



## The Relationship Between Fever and Haemodynamic Parameters in Surgical Febrile Patients: A Review

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### Abstract

**Aims:** Fever is a common event occurring in 14%–91% of postoperative patients. Most cases of fever immediately following surgery are self-limiting. For greater temperature increases, evaluation of postoperative fever can entail a lengthy differential diagnosis that must be narrowed by the interpretation of available data. The aim of this study was to evaluate factors related on fever and relationship between fever and haemodynamic parameters in surgical postoperative patients.

**Methodology:** The review covers the databases and articles published between 2005-2016 via Medline and Scientific Information database. Litarature searches were performed to identify all the researches on fever and haemodynamic parameters.

**Results:** Clinical trials showed that during fever important physiological changes such as decrease in systolic arterial blood pressure and arterial oxygen saturation and increase in pulse rate occur.

**Conclusion:** According to the published articles, it is important to appreciate the physiological effects of fever. Knowledge about the effects of fever on haemodynamic parameters can be of a benefit to clinicians in terms of quality and efficiency care in postoperative febrile patients.

**Keywords:** fever, haemodynamic parameters, surgery

## **Introduction**

Core body temperature (CBT) is a part of vital signs. Changes in physiological functions are reflected in the values of an individual's basic vital signs. Therefore, deviations from the normal values of vital signs indicate the disruption of homeostasis (Asgar Pour & Yavuz, 2014; Shiri & Nicravan, 2005).

Fever is defined as an increase in the CBT  $\geq 38.3$  °C attributed to the upregulation of the thermostatic setpoint, which is controlled by the hypothalamus (Kevin et al., 2008 Rainer, 2003). Fever is present in 29–36% of all hospitalized patients. The incidence of fever ranges between 28% and 75% in critically ill patients (Fernandez et al., 2007; Henker et al., 2001). Fever following surgery is a common event occurring in 14%–91% of postoperative patients. Most fevers that develop within the first 48 hours after surgery are benign (Asgar Pour & Yavuz, 2014; Pile, 2006). Fever can occur immediately after surgery and seen to be related directly to the operation or may occur sometime after the surgery as a result of complication related to surgery (Asgar Pour, 2012). Surgical trauma is responsible for more than 70% of early postoperative fever episodes (Lorente et al., 2007; Ryan & Levy 2003). Postoperative fever can be an inflammatory response the body against operation or symptom of serious infections (Asgarpour 2016; Kiekkas et al., 2007). Most cases of fever immediately following surgery are self-limiting. For greater temperature increases, evaluation of postoperative fever can entail a lengthy differential diagnosis that must be narrowed by the interpretation of available data (Baid et al., 2014; Burke, 2010; Dindo et al., 2004). So, during fever it is

important to recognize when a wait and see approach is appropriate, when further work-up is needed and when immediate action is indicated (Mermel et al., 2009; Ryan & Levy 2003).

It is important to appreciate the physiological effects of fever, which can cause complications in their patients. Clinicians need to know how variations in vital signs affect haemodynamic parameters and the relationship between them. Accurately assessing vital signs plays an important role in patients diagnosis, the delivery of accurate and appropriate interventions in clinics and preventing complications before, during and after interventions related to the fever. Therefore, we decided to review investigations which were conducted about factors related on postoperative period and relationship between fever and haemodynamic parameters. This review covers the databases and articles published between 2005-2016 via Medline and Scientific Information database.

### **Factors Related on Postoperative Fever**

The timing of fever after surgery is one of the most important factors to consider in generating a prioritized differential diagnosis of postoperative fever. The potential causes of fever in the immediately postoperative period are mainly limited to medications or blood products in preoperative or intraoperative period and rarely malignant hyperthermia. Fever related on trauma of surgery usually resolves within two to three days after surgery. The severity and duration of these self-limited postoperative fevers depends on the type of surgery, but tends to be greater in patients with longer and more extensive surgical procedures (Lesperance et al., 2011).

During the first few hours after surgery a drop in body temperature depend on a continuation of intraoperative hypothermia caused by interference with the hypothalamic thermoregulatory mechanism by general anesthesia. Therefore, shivering observed as the body attempts to regain control of set point related on hypothermia (Asgar Pour & Yavuz, 2010; Sikora & Embil, 2004). Early postoperative fevers (< 24 h) are usually related on the inflammatory response to surgery and are not associated with infections (Lesperance et al., 2011; Ryan & Levy, 2003).

According to 5W system (Wind- Water- Wound- Walking & Wound) postoperative fever causes are analyzed in five groups:

**1. Fever related on respiratory system (Wind):** It covers the first 48 hours after surgery. Fever reveals as body's inflammatory response to surgery in the first hours after surgery or the results of atelectasis in the second day after surgery. In assessment of respiratory system, medical and surgical history of patient's shall be assessed and respiratory monitorization and deep breathing exercises should be performed four times an hour. Patients must be in semi-fowler (30-45 °) position and should do breathing exercises with the spirometer 10 times per hours. Patients experience should be evaluated related on pain in preoperative period before surgery and preoperative pain status in terms of cultural values. In case of pain, patients should be reassessed about pain after pain treatment (Emmoth & Mansson 1997; Karadakovan & Aslan 2009; Kiekkas et al., 2008).

**2- Fever related on urinary tract (Water):** It covers 2-3. day of the postoperative period. Urinary tract infections is the most common cause of fever in this period. Patients should be evaluated for urinary tract infection symptoms. Urinary tract catheter should be removed as soon as possible and should ensure patients adequate hydration. Care and treatment methods should be done according to aseptic principles and respond of patients to maintenance should be checked and assessed (Asgar Pour, 2012; Fernandez et al., 2007).

**3- Fever related on surgical insicion (Wound):** It covers 3-5. day of the postoperative period. Surgical site infection is the main reason of fever in this time period. Clostridium and streptococcus are often the cause of necrotic wounds infection. Patients before surgery should be evaluated for underlying infection and other diseases. In addition, the patient's weight, laboratory values and the integrity of the skin of surgery insicion should be considered. Postoperatively insicion wound care should be done carefully and patients should be considered related on infection signs and symptoms (increased of core body temperature, tachycardia, redness and sensitization of incision site, smelly, purulent drainage,...). Change of dressing should be done in accordance with aseptic technique and culture of the incision site should be taken carefully if necessary. Antibiotic therapy should be initiated at the appropriate time and laboratory values should be chechek carefully (Asgar Pour, 2012; Henker et al., 2001, Kiekkas et al., 2008).

**4- Fever related on immobilization (walking):** It covers 5-7. day of the postoperative period. Deep vein thrombosis (DVT) is the main reason of fever in this time period. Patients mobilization should be done as soon as possible in postoperative period. Foot exercises should be done in bed in early period postoperative period. Homans sign should be assessed and lower limbs should be checked for sensitization, redness and pain. Anticoagulant therapy

should be started immediately in patients with high risk of DVT. Patient's with respiratory distress and changes in hemodynamic parameters should be notified immediately. The results of the transaction to prevent of DVT should be considered (Asgar Pour 2012; Emmoth & Mansson 1997; Kiekkas et al., 2008).

**5- Fever related on medicine agents (Wonder):** It covers 7. day after the surgery and medicine agents is the most common cause of fever in this time period. Patients should be evaluated in terms of medicine allergy. Patients given medicines such as vancomycin, penicillin, streptomycin and etc. should be evaluated. Inflammatory response of patients can be determined by changes in vital signs. Patients with the allergic or inflammatory response should be reported immediately (Asgar Pour 2012; Fernandez et al., 2007).

### **Effects of Fever on Haemodynamic Parameters**

During fever increase of oxygen consumption and energy expenditure occurs (Kiekkas et al., 2007). Subsequent increases in oxygen consumption, respiratory quotient and cardiac output add a considerable burden to these patients, who might be unable to compensate for the increased metabolic demand (Asgarpour & Yavuz 2010; Bacher 2005; Steven et al., 2008).

During fever, increases in the metabolic rate and serum levels of cortisol and norepinephrine hormones are thought to subsequently increase the pulse rate and arterial blood pressure. In contrast, fever can result in hypotension due to myocardial depression and vasodilation especially in the veins of the kidneys, liver, skin, and upper and lower limbs (Cooper 1994; Dalal & Zhukovsky, 2006; Pahsa 2003).

In cases of CBT increase, easily separation of oxygen from hemoglobin in cell levels occurs as a compensatory mechanism against increased of metabolism rate as a result of stimulation of the nervous system. In other words, with increasing of oxygen demand in cell levels during increase of CBT easily separated of bunding oxygen on hemoglobin in the cells and decrease of arterial SaO<sub>2</sub> occur (Asgar Pour & Yavuz, 2014; Kiekkas et al., 2007). Furthermore, as a results of increases in metabolic rate and demand-consumption of oxygen during increase of CBT increase in carbon dioxide value occurs. Based on this information, blood gas values are directly affected by increase of CBT (Laws & Jallo, 2010; Yenen & Altunay, 2002). Stimulation of the sympathetic nervous system causing increased resistance of vessels in the skin. Suddenly and rapidly increase of CBT due to tachycardia, tachypnea and acidosis

related on dehydration. In this case, using of energy sources related on increase of oxygen demands metabolic asidosis develops (Asgar Pour, 2012). In the continuing of fever, shivering cause increase in metabolism rate, heart rate, cardiac output and arterial blood pressure occur. During decrease of fever, as results of reduce activity of sympathetic nervous system in the peripheral vascular passive vasodilation occurs. On the other hand, stimulating of the sweat glands also revealed active vasodilation. Increasing capillaries circulation is provided of blood stream from center to distals after vasodilation. Increased perfusion in the skin is an indication of a reduction in vascular resistance. Decrease in mean arterial blood pressure due to increase of cardiac output associated with increase in heart rate (Asgarpour & Yavuz, 2010; Kiekkas et al., 2008; Rowsey & Pamela,2008). In Haupt & Rackow (1983) study to determine the adverse effects of fever on cardiac performance, evidence of decreased left ventricular performance and increased heart rate were observed during the febrile episode. Because all patients maintained a normal or high cardiac index in association with increases in heart rate during the febrile state, the tachycardic response of the febrile patient can serve to maintain cardiac output when myocardial performance is impaired.

In Kiekkas et al.'s (2007) study to determine the relationship between fever and haemodynamic parameters among ICU patients, during fever increase in heartrate, decrease in systolic blood pressure and arterial oxygen saturation were observed. In study results a degree celsius increase in body temperature, 4.7 beats/per minute increase in heartrate, 2.7 mmHg decrease in systolic blood pressure and,0.4% decrease in arterial oxygen saturation were observed.

In Celik et al.'s (2011) study to determine the effects of fever and nursing interventions to lower fever based on haemodynamic values and oxygenation in febrile surgical ICU patients, the patients had tachycardia before, during and after fever. There was a non-statistically significant trend towards increased heart rate with fever. Diastolic blood pressure, mean arterial blood pressure and SpO2 had a statistically non-significant decrease. Systolic blood pressure had a small but statistically significant decrease during and after fever onset. Therefore fever was associated with an increase in heart rate, decreased systolic arterial pressure, mean arterial pressure, oxygen saturation and hourly urine output.

In Asgar Pour & Yavuz (2014) study about effects of fever on haemodynamic parameters in neurosurgical ICU patients, the increase in CBT was caused by decreases in systolic blood pressure, mean arterial pressure and arterial oxygen saturation, and increases in diastolic blood pressure and pulse rate. In Asgar Pour & Yavuz study, a degree celsius increase in CBT,

decreased by 4.43 mm Hg in systolic blood pressure, 0.166 mm Hg mean arterial blood pressure and 0.64% arterial oxygen saturation, and increase of 1.61 mm Hg in diastolic blood pressure and 7.46 beats/ min pulse rate. They stated that increases in heart rate during the febrile state is associated with decreased of mean arterial blood pressure, the tachycardia response indicated failure to maintain effective cardiac output.

## **Conclusion**

Postoperative fever following any surgery, may occur due to infection or non-infectious causes. During fever important physiological changes such as decrease in arterial blood pressure and arterial oxygen saturation and increase in pulse rate occur. It is important to appreciate the physiological effects of fever, which can cause complications in their patients. Knowledge about the effects of fever on haemodynamic parameters will be of a benefit to clinicians in terms of quality and efficiency of care. Thus, accurate and careful measurements of haemodynamic parameters play an important role in preventing complications before, during and after interventions related to the fever in surgical patients.

**Consent:** No patient was involved in this study.

**Ethical Approval:** No human or animal subjects were involved in this study.

**Competing Interests:** Authors declared no competing interests exist.

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