Published in final edited form as:
Transfusion. 2011 February ; 51(2): 338–343. doi:10.1111/j.1537-2995.2010.02816.x.

Incidence and transfusion risk factors for transfusion-associated circulatory overload among medical intensive care unit patients

Guangxi Li[1,2], **Sonal Rachmale**[1], **Marija Kojicic**[1,3], **Khurram Shahjehan**[1], **Michael Malinchoc**[1,4], **Daryl J Kor**[1,5], and **Ognjen Gajic**[1]

[1]Division of Pulmonary and Critical Care Medicine, Mayo Epidemiology and Translational Research in Intensive Care (M.E.T.R.I.C), Mayo Clinic, Rochester, MN

[2]Division of Pulmonary Medicine, Guang An Men Hospital, China Academy of Chinese Medical Science, Beijing, China

[3]The Institute for Pulmonary Diseases of Vojvodina, Sremska Kamenica, Serbia

[4]Division of Biomedical Informatics and Biostatistics, Mayo Clinic, Rochester, Minnesota

[5]Division of Critical Care Medicine, Department of Anesthesiology Mayo Clinic, Rochester, MN

Abstract

BACKGROUND—Transfusion-associated circulatory overload (TACO) is a frequent complication of blood transfusion. Investigations identifying risk factors for TACO in critically ill patients are lacking.

STUDY DESIGN AND METHODS—We performed a 2-year prospective cohort study of consecutive patients receiving blood product transfusion in the medical intensive care unit (ICU) of the tertiary care institution. Patients were followed for development of transfusion-related complications. TACO was defined as acute hydrostatic pulmonary edema occurring within 6 hours of transfusion. In a nested case-control design, transfusion characteristics were compared between cases (TACO) and controls after matching by age, sex, and ICU admission diagnostic category. In a secondary analysis, patient characteristics before transfusion were compared between cases (TACO) and random selected controls.

RESULTS—Fifty-one of 901 (6%) transfused patients developed TACO. Compared with matched controls, TACO cases had a more positive fluid balance (1.4 vs 0.8 L, P=0.003), larger amount of plasma transfused (0.4 vs 0.07 L, P=0.007) and faster rate of blood component transfusion (225 vs 168 ml/hr P=0.031). In a secondary analysis comparing TACO cases and random controls, left ventricular dysfunction before transfusion (OR 8.23, 95%CI 3.36–21.97) and plasma ordered for the reversal of anticoagulant (OR 4.31, 95%CI 1.45–14.30) were significantly related to the development of TACO.

CONCLUSION—Volume of transfused plasma and the rate of transfusion were identified as transfusion-specific risk factors for TACO. Left ventricular dysfunction and fresh frozen plasma ordered for the reversal of anticoagulant were strong predictors of TACO before the onset of transfusion.

Correspond to: Guangxi Li, Address: 200 First Street SW Rochester, Minnesota 55905, Phone Number: 507-266-2612, Fax Number: 507-255-4267, li.guangxi@mayo.edu.

Conflict-of-interest disclosure: The authors declare no competing financial interests.

INTRODUCTION

Transfusion-associated circulatory overload (TACO) is a recognized complication of blood transfusion. Despite this recognition, it has received surprisingly little attention in the scientific literature1. For the fiscal year of 2009, transfusion-associated circulatory overload (TACO) and transfusion-related acute lung injury (TRALI) were the two most frequent complications associated with transfusion-related fatalities reported to the US Food and Drug Association (FDA). Although advances in donor-procurement procedures have markedly reduced the incidence of TRALI2, the impact of TACO on transfusion-related outcomes is increasing. The diagnosis of TACO requires exclusion of non-hydrostatic, permeability edema as is seen with transfusion-related acute lung injury (TRALI). Though our previous investigation confirmed a high frequency of TACO in critically ill medical patients3, the syndrome remains under-diagnosed and under-reported 4,5.

At present, investigations detailing both the pertinent risk factors for TACO and relevant predictors of outcome in patients who experience this transfusion-related complication are insufficient. A single report by Popovsky and colleagues noted advanced age and transfusion volumes to be associated with postoperative TACO in orthopedic surgical patients6. While a large proportion of TACO occurs in critically ill patients 7, the risk factors have not been assessed in this patient population. This study was performed to identify risk factors for TACO in critically ill patients.

METHODS

Following institutional review board approval, we performed a secondary analysis of a prospective cohort study which enrolled consecutive patients who were transfused in the medical intensive care unit (ICU) at a tertiary care medical center. Patients who refused to give consent for research authorization in the initial prospective cohort study were excluded. In a nested case-control design, pertinent risk factors were compared between TACO cases and controls matched one to one by age, gender and the diagnostic category at the time of ICU admission. In an effort to further evaluate the importance of risk factors before transfusion and minimize potential overmatching for significant risk factors, we performed an additional analysis comparing TACO cases to randomly selected controls.

All patients were closely observed for the occurrence of a respiratory complication in the 24-hour period following transfusion7. Expert intensivists, blinded to specific transfusion factors, reviewed the clinical data of all patients who experienced a respiratory complication and gave the diagnosis of TACO. The diagnosis of TACO was defined by a combination of clinical signs (gallop, jugular venous distension, systolic hypertension), radiographic (cardiothoracic ratio >0.53 and vascular pedicle width >65 mm),8 electrocardiographic (new ST segment and T wave changes), laboratory (elevated troponin T > 0.1 ng/mL), hemodynamic (PAOP >18 mmHg, CVP > 12), echocardiographic findings: the ratio of mitral peak velocity of early filling to early diastolic mitral annular velocity (E/e' ratio) greater than 15 and/or ejection fraction (EF) of less than 45 percent, new presence of severe left-sided valvular heart disease (aortic or mitral stenosis or regurgitation), and the prompt response to appropriate therapy: diuretic or vasodilator use, treatment of ischemia, and/or inotropic agents.9,10

Predictor variables were grouped as follows:

1. Baseline characteristics before transfusion: Severity of illness before transfusion was determined by the Acute Physiology and Chronic Health Evaluation (APACHE) III scores11. Predicted blood volume (PBV) was calculated according to Nadler predicted formula12. Cardiovascular risk factors were defined as

previous myocardial infarction (MI), arrhythmia, valvular heart disease and/or coronary artery disease (CAD)13. Left ventricular dysfunction was assessed by echocardiographic measurement of left ventricular ejection fraction (EF) and the E/e' ratio (the ratio of mitral peak velocity of early filling to early diastolic mitral annular velocity)14–16. Left ventricular dysfunction was considered present when the EF was noted to be < 45 % or the E/e' was ≥ 15. Fresh frozen plasma (FFP) was prescribed to correct the elevated international normalized ratio (INR) during anticoagulant therapy. The presence of sepsis17, pneumonia18 and chronic kidney disease19 were also determined. Standard clinical definitions were used for these diagnoses. Administration of diuretic therapy within ± 6 hours of onset of transfusion and before the development of TACO among cases was recorded as well.

2. Transfusion factors: Transfused blood components given 0–6 hours before the development of TACO were considered associated units. Similarly, blood components given 0–6 hours after the initiation of the first blood transfusion were considered associated units in controls. Transfusion rate and fluid balance were defined as the average rate of transfusion and the difference between the volume of fluid intake and output ±12 hours of transfusion time. Transfusion rates were calculated in a similar manner for both cellular and non-cellular blood components.

Statistical analysis: Categorical data are presented as counts with percentages. Continuous data are presented as mean values ± standard deviation when normally distributed or median with 25%–75% interquartile ranges (IQR) when non-normally distributed. Baseline characteristics and transfusion factors were compared between cases and matched controls. Matched –pairs analyses using univariate conditional logistic regression were performed and the odds ratio (OR) was used to estimate the relative risk. In the secondary analysis, cases were compared to randomly selected controls using univariate logistic regression. Only variables with a univariate $p \leq 0.20$ were considered as candidates in a multivariate logistic regression models. Non-significant factors ($p > 0.05$) were eliminated (one-at-a-time) until all remaining factors had a significant association with TACO development. For each variable, we calculated an OR, a 95% confidence interval (CI), and a p value (2-tailed test, $\alpha=0.05$). SAS statistical software was used for all analyses (SAS version 9; SAS Institute, Inc., Cary, NC).

RESULTS

From a prospectively collected database of 901 transfused critically ill patients7, we identified fifty-one (6%) patients who developed TACO during the study period. The median age of those whose developed TACO was 73 years (25% – 75% IQR = 57 – 81), 24 were women and 27 were men. In the nested case control study, underlying risk factors were well matched between cases and matched controls (Table 1 and Table 2). Relevant transfusion factors associated with the development of TACO are shown in Table 3. Compared with matched controls, TACO cases received a greater number of transfused units, had a more positive fluid balance, a larger volume of plasma transfused and faster rate of transfusion.

In the second analyses, TACO cases were compared with randomly selected controls. Table 4 presents the results of univariate and multivariate analyses of all the predictors of TACO before transfusion. In the multivariate analysis, left ventricular dysfunction documented by echocardiogram before transfusion and FFP ordered for the reversal of anticoagulation treatment predicted the development of TACO.

DISCUSSION

This secondary analysis of a prospective cohort of critically ill patients who were transfused in the medical ICU confirmed the common occurrence of TACO. Positive fluid balance, larger volume of transfusion, greater plasma transfusion volume, and a faster transfusion rate predicted development of TACO. A comparison of TACO cases and randomly selected controls identified left ventricular dysfunction and FFP ordered for the reversal of anticoagulation therapy predicted the development of TACO before the onset of transfusion.

Our findings confirmed TACO is a common transfusion-related complication in critically ill patients. The incidence of TACO in this report (6%) is consistent with existing literature which notes an incidence ranging from 1 to 8 percent3,6,20. Our previous study noted a higher rate of TACO (1 in 356) than TRALI (1 in 534 per unit) per unit of blood component transfused3. This is much higher than the incidence rate in a recent hemovigilance report from Ireland (1/10,000 of all components)21. In addition to a different study population (critically ill patients vs all transfused patients), the major difference is likely a result of different identification methods (prospective observation vs passive reporting). Recent reports noted TACO to be the fifth most common cause of death resulting from transfusion in the United States with an estimated mortality ranging from 5–15%22. Although the observed mortality is mostly due to underlying illness, rather than TACO per se5, this complication does result in significant morbidity and increase the length of hospital stay5.

Despite its importance, TACO has received surprisingly little attention when compared with other transfusion-related complications such as infection and TRALI 9. A single report associated age with the occurrence of TACO in an orthopedic surgery population. The mean age of patients who developed TACO in this investigation was 84 years. In contrast, the median age of our TACO patients was 73 years, similar to recent reports from Robillard23 and Andera21. This difference is explained by the differing study populations as patients undergoing total hip or knee replacements are more likely to be of advanced age than an unselected ICU population.

Left ventricular dysfunction is believed to be a risk factor for TACO with previous estimates reporting it's presence in 73% (131) of TACO cases21. TACO often occurs in elderly patients6 and those with compromised cardiac function24. FFP remains as the first-line therapy for the urgent/emergent reversal of anticoagulant therapy in the US and American Society of Anesthesiologist's recommended dose of FFP is 10–15 ml per kg25, which is similar to dosing recommendations provided by the British Committee on Standards in Haematology26. This large volume of FFP (frequently 1 – 2 liters) is clearly undesirable in patients at risk of TACO. Our unmatched univariate and multivariate analysis confirmed cardiovascular dysfunction and FFP use for reversal of anticoagulant therapy before transfusion as important predictors of TACO. Lower volume alternatives to FFP need to be evaluated in future TACO prevention trials. Further, our results identified blood component transfusion rate, cumulative fluid balance, cumulative transfusion volume, and volume of plasma transfused as significant predictors of TACO, independent of pre-existing cardiovasucular disease or left ventricular dysfunction. The average transfusion rate in patients who developed TACO was 225 (IQR 135–350) ml/hour compared to 164 (IQR 99–206) ml/hour in matched controls. Although the AABB Technical Manual27 recommends an infusion rate of 150 to 300 mL per hour for red blood cell transfusion and faster rates for plasma and platelets components, our data suggest slower transfusion rates should be observed when possible. In addition to the faster infusion rates, patients who developed TACO also received a significantly larger volume of blood product. Previous reports have described TACO following 1–4 units of administered blood product3,20. A smaller volume of blood component therapy (1–2 units) was associated with TACO in the study of

Popovsky and colleagues as well6. Indeed, even a single transfused unit may be sufficient to precipitate the reaction in a susceptible recipient.1›28

Pre-transfusion diuretic therapy was not found to be protective. This is similar to the findings of Andrea21 where 40% of patients received diuretics but still progressed to TACO. However, infrequent use of diuretics before transfusion make it difficult to determine the benefit of this prevention strategy.

There are a number of potential limitations with this investigation that deserve mention. To begin, the study was conducted in the ICU of a single tertiary center and the results are unlikely to be generalizable to non-ICU patients. In addition, the sample size was limited by the TACO cases observed in the initial prospective cohort study. As a result, the present study was not adequately powered to detect more subtle associations. Although the matched study design minimized confounding from underlying cardiovascular disease and left ventricular dysfunction, the observational nature of this investigation also has the potential for multiple additional measured and unmeasured confounding effects.

In conclusion, TACO occurs frequently after transfusion in critically ill patients. Transfusion volume and the rate of blood component administration appear to be important risk factors for development of TACO in patients with similar baseline characters. Baseline cardiovascular function and FFP ordered for the reversal of anticoagulant therapy are strong predictors of TACO before the onset of transfusion.

Acknowledgments

MK and KS performed data collection and management; MM analyzed results; GL and SR assembled the manuscript; DJK and OG designed the research and revised the paper. This work was supported by the National Heart, Lung, and Blood Institute HL78743, HL81027 and the grant from National Blood Foundation.

REFERENCE

1. Popovsky MA. Transfusion and lung injury. Transfus Clin Biol. 2001; 8:272–277. [PubMed: 11499976]
2. Chapman CE, Stainsby D, Jones H, et al. Ten years of hemovigilance reports of transfusion-related acute lung injury in the United Kingdom and the impact of preferential use of male donor plasma. Transfusion. 2009; 49:440–452. [PubMed: 18980623]
3. Rana R, Fernandez-Perez ER, Khan SA, et al. Transfusion-related acute lung injury and pulmonary edema in critically ill patients: a retrospective study. Transfusion. 2006; 46:1478–1483. [PubMed: 16965572]
4. Kopko PM, Marshall CS, MacKenzie MR, et al. Transfusion-related acute lung injury: report of a clinical look-back investigation. Jama. 2002; 287:1968–1971. [PubMed: 11960539]
5. Li G, Kojicic M, Reriani MK, et al. Long-term Survival and Quality of Life after Transfusion Associated Pulmonary Edema in Critically Ill Medical Patients. Chest. 2009
6. Popovsky MA, Audet AM, Andrzejewski C Jr. Transfusion-associated circulatory overload in orthopedic surgery patients: a multi-institutional study. Immunohematology. 1996; 12:87–89. [PubMed: 15387748]
7. Gajic O, Rana R, Winters JL, et al. Transfusion-related acute lung injury in the critically ill: prospective nested case-control study. Am J Respir Crit Care Med. 2007; 176:886–891. [PubMed: 17626910]
8. Gropper MA, Wiener-Kronish JP, Hashimoto S. Acute cardiogenic pulmonary edema. Clin Chest Med. 1994; 15:501–515. [PubMed: 7982344]
9. Popovsky MA. Transfusion and the lung: circulatory overload and acute lung injury. Vox Sang. 2004; 87 Suppl 2:62–65. [PubMed: 15209881]

10. Stroncek DF, Klein HG. Heavy breathing in the blood bank: is it transfusion-related acute lung injury, our anxiety, or both? Transfusion. 2007; 47:559–562. [PubMed: 17381610]
11. Knaus WA, Wagner DP, Draper EA, et al. The APACHE III prognostic system. Risk prediction of hospital mortality for critically ill hospitalized adults. Chest. 1991; 100:1619–1636. [PubMed: 1959406]
12. Nadler SBHJ, Bloch T. Prediction of blood volume in normal human adults. Surgery. 1962; 51:224–232.
13. Thygesen K, Alpert JS, White HD. Universal definition of myocardial infarction. J Am Coll Cardiol. 2007; 50:2173–2195. [PubMed: 18036459]
14. Vasan RS, Benjamin EJ, Levy D. Prevalence, clinical features and prognosis of diastolic heart failure: an epidemiologic perspective. J Am Coll Cardiol. 1995; 26:1565–1574. [PubMed: 7594087]
15. Hogg K, Swedberg K, McMurray J. Heart failure with preserved left ventricular systolic function; epidemiology, clinical characteristics, and prognosis. J Am Coll Cardiol. 2004; 43:317–327. [PubMed: 15013109]
16. Owan TE, Redfield MM. Epidemiology of diastolic heart failure. Prog Cardiovasc Dis. 2005; 47:320–332. [PubMed: 16003647]
17. American College of Chest Physicians/Society of Critical Care Medicine Consensus Conference: definitions for sepsis and organ failure and guidelines for the use of innovative therapies in sepsis. Crit Care Med. 1992; 20:864–874. [PubMed: 1597042]
18. Calandra T, Cohen J. The international sepsis forum consensus conference on definitions of infection in the intensive care unit. Crit Care Med. 2005; 33:1538–1548. [PubMed: 16003060]
19. Levey AS, Eckardt KU, Tsukamoto Y, et al. Definition and classification of chronic kidney disease: a position statement from Kidney Disease: Improving Global Outcomes (KDIGO). Kidney Int. 2005; 67:2089–2100. [PubMed: 15882252]
20. Bierbaum BE, Callaghan JJ, Galante JO, et al. An analysis of blood management in patients having a total hip or knee arthroplasty. J Bone Joint Surg Am. 1999; 81:2–10. [PubMed: 9973048]
21. Andrea Piccin, MC.; Ciaran, Murphy; Elva, Eakins. Transfusion Associated Circulatory Overload (TACO) Incidence and Risk Factors The American Society of Hematology (ASH) 51st annual meeting; New Orleans. 2009. p. 3157
22. FDA. Fatalities Reported to FDA Following Blood Collection and Transfusion. 2009. http://www.fda.gov/BiologicsBloodVaccines/SafetyAvailability/ReportaProblem/TransfusionDonationFatalities/ucm204763.htm
23. Robillard B IN, Chapdelaine A. Increasing incidence of transfusion-associated circulatory overload reported to the Quebec Hemovigilance System, 2000–2006. Transfusion. 2008; 48 Suppl:497A.
24. Stack, G.; Judge, JV.; Snyder, EL. Febrile and non-immune transfusion reactions. In: Rossi, E.; Simon, TL.; Moss, GS.; Gould, SA., editors. Principles of Transfusion Medicine. Philadelphia: Williams and Wilkins; 1996. p. 778
25. Practice Guidelines for blood component therapy: A report by the American Society of Anesthesiologists Task Force on Blood Component Therapy. Anesthesiology. 1996; 84:732–747. [PubMed: 8659805]
26. Guidelines on the clinical use of leucocyte-depleted blood components. British Committee for Standards in Haematology, Blood Transfusion Task Force. Transfus Med. 1998; 8:59–71. [PubMed: 9569462]
27. John Roback, M.; Martha Rae, Combs; Mt(ascp)sbb; Brenda, Grossman; Christopher, Hillyer. Technical Manual Of The American Assoc Of Blood Banks. 16 ed. Vol. 2008. American Association Of Blood Banks (AABB);
28. Popovsky MA, Taswell HF. Circulatory overload: An underdiagnosed consequence of transfusion. Transfusion. 1985; 25

Table 1

Baseline (pre-transfusion) characteristics of TACO patients and matched controls.

Variables	Cases (n=51)	Controls (n=51)	Odds Ratio (95% CI)	P-Value
Age*,§	73 (57–81)	75 (64–82)		
Gender, Female*,†	24 (47)	24 (47)		
ICU admission diagnosis*				
Gastrointestinal*,†	23 (45)	23 (45)		
Cardiovascular*,†	14 (27)	14 (27)		
Respiratory*,†	5 (10)	5 (10)		
Hematology*,†	4 (8)	4 (8)		
Genitourinary*,†	3 (6)	3 (6)		
Metabolic*,†	1 (2)	1 (2)		
Neurology*,†	1 (2)	1 (2)		
Race (White)†	48(94.1)	47(92.2)	1.3 (0.3,6.0)	0.706
PBV§	5 (4.3–5.6)	4.8(3.9–5.4)	1.26 (0.90,1.83)	0.189
APACHE III score‡,§	24(17–41)	24(16–42)	1.0(0.98, 1.02)	0.936
Smoke†	28(54.9%)	25(49%)	1.21 (0.60,2.46)	0.591
Alcohol Abuse†	9(17.6%)	5(9.8%)	3 (0.61,14.86)	0.178
Aspiration†	2(3.9%)	5(9.8%)	0.4 (0.08,2.06)	0.273
Sepsis†	10(19.6%)	9(17.6%)	1.2 (0.37,3.93)	0.763
Chronic anemia†	9(17.6%)	6(11.8%)	1.5 (0.53,4.21)	0.442
Diabetes†	16(31.4%)	17(33.3%)	0.9 (0.37,2.21)	0.819
Hypertension†	19(37.3%)	24(47.1%)	0.67 (0.30,1.48)	0.321
Chronic kidney disease†	10(19.6%)	13(25.5%)	0.7 (0.27,1.84)	0.469

IQR: 25% – 75% interquartile range; PBV: Predicted Body Volume; ICU: intensive care unit; ACEI: Angiotensin Converting Enzyme Inhibitors.

*Matched pairs and no comparisons;

†Number (%);

‡APACHE III score: Acute Physiology and Chronic Health Evaluation score 1 hour after admission;

§Median (25% – 75% interquartile range)

Table 2

Cardiovascular risk factors in TACO patients and matched controls

Variables	Cases (N = 51)	Controls (N = 51)	Odds Ratio (95% CI)	P-Value
Arrhythmia*	15 (29.4%)	12 (23.5%)	1.33 (0.56,3.16)	0.514
CAD*	23 (45.1%)	15 (29.4%)	2.14 (0.87,5.26)	0.096
Myocardial infarction*	13 (25.5%)	6 (11.8%)	2.17 (0.82,5.70)	0.117
Valvular heart disease*	5 (9.8%)	2 (3.9%)	2.5 (0.49,12.89)	0.273
Left ventricular dysfunction*,†	37 (72.5%)	39 (76.5%)	0.82 (0.34,1.97)	0.655
Diuretic therapy*	9 (17.6%)	12 (23.5%)	0.67 (0.24,1.87)	0.442
Aspirin*	19(37.3%)	16(31.4%)	1.3 (0.57,2.96)	0.533
ACEI*	16(31.4%)	20(39.2%)	0.67 (0.27,1.63)	0.374
Digoxin*	8(15.7%)	6(11.8%)	1.5 (0.42,5.32)	0.530
β-blocker*	13(25.5%)	18(35.3%)	0.64 (0.28,1.49)	0.301

CHF: Congestive Heart Failure; CAD: Coronary Artery Disease; ACEI: angiotensin-converting enzyme inhibitors.

*Number (%);

†Ejection Fraction < 45 or E/e '≥ 15.

Table 3

Transfusion characteristics of TACO cases and matched controls.

Variables	Matched Pairs	Cases	Controls	Odds Ratio 95% CI	P-Value
Lowest hemoglobin[*,†]	51	8 (7–9)	8 (7–9)	0.78 (0.58,1.03)	0.081
Number of units (total)[†]	51	3 (2–7)	2 (2–3)	1.45 (1.12,1.88)	0.005
Red Blood Cell[+]	51	2 (1–4)	2 (1–2)	1.30 (0.99,1.70)	0.06
Fresh Frozen Plasma[†]	51	0 (0–4)	0(0–0)	1.39 (1.07,1.80)	0.005
Platelet[‡]	-	-	-	-	-
Storage days for RBCs[†]	34	22(17–30)	19(16–29)	1.02 (0.97,1.08)	0.472
Total Plasma (L)[†]	51	0.41 (0.07–1.02)	0.07 (0.07–0.15)	4.88 (1.55,15.36)	0.007
Transfusion rate (mL/hr)[†]	51	225(135–350)	168 (100–205)	1.88 (1.06,3.33)	0.031
Fluid balance (ml)[†]	51	1445 (830–3520)	830 (350–1700)	1.38 (1.12,1.71)	0.003

[*] The minimal hemoglobin value within the time of transfusion ±12 hours;

[†] median (25% – 75% interquartile range);

[‡] Only four TACO cases received platelet transfusion and no platelets were used in control patients.

Table 4

Baseline predictors of the development of TACO before the onset of transfusion (comparison of TACO cases and randomly selected controls)

Variables	Cases (N=51)	Controls (N=51)	Odds Ratio (95% CI)	P-Value
Univariate analyses				
Age, year*	73 (57–81)	73 (59–81)	0.99(0.96–1.02)	0.580
Gender (female), N (%)	24 (47)	24 (47)	1(0.46–2.18)	1.000
History of cardiovascular disease, N (%)	38 (75)	27 (53)	2.60 (1.14–6.12)	0.025
Left ventricular dysfunction†	37 (72.5)	14 (27.5)	7.00 (3.00–17.21)	<0.001
PBV*	5.0(4.3–5.7)	5.0(4.1–5.5)	1.19 (0.84–1.73)	0.339
APACHE III*,‡	71 (55–83)	71(56–85)	1.00(0.99–1.01)	0.944
FFP ordered for reversal of anticoagulant therapy, N (%)	17(33)	7(13.7)	3.14 (1.21–8.93)	0.023
Chronic Kidney Disease, N (%)	10(19.6)	4(7.8)	2.87 (0.89–11.08)	0.080
Hemoglobin*,§	8.6(7.3–9.6)	8.5(7.9–9.6)	0.94 (0.72–1.20)	0.603
Sepsis, N (%)	10(19.6)	9 (17.6)	1.11 (0.41–3.07)	0.836
Aspiration, N (%)	2(3.9)	5(9.8)	0.38(0.05–1.84)	0.233
Alcohol Abuse, N (%)	9 (17.6)	12 (23.5)	0.70 (0.26–1.82)	0.464
Multivariate analyses				
Left ventricular dysfunction*	37 (72.5)	14 (27.5)	8.23(3.36–21.97)	<0.001
FFP ordered for reversal of anticoagulant therapy, N (%)	17(33)	7(13.7)	4.31(1.45–14.30)	0.008

IQR: 25% – 75% interquartile range; FFP: Fresh Frozen Plasma;

*Median (25% – 75% interquartile range);

†Ejection Fraction < 45 % or E/e' ≥ 15;

‡APACHE III score: Acute Physiology and Chronic Health Evaluation score 1 hour after admission;

§Lowest hemoglobin within 6 hours before transfusion.