

Skin care of premature newborns: integrative review

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ABSTRACT

To describe and analyze scientific evidence in national and international studies on nursing care for skin integrity of preterm newborns (PTNBs) in the Neonatal Intensive Care Unit (NICU). Integrative review in LILACS, BDNF, SciELO, CINAHL, PubMed and EMBASE. Twenty-three articles that met the inclusion criteria were selected with use of the PRISMA method. Ten studies addressed products for the skin of preterm infants; five focused on bathing and diaper dermatitis; two reported use of incubators and control of transepidermal water loss; two discussed pressure injuries; and four addressed the protocols and practices of nurses in skin care. The results showed there are many products available, but a lack of evidence for their practical application. Bath products and periodicity and care for pressure injuries were better addressed in the literature, in spite of gaps in the prevention of infections and injuries, and use of protocols.

Descriptors: Skin; Infant, Premature; Nursing Care; Intensive Care Units, Neonatal.

INTRODUCTION

The World Health Organization (WHO) definition of a preterm newborn (PTNB) is the baby with gestational age of less than 37 completed weeks. Prematurity is a public health problem, and its complications are the main cause of neonatal (up to 28 days after birth) and infant (children up to five years of age) mortality worldwide⁽¹⁾. Considering the main causes of death in these age groups, other global challenges are infection control (neonatal sepsis is the third cause of death in neonates, while pneumonia is second in children up to five years) and intrapartum complications (second cause of neonatal death and third in children aged up to five years)⁽¹⁾.

In this context, the skin is greatly important as the human body's first barrier for defense against

pathogens and infections of great epidemiological relevance⁽²⁾. As the immune system of PTNBs is immature, they are more fragile to exposure to infection risk compared to full term neonates. This fact combined with the risk of infection inherent to the hospital scenario, is an alert about the importance of actions of biosafety, surveillance and qualified care with this population.

The focus of this study was the nursing care provided to PTNBs in the field of skin care, a fundamental structure for preventing nosocomial infections.

The care for preserving the integrity and quality of PTNBs' skin begins soon after birth by making efforts in the delivery room and Neonatal Intensive Care Unit (NICU) to maintain body temperature, which contributes to newborns' adaptation to the external environment⁽³⁻⁴⁾.

In addition to acting as a protective barrier, the skin facilitates thermoregulation, helps to control transepidermal water loss and electrolyte balance. It is composed of dermis, which is formed essentially by collagen and elastin fibers, and provides resistance, sustentation and elasticity to the skin; and epidermis, which has four sublayers, including the stratum corneum that has special relevance in the subject because it is the outermost part of the skin⁽⁵⁾.

Skin functions in PTNBs are limited because there are few layers of stratum corneum, and lower number of collagen and elastin fibers between layers. Cells are thin and less compacted, with visible and superficial veins. Cutaneous attachments are immature, and hypodermis is atrophied⁽⁶⁾. Full term babies have a different reality; the stratum corneum is fully formed and resembles the adult skin structure, which reinforces the need for differentiated care with premature babies' skin⁽⁷⁾.

The immaturity of PTNBs' skin increases its permeability, reduces the protective function, increases the risks of absorption of applied substances, colonization and the consequent risk of infection^(4,6-8). In addition, it increases the loss of transepidermal water to the medium by altering the thermoregulatory function and exposing the newborn to lower body temperature and instability on its maintainance.

In addition to the anatomy and physiology of the immature skin, preterm infants hospitalized in NICUs are at increased risk for injury associated with their constant need for procedures and use of essential invasive devices for survival. Nursing care with prematures' skin in NICUs includes the following: maintenance of temperature, avoid of unnecessary exposure to the environment and use of incubators (with humidity control); bath; topical application of emollient oils and other products applied to the skin; use of cutaneous solutions for antiseptis and dressings. Note that invasive procedures involving skin rupture, such as venous or arterial punctures, and fixation or removal of adhesives are frequent, which demand reflection on applied products and minimization of damages⁽⁹⁾.

The North American Nursing Diagnosis Association International (NANDA) cites the following as risk factors for the development of skin injuries: radiation, chemicals, use of adhesives that remove hair, medications, physical immobilization, pressure, moisture, excretions, secretions, and extremes of age⁽¹⁰⁾.

Hence the importance of nurses and the team in the care with the skin integrity of PTNBs hospitalized in the NICU. These professionals are directly responsible for the maintenance of thermal balance, hygiene

and comfort care, control of humidity and ambient lighting, invasive procedures, medication administration, performance of dressings, positioning, infection control, health education for parents and family, among others.

For providing appropriate assistance, nurses need scientific evidence to help them choose the best products, techniques, materials and procedures. Despite research advances in the neonatal area, there is still a gap in this theme particularly on preterm newborns, a neonatal population with specificities given their physiological immaturity. In clinical practice, there are conflicting situations such as absence of care protocols for skin care, and lack of standardization of products namely, which product to use in the bath⁽¹¹⁾, what is the most indicated antiseptic for specific use in preterm infants before invasive procedures⁽⁵⁾, how to promote skin protection⁽⁷⁾, among others.

This gap justifies the performance of this study as a strategy to group the knowledge published in the scientific literature on products, substances and skin care of premature infants, and to assist nurses in decision making during their clinical practice and formulation of care protocols.

The aim of this study was to describe and analyze the scientific evidence available in national and international studies about the nursing care provided to the PTNB in the NICU related to skin integrity.

METHOD

This is an integrative review of the literature. The purpose is to synthesize scientifically published knowledge by providing support for decision making and improvement of clinical practice. It allows a better visualization of the evidence with the view to its incorporation in practice, besides fomenting discussions and new studies on the identified gaps⁽¹²⁻¹⁴⁾.

The PRISMA method (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) was used for standardization of steps and data analysis, as described below.

The following steps were established to perform this study: identification of the problem and definition of the guiding question; definition of search terms, and inclusion and exclusion criteria; selection of databases and search of scientific productions; evaluation of the eligibility of articles, analysis of included studies and presentation, and discussion of results⁽¹³⁾.

The PICO strategy (Patient/population/disease; Intervention or issue of interest; Comparison; Intervention or issue of interest; Outcome) inspired the formulation of the guiding question. Population was defined as 'Preterm newborns hospitalized in NICUs'; Intervention was 'Nursing Care with the skin'; there was no Comparison as several research methods were included; and Outcome was 'Skin integrity'. Thus, the following question was raised: What nursing care is provided with the skin of preterm newborns hospitalized in neonatal intensive care units for maintaining its integrity?

The analyzed aspects were: scope of the intervention; nature of the intervention (nurses' practices and clinical interventions); type of study (observational or interventional studies); target population (PTNB); and primary and secondary outcomes used to evaluate the intervention.

The selection of articles was performed independently by two researchers in May and June, 2016. The results obtained by the two researchers were compared to verify the concordance of analyzed data. Discrepancies were discussed based on eligibility criteria until reaching agreement.

For the selection of articles, was performed a search of Descriptors in Health Science (DeCS) and Medical Subject Headings (MeSH). Then, the following descriptors were identified and used: Skin; Nursing and Premature (Infant, premature); and the Boolean operator AND.

The inclusion criteria for this review were:

1. Primary articles addressing the theme of skin integrity with emphasis on nursing care and practices adopted at the NICU, including risk of injury and occurrence of injuries;
2. Studies in which samples included PTNB, and PTNB and full term newborns together;
3. Available in full text;
4. Published in English, Portuguese and Spanish;
5. Published in any period, since the purpose was covering the largest number of articles and monitoring the progression of evidence over time.

Exclusion criteria were:

1. *Guidelines*;
2. Articles addressing health professionals' knowledge on the subject without identifying the practices adopted in the theme;
3. Studies in which samples included full term newborns exclusively;
4. Studies covering the care focused on thermal and hydroelectrolytic control influenced by the thermoregulatory system of PTNBs.

Although the focus is on premature infants' skin care, some studies mix full term and preterm neonates in the sample and bring results separately. Therefore, such studies were included in the analysis of the present work.

Studies came from journals indexed in the following databases: Latin American and Caribbean Literature in Health Sciences (LILACS), Nursing Databases (BDENF), Scientific Electronic Library Online (SciELO), Cumulative Index to Nursing and Allied Health Literature (CINAHL), PubMed and EMBASE (Elsevier).

After the initial search, the following were identified: six publications in LILACS; 13 in BDENF; five in SciELO; 137 in CINAHL; 261 in PubMed; and 232 in EMBASE, totaling 654 publications. After eliminating repeated works, 435 studies remained for initial analysis, which was the title analysis given the large number of papers. Among these, 119 papers were selected for analysis of abstracts. Then, abstracts were read, and after careful analysis by using inclusion and exclusion criteria, were selected 26 articles. Finally, in a third moment, these 26 articles were read in full, and three of them were excluded for not meeting the scope proposed in this review. The final sample consisted of 23 articles. Figure 1 represents the flowchart illustrating the selection process of articles included in this integrative review.

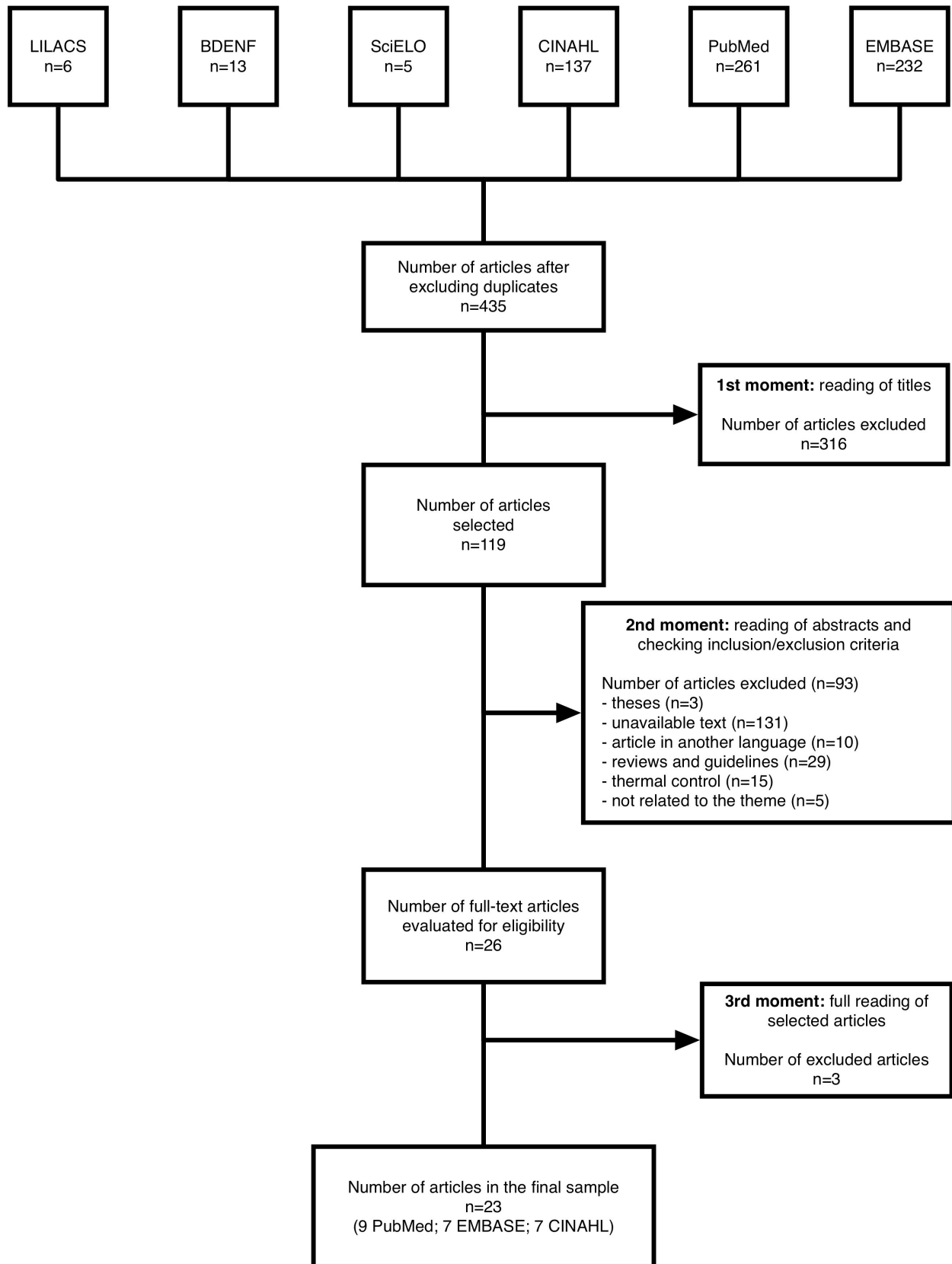


Figure 1: Identification, screening and inclusion of publications in the integrative review.

The reference of Ursi and Galvão⁽¹⁵⁾ was used for the complete analysis of selected articles with the purpose to extract, organize and summarize information by facilitating the construction of the database. The adapted instrument was used in this stage of the study, and addressed the following items: title of the

article/authors, intervention, design/sample, main outcomes and recommendations/conclusions.

RESULTS

The reviewed articles were published mostly in nursing journals (60.9%), of which 8.7% were national journals. The number of publications was distributed over the years from 1995 to 2015 with greater concentration as of 2009 (52.2%). The United States was the country with the highest number of publications (12), followed by Brazil (two), Australia (two), Russia (one), Turkey (one), China (one), Sweden (one), Germany (one), Canada (one), and one article with unspecified location.

The 20 articles included 3,934 newborns (preterm and full term), and the sample size ranged from one to 2,820 patients. The remaining three articles had care institutions or nurses as their target population.

Regarding the type of study, randomized clinical trials (8/23) and descriptive studies (8/23) prevailed. For evaluation of general skin condition, the authors used the Neonatal Skin Condition Score. Other research instruments used were Skin Erythema Scale, Premature Infant Pain Profile, Neonatal Individualized Developmental Care, and Assessment Program, and direct observations, interviews and equipment for specific measurements.

In most articles, descriptive statistics was used for demonstrating sociodemographic results with wide application of the Statistical Package for Social Sciences (SPSS) in statistical treatment of data.

With respect to interventions, ten studies addressed the products used for skin care; five were focused on care in the bath and with diaper dermatitis; two reported the use of incubators and control of transepidermal water loss; two were aimed at identifying and describing pressure injuries in this population; and four addressed nurses' protocols and practices in the care of PTNBs' skin. These data are shown on tables 1 to 5.

Table 1: Summary of the articles on products used for PTNBs' skin care included in this review.

Author/Title/Journal/Year	Intervention	Design/ Sample	Main outcomes	Recommendations/ Conclusions
Brandon DH, Coe K, Hudson-Barr D, Oliver T, Landerman LR. Effectiveness of No-Sting® skin protectant and Aquaphor® on water loss and skin integrity in premature infants. <i>Journal of Perinatology</i> , 2010 ⁽¹⁶⁾	To compare the effects of No-Sting® and Aquaphor® skin protectants on transepidermal water loss and skin integrity in the first two weeks of PTNBs' life	Randomized clinical trial	There were no significant differences comparing the Aquaphor® and No-Sting groups at 14 days in the two evaluated body sites ($p=0.36$ and $p=0.08$).	The No-Sting skin protectant is as effective as Aquaphor® in reducing transepidermal water loss and maintaining skin integrity, and more easily applied.
		69 PTNBs (38 used No-Sting, and 31 used Aquaphor®)	The skin condition in the Aquaphor® group ($p=0.04$) was statistically better than in the No-Sting group ($p=0.39$), but both had normal skin scores.	
Mouser T, Helder D. Skin matters: effectiveness of a Non-Petrolatum emollient cream in pediatric care. <i>Ostomy Wound Management</i> , 2006 ⁽¹⁷⁾	To document the efficacy of Sween® (Superior Moisturizing Skin Protectant Cream, Coloplast Corp. Marietta, Ga) used once daily in reducing xerosis.	Case series	In all three cases, the skin quality relative to hydration has improved after three weeks of use. Skin also looked healthier and had better elasticity.	Application once-a-day was convenient and effective, without the expected adverse effects for the use of non-petrolatum emollient cream.
		1 low weight PTNB; 1 low weight and septic PTNB at 30 weeks gestation; and 1 child aged 14 years with cerebral palsy since birth		
Lund CH, Nonato LB, Kuller JM, Franck LS, Cullander C, Durand DJ. Disruption of barrier function in neonatal skin associated with adhesive removal. <i>The Journal of Pediatrics</i> , 1997 ⁽¹⁸⁾	To compare the effects of application and removal of three commonly used adhesives (plastic dressing, pectin barrier and hydrophilic gel) for skin protection	Case control study	Thirty minutes after adhesive removal, transepidermal water loss, colorimetric and visual inspection measurements were significantly higher ($p<0.01$) at the plastic adhesive and pectin barrier sites compared to sites of skin control and hydrophilic gel. One day after removal of the adhesive, only the colorimetric measurements at the sites with pectin barrier were significantly higher ($p<0.05$) than values for sites of skin control and hydrophilic gel.	A single application and removal of the plastic dressing and of pectin barrier may interfere with the protective function of PTNBs' skin of different gestational ages. Authors highlighted problems with the adherence of hydrophilic gel to the skin of underweight NBs.
		30 PTNBs (sample was also control sample)		
Hu X, Zhang Y. Effect of topically applied sunflower seed oil in preterm infants. <i>Pediatric critical care medicine</i> , 2014 ⁽¹⁹⁾	To evaluate the topical therapy with sunflower seed oil in the improvement of the skin barrier, and its effectiveness for protecting against infections in preterm infants	Randomized clinical trial	Patients treated with sunflower seed oil had less dermatitis than patients treated with Johnson® oil. Both had a better outcome than the control group after 14 days ($p<0.05$).	In this study, sunflower seed oil was better than Johnson® oil.
		428 PTNBs (153 used sunflower seed oil; 140, used Johnson® oil; and 135 formed the control group)		

Author/Title/Journal/Year	Intervention	Design/ Sample	Main outcomes	Recommendations/ Conclusions
O'Neil A, Schumacher B. Application of a pectin barrier for medical adhesive skin injury (epidermal stripping) in a premature infant. <i>Journal of wound, ostomy and continence nursing</i> , 2014 ⁽²⁰⁾	To describe the use of thin hydrocolloid layer as a protection barrier between the skin and a reflective adhesive attached to the temperature probe by avoiding formation of erythematous circular area on the skin surface of a PTNB.	Case study 1 PTNB with GA = 24 weeks	A thin hydrocolloid layer (pectin barrier) was used between the NB's skin and the reflective silver adhesive, which prevented skin injuries caused by the use of adhesive attached to devices.	Skin injuries were prevented by using the hydrocolloid layer protection, and the temperature probe could be attached successfully.
Bredemeyer SL, Reid S, Evans N, Gibbons E. Randomised controlled trial of two strengths of topical aqueous chlorhexidine for prevention of nosocomial infection in neonates born before 29 weeks. <i>Journal of Paediatrics and Child Health</i> , 2011 ⁽²¹⁾	To test the efficacy and safety of 0.015% aqueous chlorhexidine solution versus its 0.5% solution in the reduction of infection rates by maintaining skin integrity in PTNBs <29 weeks.	Randomized double blind clinical trial 143 PTNBs	There were no statistical differences between the groups for 24-h skin integrity scores ($p=0.96$) and for the appearance of late sepsis ($p=0.61$). There were more deaths in the group using 0.5% chlorhexidine ($p=0.021$).	The 0.5% aqueous chlorhexidine for skin preparation does not reduce late sepsis rates and appears to be associated with a higher mortality rate.
Pabst RC, Starr KP, Qaiyumi S, Schwalbe RS, Gewolb IH. The effect of application of Aquaphor® on skin condition, fluid requirements, and bacterial colonization in very low birth weight infants. <i>Journal of perinatology</i> , 1999 ⁽²²⁾	To determine the effects of repeated application of Aquaphor® on the condition of skin and bacterial flora of a cohort of gestational age between 26 and 30 weeks.	Randomized clinical trial 19 PTNBs: 11 PTNBs in the intervention group (used Aquaphor® topical ointment twice daily); and 8 PTNBs in the control group (routine skin care)	The skin condition was significantly better in the group treated with Aquaphor® ($p=0.002$). The control group had significant worsening of skin condition scores during the two weeks of the study ($p=0.012$). There were no significant differences regarding microflora and bacterial counts in the skin or colonization patterns between PTNBs when comparing control and experimental groups. However, there was an increase in bacterial counts in both of them over time ($p=0.006$).	Twice daily applications of Aquaphor® from birth to 2 weeks appear to provide protection against epidermal rupture in preterm infants with gestational age between 26 and 30 weeks without altering skin flora, and improving overall skin condition against dryness, hyperemia, fissures and peeling.
Young DL, Chakravarthy D, Drower E, Reyna R. Skin Care Product Evaluation in a Group of Critically Ill, Premature Neonates. <i>Journal of wound, ostomy and continence nursing</i> , 2014 ⁽²³⁾	To describe the impact of a specific product line (Remedy with Phytoplex Hydrating Cleansing) containing a foam-based gel or cleanser, two moisturizers, including one with silicone, and a zinc oxide protectant cream on PTNBs' skin.	Descriptive study 29 PTNBs	There were no statistical differences in scores of pain ($p=0.132$), perineal erythema ($p=0.059$), or skin condition ($p=0.603$) of NBs between the beginning and the end of the study.	The use of the new line of hygiene products did not significantly improve the condition of total skin, erythema and pain in NBs of the study.

Author/Title/Journal/Year	Intervention	Design/ Sample	Main outcomes	Recommendations/ Conclusions
<p>Morris LD, Berh JH, Smith SL. Hydrocolloid to Prevent Breakdown of Nares in Preterm Infants. MCN: The American Journal of Maternal-Child Nursing, 2015⁽²⁴⁾</p>	<p>To determine the efficacy of a double hydrocolloid barrier (placed between the nasal cannula and nostrils) to prevent skin rupture in very low birth weight infants receiving heated and humidified O2 via high-flow nasal cannula.</p>	<p>Retrospective longitudinal study</p> <hr/> <p>53 very low birth weight PTNBs: Control group=27; Intervention group= 26.</p>	<p>There were no significant differences in the skin condition of nostrils between groups (p=0.18) or over time (p=0.45).</p>	<p>The absence of statistical difference between groups may be explained by the greater vigilance of NICU nurses in face of the risk of skin trauma. In addition, replacement of nasal CPAP with heated and humidified oxygen through the high-flow nasal cannula, which exerts less pressure on nostrils tissues, is becoming more common. In the literature, it has been proven to be less damaging.</p>
<p>Cisler-Cahill L. A protocol for the use of amorphous hydrogel to support wound healing in neonatal patients: an adjunct to nursing skin care. Neonatal network, 2006⁽²⁵⁾</p>	<p>To describe the use of a practice protocol on the use of amorphous hydrogels as a treatment modality for neonatal iatrogenic wounds.</p>	<p>Descriptive study</p> <hr/> <p>23 NBs (full term and preterm)</p>	<p>The following wounds were included in the protocol: intravenous infiltration injuries, surgical incisions, tracheotomy stomas, pressure injuries, mechanical and chemical abrasions, and perianal excoriation. Of the 35 wounds with complete healing according to the protocol, 97% showed no visible scars. Only one patient had visible depigmentation at the wound site after healing. No child needed surgical intervention, had decreased function in the healed site or infection after using any of the hydrogel products.</p>	<p>The results of this project demonstrate the effectiveness of hydrogel for treating skin injuries in infants, but raised new issues: How long does hydrogel treatment last? Should treatment be discontinued if topical prescription is prescribed?</p>

Table 2: Summary of the articles on skin care of PTNBs in the bath and with diaper dermatitis included in this review.

Author/Title/Journal/Year	Intervention	Design/ Sample	Main outcomes	Recommendations/ Conclusions
Quinn D, Newton N, Piecuch R. Effect of less frequent bathing on premature infant skin. <i>Journal of obstetric, gynecology and neonatal nursing</i> , 2005 ⁽²⁶⁾	To evaluate the effect of increased time between baths taking into consideration the skin flora of premature infants.	Randomized clinical trial	Despite the presence of pathogens in skin cultures, none of the children developed any signs or symptoms of infection. Three factors were tested, but in none of them were found statistically significant results: control group vs. intervention group ($p=0.189$), time in weeks ($p=0.263$) and group x time interaction ($p=0.525$).	It is safe to reduce the bath frequency for every four days in premature infants at the NICU. Changing bath frequency is a method of reducing exposure to manipulation and stress caused by cold.
		23 PTNBs: 11 PTNBs in control group (bath every two days); and 12 PTNB in intervention group (bath every four days)		
Franck LS, Quinn D, Zahr L. Effect of less frequent bathing of preterm infants on skin flora and pathogen colonization. <i>Journal of obstetric, gynecology and neonatal nursing</i> , 2000 ⁽²⁷⁾	To describe the effects of increased bath frequency (from two days to four days) on the number of colonies and type of microorganism in PTNBs' skin flora	Descriptive study of repeated measures	Culture of the participants were collected at 30 minutes (Culture 1), 48 hours (Culture 2), 72 hours (Culture 3) and 96 hours after bath (Culture 4). No increase was detected in the pathogenicity of colonization found in cultures over time.	The frequency of PTNBs' baths can be every four days without increased risk of infection.
		45 PTNBs		
Odinaeva NJ, Beljaeva IA, Mitish M. New technologies of skin care of newborn babies. <i>Acta paediatrica</i> , 2010 ⁽²⁸⁾	To estimate the efficiency, tolerance and safety of the 'Stelatopia' cleanser in the skin care of newborns in incubators.	Clinical trial	The use of 'Stelatopia' in bath functions (hygiene without water in the incubator) included moistening and skin care. None of the patients had allergic reactions, dryness or irritation to the skin. Doctors and parents noted tolerance and absence of unwanted side effects.	The use of 'Stelatopia' may reduce damage to skin integrity and prevent infectious complications, especially in NBs and PTNBs admitted to NICUs.
		25 NBs (full term and preterm)		
Kienast A, Roth B, Bossier C, Hojabri C, Hoeger PH. Zinc-deficiency dermatitis in breast-fed infants. <i>European journal of pediatrics</i> , 2007 ⁽²⁹⁾	To describe ten cases of infants with zinc deficiency on exclusive breastfeeding who were initially diagnosed with impetigo or eczema.	Case series	Skin injuries resulting from zinc deficiency began to disappear 24 hours after starting oral therapy with zinc sulfate or gluconate, and disappeared completely after 14 days of therapy. The cases described were previously evaluated with a different diagnosis from the real one, and undertreated with inappropriate topical medications. The authors warned breastmilk sometimes does not have sufficient zinc levels for the baby's needs, even though infants presented adequate serum levels of the substance.	The authors suggest to routinely check serum zinc levels in PTNBs on exclusive breastfeeding who do not receive regular oral zinc supplementation.
		1 full term NB and 9 PTNBs with low serum zinc levels		

Author/Title/Journal/Year	Intervention	Design/ Sample	Main outcomes	Recommendations/ Conclusions
<p>Gozen D, Caglar S, Bayraktar S, Atici F. Diaper dermatitis care of newborns human breast milk or barrier cream. Journal of clinical nursing, 2013⁽³⁰⁾</p>	<p>To establish the efficacy of human breast milk and barrier cream (zinc oxide 40% with cod liver oil formulation) in the process of diaper dermatitis healing in NBs admitted to the NICU.</p>	<p>Controlled, randomized, prospective study</p> <hr/> <p>63 NBs (full term and preterm): 30 NBs using breast milk; 33 using barrier cream</p>	<p>The barrier cream was significantly better than breast milk ($p=0.002$) in the treatment of diaper dermatitis, and it was more effective among full term NBs ($p=0.003$) compared to PTNBs ($p=0.104$). The period of clinical improvement of full term NBs was longer than that of PTNBs, but without a statistically significant difference ($p=0.294$). In addition, the barrier cream had a significantly higher clinical improvement rate than maternal milk among NBs using antibiotics ($p=0.003$), with moderate ($p=0.037$) to severe ($p=0.015$) diaper dermatitis, and on exclusive breastfeeding ($p=0.019$).</p>	<p>Barrier cream has provided more effective results than treatment with human breast milk, particularly in full term newborns with moderate to severe diaper dermatitis.</p>

Table 3: Summary of the articles on skin care of PTNBs in use of incubators and in control of transepidermal water loss included in this review.

Author/Title/Journal/Year	Intervention	Design/ Sample	Main outcomes	Recommendations/ Conclusions
Sinclair L, Crisp J, Sinn J. Variability in incubator humidity practices in the management of preterm infants. Journal of paediatrics and child health, 2009 ⁽³¹⁾	To determine the opinion and practice of nurses regarding the use of humidification in incubators in the care of PTNBs admitted to NICUs in Australia and New Zealand.	Descriptive study	In all NICUs was used supplemental humidity in the care of PTNBs, and 77% had protocols on this practice. Gestational age and birth weight were the most adopted criteria for the use of humidity. The benefits perceived by nurses regarding humidification of incubators included better thermoregulation and skin integrity, fluid and electrolyte balance, and lower transepidermal water loss.	The large variation in humidification practices, specifically on the ideal intensity and duration of humidification, reflects the paucity of evidence and the need for further research.
		26 NICUs in Australia and New Zealand		
Kjartansson S, Arsan S, Hamma Arlund K, Sjors G, Sedin G. Water loss from the skin of term and preterm infants nursed under a radiant heater. Pediatric research, 1995 ⁽³²⁾	To determine the effect of radiant energy from incubators and radiant heaters on the rate of evaporation from the skin of newborns.	Clinical trial	In groups I and III, the rate of evaporation from the skin was significantly higher when using the radiant heater than in the incubator with 50% relative humidity ($p < 0.001$ and $p < 0.05$, respectively).	The highest rate of evaporation from the skin occurred in the group of very premature NBs in a heated crib, especially if the relative humidity was low. Additional studies are required to verify respiratory water loss comparatively when using the radiant heater and the incubator.
		Group I: 12 full term NBs	In group II, there was a statistically significant difference in the rate of evaporation from the skin between the incubator with 50% relative humidity and incubator with humidity less than 50% ($p < 0.001$).	
	Measurements of this rate were made from the skin area exposed to radiant heat.	Group II: 8 moderately preterm NBs, mean GA of 31.8 weeks and weight of 1795 g Group III: 8 very premature NBs, mean GA of 27.1 weeks and weight 1126 g.	In all three groups, the average rate of evaporation when using the radiant heater was significantly lower than the expected rate of evaporation ($p < 0.01$).	

Table 4: Summary of the articles on pressure injuries in PTNBs included in this review.

Author/Title/Journal/Year	Intervention	Design/ Sample	Main outcomes	Recommendations/ Conclusions
Newnam KM, McGrath JM, Salyer J, Estes T, Jallo N, Bass WT. A comparative effectiveness study of continuous positive airway pressure-related skin breakdown when using different nasal interfaces in the extremely low birth weight neonate. <i>Applied nursing research</i> , 2015 ⁽³³⁾	To identify differences in frequency, and severity, and risk factors associated with nasal injuries caused by the use of nasal CPAP in PTNB.	Prospective randomized trial	The overall frequency of cutaneous injury was 24.2%. The most affected areas of the face with rupture of skin were nasal septum (85.3%), nasal bridge (29.9%) and forehead (26.6%). Statistically significant differences were found in the current weight while using nasal CPAP ($p=0.000$) and in the mean flow of CPAP offered during therapy ($p=0.037$), with better results in the device rotation group. Erythema ($p<0.001$) and excoriation ($p=0.007$) were less frequent and severe in the device rotation group compared to the prong group or nasal mask group. There was a significant negative correlation between time for nasal CPAP and number of days using CPAP ($r=-0.26$, $p<0.001$) and between gestational age and number of days using CPAP ($r=-0.56$; $p<0.001$).	The results of the study demonstrated a lower index of nasal injury in PTNB <1500g in device rotation (mask/prong) during nasal CPAP therapy.
		78 low birth weight PTNBs: 35 PTNBs on CPAP with mask; 21 on CPAP with prong; 22, with device rotation (mask and prong)		
Marcellus L. Determination of positional skin-surface pressures in premature infants. <i>Neonatal network</i> , 2004 ⁽³⁴⁾	To describe the pressure distributions and maximum pressure points on the skin surface generated by the following positions in healthy premature infants: lying on the right side, supine and prone.	Descriptive study	Areas of dominant pressure according to position:	The results of this study cannot be generalized beyond the study group. Further studies are needed to determine the positional pressures experienced by children of different gestational ages and weights, and the positioning strategies for optimization of the skin integrity of preterm infants by minimizing unnecessary manipulation.
		4 healthy PTNBs aged 28 to 33 weeks	- Supine position: head, trunk (more pronounced in the shoulder area) and sacral region;	
			- Prone position: head (similar to the pressure exerted in the supine position), trunk (with lower pressure than that observed in the supine position due to flexion of arms) and knees (at higher pressure intervals);	
- Right lateral decubitus: head, shoulder and hip (pressure radiated to the thigh).				

Table 5: Summary of the articles on protocols and practices of nurses regarding skin care of PTNBs included in this review.

Author/Title/Journal/Year	Intervention	Design/Sample	Main outcomes	Recommendations/Conclusions							
<p>Munson KA, Bare DE, Hoath SB, Visscher MO. A survey of skin care practices for premature low birth weight infants. Neonatal network, 1999⁽³⁵⁾</p>	<p>To provide information on skin care practices with low birth weight PTNBs (<1,000 g at birth) in a NICU in the USA.</p>	Descriptive study	Results were grouped into ten categories:	<p>This survey provided an overview of skin care practices in low birth weight children in the USA. The authors have identified the need for standardized skin care protocols based on scientific evidence and clinical trials.</p>							
		<p>104 hospitals with at least 2,500 deliveries per year and at least 20 Level III beds of NICU.</p>	- Protocol development: 25% of ICUs had no skin care protocols.								
			- Anti-microbial skin products: povidone-iodine and isopropyl alcohol were the most widely used products for skin preparation prior to insertion of peripheral access.								
			- Environmental conditions: heated cribs and incubators were the main methods used to heat PTNBs during their first days of life.								
			- Bathing practices and products: in most NICUs, PTNBs were not bathed frequently. In NICUs with frequent baths, was used shampoo or liquid baby soap.								
			- Adhesive products for IV fixation: transparent dressing alone or associated with micropore tape.								
			- Adhesive products to fix endotracheal tubes and cannulas: in 60% of units was used some type of fabric tape for fixation.								
			- Electrodes: 95% used hydrogel electrodes.								
			- Skin protectors against rashes: 36% used some zinc oxide formulation; 32% used multiple products.								
- Treatment systems for the skin of fragile preterm infants: in 68% of units, there was no protocol for immature skin protection.											
- Treatment systems for bare skin: in most units these areas were left uncovered.											
<p>Migoto MT, Sousa SNDH, Rosetto EG. Skin lesions of newborns in a neonatal unit: descriptive study. Online Brazilian journal of nursing, 2013⁽³⁶⁾</p>			<p>To identify the incidence and prevalence of skin lesions and characterize the most common among hospitalized neonates in a NICU of a university hospital.</p>	Descriptive and observational study with quantitative approach.	The incidence of skin lesions ranged from 0 to 56%, mean of 16%, while prevalence ranged from 30 to 91%, mean of 58%. The most prevalent types of lesions were:	<p>The authors highlight the need for more specific research to instrumentalize the processes of assessment of skin care, techniques and products available in the market.</p>					
				<p>40 NBs (full term and preterm)</p>	- Diaper dermatitis: use of EFA (essential fatty acid) and antifungal in perineal dermatitis with fungal infection. Dermatitis treated with EFA had a shorter duration compared to those treated with topical antifungal;						
					- Hematoma and ecchymosis: no treatment was used;						
					- Lesion from lables and infiltration: EFA was used for treatment of lesion from lables, nasal lesions, perineal dermatitis, continual lesions and fissure; hydrocolloid for necrosis, prevention of nasal septum leiions and lesions from lables; and Agarol®, was used empirically for treatment of infiltration to a large extent.						
In 39.5% of lesions, the cause could not be identified given the lack of information in nursing notes.											

Author/Title/Journal/Year	Intervention	Design/Sample	Main outcomes	Recommendations/Conclusions
<p>Rolim KMC, Farias CPX, Marques LC, Magalhaes FJ, Gurgel EPP, Caetano JA. Nurse's action in prevention of skin injury in newborns. <i>Revista de enfermagem da UERJ</i>, 2009⁽³⁷⁾</p>	<p>To know the nursing care provided in the prevention of skin injury in NBs.</p>	<p>Exploratory-descriptive study, with qualitative approach</p>	<p>The following treatments were among the most cited for the prevention of skin injuries: use of hydrocolloids in bony prominences; daily hygiene with neutral liquid soap and ointments or oils to prevent rashes; change of position; skin protection with cling film; use of mineral oil in the removal of adhesives; use of a skin barrier made of pectin and methylcellulose in cardiorespiratory electrodes. Nurses emphasized the need for a daily assessment of babies' skin for signs of infection, moisture, hyperemia, and edema.</p>	<p>The most adopted preventive measures were the following:</p>
		<p>7 nurses</p>		<p>use of skin protectors or barriers for attachment of electrodes; careful cleaning of the skin and removal of adhesives; systematic evaluation of the skin; change of position and use of small quantity of adhesives.</p>
<p>Lund CH, Osborne JW, Kuller J, Lane AT, Lott JW, Raines DA. Neonatal skin care: clinical outcomes of the AWHONN/NANN evidence-based clinical practice guideline. <i>Journal of Obstetric, Gynecology and Neonatal Nursing</i>, 2011⁽³⁸⁾</p>	<p>To test the impact of the Neonatal Skin Care Research-Based Practice Project on the condition of skin and changes in skin care practices in monitored patients.</p>	<p>Not described by authors</p>	<p>After implementation of the protocol in NICUs and special care units, it was observed: better resolution of problems related to skin injuries ($p < 0.0001$); greater use of emollient ($p < 0.0001$); significant reduction in recurrence rates of skin injuries ($p < 0.05$), in frequency of baths ($p < 0.0001$), in use of cleansing products ($p < 0.0001$), in use of vitamin A and D ointment for treatment of diaper dermatitis ($p < 0.0001$), and in use of triple dye ($p < 0.05$) and isopropyl alcohol ($p < 0.0001$) during umbilical cord care.</p>	<p>The Neonatal Skin Care Research-Based Practice Project has been successfully implemented at 51 sites. Its effectiveness has been demonstrated through changes and improvements in care practices with the skin condition in preterm and full term newborn infants. The project results support further dissemination of its practice guidelines for neonatal skin care.</p>
		<p>2,820 children: 2,464 hospitalized in the NICU and special care unit, and 356 in the neonatal unit. Fifty-six sites were analyzed in the pre-project set, and 51 in the post-project set</p>	<p>After implementation of the protocol in neonatal units, there were: better cutaneous scores ($p < 0.03$); lower occurrence of diaper dermatitis ($p < 0.01$), lower number of baths ($p < 0.0001$), lower use of vitamin A and D ointment ($p < 0.0001$); greater use of chlorhexidine ($p < 0.0001$) and antimicrobial ointment ($p < 0.0001$) in umbilical scar care; and greater use of heated cribs ($p < 0.001$).</p>	

DISCUSSION

The care of PTNBs' skin is a priority in nursing by aiming the maintenance, prevention and recovery of its integrity. This care must be dynamic, continuous, and individualized by offering user embracement in all environments⁽⁹⁾. To this end, neonatal nurses must know the characteristics and specificities of PTNBs' skin and about environmental conditions that predispose to injury, such as the involved mechanisms, the physiology of healing, the products indicated for premature infants, and care practices based on the best evidence⁽⁸⁾.

The studies of this review have brought important contributions to nurses' care by showing potentially efficient products that act as a barrier against injuries on PTNBs' skin, such as No-Sting⁽¹⁶⁾, Aquaphor^{®(16,22)}, Sween^{®(17)}, sunflower seed oil⁽¹⁹⁾, Stelatopia⁽²⁸⁾, hydrophilic gel adhesive and pectin barrier^(18,20).

These articles demonstrate nurses' interest in seeking new products and substances that meet clinical practice needs effectively for protecting the integrity of PTNBs' skin. However, there is a lack of care protocols regarding the periodicity of dressing change and use time of products. Only an article found in the search, from 1999⁽²²⁾, suggests the application of a given product every six to eight days.

A study⁽¹⁸⁾ emphasizes the importance of product compatibility with the characteristics of PTNBs' skin. According to authors, there is the assumption that less harmful adhesives such as those of hydrophilic gel, have less capacity of adhesion to the skin of babies classified as very low weight. Considering this matter, in clinical practice, nurses choose more efficient adhesives that are generally more aggressive to the epidermis. The use of a thin layer of pectin (hydrocolloid) between the skin and the adhesive is an alternative to this problem, as reported in another study⁽²⁰⁾.

The use of adhesives for fixation of electrodes, catheters and other hospital devices is crucial for maintaining therapy in a NICU. The results of this review revealed the need for more research aimed at the development of products that fulfill their function without affecting the integrity of PTNBs' skin, as well as the definition of care protocols by nurses from the literature and clinical experience.

Premature newborns' skin is more vulnerable than that of full term newborns given the lack of protection by the vernix and mainly, the stratum corneum in the epidermis. A Brazilian study conducted with nurses from a NICU showed the most frequently adopted care measures for preventing PTNBs' skin injuries are: daily hygiene; hydrocolloids in bony prominences; mineral oil for the removal of adhesives with slow and careful manipulation; and skin protection with cling film⁽³⁷⁾.

Routine use of emollients in NICUs provides external assistance in skin barrier function, balance in transepidermal water loss⁽¹⁶⁾, greater hydration⁽¹⁷⁾ and less infections in premature infants. The understanding of the potential for percutaneous toxicity, allergic sensitization and irritation⁽³⁹⁾ caused by topical products applied to PTNBs' skin is fundamental, in addition to the possible association between emollient use and greater exposure to infections⁽¹⁶⁾.

Aquaphor and No-sting emollients provide a layer of skin protection, and were similarly efficient for the reduction of transepidermal water loss. Aquaphor was statistically superior in the aspect of skin condition

in two analyzed studies^(16,22). The advantage of No-Sting was its spray application every week, while the other product requires two applications per day of the creamy solution⁽¹⁶⁾. Thus, there are multiple relevant variables for nurses' practice regarding the analysis of cost, effectiveness and operationalization of use.

Regarding bath, there is a consensus on a greater interval between events without significantly increasing the risk of infection^(26-27,40). Newborns' bath in the NICU occurs daily for skin and aesthetic care and for reducing infection by changing the skin pH. Although the bath is a simple and routine task, the nursing team must consider the best scientific evidence available to assess the risks and benefits related to how and when the activity should be performed, and which product to use⁽¹¹⁾.

By means of a randomized clinical trial, in one of the studies⁽²⁶⁾ was proven the safety in giving the bath every four days instead of daily or every other day, as it regularly occurs in NICUs by considering the number and type of skin colonizing pathogens. Note that the study was performed in premature infants from the 14th day of life. At this time, the stratum corneum is already developing or practically constituted depending on gestational age (this was also the case in another study, even though there was no control group⁽²⁷⁾). Hence the need for further research to reiterate these findings for the postnatal period in the first two weeks, when the stratum corneum is absent or in the early stage of its extra-uterine development.

The Association of Women's Health Obstetric and Neonatal Nurses (AWHONN) recommends avoiding daily bathing with soap and stimulates the use of neutral pH soaps, and alternating between water-only baths, and baths with soap and water. In PTNBs younger than 32 weeks, AWHONN indicates only warm water with cotton balls⁽⁴¹⁾. One of the analyzed studies⁽²⁸⁾ promoted the discussion about products with pathogen removal technologies developed from dry cleaning by dispensing the conventional bath with water. However, there is need for further research to investigate the efficiency and risk of allergies or other adverse events by using a rigorous methodological design and larger sample size.

In relation to product choice, skin characteristics should be recognized, namely: slightly acidic pH that requires use of products of the same nature or neutral (never alkaline, given the higher probability of injuries and infections)⁽¹¹⁾; incomplete epidermis due to absence of the total formation of the stratum corneum and weakened dermis by the low production of elastin and collagen⁽⁴²⁾; and immature physiology (deficiency of the immune system inherent in human cutaneous tissue, consistent with the incompleteness of gestation)⁽⁸⁾.

Considering the aforementioned limitations, an important factor to be discussed and investigated scientifically is the use of topical products for preventing hyperemia in the diaper area, the use of lotions and oils to form a barrier against transepidermal water loss, and the use of antiseptics before skin invasive procedures.

Diaper dermatitis in hospitalized children is a failure of nursing care. Although this is a constant problem in many services, only in one article⁽³⁰⁾ two interventions were investigated comparatively in relation to their treatment, namely: breast milk versus 40% zinc oxide barrier cream. The findings revealed the cream efficacy ($p=0.002$) especially among full term babies.

Another very important issue in neonatal care, especially in premature infants, is the use of certain

substances common to antiseptics practice, such as iodinated polyvidone that is not recommended given the risk of transient hypothyroidism⁽⁴³⁾. As PTNBs' stratum corneum is still incomplete, it cannot filter the iodine, so it turns the topical effect of a product into systemic effect.

Likewise, there is concern about the use of alcohol on extensive areas of skin given the risk of burns, especially in extreme PTNBs⁽⁵⁾. The use of chlorhexidine is also under investigation regarding the possibility of systemic impact on babies' body since its alcohol-based solution appears to be more harmful than its water-based solution⁽⁴⁴⁻⁴⁵⁾.

An article analyzed in this review showed that using chlorhexidine 0.5% aqueous solution for preparation of PTNBs' skin does not reduce late sepsis rates. Moreover, there seems to be an association of its use with a higher mortality rate in this population, thus the use of 0.015% chlorhexidine is recommended⁽²¹⁾. There is still lack of specific recommendations for the age range of PTNBs, since the maturity and quality of skin is directly related to the time of gestation and time of adaptation to the extrauterine environment.

In addition to products used in the hygiene and antiseptics of PTNBs' skin, another article of this review revealed the benefits perceived by nurses regarding the humidification of incubators, including better thermoregulation and skin integrity, lower transepidermal water loss, and balance of fluids and electrolytes⁽³¹⁾. Attention to the risks of transepidermal water loss by PTNBs that requires humidification interventions has been highlighted in the literature for more than 20 years⁽³²⁾. There is a warning about this phenomenon, because it can happen in both incubators and radiant heaters given the low water vapor pressure present in ambient air.

An article⁽³¹⁾ considered the variation in humidification practices regarding intensity and duration. Despite this variation that reinforces the need for protocols based on still limited scientific evidence, the importance of humidified incubators in the care of the PTNB is demonstrated by considering nurses' perception about the skin integrity of PTNBs assisted with this care. Thus, nurses should monitor temperature and humidity inside these equipments, and ensure proper cleaning and maintenance⁽⁴⁶⁾.

A Brazilian clinical trial of great relevance for understanding the impact of transepidermal loss in preterm infants concluded that using a semipermeable membrane may favor clinical stability. There was a significant difference in serum sodium levels, glycemia and water replacement needs. In this study, infants not using the semipermeable membrane in their first week of life had a greater need for replacement, hence making glucose metabolism more difficult, and raising glycemic and sodium levels. Thus, in the study was demonstrated the relevance of the control of transepidermal loss of PTNBs hospitalized in the NICU⁽⁴⁷⁾.

Nursing care to reduce the excessive loss of water through the skin has multifactorial impacts, since this phenomenon can generate systemic clinical alterations, besides the risk of infection and sepsis, which is one of the most concerning causes of mortality in the neonatal population. Thus, improving nursing care technologies is a fundamental action to qualify the health care of PTNBs. Nurses must recognize their clients' health needs, and decide on the best intervention alternatives with the multiprofessional team.

The rotation of body positioning and installed devices is nursing's responsibility and an important routine action to maintain skin integrity. Its absence may cause pressure injury, as in the case of nasal CPAP^(24,33-34) or even nasogastric tubes with prolonged use and recurrent installation in the same nostril. Clinical devices can generate pressure points on the skin and require constant assessment and prevention strategies to protect the skin in contact with them. In lack of preventive measures, the nursing team should intervene for promotion of injury healing and prevent its evolution as a result of maintaining the device by applying hydrocolloid, for example, as shown in the studies analyzed in this review.

In one of the studies, was tested the application of a double layer of hydrocolloid in the nostrils and in the high-flow nasal catheter device. After analysis, there was no statistical difference between the groups because of the greater surveillance of NICU nurses in relation to newborns participating in the study. This finding reinforces the importance of surveillance and monitoring for the change of positioning of the pressure point at the first sign of hyperemia⁽²⁴⁾. The authors also argue that the high-flux nasal oxygen catheter is less damaging than nasal CPAP by bringing the contribution of other studies regarding the prevention of skin injuries in PTNBs in oxygen therapy⁽²⁴⁾.

Changes of positioning and newborns' positioning are strategies for reducing the risk of pressure injury and thermal loss, and for offering more comfort to the baby, hence reducing rates of deformities and contractures^(41,48). Therefore, nursing seeks to keep newborns nested by simulating the maternal uterus environment in alignment with developmental care, and healthy growth and development.

The existence of nursing protocols focused on PTNBs' skin allows the systematization of care with a focus on injury prevention and health promotion. They provide guidance to the nursing team in the care and advice on products and topical substances suitable for application in the immature integument⁽⁴⁸⁾. An analytical study proposed a protocol for the use of amorphous hydrogel for injury treatment (its etiologies are indicated in Table 1). Despite the findings of healing without scars, the authors highlighted questions for future research, as the possibility or not of associating hydrogel with topical drugs, and about the duration of treatment with the product⁽²⁵⁾.

Preventive measures and accurate clinical evaluation are particularly important for determining the best intervention. Attention should be paid to the physiological complexity involving the integrity of skin. Another study showed that low levels of zinc in some newborns, especially PTNBs, can lead to skin injuries. It also brings the recommendation of screening substance levels in preterm infants admitted to NICU and providing oral supplementation when necessary⁽²⁹⁾.

Important findings such as the need for further and more specific research to instrumentalize evaluation processes of nursing care with PTNBs' skin, of techniques and products available in the market reinforce the relevance of creating protocols, as well as standardized care protocols based on solid evidence and clinical trials^(35-36,38).

To this end, the integration between university and health services is essential for a stronger identification of problems and needs inherent in clinical practice. Furthermore, for searching solutions that

support scientifically structured actions and return evidence-based practice to the community. This kind of initiative, either through integration of academic postgraduate programs with professionals inserted in the assistance, or through professional master's and specializations, has potential for transforming the environment. It is fomented by research and the design of new technologies for health care.

CONCLUSION

There is a lack of national studies and investigations with robust methodological designs that can generate an impact for nurses' practice.

This review brought important data about the scenario of skin care of hospitalized premature newborns by gathering orientations of researchers from the area, enabling the guidance of actions of nurses in clinical practice and scholars, and showing the need to develop care protocols in this area.

There is a considerable variety of products and topical substances used in the skin care of PTNBs, but many of them are not yet fully proven hence the need for more studies with rigorous methods and larger samples.

The absence of nursing care protocols in skin care of PTNBs is noteworthy. This deficit hinders the adoption of standardized actions and shows the need for articulation between researchers and health professionals for the development of research in the area.

A limitation of this work and inherent to review research, is that the choice of descriptors and keywords decreases the number of articles for analysis in relation to the whole production by representing impossibility of scientific synthesis. The method was extensively studied to mitigate this effect.

Finally, since nurses deal with skin care daily in various practice scenarios, they implement evaluation and care actions in spite of the lack of protocols. Therefore, sharing this empirical knowledge with the multiprofessional team is fundamental after research proving efficiency and efficacy, and measuring risks for the consolidation of nursing interventions in the face of challenges present in PTNBs' skin care.

After the evolution of research and care protocols regarding the skin of premature newborns, higher quality of care and resolutiveness in nurses' work with this population is expected hence avoiding complications such as infections and varied injuries.

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