

Review

Citation: Kumanan, T., Sujanitha, V., Guruparan, M., Premakrishna, S. and Sutharshan, V., 2020. Hypertension in a Surgical Patient - A Sri Lankan Perspective. Sri Lanka Journal of Medicine, 29(2), pp 16-24 DOI: <http://doi.org/10.4038/sljm.v29i2.156>

Hypertension in a Surgical Patient - A Sri Lankan Perspective


T. Kumanan¹, V. Sujanitha¹, M. Guruparan², S. Premakrishna² and V. Sutharshan²

¹University Medical Unit, Teaching Hospital-Jaffna, Sri Lanka

²Teaching Hospital-Jaffna, Sri Lanka

Correspondence: V. Sujanitha.
Senior Lecturer, University Medical Unit, Teaching Hospital, Jaffna.

Email: sujanitha@yahoo.com

 <https://orcid.org/0000-0002-5069-5918>

Abstract

Hypertension is the most common medical co morbidity encountered in a perioperative patient. It often causes a dilemma in management and results in postponement of surgery. Although the consequences of uncontrolled hypertension have significant adverse outcome in a surgical patient, there are no national guidelines or protocols on how to manage such a situation. Having a clear understanding about the evaluation of such patients; target blood pressure levels; selection and timing of appropriate antihypertensive medication would improve the outcome of these patients. This review article would focus on a practical guide to the clinicians in evaluating and managing a patient with perioperative hypertension in a Sri Lankan setting.

Keywords: *Pre-operative hypertension, perioperative hypertension, surgical patient.*

INTRODUCTION

Hypertension is often attributed as a risk factor for the most important causes of death in Sri Lanka which includes; coronary heart disease, cerebrovascular disease, heart and renal failure. Nearly 20-30% of the adult population have blood pressure levels that are above normal and this prevalence is on par with that of developed countries [1-3]. Hypertension increases perioperative cardiovascular events by almost 35% [4]. High blood pressure during the perioperative period significantly increases cardiovascular and cerebrovascular events. It also increases the risk of perioperative bleeding [5,6]. Almost a quarter of patients having major surgery are complicated by perioperative hypertension [7] and the incidence is much higher and reaches almost up to 80% in patients undergoing cardiac surgery [5,6]. Hence it should be identified and optimized prior to major elective non-cardiac or cardiac surgery in order to prevent significant morbidity and mortality.

Elevated blood pressure is also the most common medical problem identified during pre-operative anaesthetic evaluation of patients and it is the commonest reason for the postponement of surgery. Proceeding with the immediate control of blood pressure in emergency situations and the postponement of elective surgeries until the blood pressure is controlled is the usual practice observed in the Sri Lankan setting.

METHODOLOGY

This article is a narrative overview. It aims to summarize the studies that have been done in perioperative hypertension. The authors selected appropriate studies to emphasize their view however the review does not seek generalization or cumulative knowledge on perioperative hypertension as it is not a systematic review.



EPIDEMIOLOGY

The overall prevalence of perioperative hypertension worldwide is around 20-25 % [8]. The prevalence and incidence of perioperative hypertension in Sri Lanka is not estimated to date. However, many studies done on hypertension have shown higher prevalence in urban adult population than rural adult Sri Lankans. Male gender, increasing age, prevalence of diabetes and central obesity were significantly associated with hypertension which were almost comparable to developed countries [2,3].

When higher income countries were compared to middle and low income countries, it has been proved that age standardized prevalence of hypertension is significantly high in low and low middle income countries while the prevalence has comparatively reduced in high income countries [9]. This, in combination with increasing incidence of non-communicable diseases in Sri Lanka, contributes significantly to high pick up rate of hypertension perioperatively.

The components of perioperative hypertension are often considered under the following situations, namely preoperative, intra operative and postoperative hypertension [10]. Preoperative hypertension occurs during the induction of anaesthesia, while intraoperative hypertension is observed with vasoconstriction resulting from acute pain and sympathetic over activation. During the early postoperative period, it is associated with pain induced sympathetic over activation, hypothermia, hypoxia, or intravascular volume expansion from enthusiastic intraoperative fluid infusion and after a day of surgery when the fluid is mobilized from the extravascular space into the intravascular compartment [8]. Discontinuation of oral medications including routine antihypertensive medication can also contribute to hypertension perioperatively.

Perioperative hypertension is frequently observed in vascular surgery in particular carotid surgery, abdominal aortic surgery, peripheral vascular intervention, intra-abdominal and intrathoracic operations [11]. Nearly one fourth of patients undergoing non-cardiac surgery are noted to have hypertension during the preoperative period. A blood pressure of >180 / 110 mm Hg has been associated with complications in particular ischemic cardiac events [12].

Different cut off values of diastolic and systolic blood pressures have been proposed over the

time to define significant blood pressure elevation during the perioperative period. Generally, a blood pressure value of 180/110 mmHg is considered significant [12].

IMPORTANCE OF PRE-OPERATIVE HYPERTENSION

Preoperative evaluation provides a chance to check, identify and optimize the blood pressure. Pre-operative hypertension is not considered an emergency and usually does not involve end organ dysfunction. However optimization of blood pressure will help to reduce the risk of intra and post-operative complications [13]. Patients could be either known hypertensives with an elevated blood pressure or previously documented normotensives with elevated blood pressure pre-operatively or can have elevated blood pressure with no previous documented blood pressure [14]. All three categories will need a detailed evaluation to identify the true status of blood pressure. During the evaluation, the balance between unjustified postponement and cancellation of surgery and safety of the patient during intra and post-operative period needs to be analyzed and a clear decision needs to be made based on the assessment and the type of surgery [15]. Controlling blood pressure for a period prior to the procedure is desirable as it would allow the body's auto regulatory responses to adjust in advance to face the fluctuations in perioperative blood pressure. If this is not achieved either a hypertensive crisis or end organ hypoperfusion due to severe hypotension could complicate the perioperative period [16].

EVALUATION

Blood pressure recorded in patients referred to the preoperative clinic and prior to surgery are often well above the readings that would be recorded in the same patients in a community setting [17]. It is not advisable to diagnose new or poorly controlled hypertension on the basis of readings taken just prior to surgery [8].

1. Identify the true high blood pressure

The primary task is to identify the patients as having hypertension as opposed to elevated blood pressure

secondary to stress [14,18,19]. Hypertension secondary to defaulting the long-term antihypertensive medications is common in clinical practice and failing to identify this results in extensive investigation and evaluation unnecessarily. Clinical features that point to high blood pressure due to anxiety and stress are very high blood pressure reading on the first instance when repeated becoming normal; a documented normal blood pressure within last 12 months; a known hypertensive with normal blood pressure during the clinic visits. In contrast certain clinical pointers that favour a true high blood pressure include a previously uncontrolled blood pressure or persistently high blood pressure at clinic visits, evidence of end organ damage and evidence of features of secondary hypertension on clinical evaluation.

2. Accurate measurement of blood pressure in the pre-operative cases

Blood pressure measurement is the most important clinical assessment in any clinical condition with marked inter individual variation in the technique and interpretation [20]. Hence the reliability and reproducibility are subject to many variations. Standard precautions with regard to blood pressure measurement will help to minimize the over diagnosis of hypertension. Requirements for accurate measurement are often not met in a busy pre-assessment clinic or preoperative admission ward. Once the blood pressure is found to be truly elevated, the pathway of evaluation needs to be decided considering many factors. The potential benefits of delaying the surgery to optimize the pharmacological treatment needs to be weighed against the risk of delaying the surgical procedure [21]. This decision needs to be taken considering the urgency of surgery, type of surgery and risk category of the patient.

3. Urgency of surgery

The type and extent of evaluation depends on the urgency of surgery. In a planned elective surgery, there is always ample time to investigate and manage high blood pressure when it is deemed necessary [22] **In elective surgeries**, if the blood pressure is found to be high after taking above precautions in the measurement, referring physician or general practitioner needs to be contacted to get more detailed blood pressure values than the ones measured at

hospital setting to reduce the effect of white coat hypertension [14]. If that is also found to be high, it needs to be evaluated and ideally, we need to normalize the blood pressure for several months prior to elective surgery [23]. However, in patients with grade I and II hypertension, there is no evidence that postponing surgery to optimize the control of blood pressure is beneficial. If essential hypertension is well controlled, less likely are the patients to develop intra operative blood pressure lability and post-operative complications.

In a non emergency but urgent patients cardiac evaluation may have an influence in the perioperative measures taken to reduce the cardiovascular risk and the type of surgery. However it will not have an impact on the decision to perform the surgery [24].

In emergency surgery the patient should be managed with an injectable medication acutely if BP is found to be high and should undergo surgery. Further evaluation can be carried out post-operatively [25].

4. Type of surgery

The surgical factors that influence cardiac risk are type of surgery, invasiveness, duration of the procedure, change in body core temperature, blood loss and fluid shift during surgery [26]. The stress response during surgery is initiated by tissue injury and later neuroendocrine response which can result in increase in myocardial oxygen demand [27]. These, together with patient's position during surgery, temperature management and type of anaesthesia contribute to significant hemodynamic derangements perioperatively. Cardiothoracic surgeries, liver resection and transplants are considered as high risk surgeries [28].

5. Risk category of the patient

An important step in the perioperative evaluation is risk categorization of patients.

High risk group will need further evaluation and the low and intermediate risk group can be proceed with surgery without undue delay. High risk groups are patients with active cardiac illnesses such as Acute Coronary Syndrome, decompensated heart failure, severe valvular disease, diabetes mellitus and renal insufficiency [29,30]. This group needs pre-operative non-invasive cardiac testing to estimate the prognosis.

The other patients with minor medical problems falling into the group of intermediate and low risk category will not need extensive cardiac investigations pre operatively.

Evaluation in elective cases

It is essential to identify undiagnosed or uncontrolled hypertension perioperatively and estimate true high level of blood pressure in order to reduce perioperative risk and adverse long-term effects. The evaluation of the extent and severity of organ dysfunction is important as the presence of such organ damage is a marker of severity of hypertension and also such damage could result in increased perioperative risk itself.

Evaluation is based on history, physical examination and investigations as in any other clinical condition [31]. Assessment should focus on identifying target organ damage such as renal impairment, heart failure, coronary artery disease, or cerebrovascular disease and secondary causes of hypertension [32]. Evaluation pathway of high blood pressure in a case of elective surgery is shown in the flow chart (Figure 1).

During the evaluation, a detailed history needs to be taken as in any medical conditions. The history should focus on risk factors such as smoking, obesity, diabetes, dietary and sleep disorders, previous history and family history of atherosclerotic cardiovascular diseases, symptoms related to secondary hypertension and previous and current treatment of hypertension.

A focused yet thorough clinical examination including looking for oedema; detailed peripheral pulses; BP measurements in both arms in sitting as well as standing positions; auscultation of heart sounds and murmurs; abdominal palpation; and signs of secondary hypertension needs to be excluded. Functional capacity should be assessed to help in the overall management of these patients.

Table 1: Clinical indicators of secondary hypertension

Clinical indicators of secondary hypertension
Resistant hypertension
Young age and elderly
Sudden onset or worsening of hypertension
History and examination pointing a delayed femoral pulse, murmur, ballotable masses, abdominal bruits, Cushing's syndrome, neurofibromatosis
Abnormal Investigations –hypokalaemia, elevated markers of renal impairment

Investigations

ECG is the baseline investigation of patients with intermediate and high risk, and is routinely performed to look for features of left ventricular hypertrophy (LVH), strain pattern, ischaemia, arrhythmia, presence of Q waves, significant ST segment elevation or depression which are associated with high perioperative complications [26].

Biochemical investigations such as haemoglobin, blood glucose, serum sodium, serum potassium, serum creatinine, urine micro albumin need to be performed in all patients.

Echocardiogram is considered when a more sensitive method of detection of LVH would be useful as well as for assessment of left ventricular (LV) systolic function. It is recommended only in high risk surgeries and not recommended in asymptomatic patients.

Stress ECG test has a very high negative predictive value but low positive predictive value; hence its use in clinical practice is minimal [33].

4. Evaluation for Secondary hypertension

Nearly 5-10% of patients with hypertension may have identifiable secondary causes [34] and the clinical indicators favouring them are shown in the table 1. These category of patients will have further evaluation with regard to the suspected cause. However, completing the investigation and management of secondary hypertension may take several weeks thus delaying the surgery. On the other hand, proceeding to surgery without evaluating these types of patients may result in catastrophic complications during the surgery. Decisions on performing the surgery or to evaluate with investigations and therefore to delay the surgery should be done on case by case basis.

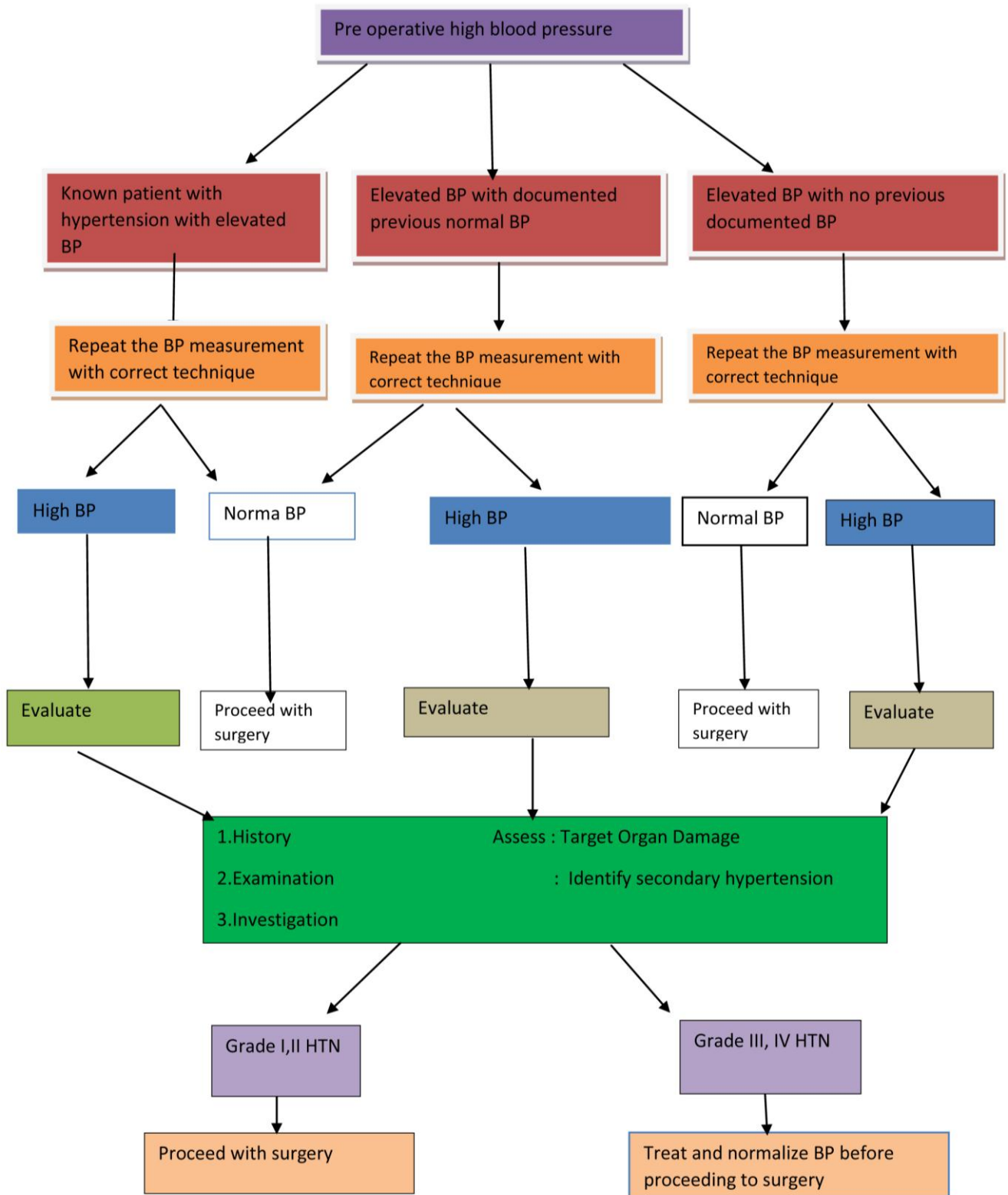


Figure 1: Evaluation pathway of high blood pressure in a case of elective surgery

General recommendations for the treatment of perioperative hypertension

An accurate perioperative assessment should identify the patients with high risk of complications and who need treatment while minimizing the disappointment of the patient, frustration of the anaesthetist and surgeon and avoiding the unnecessary delay of the surgery. Blood pressure measurements are more accurate in the primary care setting than secondary care and reducing the blood pressure in the primary care reduces the cardiovascular risks more effectively[35].

The following recommendations are adopted from British Hypertension Society (BHS) guidelines to reliably suit to our settings and include the following. However decisions should be made on case by case basis considering associated comorbidities [10,14].

Primary care physicians can refer for surgery if the BP is less than 160/100mmHg in the last 12 months. If no previous blood pressure record is available on preoperative evaluation it can be inquired from the primary care physician regarding the blood pressure records for last 12 months. The blood pressure does not need to be measured in the preoperative clinic if patient's blood pressure is documented as less than 160/100mmHg in the referral letter however it is often done as the basic clinical examination.

Secondary care physicians should accept the referral with documented blood pressure of less than

160/100mmHg in the last 6 months and can make the decision on surgery considering the other factors. It is recommended that, not to attempt to diagnose hypertension in patients who are normotensive in primary care when they present to the preoperative clinic.

When managing a patient with perioperative hypertension, it is always important to prevent the possible sustained hypertension in the future. Hence the withdrawal of routine anti hypertensives must be minimized, and suitable anti hypertensives should be administered before surgery. As long acting anti hypertensives can have deleterious effects during surgery it can be substituted by short acting medications. Clinical assessment needs to be carried out to see whether it is a hypertensive urgency or emergency and parenteral drugs need to be started if it is deemed as hypertensive emergency.

Initial choice of drug in a non urgent situation where a patient is diagnosed to have hypertension after the evaluation is shown in the table 2 [16,23].

Generally, most anti hypertensives can be continued until the time of surgery, taken with small sips of water in the morning of the day of surgery. When starting thiazide diuretics, it is very essential to pay close attention to the electrolytes and volume status of the patient perioperatively. Due to these potential problems it is ideal to withhold this medication on the morning of operation in most cases[16,19].

Table 2: Choice of antihypertensive drugs in non-urgency surgery

Drugs	Perioperative use	Remarks	Caution/Contraindications
Thiazides	Should be started early	Potential risk of hypokalaemia, volume depletion	Refractory hypokalaemia, hyponatraemia
Beta blockers	Avoid starting on previous day in high risk patients	Risk of bronchospasm, heart failure, heart block	Bronchial asthma, uncontrolled heart failure, second- or third-degree heart blocks, severe peripheral arterial disease
ACEI/ARB	Last dose day before operation	Restart ACEI/ARB with caution if the patient is euvolemic	Bilateral renal artery stenosis, Pregnancy, hypersensitivity to ACEI
Calcium channel blockers	Can be initiated as the first choice of antihypertensive medication specially in patients more than 55 years of age	Diltiazem effective in Coronary Heart Disease and verapamil in Supra ventricular Tachycardia. Well tolerated drug and its benefit in perioperative hypertension outweighs the rare slight increase in postoperative bleeding incidence	Diltiazem and Verapamil –second and third degree heart block, sick sinus syndrome, significantly reduced left ventricular function

Patients who are taking beta blockers already, could continue until the morning of the procedure as the withdrawal can lead to uncontrolled hypertension, accelerated angina or myocardial infarction. This is particularly important in patients with coronary artery disease who are undergoing surgery. If the initiation of the beta blockers are needed pre operatively specially in patients with intermediate or high cardiovascular disease, it is recommended to start at least two days prior to surgery in a low dose. Starting beta blockers in the pre-operative and perioperative period has been shown to be associated with increased peri operative hypotension, stroke and increased mortality [16,19].

ACEI/ARB are preferably withheld for a period of 24 hours prior to surgery unless there is a compelling indication to continue as it can possibly blunt the compensatory response of rennin-angiotensin system during intraoperative period and may result in prolonged hypotension during or soon after the surgery [16]. Calcium channel blockers are the ideal drugs to continue during perioperative period including the morning of surgery. It does not cause exaggerated hypotension during the intra operative period. When oral intake is resumed during postoperative period, antihypertensives can be restarted as blood pressure stabilizes [16,19].

Pre-operative management of hypertension in patients who are undergoing surgery as a treatment modality for secondary hypertension is different from the above description. In phaeochromocytoma, preoperative optimization of blood pressure and intravascular volume is very important. Blood pressure control should be achieved with adequate alpha blockade with beta adrenergic antagonists and other anti hypertensives if needed. These patients can develop hypertensive crisis intraoperatively and hypotension following the removal of the tumour, both of which needs emergency attention [36].

The need of potassium supplement and aldosterone antagonists reduces when surgery is done for Primary hyperaldosteronism and it needs to be discontinued during postoperative period [37].

In patients with renal artery stenosis, blood pressure control should be achieved preferably with calcium channel blockers prior to surgical intervention.

Drugs used in urgent or emergency situations during perioperative period are shown in the table 3. However, discretion to treat the patient in these situations is based on case by case with prompt clinical assessment [22].

CONCLUSION

Hypertension complicates a significant proportion of surgical patients. It causes undue postponement of surgery and has a significant negative impact in the surgical outcome. A target of blood pressure in a surgical patient is often set at a higher level. Avoiding routine antihypertensive medication is a common pitfall observed in surgical patients. Timely administration of long acting/sustained release preparation of drugs, avoiding undue delay in surgery, and managing hypertension with suitable parenteral preparations intra and post operatively would prevent blood pressure variability or fluctuations and results in good outcome after surgery.

Table 3: Drugs used in urgency or emergency situations during perioperative period

Drugs	Remarks
Hydralazine	Intravenous intermittent: 3–20 mg slow IV push every 20–60 min
Labetalol	Intravenous intermittent: 20 mg over 2 min, then double at 10 min intervals until desired response, a single maximal dose of 80 mg. Toxicity at a cumulative dose of 300 mg/d
Nitroglycerin	Intravenous infusion: 5 mg/min initially, then titrate in 5mg/min increments every 3–5 min until desired response or toxicity
Nitroprusside	Intravenous infusion: 0.25–0.5 mg/kg/min initially, then titrate dose every 12 min until desired response, a maximal dose of 10 mg/kg/min,

Author declarations**Acknowledgements**

No acknowledgements to disclose

Author contributions

All the authors contributed in preparing the manuscript equally

Funding sources

No funding sources to disclose

Ethics approval and consent to participate

Not relevant

Competing interests

The authors declare no competing interests

REFERENCES

1. Wijewardene K, Mohideen MR, Mendis S, Fernando DS, Kulathilaka T, Weerasekara D, et al. Prevalence of hypertension, diabetes and obesity: Baseline findings of a population based survey in four provinces in Sri Lanka. *Ceylon Medical Journal*. 2005. pp. 62–70. DOI: <https://doi.org/10.4038/cmj.v50i2.1571>
2. Katulanda P, Ranasinghe P, Jayawardena R, Constantine GR, Rezvi Sherif MH, Matthews DR. The prevalence, predictors and associations of hypertension in Sri Lanka: A cross-sectional population based national survey. *Clin Exp Hypertens*. 2014;36: 484–491. DOI: <https://doi.org/10.3109/10641963.2013.863321>
3. Kasturiratne A, Warnakulasuriya T, Pinidiyapathirage J, Kato N, Wickremasinghe R, Pathmeswaran A. P2-130 Epidemiology of hypertension in an urban Sri Lankan population. *J Epidemiol Community Heal*. 2011;65: A256–A256. DOI: <https://doi.org/10.1136/jech.2011.142976i.65>
4. Howell SJ, Sear JW, Föex P. Hypertension, hypertensive heart disease and perioperative cardiac risk. *British Journal of Anaesthesia*. 2004. pp. 570–583. DOI: <https://doi.org/10.1093/bja/ae091>
5. Cheung AT. Exploring an optimum intra/postoperative management strategy for acute hypertension in the cardiac surgery patient. *Journal of Cardiac Surgery*. 2006. DOI: <https://doi.org/10.1111/j.1540-8191.2006.00214.x>
6. Haas CE, LeBlanc JM. Acute postoperative hypertension: A review of therapeutic options. *American Journal of Health-System Pharmacy*. 2004. pp. 1661–1675. DOI: <https://doi.org/10.1093/ajhp/61.16.1661>
7. Dix P, Howell S. Survey of cancellation rate of hypertensive patients undergoing anaesthesia and elective surgery. *Br J Anaesth*. 2001;86: 789–793. DOI: <https://doi.org/10.1093/bja/86.6.789>
8. Varon J, Marik PE. Perioperative hypertension management. *Vascular Health and Risk Management*. 2008. pp. 615–627. DOI: <https://doi.org/10.2147/vhrm.s2471>
9. KT M, JD B, TN K, JE R, PM K, Reynolds K, et al. Global Disparities of Hypertension Prevalence and Control: A Systematic Analysis of Population-Based Studies From 90 Countries. *Circulation*. 2016. pp. 441–450. DOI: <https://doi.org/10.1161/CIRCULATIONAHA.115.018912>
10. Howell SJ. Preoperative Hypertension. *Curr Anesthesiol Rep*. 2018;8: 25–31. DOI: <https://doi.org/10.1007/s40140-018-0248-7>
11. Goldman L, Caldera DL. Risks of general anesthesia and elective operation in the hypertensive patient. *Anesthesiology*. 1979;50: 285–292. DOI: <https://doi.org/10.1097/0000542-197904000-00002>
12. Fleisher LA. Preoperative evaluation of the patient with hypertension. *Journal of the American Medical Association*. 2002. pp. 2043–2046. DOI: <https://doi.org/10.1001/jama.287.16.2043>
13. Soto-Ruiz KM, Peacock WF, Varon J. “Perioperative hypertension: Diagnosis and Treatment.” *Netherlands Journal of Critical Care*. 2011. pp. 143–148.
14. Hartle A, McCormack T, Carlisle J, Anderson S, Pichel A, Beckett N, et al. The measurement of adult blood pressure and management of hypertension before elective surgery: Joint Guidelines from the Association of Anaesthetists of Great Britain and Ireland and the British Hypertension Society. *Anaesthesia*. 2016;71: 326–337. DOI: <https://doi.org/10.1111/anae.13348>
15. Chamisa I. Why is surgery cancelled? A retrospective evaluation. *South African J Surg*. 2008;46: 79–81. DOI: <https://doi.org/10.7196/sajs.35>
16. Hazzi R, Mayock R. Perioperative management of hypertension. *J Xiangya Med*. 2018;3: 25–25. DOI: <https://doi.org/10.21037/jxym.2018.05.01>
17. Nadella V, Howell SJ. Hypertension: pathophysiology and perioperative implications. *BJA Educ*. 2015;15: 275–279. DOI: <https://doi.org/10.1093/bjaceaccp/mkv001>
18. Anderson SG, Beckett N, Pichel AC, McCormack T. Optimising BP measurement and treatment before elective surgery: Taking the pressure off. *British Journal of Cardiology*. 2017. pp. 11–12. DOI: <https://doi.org/10.5837/bjc.2017.005>
19. Aronow WS. Management of hypertension in patients undergoing surgery. *Annals of Translational Medicine*. 2017. DOI: <https://doi.org/10.21037/atm.2017.03.54>
20. Beevers G, Lip GYH, O'Brien E. Blood pressure measurement: Part I—Sphygmomanometry: Factors common to all techniques. *BMJ*. 2001;322: 981. DOI: <https://doi.org/10.1136/bmj.322.7292.981>
21. Handler J. The Importance of Accurate Blood Pressure Measurement. *Perm J*. 2009;13. DOI: <https://doi.org/10.7812/tpp/09-054>
22. Padma S, Sundaram Ps. Current Practice and Recommendation for Presurgical Cardiac Evaluation in Patients Undergoing Noncardiac Surgeries. *World J Nucl Med*. 2014;13: 6. DOI: <https://doi.org/10.4103/1450-1147.138568>
23. Manolis AJ, Erdine S, Borghi C, Tsioufis K. PERIOPERATIVE SCREENING AND MANAGEMENT OF HYPERTENSIVE PATIENTS *European Society of Hypertension Scientific Newsletter: Update on Hypertension Management Perioperative evaluation*. *European Society of Hypertension Scientific Newsletter: Update on Hypertension Management*. 2010.

24. Duncan D, Wijeyesundera DN. Preoperative cardiac evaluation and management of the patient undergoing major vascular surgery. *International Anesthesiology Clinics*. 2016. pp. 1–32. DOI: <https://doi.org/10.1097/AIA.0000000000000091>
25. 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: Executive Summary. *Circulation*. 2014;130: 2215–2245. DOI: <https://doi.org/10.1161/cir.000000000000105>
26. Poldermans D, Bax JJ, Boersma E, De Hert S, Eeckhout E, Fowkes G, et al. Guidelines for pre-operative cardiac risk assessment and perioperative cardiac management in non-cardiac surgery. *European Heart Journal*. 2009. pp. 2769–2812. DOI: <https://doi.org/10.1093/eurheartj/ehp337>
27. Desborough JP. The stress response to trauma and surgery. *Br J Anaesth*. 2000;85: 109–117. DOI: <https://doi.org/10.1093/bja/85.1.109>
28. Kristensen SD, Knuuti J, Saraste A, Anker S, Bøtker HE, De Hert S, et al. 2014 ESC/ESA Guidelines on non-cardiac surgery: Cardiovascular assessment and management: The Joint Task Force on non-cardiac surgery: Cardiovascular assessment and management of the European Society of Cardiology (ESC) and the European Society of Anaesthesiology (ESA). *Eur Heart J*. 2014;35: 2383–2431. DOI: <https://doi.org/10.1093/eurheartj/ehu282>
29. Freeman WK, Gibbons RJ. Perioperative cardiovascular assessment of patients undergoing noncardiac surgery. *Mayo Clinic Proceedings*. 2009. pp. 79–90. DOI: <https://doi.org/10.4065/84.1.79>
30. Domi R, Sula H, Ohri I, Beqiri A, Kaci M, Bodeci A, et al. Anesthetic challenges of patients with cardiac comorbidities undergoing major urologic surgery. *Int Arch Med*. 2014;7. DOI: <https://doi.org/10.1186/1755-7682-7-17>
31. Kaplan NM. Commentary on The Sixth Report of the Joint National Committee (JNC-6). *American Journal of Hypertension*. 1998. pp. 134–136. DOI: [https://doi.org/10.1016/S0895-7061\(97\)00480-9](https://doi.org/10.1016/S0895-7061(97)00480-9)
32. Drozd D, Kawecka-Jaszcz K. Cardiovascular changes during chronic hypertensive states. *Pediatric nephrology (Berlin, Germany)*. 2014. pp. 1507–1516. DOI: <https://doi.org/10.1007/s00467-013-2614-5>
33. Go G, Davies KT, O’Callaghan C, Senior W, Kostner K, Fagermo N, et al. Negative predictive value of dobutamine stress echocardiography for perioperative risk stratification in patients with cardiac risk factors and reduced exercise capacity undergoing non-cardiac surgery. *Intern Med J*. 2017;47: 1376–1384. DOI: <https://doi.org/10.1111/imj.13629>
34. Rimoldi SF, Scherrer U, Messerli FH. Secondary arterial hypertension: When, who, and how to screen? *European Heart Journal*. 2014. DOI: <https://doi.org/10.1093/eurheartj/ehf534>
35. Patel P, Ordunez P, DiPette D, Escobar MC, Hassell T, Wyss F, et al. Improved Blood Pressure Control to Reduce Cardiovascular Disease Morbidity and Mortality: The Standardized Hypertension Treatment and Prevention Project. *J Clin Hypertens*. 2016;18: 1284–1294. DOI: <https://doi.org/10.1111/jch.12861>
36. Ramachandran R, Rewari V. Current perioperative management of pheochromocytomas. *Indian Journal of Urology*. 2017. pp. 19–25. DOI: <https://doi.org/10.4103/0970-1591.194781>
37. A. A, T.J. F, R. Z. Management of hypertension in primary aldosteronism. *World J Cardiol*. 2014;6: 227–233.