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Review article

Pediatric pressure injuries: A systematic review of interventions to prevent hospital-acquired pressure injuries in the pediatric population

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Abstract
Introduction: Pressure injuries have been identified as a problem in adults, but there is increasing recognition that they also occur in pediatric patients. Specific prevention in this population is essential because a high percentage of pressure injuries can be prevented.
Objective: To identify interventions that prevent pressure injuries in the clinical pediatric care setting.
Methods: Systematic review with a conducted search in CINAHL, PubMed, and Cochrane databases. A total of 301 articles were found, 225 were excluded after reviewing the title and abstract. The remaining papers were subjected to a full-text screening. Eligible studies were those that (a) described interventions to prevent pressure injuries, (b) were specifically aimed at pediatric patients (0–18 years), (c) were published in English or German, and (d) were conducted in a hospital.
Results: A total of 37 studies were included. The data on interventions from the studies were extracted and clustered. The following eight categories of interventions for the prevention of pressure injury in pediatric patients were identified: (1) (Skin)Assessments, (2) Medical devices, (3) Positioning, (4) Education, (5) Moisture Management, (6) Nutrition Management, (7) Surfaces, and (8) Intervention bundles. The included studies described various interventions for pressure injury prevention. Most reported a significant reduction in pressure injury rates when intervention bundles were implemented.
Conclusion: Nurses have to know about pressure injury causation, risk factors, and prevention strategies to implement the identified interventions and prevent pressure injuries in pediatric patients during hospital stays.

Keywords: Hospital-acquired pressure injury; Nursing interventions; Pediatric pressure injury; Prevention; Skincare

Abbreviations:
ECMO: Extracorporeal membrane oxygenation; EEG: Electroencephalography; HAPI: Hospital-acquired pressure injury; ICU: Intensive Care Unit; OR: Operation Room; PI: Pressure Injury

Introduction

Pressure injuries are defined as localized injuries to the skin and underlying tissue, usually over bony prominence or associated with a medical or other device. The injury may appear as intact skin or an open ulcer and may be painful. The injury occurs due to intense and/or sustained pressure or pressure in combination with shear forces. The tolerance of tissue to pressure and shear forces can also be influenced by microclimate, nutrition, blood flow, comorbidities, and tissue condition (Edsberg et al., 2016). Due to the often-poor health status of children admitted and cared for in hospitals, they are at greater risk of developing pressure injuries (Smith et al., 2019). Pressure injuries have been identified as a problem in adults, but there is increasing recognition that they also occur in pediatric patients. Children have different anatomical, physiological, and developmental factors that influence the occurrence of pressure injuries. For example, in infants the head is proportionately larger and heavier, making the back of the head a primary site for pressure injuries to develop. Physiologically, fluid and electrolyte imbalances occur more frequently and develop more quickly in infants and young children than in older children and adults. Extracellular fluid accumulation and the resulting edema can lead to increased external pressure on the skin and thus to a pressure injury (Murray et al., 2013). A pressure injury is an adverse event that prolongs hospital stays and suffering. It has a high incidence of complications, such as infections (Rodrigues et al., 2020). Furthermore, pressure injuries not only affect the quality of life of patients but are also associated with excessive costs for health care and, under certain circumstances, lead to life-threatening situations (Delmore et al., 2019; Sving et al., 2012).

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The development of pressure injuries is an indicator of patient safety and quality of care with a desired zero incidence. The Center for Medicare and Medicaid Services (CMS) considers hospital-acquired pressure injuries (HAPI) to be a hospital-acquired complication and events that are preventable using evidence-based guidelines (Center for Medicare and Medicaid Services, 2006). Pressure injury prevention is essential because, in studies with adult patients, it is reported that 95% of all pressure injuries are preventable (Charalambous et al., 2019; Rodgers et al., 2021). Specific data for pediatric patients is not available. Therefore, nurses who work in clinical settings and have daily contact with children at high risk of pressure injuries should have an appropriate level of knowledge (Qaddumi and Khawaldeh, 2014).

With the explained background, this systematic review aims to provide an overview of nursing interventions that prevent pressure injuries in the setting of pediatric hospital care using the research question "Which nursing interventions prevent pressure injuries in the clinical pediatric setting?"

Materials and methods

The systematic search was conducted in CINAHL, PubMed, and Cochrane databases from March to May 2023 using the keywords *Pressure ulcer/Pressure injury, Skincare/Skin integrity, Intervention, Prevention, Children, and Nurse/Care*. The period of published articles was limited to ten years to ensure up-to-date information. The Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) were followed to ensure the comprehensibility of the systematic search. The result of the search and identification process is summarized in Diagram 1.

The titles of the studies were first reviewed independently by two reviewers for relevancy. The abstracts were then read to determine if the articles met the inclusion criteria. Each paper had to satisfy the following criteria to be included in the review: Studies had to be specific to pediatric patients in the hospital setting, and if adult patients were also included in the

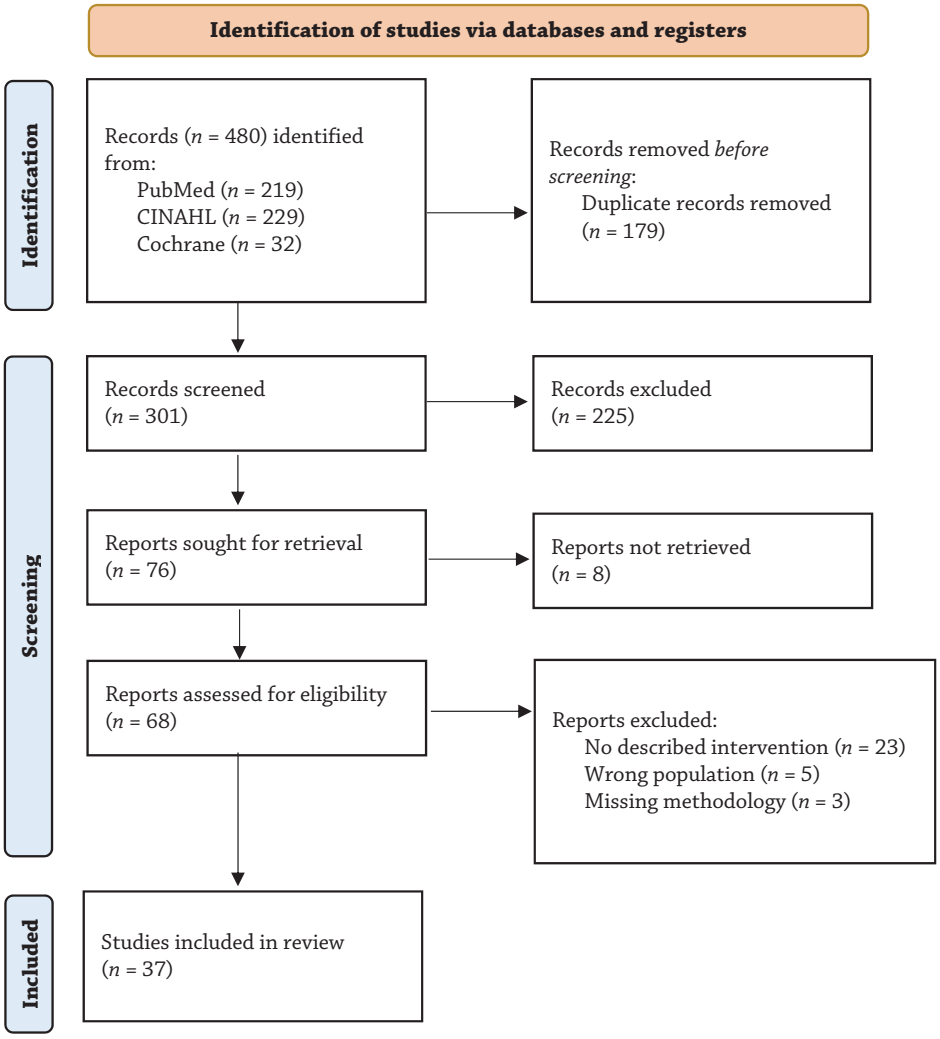


Diagram 1. PRISMA-Flow Chart of systematic search (Page et al., 2021)

studies, the pediatric-specific data had to be presented. RCTs, quasi-experimental studies, observational studies, case studies, meta-analyses, and literature reviews that described a specific intervention were included. The studies had to be written in German or English.

The mere implementation of an assessment tool was understood as a diagnosis process and not as an intervention, which is why these studies were excluded. Grey literature, non-scientific journal articles, and publications that did not describe their methodological approach were not considered. The included studies were critically appraised using the Joanna Briggs Institute Checklists (Barker et al., 2023; Tufanaru et al., 2020).

Data charting process

For data extraction, a table was created which contained the columns "author/year/title", "study design", "setting", "population", "intervention" and "main results on pressure injury prevention". In this table, the two authors extracted the data independently. The collected data was compared, and differences were discussed by both authors.

Synthesis of results

The included studies were first categorized into the two different etiological aspects of "medical device-related pressure injuries" and "immobility-related pressure injuries". Many of the existing studies do not describe individual interventions but combine them into bundles. This data was also extracted if single interventions of the bundles were described. By viewing the full texts and clustering the results from the included studies, it was possible to create the following eight categories for pressure injury prevention: (Skin)Assessments, Medical devices, Positioning, Education, Moisture Management, Nutrition Management, Surfaces, and Intervention bundles.

Results

Study characteristics

The search yielded 480 papers, of which 179 were duplicates. A total of 301 papers were found, 225 were excluded after reviewing the title and abstract. Of the remaining 76 papers, eight were not available in full text. Thus, 68 papers were subjected to a full-text screening and critically discussed based on the inclusion and exclusion criteria. After the screening process and the discussion, 37 papers were included. Exclusion criteria were: no described intervention (n = 23), wrong population (n = 5), and missing methodology (n = 3). The included studies were published between January 2013 and March 2023. Studies included randomized controlled trials (n = 3), quasi-experimental studies (n = 6), observational study designs (n = 1), quality improvement projects (n = 18), and literature reviews (n = 6). Also, one Meta-Analysis, one Case Study, and one Survey are included in the results. The characteristics of the studies included are shown in Supplement 1.

(Skin)Assessment

The assessment of skin integrity and risk for pressure injury is the first step in guiding appropriate nursing interventions that prevent pressure injuries. There is a variation in the literature when assessments are described. Many of the included studies describe the process as a "full head-to-toe skin assessment" during care procedures (Bargos-Munárriz et al., 2020; Johnson et al., 2020; Kiss and Heiler, 2014; Krzyzewski et al., 2022; Kulik et al., 2018; Palmer, 2013; Razmus and Bergquist-Beringer, 2017) and most of them recommend completing it every three to four hours or on admission. Also, different risk assessments are used, especially assessments based on the Braden Q or Braden QD (Ciprandi et al., 2022; Kriesberg Lange et al., 2018) and the e-NSRAS scale (García-Molina et al., 2018; Kriesberg Lange et al., 2018; Nie, 2020). According to Kulik et al. (2018), special attention should be paid to bony prominences, to the back and under medical devices. Studies focusing on medical device-related pressure injuries recommend specific skin assessments to observe the skin under and around the medical device (Blazier et al., 2023; Boyar, 2020; Johnson et al., 2020; Kiss and Heiler, 2014; Krzyzewski et al., 2022; Luton et al., 2017; Miske et al., 2017; Ottinger et al., 2016; Pasek et al., 2021; Peterson et al., 2015; Rowe et al., 2018).

Medical devices

The primary cause of pressure injuries in the described pediatric patients are medical devices (79%) (Cummins et al., 2019). That's why many studies have a specific focus on effective medical device-related pressure injury prevention strategies.

There are recommendations to regularly rotate or reposition the medical devices if possible and to remove the medical devices as soon as possible (Boylan, 2020). The area around and under the device should be assessed twice daily or as needed (Delmore et al., 2019; Johnson et al., 2020; Kulik et al., 2018; Nist et al., 2016; Rowe et al., 2018; Scheans, 2015). Palmer (2013) recommends the repositioning of medical devices every two to four hours and the use of specialty surfaces designed to secure medical devices, such as arm boards for IVs, whenever possible to minimize the use of adhesives and provide stabilization for medical devices.

Also, prophylactic dressings can be placed under medical devices to reduce pressure and skin injury (Boylan, 2020). Foam dressings can function as a barrier between the child's skin and any medical device that is present (Ciprandi et al., 2022; Kriesberg Lange et al., 2018; Nist et al., 2016; Ottinger et al., 2016).

Non-invasive ventilation

Because non-invasive respiratory support is often required up to 24 hours per day over areas with little to no subcutaneous fat, the risk for HAPI is high. The nasal bridge is an area with high vulnerability to pressure injury. The forehead, cartilage of the ear, cheek, occiput, and back of the neck are also impacted by the pressure points of the interface and headgear (Miske et al., 2017). Newnam et al. (2015) demonstrate an overall skin breakdown rate of 24.2%, which provides a clear opportunity for clinicians to improve skin care outcomes.

The interface must be removed with an appraisal at all pressure points every four hours (Miske et al., 2017). The selection of the correct size has significant importance in the prevention of NIV-related pressure injuries (Ottinger et al., 2016). Miske et al. (2017) recommend placing the mask in the center of the nose/face, and the edges of the mask surface should not touch the epicanthal fold or the upper lip. Furthermore, the material of the nasal mask must not press against the outer part of the nostrils, which is why it is important to use the smallest interface possible. The headgear straps are tightened so that one to two fingers fit under the straps and the cheeks are not visibly depressed.

To minimize leakage, the bands of the headgear can be tightened slightly, but measures such as the use of a pacifier can also be used to minimize leakage from the oral cavity without causing additional pressure through the bands. According to Boyar (2020) and Miske et al. (2017), special attention should

be paid to avoid irritation of the conjunctiva or nasal mucosa and creating skin barriers under the mask/prongs. To reduce pressure on the nasal septum, Behr et al. (2020) and Scheans (2015) recommend applying a protective barrier of hydrocolloid. In patients receiving non-invasive respiratory support, barrier dressing reduced pressure injuries significantly from 54.4% to 34% (Imbulana et al., 2018). The findings from the study by Boyar (2020) suggest that the use of a specialized, thin-walled nasal cannula resulted in a six-fold higher rate of nasal pressure injury occurrences when compared to its use in combination with a foam barrier dressing. Based on the results of the study, the author concludes that the use of a foam barrier dressing is effective for the prevention of pressure injuries and columellar necrosis in infants.

The study findings from Newnam et al. (2015) demonstrated significantly fewer pressure injuries when mask and prongs are systematically rotated every four hours in comparison to a continuous mask or continuous prongs group. Also, Nist et al. (2016) and Ottinger et al. (2016) recommend the rotation of masks and prongs as appropriate to alter pressure points.

No respiratory devices, like wires or tubes, must be in contact with the patient's skin (Kiss and Heiler, 2014; Peterson et al., 2015), so it is important to fix tubing from machine to interface after the interface and headgear are in place (Miske et al., 2017).

Nasotracheal tube

Only one study was identified that focused on the prevention of nasotracheal tube-related pressure injuries. In the study by Chen et al. (2020), a hydrocolloid dressing was used as an intervention to protect nasal skin. The dressing was cut into an optimal size, enabling it to cover the area from the nasal columella to the nostrils. The hydrocolloid dressing showed sufficient efficacy in protecting the nasal skin, and the authors recommend hydrocolloid dressing as a protective barrier owing to its characteristics of adhesion, thinness, reduction of pressure and shear force, and absorption of exudate.

Tracheostomy

Miske et al. (2017) described specific interventions for tracheotomized pediatric patients, such as inspecting skin in contact with the device at least daily, protecting skin with dressings in high-risk areas, and the awareness of edema and the device. The results indicate that standardizing the frequency of neck assessment under tracheostomy securement devices and the method for performing these assessments reduced the incidence of pressure injuries associated with tracheostomy security. In the study by Peterson et al. (2015), daily assessments were performed by a tracheostomy-specialized nurse on newly tracheotomized patients to assess the skin. Furthermore, head and neck rolls were used for positioning to hyperextend the neck and relieve pressure. The device-specific interventions were especially effective in reducing HAPIs. The overall occurrence of pressure injuries was reduced by 32 percent.

In tracheotomized patients, management of exudate in the wound bed is important to avoid pressure injuries. Since the wound bed is moist, a material with high absorbency should be used for moderate to heavy exudate. Pressure-reducing foam pads with silver nitrate and maltodextrin were beneficial for complete epithelialization. According to Sullivan et al. (2021), pressure injuries associated with tracheostomy can therefore be largely reduced by careful monitoring of skin health, selection of appropriate protective devices, and use of extended tracheostomy tubes.

ECMO

One included study (Pasek et al., 2021) focused on the prevention of ECMO-related pressure injuries. The ECMO cannula and monitoring equipment represent some of the medical devices that pose a risk for pressure injuries in pediatric patients.

ECMO-related interventions included placing a foam dressing between the cannula and the skin to protect the skin from the pressure of the cannula. Consultation with a wound care nurse was initiated on the first day of ECMO therapy. The wound care nurse developed individual prevention plans based on each patient's risk assessment. Due to the early application of a preventive foam dressing near the cannula site, only one injury was associated with the cannulas in the period following insertion. Before implementation, 36% of ECMO patients had one or more pressure injuries. After implementation, such injuries occurred in 19% of patients, which represents a 17% improvement.

Monitoring

Because monitoring of vital signs is often necessary for critically ill children, attention must also be paid to the medical devices used for monitoring. Recommendations for changing the pulse oximetry sensor varied between at least every eight hours (Simsic et al., 2019) and every twelve hours (Scheans, 2015), and regular changes in the position of the transcutaneous monitor were also described.

Blazier et al. (2023) and Luton et al. (2017) focused on the prevention of pressure injuries for patients undergoing continuous EEG monitoring. In the study by Luton et al. (2017), a team – including EEG technologists, neurophysiologist leadership, bedside nurses, wound care nurses, a neurologist, and a neonatologist – integrated effective HAPI prevention measures into the institution's standard care for all the patients with continuous EEG monitoring. During training sessions, all team members were informed about the new interventions. A maximum of 17 EEG leads were allowed to be placed at the same time and the leads had to be repositioned if skin redness/breakdown was noted. A wound care nurse was consulted for evaluation if indicated.Following the special quality improvement steps, the team accomplished a zero-pressure injury rate in the pediatric population. After implementing an interprofessional developed, evidence-based prevention plan for EEG-indicated pressure injuries over several phases in the study by Blazier et al. (2023), the rate of EEG scalp erythema improved from 17.5% to 15.8%, and the open scalp wound events were eliminated.

Positioning

Pressure injuries are affected by tissue pressure and tolerance. Pressure intensity and the duration of being in a certain position could increase the risk of developing pressure injuries. Prevention strategies such as turning and repositioning must be implemented so that the patient does not remain in the same position for a long time.

In the included studies, the most described interval to prevent a pressure injury is performing two-hourly repositioning (Andayani et al., 2020; Bargos-Munárriz et al., 2020; Cummins et al., 2019; García-Molina et al., 2018; Johnson et al., 2020; Kiss and Heiler, 2014; Kriesberg Lange et al., 2018; Kulik et al., 2018; Nie, 2020; Scheans, 2015; Simsic et al., 2019) to offload pressure from bony prominences. Special attention should be paid to repositioning the child's head. Even small degree changes from side to side will reduce direct pressure on the occiput (Boylan, 2020). So, if the patient's condition does not allow a complete repositioning (e.g., hemodynami-

cally unstable patients), only a repositioning of the head and the limbs can be performed (Bargos-Munárriz et al., 2020; Rowe et al., 2018). To meet the positioning needs of hemodynamically unstable patients, Peterson et al. (2015) introduced air-fluidized positioners, which are very pliable and soft positioning devices.

It is also important to keep the heels off the bed surface (Bargos-Munárriz et al., 2020; Kiss and Heiler, 2014; Kriesberg Lange et al., 2018; Kulik et al., 2018; Rowe et al., 2018; Uysal et al., 2020). Uysal et al. (2020) also used protectors for heels and elbows. Care must be taken to prevent and protect pediatric patients from lying on infusion tubes or other hard objects, such as needle caps (Scheans, 2015).

The study by García-Molina et al. (2018) determined that the mobilization of hospitalized neonates, whether performing repositioning or applying the kangaroo care method were a significant preventive measure.

Education

Pressure injury prevention is the responsibility of nurses. It presents important and exciting opportunities for nurses to function autonomously and apply the best evidence to vulnerable patient populations (Pasek et al., 2021). The quality improvement project of Cummins et al. (2019) demonstrates that nurses are not knowledgeable about the growing body of evidence regarding pediatric pressure injury causation, risk factors, and prevention strategies. Healthcare leaders should focus resources on ensuring evidence is translated into practice, and ensure technology is leveraged to link risk assessment tools with evidence-based prevention strategies to guide clinical decision-making and improve patient outcomes. In this study, an educational session was delivered to the nurses on risk factors for pediatric pressure injuries and prevention strategies. This focused on medical devices being the primary cause of pressure injuries in the pediatric population. Before the session, the mean percentage of correctly answered questions by nurses was 61.6%, and after the education it decreased to 79.5%.

Many of the included studies also saw the staff education sessions as a key point in preventing pressure injuries (Krzyzewski et al., 2022; Nist et al., 2016; Reyna, 2015). Special educational training for nurses and also for physicians was described for EEG-related PI prevention (Blazier et al., 2023), hospital-acquired pressure injury prevention (Ciprandi et al., 2022), nasotracheal tube-related pressure injuries (Chen et al., 2020), positioning and optimize nutrition (Cummins et al., 2019), correct use of devices and prevention of skin-breakdown (Miske et al., 2017), and a general educational training before implementation of new assessment-tools (Kiss and Heiler, 2014; Rowe et al., 2018; Schindler et al., 2013). Lawrence et al. (2021) provided education and hands-on practice with products. Specific topics were discussed, including the difference between premature and term newborn skin and the best skincare practices. Ottinger et al. (2016) strongly recommend holding regularly scheduled education sessions for nurses to stay current on the best practices available.

Moisture management

One part of moisture management is the protection of the skin. For skin moisturizing, hyper oxygenated fatty acids and barrier creams should be used (Bargos-Munárriz et al., 2020). But moisture can also result from sweat, secretion, baths, emesis, or feeding (Miske et al., 2017). The other part is to maintain dry bed surfaces and clothing. The skin should be kept clean and dry (Johnson et al., 2020). Kriesberg Lange et al. (2018) described the use of specific "foam-like" products in their protocol to offload pressure and wick away moisture. Many studies include moisture management as part of an intervention bundle (Kulik et al., 2018; Razmus and Bergquist-Beringer, 2017; Reyna, 2015; Rowe et al., 2018).

In addition, incontinence is a risk factor for pressure injury development, as stool contains bacteria and enzymes that are caustic to the skin. To ameliorate the risk of incontinence contributing to pressure injury development, Behr et al. (2020), Schindler et al. (2013), and Palmer (2013) recommend the use of zinc-based barrier cream with each diaper change. Johnson et al. (2020) and Rowe et al. (2018) also recommend applying barrier cream to create a moisture barrier for all diapered patients.

In three studies, special moisture management to prevent tracheostomy-related pressure injuries is described. Moser et al. (2022) recommend the use of hydrophilic foam dressing, which provides moisture wicking, exudate control, and cushioning. These absorptive dressings are designed to wick moisture away from the underlying tissue and provide a soft barrier against the tracheostomy flange. Six of the ten studies from the meta-analysis by Moser et al. (2022) compared these dressings either alone or in conjunction with other interventions. All had much lower incidences of tracheostomy-related pressure injuries among groups receiving hydrophilic foam dressings.

Delmore et al. (2019) describe the use of a moisture-redistribution dressing at the device interface to reduce tracheostomy-related pressure injuries. The wet ties and dressings around the tracheostomy should be changed as soon as possible. If there is excessive moisture and multiple changes are necessary, a Wound Care Nurse should be contacted to explore other dressing options and discuss options to decrease secretion (Miske et al., 2017).

Nutrition management

The tolerance of soft tissue for pressure and shear may also be affected by nutrition (Edsberg et al., 2016). Nutritional status can impact pressure injury development and healing, particularly in children who have a high nutritional requirement to meet their growing bodily needs (Boylan, 2020). Focus should be on enteral nutrition, as parenteral nutrition was found to be a significant risk factor (García-Molina et al., 2018). Many of the included studies focused on optimizing nutrition as part of pressure injury prevention (Boylan, 2020; Cummins et al., 2019; García-Molina et al., 2018; Johnson et al., 2020; Kriesberg Lange et al., 2018; Kulik et al., 2018; Razmus and Bergquist-Beringer, 2017; Reyna, 2015; Schindler et al., 2013). Cummins et al. (2019) explain that physicians and nursing staff pay little attention to the key role nutrition plays in the prevention of pressure injuries.

For patients identified as having nutritional deficiencies after assessments, a specific nutritional supplement plan adapted to their nutritional needs must be conceived. The construction of the plan involves using the expertise of a pediatrician, pediatric dietician, or other suitably qualified healthcare professionals. The nutrition plan provides instructions for nutritional support and nutritional supplementation requirements appropriate to the child's growth and special nutritional needs during hospitalization (Boylan, 2020). There is a recommendation to assess the nutritional status at least every 24 hours (Palmer, 2013) or on admission (Rowe et al., 2018). Uysal et al. (2020) assessed the independent feeding and dietary pattern statuses, monitored weight loss and dehydration, and provided adequate and balanced nutrition.

Surfaces

As part of a global pressure injury prevention plan, support surfaces can be used to alleviate poor tissue tolerance and shear, improve the microclimate, and/or relieve pain, but should not replace turning and repositioning (Delmore et al., 2019; García-Molina et al., 2018; Kulik et al., 2018; Simsic et al., 2019). Bargos-Munárriz et al. (2020) recommend the use of pressure-redistributing support surfaces to prevent occipital pressure injuries. Therefore, the individual's height, weight, and age must be consistent with the manufacturer's recommendation when placing a pediatric patient on a low-air-loss bed or alternating pressure support surface. Also, a pressure redistribution surface was used to offload pressure points on the face and body while patients were in the prone position. The use of high-specification foam mattresses has been shown to reduce the interface pressure on the occiput in premature neonates (Boylan, 2020).

Intervention bundles

Many pre- and postintervention studies, framed as quality improvement projects, describe interprofessional and multifaceted intervention bundles that have successfully decreased pressure injury incidence and incidence in specific populations (Bargos-Munárriz et al., 2020; Blazier et al., 2023; Ciprandi et al., 2022; Cummins et al., 2019; Johnson et al., 2020; Kiss and Heiler, 2014; Kriesberg Lange et al., 2018; Krzyzewski et al., 2022; Kulik et al., 2018; Lauderbaugh et al., 2022; Manzo et al., 2023; Nie, 2020; Nist et al., 2016; Ottinger et al., 2016; Pasek et al., 2021; Peterson et al., 2015; Reyna, 2015; Rowe et al., 2018; Schindler et al., 2013; Simsic et al., 2019; Uysal et al., 2020). In these studies, a wide variety of interventions are combined into bundles and implemented in clinical practice. In most cases, the results show a reduction in pressure injuries after the implementation of these intervention bundles, but it cannot be concluded which of the specific interventions has a significant effect on the prevention of pressure injuries. However, studies show that bundling different interventions can be recommended to prevent pressure injuries.

Discussion

This systematic review identifies various interventions to prevent pressure injuries in pediatric patients. Many of the articles included in this review describe multiple, bundled measures for pressure injury prevention, so based on these studies, no conclusion can be made to which specific interventions contribute to pressure injury prevention. Most of the included studies were monocentric in design and adapted to specific circumstances of the clinic. When implementing the interventions listed in this review, this aspect must be considered, and the interventions must be individually adapted.

However, there are also studies in this review that do not bundle the interventions, but rather have a specific focus – mostly on medical device-related pressure injuries and immobility-related pressure injuries.

The presented results point to some important aspects for preventing pressure injuries in pediatric patients. These include the use of a general skin assessment and a special assessment for skin around and under medical devices. The risk of pressure injuries from medical devices, especially (non-invasive) ventilation, tracheostomy, ECMO and monitoring, must be recognized in clinical practice. Pressure on the skin should be reduced by creating barriers, using dressings, and repositioning medical devices.

A general repositioning of children at intervals of two hours is recommended to take the pressure off bony prominences. Special focus should be paid to the child's head. If the child is too unstable for a complete repositioning, the head should at least be turned from one side to the other. The heels should not be in contact with the bed and the child should not lie on any hard objects (e.g., needle caps or infusion tubes). Mobilization, especially kangaroo-care, has shown remarkable results in the prevention of pressure injuries.

Special surfaces and mattresses can be used, but they need to be adapted to the size and weight of the child. However, the use of surfaces does not replace repositioning.

A focus should also be placed on the training of nurses. They must undergo special training to be aware of the risks and preventive measures to avoid pressure injuries. One of these risk factors is moisture, so care must be taken to eliminate moisture, for example in the diaper area or under tracheostomy tubes. Barrier creams can be used as support. Skin integrity is also influenced by the child's nutritional status, which is why the focus must be on adequate nutrition. To ensure high-quality, multi-professional care for the children, it is necessary to involve other professions (e.g., dieticians).

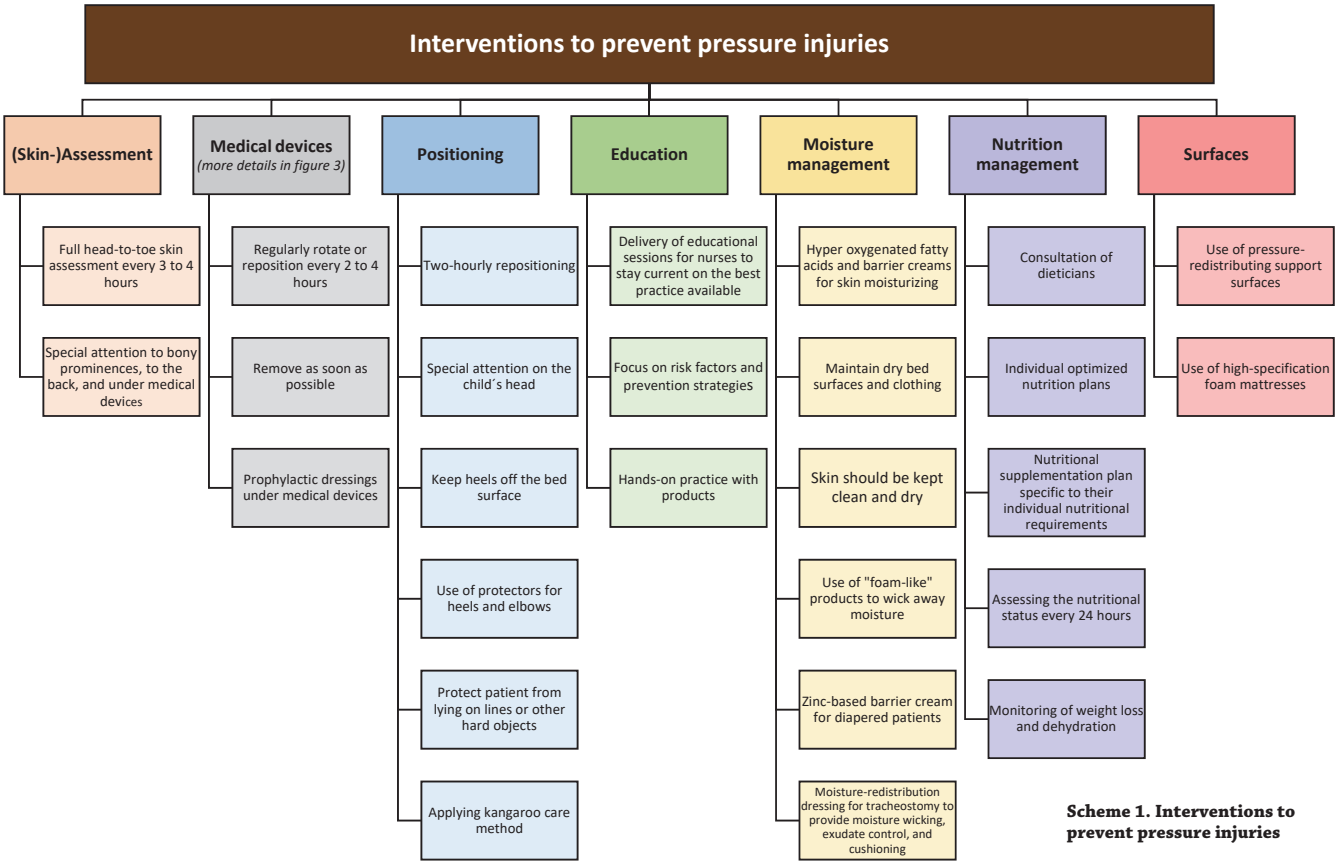
An overview of all the described interventions to prevent pressure injuries in pediatric patients is shown in Scheme 1. Because of the large quantity of interventions described for the prevention of medical device-related pressure injuries, these interventions are presented separately and can be seen in Scheme 2.

Limitations

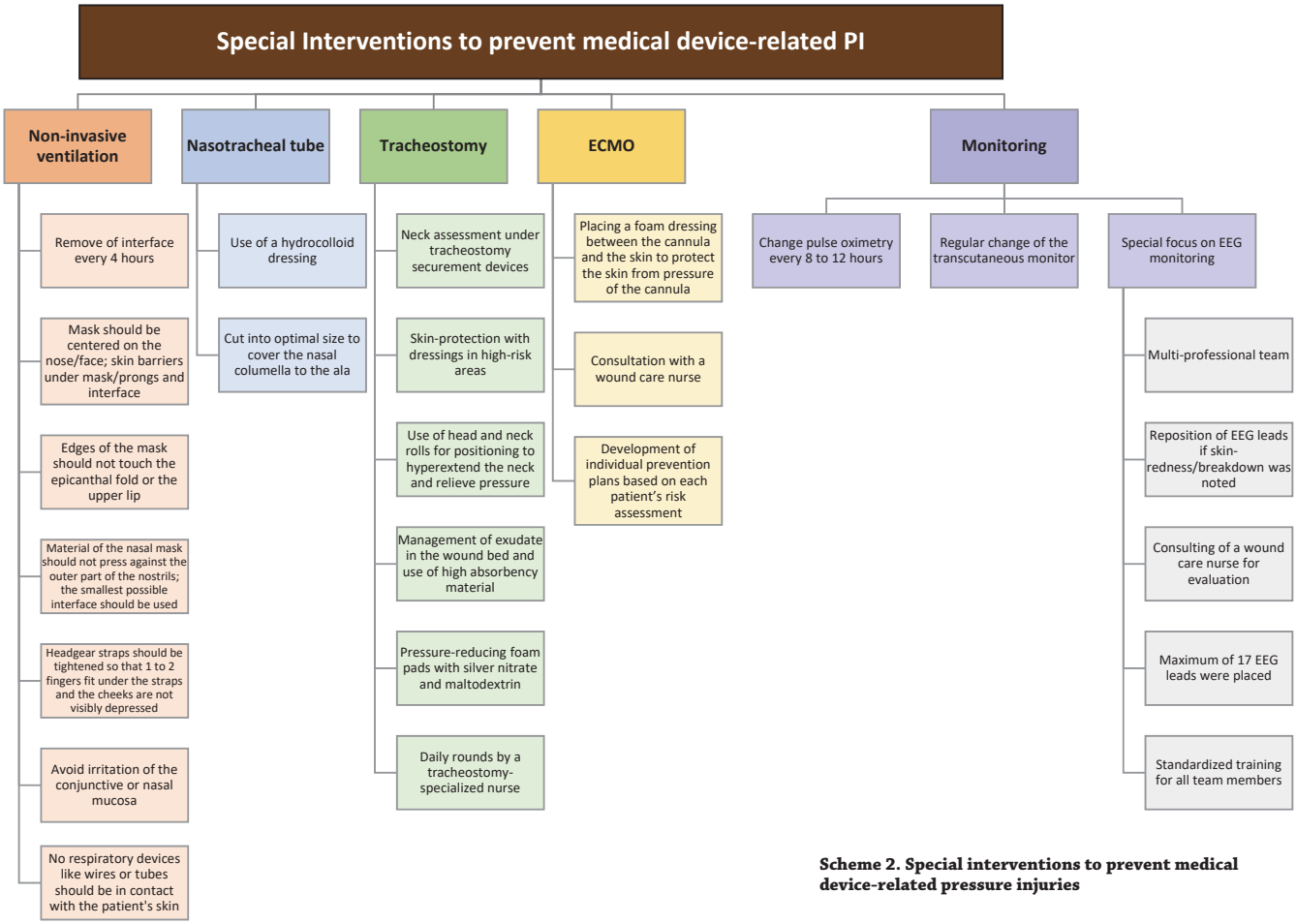
The main focus in the included studies was on the positioning and prevention of medical device-related pressure injuries. A limitation to be mentioned is that many of the interventions are described in general terms and do not focus on specific situations. For example, there is only one study for preventing nasotracheal tube-related pressure injuries. In many studies, various interventions were combined into bundles, and it is not in fact obvious which of the described interventions helped for preventing pressure injuries. Most of the included studies used a retrospective design as such there is a substantial risk of bias, and the results must be viewed critically when implementing interventions into clinical practice. Only three RCTs were included in the results, which were subjected to a critical appraisal using the Joanna Briggs Institute's checklist for RCTs (Barker et al., 2023). Overall, all three RCTs have a low risk of bias, which is why a recommendation for implementation in clinical practice can be made.

Another limitation is the wide range (0–18 years) of the patients in the studies included and the many different settings (OR, ICU, general ward). The interventions described in the results of this review should be considered in general terms and are not differentiated by setting and age. Targeted adaptation of the results to the specific pediatric population and setting should be considered when implementing interventions to prevent pressure injuries.

Therefore, further research should focus on specific interventions and investigate their effects on pressure injury prevention in randomized controlled trials.



Scheme 1. Interventions to prevent pressure injuries



Scheme 2. Special interventions to prevent medical device-related pressure injuries

Conclusion

Pressure injury prevention is the responsibility of nurses, and it is necessary to apply the best evidence to pediatric patients. Nurses must know about pressure injury causation, risk factors, and prevention strategies to implement the identified interventions and prevent pressure injuries in pediatric patients during the hospital stay. Reduced rates of pressure injuries were recorded in the studies with bundled interventions, which is why intervention bundles can be recommended for implementation in nursing practice to prevent pressure injuries in pediatric patients.

Ethical aspects and conflict of interest

The authors have no conflict of interest to declare.

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