Kinsella et al., 2002).
Vitamin E	<ul style="list-style-type: none"> Supports lipid peroxidation (Gallus, Stewart et al., 1998). Modulates photoprotection (Gallus et al., 1997; Jankovic et al., 1997) and photoprotection (Gallus et al., 1998). Modulates anti-inflammatory roles (Gallus et al., 1998; 2004; 2008).
Zinc	<ul style="list-style-type: none"> Protects from photochemical (Chakrabarti et al., 1999). Exhibits anti-inflammatory activity (Chakrabarti et al., 1999).
Copper	<ul style="list-style-type: none"> Increases collagen synthesis (Chakrabarti et al., 2002). Modulates the expression of collagen (Chakrabarti, 2002). Modulates collagen synthesis (Chakrabarti, 2002).
Selenium	<ul style="list-style-type: none"> Protects skin from UV irradiation-induced oxidative stress (Chakrabarti et al., 1997; Rastogi et al., 1997). Useful for the prevention and treatment of psoriasis (Gallus et al., 1997).



	Wound Bed Prep
T	Tissue type viable/non-viable/healthy
I	Infection/Inflammation
M	Moisture balance, avoid maceration/desiccation
E	Wound edge... able to migrate

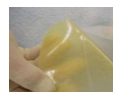
Polyurethane Film



Hydrofiber

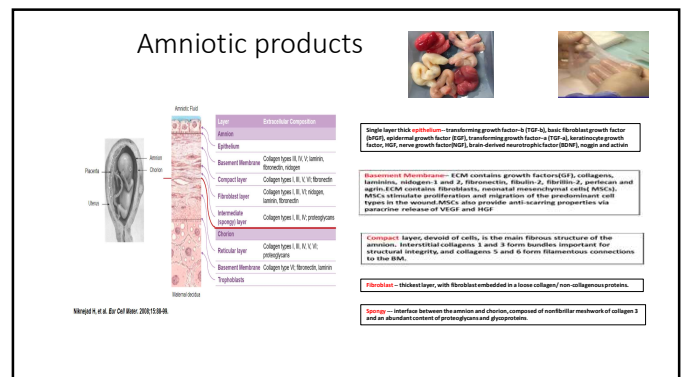
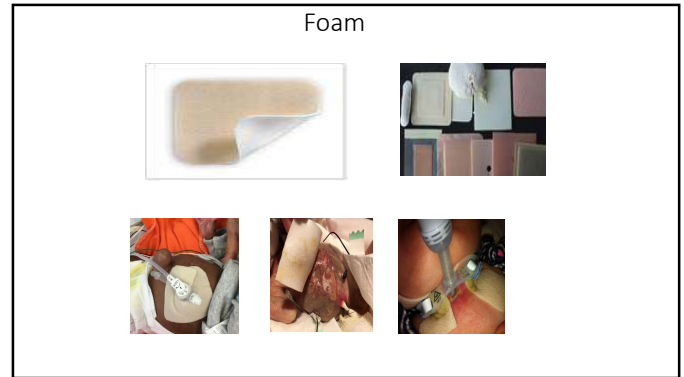


Hydrocolloid

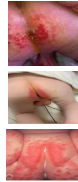
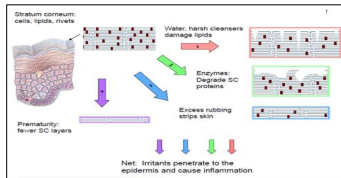
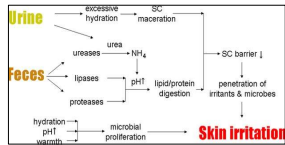


Alginates





Moisture Associated Dermatitis



Topical Preparations

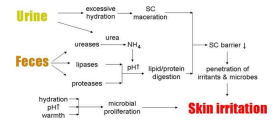
Mild-Moderate

- Zn Oxide
- Dimethicone
- Lanolin
- Petrolatum
- Cellulose gum
- Vitamin E



Severe

- Hydrophilic paste
- Crusting
- Cyanoacrylate polymer
- Liquid-skin polymer barrier
- Fungal
- Topical steroids



Thank You

ANY QUESTIONS?