

Hypertension and Anaesthesia

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Introduction

Hypertension affects more than 1 billion people worldwide, and is a major risk factor for coronary artery disease, myocardial infarction, cardiac failure, stroke, cerebrovascular events including dementia, atherosclerosis and the development of renal failure. It is also associated with dyslipidaemia, diabetes and obesity.¹ The incidence of hypertension, and in particular systolic hypertension, increases with age. It is estimated that 60% of the world's adult population are hypertensive as defined by "The World Hypertension Society/International Society of Hypertension" (WHO/ISH).²

Aetiology and classification

The majority of the world's hypertensive population (95%) suffer from essential hypertension, implying that the cause of the disease is unknown. The remaining 5% of hypertensive patients suffer from "secondary hypertension" where the cause of the hypertension is as a result of a medical condition.³ Secondary hypertension should always be considered in the younger patient group as well as in patients where the hypertension is not easily controlled by conventional treatment.

It is an undisputed fact that chronic hypertension should be treated to decrease the risks associated with an elevated blood pressure. As will be discussed below, there is a considerable difference of opinion as to what the threshold blood pressure is for starting a patient on treatment and what the target levels are that need to be met. The severity of hypertension is classified according to a band of increasingly severe hypertension and is classified as optimal, normal, high normal and then hypertension stage 1-3.⁵ Some authors include additional categories viz. stage 4, isolated hypertension and pulse pressure hypertension as seen in Table 1.⁴ When the arterial pressure falls in different categories of systolic and diastolic pressure the higher category applies.

Isolated systolic hypertension accounts for the majority of hypertension in patients over 50 years of age and is defined as a systolic blood pressure above 140 mmHg (or 150 mmHg as per JCN8 classification) and a diastolic pressure of less than 90 mmHg.⁵ Systolic blood pressure increases with age whereas diastolic pressures tend to reach a plateau in the fifth or sixth decade of life.³ Older patients have less compliant vessels and hence the higher systolic pressures and higher pulse pressures

recorded. Pulse pressure hypertension (>80 mmHg) has now been recognised as a significant risk for both myocardial infarction and stroke.

Targets for treatment

There is differing opinion as to the threshold value where treatment needs to commence. The latest Joint National Committee on prevention, detection, evaluation and treatment of high blood pressure (JNC8) published guidelines in December 2013 in the Journal of the American Medical Association (JAMA) which have relaxed treatment goals in the older population groups. These treatment goals are now summarised as follows in the JNC8 document:

- In patients 60 years or older, start treatment in blood pressures >150 mmHg systolic or >90 mmHg diastolic and treat to under those thresholds.
- In patients <60 years, treatment initiation and goals should be 140/90 mmHg, the same threshold used in patients >18 years with either chronic kidney disease (CKD) or diabetes.

Table 1: Classification of blood pressure

	Systolic blood pressure	Diastolic blood pressure
Optimal	Less than 120 mmHg	Less than 80 mmHg
Normal	120-129 mmHg	80-84 mmHg
High normal	130-139 mmHg	85-89 mmHg
Hypertension		
Stage 1	140-159 mmHg	90-99 mmHg
Stage 2	160-179 mmHg	100-109 mmHg
Stage 3	180-209 mmHg	110-119 mmHg
Stage 4	Greater than 210 mmHg	Greater than 120 mmHg
Isolated hypertension	Greater than 150 mmHg	Less than 90 mmHg
Pulse pressure hypertension	Greater than 80 mmHg	

Source: James MFM et al⁴

- In non-black patients with hypertension, initial treatment can be a thiazide-type diuretic, calcium channel blocker (CCB), or angiotensin converting enzyme inhibitor (ACE), or angiotensin receptor blocker (ARB), while in the general black population, initial therapy should be a thiazide-type diuretic or CCB.
- In patients >18 years with CKD, initial or add-on therapy should be an ACE inhibitor or ARB, regardless of race or diabetes status.⁵

The American Heart Association (AHA) and American College of Cardiology (ACC) do not support these guidelines. One of the major areas of disagreement is the raising of the target blood pressure in the 60 plus age group from 140 to 150 mmHg. Without this consensus, the management of the elderly hypertensive patient may not be clear. A further area of controversy relates to the trigger level where blood pressure treatment needs to commence. There is a body of opinion that suggests that healthy patients with stage 1 hypertension are unnecessarily started on treatment and exposed to the side effects of these drugs without any evidence of benefit. While diastolic blood pressure used to be the main target of antihypertensive therapy, it has now become evident that systolic blood pressure and an increase in pulse pressure above 65 mmHg is more important in terms of outcome, especially in the patient population above 50 years of age. The benefits of treating isolated systolic hypertension are now clearly established and carry a greater risk to the patient of developing a cardiac or neurological incident.

Hypertension together with low serum potassium probably account for more unnecessary cancellations of surgery than any other condition. Until a more rational approach to hypokalaemia in the mid-1980s, anaesthetists routinely would postpone surgery demanding that these patients have their serum potassium normalised before surgery. A rational approach to the hypertensive patient presenting for surgery is needed so that unnecessary cancellations can be avoided based purely on a blood pressure reading. A survey published in the British Journal of Anaesthesia, in 2001, by Dix and Howell, showed a great variability amongst anaesthetists as to which patients would be cancelled.⁶ This makes consensus protocols difficult to agree on, in the light of such variation in practice. Guidelines also often assume the same easy access to testing and specialist care and may sometimes be difficult to apply in resource limited settings. The difficulties faced by the anaesthetist in the peri-operative period relate to a number of issues:

- The patient may be identified for the very first time as suffering from high blood pressure and this may never have been investigated or treated.
- The anaesthetist may see a patient immediately before surgery and may make a diagnosis of hypertension based on a single reading pre-operatively.
- The patient may already be on treatment but the blood pressure immediately before surgery is beyond acceptable limits to the anaesthetist.
- The patient may have been postponed a few days before for blood pressure control and now presents having been on medication for only a few days.
- The hypertensive patient who is over-medicated may have a low blood pressure and or pulse rate.
- The patient's blood pressure is markedly raised before surgery but the surgery is of an emergent nature.
- A lack of randomised controlled trials indicating whether

hypertensive patients *per se* are at an increased risk of peri-operative adverse events.

- The hypertensive patient who has a raised blood pressure as a result of a medical condition e.g. the patient in renal failure where the blood pressure cannot adequately be controlled.

Target organ damage

The impact of hypertension on the risk of developing an adverse peri-operative myocardial event has been the focus of numerous studies. Prys-Roberts and colleagues showed an increase in arrhythmias and post-operative myocardial infarction in a small population of hypertensive patients during the early 1970s.⁷ Goldman and Caldera, in 1979, looked at a larger study population and failed to show any difference in adverse outcome between treated and untreated hypertension.⁸ More recently, Howell and colleagues, from Oxford, did an extensive literature review and meta-analysis of 30 observational studies. They found that the odds ratio for an association between elevated admission blood pressure and an adverse cardiac event was 1.35 (95% CI 1.17-1.56). There was little evidence that, if pressures were less than 180 mmHg systolic and less than 90 mmHg diastolic, that there was an increased likelihood of an adverse peri-operative event. The position is less clear for patients with pressures above these levels.⁹ This study does cast doubt that the peri-operative outcome was any different in hypertensive patients compared with normotensive patients despite the fact that hypertensive patients with pressures greater than 180/110 mmHg tended to have greater haemodynamic instability, myocardial ischaemia and arrhythmias. The heterogeneity of the studies analysed with regards the type of complications and likely risk, did however make effective correction for confounding variables very difficult. Current evidence would suggest, and is supported by the ACA/AHA guidelines that stage 1 or stage 2 hypertension alone is not an independent risk factor for peri-operative cardiac complications. The recommendations regarding patients with pressures exceeding 180/110 mmHg are less clear and a risk-benefit analysis needs to be made before pending surgery. A recent study did, however, show that increasing severity of pre-induction hypertension was an independent risk factor for myocardial injury/infarction and in-hospital death. The overall incidence of adverse events (elevated troponin levels or in-hospital death) was 1.3% and 2.8% for the subgroup with baseline systolic pressures above 200 mmHg.²⁰ Crucial to all of this is determining whether the hypertension occurs in isolation, is associated with complications related to the existence of long standing hypertension or if it is associated with other risk factors. The major organs at risk from long standing, untreated hypertension are the heart, the kidneys and the brain. The physical examination should include a search for target organ damage and evidence of associated cardiac, renal and cerebral pathology. The review by Howell and colleagues implies that patients are more likely to die from hypertension related co-morbidities or from a poor understanding of the pathophysiology of hypertension and its relation to anaesthesia than from the hypertension *per se*.¹

Heart

Hypertension leads to increased myocardial wall tension and an increase in oxygen demand. This together with concentric hypertrophy and the development of diastolic dysfunction leads to an imbalance in myocardial oxygen supply and demand. As the muscle hypertrophies and becomes stiffer the left ventricular end diastolic pressure (LVEDP) increases, which leads to a decrease in coronary perfusion pressure. The recognised association of chronic hypertension and coronary

artery disease sets the scene for intra-operative ischaemia and arrhythmias, particularly, if associated with haemodynamic instability. The vulnerable times peri-operatively are at the time of induction and intubation, immediately post induction, during surgical stimulation and again at the end of the procedure during extubation. Intubation may lead to an exaggerated pressor response and agents such as short acting opioids, esmolol, glyceryl trinitrate or magnesium sulphate can be used to control this response. It is worth remembering that an exaggerated blood pressure response intra-operatively may be due to an undiagnosed phaeochromocytoma with excess catecholamine secretion and in this instance a beta blocker will be contra-indicated. Magnesium sulphate, as a bolus of four grams, is probably the safest and most effective first line treatment.³ Following induction, the pressures may decrease due to a lack of stimulation resulting in a low diastolic pressure which may limit myocardial perfusion. Subendocardial autoregulation is also abnormal making hypertensive hearts vulnerable to unstable blood pressures.³ An exaggerated pressor response may also occur during severe surgical stimulation and extubation.

These responses and the haemodynamic instability that occurs in hypertensive patients resulting in intra-operative ischaemia can be modified by treatment and requires the understanding and appropriate skill of the anaesthetist to modify these effects. Patients with stage 3 or greater hypertension will have greater fluctuations in blood pressure during anaesthesia and as this level of hypertension may be a marker for potential coronary heart disease (CAD), it follows that control of blood pressure pre-operatively may help reduce the tendency to peri-operative ischaemia and hence post-operative cardiac morbidity.¹⁰

Brain

Hypertension is a risk factor for ischaemic and haemorrhagic brain injury. Carotid disease is also more common in patients with hypertension, making them vulnerable to a cerebral ischaemic event if pressures are not appropriately controlled in the peri-operative period. Chronic hypertension leads to a shift in the cerebral autoregulation curve to the right, making cerebral perfusion flow dependant, during severe hypotension. Normalisation of the cerebral autoregulation may take several weeks to return to near normal values.

Kidney

Loss of autoregulation in the kidneys in hypertensive patients will also increase the risk of renal failure with hypotensive episodes.

Pulse pressure hypertension has been shown to increase the risk of post-operative renal failure, strokes and to significantly increase the risk of myocardial infarction.¹³ High pulse pressure hypertension (greater than 60 mmHg) may also contribute significantly to intra-operative haemodynamic instability and may be a more important predictor than diastolic dysfunction.¹⁵

Management

The anaesthetist generally only has a short time before surgery to evaluate a patient's fitness for surgery and uncover potential risks. Medical funders do not allow admission to hospital the day before surgery as was the custom years ago, so patients are only admitted on the morning of surgery. The diagnosis of hypertension on a single blood pressure reading may lead to an incorrect diagnosis and may even result in a patient being prescribed chronic anti-hypertensive medication, unnecessarily.

In patients who are already admitted to hospital the anaesthetist is in a better position to assess the hypertension as they will have the benefit of ward blood pressures taken at different times over days or weeks. This does not imply that a single high reading should not prompt further investigation, as the pre-operative evaluation is a unique opportunity to identify patients with hypertension and initiate appropriate treatment. The Oxford group, led by SJ Howell, were not able to show a clear association between admission arterial pressure and major peri-operative cardiac complications.^{11,12}

White coat hypertension

White coat hypertension is very relevant to anaesthetic practice. Anaesthetists do not as a routine have the luxury to take a blood pressure on a number of occasions over a period of weeks before the diagnosis of hypertension is made. White coat hypertension is defined as an office/pre-surgical blood pressure of greater than 140/90 mmHg with an average daytime reading of less than 135/85 mmHg.¹ Studies have not shown an increase in long term cardiovascular events to be any different from normotensives.¹⁴

Pseudo-hypertension (Osler's sign)

Pseudo-hypertension occurs when the blood vessels are so calcified and non-compliant that they do not collapse when the blood pressure cuff is inflated so giving a falsely elevated systolic blood pressure.¹⁶

Anti-hypertensive agents

Most hypertensive patients will be on one of four groups or a combination of drugs for their hypertension. These include thiazide diuretics, beta blockers, angiotensin converting enzyme inhibitors (ACEI) or angiotensin II receptor blockers (ARBs) or calcium channel blockers (CCBs). A review of their medication is important to identify potential problems specific to each group. Anti-hypertensive therapy should in general be continued up until the day of surgery.

Thiazides

Chronic therapy may result in hypokalaemia.

Beta blockers

Abrupt withdrawal of beta blockers may result in rebound hypertension and may precipitate angina. Beta blockers are no longer recommended to be started acutely in high risk patients before surgery in the light of the published Perioperative Ischaemic Evaluation Study (POISE).¹⁸ The POISE study showed that in spite of the fact that there was a reduction in myocardial infarction, all-cause mortality and in particular stroke was increased.

ACEI/ARBs

These agents may blunt the compensatory activation of the renin angiotensin system during surgery and result in prolonged hypotension. The data is insufficient to make an absolute recommendation but it seems reasonable to continue them in patients taking them for the management of hypertension. It may also be reasonable to withhold them on the morning of surgery in patients taking them for congestive heart failure in whom the baseline blood pressure is low.¹⁷

Emergency surgery

Emergency surgery should not be delayed because of a high blood pressure. A gentle lowering of the blood pressure with short acting agents before induction may be appropriate. An appropriate anaesthetic technique to control haemodynamic instability is required.

Post-operative hypertension

Hypertensive patients may develop severe hypertension in the immediate post-operative period. A thorough investigation into the cause is mandatory before treatment is started. Common causes of hypertension that need to be excluded are pain, full bladder, ventilatory challenges, hypothermia, a cerebral event and serious endocrine causes such as thyroid storm, pheochromocytoma and as a result of withdrawal of their long term anti-hypertensive drugs. The levels at which intervention are required are ill defined and will depend on the patient's pre-operative status. As with pre-operative hypertension, a persistent blood pressure in excess of 180/110 mmHg after the causes discussed above have been excluded may warrant intervention, particularly in patients with known coronary artery disease or those at risk of cerebrovascular accidents or bleeding. Blood pressure should be decreased slowly over 30-60 minutes and by no more than 25% or to a target value less than 180/110 mmHg.²⁰

Recommendations and conclusion

The management of hypertensive patients in the peri-operative period is controversial and because of a paucity of studies providing good evidence for sound clinical management, general recommendations are difficult to make. As was demonstrated in the survey done by Dix and Howell, there is great variability between anaesthetists as to which hypertensive patients need to be cancelled.⁴ These decisions may depend on the level of training of the anaesthetists as well as institutional facilities, speciality back up and protocols. The purpose of articles such as this is to ensure that "no harm is done," that patients are not cancelled unnecessarily, and worse still, get put on chronic treatment when it is not indicated. In 2004 Howell, Sear and Foëx stated that: "There is little evidence for an association between admission arterial pressures of less than 180 mmHg systolic or 110 mmHg diastolic and peri-operative complications. The position is less clear in patients with admission arterial pressures above this level. Such patients are more prone to peri-operative ischaemia, arrhythmias, and cardiovascular lability, but there is no clear evidence that deferring anaesthesia and surgery in such patients reduces peri-operative risk " and concluded: "We recommend that anaesthesia and surgery should not be cancelled on the grounds of elevated pre-operative arterial pressure. The intra-operative arterial pressure should be maintained within 20% of the best estimate of pre-operative arterial pressure, especially in patients with markedly elevated preoperative pressures."²

Based on the available evidence the following recommendations can be made:

- Patients with stage one and two hypertension who do not have evidence of organ dysfunction and without other risks (diabetes, renal dysfunction, and smoking) may proceed to surgery.
- In patients with poorly controlled, stage three hypertension, it is probably justified to postpone elective surgery to investigate for target organ damage and to institute therapy.

- Patients with stage four hypertension appear to present a significant peri-operative risk.^{3,20} Surgery should always be deferred for treatment. The controversy exists as to how long these patients need to be on treatment before rescheduling surgery. There is no place, as stated by James *et al* for "cosmetic correction" immediately prior to surgery. These patients need to be on treatment for four to six weeks before surgery, with some re-adjustment of autoregulation in the major organs.³
- In isolated systolic hypertension, where the pressure is greater than 180 mmHg or the pulse pressure is greater than 80 mmHg, considerable debate exists. These patients do need treatment in the long term but it is controversial as to whether elective surgery should be postponed, especially, in the patient without evidence of end organ damage. In these patients it is important to consider the risk benefit ratio of delaying the surgery.

For the anaesthetists who do not have the benefit of seeing the patient's "normal average" blood pressure which has been taken at different times over a period of weeks and compounded by the well described white coat hypertension, the decision to cancel surgery is complex and should take into account the urgency of the surgery, as well as the presence of any end organ damage resulting from chronic hypertension. A detailed history and examination needs to be performed looking for evidence of coronary artery disease, cerebrovascular disease and renal dysfunction. If not already done these patients require an ECG, urea and electrolytes with a calculated GFR and a urinalysis. The decision to cancel the surgery for blood pressure control should then come with the recommendation that surgery be delayed for a period of four to six weeks, so that the flow/pressure autoregulation of the major organ systems can normalise again. The rapid control of blood pressure immediately prior to surgery is not recommended in the elective surgery patient as this can lead to inadvertent hypo-perfusion of the major organ systems during anaesthesia.

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