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# Effect of Skin Injury Preventive Strategy on Neonatal Skin Condition at Neonatal Intensive Care Unit

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## Abstract
**Background and aim:** A skin injury is one of the major neonatal issues. Physicians and nurses reported that skin injuries are one of the most common and serious problems in neonates. The study was aimed to evaluate the effect of skin injury preventive strategy on the neonatal skin condition at neonatal intensive care unit. **Subjects and Method:** A quasi-experimental research design was used. A purposive sample of sixty neonates was selected from neonatal intensive care unit of El-Monira Pediatric Hospital-Cairo University. Neonates were divided to two groups study and control. Neonatal characteristics were collected by using a structured questionnaire, neonatal skin condition score, and neonatal skin injury risk assessments were used for both groups four times. Neonates in the study group received a designed skin injury prevention strategy for four subsequent days; neonates in the control group only received the hospital routine care. **Results:** A highly statistical significant difference between total neonatal skins conditions mean score of both groups. A statistical significant correlation in the control and the study groups between gestational age and total NSCS at 4$^{th}$ day as well as there is a statistical significant correlation in the study group between weight and total NSCS at 4$^{th}$ day. **Conclusion:** skin injury preventive strategy has been shown to be successful in improving neonates' skin conditions, which has a positive effect on critically ill neonates. **Recommendation:** Skin injury preventive strategy should be applied in all neonatal intensive care units to minimize the hazards associated with skin injuries.

***Keywords: Injury, Neonatal, Preventive, Skin & Strategy.***

## Introduction:
The neonatal period is a period from birth to one month which is when the body's systems undergo excessive and ongoing transition from the uterine to extra-uterine environment **(Dipti et al., 2019).** The neonatal period is regarded as one of the most critical time in the human cycle which needs successful adaptations **(Hockenberry et al., 2018).** Neonates frequently need specialized care and admission to a neonatal intensive care unit because they have specific physiological needs to adapt to the extra-uterine environment (NICU) **(Simeoni, et al., 2019).**
Skin injuries are among the many harms that the NICU causes, even though it raises neonatal survival rates. **(Khanali Mojen & Varzeshnejad, 2020).**
Damage to various skin layers results from skin injuries ranging from the epidermis to the underlying layers, and even muscles, as well as tendons (Cho et al., 2019). Skin injuries are caused by different factors which are probably occurred and continue to occur in NICUs Despite the fact that most are avoidable **(Grosvenor et al., 2019).**
Various studies have reported that during this period of intensive care, there is a significant risk of skin damage, the incidence of skin injuries 43.1% and even more than 50% in preterm infants **(August et al., 2018).** Although there is still little evidence to consider, skin injury; previous studies have revealed that iatrogenic events occur at a rate of about 57%. The neonate's gestation or circumstance at delivery has a right away relation to the intrinsic elements that boom their chance of skin damage **(Broom et al., 2019).**
Neonatal skin is developmentally and physiologically various to pediatric and adult skin, making it more susceptible to problems, so it is a challenge to maintain the integrity of this delicate organ during the critical period **(Faria & Kamada, 2018).** Protection and preservation of the skin of neonates are significantly important; because skin is ultimate important protective mechanism in neonates and the largest organ in the human body, serving essential purposes and a protective barrier of the internal organs, thermoregulation, immunological function, and protection from invasion of microbes and ultraviolet rays **(Albahrani & Hunt, 2019).**
For parents, newborn skin damage is heartbreaking and can lead to scars, a longer hospital stay, and higher hospital expenses **(Cheng et al., 2021).** Additionally, they raise the risk of infection and can result in septicemia, which is the main cause of

neonatal morbidity and mortality in the NICU **(Lean et al., 2018)**.

Despite this, there aren't many viable therapies for neonatal skin damage because it's not ethical to test items on neonates' skin. Therefore, Health Services have shifted their emphasis during the past 10 years from the treatment of illness and damage to prevention, it is crucial to the treatment of these injuries because of this. As medical personnel become more aware that preventing neonatal skin injuries is an area of clinical practice that may be improved, the advantages of implementing a skin care tool have been emphasized worldwide in neonatal facilities in America, the United Kingdom, and Australia **(Grosvenor & Dowling, 2018).**

All health care professionals are responsible for maintaining a neonate's skin integrity and for the prevention, identification, treatment and documentation of injury for the neonates in their care **(Child & Adolescent Health Service, 2021).** So that appropriate and timely prevention strategies can be implemented such as performing regular assessments, identifying infants in danger, early detection of injury and skin care guidelines should be incorporated into all NICU to reduce the possibility of acquiring skin injuries while being admitted to a NICU and to help personnel identify children who might sustain injuries **(Broom, et al., 2019).**

Numerous studies revealed that nurses in NICUs performed moderately in terms of skincare and other previous studies found that nurses' performance in neonatal skincare was unsatisfactory. Furthermore, another study revealed a huge disparity in standards in neonatal nursing skin care **(Khanali Mojen & Varzeshnejad, 2020).** Skin injury prevention for neonates is an aspect of nursing care that can be overlooked in the busy adrenaline powered environment of the NICU. Technological advances in neonatal and maternal care have enabled infants to survive at the cusp of viability. Managing skin injuries in the NICU presents nurses with unique problems because the danger of skin breakdown rises with lower gestational ages **(Grosvenor, et al., 2019).** Because of this, it's crucial that healthcare providers adhere to specific best practices when providing for neonatal skin to minimize damage and ensure optimal outcomes. Neonates are a specialized cohort of patients requiring an individualized approach in nursing care and the newborn nurse's top priority is to protect the neonate's skin. **(Fanham, 2021).** The detection and management of these factors, preservation of skin integrity, reduction of risk factors, and neonatal skin care by nurses can significantly contribute to the decrease of skin injuries, which are a major care burden in the NICUs **(Khanali Mojen & Varzeshnejad, 2020).**

## Significance of the study:

A skin injury is one of the major neonatal issues. Neonatal skin injuries are one of the main reasons of complaints, according to reports from medical professionals, notably doctors and nurses; almost 80% of morbidity and death of neonates are due to trauma or natural skin function alterations because of their functional immaturity **(Novardian, et al., 2020).** It is discernible from the few national studies on skin care in neonates admitted to the NICU. Therefore, it is anticipated that more thorough research will be done in this field and that the facilities for the treatment of neonate in critical condition may use the information provided by this study to help target interventions and make decisions relating to skin integrity. This study will also offer evidence-based nursing skin care techniques and management to prevent damage to the delicate neonatal skin. It will also make it easier to improve the quality of the neonates' skin care, which will benefit their long-term health.

**Aim of the study:**

The current study was aimed to evaluate the effect of skin injury preventive strategy on the neonatal skin condition at neonatal intensive care unit.

**Research Hypotheses:**

The following research hypotheses were developed to achieve the study's aim:

**H1:** Neonates who will expose to the skin injury preventive strategy expected to have lower skin condition score than those in the control group.

**H2:** Neonates who will expose to the skin injury preventive strategy expected to have lower risk assessment score than those in the control group.

## Subjects and Method

**Research design:**

A quasi-experimental research design (two-groups with pre-post evaluation) was used. It is an empirical interventional study used to estimate the causal impact of an intervention on target population without random assignment **(Donald & Stanley, 2019).**

**Setting:**

The current study was managed at neonatal intensive care unit (NICU) in El Monira Pediatric Hospital, associated with hospitals at Cairo University; it is Egypt's largest children's hospital and offers all of its services for free. This unit has a 50 incubator capacity.

**Sample:**

A purposive sample of 60 neonates in the chosen study setting was equally divided into control and study groups (control group = 30 & study group = 30). The inclusion criteria for neonates were both genders, newly admitted within 24 hours, had skin

condition score equal 3.Neonates with skin diseases, genetic dermatological conditions, neonatal sepsis and fracture or dislocation were excluded.

**Sample size calculation**

The sample size was determined using information from a prior study, level of significance of 5%, and power of study of 80%. Using the following formula to calculate: n = [2(Zα/2 + Zβ) 2 × p (1-p)]/ (p1 - p2)2. Where n = sample size required in each group,

p = pooled proportion (proportion of event in group 1 + proportion of event in group 2)/2

P1-p2 = difference in proportion of events in two groups

$Z_{\alpha/2}$: This depends on level of significance, for 5% this is 1.96

$Z_{\beta}$: This depends on power, for 80% this is 0.84

$n = [2(1.96 + 0.84)^2 \times 0.30 (1-0.30)] / (0.325)^2 = 15.2$

According to the calculation above, each group needed 15 samples, giving a total sample of 30 neonates, but it increased to 60 neonates for statistical reason.

**Data collection Tools:**

Three tools were employed to gather the data:

1. A structured questionnaire. It was developed by the researchers. It was including gender, weight, length, gestational age, and method of feeding, medical diagnosis, connections and length of hospital stay.
2. Neonatal skin condition score (NSCS) was developed by **Lund & Osborne (2004).** This tool analyses the state of the skin based on three criteria: dryness, erythema, and breakdown, each of which is rated on a scale from 1 to 3. A total score of 3 denotes normal skin condition, a score of 4 is better (suboptimal), and a score of 9 is the worst.
3. Neonatal skin injury risk assessment (NSRA) was adapted from **McGurk, (2004).** It had 8 questions that evaluated 8 different factors: mobility, nutritional condition, and skin integrity, and weight, age at entry, temperature management, and gestation. Add the scores together, and then add two points for each of the following: in-situ intravenous cannula, in-situ arterial line, extravasation site, wound, evident birth trauma, moisture-associated dermatitis, electrolyte imbalance, and in-situ cord clamp. Scores ranging from 0 to 8 showed a minimal risk of skin problems, 9 to 15 a moderate risk, and 16 to 24 a high risk. Extreme chance of skin problems developing in those over 24.

**Tools validity and reliability:**

The instruments' content validity was examined in-depth by three specialists. The tools were modified in accordance with the experts' assessments of the clarity of the sentences, the suitability of the material, and the order of the items. Intrarater reliability of NSCS (r =) .70 appeared to be satisfactory for total score **Lund & Osborne (2004).** As regards the internal reliability of the NSRA, The scale's overall Cronbach's alpha was.88, while the sub articles scale grade's Cronbach's alpha values ranged from.83 to.90. **(Sari & Altay, 2017).**

**Ethical consideration:**

The primary and final approvals were obtained from research ethics committee at Cairo University's nursing faculty. The purpose, methodology, advantages, and nature of the study were explained to all neonates' parents who took part in the trial, and the researchers then received their formal written agreement. The study's participants might reject to participate for any reason, the researchers noted, and the information they collected would only be used for research purposes. Parents had the right to leave the study at any time without affecting the care given to their newborns, and the anonymity and confidentiality of the information were guaranteed.

**Pilot study:**

Six neonates (10% of the sample), were used in a pilot research to assess the usefulness and intelligibility of the study tools. The sample consisted of neonates who took part in the pilot trial.

**Procedure:**

Prior to starting the study, primary approval was received from the appropriate research ethics committee at Cairo University's faculty of nursing. The directors of Cairo University's El-Monira Pediatric Hospital and the NICU director both granted formal approval. The purpose, significance, and anticipated results of the study were clearly explained to the parents of the neonates.

When a parent agrees to take part in the study, they are put into one of two groups: the study group or the control group.

Data about neonates for both control and study groups obtained by the researchers by examining the neonate physically and individually reviewing the neonate's medical information, it took about 10-15 minutes (tool I).

Firstly, the study was implemented with the control group who received the routine unit care only. Neonatal skin condition score (NSCS) (tool II) and neonatal skin risk assessment (NSRA) (tool III) were used for both groups four times: the first time within 24 hours from admission then at the second, third and fourth day of hospitalization. Each neonate was observed at the end of morning hospital shift to assess the skin conditions post the routine hospital care it took 10-15 minutes.

After finishing the control group, intervention was carried out on neonates in the study group who received the skin injury prevention strategy. The

skin injury prevention strategy was created by the researchers following a thorough analysis of relevant literature and based on guidelines which adapted from neonatology, skin care guideline **(Child & Adolescent Health Service, 2021).** It focused on general preventive measures, skin care for neonates, care for intravenous lines, care for intubated neonates, used of adhesive tape, used of monitoring equipment, prevention of diaper rash, eye and mouth care, bathing, cord care and used of emollients. The researchers practiced skin injury preventive strategy according the frequency, duration and interval of each care, twice in the morning shift for four consecutive days.

**Statistical analysis:**

A computer application called the statistical package for the social sciences (SPSS) programme, version 21, was used to score, tabulate, and analyze the acquired data. To examine the data relevant to the study, descriptive and parametric inferential statistics were employed (paired t-test, two related sample test, and Chi-square test). A p 0.05 significant threshold was accepted.

## Results:

**Table (1): Percentage distribution of neonates' personal characteristics in the two groups (n=60).**

| Neonates' characteristics | Groups | | | | t- test / $\chi^2$ | P |
|---|---|---|---|---|---|---|
| | Control (n. 30) | | Study (n. 30) | | | |
| | No | % | No | % | | |
| **Age on admission / (days):** | | | | | | |
| 1 – 3 | 13 | 43.3 % | 16 | 53.3 % | 0.0650 | 0.518 |
| 4 – 7 | 11 | 36.7 % | 9 | 30.0 % | | |
| >7 | 6 | 20.0 % | 5 | 16.7 % | | |
| Mean ± SD | 5.73 ± 5.311 | | 4.80 ± 5.804 | | | |
| **Gestational age / (weeks):** | | | | | | |
| Preterm | 16 | 53.3 % | 19 | 63.3 % | 1.588 | 0.118 |
| Full-term | 14 | 46.7 % | 11 | 36.7 % | | |
| Mean ± SD | 36.00 ± 2.328 | | 35.53 ± 2.849 | | | |
| **Gender:** | | | | | $\chi^2$ | |
| Male | 12 | 40.0 % | 14 | 46.7 % | 0.271 | 0.602 |
| Female | 18 | 60.0 % | 16 | 53.3 % | | |
| **Weight / (grams)**: | | | | | | |
| <1500 | 2 | 6.7 % | 6 | 20.0 % | 1.882 | 0.065 |
| >1500 – <2500 | 8 | 26.7 % | 13 | 43.3 % | | |
| >2500 - 4000 | 18 | 60.0 % | 9 | 30.0 % | | |
| >4000 | 2 | 6.7 % | 2 | 6.7 % | | |
| **Mean ± SD** | 2859.83 ± 931.384 | | 2403.83 ± 942.363 | | | |

**Table (2): Percentage distribution of neonates' health characteristics in the two groups (n=60)**

| Neonates' health characteristics | Groups | | | | $\chi^2$ | P |
|---|---|---|---|---|---|---|
| | Control (n. 30) | | Study (n. 30) | | | |
| | No | % | No | % | | |
| **Diagnosis:** | | | | | | |
| Respiratory distress syndrome | 12 | 40.0 % | 15 | 50.0 % | 9.004 | 0.532 |
| Hyperbilirubinemia | 11 | 36.7 % | 6 | 20.0 % | | |
| Infant of diabetic mother | 2 | 6.7 % | 2 | 6.7 % | | |
| Cardiac | 3 | 10.0 % | 2 | 6.7 % | | |
| Others | 2 | 6.7 % | 5 | 16.7 % | | |
| **Nutritional pattern**: | | | | | | |
| Intravenous fluid | 7 | 23.3 % | 7 | 23.3 % | 3.095 | 0.797 |
| Total parenteral nutrition | 2 | 6.7 % | 3 | 10.0 % | | |
| Gavage | 2 | 6.7 % | 2 | 6.7 % | | |
| Gavage and Intravenous fluid | 5 | 16.7 % | 7 | 23.3 % | | |
| Gavage and Total parenteral nutrition | 3 | 10.0 % | 1 | 3.3 % | | |
| Bottle | 7 | 23.3 % | 5 | 16.7 % | | |
| Bottle and Intravenous fluid | 1 | 3.3 % | 2 | 6.7 % | | |
| Bottle & gavage | 3 | 10.0 % | 3 | 10.0 % | | |

| Neonates' health characteristics | Groups | | | | $\chi^2$ | P |
|---|---|---|---|---|---|---|
| | Control (n. 30) | | Study (n. 30) | | | |
| | No | % | No | % | | |
| **Neonates' connection:** | | | | | | |
| Mechanical ventilator | 8 | 26.7 % | 9 | 30.0 % | | |
| CPAP | 5 | 16.7 % | 5 | 16.7 % | | |
| Blinder | 2 | 6.7 % | 4 | 13.3 % | | |
| Nasal oxygen | 5 | 16.7 % | 6 | 20.0 % | | |
| Gastric tube | 12 | 40.0 % | 15 | 50.0 % | 2.385 | 0.474 |
| Cannula | 24 | 80.0 % | 27 | 90.0 % | | |
| Central line | 0 | 0.0 % | 1 | 3.3 % | | |
| Chest tube | 0 | 0.0 % | 3 | 10.0 % | | |
| Catheter | 0 | 0.0 % | 1 | 3.3 % | | |
| Phototherapy | 12 | 40.0 % | 10 | 33.3 % | | |
| Umbilical catheter | 1 | 3.3 % | 0 | 0.0 % | | |

**Table (3): Percentage distribution of neonatal skin condition score in the two groups at the first, the second, the third and the fourth day (n=60).**

| Neonatal skin condition score | Groups | | | | t- test | P |
|---|---|---|---|---|---|---|
| | Control (n. 30) | | Study (n. 30) | | | |
| | No | % | No | % | | |
| **First day before the intervention:** | | | | | | |
| Dryness | 0 | 0.0 % | 0 | 0.0 % | | |
| Erythema | 0 | 0.0 % | 0 | 0.0 % | | |
| Breakdown/Excoriation | 0 | 0.0 % | 0 | 0.0 % | | |
| Total neonatal skin condition score Mean ± SD | 3.00 ± 0.000 | | 3.00 ± 0.000 | | | |
| **Second day:** | | | | | | |
| Dryness | 19 | 63.3 % | 3 | 10.0 % | | |
| Erythema | 25 | 83.3 % | 4 | 13.3 % | -7.267 | 0.000* |
| Breakdown/Excoriation | 3 | 10.0 % | 0 | 0.0 % | | |
| Total neonatal skin condition score Mean ± SD | 4.77 ± 1.040 | | 3.23 ± 0.504 | | | |
| **Third day**: | | | | | | |
| Dryness | 25 | 83.3 % | 4 | 13.3 % | | |
| Erythema | 26 | 86.7 % | 7 | 23.3 % | | |
| Breakdown/Excoriation | 8 | 26.7 % | 0 | 0.0 % | -7.777 | 0.000* |
| Total neonatal skin condition score Mean ± SD | 5.33 ± 1.213 | | 3.37 ± 0.669 | | | |
| **Fourth day:** | | | | | | |
| Dryness | 26 | 86.7 % | 3 | 10.0 % | | |
| Erythema | 27 | 90.0 % | 5 | 16.7 % | | |
| Breakdown/Excoriation | 11 | 36.7 % | 1 | 3.3 % | -8.509 | 0.000* |
| Total neonatal skin condition score Mean ± SD | 5.80 ± 1.448 | | 3.30 ± 0.702 | | | |

**Statistically significant differences*

**Table (4): Relation of total mean skin injury risk assessment of both groups at first, second, third and fourth day.**

| Time | Skin injury risk assessment Mean ± SD | | t- test | P |
|---|---|---|---|---|
| | Control | Study | | |
| First day | 11.23 ± 3.963 | 12.83 ± 3.983 | 1.560 | 0.124 |
| Second day | 10.63 ± 3.864 | 12.47 ± 3.794 | 1.854 | 0.069 |
| Third day | 9.80 ± 3.438 | 11.33 ± 3.880 | 1.620 | 0.111 |
| Fourth day | 8.63 ± 3.774 | 10.70 ± 3.687 | 2.145 | 0.036* |

**Statistically significant difference*

**Table (5): Neonates' level of skin injury risk in percentage distribution of both groups (n=60).**

| Time | Skin injury risk level | | | | | | | | | | | | $\chi^2$ | p |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low risk | | | | Moderate risk | | | | High risk | | | | | |
| | Control (n. 30) | | Study (n. 30) | | Control (n. 30) | | Study (n. 30) | | Control (n. 30) | | Study (n. 30) | | | |
| | No | % | No | % | No | % | No | % | No | % | No | % | | |
| First day | 7 | 23.3 % | 7 | 23.3 % | 19 | 63.3 % | 14 | 46.7 % | 4 | 13.3 % | 9 | 30 % | 2.681 | 0.262 |
| Second day | 7 | 23.3 % | 6 | 20.0 % | 19 | 63.3 % | 17 | 56.7 % | 4 | 13.3 % | 7 | 23.3 % | 1.006 | 0.605 |
| Third day | 13 | 43.3 % | 8 | 26.7 % | 16 | 53.3 % | 17 | 56.7 % | 1 | 3.3 % | 5 | 16.7 % | 3.887 | 0.143 |
| Fourth day | 16 | 53.3 % | 10 | 33.3 % | 14 | 46.7 % | 18 | 60.0 % | 0 | 0.0 % | 2 | 6.7 % | 3.885 | 0.143 |

**Table (6): Correlation between neonatal skins condition score and skin injury risk assessment of both groups**

| Skin injury risk assessment ( SIRA) | Total neonatal skin condition score ( NSCS) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Second day | | | | Third day | | | | Fourth day | | | |
| | Control | | Study | | Control | | Study | | Control | | Study | |
| | r | P | r | P | r | p | r | p | r | p | r | p |
| First day | 0.161 | 0.394 | 0.352 | 0.057 | 0.323 | 0.081 | 0.336 | 0.069 | 0.438 | 0.016* | 0.412 | 0.024* |
| Second day | 0.107 | 0.573 | 0.363 | 0.049* | 0.285 | 0.126 | 0.281 | 0.132 | 0.453 | 0.012* | 0.483 | 0.007* |
| Third day | 0.078 | 0.682 | 0.400 | 0.028* | 0.404 | 0.027* | 0.296 | 0.112 | 0.365 | 0.054* | 0.547 | 0.002* |
| Fourth day | 0.095 | 0.619 | 0.385 | 0.035* | 0.399 | 0.029* | 0.266 | 0.156 | 0.430 | 0.018* | 0.537 | 0.002* |

**Statistically significant difference*

**Table (7): Correlation between neonatal characteristics and total neonatal skin condition score at second, third and fourth day**

| Neonatal characteristics | Total neonatal skin condition score ( NSCS) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Second day | | | | Third day | | | | Fourth day | | | |
| | Control | | Study | | Control | | Study | | Control | | Study | |
| | r | P | r | p | r | p | r | p | r | p | r | p |
| Gestational age | 0.077 | 0.688 | -0.186 | 0.324 | -0.341 | 0.065 | -0.234 | 0.213 | -0.400 | 0.029* | -0.537 | 0.002* |
| Weight | 0.065 | 0.733 | -0.145 | 0.445 | -0.089 | 0.641 | -0.255 | 0.173 | -0.167 | 0.378 | -0.473 | 0.008* |
| Age on admission | -0.102 | 0.591 | -0.161 | 0.395 | -0.069 | 0.715 | -0.170 | 0.369 | -0.289 | 0.121 | -0.288 | 0.123 |
| Gender | -0.016 | 0.931 | 0.017 | 0.930 | -0.045 | 0.813 | 0.060 | 0.754 | -0.089 | 0.641 | 0.066 | 0.727 |
| **Neonatal connections**: | | | | | | | | | | | | |
| Mechanical | -0.173 | 0.360 | 0.411 | 0.024* | -0.045 | 0.811 | -0.054 | 0.776 | 0.067 | 0.725 | 0.392 | 0.032* |
| ventilator | | 1.000 | -0.007 | 0.969 | 0.156 | 0.409 | 0.507 | 0.004* | 0.223 | 0.237 | 0.230 | 0.222 |
| CPAP | 0.000 | 0.735 | -0.195 | 0.301 | 0.129 | 0.497 | -0.234 | 0.214 | 0.230 | 0.222 | -0.195 | 0.302 |
| Blinder | 0.065 | 0.932 | -0.249 | 0.184 | 0.065 | 0.734 | -0.130 | 0.492 | -0.180 | 0.341 | -0.249 | 0.185 |
| Nasal oxygen | 0.016 | 0.410 | 0.177 | 0.349 | -0.037 | 0.846 | -0.060 | 0.754 | 0.069 | 0.719 | -0.160 | 0.398 |
| Gastric tube | -0.156 | 0.507 | 0.166 | 0.380 | 0.327 | 0.078 | 0.199 | 0.292 | 0.158 | 0.404 | 0.166 | 0.381 |
| Cannula | 0.126 | | 0.447 | 0.013* | | | 0.263 | 0.160 | | | -0.092 | 0.628 |
| Central line | | | 0.157 | 0.408 | | | 0.025 | 0.896 | | | 0.092 | 0.628 |
| Chest tube | | | 0.355 | 0.054* | | | -0.111 | 0.560 | | | 0.415 | 0.022* |
| Catheter | | | | | | | | | | | | |
| Phototherapy | 0.021 | 0.914 | 0.159 | 0.403 | -0.336 | 0.069 | -0.053 | 0.782 | -0.214 | 0.257 | 0.211 | 0.263 |
| Umbilical cathter | 0.045 | 0.814 | | | 0.123 | 0.517 | | | 0.176 | 0.352 | | |

**Statistically significant differences*

**Table (1):** Reveals that 43.3 % of neonates in the control and 53.3 % in the study groups their age were ranged from1 – 3days. Mean age ± SD of them was 5.73 ± 5.311 and 4.80 ± 5.804 days respectively. More than half (53.3 %) of neonates in the control and (63.3 %) in the study groups were preterm with mean gestational age 36.00 ± 2.328 and 35.53 ± 2.849 weeks respectively. Sixty percent (60.0 %) of neonates in the control group and (53.3 %) in the study group were females. Regarding mean neonatal weight in the control and the study groups was 2859.83 ± 931.384 and 2403.83 ± 942.363 respectively. The table also shows no statistical significant differences between neonates in the two groups related to their age at admission, gestational age, gender, and weight.

**Table (2):** Shows that forty percent (40.0%) of neonates in the control group and half of them (50.0 %) in study group diagnosed as respiratory distress syndrome followed by hyperbilirubinemia and cardiac problems (36.7 %, 20.0 % &10.0 %, 6.7 % respectively). Regarding nutritional pattern (23.3 %) of both groups had intravenous fluids and the same percentage of neonates in control group had bottle while they had gavage and intravenous fluid in study group. In both the control and the study groups, the majority of neonates were connected with cannula (80.0 % and 90.0 % respectively) while the minority of both groups connected with nasal oxygen (16.7 % and 20 % respectively). No statistically significant differences between neonates in the two groups related all items in the table.

**Table (3):** Reports that at the first day, none of neonates in both groups had dryness, erythema or breakdown with total neonatal skin condition score mean 3.00 ± 0.000. However, at second, third and fourth day the highest percentage of neonates had erythema in the control group (83.3%, 86.7 % & 90.0 % respectively) and also in the study group (13.3 %, 23.3 % & 16.7 respectively). There were highly statistically significant differences between both groups related to their mean score for the entire neonatal skin condition P= 0.000.

**Table (4):** Demonstrates that there was no statistically significant differences between the neonates in the two groups either on the first, second, or third day of the skin injury risk assessment as p value (0.124 ,0.069 &0.111 respectively). While, there was a statistically significant difference between neonates in the two groups related mean score ±SD skin injury risk assessment at day 4 (P=0.036).

**Table (5):** Detects that neonates in the control group had moderate level of skin injury risk assessment at first, second and third day (63.3 %, 63.3 % & 53.3 % respectively) As compared to those in the study group, who had moderate level skin injury risk assessments on the first, second, third, and fourth days, more than half (53.3%) of them had low level of skin injury risk assessments on the fourth day. (46.7 %, 56.7 %, 56.7 % & 60.0% respectively). The same table demonstrates that there was no statistically significant differences in the level of skin risk assessment between neonates in the two groups on the first, second, third, and fourth days.

**Table (6):** Shows there was a statistical significant correlation in the control between total NSCS at 3rd day and SIRA at 3rd & 4th day (p = 0.027 & 0.029 respectively) and between total NSCS at 4th day and SIRA at 1st, 2nd & 4th day (p = 0.016, 0.012 & 0.018 respectively). Also there was a statistically significant correlation, as this table illustrates. In the study group between total NSCS at 2nd day and SIRA at 2nd, 3rd & 4th day (p = 0.049, 0.028 & 0.035 respectively) and between total NSCS at 4th day and SIRA at 1st, 2nd, 3rd & 4th day (p = 0.024, 0.007, 0.002 & 0.002 respectively). Otherwise there were no statistical significant correlations between NSCS and their SIRA in both groups.

**Table (7):** Highlights there was no statistical significant correlation between all neonatal characteristics and total NSCS at 2nd & 3rd day in both groups. Additionally, as this table demonstrates, there was no statistically significant correlation between total NSCS at the fourth day and variables related to the weight, age at admission, and gender in the control group. here was no statistical significant correlation in study group between total NSCS 4th day and characteristics regarding age on admission and gender but there was a statistical significant correlation in control and study groups between gestational age and total NSCS at 4th day (p = 0.029 & 0.002 respectively).Additionally, there was a statistically significant correlation between weight and total NSCS during the fourth day in the study group (p = 0.008).

**Table (8):** Represents that no statistically significant differences existed among neonates in the control group between their NSCS and diagnosis at 2nd, 3rd & 4th day (p = 0.949, 0.704 & 0.901 respectively) .In the control group, there was no statistically significant relationship between NSCS and nutritional pattern at 2nd, 3rd & 4th day (p = 0.553, 0.610 & 0.782 respectively). This table also shows that there was no statistical significant relation in the study group between NSCS and diagnosis at 2nd, 3rd & 4th day (p = 0.776, 0.579 & 1.000 respectively) and there was no statistical significant relation in study group between NSCS and nutritional pattern at 2nd, 3rd & 4th day (p = 0.836, 0.276 & 0.231 respectively)

## Discussion

The study results highlighted that the skin injury preventive strategy led to significant improvements on the neonatal skin condition in the study group. This resulted in the study hypothesis being accepted. The finding is consistent with that of the 2019 article predicting Neonatal Skin Injury: A Systematic Review by **Broom et al., 2019**. The first step to reduce Skin Injuries in Neonates''. These findings demonstrated that newborns have a significant risk of skin damage, and that improving neonatal skin care requires supporting skincare policies, guidelines, preventative measures, and understanding of daily care.

The current study's findings clarified that greater than half of neonates in control and in study groups were preterm with mean gestational age, weight 36.00 ± 2.328 and 35.53 ± 2.849 weeks 2859.83 ± 931.384 and 2403.83 ± 942.363 g, respectively. These

findings are backed up by **Kusari et al., (2019)** they discovered that 195 (52.9%) out of 368 newborns were preterm infants. The mean gestational age was 33.93 weeks, the mean birth weight was 2392.63 g, and the mean hospital stay was 35.9 days.

Concerning neonates' gender, the current study finding indicated that approximately two third of neonates in the control group and more than half of them in the study group were females with no significant difference, this finding is provided by **Badr et al., (2015)** who claimed that greater than half were females. Additionally, these results are consistent with **Hunter et al., (2019)** who stated that greater than half of the study group were females and that half of the control group were males.

The current study findings revealed that two fifth of neonates in the control group and half of them in the study group were diagnosed as respiratory distress syndrome followed by Hyperbilirubinemia and cardiac problems. These results supported by **García-Molina et al., (2018)** in a study titled Pressure ulcers' incidence, preventive measures, and risk factors in neonatal intensive care and intermediate care unit'' who reported that infants are admitted to the NICUs for various reasons, such as prematurity.

Neonates both in the study and the control groups of the current study are also similar regarding their diagnosis. According to the results of the current study, respiratory distress syndrome (RDS), which affects two fifths of newborns in the control group and half of them in the study group, is by far the most prevalent diagnosis in both groups, followed by hyperbilirubinemia in each group. This is because lung tissue typically reaches maturity by week 34. Because immature lung tissue is not ready for delivery, the likelihood of respiratory distress is increased. These most recent study results concur with **Villar et al., (2015) & Pai et al., (2018)** who mentioned that most of neonates were diagnosed as respiratory distress and documented that the RDS was the most common morbidity related to prematurity followed by neonatal jaundice are the most common diagnosis found in neonates in both study and control groups.

Considering nutritional pattern, most of neonates in both groups on regular intravenous fluids, gavage then bottle feeding the current result is in agreement with **Khanali Mojen, & Varzeshnejad (2020)** in a study titled '' Skin Injuries and its Related Factors in the Neonatal Intensive Care Unit'' .They stated that the most frequent forms of nourishment during hospitalization in NICUs were intestinal, intravenous, and oral nutrition.

Also the study's findings showed that the majority of neonates in the control and the study groups were connected with intravenous cannula while the minority of them used nasal oxygen. These findings supported with **Deanne et al., (2021)** a research with the title "perspectives on hospital-acquired neonatal skin injury period prevalence from a multicenter study'' who found that 50–62% of patients in neonatal intensive care unit used nasal cannulas and facemasks and this is thought to be a risk factor for having a hospital-acquired skin injury.

The current study also demonstrates that before the skin injury prevention strategy implementation. There is no statistically significant difference in neonates skin condition total mean score of both groups, but after implementation of the prevention strategy at second, third and fourth day, there is statistical significant difference of total mean score of neonatal skin condition score in both groups and none of the neonates in study groups have skin breakdown after implementation of the prevention strategy and neonates in the control group have total mean scores at 2$^{nd}$, 3$^{rd}$ & 4$^{th}$ day greater than neonates in the study group.

According to the findings of the current study, neither the control group nor the study group's neonates experienced dryness, erythema, or breakdown on their first day of admission. This conclusion is consistent with those of a research carried out by **Grosvenor & Dowling (2018)** in titled " Prevention of neonatal pressure injuries " stated that bruising, excoriation, erythema, and according to the types of skin, erythema/redness and pressure injuries were the most common changes. At the second, third, and fourth days, the majority of infants in the control group had erythema whereas only a small percentage of the neonates in the study had dry skin. These immediate gains are pressure were the most frequent wounds. Moreover, the study titled ''alteration of skin condition in newborns admitted to neonatal intensive care'' done by **Araujo et al., (2022)** Also these findings consistent with those obtained by **AbdElrazek & Okby (2020)** in study titled 'nurses knowledge and performance about skin care: guide lines in neonatal intensive care units'' who discovered that the majority of preterm infants examined had skin free from severe dryness and that, following treatments, just 33% had dry skin.

Neonates in the control group had mean ratings for skin condition that were higher than those in the study group, and they were more likely than those in the study group to have their skin condition deteriorate at the second, third, and fourth days. These results are along the same lines as **Behr et al., (2020)** in the study titled ''prevention strategies for neonatal skin injury in the NICU'' who detected significant improvements in neonatal skin condition after a preventive skin strategy intervention. As a result,

rather than being caused by variations in baseline skin condition, any change in skin condition across the assessment period may be attributed to the Intervention (the skin injury prevention strategy).

The mean risk score among the neonates in the current investigation at various assessment points in time appear to have conflicting effects on the likelihood that skin injury develop. . Thus, a higher risk score at the first day is associated with neonates in both groups. The risk score decreased in the study group at fourth day. These results goes on line with the study by **Ahmadizadeh, et al., (2022)** titled "Skin injuries in neonates admitted to three Iranian neonatal intensive care units'' who demonstrated that neonates have a significant risk of skin damage, and that improving neonatal skin care requires supporting skincare policies, guidelines, and understanding of daily care. The current study's findings can be explained by the fact that improved skin condition was brought about by skin care after the implementation of a preventive strategy to prevent skin injuries.

Findings of this study indicated a relatively greater than half of neonates had when comparing the study group to the control group moderate risk of skin injury at first, second and third day and had low risk at fourth day majority of neonates had moderate risk at first, second, third and fourth day. This reflected skin care for neonates should be taken seriously to prevent of this unintentional health problem. These results contradicted with **Sabaq & Amer (2018)** who carry out a study titled 'Effect of Preventive Bundle Guidelines on Reducing Iatrogenic Pressure Injuries among Critically Ill Neonates" and demonstrated that approximately more than three quarters. In the first and second follow-up weeks, respectively, of the neonates in the study group were not at risk of pressure damage; this percentage rose to 90.0% before discharge. On the other hand, throughout the first week of admission until the day before discharge, almost 40% of the neonates in the control group were at high risk. According to the researchers, the improvement in the likelihood of skin injury in the control group may be attributed to the efficient skin care given by nurses during NICU regular care.

The study results represented a significant reduction in skin injury among neonates in the study group at $2^{nd}$, $3^{rd}$ and $4^{th}$ day evident by improvement in neonatal skin conditions score after implementation of skin injury preventive strategy. These results are consistent with research done by **Frank et al., (2017)** to describe the change in the rate of pressure injuries in pediatric hospitals following the implementation of a pressure injury prevention bundle, and it was discovered that there had been a significant decrease in pressure injuries, particularly stage three and stage four injuries, following the implementation of the prevention bundle's components. According to the researchers, these data provide additional evidence in favour of using the preventive skin strategy to reduce skin injury since they enable the quick dissemination of best practices among nurses, which enhances their clinical outcomes.

Otherwise there were no significant correlations detected between neonatal skin condition score and risk injury in both groups. This finding is unsupported by **August et al., (2018)** who reported that neonatal skin injury rates range from 9.25% to 43.1%, indicating a persistently high risk of skin damage throughout this period of intensive care.

The current findings highlighted that there was a strong correlation in study group between total neonatal skin condition score and connections; (mechanical ventilator and central line) at second day and CPAP at third day. In addition, at fourth day there was a strong correlation in both groups between gestational age and total neonatal skin condition score as well as weight, mechanical ventilator and catheter in the study group. These findings are consistent with **Imbulana et al., (2018)** who study'' nasal injury in preterm infants receiving non-invasive respiratory support'' mentioned that one of the main causes of skin lesions is continuous positive airway pressure (CPAP), a non-invasive breathing device for the upper airways. As for gestational age, a study conducted in the United States demonstrated that the likelihood of acquiring lesions increased with lower gestational ages at birth **(Faria et al., 2019 )** .Also, A study developed in Hungary by **(Teofilo et al., 2018 )** reported that infants with low birth weight have an alteration of skin condition.

The findings of the current study demonstrated that there was no relation between neonatal skin condition score and diagnosis or nutritional pattern in both groups at second, third and fourth day. This result contradicted with **Johnson (2016)** who study 'extremely preterm infant skin care: a transformation of practice aimed to prevent harm' highlighted that the neonates skin state at birth is directly correlated with the inherent risk factors for skin injuries. These factors might be pregnancy, birth weight, skin integrity, inactivity, poor tissue perfusion, surgery, infection, and malnutrition.

## Conclusion

Based on the findings of the current study, it can be said that putting skin injury prevention strategies into practice is a crucial part of translating evidence-based interventions into clinical settings. These strategies have also been shown to be successful in improving neonates' skin conditions, which has a positive effect on neonates in the intensive care unit.

## Recommendation

The following suggestions are made in light of the current study's findings. :

1- Create training programs for neonatal nurses on how to handle skin injuries and assess neonate' skin condition and develop protocols and/or use instruments that aim to maintain the integrity of the neonate's skin, which can be useful for identifying any alteration, preventing or minimizing its impact and consequences.
2- Skin injury preventive strategy should be used in all hospitals caring for children to reduce the harm associated with skin injuries.
3- The impact of such skin injury preventive strategy on the neonate's skin condition requires more investigation utilizing a randomized clinical trial design for more reliable evidence.

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**Declarations**

**Ethics approval and consent to participate**

The study protocol and methodology were approved by research ethics committee at faculty of nursing, in Cairo University, IORG0006883Cairo university; RHDIRB2019041701) .All participants (Neonates mothers) gave a written Informed consent.

**Conflict of interest:** The authors affirm that they have no financial or other conflicts of interest.

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