Original Article

Predictive Factors for ICU and Ward Stay After CABG

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Abstract

Background: *To determine factors that predicts ICU and ward stay during hospitalization for coronary artery surgery.*

Methods: *Data were collected retrospectively from 200 patients. ICU and ward stay time was divided into two groups and compared by X2 and t test and variables with a p value of less than 0.1 were included in logistic regression model. Specificity and sensitivity of tests were examined by ROC curve.*

Results: *Mean time of ICU and ward stay (day) was 3.89 and 11.07 days respectively. The mean volume of transfused blood in group 1 (ICU stay ≤ 3 day) was 694 ml and in group 2 (>3 day) was 1231 ml where the difference was significant (p<0/05) and this correlation between stay time and transfusion was not seen in ward stay. In univariate analysis, factors such as transfused volume, maximum flow, Chronic obstructive pulmonary disease (COPD), Ejection fraction (EF), Intra aorta pump (IABP) and drainage volume were different between two groups of ICU stay times and such factors in ward stay were transfused volume, minimum flow, COPD, reoperation due to bleeding, and amount of 24 hours bleeding. In logistic regression model variables such as age, pump time, transfused volume and COPD were predictors of ICU stay and only drainage volume was predictor of ward stay.*

Conclusion: *Transfusion of blood is associated with long ICU stay time. Mechanism of this increased time is depression of immune system and increased rate of infection. Volume of bleeding from chest tube in 24 hours is associated with long hospital stay, because chest tube dose not pull out until drainage volume reduced to 50 ml in 24 h.*

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Introduction

Despite recent efforts to bypass ICU (intensive care unit) stay,[1] cardiac surgery patients are invariably monitored in the ICU for a period of time that varies from 1 to several days. Prolonged stay in the ICU not only increases the overall costs of cardiac surgery but it may also limit the number of operations performed. Therefore, the ability to accurately predict the duration of stay in the ICU and patient outcomes is important. One study investigated the influence of blood derivatives on the acquisition of severe postoperative infection and ICU stays. The influence of blood derivatives on infection and stay was assessed for RBC (red blood cell) concentration, plasma and platelets. After multivariate analysis, the variables associated with long hospital stay were re-intubation, dehiscence, long mechanical ventilation and

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transfusion. Vamakas investigated the independent association of allogenic blood transfusion with longer hospital stay and longer hospital charges after adjustment for the effects of confounding factors that are related to both these outcomes and the receipt of a perioperative transfusion. In this study, the postoperative length of hospitalization, the postoperative length of stay in ICU and the length of endotracheal intubation after operation were used as surrogate measures of morbidity. This study confirmed the previously reported association between transfusion of blood and hospital stay.[2] The scoring system used to predict a patient's stay in these studies and in general ICU have not been useful in the postoperative cardiac surgery with special applicability to cardiac surgery patients. However, the majority of reported models are complex, impractical for inter center use and have modest predictive ability.[3-5] This may result partly from the fact that all studies analyzed pre operative variables and ignored variables related to the operation itself. In this study we have assessed determinants for ICU stay in post operative coronary artery bypass graft (CABG) surgery patients by analyzing preoperative, intraoperative and immediate post operative variables. This approach has enabled us to develop a simple model predictive of ICU and ward stay.

Method

From Jan 2004 to Feb. 2006, we retrospectively studied 200 consecutive patients undergoing elective CABG (on-pump) surgery in our hospital. We recorded variables such as age, gender, weight, atrial fibrillation, diabetes, BSA(basal surface area), ejection fraction (EF), post operative myocardial infarction (MI), aortic cross clamp time, pump time, transfusion volume, post operative 24-hour's bleeding, consumed platelet, cryoprecipitate and plasma, duration of CPB (cardiopulmonary bypass), hypotension (BP<40 mm/Hg), Cardiopulmonary bypass (CPB) flow (minimum and maximum), COPD (chronic obstructive pulmonary disease), inotropic drug use, IABP (intra aortic balloon pump) use, renal failure, ICU and ward stay. The patients with off-pump CABG, coronary-valvular surgery and tracheostomy patients (cared in post ICU unit) excluded from study.

Collection of data in no way interfered with care of patient (retrospective) and therefore patients' consent was not required. The amount of blood transfused in the operating room, during the ICU stay after operation and using of inotropic drug was recorded. Blood transfusion was given when the patient's Hct (hematocit) or Hb (hemoglubin) was reduced to 34% or 10gr, respectively. For this analysis, prolonged stay in the ICU was defined as greater than 3 days and for ward stay greater than 7 days. Duration of mechanical ventilation, atelectasia pneumothorax, pneumonia and reintubation were recorded for all patients. Patients with missing data were excluded and duration of ICU stay and ward stay divided into two time periods [(≤3and>3) and (≤7and>7)] and analyzed by X^2 or t test (Continuous variables compared by t test and categorical or discrete variables compared by X^2). To assess the ability of independent variables in predicting dependent variables, we used a logistic model and the odd ratio was calculated. Furthermore, the data were subject to logistic regression analysis where ICU stay constituted binary dependent variable (3≤vs> 3 days) and ward stay (7≤vs >7 days). The fit of the above test was assessed by the Roc (receiver under curve) curve. Data are reported as mean and were considered significant when $P< 0.05$.

Results

For all patients, mean ICU stay was 3.89±1.4 days, mean duration of ward stay was 11.07±2.2 days and mode was 3.39 days. Minimum time of ICU stay was zero (expired in operating Room) and its maximum was 30 days. Of all patients, 85% were discharged in less than 2 weeks from the word (Cumulative percent).

Of all patients, 68% were discharged in less than 3 days from ICU. From these numbers,

96% were discharged in less than 6 days and 4 percent stayed more than 6 days, all of which had acute respiratory distress with clinical and laboratory signs such as reduced saturation of PO2 and increased PCO2, pneumonia and ARDS (acute respiratory distress syndrome). Two patients with tracheotomy had received 30 and 25 units of blood production. Patients were divided into two groups with respect to amount of blood transfusion (≤750 ml and >750 ml). The two groups differ in plasma transfusion, use of PEEP (positive end expiratory pressure), COPD, reintubation, atelectasia, cross clamp time, pump time, amount of 24 hour bleeding and ICU stay ($P<0.05$); however, this difference was not seen with respect to ward stay ($P>0.05$). The mean volume of transfused blood 655 ml for group A (ICU stay≤3 days) and 1132 ml for group B (ICU stay>3 days).

This correlation was not seen in ward stay (table 1, 2).

Table 1. Comparison of two time periods (for ward stay)*

Variable	≤7 day	>7 day	P value
Blood transfusion (ml)	915±415	1247±102	0.05
Minimum pump flow (ml/min)	4094±824	4037±501	0.05
COPD	8%	4%	<0.01
Reoperation for bleeding	0.01	0.07	<0.01
Amount of 24 hour bleeding (ml)	503±268	737±595	0.02

* Data are presented as mean±SD

Table 2. Comparison of two time periods (for ICU stay)*

Variable	3 day≤	>3 day	P value
Blood transfusion (ml)	694±107	1231±795	0.04
Cryoprecipitate usage (ml)	450±100	150±50	0.04
Amount of 24 hour bleeding (ml)	606±50	739±46	0.06
PCO_2 after extubation (mmHg)	32±5	36±6	0.02
COPD	4%	6.5%	<0.01
Reintubation	1.5%	9.1%	<0.01
Atelectasia	7%	12.4%	<0.01
Ejection fraction (%)	50±10	35±7	<0.01
Pump time (min)	77±17	89±20	<0.01
Maximum Flow (ml/min)	46032±425	4369±1204	0.04
Balloon pump (%)	4.2	9.4	0.02
Use of inotropic drugs (%)	5.6	15	0.04

* Data are presented as mean±SD

In univariate analyses (X^2 and t test), factors such as volume of transfusion, maximum flow in pump, COPD, EF, IABP and amount of 24h bleeding and reoperation for bleeding were significant ICU stay, (table 2) (P<0.05). In table 3, there was no difference with regards to demographic variables such as age, sex, basal surface area (BSA) and weight. The two groups were matched with regard to demographic variables.

Table 4 shows the result of a forward stepwise selection of variables put into the logistic model with variables entered based on their statistical significance (entering criterion P< 0.1). A forward step selection procedure led to a set of 4 variables in the model i.e., COPD, amount of transfused blood age and pump time (P<0.05, odd ratio were 3.2, 7.4, 5.1, 4.2, respectively). The results of variable selection into the logistic model with ward stay as binary variables (ward stay≤7 and>7 day) showed the only variable that predict ward stay was the amount of chest tube drainage (P<0.05). Age and sex do not affect duration of ward stay**.**

Table 3. Comparison of demographic variables in two time periods of ICU stay*

Variable	3 day≤	>3 day	P value
Age (Y)	54±10.7	59±7.9	0.06
Body surface area	1.7±0.2	1.73±0.3	0.07
Weight (Kg)	72.6±5.1	75±4.6	0.06
Female/Male	40%	43%	<0.01

* Data are presented as mean±SD

Table 4. Predicting factors for ICU stay time with logistic regression model

Variable	P value	Odds ratio	Confidence interval
Pump time	0.015	4.2	3.98-4.45
Age	0.042	5.1	4.87-5.26
Amount of transfused blood	0.045	7.4	7.13-7.59
COPD	0.041	3.2	3.03-3.31

Discussion

This study included both preoperative, Intraoperative and Immediate postoperative variables in a logistic regression model to determine variables that predict duration of stay in ICU and ward after CABG. We found that patients who had long pump time, older age, COPD and received a large number of blood units remained in the ICU for a longer period than usual. Other factors significant in univariate analysis, did not turn out to be significant predictors for ICU or ward stay period.

Among all variables examined, volume of drainage was the only factor that predicted duration of ward stay (odd ratio 6.7). The volume of blood administered in the operating room and in the ICU was the most important predictor of stay in the ICU. We believe that this correlation between transfusion and ICU stay is related to complications of transfusion, because clear evidence links blood transfusion with alteration in immune function.[6]

Higgins and Eric[7-8] published one of the first reports linking transfusion with an increased incidence of complications such as infection, and documented a model for predicting hospital stay. Goodnovgh[9] found an association between respiratory complication and blood transfusion; while walker[10] reported that patients receiving preoperative allogenic blood transfusion have longer hospital stays. Examining a similar group of patients (who do not receive transfusion) our work confirms such findings as shown in figure 2. The main problem with increased length of stay was a higher incidence of respiratory complication and infection. In two separate studies,[11-12] increased incidence of postoperative respiratory complications were noted in transfused patients undergoing surgery. Carren,[13] investigated RBC transfusion and postoperative length of stay in the hospital or ICU among patients undergoing CABG and the effect of perioperative blood transfusion on stay. The variation was calculated after adjustment for the effect of 10 confounding factors that pertained to severity of illness and infection. The post operative stay averaged 8±0.3 days in the hospital and 50±4.1 hours in ICU. The postoperative length of hospitalization increased by 0.83 percent per unit transfused and the postoperative stay in the ICU increased by 0.87 percent per RBC unit. This independent association may

be due to a relationship between blood transfusion and a higher incidence of septic complication of cardiac surgery or it may reflect the function of blood transfusion as surrogate marker for severity of illness. Graves et al.[14] found a linear trend between the number of units of blood transfused and incidence of multiorgan failure. This association is very important, because most mortality in our patients correlated to multiorgan failure. Many questions related to blood transfusion remain to be answered; for example: what are the precise indications for blood transfusion in cardiac surgery? Herbert et al.[15] suggested that for most critically ill patients, hemoglobin level of less than 7 g/l is a trigger for blood transfusion but we believe in ICU, erythropoietin should be given to CABG patients besides transfusing blood.

Should transfusion practice be altered such that only leukocyte depleted blood is used for transfusion? Heal[16] made a powerful biological and economic argument that this practice would save lives and money. Regarding age of blood, there are questions about the efficacy of RBC stored>15 days, because of the reduced ability of this RBC to improve tissue oxygenation. This is the mechanism of respiratory failure in our patients. RBC stored>15 days loses ATP (adenosine tri phosphate), thus causing a decrease in deformability and reduced transportation of oxygen in microcirculation. We also found that post operative bleeding is associated with prolonged wards stay (not ICU stay) because patients with drainage from chest tube are discharged to the ward until the 24 hour drainage is reduced to 50 ml/24 h, the chest tube isn't pulled out. We also found that age and pump time prolonged ICU stay, confirming results documented by other studies.[17-18] In logistics model, variables such as age, pump time, transfusion volume, and COPD were predictors of ICU stay and only drainage volume was a predictor of ward stay.

Conclusion

Transfusion of blood is associated with long intensive care stay time. Other factors such as age, COPD and pump time correlated with this period. Volume of bleeding in 24 hours is associated with long hospital stay. We emphasized that complications like respiratory failure links to blood transfusion and were responsible for the length of ICU stay after CABG. The results of this and similar investigations strongly suggest that transfusion is associated with long ICU stay. We believe that transfusion is associated with altered immune function, infection, and mortality, therefore randomized, prospective studies to further investigate these finding should be undertaken.

References

1. Priestap FA, Martin CM, Heal JM. Impact of intensive care unit discharge time on patient outcome. Crit Care Med 2006;34:2946-2951.
2. Vamakas EC. Length of storage of transfused red cells and postoperative morbidity in patients undergoing CABG. Transfusion 2000;40:10-19.
3. Weintraub W, Jones E, Craver J. Predictors of hospital stay after CABG. Circulation 1989;80:276-278.
4. Weintraub W, Craver JM, Jones EL. Improving cost and outcome of life in patients with coronary artery disease. Am J Cardio 1997;74:1240-1244.
5. Hlatky MA, Rogers WG, Johnston I, Medical care costs and quality of life in patients with coronary artery disease. Am J Cardio 1994;74:1240-1244.
6. Blumberg N, Heal JM. Effects of transfusion on immune function. Arch Pathol Lab Med 1994;118:371-379.
7. Higgins TL. Quantifying risk and assessing outcome in cardiac surgery. J Cardio Thorac Vasc Anesth 1998;3:330-340.
8. Peterson ED, Coombs LP, Ferguson TB, Shroyer AL. Hospital variability in length of stay after coronary artery bypass surgery: results from the society thoracic surgeon's national cardiac Database. Ann Thorac Surg 2002;74:464-473.
9. Goodnovgh LT, Brecher ME, Kantar MH. Transfusion medicine: Blood Transfusion. N J Med 1999;340:438-447.
10. Walker RH. Transfusion risks. Am J Clin Patho 1987;88:374-378.
11. Leal-Noval SR, Rincon-Ferrari MD, Garcia- Curiel A. Transfusion of blood components and postoperative infection in patients undergoing cardiac surgery. Chest 2001;119: 1461-1468.
12. Taylor RW, Manganaro L, O'Brien J, Trottier SJ, Parkar N, Veremakis C. Impact of allogenic packed red blood cell transfusion on nosocomial infection rates in the critically ill patient. Crit Care Med 2002;30:2243-2254.
13. Careen GH. Length of storage of transfused red cells and postoperative morbidity in patients undergoing CABG. Transfusion 2000;40:101-109.
14. Graves TA, Captain MC, Cioffi WG. Relationship of transfusion and infection in a burn population. J Trauma 1989;29:948-954.
15. Herbert PC, Wells G, Marshall J, Martin C, Tweeddale M, Pagliarello G, Blajchman M. Transfusion requirement in Critical Care. A pilot study. Canadian Critical Care Trial Group. JAMA 1995;273:1439-1444.
16. Heal JM, Blumberg N. Effects of transfusion on immune function. Arch Pathol Lab Med 1994;118:371-379.
17. Tuman K, Bjerkest T,Najafi R. Morbidity and duration of ICU stay after cardiac surgery: A model for preoperative risk assessment of ICU stays after cardiac surgery. Chest 1992;263:241-243.
18. Tu JV, Jagal SB, Naylor CD. Multicenter validation of a risk index for morbidity, ICU care stay and overall hospital length of stay after cardiac surgery. Circulation 1995;91:677-684.