Injury, Int. J. Care Injured 45 (2014) 1942–1945

Contents lists available at ScienceDirect

Injury

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

Is body temperature an independent predictor of mortality in hip fracture patients?

Murtuza Faizi [a], Adam J. Farrier [b], Murali Venkatesan [c], Christopher Thomas [d], Chika Edward Uzoigwe [e,*], Siva Balasubramanian [b], Robert P. Smith [a]

[a] Leicester Royal Infirmary, Leicester, UK
[b] University Hospitals of North Tees, Stockton-On-Tees, UK
[c] Northampton General Hospital, Northampton, UK
[d] University Hospitals of Coventry and Warwickshire, UK
[e] Harcourt Building, 8 Harcourt Crescent, Sheffield, UK

ARTICLE INFO

Article history:
Accepted 27 September 2014

Keywords:
Hip fracture
Admission body temperature
Hypothermia
Pyrexia
Mortality

ABSTRACT

Introduction: Admission body temperature is a critical parameter in all trauma patients. Low admission temperature is strongly associated with adverse outcomes. We have previously shown, in a prospective study that low admission body temperature is common and associated with high mortality in hip fracture patients (Uzoigwe et al., 2014). However, no previous studies have evaluated whether admission temperature is an independent predictor of mortality in hip fracture patients after adjustment for the 7 recognised independent prognostic indicators (Maxwell et al., 2008).

Methods: We retrospectively collated data on all patients presenting to our institution between June 2011 and February 2013 with a hip fracture. This included patients involved in the original prospective study (Uzoigwe et al., 2014). Admission tympanic temperature, measured on initial presentation at triage, was recorded. The prognosticators of age, gender, source of admission, abbreviated mental test score, haemoglobin, co-morbid disease and the presence or absence of malignancy were also recorded. Using multiple logistic regression, adjustment was made for these potentially confounding prognostic indicators of 30-day mortality, to determine if admission low body temperature were independently linked to mortality.

Results: 1066 patients were included. 781 patients, involved in the original prospective study (Uzoigwe et al., 2014), presented in the relevant time frame and were included in the retrospective study. The mean age was 81. There were 273 (26%) men and 793 (74%) women. 407 (38%) had low body temperature (<36.5 °C). Adjustment was made for age, gender, source of admission, abbreviated mental test score, haemoglobin, co-morbid disease and the presence or absence of malignancy. Those with low body temperature had an adjusted odds ratio of 30-day mortality that was 2.1 times that of the euthermic (36.5–37.5 °C).

Conclusions: Low body temperature is strongly and independently associated with 30-day mortality in hip fracture patients.

Introduction

The risk stratification and prognostication of hip fracture patients is germane to safe clinical care. It is important for patient and family counselling, service provision, operative planning and treatment decisions [1,2]. Hu et al. performed a meta-analysis of studies examining prognosticators for hip fracture patients [3], with over 64,000 patients included. There was strong evidence for 12 predictors of mortality: advanced age, male gender, nursing home or facility residence, poor preoperative walking capacity, poor activities of daily living, higher American Society of Anesthesiologists (ASA) grading, poor mental state, multiple comorbidities, dementia or cognitive impairment, diabetes, cancer and cardiac disease. Maxwell et al. developed a scoring system to predict 30-day mortality for hip fracture patients [4]. They used multivariate regression analysis to distill the most potent predictors of mortality from the risk factors identified by previous researchers. They reported the seven most important predictors of

* Corresponding author. Tel.: +44 07527907618; fax: +44 07527907618.
E-mail address: chika@doctors.org.uk (C.E. Uzoigwe).

http://dx.doi.org/10.1016/j.injury.2014.09.024
0020–1383/

30-day mortality were increasing age, male gender, number of co-morbidities (two or more), abbreviated mental test score (AMTS) on admission (six or less), haemoglobin (10 g/dl or less), the presence of malignancy and the source of admission (institutionalisation). We have previously shown that low admission body is common amongst hip fracture patients and is associated with a high mortality [5]. This effect persisted even when taking into account patient age and American Society of Anesthesiologists (ASA) grade. However no previous studies have explored body temperature as a predictor of mortality, independent of the 7 recognised risk factors identified by Maxwell et al. [4]. It is thus unclear if this parameter adds further prognostic information over and above that provided by these 7 predictors of mortality. This is surprising given the fact that body temperature is a fundamental physiological parameter. It is critical for the assessment of the trauma patient in every other context but appears to have been neglected in the hip fracture patient [6].

Normothermia constitutes temperatures of 36.5–37.5 °C [7]. Hypothermia is defined as a core body temperature of less than 35 °C in the non-trauma setting. However, in the context of trauma, low body temperature is associated with such a poor prognosis that hypothermia is defined as a core temperature of less than 36 °C [13,15]. In 1987 Jurkovich et al. reported a 100% mortality for trauma patients with a core temperature of less than 32 °C [8]. Interrogation of the 1.1 million-patient strong US National Trauma Data Bank revealed a 41% mortality rate for patients involved in trauma, presenting with a core temperature less than 32 °C [9]. An equally large study found the adverse effects of low body temperature on mortality persisted even after controlling for the degree of exsanguinations, age, sex, mechanism, injury severity score (ISS), head, chest, and abdominal injuries, Glasgow Coma Scale score, and base deficit [10].

Depending on environmental conditions significant amounts of energy can be expending maintaining euthermia. Celi et al. reported that a drop in ambient temperature from 24 °C to 19 °C resulted in a 6% increase in energy expenditure [11]. Marken et al. reported similar findings [12]. Thermoregulatory control is impaired with senescence possibly to due its inherent energy demands [13]. Trauma also has a deleterious effect on thermoregulation [14]. There is evidence that in trauma the body adopts a more permissive attitude to hypothermia and energy is sequestered by the injury. Hence shivering, for example, is initiated at a lower core temperature in the context of trauma [14]. Low body temperature adversely affects every cellular process on a fundamental enzymatic basis [15]. There is incontrovertible evidence that low body temperature attracts a very poor prognosis in the context of trauma [8,9,14,15].

Hip fracture patients tend to be elderly with compromised homeostatic mechanisms. It is becoming increasingly appreciated that for the elderly patient, with limited physiological reserve, the hip fracture is the physiological equivalent to polytrauma in a young patient [16]. The neck of femur fracture patient may therefore be vulnerable to low body temperatures that do not necessarily constitute hypothermia. We therefore used a value of 36.5 °C to define hypothermia in this population of patients. No previous studies have examined the effect of dysthermia as a prognostic indicator adjusting for the other principle predictors of hip fracture. We therefore sought to determine if low body temperature was an independent prognosticator of 30-day mortality for patients with hip fracture.

Methods

We collected data from all patients presenting to our institution with hip fracture between June 2011 and February 2013. This included patients involved in our prospective study [5]. Poly-trauma patients were excluded (ISS $\geq$ 16) In England, Wales and Northern Ireland, institutions are required to record a number of patient parameters. These must then be submitted to the National Hip Fracture Database. This is mandatory if they are to receive the financial incentives in the form of the Best Practice Tariff, provided by the Department of Health for the care of hip fracture patients [17]. From the National Hip Fracture data we determined all patients presenting to our institution during the relevant time period. From the database, patient age, gender, source of admission, AMTS and 30-day survivorship could be extricated. The presence and quantity of co-morbid disease and cancer was ascertained from the Coding Department. This unit of the institution transcribes patients' admission details and co-morbid status into an alphanumerical code. From this the tariff paid to health care institution is also evaluated. On presentation to emergency services all patients with hip fracture have their tympanic temperature recorded by a trained triage nurse in accordance with the Royal College of Nursing's guidelines. A single model of infra-red thermometer is used (Braun 6021 Thermoscan) and the temperature taken by trained staff. Tympanic thermometers are regularly calibrated by our institution's Medical Physics department. For the purpose of this investigation we noted the first temperature recorded immediately on arrival at triage in the Emergency Department. No record of the ambient outside temperature was noted nor was the length of time from sustaining the hip fracture to presentation in the ED. Although this may have proven interesting, the purpose of this study was to reflect reality and to ascertain risk associated with patients' presentation admission tympanic temperature. Serological investigations are performed, including haemoglobin. Hence we managed to determine the 7 most potent predictors of 30-day mortality as per the work by Maxwell [4], in addition to admission tympanic temperature. This enabled us to evaluate the latter as a predictor of mortality correcting for confounders.

Statistical methods

On univariate analysis continuous variables were compared with the ANOVA. Tukey's post hoc test was used to determine any significant differences. Proportions were compared with the Chi square test. Multivariate regression was performed including the seven predictors of age, gender, comorbidities ($\geq$2), AMTS ($\leq$6), haemoglobin (10 g/dl), source of admission (institutionalised), presence of malignancy. Admission temperature was added to this. This was treated as a trichotomous variable: the euthermic admission temperature of 36.5–37.5 °C, low body temperature with admission tympanic temperature less than 36.5 °C and pyrexial with an admission tympanic temperature of greater than 37.5 °C, which were later excluded. The euthermic range allows for diurnal variation observed. Correction for the 7 potential confounders allows for determination of any association between admission temperature and mortality.

Results

1482 patients presented to our institution in the relevant time period. This included 863 patients were involved in our prospective study [5]. 1066 had a comprehensive dataset of which 781 were also in our prospective study [5]. There were 612 (57.4%) patients in the euthermic cohort (36.5–37.5 °C). 407 (38.2%) had low body temperature (<36.5 °C) and 47 (4.4%) were pyrexial (>37.5 °C). There were 273 (26%) men and 793 (74%) women. The mean age was 81. There was a statistically significant difference between the ages of the cohorts (Table 1). Tukey's post hoc analysis showed that there was no significant difference in the ages