

Working Paper 68



## Working Paper

### Comparative case study analysis of five clinical practice guidelines in anesthesiology

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### Abstract

Clinical practice guidelines (CPG) are evidence-based recommendations that influence clinical practice, with a goal of reducing patient harm and improving patient outcomes. Yet the uptake of CPGs in clinical practice may vary due to contextual factors. We sought to (1) identify whether five previously published anesthesia practice guidelines changed clinical practice; (2) assess the evidence base for previously published anesthesia practice guidelines; and (3) identify the facilitators and barriers to guideline implementation. We developed case studies for each CPG to describe the guideline, barriers and facilitators to its use, and practice change. To create each case study, we synthesized evidence across three sources: (1) the guideline document, (2) published information in peer-reviewed literature, and (3) interviews with nine anesthesiologists. We reviewed 14 CPGs from the American Society of Anesthesiologists (ASA), and we identified five CPGs for the case studies on the following common practices in perioperative settings, such as assessing or monitoring patient risk for blood transfusions, providing medication (for example, beta blockers and opioids), and using medical devices (for example, pulmonary artery catheters and central venous catheters). Case studies for the guidelines include the following themes: use of the guideline today, practice change, opportunities to improve guideline uptake, and barriers and facilitators for guideline use. We classified barriers and facilitators into clinician, guideline, task (such as skills, resources, staff, responsibility), organization, and system characteristics. To understand the similarities and differences across the cases, we conducted a comparative case study analysis.

We found that when consistent evidence supported guideline recommendations, clinical practice change occurred, and clinicians adopted new guidelines. Clinicians reported that most guidelines had recommendations that were broad or lacked clarity, which were both barriers to guideline use. Weak or insufficient evidence support vague guideline recommendations. Clinicians held positive beliefs about guidelines. They agreed with the guidelines and believed they improved care (4 guidelines), and thought the guidelines were feasible and helpful (3 guidelines). Finally, we found that organizational characteristics can facilitate practice change and promote CPG use. The results from this study demonstrate that multiple barriers and facilitators at the clinician, organization, and system levels can affect practice change and guideline use. Understanding the barriers and facilitators to practice change and CPG use is critical to improving patient care. In anesthesiology, important factors for practice change and guideline use might include the consistency of the evidence supporting the guideline and the organizational supports in place to encourage its use. More research is needed to further understand how clinicians who provide team-based care translate guidelines to practice, and the barriers and facilitators to guideline use in that setting.

### I. Introduction

Translating evidence from scientific research into clinical practice is a complex process that might take up to 17 years (Morris et al. 2011). Health care organizations and providers rely on recommendations in clinical practice guidelines (CPGs) to translate evidence to practice and standardize clinical practices across settings. CPGs are informed by a systematic review of the scientific evidence and the evaluation of the risks and benefits of clinical practices (Graham et al. 2011). Implementing CPGs can improve the quality of care health care organizations deliver, and in turn might improve patient outcomes and patient safety (Gurses et al. 2010). As CPGs strive to standardize clinical care, variations in clinical practice persist. The use of CPGs varies substantially depending on the guidelines and the context of implementation, which often encompasses characteristics of patients, providers, organizations, and policies (Bauer 2015). Understanding how these characteristics affect guideline use can inform future strategies to improve the uptake of guidelines, and consequently, quality of care and patient outcomes.

Beginning in 1968, the specialty of anesthesiology has published and used CPGs to standardize clinical care (Pierce 1990). The American Society for Anesthesiologists (ASA) and other specialty societies have published CPGs on a range of topics in anesthesiology, including procedures, administration of medications, use of devices, and care delivered before, during, and after surgery (ASA 2003, 2015, 2016, 2020a). According to guidance provided by the ASA, CPGs are not “standards or absolute requirements.” Rather, several guidelines published by the ASA describe CPGs as “recommendations that are supported by a synthesis and analysis of the current literature, expert and practitioner opinion, open-forum commentary, and clinical feasibility data” (ASA 2003, 2015, 2016, 2020a).

The uptake of CPGs in anesthesiology varies significantly, and little is known about the contextual factors that contribute to practice variation (Crosby 2013). Anesthesiology, particularly in perioperative care, has been an understudied context for the application of implementation science (Lane-Fall et al. 2018; Fixsen et al. 2005). Although previous studies have identified barriers and facilitators to specific anesthesiology practices, such as perioperative blood management or placement of central venous lines, little is known about how and why clinical practices change after the publication of CPGs, and whether the barriers and facilitators to guideline use are consistent across anesthesiology CPGs (Wijeysundera et al. 2012; Delaforce et al. 2020; Soni et al. 2016). Therefore, the goals of this exploratory study were to (1) describe practice change after the publication of five anesthesiology CPGs and (2) identify the barriers and facilitators to CPG use in anesthesiology. The results shed light on the uptake of clinical guidelines in anesthesiology and opportunities to improve their current and future implementation.

### II. Methods

This exploratory study used a cross-case analysis to identify the barriers and facilitators to CPG use and to describe practice change after the publication of the five CPGs. We identified five anesthesia CPGs to be the topics of the cases studies. We developed cases studies based on data from the guideline document, interviews with nine anesthesiologists, and a targeted literature review focused on identifying publications about guideline implementation and use. We then conducted a cross-case analysis to compare themes about guideline implementation and practice change across five guidelines.

#### A. Case study selection

To select the case studies, we reviewed CPGs published by specialty societies in anesthesia and surgery. We sought CPGs that met the following criteria:

## Guidelines uptake study

- Primarily applicable to anesthesiologists, as opposed to other types of clinicians
- Applicable in a perioperative surgical setting
- Applicable to a broad patient population

We reviewed 14 CPGs from the ASA, two from the American College of Cardiologists (ACC) and American Heart Association (AHA), two from the American College of Surgeons, eight from the Society of Thoracic Surgeons, and one from the American Society of Health System Pharmacists. We met with a clinician expert to assess whether each CPG met the inclusion criteria and confirmed that anesthesiologists would be able to discuss the guideline. Based on this discussion, we identified five CPGs for the case studies (Table 1; ASA 2003, 2015, 2016, 2020a; Fleisher et al. 2014). The final selection of CPGs included a range of common practices in perioperative settings, such as assessing or monitoring patient risk, providing medication, and using medical devices.

Topic	Guideline title and link	Professional society or societies	Date
Central venous access	<a href="#">Practice Guidelines for Central Venous Access 2020: An Updated Report by the American Society of Anesthesiologists Task Force on Central Venous Access</a>	ASA	Published 2012 Updated 2020
Perioperative blood management	<a href="#">Practice Guidelines for Perioperative Blood Management: An Updated Report by the American Society of Anesthesiologists Task Force on Perioperative Blood Management</a>	ASA	Published 2006 Updated 2015
Respiratory depression associated with neuraxial opioids	<a href="#">Practice Guidelines for the Prevention, Detection, and Management of Respiratory Depression Associated with Neuraxial Opioid Administration: An Updated Report by the American Society of Anesthesiologists Task Force on Neuraxial Opioids and the American Society of Regional Anesthesia and Pain Medicine</a>	ASA and American Society of Regional Anesthesia and Pain Medicine	Published 2009 Updated 2016
Pulmonary artery catheterization	<a href="#">Practice Guidelines for Pulmonary Artery Catheterization: An Updated Report by the American Society of Anesthesiologists Task Force on Pulmonary Artery Catheterization</a>	ASA	Published 1993 Updated 2003
Perioperative beta blocker therapy	<a href="#">2014 ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery, Section 6.2.1. Perioperative Beta-Blocker Therapy: Recommendations</a>	ACC/AHA, in collaboration with ASA, Society of Cardiovascular Anesthesiologists, and five other societies	Published 1996 Updated 2002, 2009, 2014 <sup>1</sup>

ACC = American College of Cardiology; AHA = American Heart Association; ASA = American Society of Anesthesiologists.

<sup>1</sup> Jørgensen et al. 2018 describes the timeline of guideline updates.

## B. Case study development

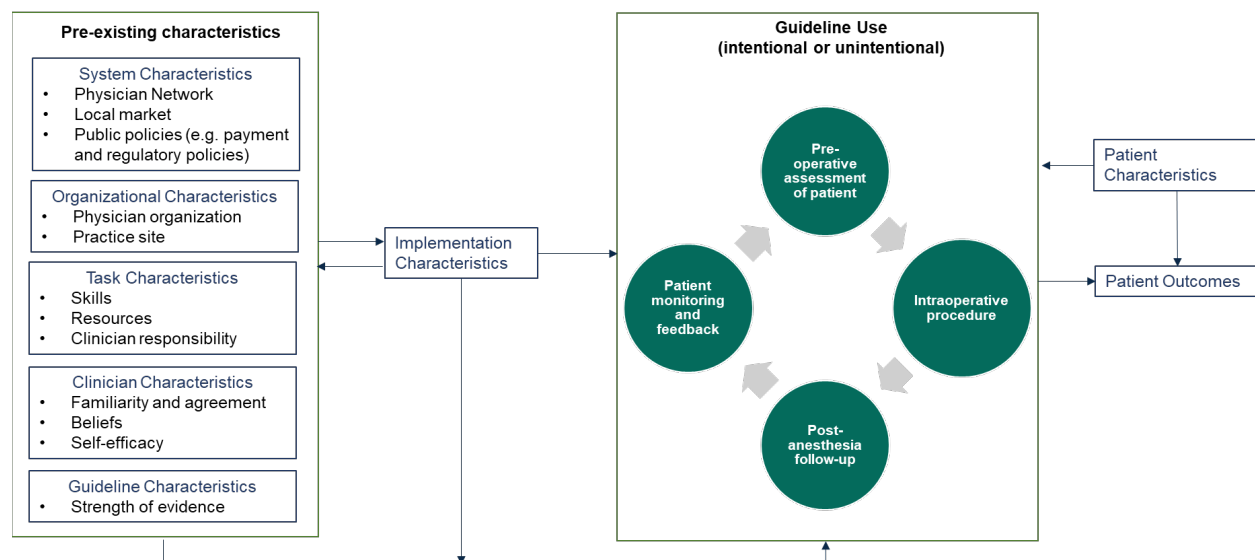
We developed case studies for each CPG to describe the guideline, barriers and facilitators to its use, and practice change. To create each case study, we synthesized evidence across three sources: (1) the

guideline document, (2) published information in peer-reviewed literature, and (3) interviews with nine anesthesiologists.

To guide the data collection for the case study development, we selected a conceptual framework that uses the principles of implementation science, which is the study of the uptake of evidence-based practices into clinical practice (Nilsen 2015). Because we were seeking to describe a comprehensive story about the context for guideline implementation in each case study, we created an adapted framework using constructs from two existing frameworks: Interdisciplinary Conceptual Framework of Clinicians Compliance with Evidence-Based Guidelines, and Factors Contributing to Variation in Physician's Use of Evidence at the Point-of-Care (Gurses et al. 2010; Reschovsky et al. 2015). Each framework defines potential constructs that fall within domains that influence guideline use (Gurses et al. 2010; Reschovsky et al. 2015).

We chose Interdisciplinary Conceptual Framework of Clinicians Compliance with Evidence-Based Guidelines, because (1) it describes the causal pathway for guideline use and the factors that may affect guideline use, and (2) it describes multiple levels of domains that could affect guideline use, including task characteristics, provider characteristics, and guideline characteristics (Gurses et al. 2010). Because this framework did not describe the organizational and system characteristics influencing guideline use, we incorporated domains from Factors Contributing to Variation in Physician's Use of Evidence at the Point-of-Care to include organizational characteristics (for example, practice site and physician organization) and system characteristics (including physician network, local market, and public policy characteristics including payment and regulatory policies; Gurses et al. 2010; Reschovsky et al. 2015).

**Figure 1. Conceptual framework for factors influencing guideline use.**



Adapted from Gurses et al. 2010 and Reschovsky et al. 2015.

Figure 1 depicts the synthesized framework using key domains from these two frameworks to fit the perioperative setting and the hypothesized causal pathway between pre-existing characteristics and guideline use (Gurses et al. 2010; Reschovsky et al. 2015).

### 1. Data collected from guideline document

We reviewed guidelines to identify the year of publication and updates, main guideline recommendations, patient populations and clinical conditions, types and strength of the evidence that informs the guideline, and accompanying decision aids.

### 2. Data collected from targeted literature review for each guideline

We conducted a targeted literature search focused on identifying publications that examined the use of the guidelines, barriers and facilitators of guideline use, the history of the guideline in practice, and quality measures associated with the guideline. We also included studies that helped validate and supplement the findings from the clinician interviews. Included articles described guideline use, quality metrics, seminal studies related to the guideline, reviews of literature, and editorials.

### 3. Data collected from clinician interviews

We interviewed nine clinicians to understand the key domains that affect guideline adherence outlined in the synthesized conceptual framework: task, clinician, guideline, organization, and system characteristics. We developed an interview guide based on the adapted conceptual framework shown in Figure 1. We used a semi-structured interview format with open-ended questions to elicit clinician perspectives. We asked follow-up questions to further probe clinicians on concepts they described in their interviews. Each interview focused on two guidelines and lasted about an hour, with about 30 minutes spent on each topic. When possible, we selected the guideline topic based on the interviewee's clinical experience.

#### *Interviewee selection*

We used purposive sampling to identify anesthesiologists from various practice settings (such as academic medical centers, community hospitals, and integrated health organizations) and authors of the guidelines. We reached out to 33 anesthesiologists via email, and 9 agreed to participate. We conducted interviews over the phone. Before the interview, we gave interviewees an overview of the interview topics and the guideline document. During the interview, we showed them a summary of the guideline recommendations for reference. The total number of interviewees for each guideline were as follows:

- Central venous access: 3 interviews
- Perioperative blood management: 3 interviews
- Respiratory depression associated with neuraxial opioids: 3 interviews
- Pulmonary artery catheterization: 3 interviews
- Perioperative beta blocker therapy: 4 interviews

A second researcher took notes during the interviews and recorded the interviews. We used meeting recordings to fill in information missing from the interview notes.

The nine anesthesiologists had an average of 17 years of experience practicing anesthesiology, with a range of 4 years to 42 years. The clinicians we interviewed typically work on a variety of cases. Three had backgrounds in intensive care units or critical care anesthesia, and three others had experience with higher risk surgeries, such as cardiothoracic, neurology, and liver transplant cases. All anesthesiologists currently work in hospitals across the United States. Seven clinicians practice in a teaching hospital, and six work directly with residents. Three of the clinicians are employed by a specialty group, rather than the health system where they worked.



### *Interview analysis*

The coding structure for the interview analysis was based on the interview guide and conceptual framework. We coded interviews in two rounds. During the first round, we coded the interview answers by question; during the second round, we coded answers to questions based on factors described in the conceptual framework. After completing the coding, we summarized the main themes for each of the following categories:

- Use of the guideline today
- Clinician characteristics
- Guideline characteristics
- Task characteristics (such as skills, resources, staff, responsibility)
- Organization characteristics
- System characteristics
- Practice change
- Opportunities to improve guideline uptake

We reviewed each summary to ensure clarity and discussed any discrepancies. We used qualitative software (NVivo version 12, QRS International) to complete the interview analysis.

### **4. Case study analysis**

Using information from the guideline document, targeted literature review, and clinician interviews, we used a common template to draft each case study summary. The case study template included a summary of the guideline; task characteristics (such as skills, resources, staff, and responsibility); key information from the guideline document, including the evidence base supporting the guideline; a summary of published information; use of guideline today; characteristics that affect guidelines use (including clinician, guideline, organization, and system); practice change; and opportunities to improve guideline implementation. We summarized key takeaway messages, including the main guideline recommendations and evidence for the guideline, clinicians' perceptions of practice change and guideline use, and key barriers and facilitators to guideline use. Except when noted in the summaries and tables, we did not distinguish whether barriers and facilitators were associated with guideline use or practice change. We summarize each guideline to provide context for the cross-case analysis, and the summaries include key recommendations, evidence supporting those recommendations, clinicians' perceptions of guideline change, and barriers and facilitators. The study team reviewed the case studies and resolved discrepancies through discussion.

### **C. Cross-case analysis**

To understand the similarities and differences in practice change and guideline use across the case studies, we conducted a cross-case analysis (Yin 2014). We conducted the cross-case analysis by populating a matrix for each of the following categories: clinician's perception of practice change, current guideline use in the field today, and barriers and facilitators to guideline use and practice change. We identified barriers and facilitators related to guideline, clinician, organization, and system characteristics. Looking across case studies, we identified themes that were present in two or more case studies. The study team reviewed these themes and resolved any discrepancies by discussion.

### III. Results

We report the results in two sections: (1) case study summaries and (2) cross-case analysis. The case study summaries describe the findings for each of the guidelines. The cross-case analysis describes the findings across the guidelines.

#### A. Case study summaries

In this section, we summarize key findings from each case study. We describe the key recommendations for each guideline, a summary of the evidence supporting the key recommendations in the guideline as described in the guideline document, clinicians' perceptions of the guideline and its impact on clinical practice, and the barriers and facilitators influencing guideline use.

##### 1. Case Study 1: Central Venous Access

###### *Summary*

The ASA first published the Central Venous Access guideline in 2012 and updated it in 2020 (ASA 2020a). This guideline provides recommendations regarding placing and managing central venous catheters (CVCs), reducing infections and other adverse outcomes associated with CVCs, and improving management of arterial trauma or injury arising from CVCs (ASA 2020a). The guideline does not indicate when a CVC should be placed but instead recommends equipment and procedures to use when a patient needs a CVC (ASA 2020a). The guideline also recommends when to use real-time or static ultrasounds based on the site selected for cannulation (ASA 2020a). It also states that ultrasounds might help confirm venous access after insertion or confirm venous placement of a threaded wire (ASA 2020a).

###### *Evidence supporting the guideline*

The guideline characterizes the evidence for ultrasound use for needle, wire, and catheter placement as Category A1, 2, 3-B. It characterizes the evidence for confirming catheter placement as insufficient. The guideline characterizes the evidence for venous placement of the way and residence of the guidewire as Category B3-B. It characterizes the evidence for confirming catheter tip placement as Category B2-B (ASA 2020a). The evidence supporting the use of ultrasounds for needle, wire, and catheter placement is based on multiple randomized controlled trials (RCTs), indicating that ultrasounds are beneficial for central venous catheter placement (ASA 2020a).

For most recommendations, expert opinions from the consultants and the ASA task force agreed with findings from the literature (ASA 2020a).

###### *Clinicians' perceptions of the guideline and its impact on clinical practice*

Clinicians discussed two recommendations that were controversial at the time of publication in 2012: (1) the recommendation to use an ultrasound to place CVCs and (2) the recommendation to use operating drapes. Today, the guideline is no longer considered controversial, and is now standard practice. Anesthesiologists place CVCs during high-risk cases, and only some anesthesiologists, such as those who work in the intensive care unit (ICU) or on cardiology cases, use CVCs.

Practice change occurred for several reasons. First, hospitals implemented policies that encouraged ultrasound use for CVC placement. Hospitals also provided resources and education to encourage guideline use. Second, new evidence showing how the practices recommended in the guideline reduced



the likelihood of sepsis also changed practices. Furthermore, clinicians reported that endorsement of the guidelines by professional organizations such as the ASA, champions at their hospital, and education on and dissemination of new evidence led to practice change. Finally, the guideline recommends that clinicians use CVCs for high-risk cases (ASA 2020a). Because few anesthesiologists encounter high-risk cases, CVC use in them decreased (Rubin et al. 2020).

Clinicians said they agree with the guideline, and they believe it is supported by strong evidence, is feasible, and improves care by reducing infections. Clinicians perceived the guideline as helpful, because it standardized practices in hospitals and helped lower rates of infections due to CVCs.

### *Barriers and facilitators*

Despite an overall decrease in the use of CVCs as described in interviews and literature, acceptance and use of guidelines can vary by clinician age and hospital resources (Rubin et al. 2020). Clinicians echoed and contextualized these findings, saying that older clinicians might have an “I’ve always done it this way” mentality or might not be aware of negative outcomes associated with poor techniques used to place CVCs. In addition, clinicians reported that many nonacademic practices might have lacked the resources to follow the guidelines and were unlikely to change practices to follow new guidelines. One clinician described the attitude toward guideline implementation at time of publication:

*“There was resistance [to implementing the guideline], but there was not a valid argument other than ego. Leaders offered [an] opportunity for them to not follow [the] guideline by letting them opt out of cases requiring a central line. Now they all use ultrasound.”*

According to studies, barriers to guideline adherence include lack of equipment, a need for ultrasounds, and clinician belief that ultrasounds are time-consuming (Bailey et al. 2007; Soni et al. 2016).

## **2. Case Study 2: Perioperative Blood Management**

### *Summary*

The ASA first published the Perioperative Blood Management guideline in 2006 and updated it in 2015 (ASA 2015). This guideline aims to improve the perioperative management of blood transfusion and adjuvant therapies and to reduce the risk of adverse outcomes associated with transfusions, bleeding, or anemia (ASA 2015). ASA published this guideline to update evidence on existing practices, such as the use of preoperative assessments, assessment of transfusion risk, and use of medications to prevent or treat bleeding. This guideline differs from blood management guidelines from other professional organizations as it includes evidence for greater use of pharmacologic therapies to minimize blood transfusions and the use of transfusion algorithms for point of care testing (for example, thromboelastographic testing), blood ordering schedules, and restrictive transfusion strategies (ASA 2015; Fleisher et al. 2014; Ferraris et al. 2007; Carson et al. 2012). Clinicians noted two key recommendations: (1) the transfusion threshold and (2) implementation of blood management protocols. The guideline recommends a transfusion threshold hemoglobin level of 6 to 10 g/dl (ASA 2015). Second, the guideline recommends a blood management protocol for transfusion (ASA 2015). The evidence regarding decisions to provide blood transfusions has changed over time, and practice change has been slow; it has taken 7 to 10 years to implement the new guidelines.

### *Evidence supporting the guideline*

The blood management protocols are primarily based on Category A evidence. The restrictive versus liberal transfusion strategy is based on Category A evidence. The recommendations for monitoring different outcomes are based on insufficient evidence (ASA 2015).

Blood management protocols were supported by evidence from RCTs, which test the efficacy of complex protocols and algorithms. The guideline does not describe the efficacy of individual intervention components. The transfusion threshold guideline is supported by evidence from RCTs (ASA 2015).

For monitoring recommendations supported by insufficient evidence, expert opinion from the consultants and the ASA task force is used to inform recommendations (ASA 2015).

### *Clinicians' perceptions of the guideline and its impact on clinical practice*

Two clinicians said the guideline was not controversial—it is simply about controlling and responding to intraoperative and postoperative bleeding. They agreed with the guideline recommendations and believed the perioperative blood management guideline is helpful and improves outcomes. Clinicians perceived the guideline validated standard practice. Clinicians believe that institutional support, such as changes to systems, protocols, and resources, is necessary to follow these recommendations. One clinician provided the following comments:

*“These guidelines have been around long enough, it just part of what we do. No one stops to think about whether we should review all the evidence underlying the guideline, because I do it on a patient. These guidelines are firmly in place and accepted universally.”*

Clinicians disagreed among themselves about the quality of the evidence and the assessment of evidence described by the guideline. Two clinicians described the evidence as “limited” and “not as robust,” which leads to broad-based recommendations. One clinician said the evidence was strong. They commented that the guideline contains many recommendations on a range of topics, which makes implementation difficult. Clinicians acknowledged the transfusion thresholds could be ambiguous, which could be a barrier to guideline use. Guidelines from other professional organizations cite different thresholds levels (Carson et al. 2012). Clinicians reported that implementing these blood management protocols requires changes to systems, protocols, and resources (such as time, funding, and tools for transfusion).

### *Barriers and facilitators*

Several factors affected guideline use. Clinicians cited consistent evidence supporting recommendations and their own knowledge about the changes in evidence to facilitate guideline use. The culture at these clinicians' institutions supports the use of the guideline. Education for different members of the care teams (anesthesiologists and surgeons) and institutional and leadership support also facilitate guideline use. Blood transfusions can be costly procedures and a large expense for hospitals (Waters 2017). This market incentive promotes the guidelines, which advocate for fewer transfusions (Waters 2017). Barriers included a lack of access to knowledge and information, time to manage preoperative anemia, resources to implement the guidelines, and tension for change (Delaforce et al. 2020; Althoff et al. 2019).

### 3. Case Study 3: Respiratory Depression Associated with Neuraxial Opioids

#### *Summary*

The guideline for Respiratory Depression Associated with Neuraxial Opioids was first published in 2009 and updated in 2016 (ASA 2016). This guideline contains recommendations for identifying patients at a high risk of respiratory depression; monitoring patients; and preventing, managing, and treating respiratory depression following neuraxial opioid use (ASA 2016). This guideline covers a range of topics, and clinicians did not identify any recommendations as more important than the others.

#### *Evidence supporting the guideline*

Many recommendations, especially relating to monitoring, are supported by insufficient evidence (ASA 2016). Some recommendations, such as those relating the route of administering neuraxial opioids, are supported by RCTs and meta-analyses of RCTs. The quality of the evidence from these trials varies (ASA 2016). For monitoring recommendations supported by insufficient evidence, expert opinion from the consultants and the ASA task force was used to inform recommendations (ASA 2016).

#### *Clinicians' perceptions of the guideline and its impact on clinical practice*

Clinicians reported that the guideline is vague but formalizes best practices. They believed the guideline was not controversial when it was published. One study shows that many hospitals changed their monitoring practices for respiratory depression in the four years following the guideline's publication (Jungquist et al. 2014b). However, the clinicians did not think that the guideline was controversial, and there was no consensus regarding approval overall of the guideline and whether it improves care. For example, one said the guideline was generally useful, and another clinician said it lacked specificity. Clinicians perceived the evidence as weak. Clinicians said they believe the guideline is feasible to follow if the resources are available.

#### *Barriers and facilitators*

Many recommendations in the guideline were supported by insufficient evidence according to the guideline authors (ASA 2016). Clinicians reported they were able to follow the guideline, noting it requires hospitals to provide the necessary resources, such as stents and reversal agents, and enough nursing staff to adequately monitor patients following surgery. The literature supports this contention (Jungquist et al. 2014a).

Clinicians said that lack of resources, "maddingly vague" recommendations, and lack of clarity on when to use the guidelines in practice are barriers to its use. For example, one clinician offered the following comments:

*"I want to know deeper than this. Does it matter what type of opioid to use? The guideline says they don't know. But it's a problem that we don't know. This particular guideline is engrained in the general practice of anesthesia. But we're still having problems with respiratory depression, so we're missing something. This [guideline] isn't what it could be."*

However, clinicians believed the guideline provided a useful framework for identifying patients within different risk categories and that hospitals have helped enable guideline use through leadership support, education, and policies that align with the recommendations.

### 4. Case Study 4: Pulmonary Artery Catheterization

#### *Summary*

The guideline for Pulmonary Artery Catheterization was first published in 1993 and updated in 2003 (ASA 2003). It aims to define the appropriate indications for pulmonary artery catheter (PAC) use (ASA 2003). The guideline recommends against the use of PACs for surgeries that have a low risk of hemodynamic complications; patient, procedure, and practice characteristics should be used to assess hemodynamic risk (ASA 2003).

#### *Evidence supporting the guideline*

The guideline describes the evidence as “poor quality.” It does not have grading system to assess the quality of evidence supporting it (ASA 2003). The guideline cites evidence from RCTs and observational studies. The trials cited in the guideline have significant limitations that affect internal and external validity of findings. Factors that affected internal validity include poor study designs and small sample sizes. Factors that affect external validity include few surgical settings included in studies and no accounting for case mix and practitioner skill (ASA 2003). Expert opinion from the consultants and the ASA task force is used to develop a framework to determine whether PACs should be used (ASA 2003).

#### *Clinicians' perceptions of the guideline and its impact on clinical practice*

Clinicians reported that they agreed with the guideline and believe that it helps to improve care, is feasible to follow, and is not controversial. However, some clinicians also thought the guideline is not helpful, noting that a weakness of the guideline is that it lacks clarity about when to use PAC. Clinicians suggested that the lack of clarity in the guideline may be due to a lack of strong evidence to support detailed recommendations. One clinician explained this viewpoint:

*“The way that the guideline is [written], is ‘don’t use PA catheters,’ and everyone follows that. But the guideline should [state] when to use [PA catheters], not ‘try not to use it.’ That is something that could make this guideline more helpful.”*

Clinicians did not agree on the quality of evidence behind the guideline. Most clinicians we interviewed, along with the guideline authors, described that the quality of evidence is weak, while one clinician said the quality of the evidence was strong.

#### *Barriers and facilitators*

Despite the lack of clarity in the recommendations, practice has changed considerably since the 1970s, when PACs first became available (Wiener et al. 2007). At that time, clinicians quickly adopted PACs into their practice, believing hemodynamic monitoring would lead to better patient outcomes (Wiener et al. 2007). Today, clinicians reported that they rarely use PACs due to the publication of the guidelines and three studies that demonstrated the potential harm of PACs and failed to find a clear benefit of using PACs in low-risk cases. Practice change resulted from the work of clinician champions who initially promoted the use of PACs and later encouraged the discontinuation of PACs when the evidence about PACs changed (Wiener et al. 2007).

Clinicians described the following as facilitators to using this guideline: the perception that PACs cause harm, lack of skills to place PACs, and few trained staff for PAC placement. Clinicians commented that PACs may be under used and not considered in cases where PACs could be beneficial:

*“Since 2003, these guidelines and everyone else have said that PA catheters are dead. And now PA catheters are starting to remerge. These guidelines need to be updated and the education of when to use needs to be updated.”*

### 5. Case Study 5: Perioperative Beta Blocker Therapy

#### *Summary*

The guideline on Perioperative Beta Blocker Therapy was published in 2014 (Fleisher et al. 2014). This guideline includes recommendations regarding which patients need beta blockers, the appropriate circumstances to initiate beta blockers perioperatively, and how beta blockers should be managed after surgery (Fleisher et al. 2014). The main recommendations, as discussed with clinicians, include continuation of beta blockers for patients undergoing chronic beta blocker therapy and not starting patients on beta blockers on the day of surgery (Fleisher et al. 2014).

#### *Evidence supporting the guideline*

The recommendation to prescribe beta blockers to patients with chronic beta blocker therapy is a Class I recommendation, which indicates that the benefits outweigh the harm. It is supported by a systematic review. The recommendation to not prescribe beta blockers to patients on the day of surgery is a Class III Harm recommendation (Fleisher et al. 2014). Several RCTs and observational studies support the recommendation to prescribe beta blockers to patients with chronic beta blocker therapy. However, some weaknesses in the RCTs include small sample sizes at single sites (Fleisher et al. 2014). Recommendations are not informed by expert opinion (Fleisher et al. 2014).

#### *Clinicians' perceptions of the guideline and its impact on clinical practice*

Clinicians said the evidence supporting the guideline is robust and agreed with the main recommendation—to continue beta blocker therapy for patients who use beta blockers and to not start patients on beta blockers on the day of surgery. They also believed the guideline improves patient care, is helpful and is not controversial. They thought the guideline was helpful because it standardized practices. Clinicians acknowledged that the guideline is ambiguous about the use of beta blockers for high-risk patients and whether patients might benefit from beta blockers before surgery.

Clinicians disagreed with the recommendation about prescribing beta blockers before surgery to patients who have not been on beta blockers, which lacks clarity on which patients need beta blockers before surgery. Although clinicians agreed that few patients would be high-risk, one clinician suggested that it is difficult to evaluate risk. One clinician suggested that this recommendation is a “loophole” that enables individual clinicians to make decisions about which patients might need beta blockers.

#### *Barriers and facilitators*

Clinicians reported that practices changed almost immediately after the publication of the guideline, likely because of a surgical care improvement program from the Centers for Medicare & Medicaid Services (CMS) that clinicians perceived to be a “mandate” (The Joint Commission 2010; CMS 2019). Clinicians described this guideline as feasible to follow and simple. One clinician recalled when the practice first announced it would implement policy changes to support guideline adherence:

*“They sent an email that said, ‘Starting tomorrow every single patient gets this [beta blocker use] documented on the anesthesia record.’ It was just that simple. This is a simple ask.”*

Other facilitators as described by clinicians include a strong evidence base, leadership support, and the fact that following the guideline does not require many resources.

### C. Cross-case analysis

The cross-case analysis synthesized themes across all five case studies. Below, we compare and contrast the findings regarding the influence of guidelines on changes in clinical practice and the barriers and facilitators to practice change and guideline use. We note the similarities and differences across guidelines and present themes based on the domains described in the synthesized framework.

#### 1. Influence of guidelines on changes in clinical practice

Table 2 describes clinicians’ perceptions of practice change related to the publication of the guideline and the use of the guideline today. Clinicians reported that practice change occurred in four of the guidelines. In these guidelines, evidence demonstrated patient harms associated with existing practices. For example, clinicians reported that after several studies demonstrated the harms of PACs, PACs became known as “death catheters,” and practice changed. The length of time to change practice and the size of practice change also varied across the guidelines. For the Perioperative Beta Blocker Therapy guideline, practice changed immediately. For two other guidelines, practice changed over several years to almost a decade. In three guidelines, practice changed dramatically but depended on clinician and practice type.

**Table 2. Themes regarding clinicians’ perceptions of practice change and current guideline use from five case studies**

	Overall theme	Central Venous Access	Perioperative Blood Management	Respiratory Depression Associated with Neuraxial Opioids	Pulmonary Artery Catheterization	Perioperative Beta Blocker Therapy
Clinicians’ perceptions of practice change	For four guidelines, practices changed. Guidelines for these practices were updated, because several studies demonstrated consistent evidence, particularly the harms of the practice.	One clinician noted that practice changed once studies showed that following the guidelines reduced the likelihood of sepsis.	Clinicians reported that guidelines changed after several trials showed the harms of blood transfusions.		Clinicians reported that practice change occurred after several studies demonstrated the harms of pulmonary artery catheters (PACs).	Clinicians reported that the guidelines reflected the change in evidence from 2003 to 2008.
	For one guideline, the change in practice was immediate. For another	Clinicians reported that the guideline changed practice, and for some it	It took 7 to 10 years to fully implement the new guideline in the field.		Clinicians reported that once the guideline was published, use of PACs dramatically decreased, and it	Clinicians described that practice changed immediately.



	Overall theme	Central Venous Access	Perioperative Blood Management	Respiratory Depression Associated with Neuraxial Opioids	Pulmonary Artery Catheterization	Perioperative Beta Blocker Therapy
	<p>guideline, change occurred over several years. In one guideline, the practice change took about 7 to 10 years.</p> <p>For three guidelines, the size of change was dramatic, at least for some clinicians and practices.</p>	<p>changed drastically. For example, older clinicians had to learn how to use the ultrasound and were resistant to change. The guideline encouraged smaller practices to obtain equipment to follow guidelines. One clinician noted that the change at his practice was minimal, but the guideline standardized practice and his hospital got more ultrasounds after publication of the guideline.</p>			<p>took several years to change practice.</p>	
	<p>For one guideline, clinicians described that the publication of the guideline did not change practice but formalized and standardized best practices.</p>			<p>Guidelines formalized best practices that clinicians were previously doing before publication of the guideline.</p>		
Clinician's perception of use of guideline today	<p>For three guidelines, clinicians reported that the guideline was widely used. Clinicians were unsure if it was used for two of the guidelines. Variation in guideline use could be due to clinician age, practice type,</p>	<p>Clinicians were unsure whether the guideline was widely used because anesthesiologists rarely place CVCs. Older clinicians may be less likely to use ultrasounds.</p>	<p>Clinicians were unsure whether the guideline was used broadly, because implementation could depend on clinician age and type of practice.</p>	<p>Clinicians reported that the guideline is used widely.</p>	<p>Clinicians reported that the guideline is applied widely, and PACs are no longer regularly used by clinicians.</p>	<p>Clinicians reported this guideline is widely applied and use it on a daily basis. One clinician described that most providers (~90%) follow the recommendations to continue beta blockers if patients are already on them and not to start a beta blocker on</p>

		Central Venous Access	Perioperative Blood Management	Respiratory Depression Associated with Neuraxial Opioids	Pulmonary Artery Catheterization	Perioperative Beta Blocker Therapy
	Overall theme					
	and availability of equipment.					the day of surgery. Some clinicians suggested that providers may not follow the recommendations for beta blocker use that rely on the revised cardiac risk index.
	Two guidelines recommend avoiding a practice, such as the recommendation s to not transfuse or to not place a PAC.					Two clinicians described the guideline as "intuitive" and a best practice.

## 2. Barriers and facilitators to practice change and guideline use

Table 3 illustrates the barriers and facilitators to practice change and guideline use across the five case studies in the following categories identified in Figure 1: guideline characteristics, clinician characteristics, organizational characteristics, and system characteristics.

### *Guideline characteristics*

Themes for barriers and facilitators related to guideline characteristics include evidence and complexity of the guidelines. Across four guidelines, consistent and strong evidence facilitated practice change and convinced clinicians to follow guidelines. In three guidelines, limited evidence can lead to guidelines that have broad recommendations that lack details. Lack of clear recommendations in the guidelines was a barrier in four guidelines, while clear recommendations often outlined the resources and practices necessary to facilitate clinical practice in three guidelines. Clinicians suggested that recommendations might be vague when the evidence is not strong. Complexity, in terms of the number of recommendations, was a barrier in one guideline, and only one guideline included a framework to reduce complexity.

### *Clinician characteristics*

For the category of clinician characteristics, we found themes related to age, clinician beliefs, skills and knowledge, and education and training. Clinician characteristics affected practice change and guideline use for only two guidelines. Clinician age was a barrier to practice change and guideline use for two guidelines, with older clinicians less likely to adopt new practices.

Clinician beliefs were complex and were barriers and facilitators to guideline use. Clinicians believed that vague guidelines and lack of time to implement guidelines were barriers for implementation in two guidelines. Clinicians reported that lack of time, knowledge about applying the guidelines, and training were also barriers to guideline use, all of which were supported by findings in the literature (Soni et al. 2016; Delaforce et al. 2020). Facilitators to practice change and guideline use included clinician beliefs about the benefits of the guidelines and education and training about the guideline. For example, for four

guidelines, clinicians suggested that the guideline helped standardized care, and for two guidelines, clinicians believed the guideline improved care and observed the benefits of the guideline.

### *Organizational characteristics*

Themes for organizational characteristics were about leadership, organizational culture, organizational supports, resources, and tracking. Across all five guidelines, leadership of the organizations facilitated guideline change by endorsing guidelines and providing resources to implement guidelines. For three guidelines, the organizational culture valued following the guidelines and providing evidence-based care, which also facilitated practice change. For four guidelines, hospitals also implemented policies, such as procedures, checklists, algorithms, trainings, and tracking in the electronic health record, to facilitate practice change. For three guidelines, a lack of resources was barrier for guideline use. An additional facilitator was that two guidelines did not require extra resources.

### *System characteristics*

Categories of themes in system characteristics included technology, incentives, and policies. There were no consistent themes related to technology or incentives across the case studies. Policies or legal liability associated with not following guidelines enabled practice change in two guidelines.

Table 3. Barriers and facilitators impacting practice change and guideline use across five anesthesiology clinical guidelines

Overall theme		Central Venous Access	Perioperative Blood Management	Respiratory Depression Associated with Neuraxial Opioids	Pulmonary Artery Catheterization	Perioperative Beta Blocker Therapy
Guideline Characteristics						
Evidence	Barrier: For three guidelines, limited evidence can lead to guidelines that have broad recommendations that lack details.		Barrier: Two clinicians described the evidence as "limited" and "not as robust," which leads to broad-based recommendations that were not prescriptive. One clinician said the evidence was strong.	Barrier: Clinicians perceived the evidence as weak. The limited evidence base supporting the guideline has contributed to it being described as "maddingly vague" or simply describing best practices (ASA 2016).	Barrier: Lack of strong evidence to make detailed recommendations about when to use pulmonary artery catheters (PACs). PACs may be used for high risk patients (ASA 2003).  Two clinicians indicate the quality was weak and one indicates the quality was strong.	
	Facilitator: For four guidelines, there was consistent and strong evidence that convinced clinicians to change practice.	Facilitator: Evidence demonstrated the benefits of ultrasound use including reduction in incidence of sepsis (ASA 2020a). Clinicians agreed that the evidence regarding ultrasound use is strong. According to one clinician, this evidence convinced clinicians that following the guideline would lead to better outcomes.	Facilitator: Evidence demonstrated harms of transfusion and convinced clinicians to change practice.		Facilitator: Evidence demonstrated harms of PACs and convinced clinicians to change practice (Wiener et al. 2007). Clinicians perceive that PACs are dangerous.	Facilitator: After the guideline incorporated the evidence from several randomized controlled trials and observational studies, practice changed almost immediately (Fleisher et al. 2014). Clinicians believed the evidence supporting the guideline is robust.

## Guidelines uptake study

	Overall theme	Central Venous Access	Perioperative Blood Management	Respiratory Depression Associated with Neuraxial Opioids	Pulmonary Artery Catheterization	Perioperative Beta Blocker Therapy
Clarity	Barrier: Lack of clarity due to the evidence in the guideline was a barrier for four guidelines.		Barrier: Clinicians thought the thresholds for transfusions was unclear, and guidelines cited different thresholds (ASA 2015; Carson et al. 2012).	Barrier: Clinician thought the guideline lacked clarity on when it should be used and how to translate it into practice.	Barrier: Clinicians reported that the guideline is clear about when not to use PACs and the recommendations lacked specificity to guide decision making. Evidence supporting this recommendation indicates that there are no clear benefits to using PACs in low-risk cases, but there are some harms (ASA 2003).	Barrier: Clinicians found it difficult to identify patients at high risk and to use the revised cardiac risk index.
	Facilitator: Clarity on when to use the guidelines and the processes needed facilitated guideline use for three guidelines.	Facilitator: Clinicians reported that the guideline is clear about processes and resources needed to place central venous catheters.			Facilitator: Clinicians thought the framework provided by the guideline to evaluate the risks were clear and easy to apply.	Facilitator: Clinicians reported that some recommendations were clear (for example, administering beta blockers to patients already on beta blockers), making it easy to implement.
Complexity	Barrier: Complexity was a barrier for one guideline.		Barrier: Clinicians thought the guideline has too many recommendations.			
	Facilitator: For one guidelines, the guideline offered a framework to help clinicians, reducing complexity of implementing the guideline.			Facilitator: Clinicians described that the guideline provided a framework for discussing patients within different risk categories for procedures (ASA 2016).		
Clinician characteristics						
Age	Barrier: For two guidelines, clinicians indicated that older clinicians might be less likely to adopt new	Barrier: Older clinicians were less likely to use ultrasounds because	Barrier: Older clinicians were less likely to know about the guideline.			

## Guidelines uptake study

	Overall theme	Central Venous Access	Perioperative Blood Management	Respiratory Depression Associated with Neuraxial Opioids	Pulmonary Artery Catheterization	Perioperative Beta Blocker Therapy
	guidelines because they do not want to change practice or may not know about new practices.	they did not want to change their practice.				
<b>Clinician beliefs</b>	Barrier: Clinicians believed that the guideline was vague for two guidelines, making it difficult to implement or follow.		Barrier: Clinicians believed the guideline was vague, making it difficult to implement		Barrier: One clinician believed the guideline was not straightforward or helpful for situations that might require a PAC.	
	Facilitator: For four guidelines, clinicians suggested that the guideline helped standardized care.	Facilitator: Clinicians perceived the guideline as helpful because it standardized practices in hospital.	Facilitator: Clinicians perceived the guideline as helpful because validated standard practice.	Facilitator: Clinicians believed that the guideline helped to standardize care.		Facilitator: Clinicians perceived the guideline as helpful because it standardized practices in hospitals.
	Facilitator: For two guidelines, clinicians believed that the guideline improved care and observed the benefits of guideline use.	Facilitator: Clinicians agreed with the guideline and believed it improves care by reducing infections.				Facilitator: Clinicians believed the guideline improved patient care and have observed that it is effective.
	Facilitator: One guideline described the guideline as easy to follow.					Facilitator: Clinicians believed the guideline is easy to follow.
	Barrier/facilitator: For two guidelines, clinicians perceived the benefits and harms of technologies affect guideline use.	Barrier: Clinicians described a lack of awareness of the benefits regarding patient outcomes associated with poor catheter placement.			Facilitator: Clinicians perceive PACs are harmful, so they follow the recommendations to avoid using the PAC (Wiener et al. 2007).	



## Guidelines uptake study

	Overall theme	Central Venous Access	Perioperative Blood Management	Respiratory Depression Associated with Neuraxial Opioids	Pulmonary Artery Catheterization	Perioperative Beta Blocker Therapy
	Barrier: For two guidelines, clinicians lacked the time to follow them.	Barrier: Clinicians believed that ultrasounds are time-consuming (Soni et al. 2016).	Barrier: Clinicians lacked the time to interpret labs or to manage preoperative anemia (Althoff et al. 2019).			
		Barrier: Clinicians believed that ultrasounds are not necessary (Bailey et al. 2007).				
<b>Skills and knowledge</b>	Barrier: For two guidelines, clinicians lacked knowledge about when to apply the guideline.		Barrier: There is a lack of knowledge about the guideline and interventions, especially for more experienced providers (Delaforce et al. 2020).		Barrier: Clinicians discussed that there is a lack of education about how and when to use the PAC. Although most clinicians know not to use PACs, some might avoid its use when it really should be a consideration.	
	Barrier/facilitator: For two guidelines, clinicians lacked training and skills.	Barrier: Clinicians believed that using ultrasounds would lead to a loss of skills (Soni et al. 2016).			Barrier: Clinicians discussed that there is a lack of training or skills among anesthesiologists who are not involved in high-risk cases (for example, cardiac surgery) and typically do not place PACs. These anesthesiologists might have difficulties placing a PAC in a high-risk case.	
	Barrier: For two guidelines, clinicians noted there was resistance to change.	Barrier: There is a lack of willingness to use ultrasounds for catheter placement.	Barrier: There is resistance to change among anesthesiologists.			
<b>Education and training</b>	Facilitator: For two guidelines, it was noted that education and training help to enhance skills and create a	Facilitator: Clinicians used simulation labs and received training in residency for catheter placement.	Facilitator: Education and shared understanding of guidelines among care team members			

## Guidelines uptake study

	Overall theme	Central Venous Access	Perioperative Blood Management	Respiratory Depression Associated with Neuraxial Opioids	Pulmonary Artery Catheterization	Perioperative Beta Blocker Therapy
	shared understanding in the care team.		(anesthesiologists and surgeons) promote use.			
<b>Organization</b>						
<b>Leadership</b>	Facilitator: Leadership guided implementation for all guidelines by endorsing them and providing resources to implement them.	Facilitator: Clinical champions and leadership endorsed the guideline and provided needed resources to implement it.	Facilitator: Leaders are committed to providing resources (for example, time, funding, and tools for transfusion) for guideline use.	Facilitator: Leadership endorses guideline.	Facilitator: Clinical champions endorsed the guideline and discontinued PACs when evidence changed (Wiener et al. 2007).	Facilitator: Clinicians described that leadership at institutions supported guideline use and directed practice changes.
<b>Culture</b>	Facilitator: For three guidelines, the guideline is ingrained in the institutional culture.		Facilitator: The guideline is ingrained in institutional culture.	Facilitator: The guideline is ingrained in institutional culture.		Facilitator: Clinicians said the guideline is ingrained in the organization and the culture.
<b>Organizational support</b>	Facilitator: For two guidelines, the ASA endorsement of the guideline facilitated guideline use.	Facilitator: The ASA endorses the guideline.  Facilitator: Hospital leadership supported guideline use. When the guideline was first published, clinicians used it to advocate for resources such as ultrasounds.			Facilitator: The ASA endorses and promotes the guideline.	
	Facilitator: For four guidelines, the hospital implemented policies to facilitate practice change such as procedures, checklists, algorithms, trainings, tracking in the electronic health record.	Facilitator: Hospitals implemented systematic changes in policies to encourage or require ultrasound use for this procedure and provided resources and education to encourage guideline use.	Facilitator: Hospitals adopting process flow algorithms.	Facilitator: Hospital policies have made guidelines standard practice. Hospitals might provide education to increase clinician skills.		Facilitator: Clinicians said that hospitals implemented policies (for example, automated order set and documentation) to track adherence to the guideline using electronic health records.

## Guidelines uptake study

	Overall theme	Central Venous Access	Perioperative Blood Management	Respiratory Depression Associated with Neuraxial Opioids	Pulmonary Artery Catheterization	Perioperative Beta Blocker Therapy
		Barrier: When the guideline was first published, smaller, nonacademic hospitals might not have had resources to follow guideline.				
<b>Resources</b>	Barrier: For three guidelines, clinicians said there were a lack of resources, such as equipment or trained staff. This might be a bigger barrier in small facilities. Facilitator: For two guidelines, the guideline does not require extra resources.	Barrier: There is a lack of equipment (for example, ultrasounds, cleaning supplies, and fully body drapes; Bailey et al. 2007).	Barrier: Facilities lack resources (especially small facilities; Althoff et al. 2019).	Barrier: There is a lack of funding, staff, and resources to monitor patient postoperatively.	Facilitator: Staff are no longer trained to place PACs, so the guideline does not require additional resources such as PACs.	Facilitator: Clinicians said the guideline does not require many resources.
<b>Tracking</b>	Facilitator: One guideline had electronic health record tools.					Facilitator: Clinicians reported that the electronic health records have a standing order for beta blocker administration before surgery.
<b>System</b>						
<b>Technology</b>	Barrier/facilitator: For two guidelines, it was noted that access to new technologies was a barrier.	Barrier: Hospitals lacked ultrasound equipment when the guideline was first published.			Facilitator: New technology replaces PACs.	
<b>Incentive</b>	Facilitator: For one guideline, one clinician noted that following the guideline is cost-effective.		Facilitator: Transfusions are expensive, and the guideline advocated for fewer transfusions (Waters 2017).			

Guidelines uptake study

	Overall theme	Central Venous Access	Perioperative Blood Management	Respiratory Depression Associated with Neuraxial Opioids	Pulmonary Artery Catheterization	Perioperative Beta Blocker Therapy
Policy	Facilitator: For two guidelines, policies or legal liability were associated with guideline use.			Facilitator: Clinicians discussed the legal liability associated with not following the guideline.		Facilitator: Guideline aligns with beta blocker measure reporting in the CMS Surgical Care Improvement Project, which some clinicians perceived to be a CMS “mandate” about beta blockers (Centers for Medicare & Medicaid Services 2019).

### IV. Discussion

We found that when recommendations were supported by consistent evidence, clinical practice change occurred, and clinicians adopted new guidelines. Previous studies showed that strength and quality of evidence can facilitate guideline use (Gagliardi et al. 2011; Francke et al. 2008; Leape et al. 2003; Gurses et al. 2010; Berenholtz et al. 2004). However, clinicians reported that two guidelines (Respiratory Depression Associated with Neuraxial Opioids and Pulmonary Artery Catheterization) were feasible even though the guidelines themselves rated the quality and strength of the evidence as weak. This indicates that strength and quality of evidence is only one factor that affects guideline implementation. We did not explore the factors that clinicians used to assess the strength and quality of the evidence, but a recent review of anesthesia clinical guideline found that strength of evidence was low for almost half of the recommendations in anesthesiology (Laserna et al. 2021). For the five guidelines in this exploratory study, CPGs were supported by different sources of evidence, including meta-analyses, RCTs, observational studies, and consensus statements by experts (ASA 2003, 2015, 2016, 2020a; Fleisher et al. 2014). Clinicians agreed with the assessment of the strength of the evidence provided in the guidelines in only three of the five guidelines (Central Venous Access, Respiratory Depression Associated with Neuraxial Opioids, and Perioperative Beta Blocker Therapy). Furthermore, study design did not always correlate with strength of evidence, indicating that other biases should be considered when assessing evidence. We found that guidelines did not always indicate that RCTs produce the strongest evidence (Guyatt et al. 2008). For example, the PAC guideline has evidence from several RCTs, but the guideline considers these trials to have low quality because of limitations with sample size and trial design (ASA 2003). Conversely, the Perioperative Beta Blocker Therapy guideline has evidence from several observational studies, and the guideline indicates there is strong evidence because of large sample size and consistency of results (Fleisher et al. 2014). The relationship between the strength and quality of evidence, clinicians' perception of the evidence, and use of the guideline is not well understood from this study, and more research is needed about how these factors impact clinical decision making.

Clinicians reported that most guidelines had recommendations that were broad or lacked clarity, which were both barriers to guideline use. These recommendations were often supported by weak or insufficient evidence. Despite these weaknesses, clinicians indicated that the guidelines were feasible. This paradox between vague guidelines and feasibility of guidelines in practice is not well understood from the data in this study. Compared with other specialists, anesthesiologists might be more comfortable translating vague guidelines, because anesthesiology guidelines are often supported by weak or insufficient evidence (Lane-Fall 2018). Clinicians might claim that guidelines are feasible because clinicians are used to making independent decisions about care on a case-by-case basis (Kheterpal 2012). Anecdotally, clinicians in our interviews and in an editorial describe anesthesiology as an art more than a science and the field was unlikely to get stronger evidence, because RCTs are difficult to design for these practices (Kheterpal 2012). Previous literature has shown that the uncertainty related to tasks, responsibilities, methods, expectations, and exceptions in the guideline recommendations can hinder practices (Gurses et al. 2008). One strategy for addressing guidelines might be the use of checklists to track guideline use (Pronovost 2013).

We found that for four of five guidelines, clinicians agreed with the guidelines and believed they improved care, and for three guidelines, clinicians thought the guidelines were feasible and helpful. Clinician beliefs about recommendations in a guideline can greatly impact its use, but the nature of the relationship is not well understood from our data. There were no meaningful patterns between clinicians' beliefs and their perceptions of guideline use in the field. For example, the Central Venous Access guideline had mostly positive clinician beliefs, but clinicians were not sure about guideline uptake, and

indicated that clinician age and practice size may hinder its use. Alternatively, for the CPG on Respiratory Depression Associated with Neuraxial Opioid Use, clinicians held mixed beliefs but also reported that the guideline was widely used. In studies of providers in intensive care units and primary care, positive attitudes toward guideline recommendations are associated with greater guideline use (Quiros et al. 2007; Lugtenberg et al. 2011, Sinuff et al. 2007). Compared with nurses, physicians were more likely to report negative attitudes toward guidelines (Quiros et al. 2007). Considering that attitudes toward guidelines might differ by specialty, understanding the relationship between beliefs among anesthesiologists and guideline use might help improve overall use (Carlsen and Bringedal 2011).

Finally, we found that organizational characteristics can facilitate practice change and promote CPG use. Clinicians described circumstances that demonstrated when institutions lead guideline implementation by providing training and resources, practice change is more likely, and uptake is higher. Consistent with findings in the literature, leadership played a major role in providing resources and endorsing the guidelines across all case studies (Delaforce et al. 2020; Wiener et al. 2007). In addition, hospital policy facilitated changes in practice. Clinicians described that hospitals changed policies and adopted new procedures, trainings, checklists, algorithms, and tracking system in electronic health records. Such systems create a positive context for guideline implementation that makes it easier for clinicians to use the guidelines in everyday practice.

The results from this study demonstrate that multiple barriers and facilitators at the clinician, organization, and system levels can affect practice change and guideline use. As anesthesiology moves toward improving the delivery of perioperative care, understanding these barriers and facilitators can improve patient outcomes and reduce costs (Kain et al. 2014). Recently, the ASA has endorsed the idea of the Perioperative Surgical Home, as a model for care throughout the surgical process (Schweitzer et al. 2013; ASA 2020b; Kain et al. 2014). A critical goal of implementing this care model is translating evidence into practice and reducing practice variation (Kain et al. 2014). In the perioperative setting, this means that protocols, staff, and equipment need to be standardized for various procedures. To promote successful implementation of the Perioperative Surgical Home care model, it will be necessary to consider how the multilevel factors interact to influence guideline use, as well as the interaction between the use of multiple CPGs.

### **1. Limitations**

This exploratory study has several limitations, and our findings demonstrated variation in themes examined in the cross-case analysis. This variation might result from the limited number of interviews conducted for each case study. Given the small sample size, we could not conclude whether we reached saturation of themes, where no new themes would be identified with additional interviews. In addition, responses to questions might be biased, as clinicians might not want to disclose negative aspects of the guideline or guideline use. However, with the supplemental evidence from the literature, these case studies capture the main story for each case study. Second, because of limited time allotted for each interview, we could not discuss each factor in the conceptual framework. Although we identified key factors from the conceptual framework that could affect guideline use, we do not know the causal relationship between these factors or the combination of factors that affect guideline use. Finally, we included case studies based on guidelines from the ASA, and results may not generalize to other fields of medicine. Although we included one case study from the AHA/ACC to address this limitation, anesthesiology and cardiology have different practices for guideline development and use that might make it difficult to compare the guidelines.



### V. Conclusions

Understanding the barriers and facilitators to practice change and CPG use is critical to improving patient care. In anesthesiology, important factors for practice change and guideline use might include the consistency of the evidence supporting the guideline and the organizational supports in place to encourage its use. Future studies should investigate whether barriers and facilitators for guideline use are consistent across medical specialties and which barriers and facilitators have the greatest influence on practice change and guideline use. The results from this study might help inform future implementation strategies for when new guidelines are published. In addition, more research is needed to understand how clinicians use, interpret, and implement vague or unclear recommendations in the guidelines, particularly in settings like anesthesiology, where clinicians make decisions at the point of care. Finally, more research is needed to further understand how clinicians who provide team-based care translate guidelines to practice, and the barriers and facilitators to guideline use in that setting.

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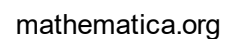
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