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# Analysis of Relationship Between Risk Factors and Degree of Nasal Pressure Injuries Consequences of CPAP Use in Neonatal Patients at Dr. Soetomo Hospital

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**ABSTRACT**

Background: Nasal pressure injuries (PI) are complications that result from the use of nasal continuous positive airway pressure (CPAP), with an incidence rate ranging from 13.2% to 50%. Problems continue to be a serious concern in hospitals and long-term care facilities. Pressure injury is associated with a decrease in patient quality of life, high medical costs, and increased morbidity and mortality. Therefore, this study aims to identify specific risk factors and effective preventive strategies to protect patients using CPAP from the risk of this pressure injury. Methods: This is a retrospective study with an observational analytical design using secondary data from the medical records. Patients are consulted by the pediatric department to the plastic reconstructive and aesthetics surgery department, who experienced complications due to the use of CPAP in the NICU of Dr. Soetemo Hospital from the period January 2020 - January 2024. Results: The study included 15 patients who met the inclusion and exclusion criteria. Variables analyzed included birth weight, gestational age, comorbidities, duration of CPAP use, use of padding, anatomical location of nasal pressure injury and laboratory parameters including hemoglobin (Hb), white blood cell count (WBC), and serum albumin (Alb) levels. A significant relationship was found between the risk factors of duration of CPAP use and absence or inadequacy of padding use with the incidence of nasal pressure injuries. Conclusion: The use of padding and the prolonged duration of CPAP usage have significant impacts on the incidence of nasal pressure injury in neonatal patients.

***Keywords:*** *Pediatric nasal pressure injury, neonatal, continuous positive airway pressure.*

## 1. INTRODUCTION

Continuous positive airway pressure (CPAP) is a method of non-invasive ventilation used in the management of patients with respiratory failure, sleep apnea, and dyspnea due to pulmonary edema. Application of CPAP requires a tight fit of the face mask around the nasal and perioral areas to be effective, which can result in complications such as pressure injuries. Over time, excess pressure can cause skin and tissue necrosis, leading to pressure injuries. Guidelines recommended CPAP use with intermittent breaks to prevent pressure injury [1]

Nasal injury is a common phenomenon that occurs as a result of CPAP use, with an incidence rate ranging from 13.2% to 50%. Pressure injuries occur when prolonged pressure, along with shear and friction forces, causes local damage to the skin and underlying soft tissue [2]. Research has found that pressure injuries related to medical devices (MDRPIs) are linked to the use of NIV masks, and stage 2 MDRPIs are more likely to worsen to stage 3 or 4 than non-MDRPIs [3]. Although the severity and risk factors of pressure injuries are well understood, cosmetic and functional problems that occur in later stages are not fully documented [4]. This problem continues to be a serious concern in hospitals and long-term care facilities. Pressure injury is associated with decreased patient quality of life, high medical costs, and increased morbidity and mortality [5]. Therefore, this study aims to identify specific risk factors and effective preventive strategies to protect patients using CPAP from the risk of this pressure injury.

## 2. METHODS

This retrospective cross-sectional study used secondary data from the medical records of neonatal intensive care unit (NICU) patients. Patients admitted to the NICU during the period January 2020 to January 2024 who wore CPAP masks during their stay and consulted to the plastic surgery department for pressure injuries were included in this study. The study excluded patients with incomplete medical records from this study. The study had received treatment approval from the ethics committee.

The clinical improvement indicators measured in this study encompass two main aspects, namely clinical wound improvement and laboratory value enhancement. Clinical wound improvement indicator is observed through the changes in the degree of pressure injuries in patients, transitioning from 2nd, 3rd and 4th stages to the first stage or complete healing after plastic surgery treatment. Meanwhile, the laboratory value indicators include three main parameters: hemoglobin, leukocytes, and albumin. The study assesses the values before and after treatment, observing a significant improvement towards normal values post-intervention. The measurements utilize the Wilcoxon statistical method to test the significance of changes in laboratory values before and after plastic surgery treatment.

A normality test was conducted using the Shapiro-Wilk test. Changes in variables before and after debridement were analyzed using T-paired test for normally distributed data or Wilcoxon test for abnormally distributed data. The study performed an independent T-test for normally distributed data and the Mann-Whitney test for abnormally distributed data to compare the wound assessment between the two groups. A value of $p < 0.05$ was considered statistically significant. All statistical analyses were conducted using the Statistical Package for Social Sciences (SPSS) version 26.0

## 3. RESULTS

A total of 15 neonatal patients using CPAP masks were included in this study (figure1). Table 1 shows the demographic characteristics of the subjects. More than half of the subjects were male (60%). All patients had low birth weight, with very low birth weight (VLBW) at 40%, low birth weight (LBW) at 33.3%, and extremely low birth weight (ELBW) at 26.7%. Most patients were born by vaginal delivery (53.3%) at a gestational age of 28–32 weeks (53.3%), and all patients had comorbid lung disease (100%).


**Figure 1 Photographs of four patients with nasal pressure injuries. Before and after treatment with autolytic debridement or moist treatment. (a, e) Patient 1. (b, f) Patient 2. (c, g) Patient 3. (d, h) Patient 4.**

**Table 1 Demographic characteristics of subjects**

| Variable | N (%) |
|---|---|
| **Sex** | |
| Male | 9 (60%) |
| Female | 6 (40%) |
| **Birth Weight** | |
| Extremely low birth weight | 4 (26.7%) |
| Very low birth weight | 6 (40%) |
| Low birth weight | 5 (33.3%) |
| **Mode of delivery** | |
| Vaginal | 8 (53.3%) |
| Cesarean section | 7 (46.7%) |
| **Gestational age** | |
| *Extremely preterm* | 3 (20%) |
| *Very preterm* | 8 (53.3%) |
| *Moderate to late preterm* | 4 (26.7%) |
| **Comorbidities** | |
| Lung disease | 15 (100%) |
| Heart disease | 8 (53.3%) |
| Sepsis | 13 (86.7%) |

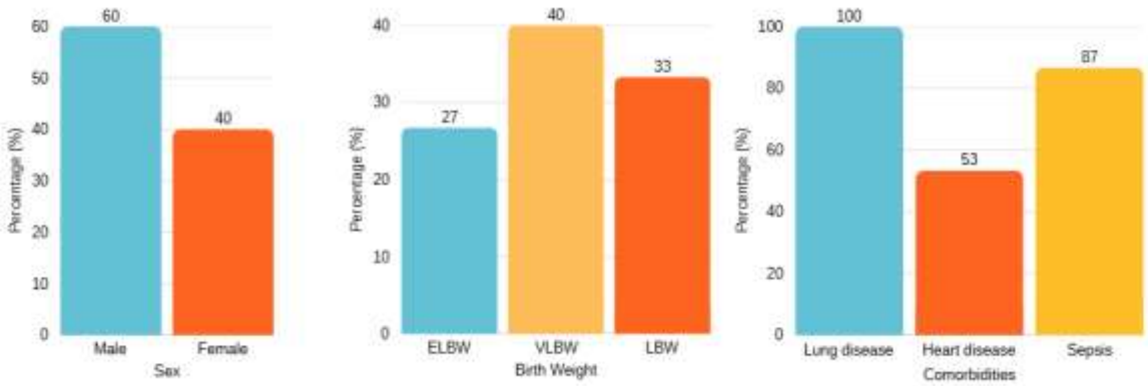


**Figure 2 Demographic characteristics of subjects**

Table 2 showed the clinical characteristics of subjects. The average duration of CPAP use was 8±4.309 days, with a range of 2–15 days. Before debridement, the majority of patients had anemia (93.3%), elevated WBC count (80%), and hypoalbuminemia (66.7%). After debridement, there was an improvement in the laboratory results, which showed normal values. The most frequent site for pressure injuries was the radix (53.3%). Debridement procedure can be done with moist treatment using antibiotic ointment or autolytic debridement using hydrogel. In this study, all patients had pressure injuries above stage I before receiving therapy, and the stage improved or recovered after receiving plastic surgery therapy. The average frequency for debridement was 4.07±1.387 times, with an interval of 3 to 5 days.

**Table 2 Clinical characteristics of subjects**

| Variables | n (%) | Mean ± SD |
|---|---|---|
| **Duration of CPAP use (days)** | - | 8 ± 4,309 (2-15 days) |
| **Padding** | | |
| Yes | 3 (20%) | |
| No | 12 (80%) | |
| **Hemoglobin pre-treatment** | | |
| Anemia | 14 (93.3%) | |
| Normal | 1 (6.7%) | |
| **Hemoglobin post-treatment** | | |
| Anemia | 1 (6.7%) | |
| Normal | 14 (93.3%) | |
| **White blood cell pre-treatment** | | |

| Variables | n (%) | Mean ± SD |
|---|---|---|
| Normal | 3 (20%) | |
| Elevated | 12 (80%) | |
| **White blood cell post-treatment** | | |
| Normal | 14 (93.3%) | |
| Elevated | 1 (6.7%) | |
| **Albumin pre-treatment** | | |
| Hypoalbuminemia | 10 (66.7%) | |
| Normal | 5 (33.3%) | |
| **Albumin post-treatment** | | |
| Normal | 15 (100%) | |
| **Location of nasal pressure injuries** | | |
| Radix | 8 (53.3%) | |
| Columella | 1 (6.7%) | |
| Dorsum nasal | 7 (46.7%) | |
| **Type of teraphy** | | |
| Autolitic debridement | 12 (80%) | |
| Moist treatment | 3 (20%) | |
| **Pressure injury grade pre- treatment** | | |
| II | 4 (26.7%) | |
| III | 8 (53.3%) | |
| IV | 3 (20%) | |
| **Pressure injury grade post-treatment** | | |
| Recovery | 12 (80%) | |
| I | 3 (20%) | |
| **Treatment frequency** | | 4,07 ± 1,387 (2 – 6 times) |

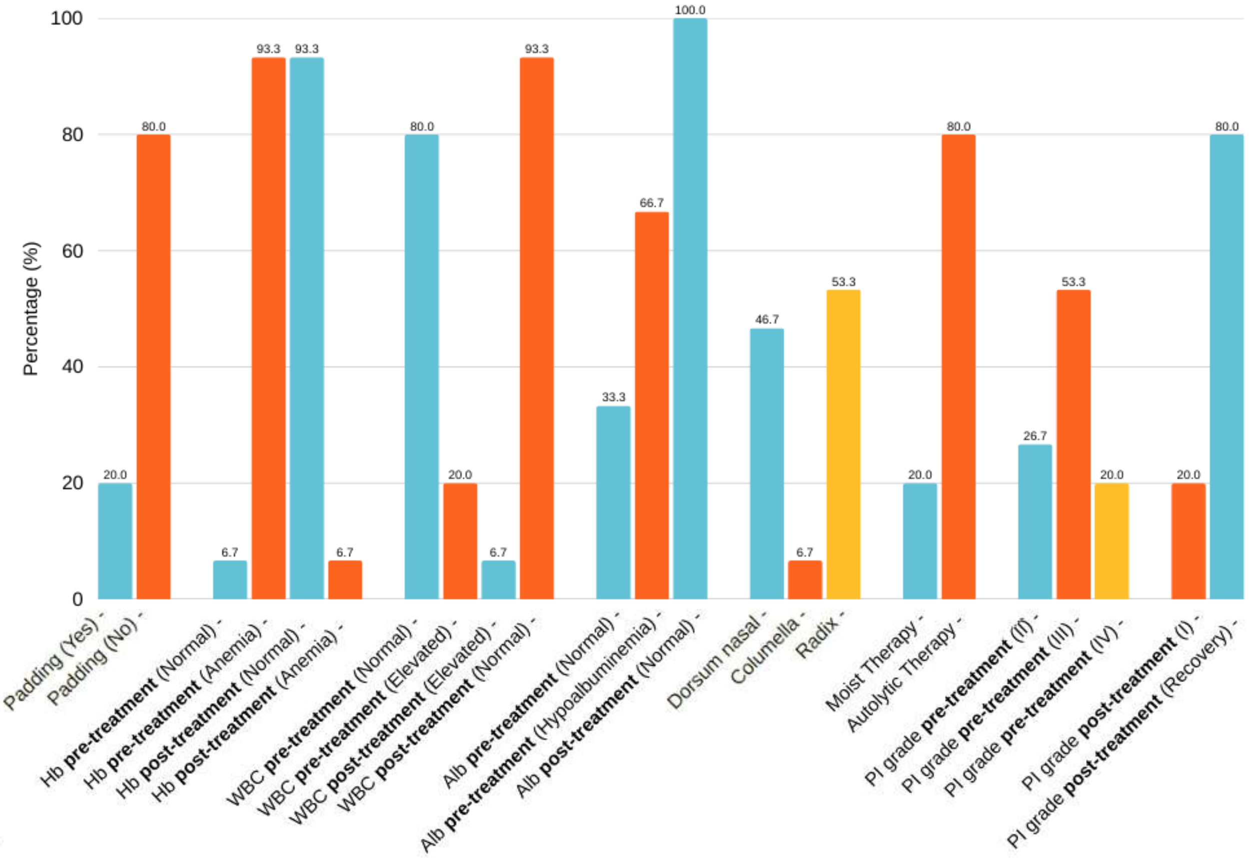


**Figure 3 Demographic of Subjects Clinical Characteristics**

A Comparison of laboratory value and pressure injury grade based on types of treatment was described in Table 3. There was no significant difference in characteristics between subjects who underwent moist treatment and autolytic debridement (p>0.05). However, there were significant differences in all laboratory values and pressure injury grades before and after debridement ($p<0.05$). This showed that debridement can significantly repair laboratory values, mainly hemoglobin, WBC, and albumin levels, and pressure injury grade.

**Table 3 Comparison of laboratory value and pressure injury grade based on type of therapy**

| Characteristics | Autolytic Debridement (AD) N = 12 | Moist Debridement (MD) N = 3 | p value | p value pre- vs post- |
|---|---|---|---|---|
| **Hemoglobin pre-treatment** | | | | |
| Anemia | 11 (91.7%) | 3 (100%) | 0.605 | |
| Normal | 1 (8.3%) | 0 (0%) | | **<0.001** |
| **Hemoglobin post-treatment** | | | | |
| Anemia | 1 (8.3%) | 0 (0%) | 0.605 | |
| Normal | 11 (91.7%) | 3 (100%) | | |
| **White blood cell pre-treatment** | | | | |
| Normal | 3 (25%) | 0 (0%) | 0.333 | |
| Elevated | 9 (75%) | 3 (100%) | | **0.001** |
| **White blood cell post-treatment** | | | | |
| Normal | 11 (91.7%) | 3 (100%) | 0.605 | |
| Elevated | 1 (8.3%) | 0 (0%) | | |
| **Albumin pre-treatment** | | | | |
| Hypoalbuminemia | 9 (75%) | 1 (33.3%) | 0.171 | |
| Normal | 3 (25%) | 2 (66.7%) | | **0.002** |
| **Albumin post-treatment** | | | | |
| Hypoalbuminemia | 0 (0%) | 0 (0%) | 1.000 | |
| Normal | 12 (100%) | 3 (100%) | | |
| **Pressure injury grade pre-treatment** | | | | |
| II | 2 (16.7%) | 2 (66.7%) | 0.194 | |
| III | 7 (58.3%) | 1 (33.3%) | | |
| IV | 3 (25%) | 0 (0%) | | **0.048** |
| **Pressure injury grade post-treatment** | | | | |
| Recovery | 10 (83.8%) | 2 (66.7%) | 0.519 | |
| I | 2 (16.7%) | 1 (33.3%) | | |

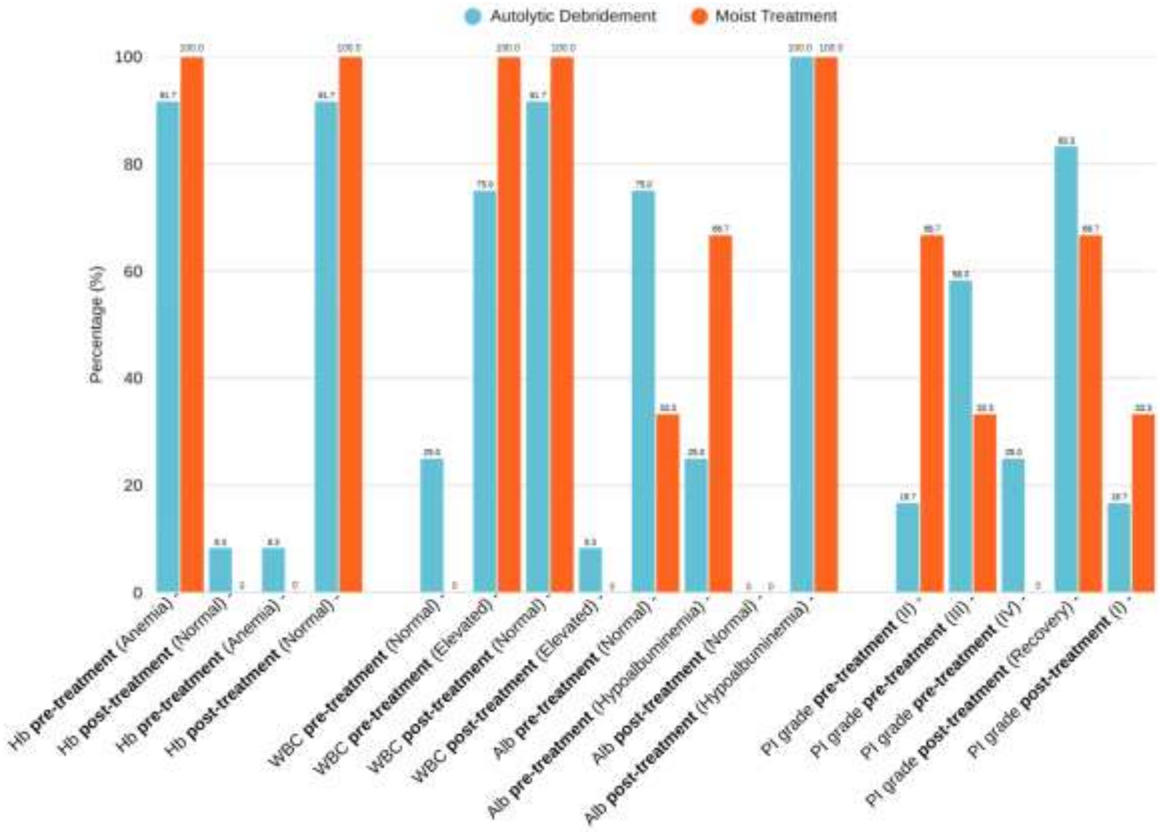


**Figure 4 Comparison of laboratory value and pressure injury grade based on type of therapy**

Table 4 showed risk factor analysis according to pressure injury grades using Spearman's rho and Chi-square analysis. Birth weight, mode of delivery, gestational age, comorbidities, location of pressure injury, and frequency of debridement were not significantly associated with pressure injury grade ($p > 0.05$). Padding use and duration of CPAP use were significantly associated with pressure injury grade ($p < 0.05$). It can be concluded that there was a significant association between the risk factors of using CPAP for some amount of time and padding use with nasal pressure injury incidence.

**Table 4 Association between risk factors and pressure injury grade**

| Characteristics | Pressure injury grade n (%), Mean±SD | | | *p value* |
|---|---|---|---|---|
| | II<br>N = 4 | III<br>N = 8 | IV<br>N = 3 | |
| **Birth weight** | | | | |
| Extremely low birth weight | 1 (25%) | 2 (50%) | 1 (33,3) | 0.991[b] |
| Very low birth weight | 1 (25%) | 5 (62.5%) | 0 (0) | |
| Low birth weight | 2 (50%) | 1 (12.5%) | 2 (66.7) | |
| **Gestational age** | | | | |
| *Extremely preterm* | 1 (25%) | 1 (12.5%) | 1 (33,3) | 0,306[b] |
| *Very preterm* | 1 (25%) | 5 (62.5%) | 2 (66,7) | |
| *Moderate to late preterm* | 2 (50%) | 2 (25%) | 0 (0) | |
| **Comorbidities** | | | | |
| Lung disease | 4 (100%) | 8 (100%) | 3 (100) | 1,000[c] |
| Heart disease | 2 (50%) | 3 (37.5%) | 3 (100) | 0,178[c] |
| Sepsis | 3 (75%) | 7 (87.5%) | 3 (100) | 0,626[c] |
| **Duration of CPAP use (days)** | 4.25 ± 1.5 | 8,38 ± 4,47 | 12 ± 2 | **0,011[a]** |
| ***Padding*** | | | | |
| Yes | 3 (75%) | 0 (0) | 0 (0) | **0,006[c]** |
| No | 1(25%) | 8 (100) | 3 (100) | |
| **Location of nasal pressure injuries** | | | | |
| *Radix* | 1 (25%) | 5 (62,5) | 2 (66,7) | 0,412[c] |
| *Columella* | 0 (0%) | 1 (12,5) | 0 (0) | 0,626[c] |
| *Dorsum nasal* | 3 (75%) | 3 (37,5) | 1 (33,3) | 0,412[c] |

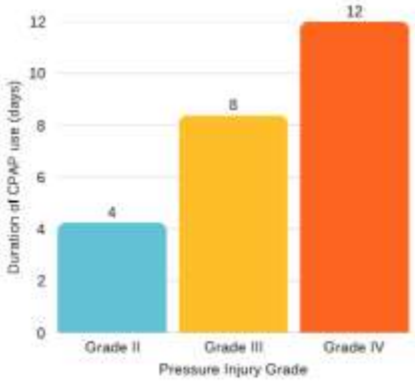


**Figure 5 Pressure Injury Grade based on Duration of CPAP use**

**Discussion**

This study aims to analyze the association between various risk factors and the pressure injury grade of the nasal region in neonatal patients using CPAP. Out of all the risk factors, only the duration of CPAP use and the use of padding showed a significant association with pressure injury. Lung disease in newborns, especially premature ones, is a main indication for CPAP use to help stabilize breathing. Continuous positive airway pressure is a breathing device that can maintain the patency of the alveolus, which facilitates breathing. The use of a CPAP device in the first few days after birth is important for newborns with respiratory distress syndrome. The most common indications for CPAP are respiratory distress syndrome (21.2%), transient tachypnea of the newborn (14.2%), infection or sepsis (13.3%), and perinatal aspiration syndrome (9.7%) [6]. Long-term use of a CPAP mask can consequently generate excessive pressure around the nasal area, resulting in pressure injuries.

The incidence of nasal pressure injuries in pediatric patients ranged from 1 to 8%, with the highest reported number being 43% from critical care [7]. A retrospective study by Lauderbaugh et al. stated that the incidence of pressure injury caused by NIV was 7.3% across all ages [8]. The numbers were higher in the NICU patients, with an incidence rate of 8–16% [9].

Newborns, especially premature infants, have thinner and less mature skin tissues, which likely explains the rapid onset of nasal pressure injuries [10]. This fragile skin is more susceptible to mechanical damage from medical devices such as CPAP. Premature infants also often require more intensive respiratory support, which increases the risk of prolonged CPAP use. A study by Pascual and Wielenga found that for every extra day of gestational age, the chance of getting a nasal pressure injury went down by 3% (OR = 0.97, 95% CI 0.947–0.987, p = 0.001) [10]. In a study by Fischer et al. [11], CPAP-induced nasal trauma to the nose developed in 90% of patients with gestational age <28 weeks and in 77% of those with gestational age <32 weeks, compared with 28% of those with gestational age ≥32 weeks and 11% in term neonates [11].

The most common injury sites were the radix (53.3%) and nasal dorsum (46.7%). These injury locations are consistent with the areas exposed to pressure from CPAP masks. Research conducted by Lauderbaugh et al. supports these findings, showing that pressure injuries primarily impact the nasal bridge. In addition, pressure injuries to the nasal septum are also a common complication of CPAP use, occurring in 20%–100% of newborns [12].

Low birth weight is closely related to prematurity and various complications, such as infection and respiratory syndromes, which necessitate the use of CPAP. Babies with low birth weight are also associated with immature skin tissue, making it susceptible to injuries. A study by Pascual and Wielenga found that every birth weight increase was associated with a 1% decrease in the odds of nasal pressure injury (OR = 0.999, 95% CI 0.998–1.0, p = 0.002) [10].

The study indicated that the duration of CPAP use is significantly associated with nasal pressure injury incidence. It was previously stated that the frequency and severity of nasal pressure injuries were significantly higher in newborns with a gestational age of less than 32 weeks and on CPAP for more than six days [13]. Some infants may require short-term CPAP support, while others may require long-term support due to more severe respiratory conditions or premature birth [14]. In the current study, the average duration of CPAP use showed large standard deviations, which indicate variation in the duration of CPAP use based on each individual's needs. A study conducted by Fischer [11] found that the duration of CPAP use for more than 5 days was the strongest risk factor for pressure injuries. In addition, 90% cases of nasal pressure injuries occurred during the first 6 days of CPAP use (OR 5.36; 95% CI 3.82 to 7.52) [11].

Eighty percent of the subjects did not use padding below the CPAP. Padding can prevent pressure injuries by reducing the pressure force the mask creates on the nasal skin. The high number of CPAP without padding in the center may be due to several factors, including limited resources, lack of awareness, or lack of experience. Padding is essential to distribute pressure evenly and reduce the risk of pressure injury. Direct force from the mask to the immature nasal skin can increase the risk of tissue necrosis, ulceration, and infection. Additionally, research by Rahayu et al. [15] supports this idea. They discovered that using padding (double skin barrier hydrocolloid) can lower the risk of nasal pressure injury in premature babies who use CPAP [15]. Meanwhile, Chen reported that the addition of a hydrocolloid bandage with two small holes can provide a better seal to prevent leakage and protect the skin from direct friction from the nasal tube [6].

Eighty percent of the patients underwent autolytic debridement using hydrogel or moist treatment with ointment antibiotics, which has been proven effective in accelerating wound healing and minimizing infection risk. All patients had pressure injuries grade II, III, and IV before the debridement. After the debridement, there was a significant improvement, with all pressure injuries improving to stage I or completely healed. This study illustrates the effectiveness of debridement in treating pressure injuries [16].

Laboratory results before treatment showed abnormal values in the majority of patients. However, hemoglobin, white blood cell count, and albumin significantly improved to normal values after the treatment. This shows that debridement had a significant effect in not only treating the injuries themselves but also improving a physical condition and general appearance of the patients, including signs of discomfort.

The average frequency of debridement in the study is $4.07 \pm 1.387$ times. This relatively short time for debridement suggests that with appropriate and effective debridement and nutritional support, the patient's condition can improve in a relatively short time. Improvements in laboratory results and healed skin injuries contribute to a reduction in hospitalization, which may also reduce the cost of care and improve the long-term prognosis for patients.

This study has several limitations. First, this study has a small sample size from a single institution. Secondly, this study failed to consider the potential impact of varying padding materials on the development of nasal pressure injuries. Further research using a larger sample size from multiple institutions and analyzing other factors that may affect the incidence of nasal pressure injury in neonatal patients wearing CPAP masks is necessary.

## 4. CONCLUSION

The use of padding and prolonged duration of CPAP are significant risk factors associated with the severity of nasal pressure injuries in neonatal patients. Clinical improvements effective wound care plays a crucial role in accelerating the wound healing process.

## REFERENCES

[1] F. A. Rathore, F. Ahmad, and M. U. U. Zahoor, "Case Report of a Pressure Ulcer Occurring Over the Nasal Bridge Due to a Non-Invasive Ventilation Facial Mask," *Cureus*, 2016, doi: 10.7759/cureus.813.

[2] A. F. Ahmed and M. M. Abdulkareem, "Essentials of Pre- and Post-Operative Evaluation of Total Hip Arthroplasty," *Pharmacol. Med. REPORTS, Orthop. Illn. DETAILS*, vol. 3, no. 3, pp. 84–100, Sep. 2024, doi: 10.55047/comorbid.v3i3.1340.

[3] L. Arundel, E. Irani, and G. Barkema, "Reducing the Incidence of Medical Device-Related Pressure Injuries from Use of CPAP/BiPAP Masks: A Quality Improvement Project," *J. Wound, Ostomy Cont. Nurs.*, vol. 48, no. 2, 2021, doi: 10.1097/WON.0000000000000742.

[4] Y. Li, A. Sepulveda, and E. P. Buchanan, "Late presenting nasal deformities after nasal continuous positive airway pressure injury: 33-year experience," *J. Plast. Reconstr. Aesthetic Surg.*, vol. 68, no. 3, 2015, doi: 10.1016/j.bjps.2014.10.036.

[5] N. Mondragon and P. M. Zito, "Pressure Injury," Treasure Island (FL): StatPearls Publishing. [Online]. Available: https://www.ncbi.nlm.nih.gov/books/NBK557868/

[6] C. Y. Chen, A. K. Chou, Y. L. Chen, H. C. Chou, P. N. Tsao, and W. S. Hsieh, "Quality Improvement of Nasal Continuous Positive Airway Pressure Therapy in Neonatal Intensive Care Unit," *Pediatr. Neonatol.*, vol. 58, no. 3, 2017, doi: 10.1016/j.pedneo.2016.04.005.

[7] M. O. Visscher, "Pediatric NIV Pressure Injury: Honing the Cause and Progress to Solutions," 2019. doi: 10.4187/RESPCARE.07520.

[8] D. L. Lauderbaugh *et al.*, "Noninvasive ventilation device-related pressure injury in a children's hospital," *Respir. Care*, vol. 64, no. 12, 2019, doi: 10.4187/respcare.06784.

[9] B. Delmore, C. VanGilder, K. Koloms, and E. A. Ayello, "Pressure Injuries in the Pediatric Population," *Adv. Skin Wound Care*, vol. 33, no. 6, 2020.

[10] A. Pascual and J. M. Wielenga, "Nasal pressure injuries among newborns caused by nasal CPAP: An incidence study," *J. Neonatal Nurs.*, vol. 29, no. 3, 2023, doi: 10.1016/j.jnn.2022.09.006.

[11] C. Fischer, V. Bertelle, J. Hohlfeld, M. Forcada-Guex, C. Stadelmann-Diaw, and J. F. Tolsa, "Nasal trauma due to continuous positive airway pressure in neonates," *Arch. Dis. Child. Fetal Neonatal Ed.*, vol. 95, no. 6, 2010, doi: 10.1136/adc.2009.179416.

[12] L. B. Moyer *et al.*, "High-stage Device-related Pressure Injury Reduction in a Neonatal Intensive Care Unit: A Quality Improvement Project," *Pediatr. Qual. Saf.*, vol. 7, no. 3, 2022, doi: 10.1097/pq9.0000000000000554.

[13] T. Dai, L. Lv, X. Liu, J. Chen, Y. Ye, and L. Xu, "Nasal Pressure Injuries Due to Nasal Continuous Positive Airway Pressure Treatment in Newborns: A Prospective Observational Study," *J. Wound, Ostomy Cont. Nurs.*, vol. 47, no. 1, 2020, doi: 10.1097/WON.0000000000000604.

[14] K. M. Newnam, J. M. Mcgrath, T. Estes, N. Jallo, J. Salyer, and W. T. Bass, "An Integrative Review of Skin Breakdown in the Preterm Infant Associated with Nasal Continuous Positive Airway Pressure," *JOGNN - J. Obstet. Gynecol. Neonatal Nurs.*, vol. 42, no. 5, 2013, doi: 10.1111/1552-6909.12233.

[15] S. Rahayu, Y. S. Dewi, and A. S. Budi, "Efektivitas Penggunaan Nirs Bundle dan Double Skin Barrier Hydrocolloid terhadap Penurunan Nasal Injury pada Bayi Prematur dengan NCPAP," *J. Telenursing*, vol. 5, no. 1, 2023, doi: 10.31539/joting.v5i1.4841.

[16] G. F. Biazus, D. M. Kaminski, R. de C. Silveira, and R. S. Procianoy, "Incidence of nasal pressure injury in preterm infants on nasal mask noninvasive ventilation," *Rev. Paul. Pediatr.*, vol. 41, 2023, doi: 10.1590/1984-0462/2023/41/2022093.