Literature review

Paediatric pressure injury prevention strategies: a review

Abstract

Background Pressure injuries (PI) are serious, preventable complications that can increase morbidity and healthcare costs for acutely ill infants and children. PIs have been historically identified as an adult issue where they have been well studied and documented; however, limited research has been conducted with paediatric populations. Due to their unique anatomical, physiological and developmental differences, research targeting paediatric patients is needed.

Aim The review aimed to identify the current quantitative evidence regarding PI prevention in hospitalised paediatric patients.

Methods A wide range of databases were searched for quantitative studies on PI interventions for hospitalised paediatric patients. The relevant papers were critically appraised using the McMaster University Critical Review Tool for Quantitative Studies; data was extracted and presented as a narrative summary due to the heterogeneity of included studies.

Findings The search strategy identified 214 potential papers and, after removal of duplicates and screening of titles and abstracts, 40 papers were selected for retrieval. Examination of the full-text of the retrieved papers found that 15 met the inclusion criteria. The included studies were low to moderate quality. PI prevention bundles and protocols were found to decrease occurrences and duration of PIs among hospitalised paediatric patients.

Conclusion Educating nursing staff on skin and risk assessments and PI prevention can also contribute to PI prevention. However, further research is needed in relation to PI prevention among hospitalised paediatric patients.

Keywords pressure ulcer, prevention, child, hospital

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Background

Pressure injuries are serious, preventable complications that affect acutely ill infants and children.[1–5] However, causes and most common sites for PI development are different compared to adults due to children's anatomical and physiological differences.[3] One key difference is infants have more fat and less muscle, resulting in a softer subcutaneous layer that is more vulnerable to pressure damage.[6] PIs have been historically identified as an issue for adults where they have been well studied; however, there is limited paediatric focused research.[7]

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Infants and children are prone to developing PIs on the scalp due to the head making up a greater percentage of total body weight and surface area and anywhere external medical devices such as nasogastric tubes, hip spicas, oximetry probes, cannulas, catheters and oxygen tubing rest against skin.[5] There is limited data in regards to PI prevalence in Australian paediatric settings; most of the data conducted is based on adult populations. The NSW Pressure Injury Point Prevalence Survey Report 2015 provided a summary of PI prevalence ranges of 0.47–72.5% for paediatric patients between January 2000 to December 2012.[8] This was based on both hospitalised patients and patients in community/outpatient settings.

PIs are caused by constant pressure on soft tissue when compressed between an external surface and bony prominence for a sustained period of time.[9] Prolonged pressure causes blood flow occlusion preventing the supply of nutrients and oxygen to tissues and results in ischaemia and reperfusion injury, leading to cell destruction and tissue death.[10] Hospital acquired pressure injuries (HAPIs)

are associated with consequent complications, involving pain, infection, increased length of stay, hospital costs and sometimes even death.[9,11] Preventing PIs not only reduces the trauma and psychological impact for children and families but also reduces treatment costs.[12]

Research into PI prevention for paediatric patients continues to emerge; however, the majority of literature focuses on adults and has been extrapolated from practices developed primarily for adults.[1–3] The focus of this review was to identify the current quantitative evidence regarding PI prevention in hospitalised paediatric patients.

Methods

Study design

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was the framework used.[13] A problem was identified, question framed and relevant literature gathered, each study's quality was then evaluated, evidence summarised and findings interpreted.[14]

The research question underpinning this review was:

What are the best prevention strategies used to prevent or reduce the incidence of pressure injuries in hospitalised paediatric patients?

Searches

A preliminary search of 'pressure ulcer' AND 'children' was conducted on the CINAHL database via EBSCO HOST which yielded 520 results. Four online databases were then chosen based on their relevancy and extensive coverage of matters related to nursing and clinical practice. The databases chosen were CINAHL, Embase, Medline and Cochrane CENTRAL. The search terms "pressure ulcer", "children" and "hospital" were individually recorded into the advanced search settings of the chosen databases and combined using the Boolean operator 'AND' to limit results. Search terms were then examined throughout whole texts.

The term 'pressure injury' (PI) will be used throughout the review as introduced by the National Pressure Ulcer Advisory Panel[4] to replace 'pressure ulcer'. However, it must be noted that in order to increase search results the search term 'pressure ulcer' was also used.

Selection criteria

This review considered quantitative studies published in English between 2010–2020, with hospitalised paediatric patients as participants. The intervention of interest was PI prevention strategies. Inclusion and exclusion criteria (Figure 1) were formed prior to the database search. Duplicate articles were removed and titles and abstracts screened. The full text of remaining articles including methodology were then explored and significance established alongside the inclusion and exclusion criteria.

Quality assessment

Each study's quality and methodology were evaluated for degree of bias and methodological rigour using the McMaster University Critical Review Tool for Quantitative Studies.[15] This tool was used to assess article quality for inclusion. Scores were separated into 'high quality' (16–12), 'medium quality' (11–7) or 'low quality' (<6) based on the total score.

A specialist librarian was involved to ensure a comprehensive search strategy was conducted to avoid selection bias and three researchers were involved to check the studies for inclusion.[16] There is a high chance detection bias may be present in the included studies as blinding/masking of outcome assessors did not occur.[17] There was 0% of attrition bias in the selected studies as no drop outs were mentioned and no participants missed one or more measurement time point.[18] Publication bias may exist as data from statistically significant studies are more likely to be published than those that are not statistically significant.[19]

Data extraction and synthesis

Study aims, participants, intervention, outcome measures, results and conclusions were extracted from the included studies (Table 1). Levels of evidence, methodological quality, information concerning the sample, outcome measures and findings were evaluated. Due to the heterogeneity of studies, a narrative review is presented.

Results

Study selection

A total of 1168 results were generated. Duplicates were removed, leaving 743 remaining. Titles were then screened leaving 315 articles. 62 articles remained after abstracts were screened and the full text of each article was then evaluated. Once the full text and methodology of remaining articles were reviewed, 15 met criteria and were included. Figure 2 displays the PRISMA flow chart.

Levels of evidence

Utilising the Australian National Health and Medical Research Council's (NHMRC) hierarchy of evidence[33], the level of evidence (level I–IV) for each article was evaluated. The highest was level II and the lowest level IV.

The majority of studies were quality improvement initiatives (level IV).[21–24,29] One was an RCT (level II)[32], two were prospective cohort studies (level II)[30,31], two were retrospective cohort studies (level III–2)[25,26], one was a secondary analysis of data from a retrospective and prospective study (level III–2)[5], two were quasi-experimental studies (level III–2)[7,27], one a retrospective correlation analysis of secondary data (level III–2)[28] and one was a cross-sectional study (level IV).[20]

Methodological rigour

Eight of the 15 studies were evaluated as medium-quality evidence[5,21,23,28–31], four were evaluated as high-quality[7,24,25,26], and the remaining three as low quality.[20,22,27] The scores ranged from 5–13 with the mean 11.4.

Study characteristics

There was a total of 8249 participants and a mean sample size of 634.5 (range 22–5346) present. One study involved 834 participants[21], while other studies included 43[23], 674[24], 134[25], 5346[26], 399[7], 22[29], 77[30], 273[5], 85[31], 50[32], 273[30] and 39[27].

One study did not disclose how many participated[22] and one was conducted on all patients who had a PI in the 99 paediatric hospitals included in the study.[28] Only two studies conducted a power analysis to establish a sufficient sample size[5,7].

Two studies disclosed the type of sampling strategy used, which was convenience sampling.[5,30] The remainder did not disclose what type of sampling method they used which is a limitation.

Inclusion criteria for studies

- Peer-reviewed published in English between 2010–2020
- Population includes children from newborn to 18 years
- Methodology is quantitative in nature
- Hospitalised patients from any paediatric setting
- Reduction in PIs due to implementation of one or more prevention strategies

Exclusion criteria for studies

- Participants over 18 years
- Neonatal only
- Did not mention a reduction in PIs due to implementation of prevention strategies
- Performed in adult or community settings
- On any other hospital acquired wound/injury that was not defined as a 'pressure' injury

Figure 1. Inclusion and exclusion criteria

Participant ages ranged from newborn to 18 years and one or more prevention strategy was implemented in all studies. The majority of studies were conducted in the USA[5,7,21–24–29], with one each conducted in Ireland[30], Latin America[31], Indonesia[32] and South India.[20]

Most of the studies were conducted in paediatric intensive care areas.[7,20,21,24–27,29–32] One was conducted in the cardiac care unit[23], only one was conducted on a general paediatric ward[5], with the remaining two conducted in paediatric hospitals[22,28], thus restricting the external validity of results to hospitalised ward patients.[34]

Each study utilised appropriate yet different methods for data collection. Four studies reviewed medical records[7,21,23,25], six used data collection forms/observation forms[5,24,29–31], one conducted a retrospective chart review[26], one analysed data from a data bank[28], two conducted audits[22,27], and one used a checklist.[20]

Each study looked at different prevention techniques to reduce the incidence or severity of PIs. Five demonstrated the value or need for prevention bundles.[7,21,27,28,30] Two looked at prevention protocols and management plans.[23,24] One looked at mepilex Ag dressings[25], another silicone adhesive foam dressing[22], and another pressure redistribution cot mattress.[29] Two looked at risk assessment tools[5,31] and three looked at or highlighted the need for multiple prevention strategies.[20,26,30]

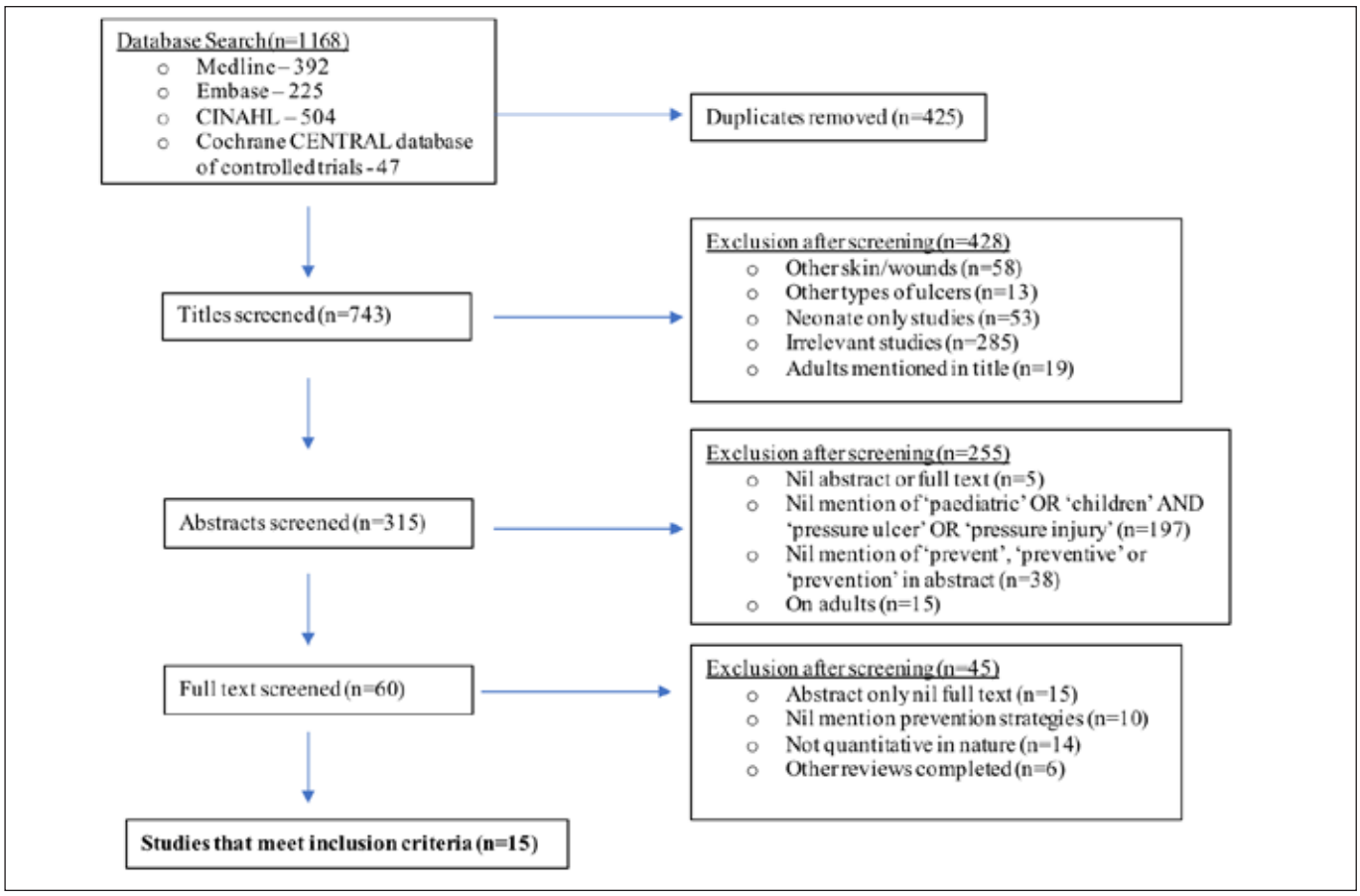

Figure 2. PRISMA flow chart

Statistical significance not only shows the validity of results but rules out that results are due to chance rather than real differences.[35] All studies used multiple methods for data analysis, with most using inferential statistical tests to establish if an association or difference between variables was statistically significant.[35] Four studies did not disclose the type of analysis methods used.[20,22,27,29]

Virtually all studies had similar outcome measures. Seven looked at a reduction in the number of PIs[20,21,23,24,26–28], five looked at PI incidence[7,22,29,30,32], one looked at the rate of wound breakdown before and after implementation of the intervention[25], and two looked at the ability of validated tools to predict the risk and aid in the prevention of PIs.[5,31]

Synthesis of findings

Reduction in PIs

Thirteen level II, III-2, III-3 and IV studies found a reduction in PI occurrences with implementation of one or more prevention strategies.[7,20-29,30,32]

Prevention strategies

All studies (level II, III-2, III-3 and IV) provided evidence and discussed recommendations in regards to PI prevention strategies. Vocci et al.[31] provided evidence suggesting skin hydration, use of a pyramidal mattress, cushions and repositioning reduced PI incidence. Boesch et al.[21] made recommendations that prioritising skin health and using anatomically appropriate devices such as extended tracheotomy tubes prevented PIs. Four studies emphasised the importance of nursing education in skin assessments and PI development.[5,21,26,27] Smith et al.[30] highlighted the necessity of being proactive in developing effective prevention strategies and that, when describing injury to the skin secondary to pressure, using consistent language is vital. Amatya and Sadasivam[20], stated that implementation and continuous reinforcement of guidelines will help reduce PIs, and Singh, Anderson, White and Shoqirat[28] suggested that PI prevention bundles should be considered when implementing a PI prevention program.

Risk factors

Four studies (level II, III-2 and IV) established that the majority of PIs were caused by medical devices.[24,26,30,32] One study (level III-2) found lower oxygen saturations a predictor[24] and two studies (level II and III-2) found compromised nutritional status a significant factor in PI development and healing.[31,32] All but four studies used a validated tool to assess PI risk; only four studies (level III-2 and II) clearly stated that using a validated tool such as the Braden QD Scale or Paediatric Pressure Ulcer Prediction and Evaluation Tool (PPUPET) was reliable in predicting and highlighting patients at risk for PI development.[5,30–32]

Discussion

The aim of this review was to establish best practice prevention strategies to prevent or reduce the incidence of PIs in hospitalised paediatric patients. Risk factors were also documented as they are vital in distinguishing the best implementation strategies to use. The selected studies have shown a reduction in PI occurrences due to implementation of various prevention strategies, with prevention bundles a key theme.

Evidence ranged from level II to level IV, with the majority at level IV. The quality of evidence ranged from low to high. Most of the studies were quality improvement initiatives and all included studies adopted different methodologies, sample sizes and measured different outcomes. Due to the varying methodologies and sample sizes (ranging from 22 to 5346 participants), inconsistency in aims, and the measurement tools and parameters used, one must be wary of the conclusions drawn.

More than half of the included studies made clear conclusions not only for the need for PI prevention bundles but that such bundles and protocols decreased occurrences and duration.[7,21,23,24,27–29,30] This is reinforced by expert opinion on the importance of prevention bundles in reducing the number of HAPIs.[36,37] Reyna[37] found that PI incidence fell by as much as 66% when bundles were first rolled out.

PIs are recognised as an indicator of care quality and literature suggests that nurses play a crucial part in prevention.[38] Effective nursing care with targeted interventions can reduce the incidence of PIs in critically ill children.[7] Interventions identified to reduce PIs in paediatric patients included regular skin assessment, PI risk assessment, moisture management, turning and repositioning every 2 hours, device repositioning, staff empowerment, NIMBUS beds, coconut oil, nutrition consultations, huddles, skin rounds, unit specific groups and dry-weave nappies.[20,23,26,29,31] Two studies found using a foam dressing barrier such as mepilex AG and silicone adhesive foam dressings significantly reduced device-related PIs[22,25], while Singh and Shoqirat[29] found that using a pressure-redistributing mattress may also reduce immobility-related PIs. Only one study found no noteworthy differences in the implementation of preventive measures to prevent PIs.[32] This involved modified guidance centred on Kiss and Heiler's guidelines or the standard hospital routine[32] with no further detail provided. These results reinforce the importance of not only how preventive measures reduce PIs but how crucial nursing interventions really are.

Medical devices, compromised nutrition status and lower oxygen saturations were key risk factors this review highlighted.[24,26,30,32] Validated tools were also found to be effective and reliable in predicting the risk of PI development and helpful in monitoring care and guiding resources.[5,30–32] However, further research is needed to determine whether the application of PI risk assessment tools does make any difference to PI prevention implementation and subsequently reduce incidence in paediatric patients.[39] The National Institute for Health and Care Excellence (NICE) guidelines[40] state the importance of using a validated tool to support clinical judgement and acknowledge the limitations of adult PI risk assessment tools and their modification for paediatric patients.

Education of nursing staff has been acknowledged as an essential part of PI prevention[41] and is also a finding of this review. A number of studies highlighted the importance of not only being proactive in developing effective preventive

strategies[30] but emphasised the importance of educating nursing staff on skin and PI risk assessments and prevention.[5,20,21,27]

Limitations

The main limitation of this review is the absence of high-level evidence articles which could have affected the quality and findings. The majority of articles included were level III-2 and IV and none were of high-level evidence. Although all articles did investigate one or more prevention strategy to reduce PI severity and incidence, only four articles clearly identified that their aim was to determine whether implementation of a strategy was associated with a reduction in PI development. This could have resulted in a lack of the best available evidence in determining prevention strategies to reduce PIs in paediatrics. The majority of studies were conducted in critical care areas thus restricting the transferability to other areas. Heterogeneity and the potential for bias is another limitation that could have affected the quality of the review. Different studies may have different levels of methodological and statistical rigour which could have been a risk to the validity and reliability of this review.[42] Excluding qualitative studies, expert opinion documents, grey literature, studies on neonates, and studies published in non-English language could have contributed to incomplete reporting.

Implications for nursing practice

Nurses play an integral role in recognising and preventing PIs in hospitalised paediatric patients.[43] Utilisation of and adhering to best-practice guidelines and providing education are considered effective in reducing PIs.[44] Educating nurses on risk factors, management and prevention strategies to prevent PIs[45,46] using validated risk and assessment tools and developing best practice guidelines are crucial for the prevention of PIs among paediatric patients.[47]

Recommendations

There is a plethora of nursing research on the incidence, prevalence and high cost of PI prevention and management with adults; however, limited evidence to date for PI prevention for children. The majority of PI preventative care for paediatric patients has been extrapolated from practices that were developed primarily for adults.[1–3] If we rely on information from adult studies rather than conducting studies with children, there is a potential risk for harm.[48] More research is needed regarding prevention strategies specifically to reduce PIs in paediatric patients.

Conclusion

Results from this review highlighted prevention strategies that can potentially reduce the severity and instances of PIs among hospitalised paediatric patients. Tailored education for nurses in regards to PIs, skin assessments, risks and prevention strategies for PI development was also a key finding. However, further research is required to fully determine the best practice prevention strategies that reduce and potentially mitigate PIs specifically for paediatric patients.

Conflict of interest

The authors declare no conflicts of interest.

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Table 1. Study characteristics, results and conclusions

Study	Aim	Geographic location	Participants	Interventions	Outcome measures	PI scale	Results	Conclusions
Amatya & Sadasivam (2020)[20]	Know the prevalence of PIs and re-evaluate the prevalence of PIs after implementation of interventions.	South India	273	Regular skin assessments, repositioning, staff empowerment, education, NIMBUS bed, coconut oil.	PI reduction	No scale used	PIs were reduced after implementation of interventions.	Implementation and continuous reinforcement of guidelines will help reduce injuries.
Boesch et al. (2012)[21]	Test a PI prevention bundle.	Cincinnati, USA	834	TRPI-prevention bundle.	PI reduction	Braden Q Scale	Prevention bundle reduced PIs. Educating nurses improved the capability to anticipate and mitigate risks.	Using devices that decrease pressure, education and continuing assessment of skin integrity successfully reduces PIs.
Clay et al. (2018)[22]	Explore the incidence and cause of device-related PIs and develop and implement interventions to reduce them.	Florida, USA	Did not disclose	Silicone adhesive foam dressings.	PI incidence	No scale used	Reduction of PIs occurred when adhesive foam dressings were applied to potential PI areas.	Prioritising skin protection has quelled harmful events and shaped a new culture that honours critical airway maintenance, positioning and preventative skin protection.
Kriesberg (Lange) et al. (2018)[23]	Develop a protocol for PI prevention.	Chicago, USA	43	Evidence-based protocol.	PI reduction	Braden Q Scale	Prevention protocol reduced PIs.	Standardised preventive protocol reduced HAPI occurrences.
Kulik et al. (2018)[24]	Develop a standardised plan to describe PI development and evaluate prevention strategies.	Boston, USA	674	Standard PI prevention plan.	PI reduction	Braden Q Scale	SCAMP bundle reduced PIs. Lower oxygen saturations increases risk. Majority of PIs were device-related.	Prevention bundle was a significant strategy to reduce the incidence and severity of PIs.
Kuo et al. (2013)[25]	Determine the value of Mepilex Ag dressings in decreasing post-tracheotomy wound complications.	Tennessee, USA	134	Mepilex Ag dressing.	Rate of wound breakdown before and after Mepilex Ag	No scale used	Foam dressing barriers reduced the number of PIs.	Using Mepilex Ag to protect fragile skin prevented ulceration.

Study	Aim	Geographic location	Participants	Interventions	Outcome measures	PI scale	Results	Conclusions
Schindler et al. (2011)[26]	Identify prevention strategies related to PI reduction.	USA	5346	Pressure redistribution surfaces, moisture control, nutrition, turning occurrence, positioning aids, tissue perfusion and oxygenation.	PI reduction	Braden Q Scale	Protective nursing strategies resulted in a lower number of PIs. Staff experience and previous education could have contributed to incidence variability. Some PIs were device-related.	Nursing interventions play a significant role in PI prevention.
Schindler et al. (2013)[7]	Establish if a prevention bundle was related to a substantial decline in PIs.	USA	399	PI prevention bundle.	PI incidence	Braden Q Scale	PUPP bundle reduced PIs. Effective nursing care with targeted interventions reduced PI incidence.	Care bundle implementation was related to a noteworthy reduction in PIs.
Simsic et al. (2019)[27]	Reduce the incidence of PIs.	Ohio, USA	39	PI bundle, huddles, skin rounds, unit specific groups.	PI reduction	No scale used	Incidence and severity of PIs decreased due to the bundle. However, PIs secondary to medical devices remain challenging.	Education and process improvement strategies reduced the number of PIs.
Singh et al. (2018)[28]	Explore the relationship between PPIPB and PI rates.	USA	All patients with a PI in 99 paediatric hospitals	PPIPB.	PI reduction	No scale used	57% reduction in PI incidence when bundle was used. Nurses' active engagement resulted in a positive impact on the reduction of PI rates.	Findings strongly suggest use of a PPIPB decreases PI incidence and should be considered when implementing a PI prevention program.
Singh & Shoqirat (2019)[29]	Evaluate a pressure redistribution mattress.	California, USA	22	Pressure redistribution crib mattress.	PI incidence	Braden Q Scale	Children positioned on the pressure-redistributing mattresses experienced no PIs. Prevention bundle reduced PIs.	Findings suggest that using a pressure-redistributing mattress may reduce PIs.
Smith et al. (2019)[30]	Determine the occurrence and risk factors for PIs and develop preventative care bundles.	Crumlin, Ireland	77	None.	PI incidence	Braden Q Scale	Study has established the need for paediatric specific care bundles. Medical devices were a causative factor. There is a need to be proactive in developing effective prevention strategies. Modified SSKIN bundle assists in the prevention of PIs.	For care bundles to be effective they must accurately recognise a patient's risk and additional support is needed.

Study	Aim	Geographic location	Participants	Interventions	Outcome measures	PI scale	Results	Conclusions
Sterken et al. (2015)[5]	Evaluate the results of recent retrospective and prospective studies of the PPUPET.	USA	273	PPUPET.	PI risk evaluation	PUPPET	Nurses require education on the significance of accurate and in-depth skin assessments. Significant association between risk category suggested by the PPUPET and PI development.	It is crucial that nurses have access to education, use consistent language and a reliable tool and have a plan of care to guide clinical decision-making and suitable interventions to reduce PI development.
Vocci et al. (2018)[31]	Classify the risk and occurrence of PIs and establish the most prevalent risk factors and preventive measures.	Latin America	85	Braden Q Scale.	Patients' Braden Q Scale score	Braden Q Scale	Braden Q Scale successfully highlights a patient's PI risk. Malnutrition is a risk factor for PI development. Common strategies were ensuring adequate skin hydration, use of a pyramidal mattress and cushions and position changes.	Risk predictor instrument usage significantly contributes to reduction in PI incidence.
Widiati et al. (2017)[32]	Establish the usefulness of injury-prevention guidance about children who need to have medical devices attached to their bodies.	Indonesia	50	Intervention: treatment following hospital routines. Co-intervention: treatment following Kiss and Heiler's guideline.	PI incidence	Braden Q Scale	No noteworthy difference in the implementation of preventative measures to prevent PIs. PI occurrence was higher in children with devices. Nutritional status is important in preventing and healing PIs.	Braden QD Scale predicts PIs and is helpful in monitoring care and guiding resources.