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Validation of a comprehensive skin risk assessment and management instrument for hospitalized neonatal patients

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Abstract

Background: Health services have increasingly shifted their focus from treating skin diseases and skin injuries to emphasizing preventive efforts through routine assessments. Various treatment equipment and neonatal conditions such as infant weight, gestational age, clinical status, and underlying diseases have been shown to have a strong association with the risk of skin injury. Early detection using valid assessment instruments is therefore essential in neonate care.
Purpose: To determine differences in skin injury risk levels in neonates using the SRAMT and NSRAS Plus instruments, and to examine the relationship between gestational age and birth weight with the risk of skin injury.
Method: This short cohort design involving a total of 66 neonates, divided into an exposed group and an unexposed group (historical control). Skin injury risk assessments were conducted using the SRAMT and NSRAS Plus instruments. Data were analyzed by comparing the first and last assessments within the exposed group, comparing exposed and unexposed groups, and testing correlations between gestational age, birth weight, and skin injury risk.
Results: The findings showed significant differences in skin injury risk levels between the first and last assessments in the exposed group ($p = 0.001$). There were also significant differences in skin injury risk levels between the exposed and unexposed groups ($p = 0.001$). However, no significant correlation was found between gestational age ($p = 0.446$) or birth weight ($p = 0.821$) and the level of skin injury risk.
Conclusion: The study concludes that preventive monitoring using the SRAMT and NSRAS Plus instruments effectively identifies changes in skin injury risk in neonates. Gestational age and birth weight were not found to have a significant relationship with the level of skin injury risk.
Suggestion: Researchers and health professionals are encouraged to integrate nurses' knowledge regarding factors contributing to skin injury and to consistently re-monitor neonates using the SRAMT instrument. Modification of the instrument is also suggested to align it with current neonatal service conditions in Indonesia, enabling more effective prevention of skin injury, especially among preterm infants.

Keywords: Neonate; NSRAS; Skin Injury; SRAMT.

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INTRODUCTION

Over the past several years, neonatal health services have gradually moved away from approaches that focus solely on treating skin diseases or injuries. Instead, there has been a stronger emphasis on preventive measures carried out through routine assessments of skin trauma. Such assessments are considered essential, especially in the NICU, because they help reduce the likelihood of skin injuries that infants may develop during hospitalization (Grosvenor & Dowling, 2018). The emergence of skin trauma in neonates is not a single-factor issue; rather, it is closely intertwined with the use of medical devices and several clinical characteristics of the infant. Factors such as the baby's weight at birth, gestational age, baseline clinical status, and any underlying problems all contribute to a higher risk of skin injury (Csoma, Meszes, Ábrahám, Kemény, Tálosi, & Doró, 2016). A clear understanding of what causes skin trauma and the conditions that make infants more vulnerable is crucial, as this knowledge forms the basis for effective preventive care. Early identification of these risks can also help prevent complications and support safer, higher-quality neonatal care (Abkenar, Mojen, Shakeri, & Varzeshnejad, 2020). Findings from a study involving 248 assessments revealed that 38% of neonates experienced some form of skin trauma; the infants had a median gestational age of 36.7 weeks (ranging from 34.2 to 39.6 weeks) and an average birth weight of 1.6 kg (1.2–2.7 kg). Notably, the researchers estimated that nearly all about 95% of these injuries might have been prevented if risk factors had been detected earlier (Broom, Dunk, & E Mohamed, 2019).

The development of skin trauma in hospitalized neonates can be traced to both intrinsic and extrinsic causes. Intrinsic causes are generally tied to the infant's physical condition. For instance, a neonate who is immobilized due to sedation or muscle relaxation therapy is at a heightened risk, as are infants experiencing poor tissue perfusion, dehydration, or undergoing procedures such as surgery or cooling therapy for Hypoxic-Ischemic Encephalopathy. Sepsis and nutritional problems may further worsen the vulnerability. Extrinsic causes, on the other hand, stem from the equipment used during treatment. Devices such as Continuous Positive Airway Pressure (CPAP) often require secure fixation, and these fixation points may create additional pressure or friction on delicate neonatal skin. Irritation can also arise from monitoring electrodes or other attachments that remain in place for extended periods (Broom et al., 2019).

Hospital data from Dr. Cipto Mangunkusumo National General Hospital (RSCM) Jakarta in 2021 provide a clear illustration of this issue. In that year, 1.566 neonates were born and admitted to the hospital, and approximately 60% were categorized as premature, with gestational ages below 37 weeks. Premature infants typically require longer bed rest and depend more heavily on respiratory support such as CPAP. They also undergo frequent needle punctures and continuous monitoring that involves electrode placement. These conditions collectively increase the risk of skin trauma, underscoring why continuous assessment and preventive care protocols are necessary to protect hospitalized neonates.

In practice, a number of healthcare facilities, including RSCM Jakarta, use the Neonatal Skin Risk Assessment Scale (NSRAS) to help predict the likelihood of skin trauma. Adapted from the Braden Scale used for pressure injury risk, the NSRAS is specifically tailored for neonates and includes six assessment categories: general physical condition, mental status, mobility, activity, nutrition, and moisture (Huffines & Logsdon, 1997). While this instrument is widely used, it mainly focuses on risk identification.

Australian researchers introduced an alternative approach between 2011 and 2013 through the development of the Skin Risk Assessment and Management Tools (SRAMT). Unlike the NSRAS, which concentrates on assessment, the SRAMT incorporates a broader framework with three components: a risk assessment tool, a care protocol, and guidelines for clinical management. Its risk assessment section is more detailed, covering eight categories—gestational age, sensory perception, activity and mobility, skin moisture, respiratory support, skin integrity, blood sampling, and nutritional support. A subsequent study conducted in 2017 further evaluated how sensitive and specific the instrument was in identifying skin trauma risk.

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Given the differences between these two tools and the recurring risk factors highlighted in previous studies, the present research aims to explore whether the use of the SRAMT protocol provides better predictive ability and preventive outcomes for skin trauma among neonates treated in the perinatology unit of Dr. Cipto Mangunkusumo National General Hospital, Jakarta.

RESEARCH METHOD

This study applied a prospective cohort approach, in which neonates were monitored for five consecutive days and divided into two groups: an exposed group and a non-exposed group that served as a historical control. In the exposed group, observations were carried out directly at the bedside, and the interventions followed the guidelines and care protocols outlined in the Skin Risk Assessment and Management Tools (SRAMT). Meanwhile, data for the non-exposed group were gathered retrospectively through daily reviews of medical records until the fifth day of monitoring. Assessments in this group were based on four NSRAS (Neonatal Skin Risk Assessment Scale) subcategories that overlap with those used in SRAMT, along with three additional subcategories adopted from SRAMT but not originally included in the NSRAS.

The four subcategories that appear in both instruments are gestational age, mental status, mobility, and skin moisture. The three additional categories taken from SRAMT include respiratory support, skin integrity, and blood sampling. Although both instruments assess nutrition, the criteria used to evaluate it differ. For that reason, the study used the nutrition component from the NSRAS rather than the SRAMT version. This modified instrument combining NSRAS with the three extra categories from SRAMT is referred to in this study as NSRAS Plus.

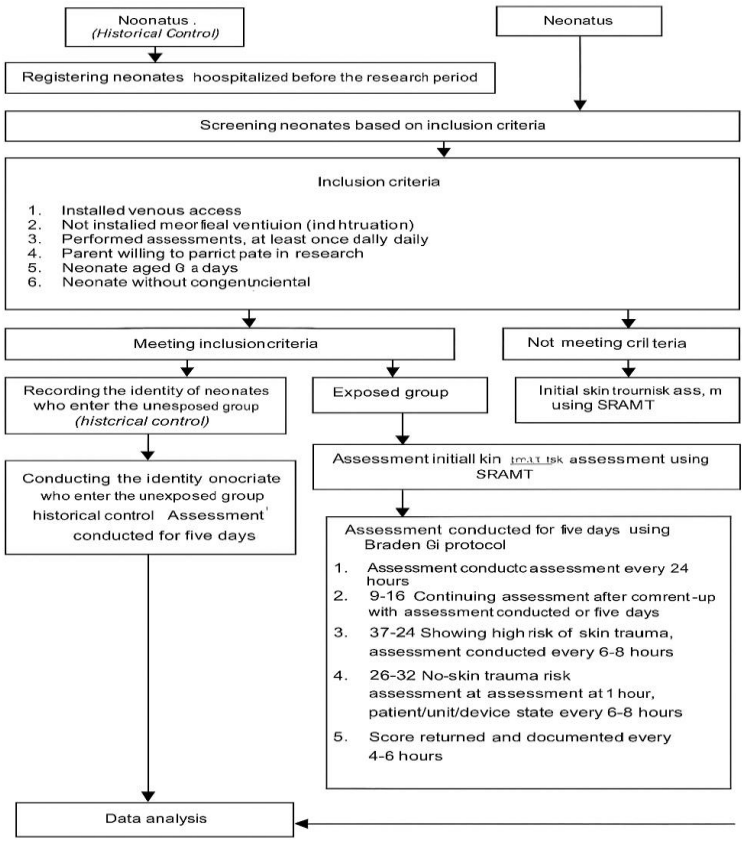


Figure 1. Sample Recruitment Process

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The inclusion criteria for this study specified that participants had to be neonates with venous access, not requiring mechanical ventilation (intubation), and undergoing at least one blood examination per day. Only infants aged 0–2 days, without congenital anomalies, and whose parents agreed to participate were eligible. Neonates were excluded if they were discharged before data collection was completed or if their parents withdrew consent during the study. Using an unpaired comparative analytical formula, the required sample size was determined to be 66 neonates, divided evenly into 33 infants in the exposed group and 33 in the non-exposed (historical control) group.

The research took place in the Perinatology Unit (UPK/Division of Perinatology) at Dr. Cipto Mangunkusumo National General Hospital, Jakarta. Data collection was carried out between May 2022 and June 2023. The exposed group was assessed using the SRAMT instrument, while the non-exposed group was evaluated using the NSRAS Plus, a modified version of the NSRAS. Ethical principles were rigorously followed throughout the research process. Parents received clear explanations about the study aims and procedures to ensure voluntary participation, respondent identity was protected through the use of initials, and confidentiality was maintained. Informed consent was obtained prior to enrollment.

A total of 16 enumerators comprising primary nurses and staff nurses supported the data collection. Before field implementation, the enumerators participated in an instrument familiarization workshop led by the principal investigator. This was followed by a one-week standardization process and inter-rater and intra-rater reliability testing. The Kappa coefficients for the two rater groups were 0.660 and 0.706, while Cronbach's alpha values were 0.999 and 0.833, indicating strong reliability across raters.

To streamline the workflow, the enumerators were divided into two teams. Team 1, consisting of 13 members, was assigned to the exposed group and was responsible for both risk assessments and intervention delivery based on the SRAMT protocol. Team 2, with three members, focused on evaluating skin trauma in the non-exposed group. Assessment for the non-exposed group relied on a five-day review of medical record documentation for each neonate. The principal investigator worked alongside the enumerators in reviewing these records, and the target of 33 neonates was reached in approximately two weeks.

For the exposed group, study information was provided directly to parents, and signed consent was obtained before assessments began. Each neonate was evaluated using the SRAMT instrument on the first day, followed by daily monitoring for five consecutive days. All procedures, observations, and protocol-driven interventions were documented meticulously in the infants' medical records. After data collection ended, the researcher compared the risk levels recorded on day one and day five, and continued with statistical analysis and report formulation.

Several statistical tests were employed. The Wilcoxon Signed-Rank Test was used to compare the initial and final risk levels within both the exposed and non-exposed groups. The Chi-Square Test examined differences in skin trauma risk between the two groups. In addition, the Spearman Correlation Test was applied to determine whether birth weight and gestational age were associated with skin trauma risk. Variance analysis showed that gestational age and birth weight had homogeneous distributions ($p = 0.923$ and 0.708). Normality testing indicated that birth weight and gestational age in both the exposed group ($p = 0.060$ and 0.053) and the non-exposed group ($p = 0.111$ and 0.187) followed a normal distribution.

The present study has adhered to the ethical principles and data collection procedures established by the Director of RSUPN Dr. Cipto Mangunkusumo, Jakarta, and has obtained approval from the Ethics Committee of the Faculty of Medicine, Universitas Indonesia – RSUPN Dr. Cipto Mangunkusumo, with the ethical approval number KET-2.99 UN2.FI/ETIK/PPM.00.02/2023.

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RESEARCH RESULTS

Table 1. Distribution of Respondents Based on Gestational Age and Birth Weight in Neonates (N = 66)

Variable	Results	*r s*	p-value
Gestational Age (Mean ± SD) (Range)[1]	(32.8 ± 3.411) (25–39)	.077	0.540
Birth Weight (Mean ± SD) (Range)[1]	(1719.39 ± 708.590) (670–3745)	.004	0.973

[1]Test correlation Spearman

On study This, age gestation respondents average 32.8±3.411 Sunday, heavy body born average 1719.39±708.590 grams and included in premature babies. Table 1 presents the characteristics of the respondents based on gestational age and birth weight. The average gestational age was 32.8 weeks (range 25–39 weeks), indicating that most neonates in this study were preterm infants. The Spearman correlation test showed an r-value of 0.077 with a p-value of 0.540, suggesting no significant relationship between gestational age and the risk of skin trauma. The average birth weight was 1719.39 grams, with a range of 670–3745 grams, which further reflects that many respondents were low-birth-weight infants. The correlation analysis for birth weight produced an r-value of 0.004 and a p-value of 0.973, indicating no significant association between birth weight and skin trauma risk.

Table 2. Distribution of Initial and Final Skin Trauma Risk Levels (N = 33)

Variable	Exposed	Non-exposed
Initial Assessment (n/%)		
Mild	0/0	0/0
Moderate	20/60.6	10/30.3
Severe	13/39.4	23/69.7
Extreme	0/0	0/0
Final Assessment (n/%)		
Mild	10/30.3	0/0
Moderate	22/66.7	13/39.4
Severe	1/3	20/60.6
Extreme	0/0	0/0

Table 2 illustrates the distribution of skin trauma risk levels at the initial and final assessments for both the exposed and non-exposed groups. At the beginning of the evaluation, the exposed group showed risk levels clustered in the moderate (60.6%) and severe (39.4%) categories, with no infants classified as mild or extreme. A similar pattern appeared in the non-exposed group, where the majority were categorized as severe (69.7%), followed by moderate (30.3%), and none fell into the mild or extreme categories. By the final assessment, notable improvement was seen in the exposed group. A portion of the infants transitioned into the mild risk category (30.3%), while most remained in the moderate category (66.7%), and only 3% were still classified as severe. In contrast, the non-exposed group showed no meaningful change; most infants continued to fall into the moderate (39.4%) and severe (60.6%) categories, with no cases in the mild or extreme categories.Neonates in the exposed group experienced a clear reduction in skin trauma risk levels, while those in the non-exposed group did not show improvement, highlighting the effectiveness of the interventions applied through the SRAMT protocol.

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Table 3. Statistical Comparison of Skin Trauma Risk Levels Within and Between Study Groups (N = 33)

Variables	Group	Mean Rank	p-value	Interpretation
Skin Trauma Risk (Initial–Final)	Exposed	11.50	**0.001**	Significant difference
	Non-exposed	2.00	0.083	Not significant
Difference Between Groups	Chi-Square	$X^2 = 29.505$	—	Significant difference

Table 3 illustrates the statistical analysis comparing skin trauma risk levels both within each group (initial vs. final assessment) and between the exposed and non-exposed groups. The Wilcoxon Signed-Rank Test results for the exposed group show a significant improvement in skin trauma risk, with a p-value of 0.001, indicating that the interventions provided through the SRAMT protocol effectively reduced the level of risk. In contrast, the non-exposed group showed no significant change between the initial and final assessments (p = 0.083), suggesting that the absence of targeted interventions resulted in stable risk levels over the monitoring period.The Chi-Square test comparing the two groups yielded a value of $X^2 = 29.505$, demonstrating a significant difference in skin trauma risk distribution between the exposed and non-exposed infants. This finding reinforces that neonates who received structured risk assessment and management interventions experienced greater improvement compared to those who did not. The intervention protocol was effective in reducing skin trauma risk and that the differences observed were statistically meaningful both within and between the study groups.

DISCUSSION

The results of this study showed that the mean gestational age of neonates in both groups was 32.8 weeks, with an average birth weight of 1719.39 grams. This corresponds to the premature category, where lower birth weight is associated with less mature physiological skin function. The skin is a dynamic organ that protects the body from the external environment. It maintains homeostasis by regulating body temperature and provides a barrier against harmful substances, microbial invasion, and skin trauma. Anatomically, the neonatal epidermis is thinner, with smaller and less functional corneocytes, sebaceous glands, and sweat glands.

As a result, transepidermal water loss (TEWL) values in preterm infants tend to be higher. Neonatal skin undergoes rapid physiological adaptation immediately after birth as it transitions from a humid intrauterine environment to a considerably drier external atmosphere. This shift increases the neonate's susceptibility to skin trauma, particularly during the early postnatal period when barrier function is still developing (Oranges, Dini, & Romanelli, 2015). Although this transition affects hydration and barrier formation, previous research indicates that transepidermal water loss does not differ significantly across sex, birth weight, or delivery mode, suggesting that epidermal maturation is driven primarily by gestational age rather than demographic characteristics (Kalia, Nonato, Lund, & Guy, 1998).

Evidence from neonatal dermatology consistently shows that epidermal thickness is closely linked to gestational maturity and body mass. Preterm neonates typically present with a thinner and more permeable epidermis, making them more vulnerable to fluid loss, external irritants, and mechanical trauma during the first days of life (Faria & Kamada, 2018). Skin integrity in this population is also influenced by a combination of intrinsic and extrinsic factors, including medical devices, clinical status, birth weight, gestational age, and comorbid conditions (Martins & dos Santos Curado, 2017). These factors often interact, increasing the risk of skin injury in hospitalized neonates.

Hospitalization and prematurity further compromise the structural stability of neonatal skin, which may affect growth trajectories and physiological recovery. For this reason, neonatal care emphasizes the preservation of structural integrity, the prevention of trauma, and the promotion of healing to support optimal developmental outcomes. Effective injury prevention also enhances parental confidence in care quality and reduces the burden of complications related to skin breakdown (Cho, Ahn, Lee, Lim, Lee, & Park, 2019).

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In this study, the Spearman correlation analysis showed that gestational age and birth weight had very weak and statistically insignificant correlations with skin trauma risk. This diverges from findings reported in earlier studies where these characteristics especially birth weight and length of hospital stay were significant predictors of injury (Willock, Habiballah, Long, Palmer, & Anthony, 2016). It is important to note that skin trauma arises not only from physiological immaturity but also from factors associated with care practices, clinical condition, and the use of medical devices (August, Hitchcock, Tangney, Ray, Kandasamy, & New, 2019). Additional investigations have similarly identified gestational maturity, low birth weight, and device use as major contributors to trauma, with factors such as adhesive application, interface pressure, and prolonged hospitalization also demonstrating associations with injury (August, New, Ray, & Kandasamy, 2018). Conversely, some work suggests that extended hospitalization itself may elevate trauma risk by two- to fivefold (Smith, Moore, & Tan, 2019), highlighting the complexity of risk interactions in this population.

A notable reduction in trauma risk was observed among neonates in the exposed group, who shifted from moderate and severe categories at baseline to mild, moderate, and severe categories at the final assessment (Table 2). This improvement is clinically significant as skin trauma in neonates is associated with scarring, parental dissatisfaction, longer hospital stays, and increased costs for families and healthcare systems (Demarré, Van Lancker, Van Hecke, Verhaeghe, Grypdonck, Lemey, Annemans, & Beeckman, 2015). The observed improvement reflects adherence to the SRAMT prevention protocol, which integrates routine reassessment, scheduled repositioning, careful management of adhesive use, protection of puncture sites during blood sampling, and proactive monitoring of devices such as oxygen saturation probes and IV tubing. These practices align with evidence-based neonatal skin protection guidelines and have been shown to reduce trauma incidence (Foster, Bergerhofer, Smith, Fix, Olney, & Sherman, 2017).

The role of regular repositioning and pressure relief has been highlighted repeatedly in the literature. Limited mobility in neonates leads to prolonged pressure on specific body areas, reducing blood flow and increasing friction-related injury (Edsberg, Black, Goldberg, McNichol, Moore, & Sieggreen, 2016). Many medical devices used in the NICU exert continuous pressure, and without careful monitoring, can significantly contribute to skin breakdown (Willock et al., 2016). For this reason, structured protocols that emphasize positioning, device adjustment, and systematic observation are essential components of trauma prevention (Faria & Kamada, 2018).

The effectiveness of the structured skin monitoring and management protocol observed in this study is consistent with Levine's Conservation Theory, which underscores the importance of preserving structural integrity to support energy conservation and facilitate growth and healing (Cho et al., 2019). Maintaining skin integrity is critical for reducing infection risk and supporting overall clinical stability during hospitalization.

Statistical analysis showed a significant difference in trauma risk between the exposed and non-exposed groups, supporting the impact of targeted interventions. Over five days, neonates in the exposed group received comprehensive risk assessment and management guided by SRAMT, in addition to routine care. Interventions included reassessment during vital sign checks, probe repositioning, ensuring the correct placement of nasal prongs, and preventing pressure from linens or infusion tubing. Both groups continued to receive standard care, but the protocol-driven approach in the exposed group yielded notable improvements.

These findings align with previous research highlighting the relationship between medical equipment and neonatal skin injury, emphasizing the importance of structured prevention strategies (de Lima, de Brito, de Souza, Salome, & Ferreira, 2016). Successful prevention requires a clear understanding of trauma mechanisms and risk factors, making staff education and consistent monitoring essential (Vance, Demel, Kirksey, Moynihan, & Hollis, 2015). Strengthening nursing knowledge and reinforcing evidence-based care practices can significantly improve neonatal skin outcomes (August, Edmonds, Brown, Murphy, & Kandasamy, 2014).

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Some studies offer alternative perspectives, suggesting that adequate hydration may protect neonatal skin by reducing irritation and helping maintain barrier function. Additionally, lower sebum production in neonates relative to adults contributes to dryness, increasing susceptibility to injury and underscoring the need for appropriate moisturization strategies.

CONCLUSION

This study concludes that the implementation of the SRAMT instrument plays a significant role in improving the effectiveness of skin trauma prevention in neonatal care units, leading to a reduction in skin trauma risk among hospitalized neonates. Although gestational age and birth weight were not significantly associated with trauma risk, structured preventive measures remain essential to maintain skin integrity and support clinical outcomes. Ensuring successful application of the SRAMT instrument requires proper socialization, hands-on training, and consistent commitment from nurses to carry out assessments and re-assessments in accordance with the established guidelines. Integrating the SRAMT instrument into routine documentation whether through daily monitoring sheets or Electronic Medical Records—along with the development of clear SOPs, skin monitoring guidelines, and management protocols, will promote uniform understanding and consistent practice among nursing staff. Future research is encouraged to combine nurses' knowledge of trauma risk factors with ongoing monitoring practices and to refine the instrument for better alignment with Indonesia's clinical context, especially in efforts to reduce skin trauma risk among preterm neonates.

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