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# The Relationship between Hypothermia Duration and Amount of Bleeding After Open Heart Surgery

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## ABSTRACT

**Aim:** This study was conducted to examine the relationship between hypothermia duration and amount of bleeding after open heart surgery.

**Study Design:** This is a retrospective, descriptive, and correlational study.

**Materials and Methods:** The data were obtained by examining the hospital records of 45 patients who underwent open heart surgery between January 2018 and January 2019 in the cardiovascular surgery clinic of an education and research hospital in Istanbul.

**Results:** The mean age of the patients was 65.30±10.05 years, and 33 (73.3%) of them were women. The mean hypothermia duration of the patients in the postoperative period was 10.35 hours, and the mean amount of bleeding was 600 ml. It was determined that the amount of bleeding increased as the duration of hypothermia increased after open heart surgery ($r=0.302$, $p<0.05$), and there was a statistically significant relationship between the presence of chronic disease and body mass index, and the hypothermia duration and the amount of bleeding.

**Conclusion:** In this study, a significant correlation was found between the postoperative hypothermia duration and the amount of bleeding. Prolonged hypothermia after open heart surgery is an important parameter that may adversely affect the amount of bleeding in patients. For this reason, surgical nurses should be aware that hypothermia causes an increase in the amount of bleeding in the early period after cardiac surgery, and awareness of patients should be increased to protect them from hypothermia.

**Key words:** Bleeding; cardiac surgery; hypothermia; nursing care

## Introduction

Hypothermia is defined as a body temperature below 36°C by the American Society of Perianesthesia Nurses. A body temperature of 34-36°C is classified as mild hypothermia, 32-34°C as moderate hypothermia, and below 32°C as severe hypothermia (1, 2). Although hypothermia undergoing surgical intervention varies according to age, gender, and body surface, patients may face the risk of hypothermia due to cold operating room, opening of body cavities, long-term and major surgical interventions, anesthetic drugs, mechanical ventilation, and fluids used (3-5). This hypothermia, which occurs as a complication after surgical intervention and anesthesia, is called "Unwanted Hypothermia" (3). Unwanted hypothermia increases the risk of mortality and morbidity by causing adverse effects and complications on the patient. It increases the risk of surgical site infections, cardiac arrhythmias, bleeding, postoperative pain, myocardial infarction and slows down drug metabolism. At the same time, it lowers immune system resistance, strains the cardiovascular system and metabolism, and adversely affects pulmonary, renal, and endocrine functions (6, 7). The Turkish Society of Anesthesiology and Reanimation reported that the postoperative mortality risk increases 40 times in hypothermia (8).

In some cases, hypothermia can be applied as a part of surgical treatment. Since open heart surgery requires the use of extracorporeal circulation (cardiopulmonary bypass), which is a perfusion system, it is a high-risk surgical intervention that affects many systems of the body and physiological processes (9-11). Therefore, a widespread inflammatory reaction begins in the organism, including endothelial cells, leukocytes, platelets, complement system and coagulation system (12, 13).

During the extracorporeal circulation, systemic and cardiac hypothermia and anticoagulation therapy are performed in order to minimize the negative effects of it (14). Before the extracorporeal circulation is terminated, it is necessary to provide normothermia with the thermoregulator in the heart-lung machine and the patient heating system externally on the patient-contacting surface of the operating table (7, 9). If hypothermia is not within the targeted range, the metabolic needs of the body cannot be adequately met, and if normothermia is not adequately provided, complications related to hypothermia may occur in the postoperative period. Likewise, inadequate anticoagulation may lead to unwanted thrombosis during the surgical intervention, while insufficient coagulation may lead to bleeding in the postoperative period (15, 16).

In addition to the relationship between undesired hypothermia and bleeding after open heart surgery and the surgical intervention and extracorporeal circulation, hypothermia also has a direct effect on bleeding (17). In hypothermia, tissue damage occurs in the body and causes a decrease in the thromboxane A2 level, causing deterioration in platelet function and increasing the risk of bleeding (18). The risk of bleeding associated with hypothermia after open heart surgery should be carefully monitored by nurses specialized in cardiovascular surgery intensive care units with advanced monitoring techniques, the risks related to the patient should be determined before and after the surgery, precautions should be taken, and in cases of deviation from normal, rapid intervention is required (1, 5, 7, 19). Therefore, this study was conducted to examine the relationship between hypothermia duration and amount of bleeding after open heart surgery.

## Materials and Methods

### Study design and sample

In this retrospective, descriptive, and correlational study, the data were obtained by retrospectively examining the hospital records of patients who underwent open heart surgery between January 2018 and January 2019 in the cardiovascular surgery clinic of an education and research hospital in Istanbul/Turkey. Sample size was not calculate before the study, all patients who underwent open heart surgery between the specified dates constituted the population of the study. Between the specified dates, 85 patients underwent open heart surgery. The data of re-operative (redo) cases (8 patients), patients who underwent surgery for a reason other than coronary artery bypass grafting and valve surgery (25 patients), and patients who underwent revision due to intraoperative (use of an intra-aortic balloon pump due to heart pumping failure – 3 patients) and postoperative (pericardial tamponade – 4 patients) complications were not evaluated. Therefore, the study was conducted with 45 patients.

### Data collection

Data were collected with a structured patient information form prepared by the researchers. In the patient information form, there are questions about the demographic characteristics of the patients, such as age, gender, body mass index (BMI) (kg/m$^2$), presence of chronic diseases, use of drugs with bleeding effects in the preoperative period, and use of peripheral vasoconstrictor drugs in the postoperative period, as well as questions about postoperative hypothermia and bleeding conditions. The data of the patients were accessed from the clinical archive with the hospital automation system.

### Outcome measures

**Hypothermia:** A body temperature below 36°C.

**Hypothermia duration:** Time for hypothermic body temperature to reach normothermia (36°C).

**Amount of bleeding:** The volume of blood loss after surgery.

### Clinical procedures for preventing hypothermia

Before the extracorporeal circulation is terminated in the operating room, normothermia is provided with the thermoregulator in the heart-lung machine and the patient heating system externally on the patient-contacting surface of the operating procedure. When the patient is taken to the intensive care unit, heating is continued with an active and passive heating methods such as forced-air warming and heating blanket. The patient's body temperature is measured at 5-minute intervals and the heater is turned off when the body temperature reaches 36°C.

### Statistical analysis

SPSS 21.0 (SPSS, Inc., Chicago, IL, USA) was used to analyse the data. In the evaluation of the data, mean ± standard deviation, minimum and maximum values for normal distribution and median, 1$^{st}$ and 3$^{rd}$ quartiles, minimum and maximum values for not normally distribution were used for continuous variables, and number and percentage were used for categorical variables. The conformity of continuous variables to normal distribution was evaluated with the Kolmogrow-Smirnov test. The Mann-Whitney U test was used to compare continuous variables between two groups. Correlation analyzes were performed with Spearman correlation analysis. $p<0.05$ level was considered statistically significant.

### Ethical considerations

In order to conduct the study, the ethics committee permission of the university (07/05/2019-3/4) and institutional permissions were obtained from the hospital and ward where the research was conducted.

## Results

The patients' some demographic and disease characteristics such as age, gender, BMI, chronic diseases, use of drugs with bleeding effects, and use of peripheral vasoconstrictor drugs are given in Table 1.

The mean total amount of bleeding of the patients was 600 ml and the mean hypothermia duration was 10.35 hours. When the relationship between the hypothermia duration and amount of bleeding of the patients was examined, it was determined that there was a statistically significant and positive relationship between the hypothermia duration and the amount of bleeding, as the postoperative hypothermia duration increased, the amount of bleeding increased ($r=0.302$, $p<0.05$) (Table 2).

**Table 1.** Demographic characteristics of patients

| | | Mean±SD | Min-Max |
|---|---|---|---|
| Age (years) | | 65.30±10.05 | 37-84 |
| BMI (kg/m²) | | 28.39±3.86 | 20.80-40.40 |
| | | n | % |
| Gender | Male | 12 | 26.7 |
| | Female | 33 | 73.3 |
| Chronic Disease | Yes | 38 | 84.4 |
| | No | 7 | 15.6 |
| Hypertension | Yes | 25 | 55.5 |
| | No | 20 | 44.5 |
| Type II Diabetes Mellitus | Yes | 24 | 53.3 |
| | No | 21 | 46.7 |
| Use of Drugs with Bleeding Effects | Yes | 20 | 44.4 |
| | No | 25 | 55.6 |
| Use of Peripheral Vasoconstrictor Drugs | Yes | 24 | 53.3 |
| | No | 21 | 46.7 |

BMI: Body Mass Index; SD: Standard Deviation

**Table 2.** The relationship between the amount of bleeding and the hypothermia duration

| | Median | Min-Max | r | p |
|---|---|---|---|---|
| Amount of Bleeding (ml) | 600 | 150-1350 | 0.302 | **0.042*** |
| | 1st quartiles = 466, 3rd quartiles =654 | | | |
| Hypothermia Duration (hours) | 10.35 | 2-20 | | |
| | 1st quartiles = 5.46 3rd quartiles=6.80 | | | |

SD: Standard Deviation, r=Spearman Correlation, *p<0.05

**Table 3.** The relationship between BMI and amount of bleeding and hypothermia duration

| | BMI | |
|---|---|---|
| | r | p |
| Amount of Bleeding | -0.310 | **0.032*** |
| Hypothermia Duration | -0.311 | **0.020*** |

BMI: Body Mass Index, r=Spearman Correlation, *p<0.05

When the relationship between the patients' BMI and the presence of chronic disease and the hypothermia duration and amount of bleeding were examined, it was determined that there was a statistically significant and negative relationship between the BMI and amount of bleeding and hypothermia duration (r=-0.310; r=-0.311; p<0.05). As the mean BMI of the patients increases, the mean hypothermia duration and amount of bleeding decrease (Table 3). It was determined that there was a statistically significant relationship between the chronic disease and the amount of bleeding and hypothermia duration of the patients (U=63.00; U=65.55; p<0.05). The amount of bleeding was higher and the hypothermia duration was shorter in patients without chronic disease (Table 4).

There was no statistically significant relationship between the use of drugs with bleeding effects in the preoperative period and the use of peripheral vasoconstrictor drugs in the postoperative period with the amount of bleeding and hypothermia duration (p>0.05).

## Discussion

Today, open heart surgery with extracorporeal circulation is among the most preferred methods in the treatment of many heart diseases. Systemic hypothermia is applied during surgery to reduce metabolic rate and protect organs. Prolonged hypothermia after surgery increases bleeding tendency. Therefore, this study was conducted to examine the relationship between hypothermia duration and amount of bleeding after open heart surgery.

In this study, the mean amount of bleeding of patients was 600 ml. Sert et al reported the average postoperative amount of bleeding of the patients as 700 ml in the coagulopathic bleeding group and 780 ml in the surgical bleeding group (20), while Ovalı and Şahin reported the average postoperative amount of bleeding of the patients as 460 ml (12). Colson et al reported the incidence of bleeding as 2.63% in their study evaluating the development of active bleeding after cardiac surgery and Sert et al reported this rate as 6.4% with patients who underwent open heart surgery (20, 21). Postoperative bleeding in cardiovascular surgery may vary depending on the literature. Continuous drainage of 1.5 ml/kg/hour in the first 6 hours after surgery, or bleeding of 500 ml or more in 1 hour, or total drainage more than 800 ml in the first 2 hours, 900 ml in the first 3 hours, and 1000 ml in the first 4 hours, 1200 ml in the first 5 hours means that the patient has severe bleeding, and this is often considered among the criteria for re-operation (21, 22). Risk factors for re-operation due to bleeding after open heart surgery are

**Table 4.** The relationship between chronic disease and amount of bleeding and hypothermia duration

| | Chronic disease (+) | | Chronic disease (-) | | | |
|---|---|---|---|---|---|---|
| | Median | Min-Max | Median | Min-Max | U | p |
| Amount of Bleeding (ml) | 541 | 289.29-939.29 | 675 | 510.71-839.29 | 63.00 | **0.027*** |
| | 1st quartiles =510,70 3rd quartiles = 646,43 | | 1st quartiles = 510.71 3rd quartiles = 646.43 | | | |
| Hypothermia Duration (hours) | 4.80 | 3.05-8.00 | 4.51 | 4.13-4.47 | 65.55 | **0.032*** |
| | 1st quartiles = 4.13 3rd quartiles = 5.47 | | 1st quartiles = 4.13 3rd quartiles = 5.47 | | | |

SD: Standard Deviation, U=Mann-Whitney U test, *p<0.05

classified as patient and surgical factors. Patient factors are advanced age, low BMI, low ejection fraction, preoperative hematological drug use, preoperative anemia, high creatinine, diabetes, and hepatic dysfunction. Factors related to the surgical procedure are high Euroscore, non-elective surgery, non-coronary revascularization operation, re-operative (redo) case, left internal mammarian artery use, high number of grafts, and prolonged cardiopulmonary bypass (CPB) time (20, 23).

In this study, it was determined that the hypothermia duration, mean time to reach normothermia, that is, the lower limit of normal body temperature, 36°C, was 10.35 hours. Systemic and topical hypothermia applied during cardiopulmonary bypass is the most widely used method for myocardial protection (10). When patients who are rewarmed after exiting cardiopulmonary bypass are admitted to the intensive care unit after surgery, normothermia may not be achieved yet. In addition, hypothermia continues due to the effects of anesthetic drugs on the central nervous system in patients who are still in the intensive care unit under the influence of anesthesia so that early postoperative complications can be followed closely. In cases where active and/or passive heating methods are not applied, it has been reported that the central body temperature can increase by 0.5 °C per hour (1). Karalapillai et al reported that 66% of the patients were hypothermic when admitted to the intensive care unit (24). In the literature, no specified period or research has been found to provide postoperative normothermia. However, it is recommended to provide normothermia as soon as possible in order to prevent complications such as myocardial ischemia, coagulopathy, and delayed wound healing due to hypothermia in the postoperative period (25). Providing normothermia in cardiovascular surgery is especially important for postoperative bleeding control (9).

When the relationship between the hypothermia duration and amount of bleeding of the patients was examined, it was determined that there was a statistically significant and positive relationship between them, as the hypothermia duration increased, the amount of bleeding increased ($r=0.302$, $p<0.05$) (Table 2). Hypothermia causes an increased risk of bleeding in the intraoperative and postoperative period. It causes a decrease in the number and functions of platelets, prolonged coagulation time, and causes problems in the kinetics of coagulation enzymes and plasminogen activator inhibitors and in the coagulation cascade (1, 18, 23, 26). Although there are studies in the literature reporting that hypothermia increases bleeding and therefore the need for blood transfusion (18, 27, 28), hypothermia does not increase blood loss and transfusion requirement (29, 30, 31) and even some studies reporting that it reduces blood loss (32). In a meta-analysis on how intraoperative hypothermia affects bleeding, even mild hypothermia (<1 °C) increased blood loss by approximately 16% (4%-26%) has been reported (27). The prolonged hypothermia duration may have caused the increased amount of bleeding in this study may be due to the impaired coagulation cascade.

In this study, the mean BMI of the patients was 28.39±3.86 kg/m$^2$ and there was a statistically significant and negative relationship between the BMI and hypothermia duration and amount of bleeding ($r=-0.311$; $r=-0.310$; $p<0.05$). As the mean BMI of the patients increases, the mean hypothermia duration and amount of bleeding decrease (Table 3). In the literature, the mean BMI of patients undergoing cardiac surgery as 26.92±4.42 kg/m$^2$ by Pitta Lopes et al and 26.1±2.7 kg/m$^2$ by Sert et al (20, 33). Obesity, which is one of the important health problems today, is closely related to cardiovascular disease risk indicators. The increase in BMI, which is an important data of obesity, causes an increase in adipose tissue and physiological dysfunction in the whole body, revealing very important risks for the development of cardiovascular disease (34, 35). BMI is associated with many morbid conditions after cardiac surgery. Although there are studies in the literature reporting that high BMI increases the amount of postoperative bleeding (36), it has also been reported that obesity has a protective effect on postoperative bleeding (37-40). In another study with 13637 patients, Ghanta et al reported that there was less bleeding in obese and morbidly obese patients, and therefore less blood product usage was required (39). It has been reported that the large amount of adipose tissue accumulated in the mediastinum and high intra-abdominal pressure increase the intrathoracic pressure, creating a compression effect in the bleeding areas, and obesity-related hypercoagulapathic state and less hemodilution requirement as the cause of less bleeding in obese patients (39, 41). In this study, the negative relationship between BMI and the amount of bleeding may have occurred due to the increase in intrathoracic pressure due to obesity. It has been reported in the literature that there is a relationship between BMI and hypothermia, and low BMI is a risk factor for undesirable hypothermia during and after surgery (3). It is an expected result that the postoperative hypothermia duration is shorter in patients with high BMI obtained from this study.

In this study, 84.4% (n=38) of the patients had chronic diseases, 55.5% had hypertension and 53.3% had type II diabetes mellitus as chronic diseases. There is a statistically significant relationship between the presence of chronic diseases and the amount of bleeding and hypothermia durations ($U=63.00$; $U=65.55$; $p<0.05$). It has been determined that the amount of bleeding is higher and the hypothermia duration is longer in patients without chronic diseases compared to those with chronic disease (Table 4). Ovalı and Şahin reported that 60% of the patients had hypertension and 49% had Type II Diabetes in their study with 53 patients who had undergone open heart surgery (12). Vascular complications such as endothelial damage, dyslipidemia and impaired hemostasis caused by diabetes mellitus may cause coagulation disorders (42). Although hypertension poses a risk for all cardiovascular diseases, coronary heart disease is 2-3 times higher in hypertensives than in normotensives. In addition, hypertension increases the risk of acute myocardial infarction 2-3 times in women and men (43). It is stated that 5-year survival in hypertensive patients with coronary artery disease or coronary artery bypass graft operation is lower than in normotensive patients (44). Local inflammation in endothelial cells caused by chronic hypertension after surgical intervention may increase the risk of bleeding by causing a decrease in endothelial fibrinolytic activity and disruption of the coagulation cascade (45). In this study, patients with chronic diseases had lower bleeding and hypothermia durations in the postoperative period compared to those who did not have chronic diseases may be that these patients should be followed more closely due to the high risk of mortality and morbidity brought about by chronic diseases, and rapid intervention in the slightest changes in metabolism.

In this study, it was determined that 44.4% of the patients used drugs with bleeding effects such as anticoagulants or antithrombolytics in the preoperative period. Sert et al reported in their study that patients with coagulopathic bleeding 34.9% used acetylsalicylic acid, 32.6% used warfarin, 7% used clopidogrel, and patients with surgical bleeding 21.4% used acetylsalicylic acid, 4% used warfarin, and 7,1% used clopidogrel preoperatively (20). Thrombosis in cardiovascular diseases can cause many problems such as acute coronary syndrome, cardiomyopathy, arrhythmia, venous thromboembolism. The effects of taking anticoagulant or antithrombolytic drug therapy in the risk group for thrombosis have been demonstrated with high levels of evidence (46). Studies have reported that the use of low acetylsalicylic acid and anticoagulant substances such as warfarin is a risk factor for bleeding (22). However, in this study, no significant relationship was found between the amount of postoperative bleeding using anticoagulant or antithrombotic drugs before surgery.

In this study, it was determined that 53.3% of the patients used peripheral vasoconstrictor drugs in the postoperative period. Peripheral vasoconstrictor drugs are widely used to treat and prevent arterial hypotension, loss of peripheral vascular tone and low cardiac output during general anesthesia or in the postoperative intensive care unit. It decreases microvascular blood flow in the peripheral tissues by making a vasoconstrictor in peripheral vessels (47). This can help reduce bleeding. However, in this study, no significant relationship was found between the amount of bleeding in patients using peripheral vasoconstrictor drugs in the postoperative period.

## Limitation

This study was conducted with a single surgical procedures such as CABG and valve surgery at a single hospital in Turkey. So, the results cannot be generalized. Another limitation is that this is a retrospective study. The study data were obtained from patient records. So, all factors that may affect bleeding could not be evaluated and controlled.

## Conclusion

Bleeding is one of the major complications that may occur during and after open heart surgery. Although hypothermia is used as a part of surgical treatment in open heart surgery performed with cardiopulmonary bypass, undesired hypothermia may cause significant complications in the intraoperative and postoperative period. One of the most important of these complications is bleeding and hypothermia increases the risk of bleeding in the postoperative period. The surgical nurse who cares for a cardiac surgery patient should evaluate the patient in terms of hypothermia, be aware of the intraoperative and postoperative factors that may cause hypothermia, create a care plan to minimize hypothermia in patients with high risk, implement the necessary interventions to prevent hypothermia and maintain normothermia, take precautions to protect body temperature and maintain hypothermia, consider complications such as bleeding that may be associated with hypothermia. Although the relationship between hypothermia and bleeding after open heart surgery supports the literature in this study, it is recommended to repeat the study with a larger sample in order to obtain more meaningful results regarding other factors that may affect bleeding.

**AUTHOR CONTRIBUTIONS:**

**Concept:** GA, Öİ; **Design:** GA, Öİ; **Supervision:** GA, Öİ; **Resources:** GA, Öİ; **Materials:** GA, Öİ; **Data Collection and/or Processing:** GA, Öİ; **Analysis and/or Interpretation**: GA, Öİ; **Literature Search:** GA, Öİ; **Writing Manuscript**: GA, Öİ; **Critical Review:** GA, Öİ.

**Ethics Committee Approval:** Ethical committee approval was obtained from Bilecik Şeyh Edebali University (07.05.2019/3/4)

**Informed Consent:** In this retrospective descriptive and correlational study, institutional permissions were obtained from the hospital and service where the research was conducted.

**Peer-review:** Externally peer-reviewed.

**Conflict of Interest:** Authors have no conflicts of interest to declare.

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## References

1. Demirarslan E. Ameliyat sonrası hipotermi kontrolü. Kastamonu Sağlık Akademisi Dergisi 2017; 2(1): 52-70.
2. ASA (2015). Patients actively warmed during surgery still experience hypothermia, study finds. https://www.sciencedaily.com/releases/2015/01/150120120459.html Erişim Tarihi:05.06.2021
3. Soysal EG, İlçe A. Ameliyat döneminde istenmeyen hipotermide kanıta dayalı uygulamalar. Bozok Tıp Dergisi 2018; 8(2): 72-79.
4. Bashaw MA. Guideline Implementation: Preventing Hypothermia. AORN J 2016; 103: 304-313.
5. Yüksel S, Uğraş GA. Cerrahi hastasında hipotermi gelişimini önlemede hemşirenin rolü. Mersin Univ Saglık Bilim Derg 2016; 9(2): 113-121.
6. Hart SR, Bordes B, Hart J, et al. Unintended perioperative hypothermia. Ochsner J 2011; 11: 259-270.
7. Vallire D, Hooper R, Theresa C, et al. Aspan's evidence-based clinical practice guideline for the promotion of perioperative normothermia. J Perianesth Nurs 2010; 25(6): 346-365.
8. Türk Anesteziyoloji ve Reanimasyon Derneği (TARD) (2013). İstenmeyen perioperatif hipoterminin önlenmesi rehberi. anestezi uygulama kılavuzları. https://www.tard.org.tr/assets/kilavuz/yeni.pdf Erişim Tarihi: 01.05.2021
9. Lok SYZ, Chen Y, Smith AJ. Understanding noncardiac complications following coronary artery bypass graft surgery. Clin. Pract 2014; 11(2): 193-206.
10. Milas BL, Jobes DR, Gorman RC. Management of bleeding and coagulopathy after heart surgery. Management of bleeding and coagulopathy after heart surgery. Semin Thorac Cardiovasc Surg 2000; 12(4): 326-336.

11. Hammon JW. Extracorporeal Circulation: A. Perfusion Systems, B. The Response of Humoral and Cellular. Cohn LW. Cardiac Surgery in the Adult. New York, The McGraw-Hill Companies. 3rd ed. 2008: 349-414.
12. Ovalı C, Şahin A. Koroner arter by-pass cerrahisi sonrası erken kardiyak komplikasyonların tanı ve tedavisinde ekokardiyografinin rolü. Cukurova Med J 2018; 43(4): 862-867.
13. Rahman A, Burma O, Bayar KM, et al. Kardiyopulmoner bypass ve çalışan kalp teknikleri ile yapılan ameliyatların kardiyak performansa etkisi. Turkish J Thorac Cardiovasc Surg 2001; 9: 68-73.
14. Jones T, Elliott MJ. Perfusion techniques. Stark JF, de Leval MR, Tsang VT. Surgery for Congenital Heart Defects. England, John Wiley and Sons. 3rd ed. 2006: 167-186.
15. Yanık ÇT, Yılmaz GS. Kardiyovasküler cerrahi sonrası yoğun bakımda yaşanan sorunlar ve hemşirelik bakımı. Sağlık Bilimleri Üniversitesi Hemşirelik Dergisi 2019; 1(2): 122-127.
16. Silvestry FE, Manaker S, King TE, et al. (2018). Postoperative complications among patients undergoing cardiac surgery. https://www.uptodate.com/contents/postoperativecomplications-among-patients-undergoing-cardiac-surgery. Erişim Tarihi: 04.03.2021.
17. Thorsen K, Ringdal KG, Strand K, et al. Clinical and cellular effects of hypothermia, acidosis and coagulopathy in major injury. The Br J Surg 2011; 98: 894-907.
18. Kander T, Schött U. Effect of hypothermia on haemostasis and bleeding risk: a narrative review. Journal of International Medical Research 2019; 47(8): 3559-3568.
19. Keklik Karadağ F, Saydam G, Şahin F. Preoperatif ve postoperatif kanama hastasına yaklaşım. Ergene Ü. Kanama Diyatezi Olan Hastaya Yaklaşım. Ankara: Türkiye Klinikleri; 1. Baskı. 2020, 15-21.
20. Sert SG, Dede Ş, Demir AZ, et al. Açık kalp cerrahisi sonrasında kanama nedenli reoperasyonlar: Cerrahi kanama mı? Koagülopati mi? GKDA Dergisi 2018; 24(4): 160-164.
21. Colson PH, Gaudard P, Fellahi JL, et al. Active bleeding after cardiac surgery: A prospective observational multicenter study. Plos One 2016; 11(9).
22. Kristensen K, Rauer LJ, Mortensen P, et al. Reoperation for bleeding in cardiac surgery. Interact Cardiovasc Thorac Surg. 2012; 14: 709-713.
23. Karthik S, Grayson AD, McCarron EE, et al. Reexploration for bleeding after coronary artery bypass surgery: Risk factors, outcomes, and the effect of time delay. Ann Thorac Surg 2004; 78: 527- 534.
24. Karalapillai D, Story D, Hart GK, et al. Postoperative hypothermia and patient outcomes after elective cardiac surgery. Anaesthesia 2011; 66(9): 780-784.
25. Kankaya EA, Bilik Ö. Kalp kapak ameliyatı sonrası güncel hemşirelik yaklaşımları: Bakım neden önemli? Balıkesir Sağlık Bilimleri Dergisi 2018; 7(2): 101-111.
26. Hall JE. Body temperature regulation and fever. Çağlayan Yeğen B., Alican İ., Solakoğlu Z. Guyton Medical Physciology. Ankara, Nobel Tıp Kitapevi. 2013, 867-881.
27. Rajagopalan S, Mascha E, Na J, et al. The effects of mild perioperative hypothermia on blood loss and transfusion requirement. Anesthesiology 2008; 108(1): 71-77.
28. Hofer CK, Worn M, Tavakoli R, et al. Evolving technology: Influence of bodycore temperature on blood loss and transfusion requirements during off-pump coronary artery bypass grafting: a comparison of 3warming systems. J Thorac Cardiovasc Surg 2005; 129: 838–843
29. Nathan HJ, Parlea L, Dupuis JY, et al. Safety of deliberate intraoperative and post-operative hypothermia for patients undergoing coronary artery surgery: A randomized trial. J Thorac Cardiovasc Surg 2004; 127: 1270-1275.
30. Stein LH, Rubinfeld G, Balsam LB, et al. Too cold to clot? Does intraoperative hypothermia contribute to bleeding after aortic surgery? Aorta 2017; 5(4): 106-116.
31. Mecklenburg A, Stamm J, Angriman F, et al. Impact of therapeutic hypothermia on bleeding events in adult patients treated with extracorporeal life support peri-cardiac arrest. Journal of Critical Care 2021; 62: 12-18.
32. Smith CE, Desai R, Glorioso V, et al. Preventing hypothermia: Convective and intravenous fluid warming versus convective warming alone. J Clin Anesth 1998; 10: 380-385.
33. Pitta Lopes RO, de Castro J, Carius Nogueira CS, et al. Complications in immediate postoperative recovery from elective cardiac surgery: A cross-sectional study based on Roy's theory. Revista de Enfermagem Referência 2019; 4(22): 23-32.
34. Kranendonk MEG, de Kleijn DPV, Kalkhoven E, et al. Extracellular vesicle markers in relation to obesity and metabolic complications in patients with manifest cardiovascular disease. Cardiovasc Diabetol 2014; 13: 37.
35. Doğan DM, Kartal TF. Kardiyovasküler sistem hastalıklarının risk faktörleri üzerine beslenme durumunun etkisi. Journal of Health Services and Education 2019; 3(1): 11-19.
36. Abanoz M., Amaç B. Kardiyopulmoner bypass eşliğinde yapılan kalp cerrahisinde vücut kitle indeksinin morbidite ve mortalite üzerine etkisi. Med Records 2021; 3(1): 36-40.
37. Lopes CT, Dos Santos TR, Brunori EHFR, et al. Excessive bleeding predictors after cardiac surgery in adults: İntegrative review. J Clin Nurs 2015; 24: 3046-3062.
38. Gümüş ÖF, Demirgan S, Abdullah T, et al. Kalp cerrahisinde yüksek vücut kitle indeksinin morbidite ve mortalite üzerine etkileri. GKDA Derg 2020; 26: 165-171.
39. Ghanta RK, LaPar DJ, Zhang Q, et al. Obesity increases risk-adjusted morbidity, mortality, and cost following cardiac surgery. Am Heart Assoc 2017; 6:e003831.
40. Wang M, Chen M, Ao H, et al. The effects of different BMI on blood loss and transfusions in chinese patients undergoing coronary artery bypass grafting. Ann Thorac Cardiovasc Surg 2017; 23: 83-90.
41. Gürbüz HA, Durukan AB, Salman N, et al. Obesity is still a risk factor in coronary artery bypass surgery. Anadolu Kardiyol Derg 2014; 14: 631-637.
42. Gürkan E, Kavaklı B. Tip 2 diyabetes mellitusun plazma fibrinojen düzeyine etkisi. Harran Üniversitesi Tıp Fakültesi Dergisi 2018; 15(3): 125-128.
43. ESH/ESC Guidelines for the management of arterial hypertension. The Task Force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). Eur Heart J 2013; 34: 2159-2219.
44. Johnstone MT, Nesto R. Diabetes mellitus and heart disease. Pickup JC, Williams G. Joslin's Diabetes Mellitus. Philadelphia: Lippincott Williams and Wilkins. 14th ed. 2005: 975- 998.
45. Sayın T. Acil hipertansiyon: Tanı, fizyopatoloji ve tedavi. Yoğun Bakım Dergisi 2003; 3(4): 251-257.
46. Zarowitz JB. Significant changes to antithrombotic therapy and prevention of thrombosis guidelines. Geriatr Nurs 2012; 33(4): 297-301.
47. Talke P, Anderson BJ. Pharmacokinetics and pharmacodynamics of dexmedetomidine-induced vasoconstriction in healthy volunteers. Br J Clin Pharmacol 2018; 84(6): 1364-1372.