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THE EFFECT OF HYDROCOLLOID PROPHYLAXIS IN PREVENTING MEDICAL ADHESIVE-RELATED SKIN INJURY (MARSI) IN CHILDREN WITH ENDOTRACHEAL TUBES IN THE PEDIATRIC INTENSIVE CARE UNIT

Juanda Mutifa[1*], Nani Nurhaeni[1], Robiyatul Adawiyah[1]

[1]Spesialis Ilmu Keperawatan Anak, Fakultas Ilmu Keperawatan, Universitas Indonesia Departemen Ilmu Keperawatan Anak, Fakultas Ilmu Keperawatan, Universitas Indonesia

*contact: juandamutifaetik@gmail.com

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Abstract

Background: Endotracheal tube (ETT) insertion is a common therapy for critically ill children in the pediatric intensive care unit (PICU). Medical adhesives used to secure the ETT may compromise skin integrity, leading to medical adhesive-related skin injury (MARSI). Preventive strategies are needed to reduce the risk of MARSI in pediatric patients.

Objective: This study aimed to examine the effect of hydrocolloid prophylaxis in preventing MARSI in children with ETT in the intensive care unit.

Methods: A one-shot case study design was used involving 15 pediatric patients with ETT in the intensive care unit. Hydrocolloid prophylaxis was applied to prevent skin injury caused by medical adhesives. Data were analyzed to determine the occurrence of MARSI after the intervention.

Results: The findings showed that only two out of 15 respondents experienced MARSI, with a statistically significant result ($p = 0.001$; $p < 0.05$).

Conclusion: Hydrocolloid prophylaxis was effective in preventing MARSI in children with ETT. The use of this prophylactic intervention is recommended for implementation by nurses in the pediatric intensive care unit.

Keywords: endotracheal tube (ETT), hydrocolloid, MARSI, pediatric

Introduction

Children in the Pediatric Intensive Care Unit (PICU) often suffer from various systemic health problems that require the support of healthcare professionals and specialized medical equipment. One of the most frequently used invasive devices for children receiving intensive care is the endotracheal tube (ETT), along with a ventilator, to provide respiratory support. Proper placement and positioning of the ETT is crucial to minimize complications such as atelectasis, pneumothorax, tracheal injury, unplanned extubation, and post-extubation stridor (Ebenebe et al., 2023). To prevent these complications, PICU nurses consistently provide ETT care, including ensuring that the ETT is securely fastened within the designated boundaries using medical adhesive. These medical adhesives are largely composed of chemical substances designed to enhance adhesion strength and contact area. Consequently, there is a correlation between skin tissue damage and the application or removal of such adhesives. One form of skin damage caused by this is known as MARSI (Medical Adhesive-Related Skin Injury).

MARSI is defined as the occurrence of erythema and/or other skin abnormalities (vesicles, bullae, erosions, or tears) that persist for 30 minutes or more following the removal of a medical adhesive (Fialho et al., 2024). MARSI is categorized into three types: mechanical, dermatitis, and maceration. Mechanical MARSI is associated with separation of skin layers and friction; dermatitis results from inflammation, chemical irritation, or direct contact with adhesive compounds; and maceration is related to prolonged moisture or exudate exposure. The most vulnerable populations to MARSI include neonates, children, the elderly, cancer patients, orthopedic surgery patients, and ostomy patients. Data show that among every 100 patients using adhesives on medical devices, 55 experience MARSI. Children's skin physiology—which is more sensitive, thinner, and more fragile—increases their risk for MARSI (August et al., 2021; Fialho et al., 2024). Research data indicate that the prevalence of MARSI among children in PICUs ranges from 23.53% to 54.17% (Wang et al., 2019).

Preventing MARSI related to ETT placement, especially in pediatric patients, is essential. Nurses play a key role in prevention through routine skin assessments, selecting appropriate products, providing education and training, using correct application techniques, monitoring ETT positioning, and utilizing barrier protection (Wu et al., 2023). One preventive measure for MARSI in ETT use is the application of hydrocolloid prophylaxis. Hydrocolloid is a type of hydrogel-based adhesive that promotes wound healing and tissue regeneration. The nanoparticles in hydrocolloid dressings are known to reduce pro-inflammatory cytokines and enhance fibroblast proliferation (Fialho et al., 2024). Hydrocolloids have been widely used in the treatment of various wounds, including chronic wounds, pressure ulcers, keloid management, and hypertrophic scar therapy. Additionally, hydrocolloid has been shown to protect skin integrity and prevent chronic irritation (Holmes et al., 2022). A randomized controlled trial (RCT) aimed at evaluating the effectiveness of hydrocolloid in preventing pressure injuries in children with nasotracheal tubes (NTT) in the PICU found that hydrocolloid dressings were more effective in preventing nasal skin damage than conventional dressings (Chen et al., 2020).

Given the harmful effects of MARSI and its high prevalence in pediatric PICU patients, hospitals must prioritize prevention efforts. Pediatric nurse specialists have an important role, as they are recognized as care managers for pediatric patients. PICU care practices led by pediatric nurse specialists must be able to design nursing interventions particularly evidence-based strategies—to prevent MARSI in the PICU setting. At Cipto Mangunkusumo National General Hospital, MARSI remains a concern for pediatric patients with ETTs during PICU care. The use of hydrocolloid prophylaxis has not yet been thoroughly examined or routinely implemented in this

setting. Therefore, the aim of this evidence-based implementation is to evaluate the effect of hydrocolloid use in preventing MARSI among pediatric patients with ETTs.

Method

The method used in this Evidence-Based Nursing Practice (EBNP) implementation was a quasi-experimental design with a one-shot case study approach. In this study, pediatric patients with endotracheal tubes (ETT) received hydrocolloid prophylaxis as the intervention, and the outcome measured was the incidence of Medical Adhesive-Related Skin Injury (MARSI) during hospitalization. Participants were selected using a purposive sampling technique, resulting in a total of 15 pediatric respondents. The inclusion criteria were children aged 1 month to 18 years who were admitted to the Pediatric Intensive Care Unit (PICU) and had no previous history of MARSI. The exclusion criteria included children diagnosed with sepsis and those with a known allergy to hydrocolloid. Data were collected using a MARSI observation sheet to assess skin integrity during a three-day hospitalization period. The data analysis focused on identifying the proportion of MARSI cases and evaluating the effect of hydrocolloid prophylaxis in preventing MARSI among pediatric patients with ETT.

Results

Table 1. Demographic of Respondent (N=15)

	Mean Score **Range**	**F (%)**
Age (months)	**32** **(2-213)**	
Gender		
Male		10 (66,7)
Female		5 (33,3)
Medical Problem		
Respiratory System		6 (40)
Digestive System		3 (20)
Neuro System		4 (26,7)
Cardiovascular System		1 (6,7)
Sensory System		1 (6,7)
Adhesive replacement frequency	6	

Based on Table 3.1, the majority of respondents were male (66.7%), most commonly experienced problems related to the respiratory system (40%), and had an average of six

adhesive replacements

Table 2 Proportion and Effect of Hydrocolloid Prophylaxis on the Incidence of MARSI in Children with Endotracheal Tubes (ETT) (N=15)

Incidence of MARSI	**F (%)**	**Z Score**	**p value**
No	13 (86,7)		
Yes	2 (13,3)	-0,394	0,001

Table 2. showed that out of 15 respondents with ETT who received hydrocolloid prophylaxis, only two experienced MARSI (13.3%). After conducting a proportion test by comparing the incidence of MARSI with previous studies, a p-value of 0.001 ($p < 0.05$) was obtained. Based on this result, it can be concluded that hydrocolloid prophylaxis has a significant effect in preventing the incidence of MARSI in children with ETT.

Discussion

The population of this study consisted of critically ill children, the majority of whom were male. Critically ill children are known to have fluctuating hemodynamics. This instability can also lead to microcirculatory disorders and may affect skin integrity (Chen et al., 2020). The younger the child, the higher the risk of developing MARSI. Wang et al. (2019) stated that children aged two years or younger are more vulnerable to MARSI. This is due to their skin physiology, which is more sensitive, fragile, and thinner (August et al., 2021; Fialho et al., 2024). Children under two years old have a thinner epidermal layer and weaker bonding between the epidermis and dermis. The skin's protective barrier function is also not fully developed in younger children. As a result, younger children are more susceptible to active agents, irritants, or percutaneous absorption that can lead to MARSI (Wang et al., 2019). Gender is one of the risk factors for impaired skin integrity. A study examining rashes in infants explained that infant gender is a potential factor influencing the incidence of dermatitis. Female infants have a lower risk of developing dermatitis compared to males (Price et al., 2021). However, this differs when directly associated with the incidence of MARSI. Wang et al. (2019) found that female gender is one of the risk factors for MARSI compared to male children. Male children, especially those under 12 years old, tend to have thicker skin and higher collagen density compared to females (Wang et al., 2019).

The majority of respondents had respiratory system-related conditions. Anatomically and physiologically, children differ from adults. In pediatric populations, lung volume is proportionally higher than airway diameter, which contributes to infants being more prone to hyperinflation and airway narrowing. Children also have less muscle mass, higher basal metabolic rates, lower nutritional reserves, and lower oxidative capacity compared to adults. Critically ill children with these conditions are more likely to require invasive respiratory support. Approximately 20% of children admitted to PICUs require ventilator support. Respiratory-related illnesses are the main indication for mechanical ventilation use (Miske et al., 2017; Sood et al.,

2023).

The high use of respiratory support devices increases the risk of MARSI (Miske et al., 2017). A study by Ji et al. (2024) also demonstrated a correlation between iatrogenic skin injury and endotracheal intubation in infants. This is also associated with an increased incidence of MARSI. Intubation devices exert pressure on the skin during fixation and can cause skin tissue injury. Improper removal of medical adhesives is also linked to MARSI. Therefore, nurses must focus on skin-related aspects during care, avoid applying medical adhesives directly to the skin, and use products to protect infant skin (Ji et al., 2024). The frequency of dressing or adhesive changes should be adjusted based on the patient's condition. Dressings can be changed regularly or when they appear soiled. The number of hydrocolloid dressing changes is known not to affect the incidence of MARSI in children (Mutifa et al., 2023).

Nurses must pay attention to strategies for applying medical devices to children's skin to protect skin health and provide optimal care. Medical devices such as endotracheal tubes (ETTs) require adhesives to keep them securely in place. These adhesives can trigger skin damage, known as MARSI. Some adhesives may contain allergens that cause epidermal stripping. Therefore, prophylactic dressings are needed (Liversedge, 2019). Several studies have used hydrocolloid as a prophylactic medium for preventing skin damage in children. This study demonstrates that hydrocolloid is effective in reducing the incidence of MARSI in children with ETTs. This is supported by a study from Chen et al. (2020), which found that hydrocolloids reduce injury caused by pressure from respiratory tubing and significantly improve skin resilience. Hydrocolloids have also become the first-line choice in preventing pressure injuries caused by noninvasive ventilation (NIV) in infants. Hydrocolloids are proven to be impermeable to bacteria and other contaminants, waterproof, occlusive, and highly suitable for dry skin conditions (Cai et al., 2019). Hydrocolloids offer several properties and advantages, including reducing pressure and shear forces, relieving pain and infection risk, absorbing exudate, promoting autolytic debridement, and stimulating granulation tissue (Cai et al., 2019; Tsioli et al., 2016). Although hydrocolloid prophylaxis has been implemented and proven effective in preventing MARSI, nurses must continue to perform routine skin assessments in children.

Conclusion

PICU patients often present with clinical conditions that require the use of invasive respiratory support. The majority of children in need of such medical devices are those with respiratory system disorders. The use of invasive medical equipment also necessitates adhesives for secure fixation. However, the use of adhesives in pediatric patients is known to carry a risk of causing MARSI. Specific characteristics of PICU patients such as younger age and gender differences further increase the risk of developing MARSI. Providing optimal and holistic care for pediatric patients must aim to prevent the occurrence of MARSI. One effective strategy is the use of hydrocolloid prophylaxis. Hydrocolloid prophylaxis has been proven to prevent MARSI in PICU patients. Therefore, this preventive measure is highly recommended for continued implementation in PICU settings to protect skin integrity. In addition, nurses are encouraged to conduct regular assessments of children's skin health, especially in areas where medical devices or adhesives are applied.

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