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Pressure injury prevention in the perioperative setting: An integrative review

Abstract

Background: Pressure injury (PI) has a significant impact on patients and their families, and is costly to health care institutions. Perioperative PI remains problematic, although little is reported about current perioperative pressure injury prevention (PIP) strategies.

Aim: To identify the key perioperative PIP strategies, following a systematic review of published research, to describe existing gaps in the literature, and to inform the development of subsequent observational study.

Design: An integrative literature review method developed by Whittemore and Knafl[1] was used.

Method: Research inclusion and exclusion criteria were identified a priori. Six data bases were searched and search terms included pressure ulcer/sore prevention, perioperative, operating room. Two review authors evaluated the quality of the studies using a validated tool, and a third author arbitrated when there was a discrepancy. Agreement between the two rates was measured using an intraclass correlation coefficient (ICC).

Findings: Based on the inclusion and exclusion criteria, 270 papers were screened and ten quantitative studies were included. Quality scores ranged from 29 per cent to 89 per cent, resulting in an ICC of 0.955 (95 per cent confidence interval, 0.821 to 0.989, $p < 0.0001$). Five key PIP strategies were identified, including skin inspection, support surfaces and positioning aids, thermoregulation, medical devices and/or equipment, and interprofessional communication.

Conclusions: This review confirmed the scarcity of current evidence of perioperative PIP practice and identified five key perioperative PIP strategies. Most of the reviewed studies focused on one main PIP strategy, and no direct observational studies have been undertaken in relation to perioperative PIP.

Keywords: operating room, perioperative, pressure injury prevention, risk assessment, positioning aids, support surface, thermoregulation, pre-warming, medical devices/equipment, communication.

Background

Pressure injury (PI) is defined as an injury on or underneath the skin that can occur in less than one hour under certain constant pressures[2–4]. If constant pressure is greater than 32 mmHg, it will result in an occlusion of blood flow, which may ultimately affect the skin, soft tissue, muscle and bone, and lead to the development of localised ischemia, tissue inflammation, tissue anoxia and necrosis[5]. PI is recognised as one of the most costly and complicated conditions[6]. PI can have devastating effects on personal and social life of patients and their families, and impose heavy financial burdens on health care institutions. While hospitalised patients with restricted mobility have increased risk of developing PI, anaesthetised patients undergoing surgery are at even greater risk[7]. However, little is

known about the strategies that are used during anaesthesia and surgery to minimise this group's risk of developing a PI in the post-operative period.

Despite international guidelines[8] and a growing evidence base for pressure injury prevention (PIP), surgical patients are at high risk of developing hospital acquired pressure injury (HAPI)[9]. It is imperative to understand current perioperative PIP practice compliance with the relevant guidelines. To address this issue, we undertook a comprehensive literature review in relation to perioperative PIP practice.

Aim

The objectives of this integrative literature review were twofold:

- to identify the key PIP strategies used in perioperative settings, based on assessment of published research related to current perioperative PIP practice
- to identify the existing gaps in the literature to inform the development of a subsequent observational study.

Methods

Design

This review used an integrative review design, based on a systematic and comprehensive approach. An integrative review can incorporate various study methodologies and subsequently has the potential to capture a broad range of issues relative to the status of current perioperative PIP practice, as reported in research literature. A widely accepted framework developed by Whittemore and Knafl[1] guided the development of this review across five stages: problem identification, literature searches, data evaluation, data integration and results presentation.

Literature search methods

The databases used to search the literature included Cumulative Index to Nursing and Allied Health Literature (CINAHL, via EBSCOhost), Medline (via EBSCOhost), PubMed, ProQuest Central, Cochrane Central, Web of Science and Scopus. The Google Scholar database does not have similar Boolean operator functions; thus, it was only used to retrieve information when the full text of an article was not found. Reference lists of selected journal articles were also reviewed, as well as articles recommended by the research student's supervisors. The following combinations of keywords, categorised into three groups, were used as search terms:

- health care issues: 'pressure injury', 'pressure ulcer', 'bedsore', 'bed sore'
- health care location/stages: 'operating room', 'operating theatre', 'surgery', 'perioperative', 'intraoperative', 'preoperative', 'post-operative'
- study core focus: 'pressure injury prevention', 'pressure ulcer prevention', 'pressure injury prevention practice', 'pressure ulcer prevention practice', 'skin inspection', 'positioning aids', 'support surface', 'thermoregulation', 'thermal regulation', 'pre-warming', 'medical device', 'medical equipment', 'communication'.

Inclusion and exclusion criteria

The inclusion and exclusion criteria were based on the review's aims, and thus focused on articles that were relevant to perioperative PIP practice. The following inclusion and exclusion criteria were applied.

Inclusion criteria:

- primary research articles, using either quantitative or qualitative methods
- quality improvement studies,
- abstract and full text available in English
- published from 2006 to 2017
- perioperative settings with adult inpatients.

Exclusion criteria:

- the topic's interest was not directly related to or did not describe PIP in the perioperative setting
- the study was conducted in ambulatory settings where patients were discharged on the day of surgery
- simulation studies conducted in perioperative settings.

Data extraction

Guided by research aims and the inclusion and exclusion criteria, the titles and abstracts of all searched articles were first reviewed by the research student for data extraction. Data were extracted and synthesised according to author, year, country, aim/design, sampling/measures, key findings, and limitations. One of the student's co-supervisors then independently screened the titles and abstracts against the inclusion and exclusion criteria. Where there was a difference of opinion, the other co-supervisor reassessed the articles to make a final decision.

Data evaluation

Following data extraction, the selected studies were critically assessed using a quantitative checklist, as described by Pluye, Gagnon, Griffiths, and Johnson-Lafleur[10]. This checklist, known as the Mixed Studies Review, provided quality scores using 14 assessment criteria (based on quantitative methods). In each criterion, the scores ranged from 0 to 2, where 0 = 'no', 1 = 'partial', 2 = 'yes' and 'NA' = 'not applicable'. A final score was calculated for each article as a percentage indicating the proportion

of items applicable to each study. Agreement between raters was measured using the intraclass correlation coefficient (ICC). A coefficient of ≥0.70 was considered acceptable for internal consistency[11]. Similar to the data extraction process, the quality assessment of the selected articles was independently appraised by the research student first, then by the student's co-supervisor.

Data synthesis

The included studies were analysed using a qualitative approach to categorise the key PIP strategies. The research student independently read, and re-read each article to identify commonalities and differences in study methods and PIP strategies used across perioperative settings in the included studies. This process was iterative and regular meetings with the student's research supervisors were held to clarify and discuss categorised findings.

Results

The results of this integrative review indicate the scarcity of published research on the status of current PIP practice in perioperative settings. All of the included studies were quantitative. Most of the included studies focused mainly on one PIP strategy, and used an interventional approach to examine health professionals' knowledge and practice, or assessed the effect of support surfaces and positioning aids, thermoregulation or medical devices and/or equipment on reducing the incidence of PI. None of the included studies used direct observation.

Descriptive findings

The first search identified 284 articles from seven databases and other resources, as reported in Table 1.

Medline and Scopus provided the bulk of the literature based on the search criteria.

Of the 270 articles initially identified, a total of 82 duplicates were removed. The titles and abstracts of 188 articles were screened, and 158 were excluded based on non-adherence to the inclusion criteria. Thirty full-text articles were then assessed and a further 20 were excluded, resulting in the inclusion of ten quantitative articles. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram in Figure 1 illustrates the flow of the search and structured screening process, with the number of publications identified at each stage of the review.

Table 1: Screening results

Database	Number of articles screened
CINAHL	9
Medline through EBSCOhost	112
ProQuest Central	22
Cochrane Central	10
Web of Science	42
Scopus	74
From student's supervisor	1

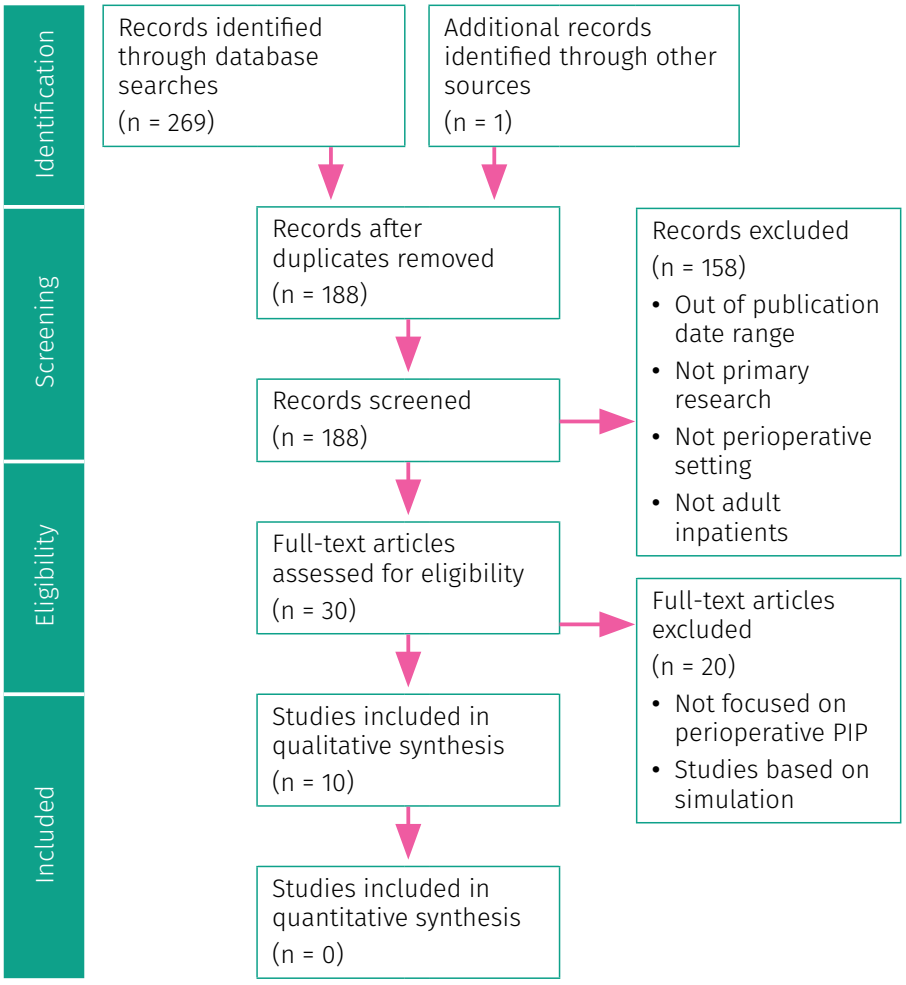

Figure 1. PRISMA flow diagram of papers for inclusion (Moher, Liberati et al. 2009).

Data presentation

The ten primary studies included in this review were selected according to the inclusion and exclusion criteria. Table 2 presents the key characteristics of each included article, including the author, published year, country, design, sampling methods, study aim, measures, key findings related to the PIP study, study limitations and quality score. The quality scores between two raters were calculated as a percentage ranging from 29 to 89 per cent. The ICC coefficient between raters was 0.955 (95 per cent confidence interval, 0.821 to 0.989, $p < 0.0001$), indicating a high level of agreement. The methodological quality of studies ranged from high (86 per cent) to low (29 per cent).

Table 2: Characteristics of included studies

Author, year and country	Design and sampling	Aim	Key measures	Key findings related to the PIP study	Limitations
Feuchtinger et al. 2006, Germany	randomised controlled trial single hospital site post-operative nurses and patient blinded n = 175 cardiac surgical patients	compare two support surfaces for the effect on the incidence of post-operative PI in cardiac surgery	standard OR table with a heating source a 4-cm thermoactive viscoelastic foam overlay and a heating source on the OR table outcome: PI stage	patients lying on the 4-cm thermoactive viscoelastic foam overlay had higher PI rates (17.6%) than patients on the standard OR table without the foam overlay (11.1%) study terminated at the interim analysis because of potential harm; 350 patients were originally needed, and finally 175 patients were randomised in the trial	PI occurrence data collected by nurses were less accurate than data collected by research assistants single site, limiting generalisability possible performance bias (on skin assessment) because of no blinding to data collectors
Sewchuk et al. 2006, USA	retrospective chart audit single hospital site n = 150 cardiac surgical patients convenience sampling data collection form developed by the researchers and piloted by perioperative nurses	examine occurrence, presentation and timing of PI development on three types of support surfaces in cardiac surgery, based on chart audit	prospectively use three interventions: • a standard foam OR bed mattress • a fluid, pressure-reducing OR bed mattress • a fluid, pressure-reducing mattress after a comprehensive educational program on PIP outcome: the occurrence of PI based on retrospective chart audit	incidence of PI decreased when the fluid, pressure-reducing OR bed mattresses were used with the nurse education program; statistical significance not reported educational invention improved preoperative documentation in relation to PIP	reliance on secondary data that could be inaccurate or incomplete single site, limiting generalisability convenience sampling possibilities of performance bias, as staff were not blinded Hawthorne effect, as documentation improved before educational sessions
Yoshimura, et al. 2016, Japan	retrospective chart audit single hospital site consecutive sampling n = 309 surgical patients in park-bench position	examine risk factors associated with intra-operative PIs in the park-bench surgical position	21 potential risk factors identified outcome: incidence of PI	perspiration, length of surgery and core temperature are risk factors associated with intraoperative PI in park-bench surgical position core temperature at completion of surgery over 38.1 degrees was related to length of surgery over six hours, and perspiration was independently related to intra-operative PI development	reliance on secondary data that may be inaccurate or incomplete single site, limiting generalisability
Aronovitch 2007, USA	prospective descriptive survey convenient sampling 37 facilities participated n = 280 surgical inpatients	determine risk factors associated with post-operative PI immediately following a surgery	the weighted index of comorbidity scores the number of comorbidities the number of anaesthesia agents used surgical position blood serum albumin level (for nutrition status) support surfaces used post-operative PI rates	cardiac surgery is one of most common surgeries for surgical patients to develop post-operative PI most PIs were stage 2 use of warming devices and standard OR table mattresses increases the risk of PI development factors that increase patient risk for developing post-operative PI include positioning, use of positioning and thermoregulatory devices, length of surgery and comorbidities	low survey response rate (3.79%)
Grisell and Place 2007, USA	prospective randomised controlled study single hospital site n = 66 consecutive elective patients participants were blinded to the assigned positioner type at all times prone position used for spinal surgery (Jackson OR table)	compare the tissue–pillow interface pressures at the forehead and chin in patients positioned prone for spinal surgery on each of three facial pillow devices	three facial positioners: (1) Dupaco (Dupaco Inc.) pillow, (2) ROHO (The ROHO Group) pillow, (3) OSI (Orthopedica System Inc.) pillow outcome: the incidence of PI	Dupaco positioner created the lowest tissue pressure on forehead and chin in an anaesthetised, prone patient population undergoing spinal surgery patients had no post-operative skin changes placed on ROHO or Dupaco pillows	single site and small sample size, limiting generalisability

Author, year and country	Design and sampling	Aim	Key measures	Key findings related to the PIP study	Limitations
Nilsson 2013, Sweden	prospective cross-sectional single hospital site n = 86 surgical patients supine position and under general anaesthesia	describe risk factors for post-operative positioning pain and PI associated with supine positioning and general anaesthesia	age, gender, preoperative pain, duration of surgery, OR bed surface, positioning of the arms, and number and types of monitoring devices outcome: post-operative pain in relation to intraoperative positioning and PI	no associations between positioning pain or PI and gender, age, duration of surgery, surface of the operation room bed and number of monitoring devices four patients reported, pain in their heels; of these, two had bilateral Grade I PI routine documentation and follow-up of a patients' intra-operative positioning is emphasised	patients with PI, but without pain were not included in the study single site and small sample size, limiting generalisability
Sutherland-Fraser et al. 2012, Australia	prospective pre-and post-intervention study two metropolitan hospitals convenience sampling staff self-reported survey n = 70 perioperative nurses	evaluate effect of educational interventions on perioperative nurses' self-reported knowledge and practice in relation to PIP	PIP educational intervention knowledge of assessment of PI stage, nursing care for patients with Stage 1 and Stage 2 PI practice of PI assessment methods and PIP strategies used in OR	improved practice after intervention, with increased use of a risk assessment tool in conjunction with clinical judgement and verbal handover from OR to PACU, and from PACU to ward no improvements in handover of new PI; incident report completion or repositioning patient no change in use of recommended or non-recommended pressure-relieving strategies in OR after intervention pillows, gel pads and gel overlays were the three most commonly reported devices used for PIP	possible reporting bias because of self-reported survey survey respondents included only perioperative nurses, rather than the full interdisciplinary team
Bulfone et al. 2012, Italy	longitudinal design, 60 days of data collection, and patients were assessed at four time points from preoperative stage to the sixth post-operative day single hospital site consecutive sampling n = 102 patients	assess incidence of intraoperative PI, risk factors and PIP strategies used by nurses from theatre to the sixth post-operative day	surgical position positioning aids length of surgery type of comorbidity intra-operative support surfaces used outcome: intra-operative and post-operative incidence of PI	83% supine surgical position used intraoperatively 12.7% of patients developed intra-operative Stage 1 PI, including the PI location of ear, and over 38% of all PI developed during cardiac surgery patients with a length of surgery over 6.15 hours or on gel mattress (not gel overlays and pad) at greater risk of developing a PI diabetes, cardiac and vascular diseases associated with the occurrence of PI	single site and small sample size, limiting generalisability no control of confounding factors because of clinical variability of the patients
Goodwin et al. 2011, USA	retrospective review single hospital site n = 66 consecutive operating notes Kraske position in sacrectomy procedure (Andrew OR table) only	evaluate modifications to the standard Kraske positioning to eliminate the risk of facial PI development in patients undergoing sacrectomy by using the Mayfield clamp	using a Mayfield clamp to position head in the Kraske position outcome: post-operative incidence of PI	no facial complications found across 66 sacrectomies the technique of applying a Mayfield clamp in patients positioned in a jackknife position has potential to prevent the development of PI	reliance on secondary data that may be inaccurate or incomplete single site, limiting generalisability
Minnich et al. 2014, US	quality improvement study pre- and post-intervention	reduce incidence of PI after implementation of process change at this hospital	process changes: early detection, the method of two nurses completing a skin check immediately after surgery, the use of 'in-the-moment' root cause analysis outcome: the incidence of PI	identified individual roles in preoperative, intra-operative and post-operative stages in relation to PIP: preoperative – focusing on identifying risks intra-operative – focusing on implementing PIP strategies post-operative – focusing on assessment and reporting if PI acquired incidence of SAPUs declined since program implementation	sample size or sampling methods not reported single site, limiting generalisability selective reporting bias, as no baseline data reported no control group used

Abbreviations: OR = operating room, PACU = Post Anaesthesia Care Unit, PI = pressure injury, PIP = pressure injury prevention, SAPU = surgical acquired pressure ulcer.

Discussion of findings

All selected studies used quantitative methodology. Half (five) of the studies were from the US[12–16] and three from Europe[17–19]. Seven studies used prospective research approaches[13,14,16–18,19,20] and eight studies consecutive sampling methods[9,12–15,18–20]. The majority (seven out of ten) of the included articles were conducted at a single hospital site[9,12,14,15,17–19].

Three included articles examined support surfaces[12,14,17], and two of these used randomised controlled trial approaches[14,17]. In this review, operating table mattresses (i.e. foam, gel or water-filled mattresses), various overlays on the mattress (i.e. air, water, gel, foam or a combination of these), and positioning aids (i.e. arm board, facial pillow, pillow, gel pad or heel pad) were used for different surgical positions. However, the effectiveness of these support surfaces and positioning aids varied[12–14,17–20]. In the literature, using higher specification foam mattress and/or overlays in the operating room rather than the standard hospital foam mattress to prevent or reduce the incidence of intraoperative PI is recommended[8,21,22]. However, increased incidence of developing PI was reported when support surfaces were in use with other positioning aids or warming devices, for example, the combined use of warming devices and two-inch foam or gel mattress[13], or the use of gel mattress[18], or the use of foam overlays on water-filled warming mattress[17].

Apart from support surfaces, various positioning aids are used for surgical positioning to avoid potential tissue injury, as patients' weight cannot be evenly distributed on the operating table in certain surgical positions[19], for example, using facial positioners/pillows to reduce interface pressure at patients' forehead and chin in the prone position during spinal surgery[8,14], using heel support in prone position on the operating table[8], or using pillows, blankets, gel pads and foam pads to reduce interface pressure intra-operatively[13]. However, one study reported the use of sheets and blankets to position patients decreased the effectiveness of support surfaces and caused additional interface pressure[23].

Four included articles focused on risk factors and/or incidence of PI[9,13,18,19], for example, using warming devices in the preoperative to post-operative phases, an important thermoregulation strategy, to prevent post-operative hypothermia and PI[7,24–28]. The commonly referred to warming devices in this review were limited to the Bair Hugger™, warmed blankets and operating bed mattresses[9,13,17]. However, using the warming devices combined with certain support surfaces increased the risk of PI development[13,17]. These results reflect other findings reported in the literature relative to the association of tissue damage and increased skin temperature, where pressure and time remained constant[3,29–31]. More recently, Yoshimura et al.[9] suggested hyperthermia was independently related to intra-operative development of PI when the length of surgery was over six hours.

One included article focused on educational interventions to improve perioperative health professionals' PIP practice, including communication and the use of positioning aids[20]. Effective interprofessional communication, such as routine documentation, is an important PIP strategy[19]. Sutherland-Fraser et al.[20] and Sewchuk et al.[12] suggested all members of perioperative teams, rather than members of just a single discipline, e.g. nursing, should collectively be involved in communication around PIP. This recommendation is echoed in the broader literature[8,32,33]. However, there are barriers to effective communication in surgery, including inadequate verbal handover and documentation[20,34]. In two of the review studies, improvements were noted in verbal communication and documentation following an educational intervention[12], and in post-operative PI incidence[16].

One included article focused on the use of medical devices to prevent intraoperative HAPI[15]. The use of medical devices and/or equipment related to PI accounted for approximately 50 per cent of HAPI development, similar to what has been reported elsewhere[35]. Those patients with a medical device were 2.4 times more likely to develop a PI in an atypical place[36] and later during their hospital admission[37]. PI related to medical devices is more likely to occur in certain locations in the body, such as the head, face, neck and ears, which are areas characterised by less subcutaneous tissue, for which PI progression can be rapid[38]. Therefore, the location of PI is one of the significant indicators that differentiates PI related to medical devices from PI not related to medical devices in the operating room.

In this review, Nilsson[19] reported no association between the number of monitoring devices on the patients' arms and the development of PI. However, Goodwin et al.[15] found that using a Mayfield clamp to position patients' head in jackknife surgical position potentially prevented the development of PI. Further, no other reviewed studies examined medical devices and/or equipment use in relation to PIP. As Apold and Rydrych[13] suggested, there is a lack of consensus on best practice for the inspection and management of skin around medical devices in relation to intervals for repositioning devices

that can be removed for pressure relief purposes and processes for replacing ill-fitting devices.

Minnich et al[16] focused on perioperative skin inspection for PIP purposes. Skin inspection, an essential perioperative PIP assessment, was not the focus but has been mentioned in other reviewed studies[12,20,21]. Skin inspection was compromised because of non-adherence to the clinical practice guidelines. This was related to staff's inadequate knowledge of using the guidelines, negative attitudes towards PIP because of lack of time or nursing staff, lack of awareness of PIP or involvement of practitioners at all levels, as identified in the reviewed studies and the broader literature[12,20,34,39–43]. In this review, frequent skin inspection as a PIP strategy has been recommended, especially during the intra-operative phase when the patient is positioned according to the surgical procedure, and at each perioperative stage[16,19,20]. Two studies found increased use of skin assessment tools in relation to perioperative PIP following educational interventions[12,20].

Post-operative PI incidence was measured in most included studies (nine out of ten) at different time points, from immediately following a procedure until 30 days afterwards[9,12–19], as the presentation of PI originating from the intra-operative phase may be delayed[8,44]. One reviewed quality improvement study[16] did not specify the breakdown of location or stage of post-operative PI's in its sample, and post-operative PI was only reported in general terms following process change. Therefore, it is difficult to accurately ascertain the incidence of perioperative-originated PI.

The most often reported locations of post-operative PI such as the coccyx and/or heel and/or buttock are related to supine surgical position being the most common for surgery[12,13,17,18], and the forehead and/or chin in prone or jackknife positions[14,15]. Patients undergoing cardiac and vascular surgery were identified as being at greater risk of developing PI post-operatively than in other surgical specialties due to associated length of surgery and/or less repositioning during surgery[12,13,17,18]. A number of studies assessed skin at different post-operative time points for up to seven days following surgery, with Stage 1 or Stage 2 PI frequently reported[12,13,17,18]. More studies identified the multiple risk factors associated with post-operative PI, and tested some interventions for post-operative PIP e.g. the use of pressure-redistribution surfaces[45–48].

Table 3: Number of selected studies that examined the five key PIP strategies

Five key PIP strategies	Number of studies*
Skin inspection or assessment	3
Thermoregulation	2
Support surfaces in relation to surgical position	7
Medical devices	2
Interprofessional communication	4

* More than one PIP strategy was examined in each included study, even when the main focus of the study was a single PIP strategy.

In summary, five key PIP strategies based on modifiable PI risk factors were identified in the review and were also supported in the current clinical practice guidelines[8]. The frequency of the five PIP strategies reviewed in the selected articles is displayed in Table 3. Support surfaces in relation to surgical position were frequently examined[13–15,17–20], while thermoregulation[9,13] and the use of medical devices and/or equipment were less frequently reported[15,19].

All studies had limitations relative to their single-site approach[9,12,14–19], small sample sizes[14,18,19], use of convenient sampling methods[9,12–15,18–20], little to no control of confounders[18] and use of secondary data[9,12,15]. There was also possible reporting bias (i.e. self-reported survey was used) in one study[20], possible performance bias (i.e. no blinding to data collectors or staff) in two studies[12,17] and a lack of representativeness (i.e. the sample obtained was not representative of the population) in two studies[19,20].

While the main focus of the selected articles was different, there were some similarities in the selection of PIP risk factors and strategies, as shown in Table 4. Patients undergoing cardiac surgery were the population of interest in four studies[12,13,17,18]. In addition to other identified risk factors, length of surgery was found to be a risk factor associated with developing PI in three studies[9,13,18], while another study found no such association[19]. Patients' comorbidities were examined in two studies, with positive associations found with PI development[13,18].

Limitations and strengths

This review has several limitations related to data searching and study methods and appraisal. Some papers may have been missed, even though the search was systematic and the terms used were broad.

Table 4: Number of key variables examined across selected articles

	Key variables examined								
Author and year	Skin inspection or assessment	Thermo-regulation	Surgical position	Support surfaces	Medical devices and/or equipment	Interprofessional communication		Post-operative PI	Other
						Verbal	Documentation		
Aronovitch 2007		X	X	X				X	Type of surgery, length of surgery, comorbidity
Feuchtinger, de Bie et al. 2006				X				X	Type of surgery
Sewchuk, Padula et al. 2006				X			X	X	Type of surgery, an educational program
Sutherland-Fraser, McInnes et al. 2012	X			X		X			An educational program
Yoshimura, Iizaka et al. 2016		X	X						Type of surgery, perspiration, length of surgery
Goodwin, Recinos et al. 2011			X		X			X	Type of surgery
Grisell and Place 2007			X	X				X	Type of surgery
Bulfone, Marzoli et al. 2012			X	X					Type of surgery, length of surgery, comorbidity
Minnich, Bennett et al. 2014	X							X	Post-intervention PI
Nilsson 2013	X		X	X	X		X		Gender, age, duration of surgery
Total number of studies focusing on each PIP strategy	3	2	6	7	2	1	2	6	Not applicable

Some selected studies used secondary data that could have been inaccurate or incomplete. Although there may have been some variability of data appraisal because of individual perceptions, attempts were made to reduce this via the independent assessment by two raters, with adjudication by a third rater when necessary. As such, this method achieved a high ICC. The overall quality of this review was strengthened by the use of a systematic and rigorous approach when undertaking this review[1,10].

Conclusion

This paper has presented a comprehensive review of the literature related to PIP in the perioperative setting. Five key PIP strategies were identified and categorised according to the published literature. Implementation of these key five PIP strategies should be based on consideration of patients, case-related and environmental factors. This review has identified a lack of research related to the observed PIP practices of health professionals in the perioperative setting. Therefore, a further research study is needed to address this knowledge gap.

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