



Perioperative Stroke Prevention: A Review of Recent Guidelines for Noncardiac and Nonneurologic Surgery

by Robert Pranaat, MD, and Jacob W. Nadler, MD, PhD

INTRODUCTION

Perioperative stroke is defined as a brain infarction of ischemic or hemorrhagic etiology that occurs during surgery or within 30 days after surgery.¹ Fortunately, perioperative stroke is uncommon. According to data from the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP), between 0.1–0.7% of patients undergoing noncardiac surgery suffer from stroke.² Additionally, the greatest risk factors for postoperative stroke were history of stroke, including transient ischemic attack, advanced age, anemia (hematocrit <27%), and renal dysfunction. Most perioperative strokes occur on postoperative days 2–9.^{3,4} Surgeries that are at particularly high risk include emergency surgery, vascular surgery (such as carotid endarterectomy and thoracic endovascular aortic repair), and brain surgery.² Since most perioperative strokes in noncardiac, nonneurological surgery are ischemic in nature, they are typically attributed to hypotension and/or low-flow states, previously undisclosed large-artery stenosis, anemia-associated tissue hypoxia, embolism (thrombus, fat, or foreign

material), enhanced coagulability or thrombosis in the setting of systemic inflammation, and/or recent discontinuation of antithrombotic medications.¹

Questions surrounding diagnosis and management of perioperative stroke continue to be a major issue for patients and health care providers, and the risks facing patients undergoing surgery appear to be underrecognized. A Canadian study assessing anesthesiologists' perception of strokes found that less than 50% of those surveyed correctly identified the overall incidence of stroke in the perioperative time period, while only 25% of those surveyed knew that thrombosis was the most common etiology.⁵ Furthermore, most respondents (64% of those surveyed) believed that the overall risk of dying from a perioperative stroke is rare when the actual stroke-associated mortality rate is 25–87%. Despite these knowledge gaps, the majority of respondents reported they were confident in delivering care to high-risk patients.⁵

TIMING OF ELECTIVE SURGERY

Patients who have had a stroke in the past are at increased risk of complications with surgery, but this risk decreases with time. The consensus opinion regarding the optimal timing of elective surgery for patients who have had a prior stroke has changed in the last several years. In 2011, a retrospective study of a Danish national health database found that for patients undergoing elective surgery the greatest risk for ischemic stroke and cardiovascular death was within the first three months of the initial event.⁶ Additionally, they found that the risk for cerebrovascular and cardiovascular complications appeared to plateau at about nine months. Based on this study, the American Stroke Association/American Heart Association (ASA/AHA) published guidelines in 2021 which recommended delaying elective surgery following stroke for nine months, but suggested that surgery could be considered after six months if the benefits outweighed the risks of waiting.⁴ In contrast to the Danish study a recent cohort study of 5.8 million patients found that the risk of stroke and death leveled off when more than 90 days elapsed between a previous stroke and elective surgery, suggesting that the initial ASA/AHA guidelines may be too conservative.⁷ In 2024, a joint guideline by the AHA, ASA, and other international societies for perioperative cardiovascular management of patients undergoing noncardiac surgery was published suggesting that patients wait at least three months after stroke before undergoing elective surgery to decrease risk of recurrent stroke and/or major adverse cardiovascular events.⁸

PREOPERATIVE RECOMMENDATIONS

Comprehensive guidelines for the prevention of perioperative stroke were published by the ASA/AHA in 2021 and the Society of Neuroscience in Anesthesiology and Critical Care (SNACC) in 2020.^{1,4} Together these guidelines emphasize the need for multidisciplinary approaches to preoperative testing and optimization, continuation of medications like beta-blockers,⁹ and appropriate management of anticoagulation (Table 1). Notably, these guidelines differ on several points. For instance, SNACC advises caution with the use of intraoperative metoprolol as it has been associated

Table 1: Summary of Preoperative Considerations.

Preoperative Evaluation	<ul style="list-style-type: none">• All patients should be assessed for their perioperative stroke risk—specifically increased age, renal disease, history of transient ischemic attack/stroke, and patent foramen ovale.^{1,4}• Patients at higher risk of perioperative stroke should be discussed by a multidisciplinary team.• Consider using web-based ACS-SRC to assess risk• Delay noncardiac surgery for ≥3 months following cerebrovascular event¹¹
Optimization	<ul style="list-style-type: none">• Perform carotid artery revascularization in patient with symptomatic carotid artery stenosis (>70%) before elective surgery.⁵
Medication Management	<ul style="list-style-type: none">• Beta blockers: Continue prescribed beta blockers, but do not initiate beta blocker therapy.^{1,4}• Aspirin: Do not routinely continue aspirin solely for stroke risk reduction. Consider continuing aspirin in patients at high risk for a major adverse cardiac events (e.g., patients on aspirin for secondary prevention) if benefits outweigh risk of bleeding. Aspirin should be continued if there is a history of percutaneous coronary intervention.^{1,4}• Warfarin: Hold for 5–6 days before surgery. Restart 12–24 hours after surgery. Consider heparin or low molecular weight heparin (LMWH) bridging for high thromboembolic risk only. For intermediate risk, bridging is at the clinician's discretion; not recommended for low risk.^{1,4}• Direct Oral Anticoagulants (DOACs): For high bleeding risk surgeries hold 3 days prior and restart 2–3 days after surgery. For low bleeding risk surgeries hold 2 days prior and restart 24 hours after surgery. Bridging is based on clinical judgment regardless of bleeding risk.^{1,4}• Timing of resuming anticoagulants should be discussed by the multidisciplinary team.^{1,4}

Patient Should Wait at Least 3 Months After Stroke Before Elective Surgery

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with perioperative stroke and suggests that alternative beta-blockers may be more appropriate, while ASA/AHA guidelines recommend continuing beta-blockers.^{1,4} The ASA/AHA guidelines raise particular concern for a higher perioperative stroke risk among patients with patent foramen ovale, advocate for the use of the web-based American College of Surgeons Surgical Risk Calculator (ACS-SRC), and recommend carotid artery revascularization in patients with symptomatic carotid artery stenosis (>70%) before elective surgery. Recommendations also differ slightly with regard to management of patients receiving vitamin K antagonists, although both guidelines recommend bridging with either therapeutic dosing of low molecular weight heparin (LMWH) or intravenous heparin in patients at high risk for thromboembolic complications (i.e., atrial fibrillation with high CHA₂DS₂-VASc score or recent thromboembolic disease). The SNACC guidelines recommend against the use of heparin whereas ASA/AHA guidelines suggest its use. Specific recommendations are also given regarding management of anticoagulation. Both guidelines agree that aspirin, warfarin, and DOACs should be held before elective surgery depending on bleeding risk and restarted shortly after surgery, with heparin bridging only for high thromboembolic risk cases.⁴ Aspirin should be continued if there is a history of percutaneous coronary intervention.^{1,4} Given the complexity of opposing risks and benefits of antiplatelet and anticoagulant medications, these decisions should be discussed by a multidisciplinary team of surgeons, anesthesiologists, neurologists, and other medical professionals involved in the patient's care. Lastly, perioperative statin administration may not reduce stroke risk, though it may improve other outcomes.¹⁰

INTRAOPERATIVE RECOMMENDATIONS

Intraoperative recommendations are largely supportive in nature focusing on ensuring adequate cerebral and end-organ perfusion, maintaining appropriate acid-base status and end-tidal carbon dioxide levels, and transfusing blood products when appropriate (Table 2). It is important to avoid large fluctuations in blood pressure given the risks of both hemorrhagic and ischemic stroke. Specific blood pressure targets to avoid hypotension are not well described across all patient populations and for all circumstances, although the ASA/AHA guidelines recommend MAP goals > 70 mmHg. In contrast the SNACC guidelines recommend careful attention to the blood pressure gradient

Table 2: Intraoperative Considerations to Minimize Risk of Stroke.

<ul style="list-style-type: none">• Maintain mean arterial pressures > 70 mmHg, especially in patients with moderate to high perioperative stroke risk.^{1,4}
<ul style="list-style-type: none">• Careful attention to blood pressure gradients between the brain and wherever the blood pressure is being measured in order to avoid hypotension.^{1,4}
<ul style="list-style-type: none">• Transfuse to Hgb > 8 g/dl in patients with recent stroke or cerebrovascular disease and maintain Hgb 8–9 g/dl if there is a history of recent stroke, ongoing bleeding, or hemodynamic instability in presence of known cerebrovascular insufficiency due to occlusion or stenosis. Consider transfusion to Hgb > 9 g/dl if patient is taking a beta blocker.^{1,4}
<ul style="list-style-type: none">• No specific recommendations for or against use of regional versus general anesthesia, and no recommendations against use of nitrous oxide or volatile anesthetics versus total intravenous anesthesia.^{1,4}
<ul style="list-style-type: none">• Maintain normocarbia.^{1,4}
<ul style="list-style-type: none">• Maintain serum blood glucose 130–180 mg/dL.^{1,4}

Table 3: Postoperative Considerations to Minimize Risk of Stroke.

<ul style="list-style-type: none">• If concern for perioperative stroke, obtain emergent brain imaging.^{1,4}
<ul style="list-style-type: none">• If high suspicion for perioperative stroke on brain imaging, a multidisciplinary group discussion is warranted to recommend either intravenous thrombolytics and/or the use of mechanical thrombectomy.^{1,4}
<ul style="list-style-type: none">• If the patient is given recombinant tissue plasminogen activator (rtPA), maintain SBP < 180 mmHg and DBP < 105 mmHg.^{1,4}
<ul style="list-style-type: none">• Additional testing should include an EKG, troponins, and cardiac telemetry for at least the first 24 hours.^{1,4}
<ul style="list-style-type: none">• Avoid hypotension. Aim for MAP targets > 70mm Hg in patients at moderate to high risk of stroke.^{1,4}
<ul style="list-style-type: none">• Initiate aspirin therapy in the first 24–48 hours after ischemic stroke onset but this can be delayed until after 24 hours in patients who have received rtPA.^{1,4}
<ul style="list-style-type: none">• Maintain serum blood glucose 140–180 mg/dL.^{1,4}

or height difference between the blood pressure measuring device (noninvasive blood pressure cuff or invasive blood pressure transducer), and the brain.¹ An appropriate blood pressure on the arm when lower than the head, for instance, could potentially result in cerebral hypoperfusion.

There is some controversy regarding blood transfusion targets. Both guidelines recommend more liberal hemoglobin transfusion targets. Specifically, ASA/AHA guidelines recommend a hemoglobin transfusion target of 8 g/dL for patients with a history of recent stroke or cerebrovascular disease, or 8–9 g/dL in patients with an acute perioperative stroke, ongoing bleeding, hemodynamic instability, or known cerebrovascular insufficiency attributable to stenosis or occlusion.⁴ The SNACC guidelines recommend a higher transfusion target of 9 g/dL or greater in patients taking beta blockers to reduce perioperative stroke risk.¹

Anesthetic technique such as the choice of regional versus general anesthesia,¹¹ propofol versus volatile inhaled agents,¹² or the use of nitrous oxide¹³ probably has little impact on stroke risk. There may be an exception for joint arthroplasty, where researchers found a benefit of regional anesthesia, likely attributable to differences in blood loss and risk of thromboembolism.¹⁴

POSTOPERATIVE RECOMMENDATIONS

Both the ASA/AHA and SNACC guidelines recommend that institutions have standardized approaches for the emergency evaluation of patients suspected to have perioperative stroke (Table 3). Since the greatest risk for stroke is within the first 72 hours following surgery, diagnostic challenge exists due to the residual effects of the procedure itself and effects from anesthesia.⁴ Multidisciplinary communication and collaboration are essential

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given the acuity of perioperative stroke and the need for ongoing care to occur efficiently and safely. The anesthesia professional is well equipped to help direct hemodynamic monitoring and management, ventilator support, and patient transportation to brain imaging, procedural rooms, and hospital floors or intensive care units.

CONCLUSION

Perioperative stroke is often an underrecognized complication by anesthesia professionals. Current recommendations suggest delay of elective surgery for at least three months after stroke. While controversy over specific perioperative interventions remain, a multidisciplinary approach to perioperative optimization and planning is important to caring for these higher risk patients. Patients with symptoms suggestive of perioperative stroke should undergo emergent evaluation with early engagement of a multidisciplinary team.

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