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The Incidence of Intraoperative Hypotension and the Importance of Timely Detection

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Author's contribution

Author RHS solely designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript until become final manuscript.

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Review Article

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ABSTRACT

Aims: Intraoperative hypotension (IOH) is a common condition faced by anesthesiologists intraoperatively which poignanting patients undergoing surgery under general and neuraxial anesthesia. Its occurrence is associated with dangerous morbid situations found perioperatively that can lead into fatal complications, such as acute kidney failure, direct myocardial injury, and even can end in mortality. Despite advanced closed hemodynamic monitoring and protocols utilizing goal directed therapy, recent trend of management is remaining reactive. Anesthesiologists tend to intervene when the episode of hypotension has already occurred. This literature review aimed to discuss the incidence of intraoperative hypotension and its urgency to overcome intraoperatively.

Conclusion: The incidence of IOH varies based on the type of surgery, type of anesthesia and fragility of the patient, for example having comorbidities. Due to the rapid development of IOH which is unwanted, the effort reducing the hypotensive burden intraoperatively, as soon as possible is mandatory. By carefully predicting and preventing IOH through closed monitoring of patient's blood pressure will surely improve patient outcome and prevent adverse unwanted post-operative event.

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Keywords: Blood pressure; high risk patient; hemodynamic monitoring; adverse outcome; post-operative complication.

1. INTRODUCTION

"Trend in surgical procedures market volume worldwide increasing rapidly. In 2022, there were approximately 294 million surgical procedure units worldwide, and by 2030, the market volume was forecast to increase to nearly 373 million units, according to market research company Next Move Strategy Consulting" [1]. "This global elevated trends resulting in a significant number of patients suffering from possible perioperative complications" [2,3]. "Perioperative complications include postoperative neurological deficits, myocardial infarction, and reoperation" [3]. Complicated surgical procedures carried out in the high-risk patients account for <15% of all of these intraoperative complication [4]; but the following consequences still account for a substantial number of intensive care unit (ICU) admissions in the perioperative period [5], remain the main cause of prolonged recovery with difficult outcome [6], and even morbidity [7]. The phrase "high risk" is not clearly determined; because it can be from the patient's condition or the procedure itself [8], and many factors can influence the frequency of complications [9], including geriatric age [10] and accompanying comorbidities [11] and the complexity and urgency of the procedure, including prolonged operative duration [12].

The basic principles of perioperative management are to keep the patient's stability, especially in the hemodynamic performance and optimization [13], especially with its focus on the avoidance or reduction of the rate of intraoperative hypotension (IOH) that defined by either reduction from baseline or absolute thresholds [14]. Unfortunately, the sudden onset of IOH [15] is responsible for rapid restriction of vital organ perfusion [16] and is associated with perioperative multiple type of morbidity and even mortality [17-20]. Principally, in order to circumvent IOH with its cardiovascular [21] and hemodynamic [22] instability, the best practice of appropriate anesthetic management is to continuously monitor the patient's hemodynamics [23]. Unfortunately, perioperative goal directed therapy [24] and ceaseless hemodynamic monitoring [25] revealed various effects on postoperative complications [26] and failed in reducing mortality [27]. The aim of this literature review is to focus on the incidence of intraoperative hypotension and its urgency to overcome IOH perioperatively.

2. INTRAOPERATIVE HYPOTENSION— THE SCOPE OF THE PROBLEM

"Despite substantial literature on the subject of adverse effects related to intraoperative hypotension, its definition is poorly defined. The most frequently reported definitions of IOH in the anesthesia literature are a systolic blood pressure (SAP) below 80 mmHg, a mean blood pressure below 55–60 mmHg, and a decrease in systolic blood pressure (SAP) or mean blood pressure of 20–25% from baseline" [28]. As mean arterial pressure (MAP) is an accurate measure of the arterial blood pressure during the whole cardiac cycle [29] and is the driving force of organ perfusion [16]. The most widely used definition of IOH cut off is MAP < 65 mmHg [30], was associated with significantly higher odds of myocardial [21] and kidney injury [22].

Study conducted by Saasouh et al [31] found out that "among 127,095 non-emergent, non-cardiac cases in community anesthesia settings, 29% had MAP < 65 mmHg for at least 15 min cumulatively, with an overall mean of 12.4 min < 65 mmHg. IOH was slightly more common in patients who were younger, female, and ASA II (versus III or IV); in procedures that were longer and had higher anesthesia base units; and in ambulatory surgery centers. Incidence of IOH varied widely across individual clinicians in both unadjusted and risk-adjusted analyses". Other report by Shah et al [32] that "analyzed the incidence of intraoperative hypotension in moderate to high risk patients undergoing non-cardiac surgery revealed that the mean duration of MAP < 65 mmHg was 28.2 min (SD 42.6) and 88% of cases had at least one hypotensive event as defined as MAP < 65 mmHg for 1 min. Across centers this varied from 83.2 to 91.6% of cases. The mean duration of hypotension ranged from 22.1 to 31.8 min". while Katori et al from Japan [33] that "studied the incidence of hypotension during general anesthesia: a single-center study at a single university hospital found out that moderate to very severe hypotension occurred in 86.3% of the patients for at least 1 to 5 min, and 48.5% experienced severe or very severe hypotension". "The results of the logistic regression analysis indicated female gender, vascular surgery, American Society of

Anesthesiologists physical status classification (ASA-PS) 4 or 5 in emergency surgery, and the combination with the epidural block (EDB) were significant factors of IOH. However, the issue of "baseline" blood pressure appears with these definitions, as there is a question about which blood pressure should be considered the baseline" [34]. "Because of the vast range of intraoperative hypotension scope, the rate of this IOH event may differ from 5 - 99%, reckoning on the definition used" [2]. In consideration of that most of the perioperative measurements are taken noninvasively, usually checked within 5 min intervals [35], the real number of intraoperative hypotension incidence is actually underrated [36].

3. EFFECT CAUSED BY INTRAOPERATIVE HYPOTENSION AND ITS ADVERSE PERIOPERATIVE OUTCOMES

Intraoperative hypotension is common in patients having non-cardiac surgery under spinal/neuraxial [34] and general [9,33] anesthesia. It has a multi-factor etiology [37], and is associated with major postoperative complications [38] such as myocardial injury [21], acute kidney injury [19,22] and mortality [17]. The decisive factors bestowing to the condition of hypotension which happened intraoperatively are unrestricted depth of anesthesia [39], obvious blood loss due to bleeding [40-41], and vasodilation [42].

Adverse events due to IOH consists of primary outcome, that was consist of major adverse cardiac [43] or cerebrovascular [44] conditions. Secondary outcomes were all-cause 30- and 90-day mortality [45], 30-day acute myocardial injury [31], and 30-day acute ischemic stroke [46]. Any association between hypotension and adverse outcomes would be of clinical significance because of the potentially alterable nature of the threat [47].

"Roughly estimated about one third of perioperative hypotensive events took place in the period after the induction of general anesthesia but before surgical incision started and can be described as post induction or pre-incision hypotension" [48]. "From the physiological point of view, hypotensive episodes begin even before they can be observed by the attending anesthesiologist" [49]. Measurement of the changes in bodily compensatory responses [50] and variability of hemodynamic parameters in the early stages of cardiovascular instability [51] might authorize very early identification of IOH, even prior IOH exists using deep learning algorithms for real-time predictions 5, 10, and 15 min before a hypotensive event [52].

4. DETECTING INTRAOPERATIVE HYPOTENSION, IS IT POSSIBLE?

Continuously monitoring blood pressure [23] in patients during general and neuraxial anesthesia is an obligatory part of standard anesthetic management [24]. "Type of surgery- and patient-related risk factors govern which is the best method to be used to monitor hemodynamic performance" [54]. "In routine clinical setting, intermittent and non-invasive blood pressure measurements are usually measured using oscillometry (upper-arm cuff method), normally at intervals of 2–5 minutes, or continuously and invasively with an arterial catheter" [55]. "However, measurement accuracy of this technique in patients suffering from sudden hypotensive attacks sometimes questionable. Arterial catheters are used for continuous blood pressure monitoring in critically ill patients with high patient-specific or surgery-related risk" [23,56].

In the coming future, safer approaches for continuous non-invasive blood pressure monitoring [57] – for example the finger-cuff technologies [58]– may be used in patients undergoing surgery as an alternative to intermittent non-invasive [59] or continuous invasive arterial blood pressure (AP) monitoring [23,56].

"Although the space for managing patient-related causes of hypotension are actually not easily modifiable, there is still a possibility for the anesthetic doctor to arbitrate on anesthesia- and surgery-related causes to prevent or promptly reverse hypotension" [37]. Pharmacology intervention of any specific cause of hypotension should be carefully escorted in a timely and appropriate manner. To do so, identifying and correcting the underlying pathophysiologic mechanisms, such as decreased cardiac preload [22], altered cardiac afterload [22], or even decreased myocardial contractility [53], is central for causal treatment of hypotension [37].

Predicting hypotensive episodes may lead to preventive treatment [2,25,52] and encourage in circumventing hypotension [47]. Recently, a new technology based on AI has shown promise in

predicting hypotension. Hatib et al. [60] managed to elaborate a trustworthy “hypotension prediction index” (HPI) to predict real-time hypotension. They applied machine learning to analyze many hemodynamic variables obtained from the arterial blood pressure waveform in real time condition. After carefully verified the method, surprisingly the model able to predict arterial hypotension 15 minutes ahead of time, with a degree of sensitivity of 88% and a specificity of 87%.

5. CONCLUSION

The exact incidence of IOH is varies based on the type of surgery, type of anesthesia and fragility of the patient, for example older age or having comorbidities. Because the development of IOH is undesirable, due to its peri- and post-operative adverse outcome; the effort reducing the hypotensive burden intraoperatively, as soon as possible is mandatory. By carefully predicting and preventing IH through closed monitoring of patient’s blood pressure will surely improve patient outcome and prevent adverse unwanted post-operative event.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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