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## Persistent Fever and Nursing Care in Neurosurgical Patients

### Opieka pielęgniarska nad pacjentami neurochirurgicznymi z długotrwałą gorączką

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#### Abstract

Fever negatively affects the recovery of the brain following neurosurgical operation and prolongs the length of stay in the neurosurgery intensive care unit. Accordingly, it is necessary to deliver nursing care as indicated by the evidence regarding the management of fever in neurosurgical patients. The management of body temperature requires teamwork. Each healthcare professional in the team should select appropriate cooling methods, provide an acceptable cooling rate, manage shivering, and monitor the patient closely, with a multidisciplinary perspective. In this context, the present article discusses the causes of fever, its incidence, treatment and care practices for neurosurgical patients and proposes evidence-based recommendations for practice upon the review of the international guidelines. (JNNN 2020;9(2):80–85)

**Key Words:** stroke, subarachnoid hemorrhage, intracerebral hemorrhage, persistent fever, nursing care

#### Streszczenie

Gorączka negatywnie wpływa na regenerację mózgu po operacji neurochirurgicznej i przedłuża pobyt pacjenta na oddziale intensywnej terapii neurochirurgicznej. Z tego powodu konieczne jest zapewnienie opieki pielęgniarskiej zgodnej z zasadami postępowania w przypadku pacjentów neurochirurgicznych z długotrwałą gorączką. Kontrola temperatury ciała pacjenta to praca zespołowa. Każdy pracownik służby zdrowia w tym zespole powinien dobrać odpowiednie dla pacjenta metody chłodzenia ciała, zapewnić odpowiednią szybkość chłodzenia, kontrolować drżenia ciała i uważnie monitorować pacjenta z wielodyscyplinarnej perspektywy. W tym kontekście w artykule omówiono przyczyny gorączki, jej objawy oraz praktyki leczenia i opieki nad pacjentami neurochirurgicznymi, w oparciu o międzynarodowe wytyczne i zalecenia dotyczące praktyki pielęgniarskiej. (PNN 2020;9(2):80–85)

**Słowa kluczowe:** udar mózgu, krwotok podpajęczynówkowy, krwotok śródmózgowy, długotrwała gorączka, opieka pielęgniarska

#### Introduction

Body temperature is defined as the balance between heat production and heat loss. It is vital to maintain the body temperature between 36.1–37.8°C to ensure optimal functionality. Increases in body temperature accelerate chemical reactions, leading to disruption of the existing functionality [1]. Although not unanimously defined, the American Association of Neuroscience Nurses defines fever as body temperature above 38.0°C, regardless of the cause [2]. Persistent fever is defined as

a temperature higher than 38.3°C that lasts for more than five days [3]. It causes more complications than short-term fever and requires longer care and treatment [1,3].

Fever is a common problem in neurosurgical patients with severe neurological damage, such as stroke, trauma, and intracranial bleeding. Particularly, fever, which occurs at a rate of 28–70% in the postoperative period due to various reasons, negatively affects the recovery of the brain following neurological surgery and prolongs the length of stay in the neurosurgery intensive care

unit. Therefore, individualized planning of care and treatment is vital for neurosurgical patients in fever management [4,5].

The present article discusses the causes of fever, its incidence, treatment and care practices for neurosurgical patients and proposes evidence-based recommendations for practice upon the review of the international guidelines.

### **Causes of Fever in Neurosurgical Patients**

Although many different organisms and non-infectious inflammatory responses play a role in the etiology of fever, central fever known as hypothalamus-induced fever can be seen in neurosurgery clinics. Central fever related to loss of the physiological regulation of body temperature by the hypothalamus is often proposed as a possible cause for persistent fever in acute neurological patients with no evidence of infection (6). Neurodegenerative/neurometabolic diseases such as tumor, bleeding, ischemia and infection in the brain stem or hypothalamus can also cause central fever. In addition, non-infectious causes of fever include medication effects, deep venous thrombosis, pulmonary embolism, atelectasis, dehydration, acute myocardial infarction, stroke, central nervous system damage and blood transfusion reactions [6,7]. Infection is another factor that causes fever in neurosurgical patients. Infection-related fever occurs in approximately 50% of this group of patients [6]. Conditions disrupting body integrity such as invasive procedures (central venous catheters, urethral catheter, intraventricular catheter, endotracheal intubation, aspiration), pneumonia, nosocomial meningitis, intra-abdominal sepsis and intrapelvic sepsis may result in infection [5,6,8,9]. On the other hand, non-infectious causes of fever also include hypersensitivity reactions due to medication use such as phenytoin and barbiturates resulting in fever through heat production and idiosyncratic reactions. Again, some anticonvulsant drugs may frequently cause fever [7,10].

70% of neurosurgical patients experience fever although the underlying cause differs. Although fever is commonly reported in intracerebral hemorrhage (ICH), subarachnoid hemorrhage (SAH), or acute ischemic stroke (AIS), incidence rates vary by studies, and the cause of fever is mostly undefined. A major retrospective study in the USA reports fever in 51% of patients with brain injuries. The incidence of fever is 60% for TBI, 54% for aneurysmal SAH, 50% for ICH and 37% for AIS [11]. Schwarz et al. [12] reported fever in 91% of patients with intracerebral hemorrhage within the first 72 hours after hospitalization. The study of Kilpatrick [13] showed that 47% of patients with head trauma experienced a fever attack, reporting a mean

temperature of  $39.6 \pm 0.6$ . A multicenter prospective study of Seguin et al. [14] including 507 patients with head injury identified severe sepsis, infection and mechanical ventilation time as independent risk factors in 87% of the patients.

It is evident that fever is quite common in neurosurgical patients although its causes vary. Fever exacerbates traumatic brain injury, subarachnoid hemorrhage, secondary neurological problems and functional neurological disorders, all of which are life-threatening. In addition, it causes permanent damage to other tissues and organs [15]. In this context, it is necessary to plan nursing care with a multidisciplinary approach including fever prevention, management of treatment and care, and determination of relevant risks. Accordingly, nursing practices are expected to be performed in line with the evidence upon the determination of effective interventions in managing fever [6,16,17].

### **Fever and Nursing Care**

#### *Assessment*

Assessment, which is the first stage of nursing care, is a dynamic process that requires continuity. Nursing care practices cannot be performed without a detailed assessment. Assessment helps to collect information about the individual's past and present health status and living conditions [1].

The nurse monitors and records the presence of shivering or excessive sweating in the patient. The color and moisture of the skin are observed for dehydration. It is vital to monitor and assess the patient's hemodynamic parameters (systolic blood pressure, diastolic blood pressure, mean arterial blood pressure, pulse rate and arterial oxygen saturation) in managing fever as it provides valuable information for assessment in clinics such as neurosurgery intensive care. This is because changes in physiological functions are reflected in the vital signs of the individual, and deviations from normal values may be an indicator of the deterioration of homeostasis [18]. Oxygen and energy consumption increase by 10–25% when the core temperature rises from 37°C to 39°C. The reason for oxygen and energy consumption is associated with the release of cortisol and norepinephrine and related changes in arterial blood pressure, pulse and respiratory rate [19]. These changes include increased pulse rate, decreased systolic blood pressure and arterial oxygen saturation. In neurosurgical patients, every 10°C increase in body temperature causes a decrease in Glasgow Coma Scale score (GCS) through increasing intracranial pressure (ICP) by 3–4 mmHg and also causes secondary injuries by preventing cerebral blood flow. Along with hemodynamic parameters, some

laboratory values (leukocyte, sedimentation rate (CRP), blood culture, etc.) should be taken into account during the assessment phase [5,18].

### *Nursing Diagnosis*

“Hyperthermia” is a nursing diagnosis regarding elevated body temperature included in the list of NANDA-I (North American Nursing Diagnosis Association-International) nursing diagnoses [20]. It is reported that fever may develop within 72 hours in the neurosurgical intensive care unit following brain trauma [21]. Fever of unknown cause is frequently seen in patients with subarachnoid hemorrhage and is closely related to the development of symptomatic vasospasm. Non-infectious fever tends to start early (within 72 hours after subarachnoid hemorrhage) and persists for several days. Persistent fever suggests central/neurogenic fever rather than infection [6].

### **Planning**

Objective/Expected Patient Results: Maintenance of body temperature at 36.1–37.8°C and prevention of fever symptoms.

### **Nursing Interventions in Temperature Management**

#### *Temperature Monitoring*

While the nurses perform routine vital signs monitoring at hourly or earlier intervals in intensive care units, this period may be longer in the clinics. Oral, rectal, axillary, esophageal, bladder or pulmonary thermistors are generally used to measure body temperature in neurological intensive care units. An available study shows that 90% of the nurses primarily prefer oral, 82% rectal and 75% axillary routes while 65% measure body temperature with a urinary thermistor and 41% with a pulmonary thermistor [4]. It is important to measure core temperature for effective diagnosis, treatment and care of fever. It is recommended to measure core temperature continuously, or at a minimum hourly, in patients with ICH, SAH, or AIS [4,11,22]. Despite disagreements on a specific measurement site in awake or coma patients with neurological problems, the esophagus, bladder and rectal routes are recommended for temperature monitoring while the importance of continuous measurement is emphasized by the US Neurocritical Care Society (NCS). However, at a minimum hourly measurement is recommended in cases where continuous measurement is not possible [23].

### *Pharmacological Methods*

The administration of pharmacological methods requires the cooperation of the nurse and physician. However, the nurses have responsibilities regarding the effectiveness and management of treatment in drug applications. In addition, observing the effects of treatment on the patient is as important as the administration of drugs. The nurse plays a key role in the treatment and follow-up of neurocritical patients. In this context, this section presents information on the effect of pharmacological methods on reducing fever.

Targeted therapy should be continued in neurological patients given that fever does not exceed 37.5 and above and there are no signs and symptoms of infection. Prophylactic treatment should be started as soon as possible to regulate body temperature in the event of an upward trend [11]. Body temperature may not be constant even in healthy individuals.  $\pm 0.5^{\circ}\text{C}$  deviations may occur at certain times of the day or under some conditions. Although fever is a widely used term, it does not have a universally accepted definition and is often used interchangeably with the terms pyrexia or hyperthermia. There is no clear temperature threshold value for fever in the literature. However, the value of 38.3°C and above is considered fever by most [24]. Although there is no definition of fever specific for neurosurgical patients, urgent treatment is recommended when fever rises above 38°C, regardless of the cause [25]. A targeted treatment plan should be initiated in the event of failure to manage fever pharmacologically within an hour. Although the effect of antipyretic agents, such as paracetamol, is limited in fever management in patients with ICH, SAH or AIS, it is considered the gold standard in managing fever [26]. However, other alternative methods should be started if no improvement is observed within 1 hour. Paracetamol is widely used to treat fever and pain in intensive care patients. However, standard paracetamol administered at a low dose (4 g/1 day) is stated to be ineffective in fever management in patients with brain damage (27). It has been shown to reduce fever significantly in patients receiving higher doses (6 g/1 day) [27–29]. Some studies report the effectiveness of paracetamol in stroke patients [30–32]. It is stated that ibuprofen, which is an alternative antipyretic agent, does not exhibit higher efficacy than paracetamol and may be associated with the risk of bleeding [28,33]. Some studies show that low dose DCF infusion is more useful for a successful control temperature better than intermittent NSAIDs dosing [34]. In addition, the use of cooling fans accompanying paracetamol treatment is stated to be a good choice [23].

### *Non-pharmacological Methods*

The application of non-pharmacological methods requires great attention from healthcare team members. It requires close monitoring of the patient in terms of various complications. Two main non-pharmacological cooling methods are used in neurocritical patients. The first is superficial cooling, and the second is endovascular cooling. Superficial cooling methods include air-circulating blankets, water-circulating blankets and hydrogel-coated water-circulating pads. Endovascular cooling systems include intravenous (IV) heat exchange catheters. The Neurocritical Care Society (NCS) guidelines recommend the use of intravascular catheters or gel pads if endovascular catheters fall short to maintain and preserve body temperature. The use of air-cooling blankets, cooling fans, cooling packs, temperature modulation devices for intranasal or intravascular surfaces, and/or cold saline infusions are among the effective methods to achieve target body temperature more quickly. The use of passive air cooling and/or ice packs and surface cooling devices is recommended to increase the likelihood of achieving target temperature in newborns with hypoxic-ischemic encephalopathy [23]. In their study, Hoedemaekers et al. [35] compared non-pharmacological cooling methods and reported that water-circulating cooling blankets, gel pads and intravascular tools were more effective than traditional cooling and air-circulating cooling blankets while emphasizing the intravascular system as the most reliable method to maintain a stable temperature. Surface cooling or intravenous methods are stated to be effective when the use of antipyretics fails to manage fever [36].

### *Shivering Management*

Shivering is the thermoregulatory response of the body to temperature changes. Attempts to cool down the patient should not be done fast enough to cause the patient to shiver [37]. This increases the oxygen, energy consumption and carbon dioxide production of the metabolism. It is very difficult to detect shivering in neurosurgical patients. Currently, no continuous monitoring device exists to detect and/or measure shivering or micro-shivering. There are conceptual studies conducted on this subject. These studies recommend the use of the Bedside Shivering Assessment Scale (BSAS) in shiver monitoring. At the same time, this scale is stated to be the most reliable measurement tool. The study of Sund-Levander et al. [38] revealed a relationship between toe temperature gradients and shivering with rising tympanic temperature. On the other hand, the study of Earp et al. [39] where they investigated the rate of pulmonary and bladder catheter use to detect shivering

in cardiac surgery patients reported low shivering level according to the temperature measurement in the two regions, which was attributed to the temperature difference in the bladder and pulmonary artery. Shivering should be defined and measured by identifying a common measurement tool and language to be included in patient care safely and effectively. Despite the subjective limitations of BSAS, research with a high level of evidence that provide a common language and investigate the effectiveness of pharmacological and nonpharmacological interventions in preventing shivering are needed [40].

### *Evaluation*

Effective nursing practices are planned and implemented in line with the determined target. For example, a nurse trying to provide for normo-therapy can monitor the effectiveness of multidisciplinary applications, continuous measurement of fever, shivering, and management of complications. Functional loss may be prevented by carrying out individual evaluations [1].

### **Implications for Nursing Practice**

The nurse responsible for monitoring the patient's vital signs delivers nursing care in the light of the current information in the treatment and care of the patient. In this context, current evidence of fever reduction in neurosurgical patients still lacks sufficient information, but the guidelines propose effective recommendations for implementation. In the light of these data, healthcare team members are advised to choose appropriate cooling methods with a multidisciplinary perspective, provide an acceptable cooling rate, manage shivering and monitor the individual closely.

### **Conclusions**

Persistent fever is an important problem in all patients with neurological problems, the solution of which requires a multidisciplinary approach. In this approach, temperature monitoring in all pharmacological or non-pharmacological interventions is vital in terms of preventing complications.

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