A review of the literature to determine the recommended nursing interventions aimed at decreasing the risk of pressure ulcer development in patients with spinal cord injury

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Abstract

Background: Pressure ulcers (PUs) present a significant problem for patients with spinal cord injury (SCI) from the acute phase and onwards. Most PUs can be prevented if risk factors are recognised early and preventative actions are implemented. Recognising risk factors is critical for successful prevention.

Method: Analysis of PU risk factors in persons with SCI, literature review published from 2005 to 2010.

Results: This analysis identified multiple factors for PU development, including lifestyle factors and biomechanical factors with a focus on changes to skin physiology following SCI and the effect of pressure loading on skin over time. Additional studies are required to improve the level of available evidence. The results of this review revealed that it is crucial for health professionals to be aware of PU risk factors so that timely and appropriate prevention and intervention can be implemented.

Keywords: spinal cord injury, spinal injury, pressure ulcer

Introduction

Pressure ulcers (PUs) are a significant source of morbidity in spinal cord injury (SCI) from the early, acute stage through to the chronic stage[1]. They are recognised as the most frequent secondary complication associated with SCI[2] and the cause of many hospitalisations after rehabilitation[3,4]. Rappl[5] has uncovered that there are metabolic and physiological differences between the skin above and below the neurologically impaired level in individuals with SCI. This provides a physiological basis to explain the increased frequency of PU development[5]. A pressure ulcer can start at the surface of the skin or in the skeletal muscle and then extend to the skin's surface[6]. A pressure ulcer in the SCI population takes a long time to heal[5] and can cause prolonged bed rest and restricted activity[7]. This has a major impact on the physical and emotional health of individuals with SCIs as well as on those around them. Individuals with large PUs experience social isolation, alteration of body image, and loss of income[7,8]. In some individuals, PUs can even be fatal[9].

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Studies confirm that most PUs are preventable if risk factors are recognised early and immediate action is implemented[3,10,11]. Intervention may include the use of appropriate support surfaces, regular repositioning, skin inspection, skin care, appropriate fluid intake, proper nutrition and targeted education[1]. The activities involved in prevention of PUs are complex and require significant changes in the life of the individual with SCI. Furthermore, many interventions necessary for prevention require understanding and cooperation between the individual with SCI receiving the support and health professionals[11]. Therefore, it is essential for health professionals to be aware of and be able to identify the risks factors that lead to PU development in this population group.

The main aim of this literature review is to provide an analysis and overview of the current evidence to identify specific risk factors for PU development in the SCI population and determine the best intervention for the prevention of PUs.

Method

A search on CINAHL, Medline, Nursing Ovid, Cochrane Database, Nursing Reference Centre, Health Source: Nursing /Academic Edition and Med-info database was attended in August 2010. Keywords were selected from terms used in

the research question. To ensure that chosen keywords were appropriate, they were entered into the thesaurus-dictionary for Medline to compare with keywords most often used in the literature. Keywords "Spinal Cord injury", "Spinal Injury", and "Pressure Ulcer" were included in the final keyword selection. They were then combined with the connector words of "or" / "and".

Criteria for inclusion in this review were: randomised controlled studies, case control cohort studies, cross-sectional studies and descriptive qualitative studies. Case report and case series studies have been excluded. The search was limited to the years 2005–2010, English language, adults and human studies. Study groups were required to include regardless of the aetiology: SCI population group, paraplegic or tetraplegic, at chronic or acute stage of SCI, at home or in hospital. Data extraction and methodological quality evaluation follow the Method for Evaluating Research Guidelines[12]. This reading tool includes descriptive information about the study, evaluation criteria and overall assessment of the study.

The set of 17 publications meet the above criteria. One article was excluded because the risk factors are specifically correlated to United States characteristics describing African Americans and cannot be specifically related to other countries.

Selected articles were classified into two groups of risk factors for development of PU: biomechanical risk factors and lifestyle risk factors.

Results

Minimising biomechanical risk factors

This review identified that the risk for PU development begins with the onset of SCI. Primarily this includes prolonged pressure loading during bed rest and heat accumulation, which are risk factors for PU development[13]. The guidelines for the management of skin in individuals with SCI recommend that a patient should be turned or repositioned every two hours[6]. A study conducted by Sae-Sia *et al.*[14] measured skin blood flow and skin temperature in three groups: with acute SCI; with acute orthopaedic trauma and a healthy control group while pressure loading was sustained for two hours on normal hospital mattresses. Individuals with SCI were found to have significantly reduced micro-vascular function, with lower capacity to maintain skin blood flow during pressure loading and post-loading periods as compared to other groups. Sae-Sia *et al.*[14] believe this impaired blood vessel innervation is most likely to be attributable to physiological changes associated with SCI. Therefore, the authors recommend the current clinical guidelines for management of skin[6] may require re-evaluation for acute SCI.

Similarly Zengyong *et al.*[15] determined that loss of neurological control after SCI might be a significant factor contributing to post-pressure regulation in the blood flow. As a result, in an individual with SCI, skin reperfusion following the release of occlusive pressure has a delayed response. This delay has an effect on oxygen delivery to tissue, which can be a precursor to deep-tissue injury and PU development.

Kanno *et al.*[16] and Makhsous *et al.*[17] concur with this view and also emphasise that deep-tissue injury is almost impossible to detect by visual inspection. To assist in early PU detection, Makhsous[17] *et al.* assessed the mechanical properties of soft tissue in areas prone to PU development using an ultrasound palpitation device. This assessment has shown that inflammation can cause an increase in tissue stiffness. The investigation provides information about potential differences in tissue stiffness, because sustained external loading causes inflammation, which alters soft-tissue properties. Additionally, Kanno *et al.*[16] support the use of ultrasound for early detection of PUs. However, the authors could not specify timing of ultrasound use, therefore strongly recommend visual skin inspection in combination with skin palpitation[16].

Furthermore, to reduce the risk of PUs, individuals with SCI are also encouraged to shift their weight whilst sitting to promote blood flow and oxygenation and improve tissue recovery to the skin[6]. This can be difficult to achieve as demonstrated by the case control study showing some evidence of impaired dynamic sitting in a person with SCI due to restricted balance[18]. Dynamic sitting stability has an important role in weight shift and seat–interface pressure distribution. Karatas *et al.*[18] support this and assert that pressure displacement is a factor which can increase risk of PU development.

Wide varieties of wheelchair cushions have been developed as a result of research in order to redistribute support more evenly and reduce the risk of developing PUs. Gil-Agudo *et al.*[19] compared different varieties of sitting cushions, the benefits in terms of the pressure distribution and the contact surface at the user–cushion interface. The authors found that the dual-compartment air cushion provided the best mechanical performance; however, for complete clinical evaluation, they believe wheelchair cushions should be evaluated in relation to skin condition[19]. Despite this evidence Linder-Ganz *et al.*[20] argue that the PU risk is still high even if optimal pressure relief is provided. This is confirmed by Finite Element Modelling Technique studies. This method allows monitoring of individual sitting habits and provides information on the effect of internal tissue loads on deep tissue during longer periods. The study proves that even with equally distributed pressure at the sitting interface, deep tissue can be under stress due to high pressure[20].

With attempts to address this problem, Makhsous *et al.*[21] studied tissue perfusion in two different sitting configurations: normal sitting configuration in a wheelchair and using a special mechanical seating device on wheelchairs that create

an alternating load distribution. The study showed that standard wheelchair push-ups in individuals with SCI are not sufficient to recover tissue perfusion compromised during sitting; therefore, alternated manoeuvres are required. The average time that participants performed pressure relieving push-ups was 49 seconds; however, research reveals that 200-300 seconds is needed to achieve normal tissue reperfusion[21]. The mechanical seating device demonstrated that intermittent shifting of pressure can contribute to improved prevention of PU risk[21].

Additionally, methods such as electric stimulation on the gluteus muscle can also decrease interface pressure which might restore blood flow. A study by Londen *et al.*[22] found that electric stimulation therapy can be of use in PU prevention when used in conjunction with a specially designed cushion and protective behaviour. However, it is not clear what the optimal frequencies of these settings need to be for increasing blood flow to tissues and whether this helps prevent PUs. The need to consider the intensive training of the user that is required to ensure accurate use should also be taken into account[22].

Minimising lifestyle risk factors

Risk factors for PU development are not only dependent on neuromuscular severity of SCI but also on lifestyle factors. There is evidence demonstrating that an individual's motivation towards health and wellbeing is an important factor in PU development.

Jones *et al.*[23] investigated prevention practice differences between individuals with SCI who rarely developed PUs and individuals who frequently sustained PUs. The authors discovered that healthy lifestyle, regular exercise and an appropriate diet were protective mechanisms against PU recurrence. The study group in which PU recurrence was decreased included participants who were mostly female, employed, within a healthy weight range, had low alcohol consumption, were non-smokers, had nil incontinence problems, had the presence of some neurological sensation and who were physically active[23]. In addition, Chen *et al.*[24] identified that PU risk remained steady for the first 10 years after injury and then significantly increased. In this long-term, longitudinal study of 3361 participants with SCI, PUs were more common in participants with complete injuries and in those with a history of PU recurrence. Smith *et al.*[25] also define increased length of time post-injury as a major risk factor for PU development. The authors suggest that this may be related to the process of ageing as well as the presence of multiple comorbidities as there was an association between diabetes, depression, smoking and PU development[25]. Corea *et al.*[26] also identified in a small study of 41 participants that the completeness of injury, presence of personality disorders and an overweight or underweight body type could increase the risk of PU development.

Clark *et al.*[27] and Jackson *et al.*[28] examined the complex determinants of PU within individual lives. The studies indicated that the multifaceted pressure of daily life often minimises the individual's ability or motivation to successfully maintain recommended PU prevention strategies. King *et al.*[29] explored preventative skin beliefs of individuals with SCI revealing that, despite the individual demonstrating knowledge of the benefits of PU prevention and belief in the seriousness of PUs, they often chose a non-adherence approach when confronted with conflicting priorities[29].

Interventions to improve PU prevention in self-care goes beyond education. Individuals with SCI can get support via health and wellness counselling to facilitate their ability to balance life priorities with the challenges of daily health care[23,27,29]. Prevention for individuals with SCI, identified as at risk of PU development, can be implemented with periodical home monitoring by community nurses[26]. Rintala *et al.*[30] suggested that the recurrence of PU especially in post-surgical treatment may be decreased with individualised education and structured monthly contact. Clinicians need to realistically understand the individuals' anxiety generated by the disruption of their lifestyle and to be able to facilitate feasible and adequate prevention practices[28].

Discussion

Overall the reviewed studies present pragmatic clinical applications. Sae-Sie *et al.*[14] challenge the current practice of second-hourly turning. However, their study was conducted on standard hospital mattresses and does not take into consideration the potential discomfort of continuous turning for acutely injured individuals or the time and physical resources required to achieve more frequent turning. To undertake one spinal log roll requires a minimum of four staff with experience in this skill[13]. An alternative to more frequent repositioning could be the use of advanced pressure redistribution surfaces, which are indicated as effective measures for PU prevention[6,31]. This would offer opportunities to research the use of these devices in relation to time between turnings. Additionally, research with a large sample size is also needed to confirm micro-vascular response with different levels of SCI as Zengyong *et al.*[15] presented data based upon the small sample of six participants.

The results of Zengyong *et al.*'s[15] study provide evidence that micro-vascular dysfunction can cause deep-tissue injury to develop faster than superficial skin injury[32] and highlights major risk factors for PU developments. For this reason, the use of ultrasound for early detection is promising[16,17]. However, further research in identifying early deep-tissue damage is needed to determine how to prevent further damage when deep-tissue injury is detected. Quintavalle[33] states that in practice diagnostic ultrasound is successfully used by health professionals because it is safe, non-invasive and a relatively cost-effective technique. However, McKiernan *et*

al.[34] argue that the potential user must have good knowledge of the ultrasound mechanics, good hand-eye coordination, a thorough understanding of anatomy and constant practice to be able to successfully perform this test. Therefore, a major barrier for incorporating this diagnostic tool into practice appears to be the availability of equipment as well as the time and availability for staff to attend training[35].

An equally important factor for deep-tissue health in individuals with SCI is prevention. The clinical practice guideline for the management of skin in individuals with SCI[6] and current studies agree that protection commences with daily skin checks, palpitation[16] and regular pressure redistribution[21]. Meanwhile Karatas *et al.*[18] argue that pressure redistribution can be difficult to achieve by an individual with SCI due to their impaired sitting stability. It is important to recognise that the study could not demonstrate a difference between PU development according to level of injury due to the small study sample and further research is required. Alternatively the literature demonstrated various solutions to resolve the issue of impaired sitting stability. Makhsous *et al.*[21], Karatas *et al.*[18] and Linrer-Ganz *et al.*[20] recommend that for full assessment of deep-tissue health and prescription of pressure relief equipment interface pressure measurement should be used in combination with measurement of tissue perfusion and skin temperature. In clinical practice the most common approach of prescribing pressure relief equipment is the use of pressure mapping, which can only measure interface pressure[18].

The literature that focuses on lifestyle factors in PU prevention following SCI has identified a number of demographic, behavioural and medical factors that provide important information regarding the issue of PU development. The results emphasised that only complete injuries and the length of time since injury were consistently associated with PU development. Of concern in these studies was that the majority of the data was based on a retrospective review of the medical record and self-reporting questionnaires, which may have skewed the results as participants may have reported subjective information.

Use of qualitative research studies[27-29] complemented this literature review as it provided in-depth information regarding the challenges individuals with SCI face with self-care. It must be noted, that as the qualitative studies included a sample of adults with SCI with high-risk potential for PU development, the results may not be applicable to the general SCI population. However, the studies are most useful in providing valuable information regarding individuals

with SCI categorised as high risk for the development of PU development.

From these studies, it is possible to recognise that multiple barriers exist, although there is also evidence that targeted education can be beneficial in decreasing incidences of PU. It is proven that education is an important part of the individuals with SCI programme[11]. However, most of the educational programmes for prevention of PUs are designed for initial hospital and rehabilitation stay, when the individual and family are still adjusting to the diagnosis of SCI and may not understand and absorb educational needs for living at home[36]. Out-patient education programmes that reinforce self-care needs are unfortunately lacking. Therefore, education needs should be focused on the individuals' responsibility for PU prevention after their discharge from a health care facility[36]. Rintala *et al.*[30] emphasise that employment of an educator who can follow up on educational needs post-discharge is a cost-effective measure. The authors demonstrated that the prevention of two surgical cases for PU management in one year would cover the salary of one educator. The authors also suggest utilising web-based learning as an alternative method for providing education. This mode offers individuals with SCI the flexibility of learning at their own pace on a medium that is accessible at any time.

The need for self-care assessment, in conjunction with follow-up by professional support, has been highlighted in the literature review. This support needs to evaluate care beliefs and routines and attempts to challenge the individuals' misconceptions and scepticism about care[27]. Such approaches provide individuals with SCI opportunities to express concerns about different aspects of life and discuss the balancing of life priorities with the challenges of care, in addition to receiving health and wellness support[28,30]. The clinician providing the individualised education and support should have clinical expertise in PU and SCI management, regardless of whether the individual is an in-patient or an out-patient[23].

Limitation of the study

This review included only studies written in English and the search has been conducted only using an electronic database. Studies have been assessed by one assessor, which can influence assessment. However, assessment has followed guideline recommendations.

Conclusion

The study results presented in this review corroborated existing literature and evidence-based documents, in that PUs are a significant morbidity problem for the individuals with SCI. This literature review identified many risk factors observed from acute to chronic stage of SCI, biomechanics of sitting and lifestyle risk factors. This literature also provided many clinically effective suggestions on how to reduce the risk factors such as selecting appropriate equipment and appropriate counselling/educational approaches as well as providing challenges for further research, which were expressed in the discussion.

Health care clinicians, in particular nurses who work with individuals with SCI, need to be aware of these risk factors and the potential solutions for prevention of PUs. Consideration of equipment, individualised education programmes and ongoing support will reduce problems with the development of PU, hospitalisation and generally improve the life perspectives of this population group. The results of this review may justify changing the management of PU prevention in the population with SCI.

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