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The correlation between the risk score and skin injuries in neonatal intensive care units

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A – Study Design, **B** – Data Collection, **C** – Statistical Analysis, **D** – Data Interpretation, **E** – Manuscript Preparation, **F** – Literature Search, **G** – Funds Collection

Summary **Background.** Preventive activities play an important role in today's healthcare systems. In this regard, the use of skin injury risk assessment tools in the neonatal intensive care unit (NICU) is advocated as an effective technique to decrease skin injury.
Objectives. This study aimed to evaluate the relationship between risk score and skin injuries in newborns admitted to the NICU.
Material and methods. This descriptive study was conducted on 265 newborns admitted to the NICUs in Tabriz, Iran. For data collection, we used the Skin Risk Assessment and Management Tool (SRAMT). Data was collected by repeated observations of newborns and was analysed using descriptive statistical methods and Spearman's correlation coefficient.
Results. The mean risk score decreased from 19.85 on the first day of hospitalisation to 13.23 on the twenty-eighth day (scoring range from 8 to 32). During the study, 557 skin injury were reported, 84.91% of which occurred in the first week of hospitalisation. There was also a statistically significant correlation between risk score and skin injury ($R = 0.37$, $p < 0.00$).
Conclusions. According to our results, a higher risk score was associated with an increased incidence of skin injuries. Thus, it is recommended that the risk score be developed through utilising risk prediction methods to identify newborns at risk of skin injuries. It is essential to develop skin care programmes and preventative measures in NICUs.
Key words: risk factors, skin, wounds and injuries, neonatal intensive care units, newborn infant.

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Background

Providing medical care to newborns in the neonatal intensive care unit (NICU) requires the use of a variety of medical equipment on the newborn's skin and performing a variety of procedures. These approaches can facilitate treatment and increase the survival of newborns. However, these interventions may adversely influence the quality of life or development of the newborns [1].

The skin, as a newborn's largest organ, has a variety of functions, including protection, regulation of body temperature, metabolism and sensory roles [2, 3]. Additionally, newborns are at significant risk of skin injury due to the lack of anatomical and physiological development of the skin in early life [4]. In this regard, one of the primary responsibilities of the care team is to protect the skin integrity in newborns [1].

Skin injury can result in systemic or local infections, which are a leading cause of newborn mortality in intensive care units. It can also cause water and electrolyte imbalances and temperature instability. Broken skin caused by several traumas can lead to pain and discomfort, increased hospitalisation time and cost, parental anxiety and possible negative outcomes, such as legal claims [5–7].

Skin injury in newborns is caused by both internal and external factors. Neonatal immobility caused by sedation and muscle relaxants, poor circulation due to the use of cooling equipment such as cool cabs and dehydration, surgery and malnutrition are among the known internal factors [8]. External factors are commonly repeated interventions [9] and are defined as those that put a newborn at risk for skin injury; these include mechanical ventilation equipment such as CPAP (Continuous Positive Airway Pressure), skin disinfectants (causing chemical injury), pressure ulcers caused by probes and monitoring electrodes, as well as adhesives used for tubes, causing skin rupture, peeling and abrasion [8, 10]. Skin injuries are common in neonatal wards [4], and their prevention begins with assessment of the patient in the early stages of nursing care [11].

Since routine skin assessment during a newborn's stay in the NICU is a critical component for lowering the risk of skin injury, the nursing staff should pay special attention to this issue [12]. The use of predictive tools to assess skin condition and the risk of skin injury is essential to direct care, which should be included in the care plan [4, 13, 14]. Health professionals have acknowledged the benefits of employing skin injury risk assessment methods internationally in the NICUs of such countries as the United States, the United Kingdom and Australia [3, 10, 15–20].

The instrument utilised must have great sensitivity, a high predictive value, as well as be practical and easy to use. However, there is a lack of specific tools for newborns. This has led many neonatal units to administer the Braden-Q (BQS) paediatrics scale [1].

Recently, Australian nursing specialists developed the Skin Risk Assessment and Management Tool (SRAMT) to measure the risk score, risk range and different skin injuries. This tool was designed specifically for neonates and has the care instructions for all types of risk areas and all types of skin injuries. The incidence of skin injury in newborns was reduced by about 20% after its first-time use in an Australian NICU [4]. However, the researchers expressed that further studies are required to determine the tool's efficacy in predicting the risk of skin injury [4].

Objectives

Given the critical nature of preventing skin injuries in newborns and the paucity of available tools for the neonatal population, there is a need to develop new objectives and valid tools for routine use in hospitals to increase early identification of patients at risk of skin injury and to implement appropriate care instructions to reduce the incidence of skin injuries. Accordingly, using the SRAMT tool, this study aimed to evaluate the relationship between risk score and skin injuries in newborns admitted to the NICU.

Material and methods

This descriptive study was conducted on newborns admitted to the NICUs in Tabriz, Iran. Considering the data of pilot study, the relation between outcome and risk factor, an OR = 2.3, as well as a test power of 90 and 95% confidence level, the minimum sample size was estimated as 265.

Newborns hospitalised to three NICUs were selected using conventional sampling. Newborns with blood or skin diseases, skin injury during birth or surgery and those who were discharged, died or were transferred to another hospital within the first three days were excluded.

Data collection tools

A demographic questionnaire was utilised to collect information on the newborns, including gestational age, gender, birth weight, diagnosis and length of hospitalisation.

To determine the risk score and the type of skin injury, we used the SRAMT developed by Broom et al. [4]. This tool consists of four sections: risk score, risk ranges, types of skin injuries and clinical practice guidelines (Table 1). Since the purpose of the study was to describe the existing conditions and not to intervene, we used the first three sections of this tool in our study.

In the first section, eight components are evaluated to determine the risk score, including: respiratory support, current

Table 1. Skin risk assessment score (based on SRAMT)

Category	Score	Descriptor
Current gestational age	4	Neonate ≤ 28 weeks
	3	Neonate > 28 weeks and ≤ 33 weeks
	2	Neonate > 33 weeks and ≤ 38 week
	1	Neonate > 38 weeks
Sensory perception	4	Diminished level of consciousness/muscle relaxed/heavily sedated/cooling for HIE
	3	Oversensitive to noise, lights and touch/easily agitated/difficult to calm
	2	Easily agitated but calms with comfort measures/few self-calming behaviours
	1	Responds appropriately to stimuli, alert, good self-calming behaviours
Activity/mobility	4	Makes no change in position – full assistance required
	3	Makes occasional slight changes in body or extremity position
	2	Makes frequent changes in body or extremity position, e.g. turns head
	1	Makes major and frequent changes in position, moving all extremities, turns head
Moisture	4	Constantly moist due to humidity/urine/wound/stoma/respiratory support/NAS
	3	Skin often moist – linen needs to be changed < 12 hours
	2	Skin occasionally moist – needs linen change > 12 hours
	1	Skin usually dry, routine nappy changes and linen once/day
Respiratory support	4	Intubated and ventilated or CPAP ≥ 6 cm H_20
	3	CPAP ≥ 5 cm H_20
	2	High flow/low flow/micro low flow/Cot O_2
	1	No respiratory support
Skin Integrity (visual examination)	4	Extensive loss of skin integrity wound/pressure area
	3	Localised loss of skin integrity/broken area/oedema/nappy rash/excoriation
	2	Minor skin irritation/redness
	1	Skin integrity intact
Blood collection	4	Neonate requires cannulation/PICCS/daily blood collection
	3	Neonate requires heel prick for blood collection
	2	Blood collection weekly
	1	No blood collection required
Nutrition	4	TPN + lipids/IV fluids/NBM/does not tolerate feeding
	3	TPN + lipids/IV fluids/trophic feeding
	2	TPN + lipids/IV fluids/gastric feeds increasing and tolerated
	1	Full gastric feeds

gestational age, sensory perception, activity/mobility, moisture, skin integrity, blood collection and nutrition. Each component was scored from 1 (lowest) to 4 (highest). The total risk score was between 8 and 32.

The second section determines the risk range according to the score achieved in the previous section: score of 8 (low risk), score of 9–16 (moderate risk), score of 17–24 (high risk), and score of more than 25 (extreme risk).

The third section defines seven different forms of skin injuries, including bruises, epidermal peeling, excoriation, extravasation and infiltration injuries, chemical burns, thermal burns and pressure injury.

To ensure the content and face validity, the questionnaire was distributed among 15 researchers and faculty members of Tabriz University of Medical Sciences. Their comments were then applied, and other potential causes of skin injury were added to the third section of questionnaire. To assess the reliability, the questionnaire was completed for 20 newborns separately by two members of the research team. The degree of agreement between the two observers was determined using Kappa Cohen, which ranged between 0.73–1, and a mean score of 0.96 indicated a high degree of inter-observer reliability.

Data collection and analysis

Data collection was conducted during the morning or evening shifts and included file documentation, as well as direct observation and examination of the newborns. Observation was done on the first, third, fifth, seventh, tenth, fourteenth, twenty-first and twenty-eighth days of hospitalisation (at least two times and at most eight times based on the length of hospitalisation). An injury was not recorded again in subsequent observations after being initially recorded.

SPSS software version 13 was used for data analysis. Qualitative data was summarised and reported as frequency and percentage, and quantitative data was reported as mean and standard deviation. The correlation between risk score and skin injury was determined using Spearman's correlation coefficient with a significance level of 0.05.

Ethical considerations

After the Ethics Committee of Tabriz University of Medical Sciences approved the study (code: IR.TBZMED.REC.1397.681), the research aims were explained to the NICU managers. Before initiating the study, a face-to-face interview was held with the parents to describe the research aims and procedures. Informed written consent was also obtained from the parents.

Results

In this study, the majority of newborns were male and had been born prematurely (less than 37 weeks of gestation). Almost half of the newborns were admitted to the hospital due to respiratory distress syndrome (Table 2). The mean birth weight (gr) was 2,307.13 ± (899.83), gestational age (week) was 33.92 ± 3.77, and hospitalisation (day) was 10.61 ± 7.93.

Table 2. Demographic characteristics of newborns

Variable	Level of change	Number (per cent)
Gender	male female	169 (63.8) 96 (36.2)
Gestational age	term preterm	59 (22.3) 206 (77.7)
Surgery	yes no	15 (5.7) 250 (94.3)
Type of disease/ diagnosis	Respiratory Distress Syndrome (RDS) prematurity digestive heart internal nervous other total	 128 (48.3) 32 (12.1) 12 (4.5) 9 (3.4) 8 (3.0) 2 (0.8) 4 (1.5) 265 (100)

The total number of observations made throughout the study period was 1,148. Due to discharge, transfer to other hospitals or death, the number of samples gradually decreased from the fourth day and reached 30 (11.3%) newborns on the 28th day. Out of 265 newborns, 191 cases had skin injuries. Out of 1,148 observations, 557 cases also had injuries. The majority (84.91%) of injuries occurred within the first week of hospitalisation. In the first three days, more than half of the newborns had a form of skin injury. As shown in Table 3, the pattern of change in risk score for skin injury in newborns indicated the highest risk score on the first day (mean: 19.85) and the lowest on twenty-eighth day (mean: 13.23). The newborns were in the high-risk range on the first and third days of hospitalisation and in the medium-risk range on the following days. This table contains the findings of the first and second section of the SRAMT.

About three-quarters of newborns hospitalised in the NICU suffered from skin injury (Table 4). Among the 557 reported injuries, the most prevalent injury types were bruising and haematoma (34.29%), epidermal stripping (33.21%) and pressure ulcers (22.62%). These findings are obtained from the third section of the SMART.

Table 3. Risk score, risk range, and incidence of newborns' skin injuries on each day of observation

Days of observation	Newborn (*n*)	RISK						Skin injury (*n*)
		Risk Score Mean (SD)	Risk Score Category *n* (%)				Overall estimation of risk range	
			Low risk 8	Moderate risk 9–16	High risk 17–24	Extreme risk 25–35		
First day	265	19.85 (3.84)	0 (0.0)	43 (16.2)	183 (69.1)	39 (14.7)	high risk	135
Third day	265	17.93 (4.73)	4 (1.5)	99 (37.4)	128 (48.3)	34 (12.8)	high risk	177
Fifth day	201	16.38 (4.29)	3 (1.4)	121 (57.6)	68 (32.4)	18 (8.6)	moderate risk	93
Seventh day	164	15.29 (5.00)	3 (1.8)	101 (61.6)	50 (30.5)	10 (6.1)	moderate risk	69
Tenth day	106	15.25 (5.59)	3 (2.8)	69 (65.1)	22 (20.8)	12 (11.3)	moderate risk	40
Fourteenth day	65	15.20 (5.29)	2 (3.1)	38 (58.5)	19 (29.2)	6 (9.2)	moderate risk	28
Twenty-first day	43	14.04 (4.93)	2 (4.7)	30 (69.8)	8 (18.6)	3 (7.0)	moderate risk	8
Twenty-eighth day	30	13.23 (4.16)	4 (13.3)	22 (73.3)	3 (10.0)	1 (3.3)	moderate risk	7

Table 4. Frequency distribution of skin injury in newborns	
Frequency of skin injury	**Newborn *n* (%)**
0	74 (27.9)
1	57 (21.5)
2	42 (15.8)
3	36 (13.6)
4	21 (7.9)
5	16 (6.0)
≥ 6	19 (7.2)
Total	**265**

As shown in Table 5, there was a significant and direct correlation between the number of skin injuries and the risk score over the hospitalisation period ($p < 0.05$, $R = 0.37$).

Table 5. Correlation between the risk score and number of skin injuries	
Days	**Correlation**
First day	$R = 0.22$ $p = 0.00$
Third day	$R = 0.26$ $p = 0.00$
Fifth day	$R = 0.21$ $p = 0.00$
Seventh day	$R = 0.31$ $p = 0.00$
Tenth day	$R = 0.24$ $p = 0.01$
Fourteenth day	$R = 0.24$ $p = 0.05$
Twenty-first day	$R = 0.07$ $p = 0.63$
Twenty-eighth day	$R = 0.48$ $p = 0.00$
Total	$R = 0.37$ $p = 0.00$

Discussion

This study used three sections of the SRAMT to determine the relationship between risk score and skin injuries in the NICU. More than half of hospitalised newborns had several skin injuries, and the change pattern in the risk score and risk range revealed that the highest risk score of skin injury was related to the first day. The newborns were classified as high risk on the first and third days of hospitalisation and as medium – risk on the following days. Over 80% of injuries occurred during the first week, particularly during the first three days of hospitalisation. August et al. showed that newborns had an increased risk of skin injury in their first week of hospitalisation, and most injuries occurred during this period [21]. This can be due to the high number of diagnostic and therapeutic procedures in the first days of hospitalisation. Kassab et al., in Jordan, showed that each newborn underwent 13.9 invasive procedures per day during the first week of hospitalisation, and each of these could lead to a range of skin injuries [22]. Sposito et al., in Brazil, reported that newborns receive an average of 16 different types of medical devices during their first week of hospitalisation [23].

In our study, most patients admitted to the NICU are premature newborns undergoing a variety of diagnostic and treatment procedures. They are at risk of skin injury due to thinner skin layers and a lesser bonding force between the layers [24]. Consistent with our findings, Visscher and Taylor showed that newborns with a lower gestational age were more at risk of skin injury [25]. However, several factors, such as skin integrity, necessary treatment methods during the treatment period and the methods of performing them, can contribute to the development of these injuries.

Our study indicated a significant and direct relationship between the total number of skin injuries and the mean overall risk score during the hospitalisation period. In other words, newborns with a high-risk score had more injuries than others. This finding is consistent with the results of Broom et al. In their study, the SRAMT correctly predicted the risk of skin injury among 42% of the newborns [26].

Newborns are at a high risk of skin injury in the NICU. Treating skin diseases caused by therapeutic interventions in preterm or ill newborns in the NICU is difficult, and skincare and wound management are equally complicated. Most skin injuries in newborns are caused by medical intervention. A study found that the majority (83%) of these injuries are preventable [27]. NICUs should adopt skin injury risk assessment methods to meet safety service standards and improve the quality of treatment [13]. Studies indicated that the use of risk assessment tools for skin injury in conjunction with clinical principles can improve the performance and outcomes of clinical therapy. Additionally, the researchers stated that employing such instruments can help decrease the incidence of skin injuries [13]. The first step to prevent, investigate and precisely diagnose different types of injuries is to use the existing technologies [28]. Although some risk assessment systems allow the nursing staff to realise that the baby may be at risk of developing skin injuries, they lack the instructions necessary to minimise the risk of developing such injuries. However, the SRAMT emphasises that all newborns are at risk and establishes the risk levels (low, moderate, very severe). While most tools used to assess newborns' risk of skin injury are improved versions of instruments for children or adults, the SRAMT is a specific neonatal instrument. This tool enables the user to progress from risk assessment to implementing a standard care programme and documenting the process. The final section of the tool includes some standards for current NICU skincare techniques and products, as well as full skincare assessment and a care guide for newborns [26].

Limitations of the study

Random sampling is a fundamental strategy for increasing the external validity and generalisability of data. One of the limitations of our study was convenience sampling. This was conducted in order to obtain a sufficient sample size. Another limitation is related to the number of observations. Due to limited resources, we could not conduct our observations on all days of the newborns' hospitalisation.

Conclusions

Our results highlighted the importance of preventing skin injury and include:

1. Most skin injuries are preventable, and it is possible to prevent them by identifying the risk factors.
2. A risk prediction score (or technique) for detection of skin injury can be utilised to identify newborns at risk of skin injury.

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