Applied Nursing Research 27 (2014) 47–52

Contents lists available at ScienceDirect

Applied Nursing Research

journal homepage: www.elsevier.com/locate/apnr

Application of the sheepskin mattress in clinical care for pressure relieving: a quantitative experimental evaluation

Jin Zhou, PhD, Bo Xu, BE, Qiuyue Tang, ME, Wuyong Chen *

National Engineering Laboratory for Clean Technology of Leather Manufacture, Sichuan University, Chengdu 610065, P. R. China

ARTICLE INFO

Article history:
Received 29 August 2012
Revised 8 July 2013
Accepted 28 October 2013

Keywords:
Contact pressure
Sheepskin mattress
Ulcer prevention
Pressure ulceration
Constant low pressure system

ABSTRACT

This study aimed at quantitatively evaluating the effectiveness of sheepskin mattress (SSM) in pressure relieving, and then variables of peak pressure (mmHg) (PP), average pressure (AP) and contact area (cm^2) (CA) at the total, back, sacrum and heel regions of 18 students supinely lying in a control mattress (CM), standard hospital mattress (SHM), SHM + SSM, SSM + CM and AM + CM were measured and contrasted. Paired-*T* test with a significant level of .05 shows that: the intervention of SSM significantly increased the total CA of SHM by 395.6 cm^2 and lowered its PP and AP by 8.8 and 2.0 mmHg respectively; further, the pressure distribution of SSM + CM was superior to that of AM + CM. The reliability of this study, with exception of the heel area, was proven to be good. Overall, the sheepskin mattress is an effective product in pressure reliving.

1. Introduction

High peak pressure is commonly deemed as a direct factor leading to the ulceration (De Simon, La Penna, Napoletano, & Uccioli, 2002; Klaesner, Hastings, Zou, Lewis, & Mueller, 2002; Nijs et al., 2009). According to a clinical report from the US, the incidence of pressure ulceration among the long-term hospitalized patients ranged 10 to 18% (Clark, Bours, & Defloor, 2002; Cuddigan, Berlowitz, & Ayello, 2001). The long time loading and the high pressure (Cherry & Ryan, 1997; Defloor, 2000) are two prerequisites for the development of pressure ulceration. Particularly, contact pressure between the skin and the mattress determines the capillary circulation. When the pressure is larger than 10 kPa, based on the observation from Color Doppler Flow Image, the capillary circulation is closed (Rithalia & Gonsalkorale, 1998). Hence, the critical purpose of nursing is to both lower the magnitude of applied pressure and ameliorate the blood supply at the pressed location.

Not only the length of stay in hospital is prolonged by the ulceration, but also the amount of expenses for the medical treatment is significantly augmented. A survey from the UK reported that the total cost in the ulcer treatment has been estimated as 1.4 to 2.1 billion pounds annually (Bennett et al., 1998). Besides, the occurrence of ulcer was also significantly correlated with the amputation, immobility and even with the shortened life span (De Simon et al., 2002; Klaesner et al., 2002; Nijs et al., 2009). Therefore, the problem of ulceration should be considered seriously and the prevention strategies should be designed as early as possible. Comparing with the active treatment, advance interventions in the nursing stage appear to be crucial. Fortunately, current literatures concluded a series of constant low pressure (CLP) system and they were mainly classified into two groups (McInnes, Jammali-Blasi, Bell-Syer, Dumville, & Cullum, 2011): one was the low-tech CLP, for instance, the sheep skin and air mattress; another one was the high-tech CLP, for example, alternative pressure air mattress (APAM). The low-tech CLP was aimed to reduce the magnitude of pressure by way of directly increasing the contact area; while the APAM was composed of large air units and it adjusted the contact area by inflation or deflation of these units; additionally, purposely inflating or deflating shifted the centre of pressure and avoided the long time loading on the same place. Although the APAM succeeds in both improving the pressure distribution and shifting the loading periodically, according to current clinical studies, it was not significantly superior to the low-tech CLP products in ulcer prevention and the cost of the APAM was several times higher than that of the low-tech CLP (McInnes et al., 2011).

Among low-tech CLP products, both sheepskin mattress (SSM) and air mattress (AM) have been commonly used in the clinical practice and these approaches have been approved to be effective in ulcer prevention (Jolley et al., 2004; McGowan, Montgomery, Jolley, & Wright, 2000; McInnes et al., 2011). McGowan et al. first reported the intervention of the SSM in clinical care. They recruited 297 post-operated patients and during their nursing period the sheepskin mat was prescribed. Their results indicated that the mattress significantly lowered the incidence of ulceration [RR = 0.30, 95% confident interval (CI): 0.17 to 0.52]. Further, the outcomes of Jolley et al. showed that the incidence of ulceration of their 539 in-hospitalized patients decreased from 9.0% (20/223) to 5.5% (12/218) (RR = 0.58, 95% CI: 0.35 to 0.96) with the help of SSM. Therefore the SSM was

* Corresponding author. Fax: +86 28 85405237.
E-mail address: wuyong.chen@163.com (W. Chen).

0897-1897/$ – see front matter.
http://dx.doi.org/10.1016/j.apnr.2013.10.008

manifested to be effective in ulcer prevention for the long-term hospitalized patients. However, until now neither the quantitative assessment of the sheepskin mattress in pressure relief, nor comparisons between the sheep skin and other low-tech CLP systems have been made.

Furthermore, questions concerning on the SSM were proposed: what the mechanism and how the effectiveness of SSM in pressure relieving were, did the SSM performed superior to other CLP products, did the results of pressure reliving was reliable and repeatable. Therefore, the aim of this study was first to quantitatively evaluate the effectiveness of the SSM in pressure relief by the way of comparing the contact pressure with and without the usage of the SSM upon a standard hospital mattress; and then to compare the distinctions between the SSM and AM; finally reliability of this study was analyzed. Since the positive and consistent outcomes of the SSM in ulcer prevention have been reported, two hypotheses were proposed: the first one was that SSM would significantly ameliorate the pressure distribution in each contacting area, reduce its magnitude and provide a much larger area to support; the second one was that results of the study would be reliable and repeatable.

2. Methods

2.1. Study design

This study was designed as an experimental one, therefore two criteria were followed: the first one was that two types of the control group [control mattress (CM) and standard hospital mattress (SHM)] and the experimental one (CM + SSM and SHM + SSM) were available and distinctions between the control group and experimental one would be analyzed by the model of paired-*T* test; the second one was that the testing order in each day's measure was randomized for each subject and all the subjects were randomly assigned to one of those mattresses, which were also combined randomly within the four types of basic mattresses.

2.2. Subjects

Since this study was designed as an experimental one and according to the similar studies summarized by Vanderwee, Grypdonck, and Defloor (2008), a strategy of small sample size was opted. Besides, as Hopkins (2000) recommended that the predictive sample size for the test–retest study was approximately equaling to "$8s^2/d^2$", where s is the typical error, while d is the change in the mean. In this study, we followed the examples of Hopkins (2000) and the s was considered as 1.5 times higher than d in order to achieve a reasonable typical error with the minimum sample size, so that the sample size was calculated as 18. Moreover, healthy adult students have been widely enrolled in the experimental studies (Vanderwee et al., 2008) in mattress evaluation.

Therefore, 18 healthy students (11 males and 7 females, leisure clothing, such as T-shirt and slacks were asked before measurement) aged 20 to 27 were recruited from our institution. The body weight and height were first measured and then BMI was calculated. Because overweight or obesity would result a larger contact pressure, according to the survey of the overweight Chinese adult (Ministry of Health, P.R. China, 2004), those students with a BMI larger than 24.5 were excluded; moreover, those students who reported with back pain would also not be further considered. Each type of mattress was tested by all the 18 subjects. Before the measurement, aims and procedures of this study were first orally explained to the subject who conformed to our inclusion criterion; and then if they were willing to continue, a written agreement was provided. This agreement not only narrates the background, aims, methods and risks of the study, but also includes the benefits and privacy protection of participating. If they agree with the content, they will sign this agreement with their name and hand them in before the first day's measurement. All procedures of this study were supervised by ethic committees of the University and followed the principles of the Declaration of Helsinki.

2.3. Mattress

Four mattresses were provided: an SSM (60 × 90 × 5 cm, own-fabricated, Chengdu, China) which was tanned under the guidelines of Australian Medical Sheepskin (Australian Standards: As4480.1) and the mean diameter of hair is 22.5 μm, mean length is 26.3 mm and density is 3095/cm^2; a SHM (180 × 90 × 6 cm, HuaZhiJie Ltd., Chengdu, China) which was composed of the foam and coir mat with thickness of 3 cm; an AM (180 × 90 × 6 cm, HuaZhiJie Ltd., Chengdu, China) which was constructed by air strips with 10 cm interval; a CM (180 × 90 × 3 cm, HuaZhiJie Ltd., Chengdu, China) which is made of 3 cm coir mat. Five mattress types were available for measure: SSM + SHM, SSM + CM, AM + CM, SHM and CM.

2.4. Pressure measurement

The mFLEX pressure measuring system (mFLEX: 32 × 32, Rsscan international, Belgium) was utilized to gain the contact pressure between the body and the mattress surface. The size of this system is 2100 mm × 890 mm × 4 mm, the area of pressure sensors is 1920 mm × 762 mm, the number of sensor is 1024, the range of measure is 0–100 mmHg (0–13 kPa) and the frequency is 5 Hz. Calibration was made before measurement.

Anatomically, the protrusions of bone, such as scapula at back, sacrum of buttock and foot calcaneus, construct a plane to support the whole body weight (Buckle & Fernandes, 1998), at which relative higher contact pressures are usually observed. Although these places are more risky to develop ulcers, the majority of the body mass is concentrated at the middle of the body in supine posture and the highest incidence of ulceration was found at the sacrum area (Daideri et al., 2006; S. V. Rithalia & Gonsalkorale, 2000). Meanwhile, suggested by Allen, Ryan, and Murray (1993), in supine posture, pressure distribution of six sub-areas were proposed to be studied: occipital, back, sacrum, buttock, heel and elbow. However, since the occipital and elbow were rarely observed with ulceration, these two positions were excluded; further, as the sacrum and buttock were too near to differentiate, they were combined as the sacrum area. Therefore, four-mask model was available (Fig. 1): total, back, sacrum and heel area. Pressure variables of the peak pressure (PP) (mmHg), average pressure (AP) (mmHg) and contact area (CA) (cm^2) were gained for each region by the software of mFLEX (V4.0, Rsscan international, Belgium). Only one experienced observer was assigned to complete all the analysis to eliminate the inter-observer's error.

Participants were asked to wear their own leisure clothing, such as T-shirt and slacks; further a procedure of 3 to 5 minutes of warm up was provided and made sure that each subject could adjust his or her own supine posture to be a natural and comfort one. When the subjects lay in the bed in supine posture (Fig. 2) without moving further and their plantar pressure becoming stable, the mFLEX system was switched on randomly by the researcher and then 10 second data were recorded, within which 50 frames (10 s × 5 Hz) of pressure distribution patterns have been saved. Thereby, the subject is not aware of the whole measuring process and only one trial was required for each measurement. The overall time cost for one trial was estimated as no more than 6 minutes, especially 10 seconds of recording could ensure that the subject keeps his or her comfortable posture stilly. The same procedure was repeated in other two successive days in order to explore the inter-session reliability and repeatability of the measurement.