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Research article

Cross-sectional study about perioperative management of Blood Pressure and effects of anaesthesia in hypertensive patients undergoing general & orthopaedic surgery

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ABSTRACT

Introduction: Hypertension is regarded as an additional risk factor during anaesthesia. There is not enough Indian evidence in literature regarding antihypertensive usage and its implications during perioperative period in patients undergoing general & orthopedic surgery. This drove us to conduct this study.

Methods: Single centre cross-sectional observational study conducted in a General Surgery and Orthopaedics wards of a Tertiary care hospital. The data was collected from the period of first visit by the anaesthetist to 24 h' postoperative period of the operated hypertensive patients. The variables accounted were of antihypertensive medications, anaesthesia drugs, hemodynamics, blood loss and fluids used. The data was analysed by using descriptive statistics, nonparametric tests and $P < 0.05$ was considered as significant.

Results: 180 patients had median age of 65 years (Interquartile range – 20). Calcium channel Blockers were the most common class and Amlodipine was most common antihypertensive medication used during perioperative period. 132 patients took antihypertensive medication on the morning of the surgery. In 136 patients' antihypertensive medication was started within 24 h' postoperative period. Bupivacaine was most common anaesthetic drug used. Intraoperative fall in SBP (Systolic Blood Pressure) was found in 31 patients, and rises were found in 7 patients. Also, intraoperative fall in DBP (Diastolic Blood Pressure) was found in 13 patients, and rises were found in 9 patients. Intraoperative hemodynamic changes were managed appropriately by the anaesthetist. The median IV fluids given intraoperatively was 1375 ml (Interquartile range – 700). Median blood loss was 272 ml (Interquartile range – 250).

Conclusion: Antihypertensive medications use during perioperative period were not associated with major hemodynamic changes.

1. Introduction

Hypertension is the most common condition seen in primary care, and it remains one of the most important preventable contributors to disease and death [1]. Withdrawal of antihypertensive drugs could lead to withdrawal symptoms like rebound hypertension, tachyarrhythmia, nervousness, anxiety, and exaggeration of angina and occasionally myocardial infarction and sudden death [2].

A hypertensive patient can undergo routine stressors like infection, trauma & surgery. During surgery, the manipulation of blood pressure (BP) is crucial for the conduct of the surgery as well as to prevent complications of surgery. Hypertension is regarded as an additional risk in anaesthesia [3]. There are different theories regarding the use of antihypertensive, whether to continue the same anti-hypertensives prior to surgery or discontinue and start on different anti-hypertensives. One of the recommendation is that if the diastolic blood pressure (DBP) is ≤110 mmHg and stable, surgery may proceed without delay provided the perioperative blood pressure is monitored closely, and hyper- or hypotensive episodes are treated appropriately [4]. Another approach is if the DBP is > 100 mmHg, with or without antihypertensive therapy, surgery should be deferred until the blood pressure is under better control [5].

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Thus, there are no guidelines as to how these antihypertensive medications should be manipulated before, during or after the surgery. Further, there are no head on comparison studies between all classes of antihypertensive medications usage during perioperative period specially in patients undergoing general & orthopaedic surgery. Also, there are no studies on Indian population who are given antihypertensive medications like beta blockers even though JNC 8 guidelines (Joint National Committee 8 guidelines) no longer recommend use of beta blockers.

Therefore, we planned an observational study, to evaluate how a hypertensive patient when undergoes surgery is managed in terms of the antihypertensive drug usage, complications and adverse events handled.

2. Methods

The study was a single centre cross-sectional observational study conducted in a tertiary care hospital for 9 months. The study began after approval from Institutional Ethics Committee. Patients admitted to General surgery and Orthopaedics wards for elective surgery consented for the study after considering the selection criteria. Inclusion criteria were patients with age of 18 years to 75 years of either gender, admitted to general surgery and orthopaedics wards. Patients who were hypertensive whether taking or not taking any antihypertensive medications and had undergone elective general & orthopaedic surgery during the duration of the study period. Exclusion criteria were patients with pheochromocytoma, pregnant women, complicated patients and emergency surgeries.

Patients files were evaluated to get the details of history of hypertension, time between the first visit of the patient to the anaesthetist and anaesthesia fitness clearance, time to control of uncontrolled hypertension, any delay or postponement of surgery due to uncontrolled hypertension, and BP recording on first visit to the anaesthetist. Similarly, modifications in anti-hypertensive treatment during the scheduled surgery and anti-hypertensive medications continued on the day of the surgery were noted. Patient notes on day of the surgery by anaesthetists and surgeon were evaluated to find anaesthesia risk (The American Society of Anesthesiologists (ASA) grades), type of surgery, whether antihypertensive drugs stopped before surgery or continued, pre-anesthetic medications started, type of anaesthesia, intraoperative hemodynamics, total blood loss, duration of anaesthesia and any perioperative adverse events and their management. The patients' files were analysed to find postoperative adverse events and its management along with the duration after which antihypertensive medications were started again. Data was collected for 24 h' in postoperative period.

Intraoperative hemodynamics included SBP, DBP & HR (Heart Rate). A total number of falls (drops) and ups (rises) in SBP & DBP were noted. Falls were defined as drop of BP 30% below the baseline value (BP at the start of surgery) and ups were defined as BP 10% above baseline value. ECG (electrocardiogram) changes were recorded as either intraoperative ECG changes were present or absent and if present whether it required any intervention.

Data collection included data from patient's first visit to anaesthetist to 24 h' postoperative period in the case record form. The study finding was recorded in a single visit after 24 h of surgery in the respective wards.

Sample size was based on duration of the study. At the end of data collection, complete data from all the case record forms were entered in a Master-chart in MS-EXCEL format for analysis. Statistics were applied using IBM SPSS statistics software version 23 and $P < 0.05$ was considered as significant.

3. Results

A total of 180 hypertensive patients' data in perioperative period was collected in the study. Normality was tested with Shapiro-Wilk test. All the variables were not normally distributed except SBP at the end of anaesthesia.

The median age of the patients was 65 years (Interquartile range – 20). Minimum age of the patient recruited was 25 years, and maximum age was 75 years. 80 patients were male, and 100 were female. The median duration of hypertension was 60 months (Interquartile range - 96) with a minimum duration of hypertension in a patient being 10 days and maximum duration of 360 months. In three patient's durations of hypertension was unknown and 8 patients were newly diagnosed hypertensives.

Out of 180 patients, 13 patients (7.2%) were not taking any antihypertensive medications at the time of admission and in 4 patients the history of taking anti-hypertensive medication was not known. Amlodipine was the most commonly taken antihypertensive medication by 104 patients. Other common antihypertensive medications were Telmisartan (n = 34), atenolol (n = 21), metoprolol (n = 19), losartan (n = 14), hydrochlorothiazide (n = 14) and others (n = 42). Classes of antihypertensive medications used were CCB (Calcium Channel Blocker) in 110 patients, ARB (Angiotensin Receptor Blocker) in 52 patients, BB (Beta Blockers) in 41 patients, Diuretics in 23 patients, ACEIs (Angiotensin Converting Enzyme Inhibitors) in 17 patients, alpha blockers (AB) in 4 and vasodilators in one patient. Most commonly prescribed combination of Antihypertensive medications was CCB + BB (n = 21), CCB + ARB (n = 18), ARB + Diuretics (n = 9) and CCB + ACE inhibitors (n = 3). 77 patients had been taking combination of antihypertensive drugs, and 84 patients were taking a single antihypertensive drug.

A total of 94 patients had 115 co-morbidities. Most common co-morbidity found was Diabetes mellitus (n = 41). A combination of Spinal and Epidural was the most common method of anaesthesia (n = 58), spinal only was in 57 patients, GA only was in 39 patients, regional anaesthesia was in 14 patients, spinal + regional in 4 patients, Epidural and GA + Epidural was in 3 patients each and spinal + local anaesthesia and GA + regional was given in 2 patients each.

SBP at the 1st visit by the patients to the anaesthetist was 133.58 ± 14.35 and DBP was 83.03 ± 9. Median time to anaesthesia fitness for surgery was 4 days (Interquartile range – 6.75). 35 patients got fitness on the 1st visit to the anaesthetist. Median duration taken to control the uncontrolled hypertension was 2 days (Interquartile range – 1) and 1 patient had uncontrolled hypertension until the day of surgery. In 13 cases, there was a delay in anaesthesia fitness due to uncontrolled hypertension for reasons as ECG changes, left ventricular failure, uncontrolled hypertension, awaiting physician and cardiology opinion.

In 2 patients antihypertensive medication taken by the patient was modified by the anaesthetist/ physician. In one case Ramipril taken by the patient was stopped 4 days before surgery, and in another case, atenolol was stopped & amlodipine was continued by the anaesthetist. In 11 patients, new antihypertensive medications were started. In 8 cases Amlodipine 5 mg OD (once daily), in 1 patient Amlodipine 10 mg BD (twice daily), in 1 patient Amlodipine 5 mg OD & Losartan 25 mg OD and in 1 patient Losartan 50 mg SOS was started.

In 132 patients antihypertensive medications were continued till the morning of surgery and in 48 patients no antihypertensive drug was continued. Most common classes of drugs continued till morning of surgery were CCB continued in 98 patients, ARB in 26 patients, BB in 26 patients, Diuretics in 11 patients, ACE inhibitors in 9 patients, AB in 2 and Vasodilators in none.

ASA class for patients undergoing anaesthesia were, ASA 2 (n = 153), ASA 3 (n = 24) and ASA 4 (n = 3). Most common type of surgeries was fracture reduction (n = 69), hemiarthroplasty (n = 23), TKR – Total Knee Replacement (n = 20), THR – Total Hip Replacement (n = 19), Spacer (n = 7), decompression Fixation (n = 5) and closed Reduction (n = 4).

A combination of Spinal and Epidural (neuraxial anaesthesia) was the most common method of anaesthesia (n = 58).

Most commonly used anaesthesia drug was bupivacaine in 137

Table 1
HR, SBP and DBP during intraoperative period.

	Median	Interquartile range	Minimum	Maximum
Heart Rate (beats per minute)				
Start of Anaesthesia	88	14	58	122
End of Anaesthesia	84	12	56	132
Maximum value intraoperatively	93	12	60	135
Minimum value intraoperatively	76	12	50	122
Systolic Blood Pressure (mmHg)				
Start of Anaesthesia	138	20	84	204
End of Anaesthesia	120	16	90	154
Maximum value intraoperatively	140	20	110	204
Minimum value intraoperatively	112	13.5	82	142
At Maximum DBP	134	24	78	204
At Minimum DBP	118	13.5	60	146
Diastolic Blood Pressure (mmHg)				
Start of Anaesthesia	88	12	44	132
End of Anaesthesia	78	12	44	104
Maximum value intraoperatively	88	12	44	132
Minimum value intraoperatively	73	12	44	100
At Maximum DBP	90	12	44	132
At Minimum DBP	70	16	40	94

patients, followed by midazolam in 90, fentanyl in 74, lidocaine in 63, buprenorphine in 51 and propofol in 37 patients. Other drugs were N2O, clonidine, desflurane, isoflurane, sevoflurane, etomidate, tramadol. Ketamine, dexmedetomidine, pentazocine and thiopentone.

HR, SBP and DBP during intraoperative period are given in Table 1. Intraoperative fall in SBP was found in 31 patients, and rises were found in 7 patients. Also, intraoperative fall in DBP was found in 13 patients, and rises were found in 9 patients. In one patient, intraoperative Injection of Nitro-glycerine at 50 mg/hr for 6 h was given for controlling rise in SBP (172 mmHg).

Intraoperative ECG changes was only found in 1 patient. Total blood loss (in ml) in patients was 342.35 ± 315.14. Maximum blood loss in a patient was 2200 ml, and the minimum was 10 ml.

In 8 patients perioperative adverse events were noted and in 1 patients there was allergic reaction to cephalosporin which was managed by Adrenaline 0.1 mg IV given 5 times and Ephedrine 6 mg. When there is fall in BP postoperative IV (intravenous) fluids and blood infusion provided and rise in blood pressure was managed with antihypertensive medication.

Median duration after which the antihypertensive medication was started was 16 h (Interquartile range – 6). Minimum duration was 5 h, and maximum duration was 24 h as the data collected was for 24 h postoperative period.

In 136 patients' antihypertensive medications were started again within 24 h' postoperative period. Most common class of antihypertensive medication which was started within 24 h postoperative period was CCB in 99 patients, ARB in 43 patients, BB in 30, diuretics in 19, ACE inhibitors in 13 and alpha blockers (AB) in 3 patients (Table 2).

If a patient was taking BB as routine antihypertensive, there was significant relation between heart rate at the end of surgery i.e. beta blockers group had a lower heart rate in the end (Mann-Whitney U Test, $P < 0.05$). If a patient was taking diuretics on the morning of surgery, there was a significant association with heart rate and DBP (higher) at the end of surgery (Mann-Whitney U Test, $P < 0.05$). Morning Beta blockers also had significant association with heart rate (lower) at the end of surgery (Table 3 and 4).

There was higher occurrence of rises in DBP in patients who received Fentanyl when compared with those who did not receive it (Chi-square test, $P < 0.05$). Also, there was a significant occurrence of rises in SBP & DBP in Desflurane group (Chi-square test, $P < 0.05$) (Table 5).

There was no significant difference in ECG changes when compared to any of the variables ($P > 0.05$).

Table 2
Profile of antihypertensive drugs used in perioperative period.

Anti HT Drugs Class	Routine	Morning of surgery	24 hrs postoperative
CCB	110	98	99
ARB	52	26	43
Beta blockers	41	26	30
Diuretics	23	11	19
ACEI	17	9	13
Alpha blockers	4	2	3
Vasodilators	1	0	0

Table 3
Association between HR at the end of anaesthesia with routine & morning use of beta blockers and morning diuretics.

HR at the End of Anaesthesia (bpm)			
Routine Beta Blockers	N	Median	Interquartile range
Not taken	135	86	12
Taken	45	80[a]	14
Total	180	84	12
Morning Diuretics	N	Median	Interquartile range
Not taken	169	84	12
Taken	11	90[a]	16
Total	180	84	12
Morning Beta blockers	N	Median	Interquartile range
Not taken	153	84	10
Taken	27	80[a]	16
Total	180	84	12

[a] Mann-Whitney U Test, $P < 0.05$.

Table 4
Association between DBP at the end of anaesthesia with diuretics use in the morning of surgery.

DBP at the end of Anaesthesia (mmHg)			
Morning Diuretics	N	Median	Interquartile range
Not taken	169	78	12
Taken	11	80[a]	4
Total	180	78	12

[a] Mann-Whitney U Test, $P < 0.05$.

Table 5
Associations between rises in DBP with use of fentanyl and desflurane.

Fentanyl with DBP Rise				
		DBP Rise		Total
		No rise	Rise	
Fentanyl	Not given	104	2	106
	Given	67	7[a]	74
Total		171	9	180
Desflurane with DBP Rise				
		DBP Rise		Total
		No rise	Rise	
Desflurane	Not given	164	6	170
	Given	7	3[a]	10
Total		171	9	180

[a] Chi-square test, $P < 0.05$.

4. Discussion

Our study was planned to look into the perioperative evaluation, care and management of the patient with hypertension undergoing general & orthopaedic surgery which included the antihypertensive drug use, anaesthesia and their effects and side effects on hemodynamics with their management strategies in perioperative period. Our study did not find any variability in perioperative outcomes according to age or gender.

Our study data matched with, a study done in geriatric patients, where the common drug classes prescribed were CCBs [6]. These findings go hand in hand with the guidelines which recommend CCBs as one of the first choices of the drug for patients with hypertension along with DM [1].

In our study, there were 13 cases of delay in surgery due to uncontrolled hypertension. The reasons for delay in surgery were patients had uncontrolled hypertension with comorbidities for which there was expert opinions sought. Some studies have proposed that high arterial pressure at the time of surgery, places the patient at risk of hemodynamic instability, and therefore, these patients would be at higher susceptibility to myocardial ischemia with extreme hypotension [7,8]. Other complications that are linked to perioperative hypertension are intracerebral bleeding, hypertensive encephalopathy, aortic dissection, disruption of the aortic or arterial suture, and left ventricular failure [9]. The level of evidence for a delay in surgery in patients with BP $<$ 180/110 mmHg is not much.

In our study patients who have been taking routine beta blockers and on the morning of the surgery were associated with lower heart rate at the end of the anesthesia. Also, patients who had taken diuretics in the morning of the surgery were associated with higher heart rate and DBP at the end of the anesthesia. No other anti-hypertensive medications was associated with any statistically significant change in hemodynamic variables.

Patients who were previously taking beta blockers or on the morning of the surgery had lower heart rate at the end of surgery compared to patients not on beta blockers. Results from studies have shown that perioperative beta blockers are cardioprotective and patients chronically treated with beta-blockers should continue to take them throughout the peri-operative period [10–12]. Withdrawal of beta-blockers during the 1st week after surgery is associated with postoperative myocardial infarction and death [13].

In our study, CCBs were the most common antihypertensive drug taken in the morning and 24 h after the surgery. CCBs, unlike beta blockers, are not found to prevent perioperative adverse events when continued during perioperative period [14]. But CCBs do not have any negative effect during the perioperative period and should be continued by the patients. Meta -analysis has shown that CCBs were associated with reduced risk of death and MI [15].

Studies have shown that ACE inhibitors and ARB are associated with higher incidence of intraoperative hypotension [16,17]. Also, a systematic review did not find any benefit of continuing ACE inhibitors and ARBs in preventing mortality, morbidity and hemodynamic complications [18]. In many studies, authors have recommended withholding ACE inhibitors on the morning of surgery [19,20]. Even patients who did not take ACE inhibitors on the morning of the surgery but were chronically treated with them experienced more episodes of hypotension and need for vasopressor drugs intraoperatively [21]. Contrary to this, some studies have found no increase in the incidence of hypotension in patients who took ACE inhibitors [22]. Because of these findings one of the authors of a study recommended to review the practice and recommendations to withhold ACE inhibitors before the surgery [23].

In a randomised controlled trial, it was found that morning dose of furosemide was not associated with intraoperative hypotension, intraoperative administration of vasopressors and fluids when compared to placebo [24].

A study found that epidural anaesthesia was associated with significantly more blood loss when compared to inhalational anaesthetic [25]. Anaesthetic technique and the pre-operative baseline BP continue to have an influence on the lability of the BP in the post-operative period, albeit to a lesser degree. Post-operative patients would probably have some degree of pain, but the intensity of the stimulus would be much lower than that during the intra-operative period. Patients who were given a spinal anaesthetic might have had better pain relief during the early postoperative period, leading to a less change in BP [26]. Also, patients with hypertension were found to have a lower heart rate. This could be because most of the hypertensive patients had β-blocker treatment [26].

In a study, Propofol caused the greatest drop in blood pressure whereas etomidate caused the least [27]. Fentanyl was associated with higher rises in DBP, which contrasts with Fentanyl as it is known to cause hypotension intraoperatively. The inadequate analgesia of fentanyl may lead to increase in intraoperative BP. Buprenorphine was associated with higher drops in SBP intraoperatively. Desflurane was associated with higher incidence of SBP rises in our study, but it is known to cause hypotension in geriatric patients [28]. Hypotension following induction of anaesthesia using propofol is caused by propofol-mediated decrease in sympathetic activity including decrease in systemic vascular resistance and decrease in cardiac output by a combination of venous and arterial vasodilation, impaired baroreflex mechanism and depression of myocardial contractility [29].

In a study it was noted that patients who received GA experience initially a drop in BP at induction of anaesthesia, followed by an increase after tracheal intubation. The BP profile is different in patients who are given spinal anaesthesia. There are less of the rise and falls seen at the start of surgery under general anaesthesia. This was consistent with previous studies that hypertensive patients are more vulnerable to blood pressure fluctuations in response to anaesthetic agents and vasodilators [26].

In 1 patient, there was ECG change (bigeminy) due to Cephalosporin allergy. To control the hypotension due to allergic reaction the patients was given Adrenaline 0.1 mg IV 5 times and Ephedrine 6 mg in a single dose.

Hypertensive patients who have either controlled or uncontrolled BP require IV fluids in the perioperative period irrespective of the type of surgery. Intraoperative fluids may be given as preloading or after loading in patients to prevent intraoperative hypotension during neuraxial blockade like spinal anaesthesia. But none of these methods is efficient in preventing the hypotension alone and has to be coupled with judicious use of vasopressors [30].

In 7 patients there were adverse events, which required special intervention like postoperative IV fluids, patients not recovering from anaesthesia, amlodipine 10 mg as and when required was started because of postoperative BP of 160/100 mmHg, postoperative ophthalmological opinion in case of blurring of vision in the patients and postoperative haemoglobin level being done and blood transfusion being given if required.

Antihypertensive drugs were started irrespective of the blood pressure of the patients on the next day of surgery in majority of the patients. A total of 44 patients were not started on any antihypertensive medication within 24 h postoperatively, and reasons were low BP postoperatively which were not recorded in the patient notes, but when consulted to the respective resident doctors on duty the information was divulged. There was no relation between blood pressure and postoperative starting of antihypertensive medications as patients were advised to continue their routine medication on next day morning of the surgery.

Limitations of our study is the Investigators were not present in the operation theatre at the time of surgery, so relying on the anaesthesia notes for data capturing might not reflect an accurate picture of the anaesthesia management during the intraoperative period. Also Intraoperative hemodynamics like heart rate and blood pressure are as

per readings written by the anaesthesia resident doctors, so our finding might not be as accurate as electronic recordings of such variables.

5. Conclusion

Patients who were taking beta blockers routinely and in morning of the surgery, had lower heart rate at the end of surgery. Patients who had taken diuretics on the morning of the surgery has higher DBP & HR at the end of surgery. No other antihypertensive medication any significant change in the hemodynamic parameters.

Key Messages

Use of beta blockers routinely and on morning of the surgery by the patients was associated with lower heart rate at end of anaesthesia. Morning use of diuretics was associated with higher heart rate and diastolic blood pressure at the end of anaesthesia. Fentanyl was associated with higher incidences of rise in diastolic blood pressure and desflurane was associated with higher incidences of rise in systolic and diastolic blood pressure intraoperatively.

Conflict of interest

The authors declared that there is no conflict of interest.

References

[1] James PA, Oparil S, Carter BL, Cushman WC, Dennison-Himmelfarb C, Handler J, et al. 2014 Evidence-based guideline for the management of high blood pressure in adults. JAMA 2014;311:507. http://dx.doi.org/10.1001/jama.2013.284427.

[2] Karachalios GN, Charalabopoulos A, Papalimneou V, Kiortsis D, Dimicco P, Kostoula OK, et al. Withdrawal syndrome following cessation of antihypertensive drug therapy. Int J Clin Pract 2005;59:562–70. http://dx.doi.org/10.1111/j.1368-5031.2005.00520.x.

[3] Prys-Roberts C, Greene LT, Meloche R, Foëx P. Studies of anaesthesia in relation to hypertension. II. Haemodynamic consequences of induction and endotracheal intubation. Br J Anaesth 1971;43:531–47.

[4] Goldman L, Caldera DL. Risks of general anesthesia and elective operation in the hypertensive patient. J Am Soc Anesthesiol 1979;50:285–92.

[5] Prys-Roberts C. Isolated systolic hypertension: pressure on the anaesthetist? Anaesthesia 2001;56:505–10. http://dx.doi.org/10.1046/j.1365-2044.2001.02136.x.

[6] Jarari N, Rao N, Peela JR, Ellafi KA, Shakila S, Said AR, et al. A review on prescribing patterns of antihypertensive drugs. Clin Hypertens 2015;22:7. http://dx.doi.org/10.1186/s40885-016-0042-0.

[7] Hanada S, Kawakami H, Goto T, Morita S. Hypertension and anesthesia. Curr Opin Anaesthesiol 2006;19:315–9. http://dx.doi.org/10.1097/01.aco.0000192811.56161.23.

[8] Varon J, Marik PE. Perioperative hypertension management. vol. 4. Dove Press; 2008. http://doi.org/10.1016/B978-1-4160-2215-2.50082-X.

[9] Skarvan K. Perioperative hypertension: new strategies for management. Curr Opin Anaesthesiol 1998;11:29–35. http://dx.doi.org/10.1097/00001503-199802000-00006.

[10] Fleisher LA, Fleischmann KE, Auerbach AD, Barnason SA, Beckman JA, Bozkurt B, et al. 2014 ACC/AHA Guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery: a report of the american college of cardiology/American Heart Association Task Force on Practice Guidelines. vol. 64; 2014. http://doi.org/10.1016/j.jacc.2014.07.944.

[11] Dai N, Xu D, Zhang J, Wei Y, Li W, Fan B, et al. Different β-blockers and initiation time in patients undergoing noncardiac surgery: a meta-analysis. Am J Med Sci 2014;347:235–44. http://dx.doi.org/10.1097/MAJ.0b013e31828c607c.

[12] Lindenauer PK, Pekow P, Wang K, Mamidi DK, Gutierrez B, Benjamin EM. Perioperative beta-blocker therapy and mortality after major noncardiac surgery. N Engl J Med 2005;353:349–61. http://dx.doi.org/10.1056/NEJMoa041895.

[13] van Klei WA, Bryson GL, Yang H, Forster AJ. Effect of β-blocker prescription on the incidence of postoperative myocardial infarction after hip and knee arthroplasty. Anesthesiology 2009;111:717–24. http://dx.doi.org/10.1097/ALN.0b013e3181b6a761.

[14] Stevens RD, Burri H, Tramr MR. Pharmacologic myocardial protection in patients undergoing noncardiac surgery: a quantitative systematic review. Anesth Analg 2003:623–33. http://dx.doi.org/10.1213/01.ANE.0000074795.68061.16.

[15] Wijeysundera DN, Beattie WS. Calcium channel blockers for reducing cardiac morbidity after noncardiac surgery: a meta-analysis. Anesth Analg 2003;97:634–41.

[16] Calloway JJ, Memtsoudis SG, Krauser DG, Ma Y, Russell LA, Goodman SM. Hemodynamic effects of angiotensin inhibitors in elderly hypertensives undergoing total knee arthroplasty under regional anesthesia. J Am Soc Hypertens 2014;8:644–51. http://dx.doi.org/10.1016/j.jash.2014.05.017.

[17] Rosenman DJ, McDonald FS, Ebbert JO, Erwin PJ, LaBella M, Montori VM. Clinical consequences of withholding versus administering renin-angiotensin-aldosterone system antagonists in the preoperative period. J Hosp Med 2008;3:319–25. http://dx.doi.org/10.1002/jhm.323.

[18] Zou Z, Yuan HB, Yang B, Xu F, Chen XY, Liu GJ, et al. Perioperative angiotensin-converting enzyme inhibitors or angiotensin II type 1 receptor blockers for preventing mortality and morbidity in adults. Cochrane Database Syst Rev 2016:CD009210. http://dx.doi.org/10.1002/14651858.CD009210.pub2.

[19] Comfere T, Sprung J, Kumar MM, Draper M, Wilson DP, Williams BA, et al. Angiotensin system inhibitors in a general surgical population. Anesth Analg 2005;100:636–44. http://dx.doi.org/10.1213/01.ANE.0000146521.68059.A1.

[20] Smith I, Jackson I. Beta-blockers, calcium channel blockers, angiotensin converting enzyme inhibitors and angiotensin receptor blockers: should they be stopped or not before ambulatory anaesthesia? Curr Opin Anaesthesiol 2010;23:687–90. http://dx.doi.org/10.1097/ACO.0b013e32833eeb19.

[21] Kheterpal S, Khodaparast O, Shanks A, O'Reilly M, Tremper KK, O'Reilly M, et al. Chronic angiotensin-converting enzyme inhibitor or angiotensin receptor blocker therapy combined with diuretic therapy is associated with increased episodes of hypotension in noncardiac surgery Sachin 2008;22. http://doi.org/10.1053/j.jvca.2007.12.020.

[22] Kwak HJ, Kwak YL, Oh YJ, Shim YH, Kim SH, Hong YW. Effect of angiotensin-converting enzyme inhibitors on phenylephrine responsiveness in patients with valvular heart disease. J Int Med Res 2005;33:150–9.

[23] Vieira Da Costa V, Caldas AC, Guilherme L, Nunes N, Sérgio P, Beraldo S, et al. Influence of angiotensin-converting enzyme inhibitors on hypotension after anesthetic induction. Is the preoperative discontinuation of this drug necessary? Rev Bras Anestesiol 2009;59.

[24] Khan NA, Campbell NR, Frost SD, Gilbert K, Michota FA, Usmani A, et al. Risk of intraoperative hypotension with loop diuretics: a randomized controlled trial. Am J Med 2010;123:1059.e1-8. http://dx.doi.org/10.1016/j.amjmed.2010.07.019.

[25] Modig J. Regional anaesthesia and blood loss. Acta Anaesthesiol Scand Suppl 1988;89:44–8. http://dx.doi.org/10.1111/j.1399-6576.1988.tb02842.x.

[26] Poh KS, Lim TA, Airini IN. Peri-operative blood pressure changes in normotensive and hypertensive patients. MedJ Malaysia 2007;62:97–103.

[27] Benson M, Junger A, Fuchs C, Quinzio L, Böttger S, Hempelmann G. Use of an Anesthesia Information Management System (AIMS) to evaluate the physiologic effects of hypnotic agents used to induce anesthesia. J Clin Monit Comput 2000;16:183–90. http://dx.doi.org/10.1023/A:1009937510028.

[28] Medscape. Suprane (desflurane) dosing, indications, interactions, adverse effects, and more 2016. http://reference.medscape.com/drug/suprane-desflurane-343095#4.

[29] Farhan M, Hoda MQ, Ullah H. Prevention of hypotension associated with the induction dose of propofol: A randomized controlled trial comparing equipotent doses of phenylephrine and ephedrine. J Anaesthesiol Clin Pharmacol 2015;31:526–30. http://dx.doi.org/10.4103/0970-9185.169083.

[30] Bajwa SJS, Kulshrestha A, Jindal R. Co-loading or pre-loading for prevention of hypotension after spinal anaesthesia! a therapeutic dilemma. Anesth Essays Res 2013;7:155–9. http://dx.doi.org/10.4103/0259-1162.118943.