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Intraoperative Hypotension and Vasoactive Treatment: An International Survey of Anaesthesiologists

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ABSTRACT

Background: Intraoperative hypotension is a common occurrence in patients undergoing anaesthesia, although there is no standardised definition of hypotension. International consensus statements provide some guidelines for the management of intraoperative hypotension, but general clinical practice is unknown. We aimed to survey anaesthesiologists' values and preferences regarding intraoperative blood pressure management, including whether they would support future research on this topic.

Methods: We conducted an international, online survey of routine practice and opinion. The target population was anaesthesiologists who regularly anaesthetise adult patients. Results are reported descriptively and in accordance with the Consensus-Based Checklist for Reporting of Survey Studies (CROSS) checklist.

Results: A total of 1640 anaesthesiologists from 11 European countries participated in the survey. The majority of respondents were specialists (1322 of 1640, 80.6%, 95% CI 78.7–82.6). Almost all respondents worked in public hospitals (1613 of 1640, 98.4%). The overall response rate was 22.7%. Most respondents reported using absolute mean arterial pressure as their main unit of measurement to quantify hypotension (1098 of 1640, 67.0%, 95% CI 64.6–69.2). Respondents were most likely to initiate vasoactive treatment at a mean arterial pressure below 60 or 65 mmHg. Chronic arterial hypertension, traumatic brain injury and surgical procedures involving head-up positioning of the patient were the three most common scenarios where respondents would raise their threshold for treatment. Most respondents considered the establishment of safe intraoperative blood pressure thresholds a critical research question, and almost all respondents (1509 of 1640, 92.0%) indicated a willingness to randomise patients to specific blood pressure targets. For 72.9% (1196 of 1640), the lowest acceptable mean arterial pressure for randomisation was 60 mmHg. Respondents were also interested in the comparison of efficacy and safety of vasoactive agents, and the

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most sought-after comparison was phenylephrine versus noradrenaline (1252 of 1640, 76.3%). The willingness of respondents to administer these agents in peripheral venous access differed according to geography.

Conclusion: In this international survey, mean arterial pressures of 60 or 65 mmHg were the most commonly reported blood pressure thresholds leading to initiation of treatment with vasoactive agents. Almost all respondents indicated patient groups for whom they would alter their treatment threshold, namely those suffering from chronic arterial hypertension, those undergoing surgery in a head-up position, and patients with traumatic brain injury. The majority of respondents supported future trials establishing optimal mean arterial pressure threshold and choice of vasoactive agent. We noticed a geographical variation in willingness to administer vasoactive agents in peripheral venous access.

Editorial Comment: This survey of anaesthesiologists from European countries queried practitioner perceptions of blood pressure management in adults during anaesthesia with focus on hypotension. Queries and responses also concerned circumstances and blood pressure levels which clinicians report being willing to treat actively, and how they might do this practically.

1 | Introduction

Intraoperative hypotension is common in anaesthetised patients with incidence rates varying between 5% and 99%, largely due to inconsistent definitions [1]. It is well-known that intraoperative hypotension is associated with adverse patient outcomes, including myocardial injury, acute kidney injury, cerebrovascular injury and death, although the strength of association is dependent on both severity, duration and definition of hypotension [2–6]. For this reason, numerous studies have attempted to establish safe thresholds for intraoperative blood pressure in different patient groups, but results remain ambiguous [7–13].

The Perioperative Quality Initiative (POQI) Statements from 2019 to 2024 suggest that mean arterial pressures (MAP) below 60–70 mmHg or systolic blood pressures below 90–100 mmHg should be avoided in patients at high risk for postoperative complications [14, 15]. Typical factors included in the categorisation of high-risk patients include advanced age [1, 6, 16], chronic kidney disease [6, 16–17], hypertension [16–18], coronary artery disease [17, 19] and heart failure [19]. However, it is unknown whether clinicians follow the POQI recommendations.

Clinicians' opinions, practices and preferences for treatment thresholds for perioperative hypotension are poorly described. A recent mixed-methods study attempted to map clinicians' beliefs around the treatment of intraoperative hypotension [20], but focused on whether the clinician felt equipped to handle hypotension when it occurred, rather than at which point they chose to intervene.

With this international survey, we wanted to establish which intraoperative blood pressure thresholds clinicians use in their everyday practice and whether certain patient co-morbidities or surgical factors influenced their intervention threshold. Furthermore, we wished to ascertain clinicians' views on future research in this area and whether they would be willing to randomise patients to specific blood pressure targets. Finally, we sought to canvass opinion regarding the safety of administering vasoactive agents via peripheral venous access.

We hypothesize that clinicians employ heterogeneous thresholds for treatment of intraoperative hypotension, with frequent situation-specific exemptions.

2 | Methods

2.1 | Study Design, Data Collection and Approvals

We conducted an international, online survey using the secure web application Research Electronic Data Capture (REDCap) hosted by the Zealand Region of Denmark [21–23]. The survey was pilot-tested and revised by the lead author group (E.S.B., V.C., M.V.-A., M.H.M. and M.K.), as well as nine researchers and clinicians before data collection.

The survey was distributed, and responses collected, between 13 January 2025 and 14 March 2025. The start date varied between countries and sites, but all respondents had a period of a minimum of 30 days to complete the survey.

This study was designed as a survey of everyday practice and opinion. It was explicitly stated that the answers of interest were the respondents' personal opinions and therefore there were no incorrect answers.

Participation in the survey was voluntary, and no financial compensation was provided. Activation and completion of the survey link was considered informed consent.

Local legal authorities were consulted in the process of designing the survey. As there were no personal identifiers, the survey was classified as anonymous, and ethical approval was waived.

We prepared this manuscript according to the Consensus-Based Checklist for Reporting of Survey Studies (CROSS) checklist [24] (included in the Data S1).

2.2 | Survey Description

The questions and response options were informed by previous literature studies on the subject [25–27]. The survey had 15 mandatory questions. None allowed a “don't know” response, but each offered an “other” option with space for free-text elaboration. Three background questions assessed respondent characteristics, including specialist status and hospital type. This was followed by seven main questions assessing respondents' opinions about blood pressure thresholds and when to initiate treatment of intraoperative hypotension in

different patient groups. Five further main questions explored the respondents' opinions on future research, specifically regarding blood pressure thresholds and which interventions to investigate.

The survey was designed with a target time of 5 min for completion. The answer options were dichotomous (yes/no), nine-point Likert scales to illustrate importance (with 1–3 = "not important," 4–6 "important" and 7–9 = "critical"), predefined multiple-choice answers and optional free text elaborations. The survey was in English with no translations.

The complete distributed survey is provided in the Data S1.

2.3 | Survey Distribution

The target study population consisted of anaesthesiologists, both specialists and those in training. All respondents were required to be involved with perioperative adult patient care on a weekly basis.

In Denmark, the survey was distributed through site investigators involved with the Collaboration for Evidence-based Perioperative Research in Anaesthesia (CEPRA) network [28].

Outside of Denmark, national coordinators were recruited based on prior collaboration with the author group. The national coordinators were instructed to personally invite individual clinicians or entire anaesthesiology departments to participate. The national coordinators were allowed to designate local investigators. Investigators sent a minimum of two reminders before the database was closed. Each national coordinator was required to report the total number of anaesthesiologists who had received the survey in their country.

2.4 | Statistical Analyses

We present data descriptively, reporting numbers with corresponding percentages and 95% confidence intervals (95% CI) and medians with interquartile ranges (IQR). Summary tables are provided where relevant. No tests for normality were carried out, and no inferential statistics were used.

All statistical calculations and graphs were carried out using R version 4.3.1 (R Core Team, R Foundation for Statistical Computing, Vienna, Austria). All incomplete surveys were excluded.

3 | Results

3.1 | Background Characteristics

A total of 1640 respondents from 11 countries (Austria, Denmark, Finland, Germany, Iceland, Italy, the Netherlands, Norway, Sweden, Switzerland and the United Kingdom) participated in the survey. Most respondents were specialists (1323 of 1640, 80.6%, 95% CI 78.7–82.6). Almost all respondents worked in public hospitals (1613 of 1640, 98.4%), and 59.1% of those in public general hospitals (953 of 1613) (Table S1).

The overall response rate was 22.7% (1640 of 7230, 95% CI 21.7–23.7). The national response rates ranged from 6.4% (9 of 140, 95% CI 3.0–11.9 for Germany) to 54.2% (19 of 35, 95% CI 36.6–71.1 for Iceland). (Table S2).

3.2 | Blood Pressure Thresholds in Clinical Practice

Two-thirds of respondents (1098 of 1640, 67.0%, 95% CI 64.6–69.2) reported using an absolute MAP value as the primary unit of measurement to define hypotension, while one in five reported using percentage drops in blood pressure (MAP or systolic) from a given baseline (332 of 1640, 22.3%, 95% CI 20.4–22.4).

Respondents were asked to indicate at which lower absolute MAP threshold they would consider starting vasoactive treatment in an adult surgical patient, from a list of pre-defined MAP value options. The most common answers were MAP 65 mmHg (637 of 1640, 38.8%, 95% CI 36.5–41.2) and MAP 60 mmHg (631 of 1640, 38.5%, 95% CI 36.2–40.9). Less than 5% of respondents picked a threshold higher than MAP 65 mmHg (76 of 1640, 4.6%, 95% CI 3.7–5.8), and 18.0% chose a threshold lower than MAP 60 mmHg (296 of 1640, 95% CI 16.2–20.0; Figure 1).

When presented with examples of co-existing diseases, patient conditions and surgical procedures, almost all respondents (1559 of 1640, 95.1%, 95% CI 93.9–96.0) chose at least one category in which they would change their treatment threshold (Figures 2–4).

Chronic arterial hypertension (1389 of 1559, 89.0%, 95% CI 87.4–90.6), traumatic brain injury (1146 of 1559, 73.5%, 95% CI 71.2–76.7), and surgical procedures involving head-up positioning of the patient (1100 of 1559, 70.6%, 95% CI 68.2–72.8) were the three most likely factors to cause respondents to use higher MAP thresholds for treatment. For patients suffering from chronic arterial hypertension and for those undergoing surgery in the head-up position, MAP 70 mmHg was the most commonly chosen threshold (746 of 1389, 53.7%, 95% CI 51.0–56.4 for hypertension and 389 of 1100, 35.4%, 95% CI 32.5–38.3 for head-up positioning). For patients with traumatic brain injury, the most commonly chosen value was MAP 80 mmHg (538 of 1559, 46.7%, 95% CI 44.0–49.0; Figures 2–4).

3.3 | Future Research

The majority (1269 of 1640, 77.4%, 95% CI 75.3–79.4) found that the research question of establishing intraoperative blood pressure thresholds was critical, providing a rating of 7 or above on the nine-point scale, with a median of 7 (IQR 7–8). Sixteen percent (262 of 1640, 95% CI 14.3–17.8) picked the highest rating of 9 on the nine-point scale (Figure 5).

Two-thirds (1104 of 1640, 67.3%, 95% CI 65.0–69.6) of respondents considered the comparison of efficacy and safety of different intraoperative vasoactive agents a critical research question,

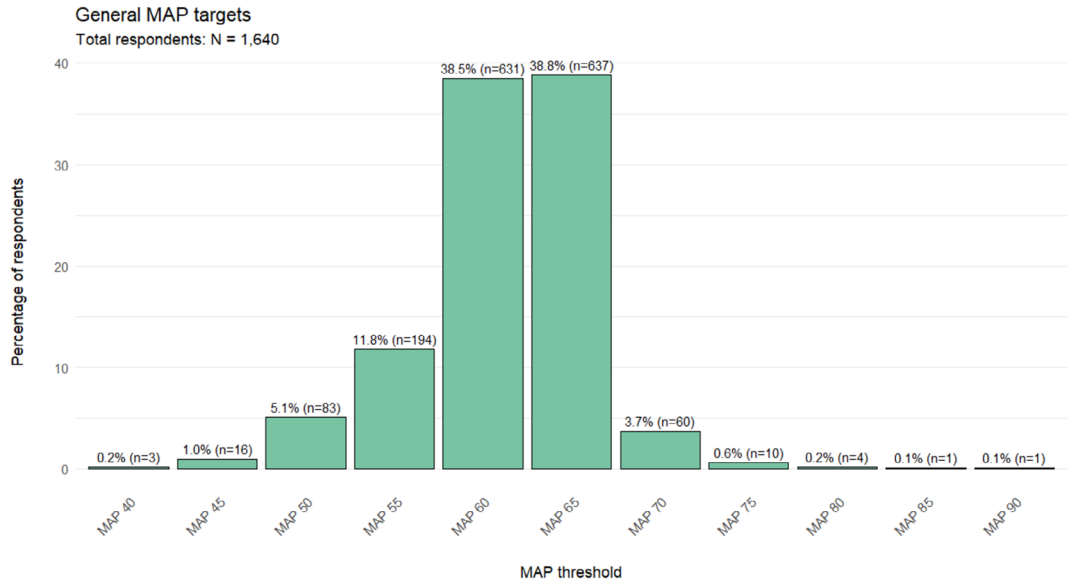

FIGURE 1 | Distribution of respondents by their selected MAP threshold. All MAP units are in mmHg.

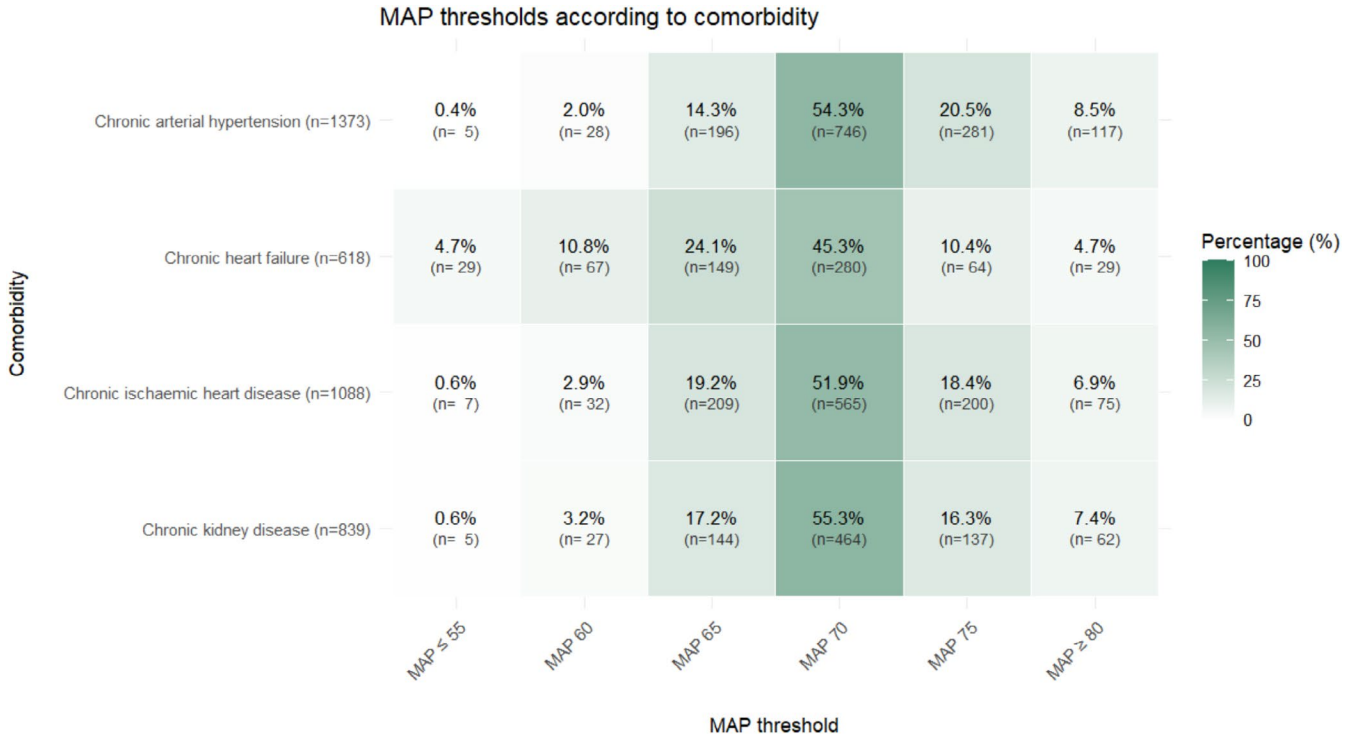

FIGURE 2 | The percentage distribution of respondents' chosen mean arterial pressure (MAP) threshold for each co-morbidity. All MAP units are in mmHg. The percentages are calculated based on the number of respondents who had chosen a MAP target for that co-morbidity.

as defined by a rating of 7 or above on the nine-point Likert scale, with a median of 7 (IQR 6–8) (Figure 6).

3.3.1 | MAP Thresholds

Nearly three-quarters of respondents (1196 of 1640, 72.9%, 95% CI 70.8–77.2) indicated that in a future trial, the lowest acceptable absolute MAP for randomisation would be 60 mmHg, and an acceptable and relevant comparator would be a percentage drop in MAP from a given baseline (1018 of 1640, 62.1%, 95% CI 59.7–64.4).

Ninety-two percent (1509 of 1640, 95% CI 90.6–93.3) stated that they would be willing to randomise patients to a specific MAP threshold.

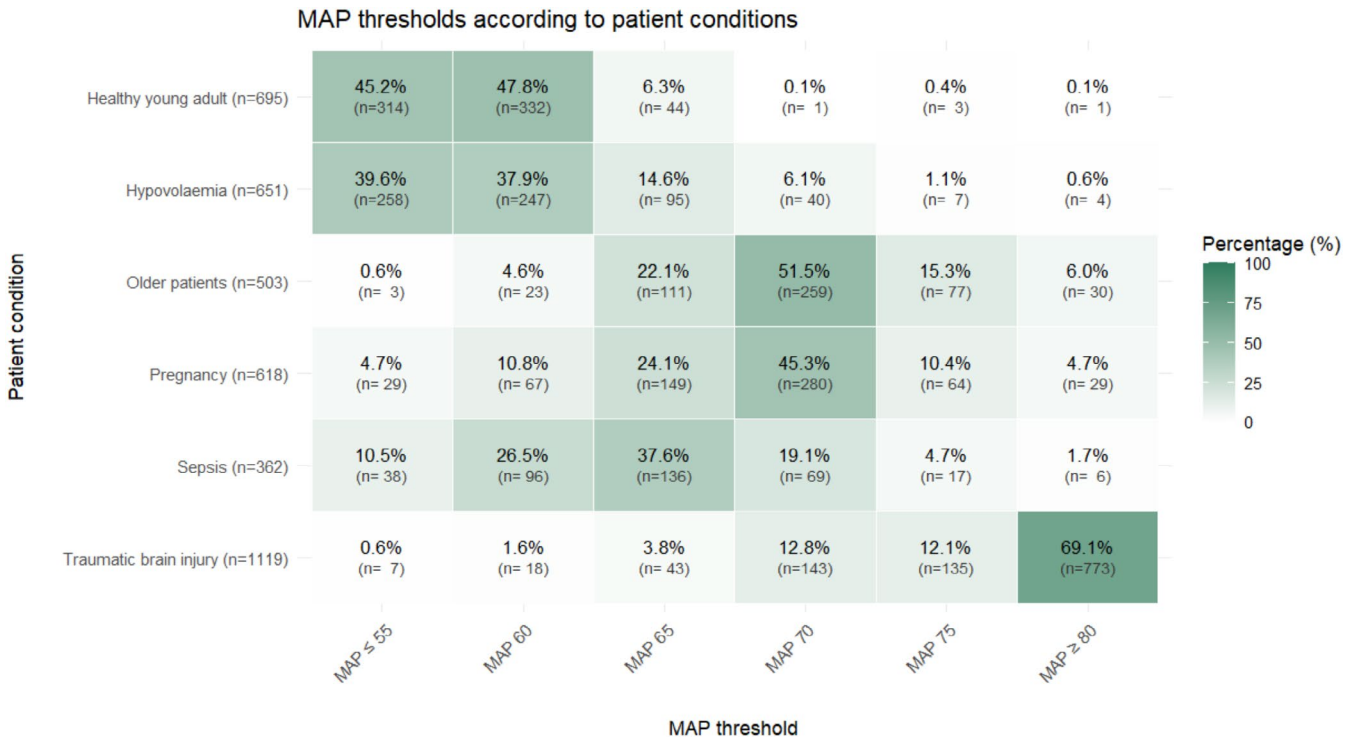

FIGURE 3 | The percentage distribution of respondents' chosen mean arterial pressure (MAP) threshold for each patient condition. All MAP units are in mmHg. The percentages are calculated based on the number of respondents who had chosen a MAP target for that patient condition.

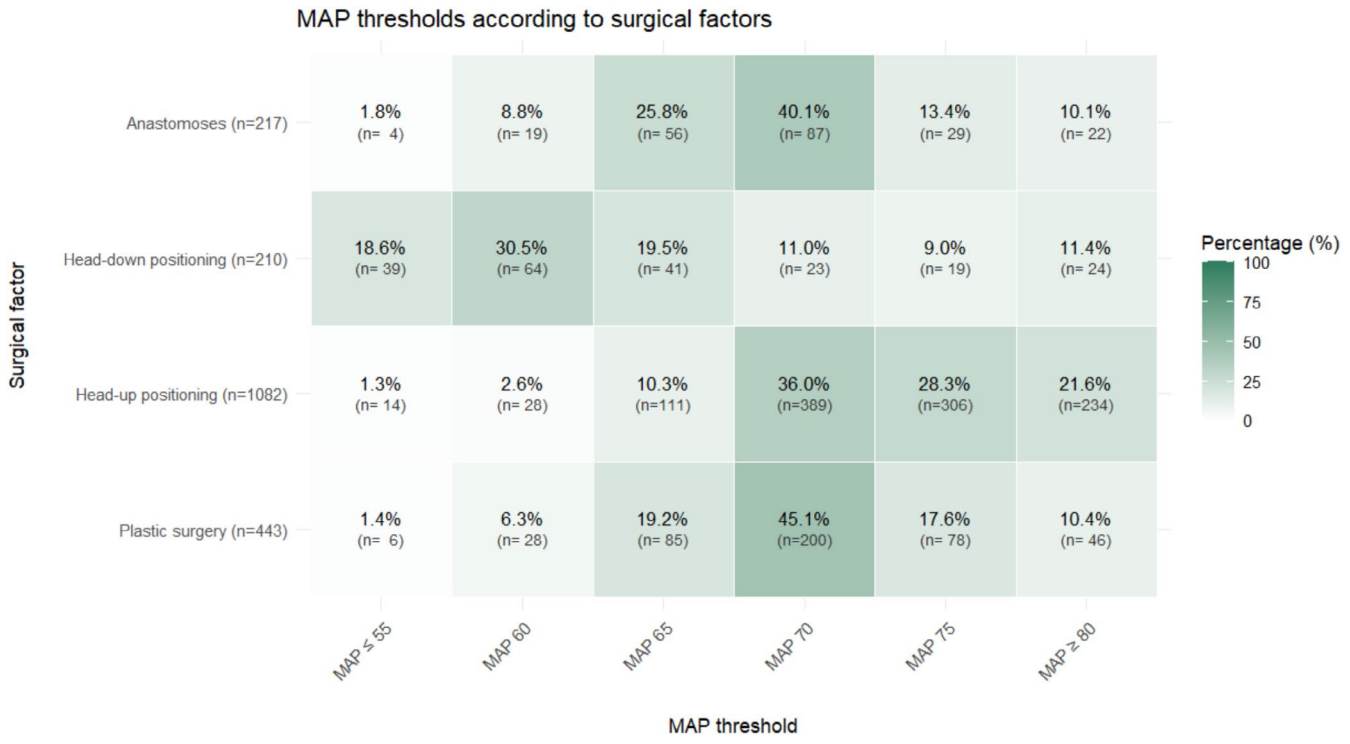

FIGURE 4 | The percentage distribution of respondents' chosen mean arterial pressure (MAP) threshold for each surgical factor. All MAP units are in mmHg. The percentages are calculated based on the number of respondents who had chosen a MAP target for surgical factor. NB. The type of anastomosis was not specified and could have been interpreted as intestinal, vascular or both.

3.3.2 | Vasoactive Agents

When asked which agents the respondents would prefer to see compared, the most frequent choice was noradrenaline vs. phenylephrine (1252 of 1640, 76.3%, 95% CI 74.2–78.4) (Figure 7). In the free text answers two agents dominated: comparisons involving metaraminol were mentioned in 199 of 1640 responses (12.1%, 95% CI 10.6–13.8), and comparisons

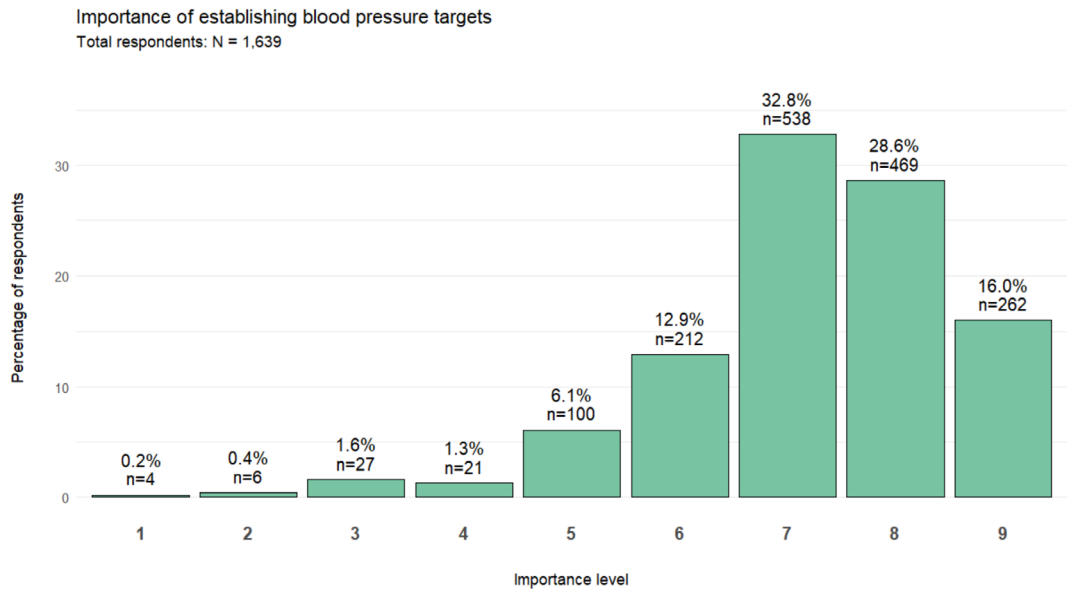

FIGURE 5 | The rated importance of establishing blood pressure thresholds (1 = not at all important, 9 = critically important).

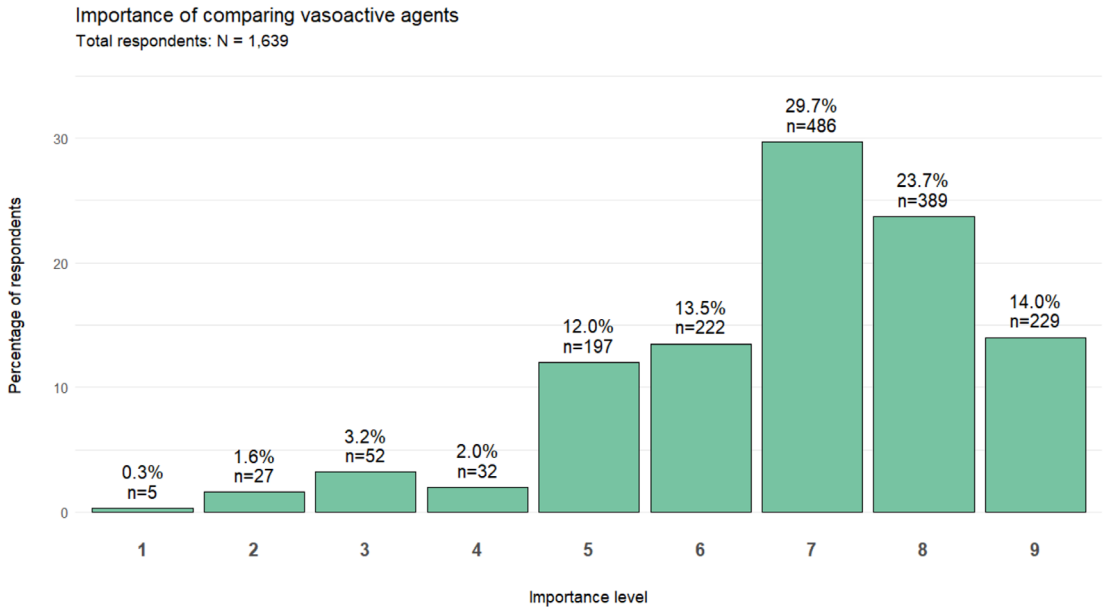

FIGURE 6 | The rated importance of research comparing vasoactive agents (1 = not at all important, 9 = critically important).

involving vasopressin in 34 of 1640 responses (2.1% of total, 95% CI 1.4–2.9) (Table S2).

3.3.3 | Route of Administration

Respondents were asked whether they were willing to administer the mentioned vasoactive agents in a peripheral venous access. Fifty-eight percent (946 of 1640, 95% CI 55.2–60.1) of respondents were willing to administer all agents via peripheral venous access. However, these responses showed a considerable geographic variation. In Italy and the United Kingdom, 30% and 32% of respondents, respectively, were willing to administer all agents in a peripheral venous access, while in Sweden and Iceland, these numbers were above 80% (Table S4).

The agents most likely to cause concerns about peripheral administration were dopamine, dopexamine and dobutamine, where more than 20% of all respondents had indicated concern. As for noradrenaline, the count was 17.3% (283 of 1640, 95% CI 15.5–19.2). These answers also showed geographical variation, especially with regards to noradrenaline. Around 40% of UK and Italian respondents were unwilling to administer noradrenaline in a peripheral venous access, while for all other countries, the numbers were < 10% (Table S3).

4 | Discussion

In this international survey, we found that anaesthesiologists working in the perioperative field most commonly used an absolute MAP as a unit of measurement for quantifying hypotension

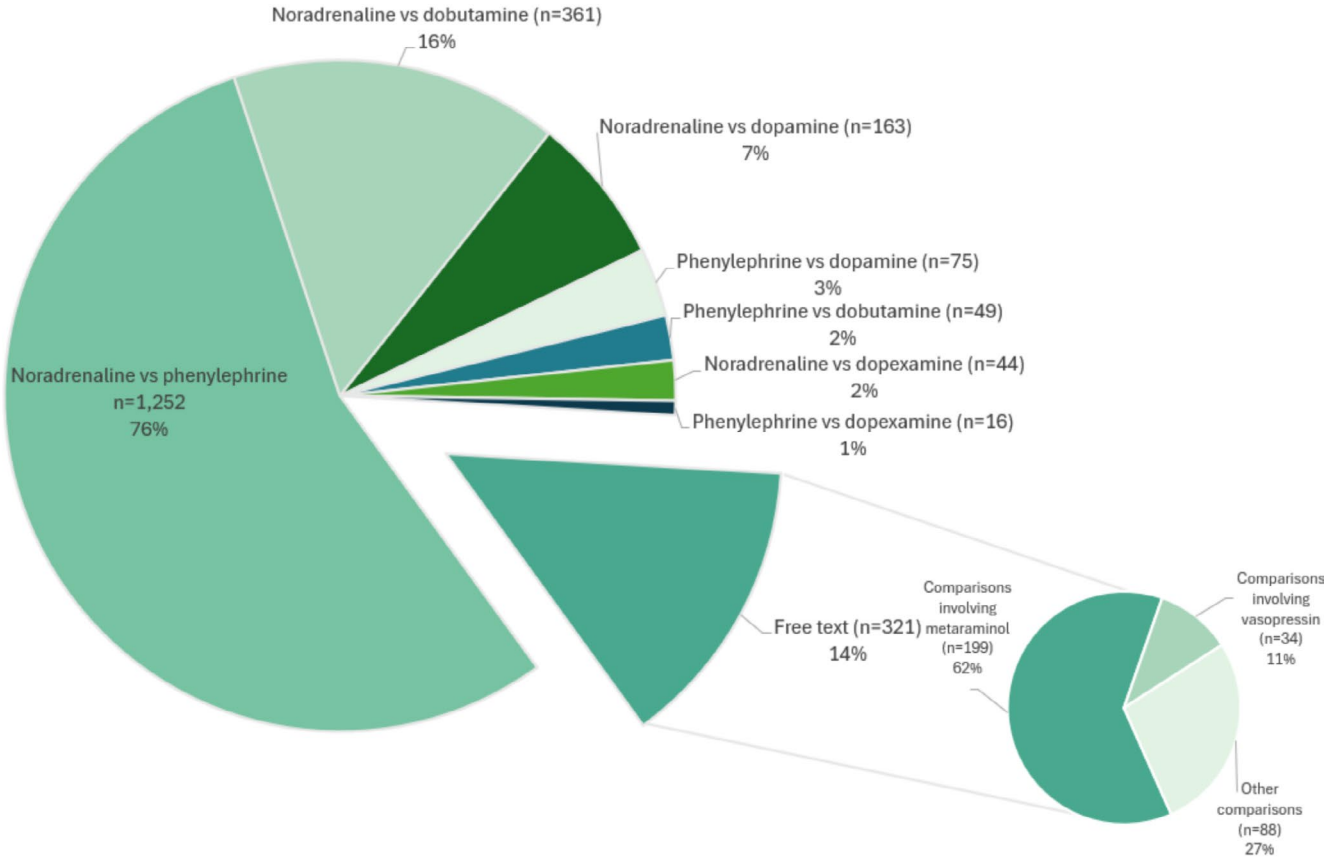

FIGURE 7 | The respondents' choice of agent comparisons. Respondents were allowed to pick more than one option (with a maximum of three). Percentages are calculated from a total $n = 1640$ in the large diagram, and from a total $n = 321$ in the smaller subset diagram.

in clinical practice and, contrary to our hypothesis, the majority indicated MAP of 60 or 65 mmHg as the lower threshold leading to initiation of treatment with vasoactive agents. However, as per our hypothesis, respondent clinical practice varied from general treatment thresholds when accounting for patient co-morbidities, patient conditions or surgical factors. Furthermore, respondents recognised both the establishment of safe blood pressure thresholds and the comparison of safety and efficacy of vasoactive agents as critical research topics. The majority indicated willingness to randomise patients to a specific MAP threshold in a future trial, most often 60 mmHg, and the most frequent vasoactive agent comparison of interest was noradrenaline vs. phenylephrine. Finally, we found that geographical spread in answers when it came to assess willingness to administer vasoactive agents in a peripheral venous access.

4.1 | Blood Pressure Thresholds in Clinical Practice

Our findings complement the results of prior studies in this field. In a large cohort study focusing on intraoperative hypotension in older patients, an accompanying survey of the treating clinicians showed a median intended treatment threshold of MAP 60 mmHg [29]. This is in keeping with both current practice recommendations [14, 15] and aligns with the opinions stated by the respondents in our survey.

Current recommendations for intraoperative blood pressure treatment thresholds suggest keeping blood pressure above MAP 60–70 mmHg [15], which largely corresponds to the overall thresholds indicated by our respondents, although 18% of the respondents would initiate treatment at a lower MAP target. Our respondents were largely in agreement on the comorbidities, patient conditions and surgical factors that required an alteration of their standard approach to intraoperative hypotension. Patients suffering from chronic arterial hypertension, chronic ischaemic heart disease and chronic kidney disease were highlighted, corresponding with earlier studies highlighting these groups as being at high risk for complications from perioperative hypotension [6, 16–19]. However, despite these associations, current evidence indicates that targeting higher intraoperative blood pressure thresholds does not reduce complication rates [7, 9, 19]. Both the recently published PRETREAT trial, which stratified patients by risk for hypotensive episodes to a progressively higher MAP [30], and the IMPROVE trial, where investigators compared an individualised approach to blood pressure management to a standard MAP threshold of ≥ 65 mmHg during major abdominal surgery, showed no difference in outcomes [30, 31]. A 2025 meta-analysis of randomised trials comprising over 9000 patients similarly found no significant differences in postoperative complications between moderate and high MAP management [32]. The IMPROVE trial did, however, show higher use of noradrenaline in the individualised group [31].

Although we did not ask specifically about amounts of vasoactive agents used, it is probably safe to assume that those groups in whom our respondents choose to raise their MAP threshold also receive more vasoactive treatment, in parallel with this trial's findings. Given that vasoactive treatment is not without its adverse effects [33, 34], increasing treatment dosage to attempt to counteract the deleterious effects of hypotension may not be an ideal solution. Indeed, evidence on whether increasing blood pressure thresholds intraoperatively increases complication rates is conflicting and seems to be related to the surgical specialty, for example, reduced bleeding with higher MAP in bariatric surgery but poorer outcomes with higher MAP in ophthalmic surgery [35].

4.2 | Future Research

The current POQI consensus statement states that the ideal vasoactive agent for the management of intraoperative hypotension is unknown [15]. This is supported by a scoping review published by our research group identifying over 100 clinical trials in the perioperative setting comparing vasoactive agents for the treatment of perioperative hypotension [27]. However, the certainty of evidence regarding benefit or harm of individual agents was judged to be low. This could explain why two-thirds of our respondents indicated that future trials assessing the efficacy and safety of vasoactive agents are of "critical" importance (Table S2).

A large, multicentre randomised trial comparing noradrenaline and phenylephrine for the treatment of intraoperative hypotension is currently recruiting patients (www.clinicaltrials.gov, study ID NCT06802224), with expected completion set to 2028 [36]. The "Tight Perioperative Blood Pressure Management to Reduce Serious Cardiovascular, Renal and Cognitive Complications (GUARDIAN)" trial (www.clinicaltrials.gov, study ID NCT04884802) is currently recruiting adults undergoing major non-cardiac surgery. Participants are randomised to MAP > 85 mmHg with noradrenaline or phenylephrine compared with routine blood pressure management without a specific MAP target, testing the hypothesis that tight intraoperative blood pressure management will reduce a composite of major complications. Both trials are expected to add valuable knowledge to the field of treating intraoperative hypotension. Given the variability in management and definitions, standardised planning is needed to ensure patient safety before new knowledge is applied.

4.3 | Safety Concerns

Most perioperative evidence on peripheral venous administration of vasoactive agents concerns noradrenaline. A 2017 Danish review found that, with protocolled monitoring and care of the venous access, peripheral noradrenaline is a safe alternative to central administration [37]. A 2020 Dutch study of more than 14,000 surgical patients reported no complications requiring intervention [38]. In our study, 92% of Danish and 95% of Dutch participants were willing to use peripheral noradrenaline, compared with 59% in Italy and 60% in the United Kingdom. The survey did not specify noradrenaline concentration, which may have influenced responses. Other vasoactive agents have limited perioperative safety data regarding route of administration, side effects or both.

4.4 | Strengths and Limitations

The strength of this survey includes the large number of respondents, as well as its international scope adding to its external validity. More than 80% of respondents were specialists in the field of anaesthesiology, and all types of hospitals were represented.

The generalisability of the survey may be compromised with the response rate at ~23%. This is lower than expected, according to a recent review, where mean response rates were calculated to be ~35% [39]. Additionally, as the survey was only distributed in English, a language bias may have been introduced.

For the sake of simplicity and comparability, we chose a general framework for the survey, and we acknowledge that this cannot capture all nuances of intraoperative treatment of hypotension.

We deliberately refrained from comparing most other results across countries, as the national samples were highly unbalanced. The vast majority of answers were generated by respondents from Denmark, Finland, Norway and the United Kingdom (1406 of 1640, 85.7%), which may further limit generalisability.

The varying proportion of respondents by country, as well as the pre-selection of national coordinators by the authors and their recruitment of participants, may have led to a selection bias in participant population. Furthermore, those who completed the survey may have had a keener interest in the subject, and hence their answers may have been different to non-responders.

5 | Conclusions

In this international survey, mean arterial pressures of 60 or 65 mmHg were the most commonly reported blood pressure thresholds leading to initiation of treatment with vasoactive agents. Almost all respondents indicated patient groups for whom they would alter their treatment threshold, namely those suffering from chronic arterial hypertension, those undergoing surgery in a head-up position, and patients with traumatic brain injury.

The majority of respondents supported future trials establishing optimal mean arterial pressure threshold and choice of vasoactive agent. However, we noticed a geographical variation in willingness to administer vasoactive agents in peripheral venous access.

Author Contributions

Conceptualisation and methodology: E.S.B., M.V.-A., V.C., M.H.M., M.K. Data curation, formal analysis and visualisation: E.S.B. Project administration: E.S.B. and national coordinators S.Y., R.P., F.H., P.U., C.B.S., M.R., K.v.d.S., A.C., J.K., G.B. Investigation: all authors. Manuscript writing – original draft: E.S.B. Manuscript writing – review and editing: all authors.

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Conflicts of Interest

J. Kreutziger has received travel reimbursement and scientific lecture fees from AOP Health Austria, Fresenius Kabi, Austria, and CytoSorbents Europe GmbH, Berlin, Germany, unrelated to the current project.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Data S1:** Supporting Information.