Review

Risk assessment of pressure injuries in newborns. Appropriateness of Glamorgan and NSRAS scales: a scoping review

Citation: Nicolosi B., Curcio F., Gheorghe M. A., Prisco R., Parente E. "Risk assessment of pressure injuries in newborns. Appropriateness of Glamorgan and NSRAS scales: a scoping review" (2024) *infermieristica journal* 3(1): 45-60. DOI: 10.36253/if-2403

Received: August 18, 2023

Revised: December 21, 2023

Just accepted online: February 3, 2024

Published: March 31, 2024

Data Availability Statement: All relevant data are within the paper and its Supporting Information files. This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record.

Competing Interests: The Author(s) declare(s) no conflict of interest.

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Abstract

The newborn's skin must undergo a transition process as a result of the passage from an aqueous to an aerobic environment. This process occurs over a period of approximately 2 to 8 weeks. The skin of newborns has important anatomical and physiological differences compared to those of older children and adults. It is thin, with fewer appendages; the stratum corneum is not present; the dermalepidermal junction is reduced; intercellular junctions are weaker; the secretions of the sebaceous glands are limited and the pH is generally neutral. All these factors make the newborn's skin more fragile to any stimulus. To have effective prevention and intervention procedures, an accurate and practical risk assessment tool should be identified as a preliminary step for adequate prevention. Unfortunately, only few validated tools are available to assess the risk of PUs in children, especially newborns. The objective of the study is to examine the adherence of the most used tools for the assessment of PU risk in newborns, in particular to make a comparison of the limits and advantages of the most frequently used tools in neonatal settings, the Glamorgan scale and NSRAS. To respond to the main objective, a scoping review of the literature was conducted. 54 studies were identified. Further analysis was conducted, which led to the exclusion of articles that did not examine the characteristics of newborn skin, the risk factors related to PUs and the appropriateness of the NSRAS and Glamorgan tools, for a final selection of 35 studies.

Patients admitted to NICU represent the paediatric category most exposed to the risk of developing pressure ulcers. Factors such as reduced mobility, together with the pressure exerted by aids or devices, increase the risk of pressure injuries. The risk factors that most expose the newborn to risk are the structure of the skin and medical devices. Nurses should implement preventative measures to control the risk of PU. The use of specific tools is necessary to detect the risk of PUs in newborns and implement preventive measures. PUs risk assessment is one of the nursing care strategies for prevention. Therefore, operators need a valid, reliable, and predictive scale. Lastly, we recommend the use of NSRAS for future research and for the education of healthcare professionals in the neonatal area.

Keywords: Wound Healing, Stevens-Johnson Syndrome, Nursing, Erythema Multiforme, Pediatric Intensive Care Unit

Background

The skin is made up of three layers: epidermis, dermis, and subcutaneous tissue. The stratum corneum represents the outermost part of the epidermis, therefore its main function is to protect against bacteria, toxins, fungi and viruses.[1,2,3,4]

The newborn's skin must undergo a transition process as a result of the passage from an aqueous to an aerobic environment. This process occurs over a period of approximately 2 to 8 weeks.[5,6] Preterm newborns have an underdeveloped stratum corneum, particularly premature newborns with a gestational age of less than 24 weeks may not have any stratum corneum.[5,6] Due to these characteristics, the Trans-Epidermal Water Loss (TEWL) is greater, thus exposing the skin to considerable fragility. This vulnerability also leads to reduced cohesion between the epidermis and the dermis, increasing the risk of damage resulting from friction.[5,6]

The skin of newborns has important anatomical and physiological differences compared to those of older children and adults. It is thin, with fewer appendages; the stratum corneum is not present; the dermal-epidermal junction is reduced; intercellular junctions are weaker; the secretions of the sebaceous glands are limited and the pH is generally neutral. All these factors make the newborn's skin more fragile to any stimulus.[5,6]

Preterm newborns are more prone to iatrogenic skin injuries such as pressure ulcers (PU).[7] The development of pressure injuries is prevalent in this population due to immaturity of the skin, limited mobility, and the frequent use of medical devices in Neonatal Intensive Care Unit (NICU) settings.[8,9]

Risk factors of PUs in newborns, especially preterm, can be distinguished into:

a) extrinsic factors: temperature and humidity of the air in the incubator, support surfaces, duration and amount of pressure, friction;

b) intrinsic factors: size and physical shape of the newborn, physiological reactions and skin maturity, perfusion, infection, anemia, immobility.[10]

In particular, it is known that the most important characteristics related to PUs in neonatal age are:

a) related to gestational age: time elapsed from birth to the development of the ulcer; length of time the lesion remains; age at the onset of the lesion (in weeks); weight at appearance (in grams);

b) device-related PUs: oximeters, tracheostomies, cables, catheters, identification bracelets, nasogastric tubes, endotracheal tube electroencephalogram cables, CPAP masks, oximeters, ECMO cannula, nasogastric tubes, chest drains, cooling blankets.[11,12]

Medical devices are the leading cause of PI in young children and newborns. Have been reported an incidence rates of PIs ranging from 3.7% to 19% in NICUs and Surgical Intensive Care Units (SICUs)[13], while a previous study reported an incidence rates of 28%.[14] Other previous studies have identified prevalence rates of between 12% and 26% in the neonatal population.[15,16] In another more recent study, the overall prevalence ranged from 0.47% to 31.2% and the cumulative incidence ranged from 3.7% to 27%.[17]

In the study of August D.L. (2014), 247 patients were included and 77 out of 247 had skin lesions, for a total of 107 ulcers, with a prevalence rate of

31.2%. The sample had a mean gestational age of 28 weeks (range 22-41 weeks) and a mean birth weight of 1155 g (range 445-2678 g). In this study population, the use of medical devices was the most common risk factor associated with the identified injuries.[18]

These vulnerabilities are increased in preterm infants who are 25 weeks of gestation or younger. For infants with extremely low gestational ages of 22 to 25 weeks, inflammation from these skin injuries can result in permanent scarring.[19]

The healing process of PUs is more painful and has a negative impact on the rest and, consequently, with its neurodevelopmental status. These aspects lead to longer hospital stays, higher risk of infection and systemic absorption, compared to the topical treatment of lesions.[10]

To have effective prevention and intervention procedures, an accurate and practical risk assessment tool should be identified as a preliminary step for adequate prevention.[14,20] Unfortunately, only few validated tools are available to assess the risk of PUs in children, especially newborns.[20]

The objective of the study is to examine the adherence of the most used tools for the assessment of PU risk in newborns, in particular to make a comparison of the limits and advantages of the most frequently used tools in neonatal settings, the Glamorgan scale and NSRAS.

Methods

3.2 Research Strategies

To respond to the main objective, a scoping review of the literature was conducted, according to a clear definition of the research question (Table 1); literature review to identify studies; determination of the studies that answer the research question; synthesis of studies and the evaluation of heterogeneity in terms of results.

Population	Intervention	Comparison	Outcome	Method
Newborns hospitalized in NICU	Pressure injury risk assessment	Appropriateness of NSRAS vs. Glamorgan scale	Identification of the best risk assessment tool for the neonatal population	SystematicLiterature review

Table 1. Population, Intervention, Comparison, Outcome, Methods (PICOM) research query

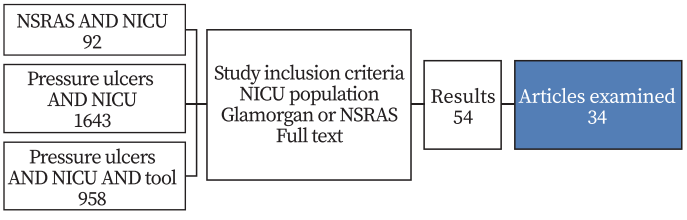
A preliminary search of available full-text literature was conducted via international databases (PubMed, Cinahl). The key words used were “neonatal intensive care unit”, “neonatal skin risk assessment scale”, “pressure ulcers”, combined by the Boolean operators AND and OR. The choice of these keywords was suggested by MeSH and Thesaurus terms. The combination that produced the most records was "pressure ulcers AND neonatal intensive care unit”.

The filters used for each string were: publications in the last 5 years, excluding articles that are too dated, to have information that better represents the current situation, articles that analyzed the population of patients admitted to Neonatal Intensive Care and articles exclusively available in full-text.

The validity of a review is closely linked to both the quality of the original studies and the methods used by reviewers to organize and systematize the information for review. To implement a critical appraisal and, therefore, to select and evaluate the "goodness" of the studies, two checklists were used: Strengthening the reporting of observational studies in epidemiology (STROBE)[21] for cohort and cross-sectional studies, and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)[22] for literature reviews. The external validity, internal validity, data relevance, generalizability and applicability of each individual study were assessed.

Results

54 studies were identified. Further analysis was conducted, which led to the exclusion of articles that did not examine the characteristics of newborn skin, the risk factors related to PUs and the appropriateness of the NSRAS and Glamorgan tools, for a final selection of 35 studies (Graph 1).



Graph 1. Search strategy

The following data extraction table was defined (Table 2) to obtain the necessary information on the characteristics and results of the included studies.

The information extracted was on: a) general information: author, journal, setting; b) the characteristics of participants: number of subjects in the sample, age of the subjects, and demographic origin; c) study design; main and any secondary objectives of the study; e) results: the main results presented by the studies; f) description of the tools used to detect and measure the outcomes; g) conclusions: gaps, agreements, and disagreements with the research question, possible implications for future practice.

The appropriate content provided a framework related to the focus of the review. PUs affect the pediatric and neonatal population, especially in the presence of serious disease or debilitating conditions. However, empirical evidence on which new guidelines can be established for this area is very scarce[23].

The Glamorgan scale, due to its greater adherence and accessibility, represents the first choice in paediatric and neonatal settings.20 The risk of injuries detected in newborns and preterm infants is not well represented in the scale indicators, because the scale considers aspects that are infrequent in these populations.[1,20]

The Neonatal Skin Risk Assessment Scale (NSRAS) has provided evidence of high validity and reliability in measuring risk in neonatal setting.8 The NSRAS scale meets the criteria for application in a neonatal population: high sensitivity, high specificity, good predictive values, high efficacy and ease of use, employing clear definitions applicable in different settings.[8]

Discussion

Patients admitted to NICU represent the paediatric category most exposed to the risk of developing pressure ulcers.[9] Factors such as reduced mobility, together with the pressure exerted by aids or devices, increase the risk of pressure injuries.[14] The risk factors that most expose the newborn to risk are the structure of the skin and medical devices.[11,14] The immaturity of the skin is certainly influenced by gestational age.[10] Being a category exposed to the risk of developing PU, the application of specific scales to measure the risk of developing lesions is necessary to promote adequate preventive measures. Several scales are available to assess the risk of injury in paediatric settings, but most of these have been produced from adult rating scales.[23,24,25,26] On the other hand, the Glamorgan scale is specifically designed for children and, thanks to its greater compliance and accessibility, represents the first choice in paediatric and neonatal populations.[23]

Kottner J. (2012) and Willock J. (2015) established the reliability of the scores obtained from the items included in the Glamorgan scale, which is currently used regularly to assess the risk of PU in the pediatric patients, with the exception of neonatology.[27,28] The authors reported that in several paediatric hospital settings in the UK, the reliability and agreement of the Glamorgan scale scores were very high compared to scores on other scales (48% agreement).[27,28] However, in the validation studies of this tool, children with bedsores were taken as the reference standard, which however represents a questionable strategy, as the scale in question does not establish the close and necessary correlation between the subject at risk and the development of pressure sore: although the score can identify a child as at risk, this does not mean that the child is actually exposed or will even develop a pressure sore, as Galmorgan detects scores that overestimate the risk, identifying false positives.[27,28] For example, reporting the presence of a device highlights a high risk of onset of injuries, even when the child or newborn has a general state of health that would exclude them from this risk.

The results of the study highlight the poor "discriminatory" power of the Glamorgan scale. For example, items such as “Significant anemia” or “Low serum albumin”, do not provide information, in terms of scores, that distinguishes children with respect to the risk of developing pressure ulcers or not.[27,28]

This calls into question the usefulness of the results provided by the tool for any clinical and healthcare decision-making process.[27,28]

According to further consideration, the risk of PU is not well represented in the scores of the investigated scale, because the items considered are rather infrequent or in any case intrinsic aspects of the newborn, especially preterm, with the exception of the item that evaluates the risk of medical device related pressure ulcers (MDRPUs), being a population particularly exposed to contact with devices.[27,28]

The Glamorgan scale probably has good validity in paediatric intensive care areas and for more

severe PU.[27,28]

The authors' conclusions establish a low reliability of the Glamorgan scale, as it provides little additional discriminatory information on the risk of PUs. Reliability is also low for subjective risk assessments. The instrument is especially unreliable in contexts where the risk of pressure injury is low. In a more heterogeneous population, the performance of Glamorgan scale scores may be better.[27,28]

On the applicability of the Glamorgan scale, the study by Willok J. (2015) stated that staff awareness of the clinical risk of PUs should be increased and, for clinical practice, a rating scale with good reliability regardless of interoperability.[28] Indeed, it was described that when staff are unaware that their work is being scrutinised, they may be less alert or less aware of potential clinical issues arising from their assessment and completion of the risk assessment tool.[28] Furthermore, staff may not re-assess patients every time their clinical conditions change and be less vigilant about documenting date and time of assessment. Assessment tools, such as the Glamorgan scale, should be clear enough to alert all staff to potential risks.[28]

Given the limitations of the tools mentioned above, we suggest the implementation of studies in favour of NSRAS, which appears to be highly suitable for neonatal intensive care in terms of compliance, practicality and acceptability of the results.[23,29]

Garcìa-Molina P. (2017) and Curcio F. (2022) proposed in their studies the NSRAS scale for the risk assessment of PUs in newborns.[29,30]

Garcìa-Molina P. 2018 evaluated the incidence, the risk factors and the preventative measures of pressure ulcers in NICU and SICU. The investigation clarified the influence of different factors and preventive measures through direct observation.14 The results of this observational study promote the applicability of the NSRAS scale in clinical practice, as it produced highly reliable results in Spain, while suggesting the need for further research on newborns hospitalized in intensive care.[14,29]

The authors promote the direct applicability of the NSRAS scale in clinical practice, and underline that low score on the instrument, associated with factors such as prolonged hospitalization or invasive ventilation, represent a greater risk.[29,30]

The NSRAS has provided evidence of high validity and reliability in measuring neonatal PUs risk.[29,30]

It identifies newborns who require preventative measures and specific risk factors useful to provide diagnostic information to improve neonatal skin care.[29,30]

NSRAS ensures efficient and effective allocation of limited preventative resources, supports clinical and management decisions, and facilitates development of risk assessment procedures. All these features can facilitate the development of best practices in nursing management of pressure ulcers, improving the quality and safety of care.[29,30]

The NSRAS scale meets the criteria for application in a neonatal population: high sensitivity, high specificity, good predictive values, high efficacy, and ease of use, employing clear definitions applicable in different settings.[29,39]

The application of a scale with these characteristics provides an objective criterion to identify children who are not at risk of pressure injuries and, therefore, allows you to manage and plan the necessary preventive care plan.[29,30]

These results were not compared with scores on other scales or with the clinical judgment of healthcare professionals. The objective was to validate a tool that assesses risk and subsequently guides the management of preventive measures in neonatal intensive and subintensive care.[29,30]

According to Çigdem S., since the risk assessment of pressure injuries is one of the main nursing actions of prevention in the neonatal setting, nurses need a valid, reliable and convenient scale to assess the risk.[31] This study also established the validity and reliability of the NSRAS scale, obtaining good results in terms of applicability and safety.[31]

In relation to the prevalence of PIs reported in the literature, the limitation of NSRAS of not evaluating the risk of MDRPUs cannot be overlooked. In fact, in NICUs and SICUs, it has been reported that devices are responsible for 50%-70% of pressure ulcers in neonatal care.[12,14]

This scoping review highlighted that the NSRAS scale meets the criteria for application in a neonatal population: high sensitivity, high specificity, good predictive values, high efficacy, and easy to use, employing clear definitions applicable in different settings.[29,30]

However, it does not include an item that evaluates the risk of MDRPUs, which due to incidence and prevalence cannot be overlooked.

In conclusion, hospitalized newborns are at risk of developing PIs. Specific tools are needed for

the detection of PUs and for the implementation of prevention. Healthcare professionals should assign preventive measures based on risk assessed with an objective criterion. NSRAS is a nursing care management tool that could be part of a strategic plan to prevent PU in neonatal units.

CONCLUSION

Based on objective evaluations, nurses should implement preventative measures to control the risk of PU. The use of specific tools is necessary to detect the risk of PUs in newborns and implement preventive measures. PUs risk assessment is one of the nursing care strategies for prevention. Therefore, operators need a valid, reliable, and predictive scale.

Furthermore, the authors recommend the use of NSRAS for future research and for the education of healthcare professionals in the neonatal area.[29,30]

	Authors Year	Study title	Patients and setting	Study design
1v	Ligi I 2008.	Iatrogenic events in admitted neonates: A prospective cohort study.	Neonates. Neonatology.	Observational prospectiv cohort.
2	Delmore B. 2019.	Pressure injuries in the pediatric population: a National Pressure Ulcer Advisory Panel white paper	Neonates, infants.	Review, panel white paper.
3	Dolack M. 2013.	Updated neonatal skin risk assessment scale (NSRAS).	Neonates. NICU, SICU, neonatology.	Cross sectional.
4	Fujii K. 2010.	Incidence and risk factors for pressure ulcers in seven neonatal intensive care units in Japan: a multisite prospective cohort study.	Neonates. NICU.	Multisite prospective cohort.
5	Visscher M. 2014.	Pressure ulcers in the hospitalized neonate: rates and risk factors.	Neonates. NICU.	Prospective.
6	Baharestani MM. 2007.	Pressure ulcers in neonates and children: an NPUAP white paper.	Neonates, children.	Review, white paper.
7	Huffines B. 1997.	The neonatal skin risk assessment scale to predict skin break-down in neonates.	Neonates. NICU, SICU, neonatology.	Review
8	McLane KM. 2004.	The 2003 national pediatric pressure ulcer and skin breakdown prevalence survey: a multisite study.	Neonates, children. Neonatology, pediatrics.	Descriptive.
9	Kottner J. 2010.	Frequency of pressure ulcers in the pediatric population: A literature review and new empirical data	Children. Pediatrics	Systematic review and data analysis.

	Results	Outcomes
	A total of 388 patients were studied during 10 436 patient days. We recorded 267 iatrogenic events in 116 patients. The incidence of iatrogenic events was 25.6 per 1000 patient days. 92 (34%) were preventable and 78 (29%) were severe.	Iatrogenic events occur frequently and are often serious in neonates, especially in infants of low birthweight. Improved knowledge of the incidence and characteristics of iatrogenic events and continuous monitoring could help improve quality of health care for this vulnerable population.
	Clinicians are gradually realising that, compared with adults and other specific populations, paediatric patients require special consideration, protocols, guidelines, and standardised approaches to pressure injury prevention. This white paper from the National Pressure Advisory Panel reviews this history, and the science of why paediatric patients are vulnerable to pressure injury formation.	Successful pediatric pressure injury prevention and treatment can be achieved through the standardized and concentrated efforts of interprofessional teams.
	The Neonatal Skin Risk Assessment Scale (NSRAS) was piloted with 32 neonates. Reliability was high for the subscales of general physical condition, activity, and nutrition, but low for the other three subscales. For predictive validity, the sensitivity was 83% and the specificity was 81%.	The NSRAS appears to be useful in predicting the days most likely for skin breakdown to occur.
	A total of 14 pressure ulcers occurred in 13 infants during the 11-month study period, the incidence was 0·01 persons per day and the cumulative incidence rate was 16.0%. Seven (50·0%) of 14 pressure ulcers were located on the nose. Multivariate analysis identified the following risk factors: skin texture (Dubowitz newborn maturation assessment scale: skin texture score of 1 point or lower) [odds ratio 7·6; 95% confidence interval (CI) 1·58 -36·71, P = 0·012] and endotracheal intubation usage (odds ratio 4·0; 95% CI 1·04-15·42, P = 0·042).	From these results, we believe that skin texture scores as determined by the Dubowitz neonatal maturation assessment scale could be used to assess the risk of pressure ulcers and new protective nasal materials for newborns that use endotracheal intubation must be developed.
	A two-year prospective study was conducted among 741 neonatal intensive care patients for 31,643 patient-days. The risk factors were determined by comparing the characteristics of the infants who developed PU with those who did not. There were 1.5 PU per 1000 patient days with 1.0 PU per 1000 days in premature infants, and 2.7 per 1000 days in term infants. The number of PUs associated with devices was nearly 80% in general and more than 90% in premature infants. Infants with PU had longer hospitalizations and weighed more than those without PU.	Infants with device-related PU were younger, of lower gestational age, and developed the PU earlier than patients with PUs due to conventional pressure. The time to development of PU was longer in prematurely born versus in term infants. Hospitalized neonates are susceptible to device-related injury and the rate of stage II injury is high. Strategies for early detection and mitigation of device-related injuries are essential to prevent PUs.
	Acutely ill and immobilised neonates and children are at risk for pressure ulcers, but there is a lack of evidence-based research exists on which to base guidelines for clinical practice. Most prevention and treatment protocols for pressure ulcers in the pediatric population are extrapolated from adult practice. Guidelines for clinical practice for prevention and treatment of pressure ulcers that specifically address the needs of the paediatric population are needed.	The purpose of this article is to highlight the research currently available and to identify the gaps that need to be addressed so that age-appropriate prevention and treatment guidelines can be developed.
	Reliability was high for the subscales of general physical condition, activity, and nutrition, but low for the other three subscales. For predictive validity, the sensitivity was 83% and the specificity was 81%.	The NSRAS appears to be useful in predicting the days most likely for skin breakdown to occur.
	There were 1,064 children surveyed, with a prevalence of pressure ulcers of 4.0% and other skin breakdown prevalence of 14.8%. Ninety-two percent of the pressure ulcers were of partial thickness, Stages I and II. Sixty-six percent of the pressure ulcers were associated with the facility. The pressure ulcers were predominately in the head 31%, seat area 20%, and foot area 19%. The 3 most common types of skin breakdown were excoriation/diaper dermatitis, skin tear, and IV extravasation. The predominant locations for skin breakdown were the seat area 35%, the foot area 20% and upper extremities 18%.	The prevalence of pressure ulcers was low in the paediatric population studied, but the prevalence of skin breakdown (excluding pressure ulcers) was higher, with 74% of all wound types consisting of excoriation/diaper dermatitis, skin tears, and IV extravasation sites. Future studies are needed to evaluate prevention and treatment options for pressure ulcers and skin breakdown in this population. Repeating this multisite study at intervals may be beneficial in continuing to build and modify the benchmark data.
	In total, 19 studies were identified containing any information about pressure ulcer frequency in the paediatric population. The methodological quality of many studies was low. Taking only higher-quality studies into account, pressure ulcers was approximately 7% in the total paediatric population and 26% in the ICU setting. The prevalence estimates ranged from 2% and 28%. Excluding grade 1 pressure ulcers, prevalence ranged from 1% to 5%. Especially in newborns and infants, the head was most often affected by pressure injuries. Many pressure ulcers were caused by medical devices. In Germany, the prevalence of pressure ulcers grade 1-4 in the general paediatric population was 2.3% (95% CI 1.4-3.6%). Excluding grade 1 pressure ulcer, the prevalence was 0.8% (95% CI 0.4-1.8%).	Due to considerable methodological limitations and insufficient reporting, there is a lack of sound empirical evidence on the frequency of pressure ulcers in the paediatric population. Conducting and reporting of future studies must be improved. The prevalence in German hospital samples was comparable to international figures. Newborns, infants, and small children are at increased risk of developing pressure ulcers in the occipital region as compared to other anatomic locations. The likelihood of developing sacral and heel pressure ulcers increases with increasing age and growth.

10	Triantafyllou C. 2021.	Prevalence, incidence, length of stay and cost of healthcare-acquired pressure ulcers in paediatric populations: A systematic review and meta-analysis.	Neonates, children.	Systematic review and meta-analysis
11	August DL. 2014.	Pressure injuries to the skin in a neonatal unit: fact or fiction.	Neonates, infants. NICU.	Descriptive cohort.
12	Lund C. 2014.	Medical adhesives in the NICU.	Neonates. NICU.	Review.
13	Kottner J. 2013.	Validation and clinical impact of paediatric pressure ulcer risk assessment scales: A systematic review.	Children. Pediatric.	Systematic review
14	Willock J. 2016.	A comparison of the performance of the Braden Q and Glamorgan paediatric pressure ulcer risk assessment scales in general and intensive care paediatric and neonatal units.	Neonates, children.	Cross sectional.
15	Nie AM. 2022.	Neonatal Skin Structure: Pressure Injury Staging Challenges.	Neonates. Neonatology, NICU.	Review.
16	Teng JMC. 2017.	Overview of Dermatologic Care in Children	Infants, children.	Review.
17	Black J. 2010.	An overview of tissue types in pressure ulcers: a consensus panel recommendation.		Review. Consensus panel recommendation.

	Of the 1055 studies appeared in the literature search, 21 studies were included in the systematic review and 19 were included in the meta-analysis. The overall prevalence ranged from 0.47% to 31.2% and the cumulative incidence ranged from 3.7% to 27%. The pooled prevalence was estimated at 7.0% (95% confidence interval (CI): 4.3%-10.4%) and the pooled cumulative incidence at 14.9% (95% CI: 7.7%-23.9%). The pooled prevalence among newborns was 27.0% (95% CI: 22.1%-33.1%) among children under 1 year old was 19.2% (95% CI: 9.4%-31.3%) and among children older than 1 year was 12.3% (95% CI: 2.3%-27.9%). The cumulative incidence of hospital-acquired pressure ulcers in neonates was 9.8% (95% CI: 2.9%-19.8%) and in children aged <1 year old was 11.3% (95% CI: 4.4%-20.7%), while no data was available to estimate this figure for children older than 1 year. The attributable length of stay ranged from 0.9 to 14.1 days and the attributable cost ranged from $894.69 to $98,730.24 (United States dollars; value of a dollar in 2020) per patient with hospital-acquired pressure ulcers.	
	247 neonatal patients were reviewed during the study period; of these in- fants, 77/247 were identified as having a skin injury (a prevalence rate of 31.2%). In total, 107 injuries were identified with a mean number of 1.4 injuries (range 1e4, SD 0.71). The mean gestational age was 28 weeks (range 22e41 weeks, SD 4.1 weeks) and the mean birth weight was 1155 g (range 445e2678 g, SD 620 g). Factors identified as contributing to pressure injuries included indwelling vascular cathe- ters (22.4%), non-invasive continuous positive airway pressure delivery devices (14.0%), oxygen saturation and temperature probes (17.8.%). 31.8% of injuries could not be associated with a specific risk factor.	However, neonates are undeniably at risk of pressure injuries however; it is still unclear which proportions of injuries are entirely preventable. evelopment of a risk assessment and prevalence tool will provide practitioners with information on the specific risk factors applicable to neonatal pressure injuries. Additional studies with larger group of patients will more accurately update practice related to the prevention and management in neonatal units; as well as critically evaluate the adverse effects of routine care processes that unintentionally harm the skin of these fragile patients.
	The challenges of using medical adhesives in NICU patients are significant and involve premature, full term and chronically hospitalized infants. Although securing life support devices is imperative for patient safety, skin injury from medical adhesives is also of importance.	Research is needed on the use of silicone barrier films and adhesive removers, as these may reduce the incidence of MARSI in this population. Studies to demonstrate the "gentleness" of silicone adhesives and the development of silicone adhesive products may also prove beneficial. Awareness and vigilance on the part of NICU care providers are necessary to draw attention to the problem of MARSI in our NICU infants, and may also help to reduce the incidence.
	The search yielded 1141 hints. Finally, 15 publications were included that describe or apply 12 paediatric pressure ulcer risk scales. Three of these scales (Neonatal Skin Risk Assessment Scale to Predict Skin Breakdown, Braden Q Scale, Burn Pressure Skin Risk Assessment Scale) were investigated in prospective validation studies. Empirical evidence about interrater reliability and agreement is available for four instruments (Neonatal Skin Risk Assessment Scale to Predict Skin Breakdown, Starkid Skin Scale, Glamorgan Scale, Burn Pressure Ulcer Risk Assessment Scale). No studies investigating the clinical impact were identified.	There is little empirical evidence on the performance of paediatric pressure ulcer risk assessment scales. Based on the few results of this review, no instrument can be regarded as superior to the others. It is unknown whether the application of pressure ulcer risk assessment scales reduces the incidence of pressure ulcers in paediatric practice is unknown. Perhaps clinical judgment is more efficient in evaluating pressure ulcer risk than the application of risk scale scores.
	The two scales were similar in this population in terms of the area under the curve. Neonatal and paediatric intensive care were similar in terms of AUC for both scales, but in general paediatric wards the Braden Q may be better suited to predict risk.	Either scale could be used if predictive ability was the outcome of interest. The scales appear to work well with neonatal, paediatric intensive care, and general children's wards. However, the Glamorgan scale is probably preferred by children's nurses as it is easy to use and designed for use in children. There is some suggestion that while the two scales are similar in intensive care, for general paediatrics the Braden Q may be the better scale.
		After participating in this educational activity, the participant will:1. Recognize the causes of PIs in preterm neonates.2. Choose the outcomes of PIs in preterm neonates.3. Distinguish the common characteristics of preterm neonates' skin.4. Summarize the challenges clinicians face when classifying the PIs of preterm neonates.
	Special situations occur in childhood resulting in normal skin changes that may be addressed with simple interventions.	This chapter provides an overview of recommended skin care practices for infants and children.
	A multidisciplinary panel of wound experts was assembled to provide anatomically accurate and practical terms associated with the assessment, healing and non-healing of pressure ulcers to help clinicians identify and describe tissue types and pressure ulcer stages. Specifically, anatomical markers and/or structures within the wound are described to facilitate the identification of tissue types and pressure ulcer staging.	The panel agreed that the provision of a common language facilitates quality care across settings. Although some research has been conducted, additional studies are needed to determine the validity and reliability of wound assessment and healing terms and definitions, as well as pressure ulcer staging systems.

18	Irving V. 2001.	Caring for and protecting the skin of preterm newborns.	Pre-terms, neonates. NICU	Review.
19	Bonell-Pons L. 2014.	Neonatal facial pressure ulcers related to noninvasive ventilation: Incidence and risk factors.	Neonates. NICU, SICU.	Multicentre, prospective, observational.
20	Curley MA. 2003.	Pressure ulcers in pediatric intensive care: incidence and associated.	Children. PICU.	Multisite prospective cohort
21	de Lima EL. 2016.	Cross-cultural adaptation and validation of the Braden Q risk assessment scale.	Neonates, infants. NICU.	Observational. Cross-cultural daptation.
22	Anthony D. 2010.	A comparison of Braden Q, Garvin and Glamorgan risk assessment scales in paediatrics.	Children. Pediatric.	Observational. Cross sectional.
23	Tume LN. 2014.	The prognostic ability of early Braden Q scores in critically ill children.	Children. Pediatric.	Retrospective cohort.
24	Willock J. 2016.	A comparison of the performance of the Braden Q and the Glamorgan paediatric pressure ulcer risk assessment scales in general and intensive care paediatric and neonatal units	Children, Pediatric.	Observational. Cross sectional.
25	Kottner J. 2012.	Inter-rater agreement, reliability, and validity of the Glamorgan Paediatric Pressure Ulcer Risk Assessment Scale	Children. Pediatric.	Observational.
26	Willock J. 2015.	Inter-rater reliability of the Glamorgan Scale: overt and covert data.	Children. Pediatric.	Observational.

	Preterm infants have very immature skin that needs special care and attention and very cautious use of products	More research and guidelines are urgently needed on the management of this group of patients.
	A sample of 268 infants was included. The cumulative incidence of PU was 12.70% (95% confidence interval, CI95% = [8.95% 17.28%]). The cumulative incidence in intermediate care units was 1.90% (CI95% = [0.39% 5.45%]), while it was 28.18% (CI95% = [20.02%-37.56%]) in the intensive care units. PUs were classified as stage I, 57.10%; stage II, 31.70%; and stage III, 11.10%. The multivariate analysis found the following to be risk factors: low scores on the Spanish version of the Neonatal Skin Risk Assessment Scale (eNSRAS) (Relative Risk (RR) 0.80; CI95% = [0.66-0.97]), the use of non-invasive mechanical ventilation use (RR 12.24; CI95% = [4.02-37.32]), and length of stay (RR 1.08; CI95% = [1.02-1.15]), suggesting a direct impact of these factors on PU development in infants. Kangaroo care influenced the prevention of PUs (RR 0.26; CI95% = [0.09-0.71]). The infants admitted to intermediate care units suffered PUs. In the case of intensive care units, the incidence is even higher. The risk increases with the length of stay, while the presence of medical devices, particularly noninvasive mechanical ventilation, is the main causal relationship	
	Pressure ulcers were classified according to the recommendations of the American National Pressure Ulcer Advisory Panel Consensus Development Conference. Eighty-six patients (27%) developed 199 pressure ulcers; 139 (70%) were Stage I, 54 (27%) were Stage II, and 6 (3%) were Stage III. Of the 60 stage II / III pressure ulcers, 19 (32%) involved the head. Stage III pressure ulcers involved the occiput, ear, chest, and coccyx. An additional 27 pressure-related injuries were caused by medical devices. Statistically significant Stage I pressure ulcer predictor variables include the use of mechanical ventilation, mean arterial pressures < or =50 mm Hg, and lower Braden Q scores.	PICU patients at risk include those supported with mechanical ventilation, those with hypotension, and those who have low Braden Q scores. This study provides unique benchmark data for the general population of the PICU from which pediatric interventional studies can be designed to reduce the incidence of pressure ulcers in this vulnerable patient population.
	The scale showed inter-rater reliability (ICC = 0.98; P < 0.001) and intra-rater reliability (ICC = 0.79; P < 0.001). A strong correlation was found between the Neonatal/Infant Braden Q Scale and Braden Q Scale (r = 0.96; P < 0.001).	The cross-culturally adapted Brazilian version of the Neonatal/Infant Braden Q Scale is a reliable instrument, showing face, content, and construct validity.
	Data were collected from 236 children. 71 were from children in 11 hospitals who were asked to provide data on children with pressure ulcers (although seventeen did not have a pressure ulcer), of whom five were deep (grade 4). A sample of 165 were from one hospital, of which seven had a pressure ulcer, none grade four. The Glamorgan risk assessment scale had a higher predictive capacity than the Braden Q or Garvin. The mobility subscore of each of the risk assessment scales was the most predictive in each case.	The Glamorgan scale is the most valid of the three paediatric risk assessment scales studied in this population. Mobility alone may be as effective as employing the more complex risk assessment scale.
	The Braden Q score was found to perform well in children aged 3 weeks to 8 years without congenital heart disease (CHD), which is the population in which it was validated. At a cut-off score of ≤16 it yielded a sensitivity of 100% specificity of 73.1%, positive predictive value (PPV) 2.56 and a negative predictive value (NPV) of 100 and an area under the curve (AUC) of 0.87(0.75-0.98). When used in other age groups and when including children with CHD, it performed less well with lower AUC and wider confidence intervals, but it performed moderately well in the term to 14 years with a sensitivity of 75% specificity of 72.6%, PPV 1.5 and a NPV of 99.8 and AUC of 0.74 (0.49-0.98).	Our results in a heterogeneous UK PICU population found that the Braden Q score performed well in the specific population it was validated for (PICU children aged 3 weeks to 8 years without CHD); however, it performed moderately well in the more heterogonous PICU population of term to 14 years including children with CHD.
	The two scales were similar in this population in terms of the area under the curve. Neonatal and paediatric intensive care were similar in terms of AUC for both scales, but in general paediatric wards the Braden Q may be better suited to predict risk.	Either scale could be used if the predictive ability was the outcome of interest. The scales appear to work well with neonatal, paediatric intensive care, and general children's wards. However, the Glamorgan scale is probably preferred by children's nurses as it is easy to use and designed for use in children. There is some suggestion that, while the two scales are similar in intensive care, for general pediatrics the Braden Q may be the better scale.
	27 nurses rated by 27 nurses. The median age was 5·5 years. The agreement between the score of the items was high, while the reliability coefficients of the score of the items were low. The inter-rater reliability for the Glamorgan scale sum scores was higher than for VAS scores. The correlation between both scales was moderate.	High agreement among item scores indicates that nurses are able to make precise judgments. The low interrater reliability of the item and sum scores indicates that nurses were unable to differentiate the children rated based on their item and sum scores, thus providing little additional clinical relevant information about the risk of pressure ulcers in this setting.
	In the overt data collection, 24 of 27 nurses agreed with the researcher (88.9% agreement, kappa 0.867). In the covert data collection, 41 out of 55 risk assessments had been completed. Of the 41 completed assessments, 34 agreed with the researcher and the tissue viability link nurse (82.9% agreement, kappa 0.763).	The level of agreement was good for overt and covert interrater reliability data.

27	García-Molina P. 2017.	Cross-cultural adaptation, reliability, and validity of the Spanish version of the Neonatal Skin Risk Assessment Scale.	Neonates. NICU.	Observational. Cross-cultural adaptation.
28	Curcio F. 2022.	Translation and cross-cultural adaptation of the Neonatal Skin Risk Assessment Scale (NSRAS) to Italian.	Neonates. NICU.	Observational. Translation and cross-cultural adaptation.
29	Çigdem S. 2017.	Validity and reliability of the Turkish Version of the Neonatal Skin Risk Assessment Scale.	Neonates. NICU.	Observational. Translation and cross-cultural adaptation.

Table 2. Data extraction table.

	In the first phase, the content validity index was 0.93. In the second phase (336 neonates), the intra-rater reliability was 0.93 and the inter-rater reliability was 0.97. The construct validity has shown a two-dimensional model that fits better, representing "pressure duration and intensity" and "skin immaturity." In the third phase (268 newborns) the best values were those presented by the score 17: the receiver operating characteristic curve was 0.84, showing a sensitivity of 91.18%, specificity of 76.50%, positive predictive value of 36.05%, and negative predictive value of 98.35%.	The scale has shown evidence of validity and reliability in measuring the neonatal risk of pressure ulcers in the Spanish context.
	The final version approved by the expert committee was well understood by all nurses who participated in the study and has obtained good face validity and content validity. Expert evaluation provided a CVI total of 0.92 [0.85-0.96], with Aiken V values for each item analysed ranging between 0.85 and 0.97.	i-NSRAS is a clear, simple, relevant, and unambiguous tool. It is also updated with current knowledge on PUs and evaluates the presence of clinical devices as a risk factor in the neonatal population.
	Cronbach's α for the overall scale was.88, and Cronbach's α values for the sub-articles were between .83 and .90. The results showed a positive relationship between all sub-articles and the overall NSRAS scale grade ($P < .01$) with correlation values between 0.333 and 0.721. Explanatory and predicative factor analysis was applied for structural validity. Kaiser-Meyer-Olkin analysis was applied for sample sufficiency and Bartlett test analysis was applied to assess the factor analysis of the sample. The Kaiser-Meyer-Olkin coefficient was 0.73, and the χ value found according to the Bartlett test was statistically significant at an advanced level ($P < .05$). In the six sub-articles of the total grade of the scale and in the general scale, a high, positive, and significant relationship was found between the grades given by the researcher and the nurse observers ($P < .05$).	The Turkish NSRAS is reliable and valid.

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