Abstract

Aim

The aim of this study was to assess student nurses' knowledge of and attitudes towards pressure injury prevention evidence-based guidelines.

Background

Pressure injuries are a substantial problem in many healthcare settings causing major harm to patients, and generating major economic costs for health service providers. Nurses have a crucial role in the prevention of pressure injuries across all health care settings.

Design

A multi-centered, cross-sectional study was conducted using a paper-based questionnaire with undergraduate nursing students enrolled in seven universities with campuses across five Australian states (Queensland, New South Wales, Western Australia, Victoria and Tasmania).

Methods

Data were collected from nursing students using two validated instruments (Pressure Ulcer Knowledge Assessment Instrument and Attitude Toward Pressure Ulcer Prevention Instrument), to measure students' pressure injury prevention knowledge and attitudes.

Results

Students reported relatively low pressure injury prevention knowledge scores (51%), and high attitude scores (78%). Critical issues in this study were nursing students' lack of knowledge about

preventative strategies to reduce the amount and duration of pressure/shear, and lower confidence in their capability to prevent pressure injury. Level of education and exposure to working in a greater number of different clinical units were significantly related to pressure injury prevention knowledge and attitude scores.

Conclusion

The study findings highlight the need to implement a comprehensive approach to increasing Australian nursing students' pressure injury prevention and management knowledge, as well as ensuring that these students have adequate experiences in clinical units, with a high focus on pressure injury prevention to raise their personal capability.

Keywords: attitudes; guidelines; knowledge; nursing students; patient safety; pressure injury

What is already known about the topic?

- Pressure injury continues to be a significant source of harm to patients.
- Pressure injury prevention is a nurse-initiated action.
- Previous studies found that although nursing students have positive attitudes towards pressure injury prevention, their knowledge is relatively low.

What this paper adds

- Nursing students in this study displayed poor knowledge but good overall attitudes towards pressure injury prevention.
- Increased levels of education and wider experience from working within a range of different clinical settings were significantly associated with student nurses' higher knowledge and positive attitudes towards pressure injury.
- There is a need to implement a comprehensive approach to increasing Australian nursing students' knowledge of pressure injury prevention and management.

1. INTRODUCTION

Pressure injuries are a recognized indicator of quality care and a major problem for patients in many healthcare settings (Baharestani et al., 2009; Gunninberg & Stotts, 2008). Also referred to as pressure ulcers, pressure sores or decubitus ulcers, pressure injuries are defined as localised damage to the skin or underlying soft tissue, which can be intact or open, and graded from Category I (non-blanchable erythema with skin intact) to Category IV (full thickness skin and tissue loss) (National Pressure Ulcer Advisory Panel, 2016). Pressure injuries have the potential to cause major harm to patients, in the form of pain, distress, complications and prolonged hospitalisation (Demarré et al., 2011; Jackson et al. 2017), thereby generating major economic costs for health service providers (Jackson et al., 2016). In fact, the burden of these preventable health outcomes is so serious that many countries have introduced targets for reducing the occurrence of pressure injuries including penalties for hospitals where patients develop pressure injuries (Gunningberg, Mårtensson, Mamhidir, Florin, Muntlin Athlin, & Bååth, 2013; Lyder & Ayello, 2012). A recent systematic review concluded that the cost of preventing pressure injuries in patients at risk is significantly lower than the cost to treat a pressure injury (Demarré et al., 2015).

Similar to other forms of healthcare-related harm to patients, nurses have a crucial role in the prevention of pressure injury. Pressure injury avoidance is considered one of the nurse sensitive indicators, or a "…valid and reliable means to support nursing care quality and performance measurement in the hospital unit setting…" (Heslop & Lu, 2014, p. 2440). Poor knowledge and negative attitudes toward pressure injury prevention have been found to effect the implementation of pressure injury preventive care strategies in practice (Moore & Price, 2004;

Simonetti, Comparcini, Flacco, Di Giovanni & Cicolini, 2015). Internationally however, despite the importance of pressure injury prevention and the ongoing development of guidelines for deterrence, the level of Registered Nurses' knowledge of both risk and impedance strategies is varied and little is known of nursing students' knowledge of pressure injuries or their prevention (Gunninberg et al., 2013). It is also the case that there is currently little understanding of how Australian nursing students perceive this important topic. What is reported in the international literature indicates that student nurses do have the appropriate attitudes towards pressure injury prevention (Gill & Moore, 2013; Gunninberg et al., 2013; Rafiei et al., 2015), but their knowledge and skills are inadequate (Gill & Moore, 2013; Gunninberg et al., 2013; Rafiei et al., 2015).

Bandura's theory of self-efficacy indicates that high confidence in knowledge and skills influences a person's persistence with challenging tasks such as patient safety. Hence, confident clinicians are likely to believe their actions and decisions shape events (Usher et al., 2017), and are therefore more likely to persist with efforts to improve patient outcomes, such as pressure injury prevention. As nurses have the opportunity to significantly impact this problem (Moore & Price, 2004), it is important that student nurses' are educationally prepared to contribute to pressure injury prevention, both during their time as students and when they become Registered Nurses. It is essential that graduate nurses have sufficient knowledge and skills to prevent the occurrence of pressure injuries and to recognize, assess and treat appropriately when required. Nurse educators are vested with the responsibility to ensure curriculum design includes students' development of the requisite knowledge, skills and attitudes about pressure injury prevention to ensure new graduates are ready for the clinical environment (Francis, 2013; Mansour, 2013). Clinical nurses also have an important role in developing student nurses' pressure injury

prevention knowledge and skills during their attendance at clinical placements. Nursing curricula and clinical placements should be designed to ensure these issues are adequately covered (Ginsburg et al., 2012). Unfortunately, there is some evidence that nursing curricula lacks sufficient attention to patient safety, which includes pressure injury prevention (Attree et al., 2008).

1.1 Aim

The aim of this study was to assess nursing students' knowledge and attitudes towards pressure injury prevention evidence-based guidelines. This is the first Australian study specifically designed to assess both knowledge and attitudes of pressure injury prevention. The study was undertaken to inform curriculum development and to improve the resultant quality of care and patient health outcomes.

2. METHODS

2.1 Design and setting

A multi-centered cross-sectional study was conducted using a paper-based questionnaire with undergraduate nursing students enrolled in seven universities with campuses across five Australian states (Queensland, New South Wales, Western Australia, Victoria and Tasmania) between June and December 2016. Bandura's (1988) theory of self-efficacy guided this study. The questionnaire consisted of a demographics section, a validated pressure injury knowledge questionnaire (Beeckman et al., 2010b), and a validated pressure injury attitudes questionnaire (Beeckman et al., 2010a).

2.2 Participants

Using convenience sampling, all first, second and third year students enrolled in an undergraduate-nursing programme (Bachelor of Nursing or equivalent) at each of the seven participating universities were deemed eligible to participate. The undergraduate Bachelor of Nursing programme is a 2-4 year programme with most universities offering it over a 3 year period and requires a minimum of 800 hours supervised clinical placements in a range of health settings to prepare students for a career as a registered nurse. The programme is scaffolded to progressively build nursing students' knowledge and skills.

2.3 Sample size analysis

The primary outcome was to estimate pressure injury knowledge in the population of nursing students. Previous studies have examined samples of nursing students (Simonetti et al., 2015) and nurses (Beeckman et al., 2011) using the same instrument and reported mean knowledge scores of 51.1% and 49.6% respectively. Using an estimated mean of 49 with a 95% confidence interval, a margin of error of ±10, and an alpha of 0.05, a required sample size of 325 was calculated.

2.4 Data collection

In each university, a research partner was responsible for participant recruitment and administration of the questionnaire. A member of the university staff not involved in the study informed nursing students about the study verbally, and distributed the participant information sheet and consent form to those who voluntarily agreed to participate. The self-report questionnaire was distributed to each student during a lecture or tutorial in the second semester

(June to November) of 2016 at each of the participating universities. Students were asked not to use any resources or ask other students for answers while completing the questionnaire. The university staff member supervised students while they were completing the questionnaire to ensure no resources were consulted. Students who chose not to participate were allowed to leave the room. Students were given up to 45 minutes to complete the questionnaire. No identifying information about individual students was collected, and completed consent forms and responses were collected separately to ensure confidentiality and anonymity.

2.5 Ethical considerations

Approval to conduct the study was initially received from the University of New England, Human Research Ethics Committee (HE15-205). Each participating university obtained reciprocal ethical approval from their respective human research ethics committee. All participation in the study was voluntary.

2.6 Data collection instruments

The questionnaire consisted of three sections incorporating demographic information and two questionnaires, the Pressure Ulcer Knowledge Assessment Instrument (PUKAT) (Beeckman et al., 2010b) and the Attitude Toward Pressure Ulcer Prevention (APuP) (Beeckman et al., 2010a) that were originally validated with nurses and student nurses in Belgium and the Netherlands. These are detailed below:

Section 1: *Demographic information*: sex, age, year of course enrolment, number of years of clinical placement experience, number of units and unit types worked in during clinical placements, were collected.

Section 2: *Pressure Ulcer Knowledge Assessment Tool:* this questionnaire consists of 26 multiple choice items related to pressure injury prevention with three alternate responses. The 26 items reflect six themes: (1) aetiology and development – 6 items; (2) classification and observation – 5 items; (3) nutrition – 1 item; (4) risk assessment – 2 items; (5) reduction of the magnitude and shearing – 7 items; and, (6) reduction of the duration of pressure and shearing – 5 items.

Example question: classification and observation;

In a sitting position, pressure injuries are most likely to develop on:

- Pelvic area, elbow and heel.
- Knee, ankle and hip.
- Hip, shoulder and heel.

Correct responses are scored 1, and incorrect responses are scored 0. A maximum score of 26 is possible (Beeckman et al., 2010b).

Section 3: *Attitude Toward Pressure Ulcer Prevention (APuP)*: this questionnaire consists of 13 items that measure attitudes towards pressure injury prevention. The instrument includes five subscales that use a 4-point Likert scale (1=strongly disagree to 4=strongly agree): (1) personal competency to prevent pressure injuries – 3 items; (2) priority of pressure injury prevention – 3 items; (3) impact of pressure injuries – 3 items; (4) responsibility for pressure injury prevention – 2 items, and (5) confidence in the effectiveness of prevention – 2 items.

Example question: personal competency to prevent pressure injuries;

- I feel confident in my ability to prevent pressure injuries

The minimum score value for the total scale is 13 and the maximum score value is 52 (Beeckman et al., 2010a).

A minor change was made to the two instruments to ensure they were relevant to the Australian context: pressure ulcer was changed to pressure injury, and department was changed to unit.

2.7 Data analysis

Data were entered manually into Survey Monkey and exported in an SPSS database format.

Descriptive statistics were used to describe the sample (frequency, percent). As undergraduate nurse education is usually undertaken over a three-year period, responses from fourth year students were amalgamated with third year student responses.

For the multiple choice knowledge assessment questions, percent of correct answers for each question was calculated. Knowledge scores were summed for each subscale, and summed scores were calculated to create a total knowledge score.

Descriptive statistics (mean, standard deviation (SD)) were used to summarise the scores for the pressure injury prevention attitude questions. Negatively worded questions (e.g., Pressure ulcer prevention is not that important) were reverse scored, and attitude scores were summed for each subscale. Summed scores were calculated to create a total attitude score. As the attitude scores were normally distributed, *t*-tests and ANOVA were performed using F-distribution to test for differences between groups. Post hoc testing for pairwise comparisons was conducted using Tukey's procedure (Keppel, 1982).

Pressure injury prevention knowledge and attitude scores were compared between year of nursing education (one to three-four years), clinical placement experience (none to three-four years) and number of different clinical units (none to three or more) students worked in during

their clinical placements by using generalized-estimating-equations models. Generalized-estimating-equations models were selected in order to take into account the clustered nature of the data; underestimation of between-cluster variances can occur without adjusting for clustering effects (Hardin & Hilbe, 2003). Generalized-estimating-equations is robust to non-independence within a cluster and does not assume independence between observations. An identity link and distribution function was specified. Using the Wald statistic, adjusted means, standard errors, and *P* values were obtained, which were used to determine predictors of knowledge and attitude scores after adjustments for potential confounders (age, sex). A Spearman's Rank Order correlation analysis was conducted to quantify the direction and strength of association between knowledge and attitude scores. Spearman's test was selected because the knowledge scores are ordinal. *P* values of <0.05 were considered statistically significant. Analyses were performed using SPSS version 23 (IBM SPSS, Armonk, NY).

3. RESULTS

3.1 Characteristics of the sample

Seven universities that offer an undergraduate nursing programme (Bachelor of Nursing or equivalent) agreed to participate in the study, and a total of 2949 nursing students completed the questionnaire. The median age of participants was 23 years (interquartile range (IQR) = 20-29) (Table 1). Most participants were female (85%), the largest proportion were first year student nurses (38.3%) and the smallest proportion were third year student nurses (26.1%). Overall, 36.2% of participants had three or more years of clinical placement experience, 41.0% had attended placements in three or more clinical units, and the most common clinical placements were in medical and surgical units (61% and 48% respectively).

3.2 Knowledge

Multiple choice questions, response possibilities, and participant responses are shown in Table 2. The overall mean knowledge score was 51.1% (13.3/26), with scores ranging from 2 to 21 with no students achieving 100% correct answers. Only 23% of students had a mean score ≥ 60%. The lowest overall scores were achieved on the themes *Preventive measures to reduce the amount of pressure/shear* (44.1%) and *Preventive measures to reduce the duration of pressure/shear* (48.5%) [Table 2]. Analysis of the seven items of *Preventive measures to reduce the amount of pressure/shear* shows a high rate of incorrect responses to questions relating to posture, pressure relieving devices and mattresses.

Most students did not know: how to position patients to minimise contact pressure between the seat and the body (68.5%), when a patient is sliding down in a chair, how to minimise the amount of pressure at the seat (67.9%) and how to use a visco-elastic foam mattress, in conjunction with repositioning, for patients at risk of developing a pressure injury (66.4%). Analysis of the five items of *Preventive measures to reduce the duration of pressure/shear* showed a high rate of incorrect responses on two questions relating to repositioning. Most students did not know: why repositioning is an accurate preventative method (68.9%), and how often to reposition an at-risk patient by mattress type (82.2%). In the theme *Classification and observation*, 74.4% of students did not know how to classify a grade three pressure injury, or how often to inspect the skin or observe an at-risk patient (82.2%).

The highest scores were achieved in the themes: *Nutrition* (87.9%), *Risk assessment* (58.5%) and *Aetiology and development* (54.1%). Most students knew that optimizing nutrition can reduce the risk of pressure injuries. In the theme *Risk assessment*, most students knew that a risk assessment

scale should be combined with clinical judgement (65.8%), and in the theme of *Aetiology and development*, most students knew there is no relationship between pressure injury and hypertension (74.6%), and that recent weight loss increases the risk of pressure injury (73.4%).

There were no statistically significant differences in the knowledge mean score between males and females ($t(1937) = 1.88$, $p=0.60$) (Table 3). Knowledge scores were significantly different when related to year of education ($F(2,1932) = 17.54$, $p < 0.001$), clinical placement experience ($F(3,1936) = 7.32$, $p < 0.001$) and number of clinical units attended ($F(3,1931) = 16.21$, $p < 0.001$). In particular, students' knowledge scores increased with each year of nursing course enrolment, were higher with one or more years of clinical placement experience compared with no experience, and increased with number of different clinical units attended.

3.3 Attitudes

Table 3 shows the mean attitude sub-scales scores and the total mean attitude score (mean = 40.8, $SD = 3.9$). The highest mean scores were for items in the theme: *Priority,* where most students agreed that pressure injury prevention is very important (reversed), (mean = 3.63, $SD = 0.67$), and pressure injury prevention should be a priority, (mean = 3.43, $SD = 0.66$), and in the theme: *Responsibility,* where most students agreed that they personally have an important task in pressure injury prevention, (mean = 3.52, $SD = 0.63$), and they personally feel responsible if a pressure injury develops in their patients (reversed) (mean = 3.42, $SD = 0.70$). In the theme: *Impact,* most students agreed that a pressure injury almost always causes discomfort for a patient (reversed), (mean = 3.63, $SD = 0.67$), and in the theme: *Effectiveness,* most students agreed that pressure injuries are almost always preventable (reversed), (mean = 3.28, $SD = 0.65$).

Lowest mean scores were for items in the theme: *Personal competency,* I am well trained to prevent pressure injuries, (mean = 2.63, *SD* = 0.66), I feel confident in my ability to prevent pressure injuries, (mean = 2.81, *SD* = 0.61), and pressure injury prevention is too difficult, others are better at it than I am (reversed), (mean = 2.77, *SD* = 0.69).

When the total mean attitude score was stratified by sex, females had a slightly more positive attitude about pressure injury prevention than males (female mean = 41.0 vs. male mean = 40.2, $t(2517) = 3.09$, $p=0.002$). Statistically significant differences were found between attitude and year of education ($F(2,2511) = 53.78$, $p < 0.001$), clinical placement experience ($F(3,2515) = 13.49$, $p < 0.001$), and number of different clinical units attended ($F(3,2514) = 32.61$, $p < 0.001$). In particular, students' attitude scores increased significantly with each year of enrolment, students with two or more years of clinical placement experience had significantly higher attitude scores than students with none or one year of experience, and students with training experiences in two or more different clinical units had significantly higher attitude scores than students with experience in none or one clinical unit.

A Spearman's rank-order correlation was conducted to determine the relationship between students' knowledge and attitude scores. There was a weak, positive relationship between knowledge and attitude scores, which was statistically significant ($r_s(1793) = 0.193$, 95% BCa CI [.147-.235] $p < 0.001$).

3.4 Results of Generalized-estimating-equations analyses

Analysis was conducted using generalized-estimating-equations to examine factors independently associated with knowledge and attitude scores (Table 4). The following variables: year of course enrolment, clinical placement experience, and number of different clinical units

attended, were all independently significantly associated with knowledge and attitude scores and therefore included in the generalized-estimating-equations multivariable models. Table 5 displays response comparisons between pressure injury prevention guidelines knowledge scale and student nurse groups based on year of course enrolment, clinical placement experience, and number of different clinical units attended. After controlling for age and sex, it was found that year of enrolment significantly predicted high pressure injury knowledge scores ($\beta = 0.33$, $p = 0.015$), as did number of different clinical units attended ($\beta = 0.26$, $p = 0.004$), with year of enrolment recording a higher beta value than number of different clinical placements. Table 5 also displays response comparisons between pressure injury prevention attitudes and nursing student educational and clinical experience. After controlling for age and sex, it was found that year of enrolment significantly predicted high pressure injury attitude scores ($\beta = 0.73$, $p < 0.001$), as did number of different clinical units attended ($\beta = 0.47$, $p < 0.001$), with year of enrolment recording a higher beta value than number of different clinical placements.

4. DISCUSSION

This study was undertaken to determine the knowledge of and attitudes towards pressure injury prevention of nursing students enrolled at seven universities across five states in Australia. Adequate knowledge of and appropriate attitudes towards pressure injury prevention are needed to ensure healthy outcomes for people in healthcare facilities. In keeping with previous studies, students demonstrated relatively low pressure injury prevention knowledge scores (mean knowledge score of 51.1%) (Demarré et al., 2011; Gunninberg et al., 2013; Simonetti et al., 2015). This may indicate that classroom educational material may not consider the full range of risk/contributory factors for pressure injury; meaning that students may not be optimally

prepared for their roles in the prevention of harm to patients. What is shown by these findings is the association between knowledge levels and higher levels of education and exposure to working in a greater number of different clinical units. Although it is recognised that the number of clinical placements increase with each year of enrolment, some clinical units have a higher risk of pressure injury than others due to the characteristics of patients (e.g., intensive care unit, orthopaedic units, palliative care, and residential aged care facilities). Thus, experience working in a wide range of clinical units should increase knowledge of and attitudes towards pressure injury prevention (Beeckman et al., 2010b; Garrigues, Cartright & Bliss, 2017; Pancorbo-Hidalgo, García-Fernández, López-Medina & López-Ortega, 2007). In addition, previous studies have demonstrated that experience caring for a patient with a pressure injury increases the degree to which student nurses value prevention strategies (Samuriwo, 2010).

Conversely, students overall had high scoring attitudes towards pressure injury prevention. For example, the students in this study agreed they had a role in pressure injury prevention and that it should be a priority. The greatest concern about pressure injury prevention attitudes is personal competency beliefs, which had the lowest scores. Similar to findings reported by Simonetti et al. (2015), our findings suggest that nursing students have low confidence in their ability or training to prevent pressure injury. However, confidence of students in this study increased across the years of study, number of clinical placements attended and years of enrolment, as was the case in the study by Simonetti and colleagues (2015).

Assessment, accurate staging and documentation of pressure injuries is an essential element of the ongoing efforts to reduce pressure injuries (Tschannen, Mckay, & Steven, 2016). However, in the current study nearly three-quarters of students were not able to classify a category three pressure injury. This result is significantly higher than similar studies conducted in the United

States of America (USA) (Tschannen et al., 2016), Iran (Rafiei, Mehralian, Abdar, & Madadkar, 2015) and Italy (Simonetti, Camparcini, Flacco, Di Giovanni, & Cicolini, 2015).

Tschannen, Mckay and Steven (2016) and Garrigues et al. (2017) improved students' ability to categorise pressure injuries and vigilance and passion to prevent pressure injuries by having them spend time with specialist nurses during their clinical placements. The importance of improving student attitudes towards pressure injury prevention by exposing them to positive role models and skin champions, is a valuable consideration (Garrigues et al., 2017). In the current study, over 80.0% of students did not know how often to check skin integrity or observe an at-risk patient. Simonetti and colleagues (2015) reported similar results using the same survey. However, in their study, 52.3% of Italian nursing students understood the importance of repositioning (Simonetti et al., 2015) compared to 31.1% of students in our sample who answered correctly to the same questions.

Similarly to other studies (Beeckman, Defloor, Schoonhoven, & Vanderwee, 2011; Simonetti et al., 2015), in the current study there was a weak correlation between knowledge and total attitude scores. This indicates that students with higher levels of knowledge about pressure injuries will be more likely to have a positive attitude towards pressure injury prevention. It is critical that nursing education courses and clinical placement experiences provide explicit training in pressure injury prevention so graduate nurses have the requisite knowledge and personal competency beliefs to undertake pressure injury prevention according to current guidelines. In recent years Australian nursing curricula have responded to the Australian Commission on Safety and Quality in Healthcare (2012), increasing taught content in a number of areas. This increase includes pressure injury prevention, Standard 8 in the National Safety and Quality Health Service Standards (Australian Commission on Safety and Quality in Healthcare, 2012).

Although contemporary undergraduate nursing education delivers more learning opportunities about pressure injury for students and greater knowledge about pressure injury prevention guidelines across the curricula, our results indicate that students' knowledge is inadequate, suggesting further pressure injury prevention content is required.

Despite all undergraduate nursing curricula in Australia undergoing rigorous design and review, there is no requirement for a discrete or embedded area of study specifically addressing wounds or pressure injuries (ANMAC, 2017). For this reason, little is known about how or when this content is taught, either in the classroom, in laboratories or simulation, or in clinical practice.

Australia is not unique in this respect with studies in Europe (Gill & Moore, 2013; Moore & Clarke, 2011), the United States (Ayello, Zulkowski, Capezuti, Harris, & Sibbald, 2017; Zulkowski, Capezuti, Ayello, & Sibbald, 2015) and Spain (Romero-Collado, Raurell-Torreda, Zabaleta-del-Olmo, Homs-Romero, & Bertran-Noguer, 2015) all finding a dearth of content pertaining to pressure injury in undergraduate nursing programs indicating that may be an international issue.

Although little is known about pressure injury content in curricula in Australian universities, inspecting skin integrity and inspecting and palpating for signs of pressure injury were named core physical assessment skills in a recent Australian delphi study (Douglas et al., 2016). These results indicate it is crucial educational strategies incorporate the full range of relevant information about factors influencing pressure injury, including shear. Within a crowded curriculum the challenge is to provide the opportunity for students to acquire this knowledge and experience the care of a patient who is at risk of, or has a pressure injury. The flipped classroom model, adopted in many universities, creates this opportunity. This model requires students to familiarize themselves with new content by undertaking reading and viewing digital media prior

to attending a face-to-face session that is designed to consolidate their learning (Lage, Platt & Treglia, 2000). Academic staff are still tasked with setting the preliminary activities necessary to engage learners for more applied learning in the classroom or laboratory.

Resources to assist with student learning have also been found wanting. In a review of nursing texts, Ayello and colleagues (Ayello & Meaney, 2003) found that these resources may not be the best source of information, possibly because the evidence for best practice care and management of pressure injuries changes more rapidly than can be reflected in textbooks (Siegel, 2016). There are however excellent sources of wound management information in other documents developed by societies and associations of wound nurse specialists (Australian Wound Management Association, 2012) which include high quality evidence from randomized controlled trials.

E-learning is also increasing in popularity as one method of augmenting practical, and face-to-face instruction across large numbers of participants. Bredesen and co-workers (2016) found equal or better results than classroom teaching, using an e-learning program to increase nurse proficiency in pressure injury risk assessment and classification. Beeckman and colleagues (2008) reported similar results with a convenience sample of qualified nurses and nursing students, noting that nursing students achieved better results with e-learning compared to the qualified nurses. E-learning programs have the added advantage of being convenient and useful for repetitive training (Beeckman et al., 2008). Advances in technology mean that learning can be mobile, with Rajpaul and Acton (2015) reporting an increase in the number of days free of avoidable pressure injuries, following the implementation of five modules via app technology. However, teaching this content may pose a problem for academics, with Zulkowski and colleagues (2015) reporting that less than 15% of staff teaching wound content are certified to do so. Additionally, there are inconsistencies in teaching between wound certified and non-certified

staff. Huff (2011) demonstrated the difference in student learning outcomes when content was delivered by a nurse specialist (intervention) compared to non-specialists, with knowledge scores significantly higher in the intervention group.

Most importantly though, educators, registered nurses, and nurse supervisors need to involve students in pressure injury prevention in order to improve patient outcomes (Layla et al., 2017). Face-to-face opportunities for students to acquire knowledge regarding the prevention of pressure injuries include theoretical teaching, practice laboratories and simulation, as well as clinical practice (Gunninberg, Poder & Carli, 2016).

These results indicate that the further advanced students are in their undergraduate programme, the greater their knowledge about pressure injury prevention. In this context it is important to consider the opportunities students have to experience authentic clinical situations that expose them to the opportunity to care for patients at risk of developing or with pressure injuries. Tschannen and colleagues (2016) found that immersion in the clinical environment, coupled with a face-to-face lecture and an online learning module significantly increased student knowledge regarding pressure injury staging. What is not evident in the literature is the role that human patient simulation, a learning modality gaining popularity in nursing education, may be able to play in knowledge acquisition.

5. Strengths and limitations

The main strengths of this study are the participation of seven universities with campuses in five of the eight Australian jurisdictions and the large sample size, increasing the representativeness and generalisability of the results. The study used previously validated survey instruments to measure study outcomes, and the data analysis technique used (generalized-estimating-

equations) addressed the clustered nature of the data and controlled for potential confounders. Participants were supervised during completion of the questionnaires, reducing the opportunity for consultation of outside sources and thereby increasing the accuracy of the knowledge scores. There are a number of limitations in this study that must be considered. As with all cross-sectional studies, data are collected only once and provide a snapshot in time, limiting the ability to draw valid conclusions about any association or possible causality. Self-report measures can be affected by social desirability bias, thus attitude scores should be interpreted with caution. The respondents did not have the option to indicate 'I do not know the answer' to multiple choice knowledge questions. The forced choice may have artificially inflated the proportion of correct responses and affected the interpretation of the data. In addition, one of the instruments used in this study (PUKAT) was recently revised to be consistent with the latest guidelines. Unfortunately, the new version of the tool, the *Pressure Ulcer Knowledge Assessment Tool 2.0* (PUKAT 2.0) (Manderlier, Van Damme, Vanderwee, Verhaehge, Hecke & Beeckman, 2017), was released after this study was complete. Results may have differed slightly if the new tool was used and it is a reminder that we need to constantly reconsider items included in data collection tools to ensure they reflect contemporary evidence.

6. Conclusion

Measuring Australian nursing students' pressure injury prevention knowledge and attitudes allows educators to implement targeted strategies to improve specific dimensions of pressure injury prevention knowledge. These strategies ultimately may improve the care that patients receive. Study findings highlight the need to implement a comprehensive approach to increasing pressure injury prevention and management knowledge among Australian nursing students, as well as ensuring that these students have adequate experiences in clinical units with a high focus

on pressure injury prevention so as to raise their personal capability. A national review of pressure injury content in undergraduate nursing curricula is recommended.

7. Clinical implications:

Poor knowledge and negative attitudes toward pressure injury prevention could undesirably affect preventive care strategies. Curriculum developers may find the results of this study useful to tailor specific educational programs to increase knowledge about pressure injury prevention, and personal capability towards prevention and improved management of pressure injuries in future registered nurse cohorts.

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Table1

Table 1 Characteristics of the sample

Characteristics	
Overall sample, *N* (%)	2949 (100)
Age (years)[a], median (IQR)	23.0 (20-29)
University[b], *n* (%)	
1	373 (12.7)
2	1229 (41.9)
3	171 (5.8)
4	384 (13.1)
5	472 (16.1)
6	136 (4.6)
7	168 (5.7)
Sex[c], *n* (%)	
Female	2487 (85.2)
Male	433 (14.8)
Year of education[d], *n* (%)	
First	1116 (38.3)
Second	1037 (35.6)
Third and Fourth	759 (26.1)
Clinical placement experience[e], *n* (%)	
None	205 (7.0)
One year	824 (28.3)
Two years	828 (28.4)
Three or four years	1055 (36.2)
Number of clinical units[f], *n* (%)	
None	363 (12.5)
One unit	917 (31.5)
Two units	435 (14.9)
Three or more units	1195 (41.1)
Unit types[g], *n* (%)	
Medical unit	1803 (61.1)
Surgical unit	1420 (48.2)
Maternal-child unit	215 (7.3)
Mental health unit	930 (31.5)
Intensive or critical care unit	408 (13.8)
Nursing home	1195 (40.5)
Community health centre	686 (23.3)

[a] 74 missing responses
[b] 16 missing responses
[c] 29 missing responses
[d] 37 missing responses
[e] 37 missing responses
[f] 39 missing responses
[g] Total *n* >100% due to ability to choose multiple responses.
IRQ = interquartile range

Table 2

Table 2 Students' responses on multiple-choice questions regarding prevention of pressure injury.

Item	Overall % of correct answers
Theme 1: Etiology and development	54.1%
Theme 2: Classification and observation	50.5%
Theme 3: Risk assessment	58.5%
Theme 4: Nutrition	87.9%
Theme 5: Preventive measures to reduce the amount of pressure/shear	44.1%
Theme 6: Preventive measures to reduce the duration of pressure/shear	48.5%

Table 3

Table 3 Mean PI attitude sub-scale scores

Item	Mean scores	*SD*
Personal competency to prevent PI	8.2	1.4
Priority of PI prevention	10.0	1.5
Impact of PIs	9.2	1.3
Responsibility in PI prevention	6.9	1.1
Confidence in effectiveness of prevention	6.4	0.9
Total scale	40.8	3.9

Table(s)

Table 4 Independent predictors of knowledge of and attitudes towards pressure injury prevention guidelines – GEE models

Knowledge	β	95% CI	*P* values
Year of nursing course enrolment	0.52	0.37, 0.67	< 0.001
Years of clinical placement experience	0.25	0.14, 0.36	< 0.001
Number of different clinical units attended	0.39	0.28, 0.49	< 0.001
Attitudes			
Year of nursing course enrolment	1.10	0.85, 1.26	< 0.001
Years of clinical placement experience	0.49	0.33, 0.66	< 0.001
Number of different clinical units attended	0.75	0.60, 0.89	< 0.001

Table 5 Models of predictors of knowledge and attitudes towards pressure injury prevention guidelines – GEE models

Knowledge (model 1) (*n* = 1860)	β	95% CI	*P* values[a]
Year of nursing course enrolment	0.33	0.06, 0.59	0.015
Years of clinical placement experience	-0.11	-0.29, 0.08	0.274
Number of different clinical units attended	0.26	0.08, 0.45	0.004
Attitudes (model 2) (*n* = 2409)	β	95% CI	*P* values[a]
Year of nursing course enrolment	0.73	0.44, 1.03	< 0.001
Years of clinical placement experience	-0.21	-0.42, 0.01	0.061
Number of different clinical units attended	0.47	0.26, 0.67	< 0.001

[a]GEE adjusted for age and sex