



What is "normal" intraoperative blood pressure and do deviations from it really affect postoperative outcome?

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Introduction

In our clinical practice, we are accustomed to dealing with perioperative hemodynamic and blood pressure changes on a daily basis. Intraoperative blood pressure variations outside of the accepted "normal" physiologic ranges are in fact very common. A recent publication analyzing intraoperative blood pressure data from electronic medical records found hypotension [systolic blood pressure (SBP) < 80 mmHg for > 5 minutes] in 26% and hypertension (SBP > 160 mmHg for > 5 minutes) in 20% of 16,913 anesthetic cases^[1]. When we reflect upon our daily practice and look at these numbers, the following two questions arise. What is considered the "normal physiologic range" of intraoperative blood pressure and how much does intraoperative hypotension (IOH) really affect postoperative outcome?

Although intraoperative blood pressure is regarded as an important parameter to monitor and the correction of IOH is seen as mandatory, there is in fact no universally accepted definition for what BP values really constitute IOH. Bijker and colleagues performed an extensive literature search in 2004 seeking articles that defined hypotension and found 130 articles providing 140 definitions of IOH. The most frequently used definitions were "A SBP below 80 mmHg, a decrease in SBP more than 20% below baseline, and the 'combination definition' of an absolute and relative threshold described as a decrease in SBP below 100 mmHg and/or 30% below baseline^[2]." It should not come as a surprise that the prevalence of IOH in these studies

varied dramatically depending on the definition of IOH that was used in a particular study. It ranged from 5% to 99%. The lack of consensus on the definition of IOH may in fact be responsible for the very wide range in the number of adverse outcomes that have been previously reported in the literature. Here, we look into various expert opinions and research findings on the correlation between IOH and the incidence of a number of adverse clinical outcomes. We hope to shed some light onto how much IOH really matters during daily anesthesia practice. We will focus on the association between IOH and perioperative myocardial infarction (MI), perioperative stroke, and 1-year mortality.

Intraoperative hypotension and MI

Basic physiology dictates that IOH has the potential to cause an ischemic injury that may lead to dysfunction of a number of vital organs. IOH has long been believed to lead to perioperative MI as a result of the imbalance between oxygen supply and demand of the myocardium. However, the association between hypotension and the degree of myocardial injury varies widely depending on the definition of hypotension that is used in one particular study which the authors found that a 40% decrease from the preinduction mean arterial blood pressure (MAP) with a cumulative duration of more than 30 min was associated with postoperative myocardial injury in elderly patients having vascular surgery^[3]. This study also demonstrated that it was both the severity and the actual duration of the episodes of perioperative hypotension that play a critical role in

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determining the risk of perioperative MI. Another study looked into more than 30,000 perioperative cases for non-cardiac surgical patients from 2005 to 2010 to evaluate the association between intraoperative MAP less than 55 to 75 mmHg and postoperative MI. The authors found a statistically significant association between a MAP less than 55 mmHg for duration greater than 1 min and postoperative myocardial injury in these non-cardiac surgical patients^[4]. There was no association of perioperative MI with any other MAP range or duration. These results suggest that the occurrence of IOH is not a direct predictor of perioperative MI. Perhaps it is merely a marker of other intraoperative events and comorbidities that are associated with an increased risk of developing postoperative myocardial injury. Tachycardia may be a more significant cause of perioperative myocardial ischemia than hypotension.

Intraoperative hypotension and stroke

Perioperative stroke is a relatively uncommon but devastating complication after surgery. The incidence of perioperative stroke ranges from 0.08% to 2.9% after general surgery, and up to 1.9% to 9.7% after cardiac surgery^[5-7]. Hypotension has regained interest as a potential risk factor for perioperative stroke since the publication of the POISE trial in 2007, which found an increased rate of morbidity and postoperative stroke in patients receiving metoprolol vs. placebo for non-cardiac surgery^[8]. However, due to many confounding factors, the role of perioperative hypotension in perioperative stroke remains unclear. One study suggested that only when the duration of mean arterial pressure was decreased more than 30% from baseline, was there a statistically significantly increased incidence of postoperative stroke^[8]. On the contrary, in another publication, the author stated that deliberate hypotension induced by anesthesia does not seem to adversely affect cerebral perfusion, nor does it considerably increase the risk of perioperative stroke due to hypoperfusion in patients with carotid stenosis^[6]. Several other studies also failed to find an association between IOH and postoperative stroke and concluded that there was no association between stroke and IOH and that it is likely that factors other than blood pressure contribute more to the risk of postoperative stroke^[10-11]. Many prior studies have shown that conflicting conclusions about the relationship between IOH and perioperative stroke persist. This is probably due to the combination of a low stroke incidence, the complexity of the mechanism of postoperative stroke, and the absence of a uniform definition for IOH. These factors

make it challenging to study the association between IOH and postoperative stroke. In addition, postoperative hypotension might be even more important than hypotension in the highly monitored and controlled intraoperative period. Unfortunately, the impact of postoperative hypotension on stroke has not been looked at as thoroughly as that of IOH.

Intraoperative hypotension and postoperative mortality

Both hypotension and hypertension have been reported to be associated with increased postoperative mortality. Various studies have posted the pros and cons of this subject throughout the medical journals, but again the conclusion remains unclear. In a study on the associations between intraoperative blood pressure and 30-day mortality in more than 18,000 non-cardiac surgical patients, the authors found that increased 30-day mortality was associated SBP < 70 mmHg for more than or equal to 5 minutes MAP < 49 mmHg for more than or equal to 5 minutes and MAP decreases to more than 50% from baseline for more than or equal to 5 minutes. In another study of 1,705 consecutive adults having general and vascular surgery, the authors found no association between IOH and risk-adjusted 1-year mortality. It is suggested that lower blood pressures are tolerated for shorter durations and the effect of IOH on 1-year mortality remains controversial^[12]. The effect of IOH on long-term mortality remains highly controversial as well. Once again, hypotension may be a marker of other direct causes of death and it is unknown whether interventions to improve or maintain blood pressure would improve ultimate outcome in patients with various prior risk factors.

Summary

Despite the widely-presumed importance of blood pressure management during the perioperative period, there is neither a clear answer on the impact of IOH and perioperative outcome nor are there standardized guidelines for the maintenance of intraoperative blood pressure. In fact, the only evidence-based guideline from the American Society of Anesthesiologists for the management of intraoperative blood pressure states that blood pressure should be measured intraoperatively at least at 5-min intervals. It is clear that additional guidelines should be developed. But first we must come to a consensus on the accepted "normal" range of intraoperative blood pressure and its true impact on patient outcomes. Confirmatory data from much larger prospective, randomized controlled studies will be

needed to draw more solid conclusions. We agree, however, with the statement that it is ethically and morally not feasible to randomly assign patients to a potentially detrimental intervention that deviates from accepted standards of care^[13].

In the meantime, should we be reassured by the current study results or should we still be very vigilant regarding the presence of IOH? We also need to know at what threshold and episode duration of IOH there will a clinically relevant effect on patient outcome. These remain very difficult questions to answer. But there should be no doubt that IOH is a very dynamic phenomenon depending on patient characteristics, risk factors, and surgical factors rather than a static phenomenon based on fixed and arbitrarily chosen thresholds. In the end, it can be concluded that perioperative blood pressure is a "risk factor" that is relatively easy to control and its treatment can potentially provide an opportunity to prevent a number of adverse outcomes. This is especially true in high-risk patients and it makes sense to still have a low threshold to treat IOH especially if it persists for a significant amount of time.

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