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Effects of fever on haemodynamic parameters in neurosurgical intensive care unit patients

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KEYWORDS
Fever;
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Summary
Objective: To investigate the effects of fever on the haemodynamic parameters (pulse rate, arterial oxygen saturation, systolic blood pressure, diastolic blood pressure and mean arterial blood pressure) of patients in a neurosurgical intensive care unit.
Design: A prospective, repeated-measures study.
Methods: This study was performed in the neurosurgical intensive care unit of a University Hospital in the West of Turkey. The research sample included all patients with at least two occurrences of fever in the postoperative period. Body temperature and haemodynamic parameters of patients were measured on admission, one hour before the onset of fever and during fever (peak temperature).
Results: Increase of body temperature during fever episodes was followed by a significant increase in pulse rate ($p = 0.001$) with significant decreases in systolic blood pressure ($p = 0.002$) and arterial oxygen saturation ($p = 0.001$). Furthermore fever episodes were followed by a non-significant increase in diastolic blood pressure ($p = 0.074$) and a non-significant decrease in mean arterial blood pressure ($p = 0.097$). In this study, a degree celsius (1 °C) increase in body temperature, was associated with a decline of 4.43 mmHg in systolic blood pressure, 0.166 mmHg mean arterial blood pressure and 0.64% arterial oxygen saturation, respectively. It was also associated with an increase of 1.61 mmHg in diastolic arterial blood pressure and 7.46 beats/per minute pulse rate, respectively.
Conclusions: The findings from this research have demonstrated the effects that fever can have on haemodynamic parameters of patients in one neurosurgical intensive care unit. Hence the study highlights the importance for intensive care unit (ICU) nurses to appreciate the

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physiological effects of fever which have the potential to cause complications in febrile patients. Increasing knowledge about the effects of fever on haemodynamic parameters can therefore be of benefit to nurses in terms of quality and efficacy of patient care.

Implications for Clinical Practice

- This study provides data concerning the effect of fever on haemodynamic parameters, relationships between them and, nursing actions related to these changes. Information about accurate and careful measurements of body temperature and haemodynamic parameters play an important role in the prevention of complications during fever among patients in neurosurgical ICU settings.
- Neurosurgical intensive care unit staff, particularly during postoperative care, should be proactive in ensuring that they have a formal, evidence-based management plan for management of fever that conforms to the relevant clinical guidelines and integrates multidisciplinary care.
- An increase in resources for professional development in the assessment and management of fever is essential for improving and maintaining the skills of staff during and after care.

Introduction

Monitoring and evaluating haemodynamic parameters (systolic blood pressure, diastolic blood pressure, mean arterial blood pressure, pulse rate, and arterial oxygen saturation) are essential nursing assessment measures, particularly for patients in intensive care settings (Basoglu et al., 2000; Erdal, 2005; Karadakovan and Eti Aslan, 2012). In addition pulse, body temperature, arterial blood pressure, respiration and pain are basic vital signs and indicators of an individual's health status. Changes in physiological functions are reflected in the values of an individual's basic vital signs, consequently deviations from the normal values can indicate disruption of homeostasis (Akinci, 2003; Celik et al., 2011). Therefore assessing vital signs is an effective method for monitoring health status and is essential for accurate diagnosis and delivery of appropriate nursing interventions (Asgari and Soleymani, 2009; Giuffre et al., 1990; Schutz, 2001).

The diagnostic value of standard monitoring parameters is high when these values are abnormal, as they are considered sensitive indices of the overall health of patients (Dicle and Istan, 2002; Heydari, 2000; Kanan, 2004; Kiekkas et al., 2007). Whilst measuring and monitoring vital signs are basic nursing skills, nurses also need to know how variations in vital signs affect haemodynamic parameters of patients, relationships between these parameters and, appropriate nursing and multi-disciplinary follow-up that might be required (Ahmadi and Mohammadi, 2003; Asgarpour and Yavuz, 2010; Heydari, 2000; Pahsa, 2009).

Fever is an adaptive response to a variety of infectious, inflammatory foreign stimuli. The febrile response confers an immunological advantage to the host over invading microorganisms (Kothari and Karnad, 2005; Laws and Jallo, 2010). Fever results from a cytokine-mediated reaction that results in the generation of acute phase reactants and controlled elevation of body temperature. Fever is defined as an increase in core body temperature $\geq$38.3 °C ($\geq$101 °F) attributed to the upregulation of the thermostatic setpoint, which is controlled by the hypothalamus (Heydari, 2000; Jonathan et al., 2009; Kiekkas et al., 2007; Kothari and Karnad, 2005; Laws and Jallo, 2010; Naomi et al., 2008; Willke et al., 2002).

Fever is present in 29—36% of all hospitalised patients (Celik et al., 2011; Ferguson, 2007), although the incidence of fever ranges between 28% and 75% in critically ill patients (Celik et al., 2011; Henker et al., 2001; Kiekkas et al., 2007). Fever can result from both infectious and non-infectious causes (Ballestas, 2007; Celik et al., 2011; Cunha, 2013; Kiekkas et al., 2007; Laupland, 2009; Ryan and Levy, 2003; Steven et al., 2008) and febrile episodes occur in roughly 50% of patients in the NICU with neurocritical patients having a slightly lower frequency of fever, approximately 23%, 6 than patients in the neurosurgical ICU, approximately 47% (Laws and Jallo, 2010). Fever is more often an indicator of infection, however in ICU patients, pulmonary embolism, gastrointestinal bleeding, drug reactions, cardiac problems, trauma, surgery, and intracranial bleeding are also associated with fever (Axelrod and Diringer, 2008; Celik et al., 2011; Henker et al., 2001; Jonathan et al., 2009).

Fever symptoms among the neurocritical and neurosurgical patient populations predominate with vascular injuries, such as intracerebral haemorrhage and subarachnoid haemorrhage (Laws and Jallo, 2010; Polderman, 2008). According to Laws and Jallo (2010) the highest rates of febrile episodes occur in patients diagnosed with subarachnoid haemorrhage (65%), followed by traumatic brain injury (40%) and then intracranial haemorrhage (31%). Where no cause of fever was identified (in 28% of patients), the authors suggested a fever of central origin.

As the body temperature rises, important physiological changes occur (Henker et al., 2001; Kiekkas et al., 2008). A body temperature increase from 37 °C to 39 °C has been found to be followed by a 25% increase of oxygen consumption and energy expenditure in ICU patients (Kiekkas et al., 2007; Kothari and Karnad, 2005). These increases in the metabolic rate and serum levels of stress hormones are suggested to subsequently increase heart rate