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International consensus on pressure injury preventative interventions by risk level for critically ill patients: A modified Delphi study

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Abstract

The aim of this modified Delphi study was to determine a minimum pressure injury preventative intervention set for implementation relative to critically ill patients' risk level. Preventative interventions were identified via systematic review, risk levels categorised by an intensive-care-specific risk-assessment-scale (COMHON Index), and panel members ($n = 67$) identified through an international critical care nursing body. Round 1: panel members were asked to rate implementation of 12 interventions according to risk level (low, moderate, high). Round 2: interventions were rated for use at the risk level which received greatest round 1 support. Round 3: interventions not yet achieving consensus were again rated, and discarded where consensus was not reached. Consensus indicated all patients should receive: risk assessment within 2-hours of admission; 8-hourly risk reassessment; and use of disposable incontinence pads. Additionally, moderate- and high-risk patients should receive: a reactive mattress support surface and a heel off-loading device. High-risk patients should also receive: nutritional supplements if eating orally; preventative dressings (sacral, heel, trochanteric); an active mattress support surface; and a pressure-redistributing cushion for sitting. Repositioning is required at least 4-hourly for low-risk, and 2-hourly for moderate- and high-risk patients. Rigorous application of the intervention set has the potential to decrease pressure injuries in intensive care.

KEYWORDS

critical care, intensive care unit, patient care bundles, pressure injury, pressure ulcer

1 | INTRODUCTION

Pressure injury (PI) is considered to be a primarily preventable adverse event of hospitalisation,[1,2] thus its occurrence is regarded as an indicator of the quality of care provided by healthcare facilities.[3] In a recent systematic review and meta-analysis, global PI prevalence and incidence in hospitalised adults between the years 2008 and 2018 was found to be 12.8% and 5.4 per 10 000 patient days, respectively.[4] Furthermore, 62% of PI were hospital-acquired, resulting in an overall hospital-acquired PI rate of 8.5%.[4] The on-going occurrence of hospital-acquired PI is of substantial concern given its consequences of patient harm and pain,[5] increased mortality,[6] and increased healthcare costs.[7,8]

While PI prevalence across hospital settings is significant,[4] critically ill people admitted to intensive care are particularly vulnerable to PI.[9-11] A systematic review

of PI in intensive care reported that, internationally between 2002 and 2017, PI prevalence was as high as 23.8%, with the 95% confidence interval of cumulative incidence as high as 29.5%.[12] In Australia, a comparative study of one state's public hospitals over 3 years found that people admitted to intensive care had significantly more hospital-acquired PI than those admitted to other areas (11.5% vs 3%), and were 3.8 times more likely to develop a PI.[9] These significant differences were evident in another Australian study in one tertiary hospital, with intensive care hospital-acquired PI incidence 10-fold greater than that of other settings.[11] Similarly, a German comparative study in 256 participating hospitals over 8 years found that intensive care-acquired PI prevalence was 14.9%, compared to 3.9% in general wards.[10]

Vulnerability to PI within intensive care is associated with oxygenation and perfusion impairment,[13] use of vasopressors,[13,14] and mechanical ventilation.[14,15] Furthermore, the ability of a critically ill person to react to tissue pressure may also be diminished by treatment with sedatives, analgesia, and muscle relaxants.[16,17] It is contended that some PI associated with intensive care may thus be unavoidable.[2,11,18] Nonetheless, prevention measures are key to patient safety.[1,19]

PI prevention begins with risk assessment, which should be undertaken using a structured risk assessment scale combined with clinical judgement.[19] However, many scales are not specifically designed for use with critically ill people and consequently do not account for factors that predispose those admitted to intensive care to a PI.[14,16,20] To address this, the COMHON Index (COnsciousness, Mobility, Haemodynamics, Oxygenation, Nutrition)[21] was developed and tested in Spain as an intensive care-specific, user-friendly, risk assessment scale. The scale is used to assess the five COMHON components that are related to PI risk in people who are critically ill. In use, each component is given an individual score, all of which are tallied to result in an overall sum score. The sum score is then used to categorise level of PI risk (low, moderate or high risk). In the initial testing with a sample of 496, the scale demonstrated good internal consistency (Cronbach's alpha .72–.80), concurrent validity (compared to Braden and Norton scales; Kappa = 0.90 and 0.79, respectively) interrater reliability (Kappa = 0.89), sensitivity 97.1%, specificity 73.2%, positive predictive value 36.3% and negative predictive value 99.4%.[21]

Another study in Spain[20] found that when compared to another intensive care-specific scale, the COMHON Index had a higher efficiency level in predicting PI risk scores using a three-day moving average. Furthermore, an Australian study conducted within an intensive care setting compared the COMHON Index to three other commonly used risk assessment scales (Braden scale, Norton scale, Waterlow scale) which were not intensive care specific.[16] In this study, the COMHON Index demonstrated a higher interrater reliability in regard to total sum score (intraclass correlation [ICC] 0.90) and risk level categorisation (ICC 0.87) when compared with the Braden scale (sum score ICC 0.66; risk level ICC 0.65), Norton scale (sum score ICC 0.77; risk level ICC 0.45), and Waterlow scale (sum score ICC 0.47; risk level ICC 0.43).[16] Furthermore, the COMHON Index was more sensitive in detecting small changes in a person's condition and, subsequently, risk level changes, than the other three scales.[16]

While these studies[16,20,21] have indicated that the COMHON Index is an effective method of risk assessment within intensive care, risk assessment itself does not prevent a PI.[22] Rather, risk assessment informs the prescription and implementation of preventative interventions which aim to mitigate the identified risk and thus prevent a PI.[19,23] An exploratory descriptive study of prescribed and implemented PI preventative interventions in one hospital setting identified that a minimum intervention set applied to each level of PI risk would be an effective means of structuring PI preventative

Key Messages

- a risk assessment scale may be used to assess critically ill patients' pressure injury level of risk; however, there is no clear guide as to which preventative interventions should be implemented relative to the assessed level of risk
- using a 3-round modified Delphi design, the study aimed to determine, through international consensus, a minimum pressure injury preventative intervention set for implementation relative to critically ill patients' level of risk as identified by the COMHON Index
- the minimum pressure injury preventative intervention set developed indicates bundled interventions that should be used at a minimum for each COMHON Index risk level, with the number and intensity of interventions required increasing as risk level increases. Additional interventions should also be implemented as clinically indicated to mitigate other identified individual patient risk factors.

intervention implementation.[23] Bundled approaches have also been demonstrated to be effective in the intensive care setting.[24]

1.1 | Study aim

The COHMON Index categorises people admitted to intensive care as low-, moderate-, or high-risk for PI,[16,21] presenting an opportunity for application of a minimum intervention set. However, with a wide variety of PI preventative interventions available in the intensive care setting, it is unclear which interventions should be applied for each level of risk. Therefore, the aim of this study was to determine, through international consensus, a minimum PI preventative intervention set relative to the COMHON Index risk levels.

2 | METHODS

2.1 | Design

A three-round online modified Delphi study was undertaken to address the study aim. Delphi techniques are considered an appropriate means of establishing consensus from a panel of pertinent experts, in order to address a research aim or question.[25,26] Converging expert opinion using such a design was deemed most fitting to answer the research question, as it could not be answered through the available evidence, or through testing in a randomised controlled trial. Furthermore, when conducted online, such an approach with no face-to-face meetings facilitates the participation of experts regardless of location,[25-27] thus enabling the international participation required for this study. This approach also lends itself to maintaining expert confidentiality and decreasing the risk of peer pressure within the panel.[25-27] The technique involves a series of iterations, or rounds, in which a questionnaire, amended after each round, is distributed to panel members for their timely response, from which consensus is calculated.[25-27] Delphi questionnaires may contain open-ended or structured questions.[25] Given the wide availability of evidence supporting PI preventative interventions, the questionnaire was designed using evidence synthesised from a systematic review.[28] Because an online approach and structured questions were used from the first round, it is considered to be a modified Delphi study, as opposed to a classical technique.[25,26]

2.2 | Instruments

To form the basis of the study, a questionnaire was developed for the first round. It contained a list of evidence-based preventative interventions. Interventions were identified through a systematic review of randomised controlled trials examining the effectiveness of interventions in preventing PI in adults admitted to acute hospital settings.[28] In round 1, interventions were included that were singular interventions that demonstrated a statistically significant reduction in PI. Risk assessment using the COMHON Index[21] was used to underpin use of a minimum intervention set according to risk level. Interventions that were not generally applicable to the everyday intensive care setting were excluded. Similarly, interventions were not included where a trial tested multiple interventions, but the effectiveness of each intervention separately could not be established. Where no Level II or above evidence[29] was found for some interventions that are widely recognised as being appropriate to prevent PI, the gold standard international clinical practice guidelines[30] current at the time of the study were used to justify their inclusion. Furthermore, where intervention frequency was relevant but evidence was unclear, frequency options were included in the questionnaire (for example, repositioning) that were sourced from international clinical practice guidelines.[30] The interventions that were included in the round 1 questionnaire are shown in Table 1.

From the first round, panel members were asked to rate the appropriateness of each intervention for implementation at each level of PI risk. The COMHON Index[21] was used for categorisation of PI risk level. The tool is presented in full in the publication by Fulbrook and Anderson.[16] It is used to assess five components: level of consciousness using the Richmond Agitation Sedation Scale[31]; mobility, haemodynamic support including vasoactive drugs, mechanical support, and intravenous fluids; oxygenation including invasive and non-invasive mechanical ventilation, and supplementary oxygen requirements; and nutrition including oral intake and parental or enteral feeding. Each of the components is scored from 1–4, resulting in a potential score of between 5–20. The final score equates to one of three levels of risk; 5–9 is considered low-risk, 10–13 moderate-risk and 14–20 high-risk.

During study preparation, the synthesis of evidence and resulting full list of interventions for inclusion, and all survey questionnaires were developed by one researcher and reviewed independently by three other researchers; of which two have an intensive care nursing background, and one is a statistician; minor revisions were then made accordingly.

Within the context of this study, if a minimum PI preventative intervention set was to be implemented for people at low-risk, it follows that the same—or more—

TABLE 1 Intervention evidence base

Interventions		Level of evidence	Evidence base
Risk assessment	Following admission, pressure injury risk assessment should be completed within 2, 4, 6, or 8 h	CPG	NPUAP, EPUAP, and PPPIA[30]
	Patients should be reassessed for pressure injury risk once every 8, 12, 24 h or when there is a significant change in patient condition	CPG	NPUAP, EPUAP, and PPPIA[30]
Continence	Indwelling urinary catheter entry points should be washed with soap and water, and the catheter should be repositioned to the opposite thigh and secured, three times daily	RCT	Rassin et al[32]
	For patients who are incontinent of urine and/or faeces, disposable adult incontinence pads should be used	RCT	Francis et al[33]
Heel elevation	Pressure should be offloaded from the heels using a heel offloading device	RCT	Bååth et al[34]; Donnelly et al[35]; Meyers[36]
Nutrition	For patients who are able to eat food orally, oral nutritional supplements should be provided in addition to standard nutrition	RCT	Bourdel-Marchasson et al[37]
Pressure injury preventative dressing	A preventative sacral dressing should be applied	RCT	Dutra et al[38]; Forni et al[39]; Kalowes et al[40]; Lee et al[41]; Santamaria et al.[42]
	Preventative heel dressings should be applied	RCT	Santamaria et al.[42]
	Preventative trochanteric (hip) dressings should be applied	RCT	Dutra et al.[38]; Nakagami et al.[43]
Repositioning	Patients should be repositioned at least 2, 3, or 4-hourly	CPG	NPUAP, EPUAP, and PPPIA[30]
Support surfaces	Medical grade sheep skin overlays should be used	RCT	Jolley et al.[44]; McGowan et al[45]
	Reactive mattress support surfaces should be used	RCT	Andersen et al[46]; Bueno de Camargo et al.[47]; Gray and Campbell[48]; Park and Park[49]; Takala et al[50]
	Active mattress support surfaces should be used	RCT	Andersen et al.[46]; Aronovitch et al[51]; Gebhardt[52]; Sanada et al.[53]
	When a patient is sat out of bed, a pressure redistributing seat cushion should be used	CPG	NPUAP, EPUAP, and PPPIA[30]

Abbreviation: CPG, clinical practice guidelines; RCT, randomised controlled trial.

interventions would be implemented for people at higher levels of risk (moderate- and high-risk). Logically, the number and/or frequency of interventions implemented for each risk level would increase as risk increases. Therefore, panel members were required to consider interventions for three risk levels; all patients (low-, moderate- and high-risk), moderate- and high-risk patients, and high-risk patients only. Panel members were asked to rate interventions, which in their expert opinions, were appropriate for use for each risk level, using a 9-point strength-of-agreement scale with the end-points labelled strongly disagree (1) and strongly agree (9). Where frequency options were included in the questionnaire, multiple-choice responses were used. The opportunity to comment was provided to panel members after each question.

2.3 | Participants

While the make-up of the expert panel is imperative to the quality of a Delphi study, there is little agreement regarding the definition of an "expert".[27,54] Thus, it was necessary to consider the requirements of this study in relation to the study aim. Given that it is nurses who primarily undertake PI preventative care, expert panel members were defined as nurses with at least 5 years' experience in an intensive care setting, or currently working within a senior intensive care nursing role, with peer-recognised expert knowledge of PI prevention and management. Furthermore, panel members were required to be fluent in English as the study instruments would be provided in English.

For the purpose of participant recruitment, the World Federation of Critical Care Nurses, a worldwide federation of national intensive care nursing associations,[55] provided access to the national representatives of its member associations. The national representatives identified by the World Federation of Critical Care Nurses were provided with study information and asked to nominate two eligible expert panel members from their national association via email or a secure online survey platform (SurveyMonkey™). Prior to nomination, the representatives were required to confirm their nominees' readiness to participate. Representatives were asked to nominate up to two potential panel members who did not work in the same intensive care unit. Nominees were then contacted directly to confirm their contact details and willingness to participate. They were provided with a participant information letter to consider before commencement of the Delphi survey; those that no longer wished to participate were excluded.

Identifying potential panel members through an international body ensured the panel was globally representative. Given that there is no agreed ideal sample size for an expert panel,[25,26] sample size was determined by the number of associations the international body provided access to that agreed to nominate potential panel members.

2.4 | Data collection

Data collection commenced in September 2019 and was concluded in December 2019. Prior to commencement of round 1, expert panel members were provided with the COMHON Index[21] and a list of the PI preventative interventions that would be included in the Delphi survey and their evidence-base sources (Table 1).

For each round, the survey questionnaire was entered into SurveyMonkey™ for distribution and completion. Settings were applied to ensure panel members could respond only once within each round. At the commencement of each round, panel members were sent an email containing a SurveyMonkey™ weblink to the questionnaire. They were encouraged to respond within 2 weeks, with regular email reminders sent to those that had not yet responded. A minimum response rate of 75% per round was targeted. After the allotted timeframe and provided the minimum response was achieved, the round was closed. This was achieved for all three rounds. Each round was analysed immediately following closure. Results were used to draft the subsequent round, as necessary (Figure 1). Only complete questionnaire responses were included in the analysis of each round.

In round 1, all PI preventative interventions were included (Table 1). For most interventions, panel members were asked to indicate their strength-of-agreement for each intervention to be implemented at the risk levels described by the COMHON Index: all patients (low-, moderate-, and high-risk); moderate- and high-risk patients only; and high-risk patients only. For questions that were related to frequency (risk assessment and repositioning interventions), panel members were asked to select one multiple-choice response.

On completion of round 1, the risk category for each intervention that received the greatest support (median score), or greatest support with the most agreement between panel members (smallest mean absolute deviation from the median) was identified for inclusion in the second round. Interventions that received lower levels of support with less agreement between panel members were discarded. Similarly, the frequencies with the highest percentage of support for multiple-choice interventions were identified and retained for the second round, while those frequencies with less support were discarded. Where panel member support was similar for two frequencies for an intervention, both frequencies were retained and entered into the next round.

In round 2, panel members were asked to indicate their strength-of-agreement for each intervention to be implemented for the one retained risk category or for the retained frequencies. To assist their decision-making, panel members were provided with the median and percentage scores from round 1. On completion of round 2, interventions that reached the criteria for consensus for use at the various risk levels were identified and excluded from the final round. Where intervention frequency was rated, the frequency with the highest level of support was identified and retained for confirmation and rating in the final round, while the frequency with lower support was discarded.

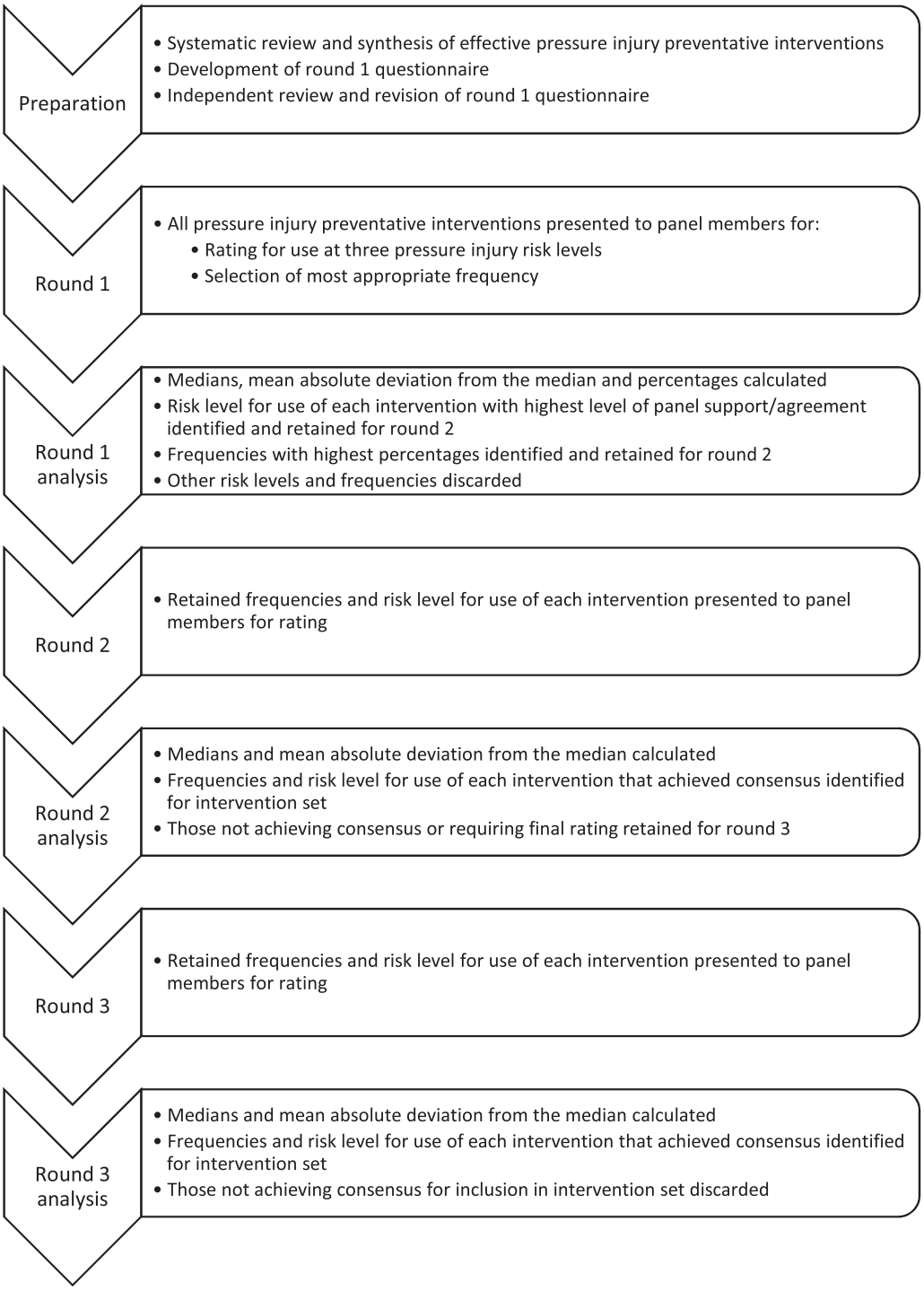

FIGURE 1 Delphi process

Round 3 contained only those interventions which did not meet consensus criteria in the previous round, or intervention frequency which required a final rating to establish consensus. Panel members were again asked to rate the interventions in the same manner as the previous rounds and, as before, were provided with the median scores from the previous round for included interventions. Interventions that achieved consensus in the final round were retained and those that did not reach the criteria for consensus were discarded.

2.5 | Data analysis

Data were exported from SurveyMonkey™ into Microsoft Excel™ for analysis. Descriptive statistics (medians and percentages) were used to summarise the responses from

each round. Median scores indicated the panel's support for inclusion of each intervention according to risk level.[56-59] Mean absolute deviation from the median was also calculated to describe the dispersion of, or agreement between, panel member responses.[56-59] Consensus for

TABLE 2 Round 1 results

Interventions (multiple choice)	Frequency	%	n
Following admission to intensive care, pressure injury risk assessment should be completed within:	2 h	44[a]	22
	4 h	22	11
	6 h	14	7
	8 h	14	7
	Other	6	3
Intensive care patients should be reassessed for pressure injury risk once every:	8 h	32[a]	16
	12 h	18	9
	24 h	24[a]	12
	Only when significant condition change	14	7
	Other	12	6
Low-risk patients should be repositioned at least:	2-hourly	14	7
	3-hourly	20	10
	4-hourly	66[a]	33
Moderate-risk patients should be repositioned at least:	2-hourly	52[a]	26
	3-hourly	28	14
	4-hourly	20	10
High-risk patients should be repositioned at least:	2-hourly	78[a]	39
	3-hourly	12	6
	4-hourly	10	5

	Median (MADM)		
Interventions (9-point scale)	Low-, moderate- and high-risk	Moderate- and high-risk	High-risk only
Indwelling urinary catheter entry points should be washed with soap and water, and the catheter should be repositioned to the opposite thigh and secured, three times daily for:	5 (2.84)	5 (2.66)	6.5 (3.24)[b]
For intensive care patients who are incontinent of urine and/or faeces, disposable adult incontinence pads should be used for:	8 (2.20)[b]	7 (2.60)	7 (3.00)
Pressure should be offloaded from the heels using a heel offloading device for:	5 (2.10)	9 (1.56)[b]	8.5 (2.44)
For intensive care patients who are able to eat food orally, oral nutritional supplements should be provided in addition to standard nutrition for:	5 (2.64)	6 (2.34)	8 (2.66)[b]
A preventative sacral dressing should be applied for:	3 (2.20)	6 (2.40)	8 (2.40)[b]
Preventative heel dressings should be applied for:	3 (2.26)	6 (2.42)	8 (2.38)[b]
Preventative trochanteric (hip) dressings should be applied for:	1.5 (1.76)	4.5 (2.54)	8 (2.78)[b]
Medical grade sheepskin overlays should be used for:	3 (2.22)	5 (2.26)[b]	5 (2.72)[b]
Reactive mattress support surfaces should be used for:	4 (2.40)	7 (1.80)[b]	9 (2.26)[b]
Active mattress support surfaces should be used for:	3.5 (2.42)	7 (1.66)	9 (1.42)[b]
When an intensive care patient is sat out of bed, a pressure redistributing seat cushion should be used for:	4.5 (2.46)	7.5 (1.86)	9 (1.70)[b]

Abbreviation: MADM, mean absolute deviation from the median.
[a]Highest percentages—frequency retained for second round.
[b]Highest level of support or highest level of support with most panel member agreement—risk level retained for second round.

inclusion in the intervention set was defined *a priori* as a median score of 7 or above.[58]

2.6 | Ethical considerations

Preliminary ethical approval was granted by the World Federation of Critical Care Nurses for the purposes of participant recruitment. Full ethical approval was granted by the Australian Catholic University Human Research and Ethics Committee (ref: 2019-25E). Informed participant consent was implied by the completion and submission of each survey questionnaire.

3 | RESULTS

3.1 | Expert panel

Initially, 51 member organisations of the World Federation of Critical Care Nurses were contacted. Of these, 37 responded, with each nominating one or two expert panel members, resulting in a total of 68 potential expert panel member nominations. One nominee withdrew following distribution of the participant information letter, giving a final panel of 67 members from 35 countries representing 37 national associations (see acknowledgements below). Of the 67 panel members, nine did not respond to any of the rounds.

3.2 | Round 1

In the first round, there were 50 (75%) complete responses, which were included in analysis. The consensus results and the corresponding risk levels and frequencies, which were retained for round 2, are presented in Table 2. For most interventions with frequency options, panel support was greatest by at least 22% for a particular frequency, with one exception. With regard to reassessment of PI risk, 32% supported 8-hourly reassessment and 24% supported 24-hourly reassessment. Both frequencies were retained for the second round.

Of the interventions rated on a 9-point scale, the highest median score was evident in the majority of cases, which were retained for the second round. However, the use of medical grade sheepskin overlays had a median score of 5 for both moderate- and high-risk patients, and high-risk patients only; thus, the risk category with the lowest mean absolute deviation from the median was retained (moderate and high-risk patients; mean absolute deviation from the median 2.26). The use of reactive mattress support surfaces had a median of 7 for moderate- and high-risk patients, and a median of 9 for high-risk patients only, both of which met the criteria for consensus. While the median for moderate- and high-risk patients was lower, the mean absolute deviation from the median (1.8) indicated greater panel agreement and therefore was retained for round 2.

3.3 | Round 2

There were 53 complete responses (79%), which were included in the analysis. The results of the second round are presented in Table 3. Reassessment frequency of PI risk had two options, of which the frequency with the lowest median score (every 24 hours) was discarded. The frequency with the highest median score (every 8 hours) was retained for the third round. Interventions that did not achieve consensus (indwelling urinary catheter cleansing/positioning; medical grade sheepskin overlay) were carried over to round 3 for confirmation.

3.4 | Round 3

In the final round, 54 (81%) complete responses were included in the analysis. Reassessment of PI risk every 8 hours met the consensus criteria (median 7, mean absolute deviation from the median 1.80), and was included in the final PI preventative intervention set. Two interventions: indwelling urinary catheter cleansing/positioning for high-risk patients only (median 6, mean absolute deviation from the median 2.37) and use of medical grade sheepskin overlays for moderate- and high-risk patients (median 6, mean absolute deviation from the median 2.00) did not reach consensus and were discarded. The final minimum PI preventative intervention set for implementation relative to the COMHON Index risk levels, as determined by international consensus, is shown in Table 4.

3.5 | Qualitative comments

In each round, all qualitative comments were reviewed but nothing of significance was found that merited amendments to subsequent questionnaires. However, where relevant, qualitative comments are referred to in the discussion below.

4 | DISCUSSION

Worldwide, as far as the authors are aware, this is the first study of its kind that has developed a minimum set

TABLE 3 Round 2 results

	Round 2	
Interventions (9-point scale)	**Frequency or risk level**	**Median (MADM)**
Following admission, pressure injury risk assessment should be completed within:	2 h	9 (1.42)
Patients should be reassessed for pressure injury risk once every:	8 h	8 (2.11)[a]
	24 h	5 (2.92)[a]
Low-risk patients should be repositioned at least:	4-hourly	9 (1.34)
Moderate-risk patients should be repositioned at least:	2-hourly	8 (1.60)
High-risk patients should be repositioned at least:	2-hourly	9 (1.04)
Indwelling urinary catheter entry points should be washed with soap and water, and the catheter should be repositioned to the opposite thigh and secured, three times daily for:	High-risk patients only	6 (2.42)[b]
For intensive care patients who are incontinent of urine and/or faeces, disposable adult incontinence pads should be used for:	All patients (low-, moderate-, high-risk)	8 (1.45)
Pressure should be offloaded from the heels using a heel offloading device for:	Moderate- and high-risk patients	8 (1.08)
For intensive care patients who are able to eat food orally, oral nutritional supplements should be provided in addition to standard nutrition for:	High-risk patients only	7 (1.91)
A preventative sacral dressing should be applied for:	High-risk patients only	8 (1.81)
Preventative heel dressings should be applied for:	High-risk patients only	8 (1.89)
Preventative trochanteric (hip) dressings should be applied for:	High-risk patients only	8 (1.79)
Medical grade sheepskin overlays should be used for:	Moderate and high-risk patients	6 (2.00)[b]
Reactive mattress support surfaces should be used for:	Moderate and high-risk patients	8 (1.62)
Active mattress support surfaces should be used for:	High-risk patients only	9 (1.45)
When an intensive care patient is sat out of bed, a pressure redistributing seat cushion should be used for:	High-risk patients only	8 (1.57)

Abbreviation: MADM, mean absolute deviation from the median.
[a]Multiple options—highest scoring retained for round 3, lowest scoring discarded.
[b]Did not meet the criteria for consensus—for re-rating in round 3.

TABLE 4 Minimum pressure injury preventative intervention set relative to the COMHON Index risk levels, as determined by international consensus

Intervention	Risk category		
	Low	Moderate	High
Following admission, pressure injury risk assessment should be completed within 2 h	✓	✓	✓
Patients should be reassessed for pressure injury risk once every 8 h	✓	✓	✓
For intensive care patients who are incontinent of urine and/or faeces, disposable adult incontinence pads should be used	✓	✓	✓
Intensive care patients should be repositioned at least:	4-hourly	2-hourly	2-hourly
Pressure should be offloaded from the heels using a heel offloading device		✓	✓
Reactive mattress support surfaces should be used		✓	✓
Active mattress support surfaces should be used			✓
When an intensive care patient is sat out of bed, a pressure redistributing seat cushion should be used			✓
A preventative sacral dressing should be applied			✓
Preventative heel dressings should be applied			✓
Preventative trochanteric (hip) dressings should be applied			✓
For intensive care patients who are able to eat food orally, oral nutritional supplements should be provided in addition to standard nutrition			✓

of PI preventative interventions that is linked directly to risk assessment and are specific to intensive care. The results are clinically significant and provide evidence-based guidance for nurses to implement interventions to mitigate the PI risk of critically ill people. While some elements of the minimum intervention set are supported by professional consensus only, in the absence of high-quality research, they represent best evidence at this point in time.

The questions relating to risk assessment and repositioning included in this study were not supported by randomised controlled trials but were included based on international recommendations.[30] The international guidelines have since been updated,[19] but remain similar. Furthermore, the frequencies in which risk assessment and repositioning interventions should be implemented are unclear in the literature. Both the previous and current international guidelines[19,30] recommend that PI risk assessment should be undertaken as soon as possible after admission, with the earlier guidelines specifying a maximum time limit of within 8 hours of admission. However, evidence indicates that tissue damage may begin to occur within as little as an hour.[60] Thus, it has been argued that interventions should be planned and implemented as soon as possible,[22] and risk assessment is required at the earliest opportunity to inform intervention use. One study suggests that skin assessment at the least should be undertaken at point of entry to hospital care.[61] It would appear that this view is supported by the results of this study, with consensus indicating that risk assessment should be undertaken within 2 hours of intensive care admission. This is particularly pertinent given critically ill people are acutely vulnerable to PI development.[9-11] Reassessment of PI risk is also recommended periodically, or when there is a change in the person's condition.[19] However, outside of this, no timeframe is indicated. The consensus in this study determined that reassessment should occur every 8 hours, but some panel members felt that reassessment should only occur when there was a change in a person's condition. Some qualitative comments also suggested that specifying a frequency along with required reassessment due to changes in a person's condition would be appropriate. In this context, it is important to recognise that the intention of the results of this study was to establish a minimum intervention set; thus,

at a minimum, PI risk should be reassessed every 8 hours, but a nurse should reassess in a shorter timeframe if clinically indicated by changes in a person's condition.

International guidelines[19,30] recommend regular repositioning with frequency determined according to individual patient factors, but no specific frequency is detailed. Large randomised controlled trials have examined various repositioning schedules within aged care and long-term care settings with inconsistent results. Defloor et al[62] found that 4-hourly repositioning on a viscoelastic polyurethane foam mattress was significantly more effective than other frequency and mattress combinations; and Moore et al[63] found 3-hourly repositioning with a 30° tilt at night was more effective than 6-hourly repositioning with a 90° lateral rotation. In another study, Vanderwee et al[64] did not find a significant difference in PI incidence in alternate 2-hourly lateral and 4-hourly supine repositioning compared to 4-hourly repositioning; and Bergstrom et al[65] found no significant difference in PI incidence between 2-hourly, 3-hourly, and 4-hourly repositioning on a pressure reducing mattress. In a cohort study of repositioning in bed-bound people with hip fractures, no association between repositioning frequency and PI incidence was found.[66] Likewise, within intensive care, Manzano et al[67] found no difference in PI incidence between 2-hourly and 4-hourly repositioning on an alternating pressure air mattress. While 2-hourly repositioning has been acknowledged as the standard of care,[68] wide study variations in repositioning frequency and mattress combinations, with conflicting results, means that optimal repositioning frequency remains unknown.[69]

While the evidence surrounding repositioning is conflicting, repositioning itself has a strong theoretical justification.[68,69] Generally, PI occurs due to unrelieved pressure forces on body tissues, such as tissue between a bony prominence and a mattress surface;[60,70] however, repositioning the body to relieve that pressure subsequently relieves the PI development forces on the affected tissue.[19,69] In our study, the expert panel established a minimum repositioning frequency of 4-hourly for critically ill people at low-risk, increasing to 2-hourly for people at moderate- and high-risk. These results further highlight the concept that as risk level increases, intervention use or intensity should also increase;[23] a theory which underpins this study. The inclusion of pressure redistributing mattress support surfaces in the bundle also demonstrates panel acknowledgement that repositioning should occur regardless of whether a pressure redistributing mattress is used.[19,71] Consensus indicated that people at moderate risk should have a reactive mattress support surface, but showed that people at high risk should receive an active mattress support surface. This suggests that panel members recognise that support surfaces should be upgraded as risk level increases, although our results reveal an overlap within the bundle in that high-risk patients could receive either a reactive or an active mattress support surface. Thus, nurses would have to select the most appropriate mattress based on their clinical judgement. However, this perhaps reflects the available evidence; the benefit of active over reactive support surface use in relation to PI prevention has not been clearly demonstrated.[72]

The use of a medical sheepskin overlay as a PI preventative intervention did not achieve consensus for inclusion in the minimum preventative intervention set, despite supporting evidence that it is effective in decreasing PI incidence.[44,45,72,73] It was evident from the panel member comments that these results reflect the global nature of this study, with limited availability and routine use of medical sheepskins in some countries; and thus, less familiarity with the device amongst the panel. It may also reflect contemporary technological developments in support surface design, which may negate the need for sheepskin overlays. In their qualitative comments, some panel members raised concerns around maintenance and infection control, perhaps considering the burden of laundering soiled sheepskins and whether washing was sufficiently adequate for hygiene and multi-patient use. Interestingly, however, the pressure redistribution characteristics of Australian medical sheepskins and another commonly used reactive support surface, low-pressure air mattresses, were compared using healthy volunteers.[74] The researchers found that the pressure redistribution demonstrated by the sheepskin was superior to that of the low-pressure air mattress. The sheepskins were also reported to be easily machine-washed and implemented into nursing practice. McGowan et al[45] also reported that the Australian medical sheepskin can be disinfected to a high level, while maintaining its integrity after over 50 washes, with appropriate laundering techniques. Given that Australian medical sheepskin overlays have demonstrated effectiveness in decreasing PI incidence, promotion of the product internationally, and further education and research into its use in intensive care may be warranted.

The second intervention that did not achieve consensus for inclusion in the minimum preventative intervention set was: *Indwelling urinary catheter entry points should be washed with soap and water, and the catheter should be repositioned to the opposite thigh and secured, three times daily*. This intervention was supported by one randomised controlled trial[32] in which the researchers found this combination to be more effective than the same intervention implemented once daily, and more

effective than the control comparison of washing with only soap and water daily. Several qualitative comments by panel members suggest that lack of consensus for this intervention was probably because it comprised multiple components (washing; repositioning; frequency). For example, while a panel member might have agreed with two components, disagreement with a third may have resulted in a lower rating of the intervention overall. Regardless, the prevention of medical device-related PI remains imperative for patient safety, particularly in intensive care.[75] As such, some variation of this intervention is clearly necessary, not just for PI preventative measures but also for hygiene and comfort reasons. However, further research is required to identify and compare other variations of the intervention before widespread use can be recommended.

The minimum intervention set derived from this Delphi survey has established an evidence-based, professionally agreed set of PI preventative interventions grouped according to patient risk level. At each risk level, the relevant interventions should be regarded as a bundle of interventions that should be applied to all patients all of the time. This approach is based on the principle of grouping evidence-based practices together within a single clinical protocol to improve outcomes.[76] The importance of acknowledging that each bundle is intended as a *minimum* intervention set cannot be overstated. The bundle ensures that, *at a minimum*, appropriate and effective preventative interventions are implemented relative to a person's risk. However, it is imperative that individual patient factors are also taken into account, and PI preventative interventions are tailored to address factors pertinent to each person.[19] While the proposed bundle is intended to guide clinicians' use of PI preventative interventions based on assessed risk level, clinicians must also employ their clinical judgement in recognising additional individual patient risk factors and selecting further mitigating interventions. In other words, additional interventions should *always* be implemented as clinically indicated by individual patient needs, regardless of assessed risk level. Potentially, this might include some of the interventions proposed in round 1 that did not reach consensus for inclusion in the minimum intervention set. For example, a patient may be assessed as being at low risk of PI overall; however, their nurse may identify factors which indicate the patient is vulnerable to the development of heel PI despite being low risk. Thus, the nurse must then implement a heel offloading intervention to address the additional risk. Such use of clinical judgement and subsequent action is crucial to patient safety and providing patient-centred care.

Conversely, interventions may be omitted if they are clinically contraindicated. In real-world practice, it may not be possible to implement all of the minimum interventions to some people admitted to intensive care. For example, haemodynamic instability may prevent the ability of healthcare providers to implement regular repositioning,[77] although newer subtle repositioning devices may negate this concern.[68] Other individual patient factors may also negate the need for an intervention; for example, some panel members suggested that when a person had both an indwelling catheter and a faecal management system, incontinence pads would be unnecessary regardless of their risk category or continence status.

In this study, a good response rate of at least 75% was achieved in every round. This suggests that, globally, intensive care nurses recognise the importance of PI prevention in this setting. This is supported by other intensive care studies worldwide, which have reported nurses' positive attitudes towards PI prevention.[78-80] Furthermore, Strand and Lindgren[79] also found that nurses had acceptable levels of PI prevention knowledge, while an Iranian study[81] found a significant association between PI prevention knowledge and nurses' attitudes towards PI prevention.

Expert knowledge of PI prevention and management was a requirement for panel members, and it is conceivable that the experienced, senior intensive care nurses included in the panel would have higher levels of intensive care and/or PI education, and thus potentially more positive attitudes towards PI prevention. Reassuringly, Cox and Schallom[78] found that, despite competing priorities, intensive care nurses considered PI prevention to be an essential component of their care. However, Tayyib et al[80] reported that it was not always recognised as a clinical priority. Perceived barriers to PI prevention include time demands and the severity of a person's illness.[79,80] While it is conceivable that the clinical demands of people who are critically ill may override the perceived importance of PI prevention, the consequences of inadequate PI prevention measures cannot be ignored.

In summary, this Delphi survey has developed a structured, evidence-based approach to the assessment of PI risk and consequent implementation of preventative interventions; which is supported by international professional expert consensus. Thus, the minimum preventative intervention set developed in this study has the potential for global implementation into intensive care nursing practice.

4.1 | Limitations

A recognised challenge of the Delphi technique is maintaining panel member engagement, and minimising attrition.[26,27,54] The response rate of panel members was

at least 75% in every round. When developing core outcome sets, better Delphi response rates are associated with smaller panel sizes and fewer items.[82] A minority of panel members did not respond at all in this study; however, it was noted that most non-responses were from lower wealth countries, where Internet access may have been problematic. Future studies should consider the use of alternate methods of data collection for use in countries where Internet access may be challenging, although this would inevitably increase data collection time. While inclusion criteria were set for panel member expertise, invariably knowledge and experience would have differed, and this may have been a factor that affected responses. However, given that all panel members were highly experienced intensive care nurses, it is reasonable to assume that they would have above average knowledge of PI prevention in this setting. Prior to commencement of the survey, panel members were provided with resources and research supporting the included preventative interventions to guide their decision-making. However, from a pragmatic perspective, some panel members may not have been familiar with all interventions. The expert panel was globally representative, but it was limited to individuals who were fluent in the English language. This will have restricted the pool of experts in some countries, especially those in which English is spoken uncommonly. Also, with the exception of repositioning and risk assessment frequencies, only preventative PI interventions supported by randomised controlled trials were included in this study. Potentially, there are other interventions, which may have warranted inclusion but have not yet been tested in a randomised controlled trial. Finally, panel members were unable to select one mattress support surface for each risk level, resulting in both reactive and active mattress support surfaces being included in the bundle for high-risk patients. Further research may help to clarify this.

5 | CONCLUSION

A minimum PI preventative intervention set has been developed based on international consensus, which has the potential to decrease PI incidence within intensive care. While other multicomponent bundles have been found to be effective in decreasing PI in intensive care,[24] the intervention set developed in this study specifically targets different levels of PI risk and may prove to be more effective. Furthermore, the intervention set was developed through international collaboration between experienced, senior intensive care nurses, and thus potentially may be more appropriate for far-reaching global implementation. Even if the intervention set as a whole is not implemented into a particular setting, this research clearly demonstrates that preventative interventions should be implemented relative to assessed level of risk and this approach should guide practice. Given that many studies which have tested PI preventative bundles have been quality improvement projects,[24] higher level research is required into the use of PI preventative bundles, and more specifically, the minimum PI preventative intervention set determined in this study.

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CONFLICT OF INTEREST

We declare there are no known conflicts of interest associated with this manuscript and there has been no financial support for this work that could have influenced its outcome.

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