

Relationship between intra-operative hypotension and post-operative complications in traumatic hip surgery

Address for correspondence:

Dr. Mahmoud M Almustafa,
Department of Anesthesiology,
Faculty of Medicine,
The University of Jordan,
Amman, Jordan.
E-mail: Mahmoud_juh@hotmail.com

Received: 19th May, 2019

Revision: 19th June, 2019

Accepted: 03rd September, 2019

Publication: 07th January, 2020

Subhi M Alghanem, Islam M Massad, Mahmoud M Almustafa, Luma H Al-Shwiat, Mohammad K El-Masri, Omar Q Samarah¹, Osama A Khalil¹, Muayyad Ahmad²
Departments of Anesthesiology and ¹Orthopedic, Faculty of Medicine, The University of Jordan, ²Department of Clinical Nursing, Faculty of Nursing, The University of Jordan, Amman, Jordan

ABSTRACT

Background and Aims: The relationship between intra-operative hypotension and post-operative complications has been recently studied in non-cardiac surgery. Little is known about this relationship in traumatic hip surgery. Our study aimed to investigate this relationship. **Methods:** A retrospective study was conducted on patients who underwent surgical correction of traumatic hip fracture between 2010 and 2015. We reviewed the perioperative blood pressure readings and the episodes of intra-operative hypotension. Hypotension was defined as $\geq 30\%$ decrease in the pre-induction systolic blood pressure sustained for ≥ 10 min. The relationship between intra-operative hypotension and post-operative complications was evaluated. Post-operative complications were defined as new events or diseases that required post-operative treatment for 48 h. Factors studied included type of anaesthesia, blood transfusion rate, pre-operative comorbidities and delay in surgery. We used the Statistical Package for Social Sciences (SPSS, IBM 25) to perform descriptive and non-parametric statistics. **Results:** A total of 502 patients underwent various types of traumatic hip surgery during the study period. Intra-operative hypotension developed in 91 patients (18.1%) and 42 patients (8.4%) developed post-operative complications. Significantly more patients with hypotension developed post-operative complications compared to patients with stable vitals (18.7% vs. 6.1; $P < 0.001$). There was no statistically significant difference in the incidence of post-operative complication in patients receiving general or spinal anaesthesia. Pre-operative comorbidities had no significant relationship with post-operative complications. Intra-operative blood transfusion was related to both intra-operative hypotension and post-operative complications. **Conclusion:** There was an association between intra-operative hypotension and post-operative complications in patients undergoing traumatic hip surgery.

Key words: Blood transfusion, complications, hip surgery, intra-operative hypotension

Access this article online
Website: www.ijaweb.org
DOI: 10.4103/ija.IJA_397_19
Quick response code


INTRODUCTION

Surgical correction of traumatic hip fracture is a standard method of treatment which helps early mobilisation and reduces the incidence of complications such as infections and pulmonary embolism. Surgery for traumatic hip fractures is associated with significant blood loss and may result in intra-operative hypotension.^[1]

The American Society of Anesthesiologists (ASA) physical status of patients with hip fracture is usually III or more since heart, respiratory diseases and

other comorbidities are common in these patients. Despite early surgical correction of fracture, around 8% of patients die at 1 month and 30% at 1 year

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Alghanem SM, Massad IM, Almustafa MM, Al-Shwiat LH, El-Masri MK, Samarah OQ, *et al.* Relationship between intra-operative hypotension and post-operative complications in traumatic hip surgery. Indian J Anaesth 2020;64:18-23.

post-operatively. It has been estimated that 20% of the patients suffer from one or more post-operative complications.^[2]

Le-Wendling *et al.* found that there was no difference in hospitalisation costs, re-hospitalisation rates, post-operative morbidity and in-patient mortality in geriatric patients, the majority being older than 80 years, undergoing regional or general anaesthesia for hip fracture repair. Delay in surgery beyond 3 days and ICU admission both increased the cost of hospitalisation in geriatric patients who underwent surgery for hip fracture.^[3] The effect of intra-operative hypotension in non-cardiac surgery on post-operative cardiac and kidney injuries has been investigated by many authors, and a sustained relationship was found between intra-operative hypotension and these complications.

Mascha *et al.*^[4] found a strong relationship between intra-operative hypotension and mortality in non-cardiac surgery. Sun *et al.*^[5] found that acute kidney injury is associated with intra-operative mean arterial pressure (MAP) of less than 55–60 mmHg for ≥ 11 –20 min in non-cardiac surgery. Salmasi *et al.*^[6] found that a reduction of intra-operative MAP of less than 50–60 mmHg for 1–30 min or 20–50% reduction of MAP of the pre-operative value for ≥ 5 min increases the risk of post-operative heart and kidney injury in non-cardiac surgery.

The relationship between intra-operative hypotension and post-operative complications has not been studied adequately in traumatic hip surgery patients. Therefore, this study is primarily aimed at investigating the relationship between intra-operative hypotension and post-operative complications in these patients. The secondary objective is to assess the relationship of delayed surgery, type of anaesthesia and intra-operative blood transfusion with post-operative complications.

METHODS

A retrospective study was conducted at our tertiary referral hospital on patients who underwent hip fracture surgery between January 2010 and January 2015. Institutional review board and ethics approval was obtained (No. 2678/2016/10), date of approval 21/2/2016, and since it was a retrospective observational study and there was no intervention, informed consent was not necessary. We included all ≥ 20 -year-old patients with unilateral acute femur

neck or intertrochanteric fracture who underwent operative treatment. The exclusion criteria were bilateral hip fracture, pathological hip fracture, multiple fractures, previous hip fracture surgery and femur shaft fracture.

The records of patients who underwent partial hip replacements, intramedullary nail and dynamic hip screw surgery under spinal or general anaesthesia were reviewed. The available variables were age, gender, the length of stay in the hospital and surgery delay. The length of stay was the number of days from admission until discharge. Surgery delay was defined as the number of days from the time of admission until the commencement of surgical correction of hip fracture.

The comorbidities recorded in the patient population included hypertension, diabetes mellitus, cardiovascular disorders, chronic respiratory diseases, renal disease and other medical illnesses.

The primary aim of this study was to find the relationship between intra-operative hypotension and post-operative complications within 48 h from the end of surgical repair of hip fracture. Intra-operative blood pressure was monitored continuously when the arterial catheter was in place or every 2.5–5 min when the non-invasive method was used. We collected blood pressure data from the patients' records where systolic blood pressure was recorded every 5 min.

In this study, hypotension was defined as any sustained pre-operative reduction of $\geq 30\%$ in the systolic blood pressure for ≥ 10 min. We considered the pre-operative systolic blood pressure value immediately before the induction of general anaesthesia or before the spinal block as the reference.

Post-operative complications were defined as new events or diseases that required treatment within 48 h post-operatively. Acute post-operative kidney injury was diagnosed if post-operative creatinine level was either more than 2-fold or 0.3 mg/dl more than the pre-operative value. Myocardial infarction was diagnosed when there was an elevation of > 26.2 pg/ml of high-sensitive troponin I enzyme. The diagnosis of atrial fibrillation was based on electrocardiogram (ECG) findings and rapid ventricular response if the heart rate was > 100 beats/min. Cerebrovascular accident was diagnosed in the presence of neurological deficits and/or computed tomography (CT) or magnetic

resonance imaging findings. Decreased level of consciousness was diagnosed when there was a decrease of ≥ 3 points on Glasgow Coma Scale. The diagnosis of pulmonary embolism was based on positive findings on ECG, hypoxia evident by arterial blood gases and/or positive findings of chest CT.

Vasopressors used to treat intra-operative hypotension and intra-operative blood transfusion rate were also examined in patients' records. The secondary objective of this study was to examine the association between the intra-operative hypotension and comorbidities of patients, intra-operative and post-operative blood transfusion, type of anaesthesia and delay before surgical correction of hip fracture.

We used SPSS version 23.0 (Chicago, USA) for statistical analysis. We used mean (\pm standard deviation) to describe continuous variables (e.g., age) and count (frequency) to describe nominal variables. We performed Chi-square test to analyse the difference between the study's variables, including haemodynamic variable, post-operative complications, patients' comorbidities, surgery delay and type of anaesthesia. All underlying assumptions were met unless otherwise indicated. We adopted $P = 0.05$ as a significant threshold.

RESULTS

The total number of hip fracture surgeries during the study period was 750. Records of 100 patients were not available, 30 records had inadequate data, 99 patients had femur shaft fracture, 9 patients had pathological fracture, 9 patients had multiple fractures and 1 patient was less than 20 years of age. The number of eligible patients who met the inclusion criteria was 502 [Figure 1]. There were 265 male patients. The ASA physical status score I was seen in 48 patients, II in 185 patients, III in 244 patients and IV in 25 patients. Comorbidities reviewed in the study were hypertension, diabetes mellitus, cardiovascular disease, chronic obstructive pulmonary disease, renal disease and other comorbidities.

The total number of patients with comorbidities were 388, and 42 patients had post-operative complications. Out of 112 patients with one comorbidity, 4 had post-operative complications. Out of 125 patients with two comorbidities, 10 had post-operative complications. Out of 100 patients with three comorbidities, 11 had post-operative complications.

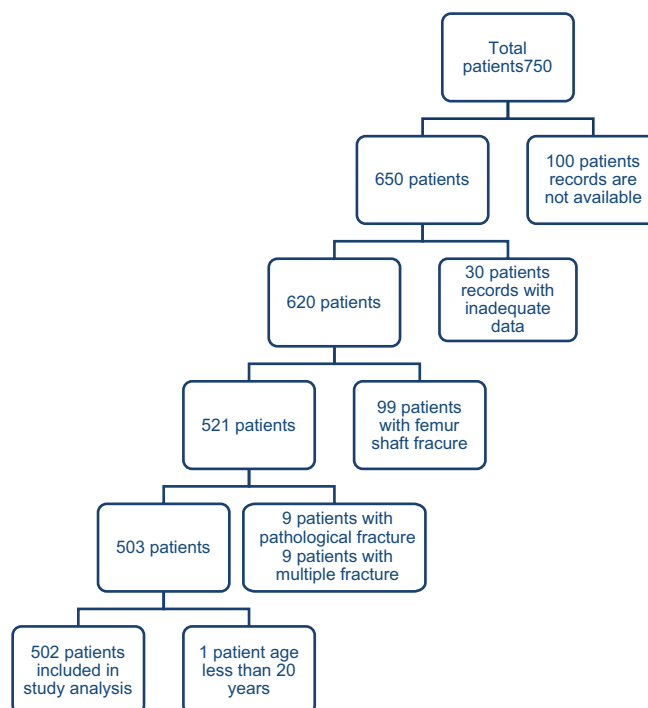


Figure 1: Details of the patients excluded from the study

Out of 43 patients with four comorbidities, 10 had post-operative complications. Out of 8 patients with five comorbidities, 3 had post-operative complications.

The most prevalent comorbidity was hypertension. Three hundred and seventy-three patients received spinal block for their surgery. No patients received epidural with general anaesthesia [Table 1]. Three hundred and forty-four patients (68.4%) underwent surgery within 24 h from admission to the hospital while the remaining patients had surgery in ≥ 2 days from admission.

Ninety-one patients sustained intra-operative hypotension [Table 1]. The duration of hypotension was 10–180 min with an average of 45 min. Ninety patients required vasopressors to treat intra-operative hypotension. Forty-two patients suffered complications within 48 hrs in the post-operative period which include cardiac arrhythmias, myocardial ischaemia, pulmonary embolism, kidney injury, cerebrovascular accident, diabetic ketoacidosis, decrease in the level of consciousness and post-operative bleeding [Table 2].

Significantly more patients with hypotension developed post-operative complications than those with stable vitals (18.7% vs. 6.1; $P < 0.001$) [Table 3].

About 1/3 of the hypotensive patients and about half of the patients with post-operative complications

Table 1: Description of the total sample and hypotensive patients

Characteristics	All patients (n=502)	Hypotensive patients (n=91)
Age (years)	71.7 (14.2), 20-105	71.5 (14.5), 22-94
Hospital stay (days)	8.3 (5.7), 1-51	9.7 (7.0), 1-48
Gender		
Male	265 (52.8)	43 (47.3)
Female	237 (47.2)	48 (52.7)
Comorbidities		
Diabetes Mellitus	213 (42.4)	41 (45.1)
Hypertension	291 (58.0)	51 (56.0)
Cardiovascular disorders	129 (25.7)	25 (27.5)
Chronic obstructive pulmonary disease	43 (8.6)	11 (12.1)
Renal failure	40 (8.1)	8 (8.8)
Other medical illness	158 (31.3)	29 (31.9)
Types of anaesthesia		
General	129 (25.7)	28 (30.8)
Spinal	373 (74.3)	63 (69.2)
Vasopressors	90 (18.0)	57 (62.6)
Post-operative complications	42 (8.4)	17 (18.7)

Data is presented as Mean (SD), Range or number (%) of patients

Table 2: Incidence of complications in hypotensive and normotensive patients

Complications	Stable vitals group (n=411)	Hypotension group (n=91)
Decrease LOC	1	2
AFib with RVR	6	2
Myocardial Ischaemia	3	1
CVA	1	2
Acute Kidney Injury	3	3
Pulmonary Embolism	6	2
Allergic Reaction	1	1
Bleeding and haemoglobin drop	3	3
DKA	1	1
Total	25 (6.1%)	17 (18.7%)

LOC – Level of consciousness, AFib – Atrial fibrillation, RVR – Rapid ventricular response, CVA – Cerebrovascular accident, DKA – Diabetic ketoacidosis

Table 3: Relationship between haemodynamics, surgery delay and blood transfusion and the incidence of post-operative complications

Variables	Post-operative complications	P
Haemodynamics		<0.001
Stable vitals	25 (6.1%)	
Hypotension	17 (18.7%)	
Surgery delay		<0.001
0-1 day	17 (4.7%)	
2-3 days	14 (18.9%)	
>3 days	11 (16.2%)	
Blood transfusion		<0.001
No	22 (5.9)	
Yes	20 (15.6)	

Data is presented as number (%) of patients

received blood transfusion [Table 3]. More patients with ≥ 2 days of surgery delay had post-operative complications than patients with < 1 day of surgery delay [Table 3]. More patients with intra-operative

hypotension received blood transfusion than patients with stable vitals (33 out of 58 hypotension patients vs. 95 out of 316 with stable vital signs). More patients who received blood transfusion had post-operative complications compared to those who did not [Table 3]. There was no statistically significant difference in the incidence of post-operative complications between spinal and general anaesthesia (13 out of 129 patients who received general anaesthesia vs. 29 out of 373 patients who received spinal anaesthesia).

DISCUSSION

Intra-operative hypotension is known to be an important risk factor for the development of post-operative complication, especially in the kidneys and heart. Acute kidney injury and myocardial injury occur in 7.5% and 11.6%, respectively, of non-cardiac surgeries. In addition, intra-operative hypotension is a major contributor to these post-operative injuries.^[7-9]

The incidence of post-operative complications was higher in patients who had developed intra-operative hypotension. Hypotension was defined as the sustained reduction of $\geq 30\%$ of the pre-induction systolic blood pressure. The literature provides 140 definitions for intra-operative hypotension in 130 studies using various levels of reductions in systolic, diastolic and mean blood pressure with different cumulative time intervals.^[10,11]

Bijker *et al.*^[12] found that the definition of intra-operative hypotension relative to the patient's baseline blood pressure offers a better post-operative

risk assessment on the adverse outcome than using fixed chosen values. Salmasi *et al.*^[6] assessed the relationship between intra-operative hypotension and acute kidney and myocardial injury in non-cardiac surgery; both relative or absolute intra-operative hypotension give the same results in relation to post-operative kidney and heart injury. In addition, they found that sufficient time is needed to produce heart or kidney injury when blood pressure decreases by 20% relative to the baseline and that the classical teaching that intra-operative blood pressure should be maintained within 20% of the pre-operative value is justified.

Walsh *et al.*^[13] found that, with mean arterial blood pressure <55 mmHg or the mean blood pressure decreased more than 20% relative to the baseline reading, the time spent (in min) during non-cardiac surgery is associated with increased risk for post-operative myocardial and kidney injury.

In this study, most patients were old and belonged to the ASA physical status III. They were classified based on the number of comorbidities but no statistically significant relationship between the number of comorbidities and intra-operative hypotension was found.

Pre-operative comorbidities are not modifiable, and the optimisation of severe abnormalities rather than cure is required. Maxwell *et al.*^[14] reviewed anaesthetic management of patients with hip fracture and found no evidence of delay in surgical repair of hip fractures for pre-optimisation of patient comorbidities to improve outcome.

In this study, no effect of the type of anaesthesia on the rate of intra-operative hypotension was found. Several studies found no definitive advantage of one anaesthetic technique over another (general vs. spinal) regarding intra-operative and post-operative complications.^[15-19] We found an association between the delay of surgery by more than 24 hrs and the rate of post-operative complications, and these findings are consistent with many recent publications. Many studies show that surgery delay beyond 48 h from admission increases the rate of mortality, complications and the length of stay in hospital.^[20-22] Despite the recommendation, Maxwell *et al.* list acceptable reasons for delaying surgery for more than 48 h, such as severe anaemia, severe electrolyte disturbance, uncontrolled heart failure and diabetes, since their risks outweigh

the benefit of early surgery and thus recommend pre-operative optimisation.

In our study, a factor related to both intra-operative hypotension and post-operative complications was blood transfusion. Sabat *et al.*^[23] found that intra-operative hypotension and blood transfusion were among the predictors of major adverse events in non-cardiac surgery. Anaemia and blood transfusion^[24-27] increase morbidity, intensive care admissions and the development of atrial fibrillation in cardiac and non-cardiac surgery.

Despite these reports, it remains a continuous debate on whether to transfuse blood and what haemoglobin level triggers blood transfusion. According to the World Health Organisation, the definition of anaemia is a haemoglobin level of <12 gm/dl for women and <13 gm/dl for men. In elderly people, most of the time, haemoglobin level of 8–10 gm/dl needs blood transfusion, and these criteria are taken into consideration in non-anaesthetised patients. Multimodal protocols or algorithms may be employed as strategies to reduce the usage of blood products. However, no single algorithm or protocol can be recommended. A restrictive red blood cell transfusion strategy may be safely used to reduce transfusion administration. The determination of whether haemoglobin concentrations between 6 and 10 g/dl justify red blood cell transfusion should be based on potential or actual ongoing bleeding (rate and magnitude), intravascular volume status, signs of organ ischaemia and the adequacy of cardiopulmonary reserve.^[28] In our cases, the estimation of intra-operative blood loss depended upon the amount of blood in the suction and soaked gauzes, and we transfused our patients once the estimated blood loss was more than 20% of the patient's blood volume.

Anaesthesiologists not only depend on haemoglobin level to start blood transfusion intra-operatively, especially when doing haemoglobin level takes a long time. The intra-operative cardiovascular parameters like blood pressure, heart rate and ongoing blood loss usually lead to blood transfusion.

In our study, 18% of the patients received vasopressors to treat intra-operative hypotension and 25% were transfused with blood. We over-transfused our patients because the transfusion might be started in some patients to treat pre-operative anaemia which is common in these patients and not due to intra-operative hypotension or blood loss.

A limitation of this study is the small number of the patient population that prevented us from applying any inferential statistics such as regression.

CONCLUSION

In conclusion, 18% of patients had intra-operative hypotension, and the rate of post-operative complications increased with intra-operative hypotension. Blood transfusion was associated with intra-operative hypotension and post-operative complications.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

- Thippampall AK, Gurajala I, Gopinath R. The effect of different dose regimens of tranexamic acid in reducing blood loss during hip surgery. *Indian J Anaesth* 2017;61:235-9.
- Haentjens P, Magaziner J, Colon emeric CS, Vanderschueren D, Mellisin K, Velkenier B, et al. Meta-analysis: Excess mortality after hip fracture among older women and men. *Ann Intern Med* 2010;152:380-90.
- Le-Wendling L, Bihorac A, Baslanti TO, Lucas S, Sadasivan K, Wendling A, et al. Regional Anesthesia as compared with general anesthesia for surgery in geriatric patients with hip fracture: Does it decrease morbidity, mortality, and health care costs? Results of a single-centered study. *Pain Med* 2012;13:948-56.
- Mascha EJ, Yang D, Weiss S, Sessler DI. Intraoperative mean arterial pressure variability and 30-day mortality in patients having noncardiac surgery. *Anesthesiology* 2015;123:79-91.
- Sun LY, Wijeyesundera DN, Tait GA, Beattie WS. Association of intraoperative hypotension with acute kidney injury after elective noncardiac surgery. *Anesthesiology* 2015;123:515-23.
- Salmasi V, Maheshwari K, Yang D, Mascha EJ, Singh A, Sessler DI, et al. Relationship between intraoperative hypotension, defined by either reduction from baseline absolute thresholds, and acute kidney and myocardial injury after oncardiac surgery: A retrospective cohort analysis. *Anesthesiology* 2017;126:27-65.
- Abelha FJ, Botelho M, Fernandes V, Barros H. Determinants of postoperative acute kidney injury. *Crit care* 2009;13:R79.
- Bijker JB, van Klei WA, Vergouwe Y, Eleveld DJ, van Wolfswink L, Moon KG, et al. Intraoperative hypotension and one-year mortality after noncardiac surgery. *Anesthesiology* 2009;111:1217-26.
- Monk TG, Saini V, Weldon BC, Sigl JC. Anesthetic management and one-year mortality after noncardiac surgery. *Anesth Analg* 2005;100:4-10.
- Bijker JB, van Klei WA, Kappen TH, van Wolfswinkel L, Moons KG, Kalkman CJ. Incidence of intraoperative hypotension as a function of the chosen definition: Literature definitions applied to a retrospective cohort using automated data collection. *Anesthesiology* 2007;107:213-20.
- Brady K, Hogue CW. Intraoperative hypotension and patient outcome: Does one size fit all. *Anesthesiology* 2013;119:495-7.
- Bijker JB, Persoon S, Peelen LM, Moons GM, Kalkman CJ, Kappelle LJ, et al. Intraoperative hypotension and perioperative ischemic stroke after general surgery. *Anesthesiology* 2012;116:658-64.
- Walsh M, Devereaux PJ, Garg AX, Kurz A, Turan A, Rodseth RN, et al. Relationship between intraoperative mean arterial pressure and clinical outcome after noncardiac surgery: Towards an empirical definition of hypotension. *Anesthesiology* 2013;119:507-15.
- Maxwell L, White S. Anaesthetic management of patients with hip fractures: An update. *BJA Educ* 2013;13:179-83.
- Luger TJ, Kammerlander C, Gosch M, Luger MF, Kammerlander-Knauer U, Roth T, et al. Neuroaxial versus general anaesthesia in geriatric patients for hip fracture surgery: Does it matter?. *Osteoporosis Int* 2012;21:555-72.
- Neuman MD, Silber JH, Elkassabany NM, Ludweg JM, Fleisher LA. Comparative effectiveness of regional versus general anesthesia for hip fracture surgery in adults. *Anesthesiology* 2012;117:72-92.
- Gilbert TB, Hawkes WG, Hebel GR. Spinal anesthesia versus general anesthesia for hip fracture repair: A longitudinal observation of 741 elderly patients during 2-year follow-up. *Am J Orthop* 2000;29:25-35.
- Paterno E, Neuman MD, Schneeweiss S, Mogun H, Bateman BT. Comparative safety of anesthetic type for hip fracture surgery in adults: Retrospective cohort study. *BMJ* 2014;348:g4022.
- Ftough S, Morga A, Swift C. Management of hip fracture in adults: Summary of NICE guidance. *BMJ* 2011;342:d3304.
- British Orthopaedic Association. Standards for Trauma: Patients sustaining a fragility hip fracture (BOAST 1, version 2) 2012. Available from: <https://www.boa.ac.uk/wp-content/uploads/2014/12/BOAST-1.pdf>. [Last accessed on 2016 Aug 02].
- Griffiths R, Alper J, Beckingsale A, Goldhill D, Heyburn G, Holloway J, et al. Management of proximal femoral fractures 2011: Association of anaesthetists of Great Britain and Ireland. *Anaesthesia* 2012;67:85-98.
- Lewis PM, Waddell JP. When is the ideal time to operate on a patient with a fracture of the hip?: A review of the available literature. *Bone Joint J* 2016;98:1573-81.
- Sabate S, Mases A, Guileria N, Canet J, Castello J, Orrigo C, et al. Incidence and predictors of major perioperative adverse cardiac and cerebrovascular events in non-cardiac surgery. *BMJ* 2011;107:879-90.
- Bursi F, Barbieri A, Politi L. Perioperative red blood cell Transfusion and outcome in stable patients after elective major vascular surgery. *Eur J Vasc Endovasc Surg* 2009;37:311-8.
- Whitson BA, Huddleston SJ, Savik K, Shumway SJ. Risk of adverse outcomes associated with blood transfusion after cardiac surgery depends on the amount of transfusion. *J Surg Res* 2010;158:20-7.
- Kuduvalli M, Oo AY, Newall N. Effect of peri-operative red blood cell transfusion on 30-day and 1-year mortality following coronary artery bypass surgery. *Eur J Cardiothorac Surg* 2005;27:592-8.
- Koch CG, Li L, Van Wagoner DR, Duncan AI, Gillinov AM, Blackstone EH. Red cell transfusion is associated with an increased risk for postoperative atrial fibrillation. *Ann Thorac Surg* 2006;82:1747-56.
- Practice guidelines for perioperative blood management: An updated report by the ASA Task Force on perioperative blood management. *Anesthesiology* 2015;122:241-75.