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Review Article

Frequent Skin Injuries in Neonates from Various Skin Injuries Monitoring Instruments: A Systematic Review

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Abstract

Aims: Maintenance of skin and tissue integrity is one of the main focuses of various health care facilities throughout the world so that the implementation of effective prevention of skin trauma requires a protocol for early identification of at-risk patients in prevention of skin trauma.

Objective: Knowing the effectiveness of the SRAMT instrument compared to other skin trauma monitoring instruments for monitoring neonatal skin trauma.

Method: This research method is in the form of systematic review, database search is done through proquest, SAGE Journal, Scencedirect, Clinicalkey Nursing and manual research. There were eight journal articles that met the inclusion criteria. Based on the article it was concluded that the instrument had gone through validity, reliability, interrater tests and correlation coefficients so that it was suitable for use in pediatric and neonatal patients.

Result: There were seven journal articles that met the inclusion criteria. The most common type of skin injury are caused by the use of an indwelling vascular catheter and medical devices. The most common locations for skin injury are the nasal septum and the head area, including the face and scalp. Compared to other skin injury monitoring instruments, the SRAMT subscale is more comprehensive by having three skin trauma risk assessment sections, including skin trauma risk categories, management guidelines based on skin injury risk categories and prevention that can be carried out based on the type of skin injury that occurred. This guide is very important to reduce the risk of skin injury in neonates and provide uniformity in nursing care provided by nurses.

Keywords:

Neonate, Skin injury, Skin Risk Assessment

INTRODUCTION

Functional and structural skin maturity is a dynamic process, starting at birth and ending in the first year of life. In term infants, this maturity process begins after birth, whereas in premature infants this maturity process begins two to three weeks after birth(1). Risk factors for skin injury in neonates treated in the neonatal intensive care unit range from 9.25% to 43.1% (2). Reported that 38% of neonates experienced skin injury and 36.5% the most common

finding was redness in the area where the needle was inserted (3).

Instruments for monitoring skin injury used in pediatric and neonatal patients are the Neonatal Skin Risk Assessment Scale (NSRAS), Braden Q Scale (BQS), Skin Risk Assessment and Management Tools (SRAMT), Neonatal Infant Pressure Injury Risk and Assessment tool (NIPIRA), Neonatal/Infant Braden Q Risk Assessment Scale, Glamorgan and SIRA+P. The instrument commonly used in Indonesia is

the NSRAS instrument. This instrument is used based on ease of use, specificity of the population, and research that has been done before. Early identification of the level of risk, knowledge of etiology and risk factors associated with the development of injuries resulting from assessments using certain instruments can reduce skin injury up to 95%(4).

Skin injury not only has a negative impact of increased pain in neonates, but also increases the risk of secondary infection of the skin. The maintenance of skin and tissue integrity is one of the main focuses of many healthcare facilities around the world. This literature review is very important to identify various instruments for monitoring skin injury and skin injury that often occurs in neonates. The results of this literature review are expected to provide recommendations regarding the use of the most comprehensive instruments in the neonatal population in Indonesia.

METHODS

A systematic review is used in this research methodology. A study technique called

systematic review is used to find, assess, and analyze numerous research findings that are pertinent to particular research questions, phenomena, or subjects (5). The search scheme was developed using the keywords connected to PICO (population, intervention, comparison and output). The population of this review were neonates whom hospitalized, intervention with various skin injuries monitoring instrument to predict frequent skin injury in neonate.

Proquest, SAGE Journal, Scencedirect, Clinicalkey Nursing, and manual research were used for database searches. Medical subject headings terms used during the online search were Skin Injury, Neonate, Skin Risk Assessment, and Braden Q are the keywords used. The next journal article selection involves entering the research year, which is 2012–2022, journal articles in English, and suitability between title and abstract for this systematic review. There are no duplicates among the journal papers that were reviewed, and they are all full-text journal articles. Eight journal publications in total have been examined.

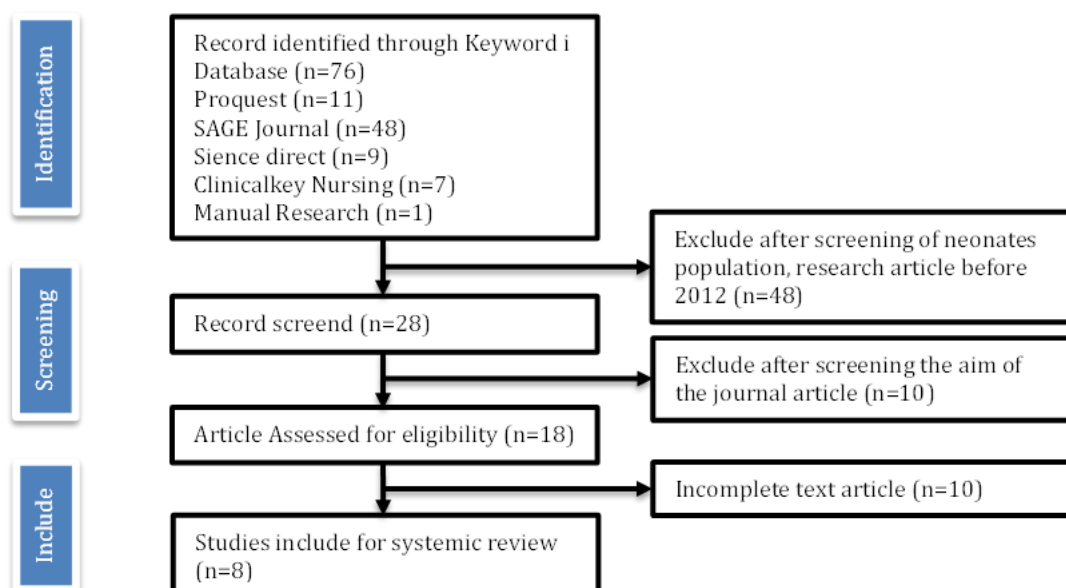


Fig. 1. PRISMA (Preferred Reporting Items for Systematic Reviews)

The eight journal papers were then examined with the JBI's critical evaluation methods (The critical appraisal checklist). One factor analysis study, four cohort studies, one experimental study, and two cross-sectional studies were among the journal articles that were examined. Every critical appraisal checklist were filled clearly includes population of the study, consist of exposure or with unexposed group, confounding factors identified, valid and reliable instruments and appropriate statistical analysis used.

RESULT

In the initial search, 152 journal articles were obtained, then these articles were selected based on the neonatal population, *full text* and in accordance with the purpose of the literature review. A further search resulted in seven journal articles which will be discussed in this literature review. The journal articles discussed include monitoring instruments used for skin injury, characteristics of respondents, skin injury that occurred and risk factors for skin injury.

Integrated the SIRA+P skin injury monitoring instrument into the EHR and compared it with the NSRAS, Braden Q and Braden instruments (6). This study involved 385 children of various ages including neonates aged 0-30 days (using the NSRAS instrument), children aged 31 days -17 years (using the Braden Q instrument) and aged over 18 years (using the Braden instrument). Although comparing the SIRA+P instrument with the NSRAS, Braden Q and Braden instruments, this study did not discuss about the prevalence of skin injury in children or neonates. However, it discusses more about the development of the SIRA+P instrument, the integration of the instrument into the EHR, implementation into the EHR which is integrated with nursing plans and nursing records, the demographics of respondents and the SIRA+P sensitivity value (0.878) which is almost the same as the NSRAS

instrument (0.961), Braden Q (0.883) and Braden (0.856).

Martins and Curado (2017) conducted a study of translating the NSRAS instrument into Portuguese by making 131 observations on neonates. The gestational age of neonates was observed to be in the age range of 24-36 weeks, body weight 510-3490 grams and 59% of neonates were male. The NSRAS cutoff value between 16-18, an average value of 15 points, *a mean of* 15.36 and a standard deviation of 4 points (SD = 3.871). It shows that the risk limit value for skin injury in the Portuguese version of the NSRAS instrument is 15, while the original version of the NSRAS has a limit value of 13 for a high risk of skin injury with an acceptable reliability value of 0.787. The sensitivity value was assessed using skewness and kurtosis measurements. However, this study did not discuss the skin injury that occurred.

Compared the BQS and Glamorgan skin injury monitoring instruments in patients in pediatric inpatient rooms, PICU and NICU involving 513 pediatric patients (7). Assessment using the BQS and Glamorgan instruments was carried out three times a week (every two to three days) in the first and second weeks of treatment, then the assessment was carried out once a week until the patient went home, died or the study was completed. During the study period, there were 35 children with skin injury, consisting of 11 children from the PICU, 15 children from the NICU and 9 children from the pediatric ward with skin injury grade 1, 2 and 3.

Carried out *a cross-cultural* adaptation and validation of *the Neonatal/Infant Braden Q risk Assessment Scale* into Portuguese, involving 30 neonates aged 0-28 days, premature with gestational age > 23 weeks, treated for more than 24 hours at NICU *University Hospital Brazil* and did not have skin injury on admission to the NICU (8). Most of the neonates were female (n=18, 60%) and premature (n=25, 83.3%), mean body weight 1777±1003 and gestational

age 31.5 ± 4.4 weeks. Only four of 30 neonates experienced skin injury during the study period (13%), two of four neonates experienced skin injury in the occipital area and the rest experienced skin injury in the nasal septum area.

Modified the Neonatal Braden Q Instrument/Braden in the mobility and activity section which is more appropriate for neonates and infants who are critically ill; as well as the category of friction that is sensitive to skin and tissues caused by various medical devices, the modification of the instrument is called NIPIRA (2). This study involved 247 pediatric patients and found 31.2% of pediatric patients had skin injury. Medical devices were the most common risk factors identified and associated with skin injury such as indwelling vascular catheters 22.4% (n=24), CPAP use 17.8% (n=19), temperature and saturation probes 16.8% (n=18). A total of 31.8% (n=34) injuries could not be attributed to any particular risk factor. Location of injury included lower leg 29.9% (n=32); upper limbs 25.2% (n=27); head area 35.5% (n=38); abdomen and back 9.4% (n=10).

Compared the SRAMT and BQS instruments by conducting 248 skin injury studies, obtained 93 neonates with skin injury (38%) with a median gestational age of 36.7 weeks (26.8-56.6 weeks) and a median body weight of 2.44 kg (0.99-4.06 kg) (9). The four most frequently reported types of skin injury are redness, excoriations, erythema and pressure injuries. Besides that, there are four main causes of skin injury namely venepuncture, humidity, heel lance and the use of medical devices. The most common skin injury found was redness in the area where the needle was inserted, which was 36.5%.

BQS involving 77 children, the majority of whom were boys (n = 42, 54.5%). Nine children who experienced skin injury (11.7%) were boys (6). Among the nine boys, eight had *grade* one pressure injuries (89%), seven of them had skin injury to the face and scalp area caused by using a respirator (77.8%). The main risk factors for skin injury are lack of physical activity and use of medical devices (6).



Author and the year of publication	Title Article	Purpose	Sample	Method	Result
(Foster et al., 2017)	SIRA + P: Development and Testing	SIRA+P.	All pediatric wards (NICU, PICU, <i>acute care pediatrics, Hematology/Oncology/Stem Cell Transplant and Fetal Health Center obstetric patients</i>) and adult patients	SIRA+P sub-scale of measurement: <ul style="list-style-type: none"> • Mobility/activity • Sensory perception • Friction/slide • Humidity • Tissue perfusion and oxygenation • Tools used • Weight Corrected age (patient age ≤ 90 days). • 	There is no numerical assessment, there are only two SIRA+P risk categories: There is no risk of skin injury Risk of skin injury
(Martins & Curado, 2017)	Observations Neonatal Skin Risk Assessment Scale: statistical validation with newborns	NSRAS in Portuguese	Neonates, children aged 21 days-18 years.	NSRAS measurement sub-scale: <ul style="list-style-type: none"> • Mental states • Mobility • Activity • Nutrition • Physical condition • Skin moisture 	There are two risk categories of NSRAS instruments: <ul style="list-style-type: none"> • High risk group (Score over 15) • Low risk group of skin injury (score less than 15)
(Willock et al., 2016)	A comparison of the performance of the Braden Q and the Glamorgan pediatric pressure ulcer risk	BQS and Glamorgan	Children aged less than 18 years	BQS measurement sub scale: <ul style="list-style-type: none"> • Mobility • Activity • Sensory perception 	BQS instrument risk categories: Low risk (score 25) <ul style="list-style-type: none"> • Moderate risk



	assessment scales in general and intensive care pediatric and neonatal units			<ul style="list-style-type: none"> • skin moisture • Skin integrity • Nutrition • Network perfusion <p>Glamorgan measurement subscale:</p> <ul style="list-style-type: none"> • Physical mobility • Medical tools • Anemia • Pyrexia • Poor perfusion • Inadequate nutrition • Low albumin value • Malnutrition • Incontinence 	<p>(score 21)</p> <ul style="list-style-type: none"> • High risk (score 16) <p>Glamorgan instrument risk categories:</p> <ul style="list-style-type: none"> • Low risk (score ≥ 10) • Moderate risk (score ≥ 15) • Very high risk (score ≥ 20)
(De Lima et al., 2016)	Cross-cultural adaptation and validation of the Neonatal/Infant Braden Q Risk Assessment Scale	Neonatal/Infant Braden Q Risk Assessment Scale instrument in Brazilian-Portuguese	Neonates	Sub-scale of measurement:	Three risk categories of BQS instruments:
				<ul style="list-style-type: none"> • Sensory perception • Activity • Mobility • Skin moisture • Nutrition • Skin integrity • Tissue perfusion and oxygenation Gestational age 	<ul style="list-style-type: none"> • Low risk (score 25) • Moderate risk (score 21) • High risk (score 16)



<p>(August et al., 2014)</p>	<p>Pressure injuries to the skin in a neonatal unit: Fact or fiction</p>	<p>Neonatal Infant Pressure Injury Risk and Assessment tool (NIPIRA)</p>	<p>Neonates</p>	<p>Modification of The Neonatal/Braden Q Braden instrument in the mobility and activity section that is more appropriate for neonates and infants who are critically ill; as well as the category of friction that is sensitive to skin and tissues caused by various medical devices</p>	<p>There is no discussion of skin injury risk categories based on the NIPIRA instrument.</p>
<p>(Broom et al., 2019)</p>	<p>Predicting neonatal skin injury: The first step to reduce skin injuries in neonates</p>	<p>SRAMT and BQS</p>	<p>Neonates</p>	<p>SRAMT sub-scale of measurement:</p> <ul style="list-style-type: none"> • Gestational age • Sensory perception • Activity/mobilization • Humidity • Respirator used • Skin integrity • Blood draw • Nutrition <p>BQS measurement scale:</p> <ul style="list-style-type: none"> • Mobility • Activity • Sensory perception • Skin moisture • Skin integrity • Nutrition • Network perfusion 	<p>SRAMT instrument risk categories:</p> <ul style="list-style-type: none"> • Low risk (Score ≤ 8) • Moderate risk (Score 9-16) • High risk (Score 17-24) • Extreme risk (Score 25-32) <p>BQS instrument risk categories:</p> <ul style="list-style-type: none"> • Low risk (score 25) • Moderate risk (score 21) • High risk (score 16)



(Smith et al, 2019)	Cohort study to determine the risk of pressure ulcers and develop a care bundle within a pediatric intensive care unit setting	Braden Q Scale (BQS)	Pediatric patient in PICU	<ul style="list-style-type: none"> • Mobility • Activity • Sensory perception • Skin moisture • Skin integrity • Nutrition • Network perfusion 	<p>Three risk categories of BQS instruments:</p> <ul style="list-style-type: none"> • Low risk (score 25) • Moderate risk (score 21) • High risk (score 16)
(Foster et al., 2017)	SIRA + P: Development and Testing	SIRA+P.	All pediatric wards (NICU, PICU, <i>acute care pediatrics, Hematology/Oncology/Stem Cell Transplant</i> and <i>Fetal Health Center obstetric patients</i>) and adult patients	<p>SIRA+P sub-scale of measurement:</p> <ul style="list-style-type: none"> • Mobility/activity • Sensory perception • Friction/slide • Humidity • Tissue perfusion and oxygenation • Tools used • Weight corrected age (patient age ≤ 90 days). 	<p>There is no numerical assessment, there are only two SIRA+P risk categories:</p> <ul style="list-style-type: none"> • There is no risk of skin injury • Risk of skin injury



DISCUSSION

Skin injury monitoring instruments used in pediatric and neonatal patients are NSRAS, Braden Q, SRAMT, NIPIRA, Neonatal/Infant Braden Q Risk Assessment Scale, Glamorgan and SIRA+P. This instrument was developed and used in various countries based on consideration and specific conditions, culture and ease of implementing skin injury monitoring in that country. However, not all have discussed the specific protocols used to prevent skin injury in pediatric and neonatal patients.

Braden The Q Scale (BQS) is one of the instruments that has been modified a lot and then developed into a new skin injury risk assessment instrument (10). Skin injury risk assessment instrument developed based on BQS including SIRA + P and NSRAS Instruments. SIRA+P was developed to assess specific parameters of skin injury by assessing humidity and the use of medical devices. SIRA+P combines prevention of skin injury in nursing interventions and integrated into the *Electronic Health Record* (EHR). This instrument consists of eight categories, namely mobility/activity, sensory perception, friction/shear, humidity, tissue perfusion and oxygenation, tools used, body weight and age of correction (patient age \leq 90 days). This instrument combines intervention plans to prevent skin injury at the same time that risks are identified. The assessment is carried out at the EHR, the activity planning is automatically connected to the nursing record so that it does not make duplication in writing interventions carried out by nurses. This instrument only classifies into two risk categories, namely no risk and risk, without a numerical assessment. The interventions presented in the SIRA+P instrument are not specific based on the risk of skin injury experienced by the patient and the selection of interventions is based on the nurse's judgment. This of course will provide different management for each patient depending on the nurse's work experience and critical thinking. In

addition, system integration in EHR also requires adequate electronic facilities so that not all hospitals are able to implement the instrument.

The NSRAS instrument is a development and modification of the Braden scale, it can be used in the neonatal population (11). The NSRAS assesses six risk categories, namely mental status, mobility, activity, nutrition, physical condition and skin moisture. Each subscale has 4 values to choose from (range 1-4), a value of 1 indicates low risk and a value of 4 indicates high risk. This instrument has a total value in the range of 6-24, categorizing high risk groups as > 13 and low risk skin injury groups as < 13 . The risk value of skin injury in a study conducted by Martins and Curado shows that the risk The high risk of skin injury is above 15 (12). The difference in risk scores between the original NSRAS version and the Portuguese version can be caused by the different interpretation of skin injury assessment in each country. Although there are differences in interpretation and risk limit values for skin injury in the original and Portuguese versions of the NSRAS instrument, the guidelines for preventing skin injury used are general regardless of the type of skin injury that occurred in the neonate. The factors that influence the risk of skin injury are not only caused by physical mobility, but also caused by other extrinsic and intrinsic factors such as physical immobility, use of muscle relaxants, surgery, use of health technology and fixation in neonates (13). So it requires different guidelines and procedures.

Modified the Braden Q *Neonatal* and Braden Q instruments, resulting a new instrument called NIPIRA. These modifications are in the mobility and physical activity section for neonates who are critically ill and skin friction due to the use of medical devices (14). This study does not show the results of modifications to the NIPIRA instrument, only mentions modifications and does not

discuss the value of the instrument. More percentages of skin injury that occurred, locations of skin injury and categories of skin injury during the study period (14). The study stated that 31.8% (n=34) of the injuries could not be associated with certain risk factors, the highest percentage of injuries were due to the use of indwelling vascular catheters 22.4% (n=24) and the most common location for skin injury was the head area 35.5% (n=38).

The results of this study are in line who stated that one of the most common skin injuries found in neonatal intensive care units is caused by the use of adhesives for vascular access, the use of oximeter probes and thermal sensors and the use of adhesive endotracheal tubes in neonates (4). Neonatal medical devices and condition, including weight and age of baby, clinical status, and underlying disease. The causal factors have a strong correlation with the risk of skin injury.

Comparing the BQS and Glamorgan instruments stated that the instrument was used for children aged 21 days to 8 years (7). The BQS instrument assesses seven sub-scales, namely mobility, activity, sensory perception, skin moisture, skin integrity, nutrition and tissue perfusion. Each sub-scale has a value of 1 to 4, with a value of four indicating low risk and a value of one indicating high risk. The total score of this instrument is 7 to 28, 25 is for low risk, 21 is for medium risk and 16 is for high risk. While the Glamorgan instrument has a range ranging from 0 to 42 with a low risk category at a value of ≥ 10 , moderate risk at a value of ≥ 15 and very high risk at a value of ≥ 20 . This study shows that the sensitivity of the Glamorgan instrument (0.98) is higher than the BQS (0.88) and the specificity of the Glamorgan instrument (0.67) is higher than the BQS (0.58). The study showed that during the study period, 35 children (7%) experienced skin injury, consisting of 11 children from the PICU ward, 15 children from the NICU and 9 children from the pediatric ward with grade 1, 2 and 3 skin injury.

The Glamorgan instrument was considered more suitable and easier to use than the BQS for the population of neonates and pediatric patients treated in the PICU. However, the BQS instrument is easier to use in patients admitted to pediatric wards. The Braden Q Scale and Glamorgan did not have a significant difference in their assessment, only differed in the range of values and could be used for the pediatric and neonatal population (7).

SRAMT was developed by Margaret Broom and the Skin Care Working Group (SCWG) team since 2011. SRAMT was formulated to assess the risk of skin injury in neonates by considering current risk factors such as: medical devices used, intravenous access, blood sampling, breathing apparatus used based on the results of a review of the literature and the incidence of skin injury that occurred. Unlike other instruments, SRAMT has three parts to assessing the risk of skin injury, including:

- 1) The first part is an assessment of the risk of skin injury using eight risk subscales, namely: gestational age, sensory perception, activity/mobilization, humidity, breathing apparatus used, skin integrity, blood sampling and nutrition. Each risk category is scored from 1 to 4 (1 being the lowest and 4 being the highest).
- 2) The second part, guidelines for monitoring skin injury based on four categories, namely low risk, moderate risk, high risk and extreme risk and provides actions that are carried out according to the risk assessment of neonatal skin injury. The aim is that the actions taken are standardized and documented.
- 3) The third part, skin management guidelines used to prevent and treat skin injury.

All of the instruments for monitoring skin injury in children and neonates have been discussed, only the Glamorgan and SRAMT instruments have more than two skin injury

risk categories. Compared to these two instruments, only the SRAMT instrument has guidelines for monitoring skin injury that are more comprehensive according to the risk category of skin injury including re-monitoring, changing sleeping positions and changing medical devices attached to neonates and making sure there are no medical devices or other objects pressing on the skin neonates. This guideline is very important to reduce the risk of skin injury in neonates and provide uniformity in nursing care provided by nurses.

Compared to other instruments, SRAMT is the only instrument that has a more up-to-date skin injury risk assessment sub-scale, which includes the use of breathing apparatus and blood sampling as its assessment. Skin injury generally occurs in anatomical areas such as fingers and toes as a result of connecting oximetry sensors; skin in the area of pressure on vascular access; thoracic area as a result of the placement of electrodes; ears, nasal septum and back of neck, forehead and cheek area as a result of CPAP insertion and fixation (15). Although this instrument appears to be superior to other instruments, SRAMT does not yet have further criteria in each of its assessment subscales, such as the use of Non-Invasive Ventilation (NIV) in the respiratory support sub-scale and the size or diameter of skin injury that has occurred in the skin integrity assessment sub-scale. These two sub-scales can provide different interpretations and will certainly have an impact on the final monitoring value and skin injury risk category. Besides that also stated that 95% of skin injury can be avoided through identification of the level of risk, knowledge of the etiology of skin injury and risk factors associated with skin injury (4). It takes an important role in the strategy to prevent skin injury in neonates, so that the comprehensiveness of skin injury monitoring instruments which includes assessment, guidelines for monitoring and management skin injury will become an important thing.

CONCLUSION

Based on the skin injury monitoring instrument used, skin injury that often occurs in neonates is caused by the use of indwelling vascular catheters and the use of medical devices. The most common locations for skin injury are the nasal septum and the head area, including the face and scalp. This injury is generally caused by the use of a respirator with grade 1, 2 and 3 skin injury.

Instruments for monitoring skin injury in children and neonates include the Braden Q scale, SIRA+P, NSRAS, NIPIRA, Neonatal/Infant Braden Q Risk Assessment Scale, Glamorgan and SRAMT. Although all of the discussed skin injury monitoring instruments are suitable for use in pediatric and neonatal patients, the SRAMT more comprehensive than the other instruments. SRAMT has an up-to-date skin injury risk assessment sub-scale, which includes the use of breathing apparatus and blood sampling as an assessment, there are guidelines for monitoring skin injury based on four risk categories and guidelines for skin management. This is important to assess and apply, bearing in mind that the increasing use of medical devices can increase the risk of skin injury occurring.

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