Research

Risk Factors for Skin Injuries in Hospitalized Children: a Retrospective Study

Citation: Nicolosi B., Parente E., Fontani I., Idrizaj S., Stringi D., Bamonte C., Longobucco Y., Buccione E., Maffeo M., Granai V., Gregorini M., Ciofi D. "Risk Factors for Skin Injuries in Hospitalized Children: a Retrospective Study" (2024) *infermieristica journal* 3(4): 277-285. DOI: 10.36253/if-3159

Received: October 25, 2024

Revised: November 26, 2024

Just accepted online: December 20, 2024

Published: December 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

Background. Skin injuries in hospitalized pediatric patients can slow recovery, increase infection risk, pain, stress, length of stay, and healthcare costs, while reducing family quality of life. The prevalence and incidence of these injuries vary by environment, comorbidities, and specific pathologies.

Objective. Identify the main risk factors related to skin lesions in hospitalized children

Methods. This retrospective, observational, monocentric study aims to identify the main risk factors for skin injuries in hospitalized children.

Results. A study of 880 hospitalized children aged 0-17 from January 2019 to December 2020 found that 133 developed skin injuries. Factors increasing risk included longer hospital stays, comorbidities, forced bed rest, and the number of medical devices. Each additional hospitalization day and lower weight raised the risk. Continence was protective. Injuries mainly affected the perineum, upper limbs, face, lower limbs, abdomen, and occiput. These findings emphasize the need for tailored prevention strategies for pediatric patients due to their unique characteristics.

Conclusions. This study underscores the need for further research to develop effective prevention protocols specifically for pediatric populations, emphasizing the role of comprehensive risk factor assessment and resource allocation to mitigate skin injury risks in hospitalized children.

Keywords: Pediatric Skin Injuries, Hospitalization, Risk Factors, Pressure Ulcers, Comorbidities, Medical Devices, Prevention Strategies

Introduction

Skin Injuries in pediatric environment are mainly due to hospitalization. Their onset can slow down the functional recovery and expose to infection risk, pain, extend length of stay, stress, reduce the family's quality of life, and increase of the health spending. [1-2]

The prevalence of the skin varies in relation to environment in which the children lives or is cared, and the concomitance of particular pathologies or comorbidities. [3-4]

Pressure injuries (PIs), medical device-related pressure injuries (MDRPIs), and incontinence-associated dermatitis (IAD) are common challenges in neonatal and pediatric care, each with distinct risk factors due to the unique characteristics of this population.

For PIs, the immaturity of neonatal skin plays a central role. The thinner stratum corneum and weaker dermo-epidermal junction make the skin highly susceptible to mechanical trauma, stripping, and infections. Preterm infants are at greater risk due to their underdeveloped subcutaneous fat and limited thermoregulation capacity, further predisposing them to pressure-related damage.[5-6] Prolonged immobility, edema, and malnutrition compound the risk by reducing tissue resilience and increasing pressure on bony prominences. [7]

MDRPIs are primarily caused by prolonged contact with medical devices, such as nasal cannulas, tracheostomy tubes, and face masks. These devices exert continuous localized pressure, which, when combined with shear forces and friction, damages the skin. Excessive moisture, particularly under occlusive devices, softens the skin and amplifies friction-related injuries.[7]

IAD, on the other hand, is driven by prolonged exposure to urine or feces. The acidic environment damages the stratum corneum, while enzymatic activity from fecal matter exacerbates the breakdown of the skin barrier. Factors such as frequent diaper changes, high moisture, and poor ventilation increase the risk.[8]

The current guidelines for managing neonatal and pediatric skin focus on the unique vulnerabilities of this population. For pressure injury prevention, the guidelines emphasize the need for regular repositioning, the use of pressure-redistribution surfaces, and protective dressings to minimize friction and shear forces. Special attention is given to device-related injuries, urging frequent inspections under medical devices and applying interface layers like silicone dressings to reduce pressure.[7]

In the context of moisture-associated skin damage (MASD), the guidelines outline strategies for preventing and managing incontinence-associated dermatitis (IAD). These include frequent diaper changes, application of barrier creams, and the use of superabsorbent materials to maintain skin dryness and integrity.[9]

For wound care, holistic assessment and management are central. This includes evaluating skin condition, using age-appropriate tools for pain management, and selecting dressings that support moist wound healing while considering the delicate nature of neonatal and pediatric skin.[10]

The guidelines stress continuous education for healthcare providers and collaboration with families to ensure tailored care that meets the physical and emotional needs of pediatric patients.[10]

The anatomical, physiological and developmental characteristics of the pediatric population are completely different from those of adults, consequently the risk factors for skin Injuries are also different.[11] Therefore, have a deeper understanding of the problem is of great importance for the prevention and control of the phenomenon, as well as for the allocation of resources in the pediatric population.

The aim of this study is identify updated and specific date on the main risk factors, so as to suggest useful information for defining appropriate prevention care strategies for neonates and children.

Methods

Study design

The study is observational, retrospective case-controll, monocentric.

Sample size

To calculate the sample size, we used the Online Sample Size calculator (Online Sample Size Calculator. Available at: https://www.calculatorsample.com. Accessed 2024 Nov 01), with a 95% confidence interval, a margin of error of 5% and an expected prevalence of 20%. We based the reference population on the report of the Regional Health Agency Tuscany 2016, which highlighted pediatric hospitalizations in

patients aged 0 to 17 years, which amounted to 40,635. (12)

We calculated a sample size of 245, but not knowing the prevalence we decided to increase the sample to 1000 units, in order to increase the possibility of having a number of cases that would allow us to control the selection bias. We extracted 880 files in the index period, which were still considered a valid number even if less than 1000.

The selected sample was 880 children, with age included 0-17 years and 364 days old, hospitalized in general medical pediatrics (n = 141), pediatric neurosurgery (n = 237), pediatric neurology (n = 77), pediatric intensive care unit (n = 33) and neonatal intensive care unit (n = 392) during January 2019-December 2020. Of these, 133 were children that developed skin injuries during the hospitalization and 747 were those that didn't develop skin injury.

We extracted data through electronic or paper clinical records, with non-probability convenience sampling.

We excluded the children with surgical wounds healed by primary intention, puncture wounds, stab wounds or blunt force wounds and burns were excluded. Included skin injuries were: PIs, Medical Device Related Pressure Injuries (MDRPIs), skin tears, Moisture Associated Skin Damage (MASD), Medical Adhesive Related Skin Injuries (MARSI).

Statistical analysis

Through statistical analysis, we compared cases and controls, to determine the main conditions and factors that more prepare to skin injuries development.

The data were analyzed anonymously and aggregated using Epi Info 7.2.2.6 01/24/2018 statistical software, Italian version, for the frequencies relating to each variable. Subsequently, the data are subjected to the Mann-Whitney for the comparison between the means, while the "Chi Square" was used for the comparison between qualitative variables and to establish the relationships between dependent variables and independent variables, in order to determine statistical significance with P Value 0.05.

To account for multiple factors potentially influencing the development of skin injuries, a logistic regression model was implemented. This model allowed simultaneous analysis of several independent variables to identify the main risk factors. Variables significantly associated with skin injury development in univariate analyses (P-value ≤ 0.05) were included in the logistic regression model. Adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to estimate the strength of the associations, providing a comprehensive understanding of the interplay between various risk factors.

Ethical

The data submitted in this study were collected following the approval of the Regional Pediatric Ethics Committee of Tuscany (prot. Nr. 199/2021) and the acquisition of informed consent and authorization for the processing of personal data.

For children older than 7 years, both their assent and the informed consent of their parents/guardians were obtained.

All procedures were conducted in accordance with the Declaration of Helsinki and current regulations regarding the protection of personal data.

Results

In this study we have enrolled 880 patients, 747 (84.8%) in the control group and 133 (15.2%) in the case group, children with injury. Most of the children were enrolled in the NICU (44%, n = 392). The 55% (n = 488) were males, the 45% (n = 392) were females. The average age of the sample was 76 months (.03 – 216); the average weight was 13.87 Kg (1.8 – 103).

The children were hospitalized for neonatal pathology (40%, n = 352), especially neonatal surgical pathologies of the digestive tract (5%, n = 18), surgery pathology (36%, n = 321), in particular neurosurgery (permanent drainage implants, malformations, tumors, trauma) (18,2%, n = 42), and medical pathology (24%, n = 206), above all for respiratory diseases and fever (9.2%, n = 19). In the 42% (n = 370) cases the children had comorbidity, of which 43% (n = 159) had more one than it. We have investigated the principal pharmacological therapies administered, and the drugs most used were antibiotics, associated with other drugs (23%, n = 206), analgosedation with other drugs (18%, n = 160), and pharmacological therapies for specific pathologies (15%, n = 130). During the hospitalization, we have counted until 11 devices, in the specific 7% (n = 61) had 1 device, 93% (n = 819) had more than 1 devices (Table 1). The presence of device and its numbers determined the onset of skin injuries (Table 2).

Table 1. Number of devices for child in cases group.

Devices (*n*)	Children (*n*)
2	21
3	19
4	18
5	25
6	16
7	16
8	9
9	3
10	4
11	1

Table 2. Relation between onset and number of injuries and devices.

Presence of devices	*OR*	*95% IC*	*p*
	1.25	[1.10-1.42]	0.001

Number of devices	**CONTROLS GROUP**		**CASES GROUP**				
	i	*a*	*i*	*a*	*OR*	*95% IC*	*p*
	(1 - 11)	4	(2 - 11)	5	0.216	[.137-.294]	0.000

95% (n = 833) of the sample were continents, 5% (n = 46) had functional incontinence.

In the sample, the children with forced to bed rest were 10% (n = 88), the others (90%, n = 792) were children with physiological bed rest by age.

Table 3 displays demographic differences and clinical features of the patients between the two groups, and the principal variables which we investigated. The data identified significance between the two groups, compared weight (p<0.004), length of stay (p<0.000), and comorbidity number (p<0.013), and forced bed rest (p<0.002), about the risk and number of wounds. We didn't detect significance about the ethnicity.

Table 3. Univariate groups control and cases relative to the injury risk and total number of injuries.

VARIABLES	CONTROLS GROUP		CASES GROUP		*OR*	*95% IC*	*p*
	n	%	*n*	%			
Sample	747	84.8	133	15.2			
Gender	M 410; F 337	M 55; F45	M 78; F 55	M 58; F 42	0.854	[0.516-1.414]	0.54
Entry diagnosis	**Diagnosis**	*n (%)*	**Diagnosis**	*n (%)*			
	Surgical abdominal pathology	104 (13.9)	Respiratory distress/Dyspnea	13 (9.7)			
	i	*a*	*i*	*a*			*p*
Age (months)	(0.03 - 204)	72,78	(0.03 - 216)	78,81	0.933	[1.03-1.48]	0.200
Weight (Kg)	(1.8 - 103)	15.7	(0.51 - 73)	12.3	0.729	[0.588-.905]	**0.004**
Length of stay (days)	(1 - 61)	9.1	(1 - 284)	26.8	1.06	[1.03-1.09]	**0.000**
	n	%	*n*	%			*p*
Comorbidity	305	41	65	57	1.38	[0.835-2.28]	.20
	> 1 comorbidity		**> 1 comorbidity**				
	124	41	35	54	1.30	[1.05 - 1.61]	**0.013**
Continence	33	4	13	10	.433	[-.162 – 1.15]	0.095
Forced bed rest	58	8	30	23	3.43	[1.55 – 7.57]	**0.002**

Values are numbers (n), average (a) and intervals (i), comparisons with regression logistic.

The wound more represented were Incontinence Associated Dermatitis (IAD) (38.3%, n = 51), PIs (22.5%, n = 30) and MDRPIs (17.2%, n = 23). Children with injury had from 1 to 11 wounds as we reported in Table 4.

Table 4. Injury and children number.

Wound (*n*)	Children (*n*)	%
1	90	67
2	25	18.6
3	13	9.7
4	2	1.5
5	1	0.7
7	2	1.5
11	2	1.5

The main areas affected by the Injury were: perineum (41%, n = 55), upper limb (12%, n = 16), face (12%, n = 16), lower limb (8%, n = 11), abdomen (8%, n = 11), and occiput (6%, n = 8).

The results of the multivariate analysis conducted to identify the variables associated with the number of skin injuries in hospitalized children have been reported (Table 5). This analytical approach allowed for the simultaneous evaluation of the effects of different independent variables, accounting for their interactions, and estimating their impact on the number of reported injuries.

Table 5. Multivariate analysis, compared with number of wounds.

VARIABLES	*B*	*95% IC*	*p*
Hospital stays	0.018	[0.013-0.023]	0.000
Continence	-0.870	[-1.48- -0.259]	0.005
Forced to bed	-0.578	[-1.05- -0.105]	0.017
Comorbidity number	0.156	[0.041-0.271]	0.008

Discussions

In this retrospective monocentric study we analyzed the risk factors associated with skin injury in a sample of hospitalized children, and we detected that several variables were significantly associated with skin wounds: increased weight is associated with reduced risk of injury; longer hospital stays were correlated with a higher risk of skin injury; the presence of comorbidities, especially multiple, increased the likelihood of developing wounds and wounds number; continence was a significant factor protective; children forced to bed for non-physiological reasons had a higher risk of Injuries. With our investigation we have highlighted that skin Injuries are a common problem in hospitalized children.

From the data we identify that length of hospital stay is one of the most determinants risk factor for injuries in pediatrics. Children who spend more days in the hospital are more at risk of injury than children who spend fewer days in the hospital.[13] In agreement with Fischer et al (2010), each day of hospitalization increases the likelihood of PIs by 13%.[14] Moreover, Garcìa-Molina et al (2018) reports that every additional day of stay increased the risk by 1.15%.[15]

In McCord et al (2004) the risk of injuries increases for length of stay greater than 96 hours[16]; in Schlüer et al (2014) is reported a mean length of stay of 24 days related risk of PIs.[4] Hospital-acquired injuries have significant economic implications for healthcare systems as they prolong patient stays.[14]

Children hospitalized for prolonged periods naturally have a greater exposure to the risk of developing skin injury.[17-18-19]

In this study we detected that the children with a lower weight are a greater risk of injury than people with a higher weight. This result is consistent with available studies, that show as obesity and normal weight appeared to protect patients from developing PIs: patients in the underweight and extremely obese groups have higher rates of PIs than patients in the normal weight or obese groups.[20-21-22-23] In our case, this result may depend of the sample characteristics, in which are presents more neonates. The skin of newborns has important anatomical and physiological differences compared to that of older children and adults.[6] It is thin, with fewer hair 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. Furthermore, there are greater water losses at the trans-epidermal level, therefore the tendency towards dryness is greater; the adipose tissue is small; neonatal cephalic dimensions increase the risk of Injuries in the occipital and temporal area, as it is also an area exposed to greater pressure. In the preterm newborn all these characteristics are more decisive.[6] For the assessment of the risk and the prevention of wounds, we should consider the weight and BMI value.[22]

As turns out from our data, the comorbidity is a risk factors of skin injury, which also influence its number. That is confirmed from the data available in literature, in which the comorbidity is conditioned with entry diagnosis, long length stays, multipharmacology, humidity, and conditions on mobility and incontinence.[3-24-25]

About the relation between risk of skin injuries and comorbidity in pediatric environment, there are few available information. The main data reported are about the adult; from this context, we know for sure that many people with chronic conditions develop complications which contribute to the onset of injuries.[26]

In our cases group, the entry pathology most frequent was respiratory distress in respiratory infections, with one or more comorbidity. This condition involves exposure at pharmacological therapies for the sedation and intubation, antibiotics for infections, immobility, and continuous contact with the medical devices. In these children, we also detected comorbidity neurological and neurosurgeries, with limited mobility or immobility and functional incontinence. All this information shows as comorbidity is a risk factors to develop of injuries, and as these are multifactorial problems.[4-18-19-27] PIs are a serious complication of multimorbidity and immobility.[28] Patients with high risk of injury include those who are immobilized by an illness or temporary condition and who have multiple risk factors, such as comorbidities and functional limitations, e.g. incontinence.[28] Risk factors should always be assessed, especially in a patient with multiple associated comorbidities, to establish the patient's risk and define appropriate measures for prevention.[28-29] The feasibility, implementation and effectiveness of the applied measures should be periodically reviewed and documented, and any necessary corrections should be made.[28-29] According to international best practices, repositioning should be included in PIs management strategies.[30]

We demonstrated that the presence of injuries is significantly correlated with the presence and number of medical devices. This result of ours is confirmed in the literature, many authors confirm the enormous impact of the devices on the risk of PIs. Among newborns and children, more than 50% of PIs are due to the presence of devices MDRPIs are related to the patient's condition and increase as the severity of the patient's condition increases.[31-32]

Belong to this group the children with more one injury, also to different etiology (PIs, MDRPIs, IADs). In the hospitalization context, comorbidity, disability, and dependence, PIs represents one of the adverse events most severe; occur in all setting and age group.[33-34] In the clinic practice, are found other skin injury, as IADs, friction injury, MDRPIs.[35-36-37]. PIs are caused by continuous mechanical force, tissue deformation (skin, subcutaneous fat, muscle, including bone, tendon), external surfaces or devices. If the intensity and duration of deformation exceed the resistance capacity of the deformed tissues, cells die and necrotic regions develop.[38] In addition to mechanical factors, it is now clear that the structure and function of the skin also play a key role in the susceptibility and development of skin injuries.[39-40]

The relationship between the length of hospital stay and the high percentage of devices may indicate a susceptibility to iatrogenic damage in the child population, also deriving from the physiological characteristics of the child's skin. This aspect does not only apply to the newborn, in fact the characteristics of the skin, such as the integrity of the stratum corneum, permeability, hydration and fully formed dermal architecture vary substantially for months after birth in newborns, especially if premature. [6-8-41-42-43-44]

As reported in other studies[13-45-46], ours also confirm that in the pediatric field, the onset of skin injuries is influenced by intrinsic factors (maturity of the skin, weight, functional characteristics, comorbidities, pharmacological therapies) and extrinsic factors (medical devices, hospitalization). Overall, there is no single factor that can explain the risk of injuries in the hospitalization children, rather a complex interaction of factors that increase the likelihood of them development.

The establishment of a support system for prevention and treatment, and related education, are of the utmost importance in the prevention and treatment of skin Injuries.[47-48]

To correctly apply prevention strategies, nurses must carefully monitor and record the information necessary to establish the hospitalized child's risk.[47-48]

Our study provides a further step towards the development of an epidemiological conceptual framework, which improves our understanding of the role of individual risk factors in the development of skin injuries.

Limitations

The study design is retrospective, for this liable of selection bias and recall. The study was conducted in a single pediatric center in Italy, so the results may not be generalizable to other pediatric populations.

The sampling was conditioned from various problems, as availability of clinical records. Several records referred at the two-year period were archived, in the same period was changed the software of the clinical records. Furthermore, the data collection was conducted partly during the Covid-19 pandemic, making the continuation of the study very complex.

Conclusion

This study highlights the multifactorial

nature of skin injuries in hospitalized children, emphasizing their prevalence and complexity in pediatric care. Key findings underscore the significance of prolonged hospital stays, comorbidities, and medical devices as major risk factors. The immaturity of pediatric skin, particularly in neonates and preterm infants, increases susceptibility to mechanical, moisture-associated, and device-related injuries. These injuries not only impact the child's health but also prolong hospital stays, contributing to stress, pain, and increased healthcare costs, ultimately affecting the quality of life for both patients and their families. While quality of life and prevention strategies are critical components of effective care, they were beyond the scope of this study and warrant further investigation. Nonetheless, the findings advocate for the implementation of tailored prevention strategies, including regular monitoring, appropriate use of medical devices, and education for healthcare providers and families. These measures are crucial to reducing the incidence of skin injuries and improving outcomes in hospitalized pediatric patients.

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