Intensive & Critical Care Nursing xxx (2018) xxx–xxx

Contents lists available at ScienceDirect

Intensive & Critical Care Nursing

journal homepage: www.elsevier.com/iccn

Research article

Therapeutic hypothermia and pressure ulcer risk in critically ill intensive care patients: A retrospective study

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ARTICLE INFO

Article history:
Accepted 26 February 2018
Available online xxxx

Keywords:
Hypothermia
Intensive care
Jackson/Cubbin risk scale
Pressure ulcer

ABSTRACT

Objective: To examine the role of therapeutic hypothermia in pressure ulcer development in critically ill patients.

Research methodology: Retrospective study in a mixed intensive care unit over 2010–2013. The incidences of pressure ulcers among patients treated with therapeutic hypothermia (n = 148) and the non-hypothermia patient population (n = 6197) were compared.

Results: Patients treated with hypothermia developed more pressure ulcers (25.0%) than the non-hypothermia group 6.3% ($p < 0.001$). More patients in the hypothermia group were rated as the high pressure ulcer risk group, as defined by the modified Jackson/Cubbin (mJ/C) risk score ≤29 than the rest of the patients. Among the therapeutic hypothermia patients more pressure ulcers tended to emerge in the lower risk group (mJ/C score ≥30) ($p = 0.056$). Intensive care mortality was higher in the hypothermia (24.3%) than the non-hypothermia group (9.3%, $p < 0.0001$).

Conclusion: Patients treated with therapeutic hypothermia should be considered at high risk for pressure ulcer development and should be managed accordingly. The hypothermia may not as such increase the risk for pressure ulcers, but combined with the severity of the underlying illness, may be more likely. The pressure ulcer risk in this patient group cannot be reliably assessed by the Jackson/Cubbin risk scale.

Implications for Clinical Practice

- Patients treated with therapeutic hypothermia are at high risk for pressure ulcer development.
- The pressure ulcer risk in hypothermia patient group cannot be reliably assessed by the Jackson/Cubbin risk scale.
- Endovascular and extravascular cooling systems are used for the post cardiac-arrest and neurologically injured patients, respectively to achieve the target temperatures.
- The severity of the patients' health status might increase the risk for pressure ulcers more than hypothermia itself.
- Hypothermia lowers the oxygen need in tissues.
- Hypothermia treatment causes limitations in repositioning protocol.

Introduction

Critically ill patients are at significant risk for pressure ulcers (PUs) and prevalence has varied from 10 to 50% depending on the intensive care patient populations studied (Takala et al., 1996; Nijs et al., 2009; VanGilder et al., 2009; Tayyib et al., 2013; Bly et al., 2016). PUs result in major morbidity and suffering to the patient and a significant economic burden to society (NPUAP, EPUAP & PPPIA, 2014). These patients are also predisposed to significant deviations in body temperature, i.e., both hypothermia and fever due to the illness and to treatment interventions (Faulds and Meeking, 2013). Marked fluctuations in body temper-

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https://doi.org/10.1016/j.iccn.2018.02.008
0964-3397/

ature may contribute to the development of PUs (NPUAP, EPUAP & PPPIA, 2014).

Thermal control has an impact on PU development but the pathophysiology behind the phenomena is highly complex. In addition to reflex control of skin perfusion by sympathetic vasodilator and vasoconstrictor systems, the local temperature of an area of skin also contributes importantly to the control of skin blood flow at that site (Charkoudian, 2003). It has been shown previously that local temperature influences capillary flow and tissue oxygenation and can be modified by the support surface used (Soppi et al., 2015). Recent systematic reviews by Coleman et al. (2013) and NPUAP, EPUAP & PPPIA (2014) identified eight trials that included body temperature in a multivariate analysis. Out of these, three reported an independent association between elevated body temperature and PU development, one reported an association without direction, three reported body temperature as no risk factor and one (Nijs et al., 2009) reported elevated body temperature as being protective. Previous data have also indicated that decreasing the body temperature during surgery may be a risk factor (Fred et al., 2012), while intraoperative warming may protect from PU development (Scott et al., 2001). Currently there are two risk scales that identify hypothermia (Jackson, 1999) as well as fever (Soppi et al., 2014) as risk factors for PUs. The impact of increased temperature in PU development remains controversial, since metabolism and oxygen consumption change by 10–13%, when the body temperature changes one degree Celsius (Landsberg et al., 2009; Lakshmanan et al., 2013; Soppi et al., 2014).

Hypothermia causes vasoconstriction and stiffening of tissues. This, in turn, causes superficial tissue breakdown and deep tissue strain and increases the risk for PUs (Muraoka et al., 2008). In recent years, controlled hypothermia has been used in the treatment of cardiac arrest patients after successful resuscitation, and for managing high intracranial pressure of patients who have sustained a traumatic brain injury. However, the role of hypothermia with regard to the development of PUs is not known and anecdotal at best (Sagalyn et al., 2009; Lakshmanan et al., 2013).

The purpose of this study was to investigate the role of therapeutic hypothermia in the development of PUs. The records of adult patients in a mixed ICU over four years were retrospectively examined and 148 patients treated with therapeutic hypothermia were compared with the total ICU population.

Methods

Patients

Patient data were retrospectively retrieved from the intensive care unit clinical database (Clinisoft, GE Healthcare, Buckinghamshire, UK). The mode of hypothermia treatment, data on PUs and other clinical data such as mattress use were retrieved from the same database.

The Turku University Hospital (Turku, Finland) serves a population of 700,000. The adult ICU has 24 beds and is staffed by about 180 nurses. The PU risk of patients is assessed using a modified Jackson/Cubbin risk scale (Jackson, 1999; Ahtiala et al., 2014, 2016). The risk assessment is carried out at ICU admission, repeated daily and documented in the data base. The highest possible score is 48, the lowest 9, and the lower the score, the higher the risk for PU. If the patient scores $\leq$29 points (Jackson, 1999; Ahtiala et al., 2014) the PU risk is high or extremely high. The Sequential Organ Failure Assessment (SOFA) score (Vincent et al., 1996) was also recorded at admission and thereafter daily. The SOFA includes six subcategories; bilirubin concentration, platelet count, renal function, Glasgow coma score, hypotension, respiratory disorder. The SOFA scores can range from zero to 24. The higher the score, more severely ill are the patients. Patient care to prevent PU followed general guidelines (NPUAP & EPUAP, 2009) taking into consideration the patients' conditions. Patient outcome was classified as a) recovering, transferred from the intensive care unit, b) Transferred from the intensive care unit so that patients' outcome could not reliably be determined i.e. transferred interim or c) deceased or transferred without response to ICU treatment. The total number of patients admitted was 6582 (Fig. 1), with mean age 60.7 years and 63.9% of them were males.

Targeted temperature management

Active cooling of resuscitated patients was initiated when they arrived to the ICU (Arola et al., 2013). The patients were cooled with an invasive endovascular temperature management device (Alsius CoolGard® 3000, Zoll Medical Corporation, Chelmsford, MA, USA) with a target temperature of 33 °C for 24 h. The endovascular catheter is inserted via the femoral vein and temperature-controlled saline circulates within a balloon in a closed loop; the saline never comes in contact with the patient. Cooling of the blood takes place by contact with the balloon membrane (Microtherm™, Zoll Medical Corporation). The Alsius system can cool at a rate between 0.5 and 1.5 °C per hour, depending on the endovascular catheter used. The patient's core temperature was measured with probes placed in the oesophagus and in the urinary bladder.

Usually, the target core temperature was achieved within three hours after ICU admittance. The target core temperature was maintained for 24 hours. Thereafter, 0.5 °C/hour rewarming of the patients was initiated until the normal body temperature was reached.

The body temperature of non-cardiac arrest patients, mainly neurosurgical and neurological patients, was controlled by the Allon external cooling system (MTRE Advanced Technologies, PA, USA) which consists of an algorithm-driven pump that supplies cold water to the ThermoWrap™ garment worn by the patient (MTRE Advanced Technologies). The period of controlled temperature varied and the target temperature was adjusted individually to 34–35 °C.

Statistical data analysis

Age, SOFA scores, mJ/C scores and PU positive and negative patients were regarded as discrete values. The normality of their distribution was not tested and suitable nonparametric statistical analyses were used as defined in the text where the statistical analyses have been presented. Statistical analyses were performed with SAS® version 9.4 (SAS Institute Inc., USA) and reviewed by a statistician.

Ethical approval

The study plan was approved by the Ethics Committee of Hospital District of Southwest Finland (T25/2011, 14.06.2011, §172).

Results

There was an overall total of 6582 patients treated in a large mixed intensive care unit between 2010 and 2013 (Fig. 1). Of the patients 201 with PUs present-on-admission were excluded from the analysis. Out of the remaining patients there was an overall PU incidence of 7.3% (464/6381). Of the 464, there were 36 patients who had medical device related nasal PUs and these were also excluded from the overall analysis: 428/6345 (6.7%) (Table 1). This cohort was divided into a cooled group sample of 148 and an

Please cite this article in press as: Ahtiala, M., et al. Therapeutic hypothermia and pressure ulcer risk in critically ill intensive care patients: A retrospective study. Intensive & Critical Care Nursing (2018), https://doi.org/10.1016/j.iccn.2018.02.008