Effects of transfer from the operating room to the intensive care unit after cardiac surgery on hemodynamics and blood gases

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ABSTRACT

الأهداف: تقييم أثر نقل مرضى عمليات القلب المفتوح من غرفة العمليات إلى وحدة العناية المركزة على قياس حركيات وغازات الدم.

الطريقة: أجريت هذه الدراسة كدراسة وصفية ودراسة ملحوظة بمدينة جريمان بتركيا في عام 2007م. سجلت حركات الدم وقيم غازات الدم وقيم SpO_2 لدى 37 مريضاً خضعوا لعملية جراحية للقلب المفتوح. تم تقييم البيانات بالطريقة الإحصائية الوصفية وبإختبار فريدمان وتحليل العلاقة.

النتائج: شملت هذه الدراسة 37 مريضاً. ازدادت قيم ضغط الدم في الشريان الانقباضي والانبساطي قبل النقل، بينما كان المرضى لا يزالون تحت تأثير التخدير أثناء نقلهم عند دقيقة و30 دقيقة بعد إكمال النقل والعودة إلى القيم الطبيعية ($p<0.05$). تم قياس قيمة SpO_2 عند 30 دقيقة بعد إكمال النقل وكان أعلى من القيمة الأولى ($p>0.05$). ازدادت قيم pH ($p<0.001$) و PaO2 ($p<0.001$) في بداية النقل بشكل ملحوظ وفي نهاية النقل، وانخفضت قيم PaCO2 بشكل ملحوظ ($p>0.001$).

خاتمة: تعتبر عملية نقل المرضى الذين أجريت لهم عملية القلب المفتوح آمنه.

Objective: To evaluate the effect of transferring open-heart surgery patients from the operating room to the intensive care unit on hemodynamic parameters and blood gases.

Methods: The study was conducted as a prospective, observational study at the German Hospital, Istanbul, Turkey in 2007. Hemodynamic, blood gas values, and oxygen saturation measured by pulse oximetry (SpO_2) values were recorded in 37 patients who had undergone open-heart surgery. Data were evaluated by descriptive statistical methods, Friedman's test, and correlation analysis.

Results: Thirty-seven patients were included in this study. The low systolic and diastolic arterial blood pressure values prior to transfer, while patients were still under the effect of anesthesia, increased during the transfer, and at one and 30 minutes after completion of transfer and returned to normal values ($p<0.05$). The SpO_2 value measured at 30 minutes after completion of transfer was higher than the first value ($p<0.05$). The pH ($p<0.001$) and arterial partial pressure of oxygen ($p<0.001$) values at the beginning of the transfer had significantly increased at the end of the transfer, and arterial partial pressure of carbon dioxide values had significantly decreased ($p<0.001$).

Conclusion: The transfer of open-heart surgery patients was observed to be safe.

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Open-heart surgery procedures not only provide important benefits, but they are one of the types of major surgical procedures with high mortality and morbidity from its postoperative effect on pulmonary, cardiovascular, neurological, gastrointestinal, hematological, and renal systems.[1,2] It is known that after surgery, conditions

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related to the general anesthesia used during the surgical procedure can develop, including decrease in residual capacity, inhibition of pulmonary function, changes in chest wall, and diaphragmatic movement and shape, hypotension, and bradycardia.[1,3,4] After open-heart surgery, when patients are transferred from the operating room to the intensive care unit (ICU), the effect of anesthesia as well as patient-related factors, lack of appropriate preparation before moving the patient, problems while moving, changes or cut off of respiratory and infusion support can have negative, life-threatening results, such as hypotension, decrease in arterial oxygen saturation, arrhythmias, changes in respiratory rate and increase in intracranial pressure.[4-9] These complications that can develop in the early postoperative period after open heart surgery, can also lead to increases in length of stay in ICUs for mechanical ventilation and in the hospital, which lead to an increase in cost of treatment.[9] As the time following a surgical procedure is a critical process for heart patients, they are carefully and painstakingly transferred to the ICU for the prevention of complications.[7] However, in a review of the literature, although there were many research studies reporting the postoperative complications and causes following cardiac surgical procedures, no studies were found that examined complications that could develop during transfer from the operating room to the ICU after cardiac surgery. Acting from these results, this research was conducted to evaluate the effect of transferring open-heart surgery patients from the operating room to the ICU on hemodynamic parameters and blood gases.

Methods. This prospective, observational study was conducted from January to February 2007. The hospital's Scientific Ethics Committee approved the study. The patients were given information on the study and the procedure, and their written permission was received. A total of 37 patients who had undergone only coronary artery bypass (CABG) surgery at the German Hospital, Istanbul, Turkey were included to the study.

Data collection. Following the cardiac surgery, the anesthesiologist in the operating room makes the decision (Critical Care Medicine Society Guidelines) to transfer. Next, the patient is prepared for transfer. At the hospital where the research was conducted, when the physician makes the decision that a patient can be transferred the following criteria are evaluated: appropriate perfusion pressure is ensured with or without positive or negative inotropic support, respiratory support is adjusted according to blood gas results, the presence of a stable cardiac rhythm and the absence of a dysrhythmia, and absence of bleeding and symptoms or excessive drainage. When the patient is prepared for transfer all the patient incisions are covered with dressings. Supporting the entry sites, intubation, nasogastric, drainage and infusion catheters, and tubes loosened or soiled dressings are changed using aseptic techniques and the sites covered. All the batteries for instruments used during the research were checked to assure they were full and had been calibrated before the patient was transferred. In addition, hemodynamic measurements were recorded at 10 minutes and one-minute prior to transfer to ensure that the patient had stable values. At the first minute of transfer, at the completion of transfer, and at the first and thirtieth minute after transfer, and blood gas results were recorded at the first minute of transfer and at the completion of transfer. In addition, any negative situations that occurred during transfer, such as with urinary and drainage status increase in bleeding, removal of catheters, or extubation were also recorded on the record form. Arterial blood gas values were measured by taking up to a 2 cc blood sample from the arterial catheter into a 2 cc heparinized syringe and using a blood gas analysis machine. When blood was taken from the patients for arterial blood gas analysis first 1.5 cc of blood was removed to prevent mixing with flush solution. The patients' demographic characteristics, type of surgical procedure, length of anesthesia and pump, length of time for transfer, and health care personnel accompanying the transfer were recorded. The anesthesiology team recorded the research group patients' findings at 10 minutes and one-minute prior to transfer in the operating room. The patients were turned over by the anesthesiology team and received by the responsible surgeon, 2 ICU nurses, and assistant health care personnel in the operating room and transferred to the ICU. The hemodynamic parameters and blood gases at the first minute after transfer was begun and ended were recorded by one of the nurses participating in the transfer. The nurses monitoring the patients in the ICU recorded the patients' hemodynamic parameters at the first and thirtieth minute after admission to the ICU. Since the mechanic ventilator used during the transfer is designed differently than the one in ICU, we did not intend to take the respiratory parameters and blood gases in ICU. A Bionet Transport Monitor BM5, which is routinely calibrated by the biomedical department every year, and which is checked by intensive care nurses to verify it is working and that the pressure has been reset to zero, and has a fully charged battery before every use, was used to monitor hemodynamic parameters of patients who were included in the sample, including arterial blood pressure, heart rate, respiratory rate, and oxygen saturation. During transfer, to maintain adequate and effective ventilation, a transfer ventilator (Drager Oksolog 1000), which is calibrated by the biomedical department once a year and checked by the ICU nurses to confirm it was working and has a full oxygen tank before every use, was used with settings on volume control mode, 100% fraction of inspired oxygen, positive end-expiratory pressure, 0cmH_2O, and respiratory rate of 12. Arterial

blood gas values were measured using an arterial catheter, a 2 cc heparinized syringe and using a blood gas analysis machine (ABL 550 and ABL 620 Radiometer), which are routinely calibrated once every 2 hours in the clinical research laboratory. The line that is used for obtaining arterial blood is 10 cm from the 3-way stopcock, the internal diameter of the line is 0.3 ml and the internal diameter of the intravenous catheter used was up to 0.1 ml. To continue uninterrupted medication infusions during transfer that were begun during surgery, a battery-operated infusion pump (Perfusor Compact-Braun), which is routinely calibrated by the biomedical department twice a year and is checked to confirm it is working and the battery is fully charged by the anesthesia technician prior to every use, was used. In addition, emergency medications, such as, atropine sulfate, epinephrine, and 2% lidocaine, a balloon-valve mask system (ambu bag) and oxygen connector were kept ready for use for any untoward situations that might occur during transfer. All ICU nurses in the hospital are given a 3-month orientation to the ICU, which includes transfer procedure, hemodynamics, and so forth. One of the 2 nurses has at least 3-years of ICU experience during transfer according to the hospital transfer protocol. The nurses who transferred patients had at least 10 years of experience in the Cardiovascular Surgery ICU in this study. The doctors accompanying the patient are experienced cardiovascular surgeons who also follow the patients in the ICU.

Statistical analysis was performed using the statistical package SPSS Version 11.0. The patients' demographic characteristics and measurement results were evaluated with descriptive statistical methods as well as non-parametric methods of two-way analysis of variance and correlation analysis. The results were evaluated at a 95% confidence interval and at a $p<0.05$ level of significance.

Results. All the patients had undergone a coronary bypass graft surgical procedure, 62.2% were male (n=23), their mean age was 62.84 ± 9.13 years (range 40-75 years). It was determined that 37.8% (n=14) of the patients were being treated for hypertension prior to surgery, and 62.2% did not have a diagnosis of hypertension. None of the patients had undergone previous CABG surgery. These patients were transferred to the ICU from the operating room in a mean of 4.05±0.52 minutes (range 3-5minutes). It was determined that the low systolic and diastolic arterial blood pressure values prior to transfer, while patients were still under the effect of anesthesia increased during the transfer and at one and 30 minutes after completion of transfer and returned to normal values. The differences in the changed values were found to be statistically significant (p=0.000). The patients' heart rate also increased after transfer, compared to the pre-transfer value, however, the difference was not significant (p=0.29) (**Figure 1**).It was determined that the oxygen saturation measured by pulse oximetry (SpO_2) value at the measurements 10 minutes prior to transfer, during the transfer, and one, and 30 minutes after the transfer procedure occasionally fell and rose. The SpO_2 value at the 30-minute measurement after completing transfer had increased compared to the first SpO_2 value. A mean SpO_2 did not fall below 99% (range 99.6-99.8%) at any time point and, the difference in the SpO_2 values was found to be statistically significant (p=0.002). In the examination of blood gas changes it was determined that the beginning of transfer pH (p=0.000) and arterial partial pressure of oxygen (PaO_2) (p=0.001) values had significantly increased at the end of transfer and the arterial partial pressure of carbon dioxide ($PaCO_2$) (p=0.000) and bicarbonate (HCO_3) (p=0.000) values had significantly decreased (**Figure 2**). During the postoperative transfer

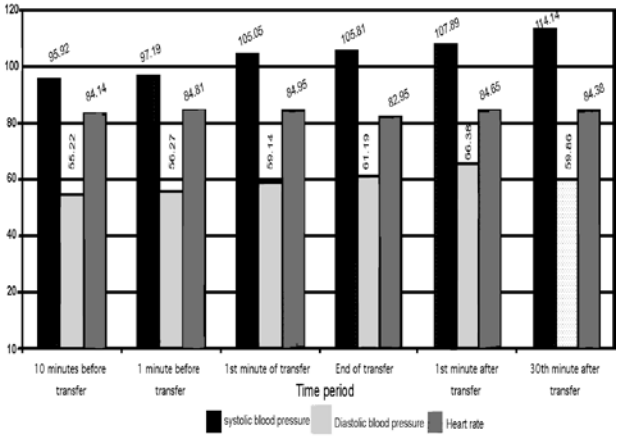

Figure 1- Changes in Hemodynamic Parameters (N=37)

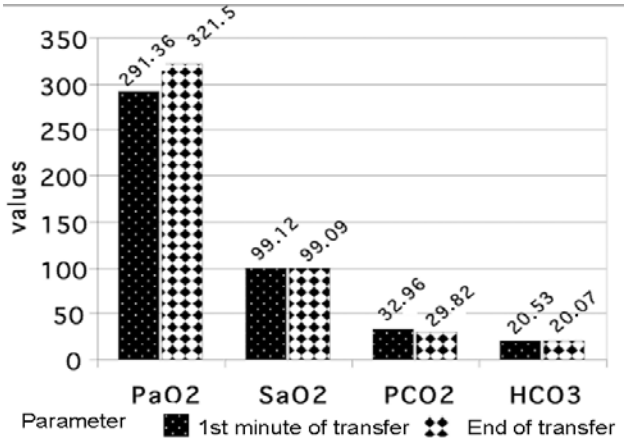

Figure 2 - Changes in Arterial Blood Gas Values (N=36)

to the ICU one patients' (2.7%) arterial catheter was removed. Immediately after transfer to the ICU the anesthesiologist reinserted the arterial catheter. This patient's blood pressure was monitored noninvasively during transfer. No other untoward events occurred during transfer, such as, death of a patient, extubation, central vein catheter removal, nasogastric tube removal, or increase in bleeding.

Discussion. This study shows that when open-heart surgery patients are transferred from the operating room to the ICU under safe conditions, when ventilation is continued, and when infusion support is continued, the possibility of having a negative result is very low. In this study, it was determined that patients' systolic and diastolic blood pressure and heart rate values were within normal limits during transfer. The increase in patients' heart rates and blood pressure values at the thirtieth minute after transfer can be explained by the decrease in depth of patients' anesthesia. Although low systolic and diastolic arterial blood pressure values (96/55 mm Hg) at the beginning of transfer are risk indicators for organ perfusion, the slow increase to normal levels suggests that this was not a probability. While the patients' PaO_2 value decreased in the first minute of transfer, their $PaCO_2$ value increased, at the end of the transfer this was reversed and the PaO_2 value increased and the $PaCO_2$ value decreased. The patients were hypocapnic (29-32 mm Hg) after cardiac surgery. Cerebral hypoperfusion (SjO_2<50%) in the early postoperative period following CABG surgery may occur. Postoperative cerebral hypoperfusion may be influenced by $PaCO_2$, SaO_2, mean arterial pressure, and arterial hemoglobin concentration.[10] In cardiopulmonary bypass surgery, reductions in $PaCO_2$ (range 30-32 mm Hg) during periods of embolic risk may reduce the risk for brain injury.[11] In the results of SpO_2 measurements at the beginning of transfer there was no clinically significant decrease, but at the end of the transfer this value had increased compared to the pre-transfer value. The use of fixed oxygen and tidal volume settings due to the limitations in the flexibility of the portable ventilator used during transfer may have caused the changes in blood gas values seen in respiratory alkalosis. In the literature it has been recommended that an electrocardiogram and invasive arterial pressure monitoring, and oxygen saturation monitoring be carried out during transfer, and that basic resuscitation medications (for example, adrenalin) be easily accessible throughout the transfer for safe transfer conditions.[7,12] The first studies on potential complications during transfer began in the 1970s, and 84% of the patients during this time who had high risk from cardiovascular disease were found to have arrhythmias and 44% had an indication for emergency treatment.[13] In a study by McBride et al[14] researching the complications that developed in 16 patients during transfer of whom 13 were postoperative cardiac surgery, 2 had the diagnosis of myocardial infarct, and one of myocarditis, it was reported that 2 patients had worsening of their hemodynamic parameters, one patient had a cerebrovascular attack, and 3 patients died.[14] The complication rate was 2.7% during transfer for the removal of an arterial catheter. In an article by Waydhas[13] on ICU patients in-hospital transfers, a higher rate of complications from catheters and connections was reported as 5%.[13] The study was conducted with a small sample size in the hospital. There is a need for a larger sample group to investigate the differences and be able to generalize the research results.

In conclusion, negative changes in hemodynamics and blood gases did not occur during the transfer of open-heart surgery patients from the operating room to the ICU and the transfer conditions were observed to be safe.

References

1. Walcot N, Marchbank A. Postoperative care of adult cardiac surgery patients. ***Surgery*** 2007; 25: 211-214.
2. Hawkes AL, Nowak M, Bidstrup B, Speare R. Outcomes of coronary artery bypass graft surgery. ***Vasc Health Risk Manag*** 2006; 2: 477-484.
3. Karabulut H, Toraman F, Tarcan S, Demirhisar O, Alhan C. Adjustment of sweep gas flow during cardiopulmonary bypass. ***Perfusion*** 2002; 17: 353-356.
4. Magnusson L, Spahn DR. New concepts of atelectasis during general anaesthesia. ***Br J Anaesth*** 2003; 91: 61-72.
5. Rosenberger P, Shernan SK, Shekar PS, Tuli JK, Weissmüller T, Aranki SF, et al. Acute hemodynamic collapse after induction of general anesthesia for emergent pulmonary embolectomy. ***Anesth Analg*** 2006; 102: 1311-1315.
6. Holst D, Rudolph P, Wendt M. Practical realization of patient-accompanying concept in anesthesia and intensive care. ***Anasthesiol Intensivmed Notfallmed Schmerzther*** 2000; 35: 25-29.
7. Whitely S, Gray A, McHugh P, O'Riordion B. Guidelines for transport of critically ill adult. Intensive Care Society Standards. London: Copyright Licensing Agency; 2002. p. 1-24.
8. Warren J, Fromm RE Jr, Orr RA, Rotello LC, Horst HM. Guidelines for the inter and intrahospital transport of critically ill patients. ***Critical Care Med*** 2004; 32: 256-262.
9. Andrejaitiened J, Sirvinskas E, Boyls R. The influence of cardiopulmonary bypass on respiratory dysfunction in early postoperative period. ***Medicina*** 2004; 40: 7-12.
10. Millar SM, Alston RP, Andrews PJD, Souter MJ. Cerebral hypoperfusion in immediate postoperative period following coronary artery bypass grafting, heart valve, and abdominal aortic surgery. ***Br J Anaesth*** 2001; 87: 229-236.
11. Plochl W, Cook DJ. Quantification and distribution of cerebral emboli during cardiopulmonary bypass in the swine: the impact of $PaCO_2$. ***Anesthesiology*** 1999; 90: 183-190.
12. Lemmer JH, Richenbacher WE, Vlahakes GJ. Handbook of Patient Care in Cardiac Surgery. Philadelphia (PA): Lippincott, Williams and Wilkins; 2003. p. 65.
13. Waydhas C. Intrahospital transport of critically ill patients. ***Crit Care*** 1999; 3: 83-89.
14. Mcbride LR, Lowdermilk GA, Fiore AC, Moroney DA, Brannan JA, Swartz MT. Transfer of patients receiving advanced mechanical circulatory support. ***J Thorac Cardiovasc Surg*** 2000; 119: 1015-1020.