

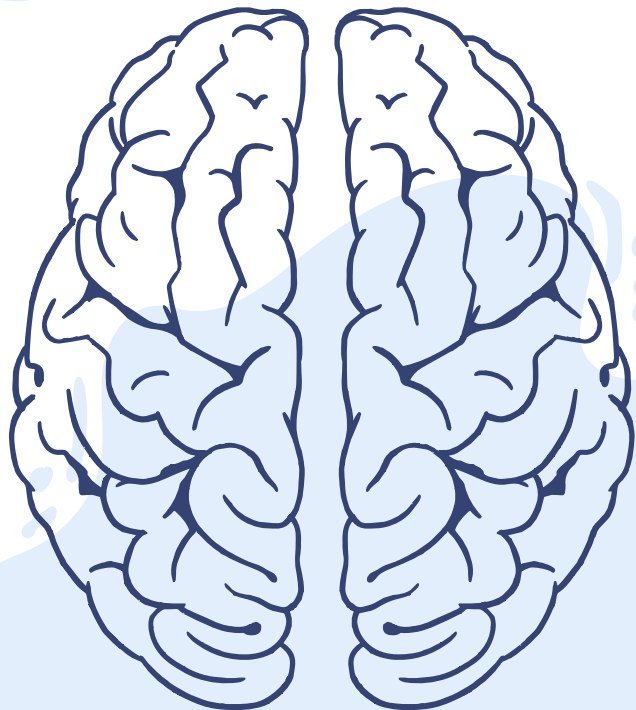
Perioperative Care of Patients at High Risk for Stroke During or After Non-cardiac, Non-neurological Surgery

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INTRODUCTION



- Stroke recognition and diagnosis are challenging perioperatively.
- Updated guidelines from the Society for Neuroscience in Anesthesiology and Critical Care of patients at high risk for stroke.
- Review incidence, pathogenesis, prevention, and management of perioperative stroke.
- Published by the Society for Neuroscience in Anesthesiology and Critical Care (SNACC) in 2014.

OUTLINE

01 DEFINITION OF
PERIOPERATIVE STROKE

02 PREOPERATIVE
GUIDELINES

03 INTRAOPERATIVE
GUIDELINES

04 POSTOPERATIVE
GUIDELINES

01

DEFINITION OF PERIOPERATIVE STROKE





“Perioperative stroke” is defined as a brain infarction of ischemic or hemorrhagic etiology that occurs during surgery or within 30 days after surgery.

Purpose of the Guidelines

- (1) Preoperative risk stratification and optimization
- (2) Intraoperative management to mitigate risk
- (3) Appropriate steps for clinical care if the stroke is suspected or identified in the postoperative period.

SNACC : assist decision-making in patients at high risk for perioperative stroke.

02

**PREOPERATIVE
GUIDELINES**

Stroke Pathophysiology and Etiology

- Noncardiac, nonmajor vascular surgical procedures increased risk of stroke and/or TIA, with the highest between 1 and 3 days after surgery.
- Classify perioperative stroke etiology
 - Large-vessel stroke
 - Cardioembolic stroke
- Commonly in the anterior circulation (ACA,MCA)
- Limited cerebrovascular reserve : Preexisting cerebrovascular disease.
- Hypotension, hypocapnia/hypercapnia, vascular beds may predispose to **hypoxic-ischemic injury**.



Preoperative Evaluation and Risk Evaluation



- **No** standard preoperative system for evaluating cerebrovascular physiology.
- **Cerebrovascular reserve** mapped via blood oxygen level-dependent signal and vasoactive stimuli (e.g. CO₂)
- **Cerebral microembolic** detected via high-intensity transcranial Doppler signals and electroencephalographic patterns (oscillatory asymmetry and increased delta/alpha ratios).

Preoperative Evaluation and Risk Evaluation

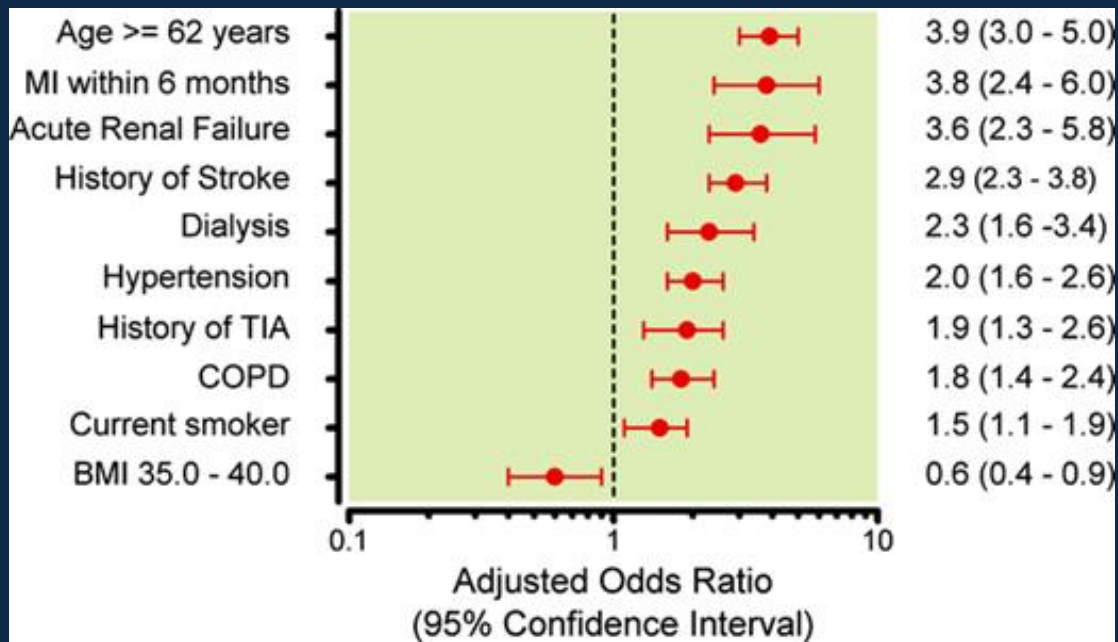
Cerebrovascular risk evaluation guided by comorbidity-based risk factors in these surgical populations.

Identified clinical risk factors for perioperative stroke

1. Advanced age
2. Prior cerebrovascular disease
3. Renal failure

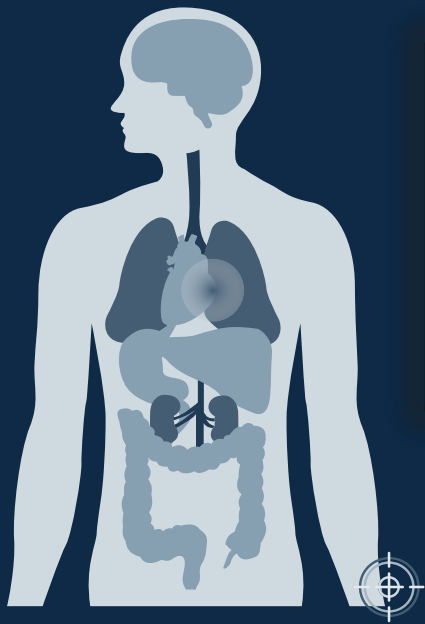


Preoperative Evaluation and Risk Evaluation



Independent predictors of perioperative stroke.

Preoperative Evaluation and Risk Evaluation



(1) Preoperative physiological testing is not recommended for determining cerebrovascular vulnerability.

(2) Screen for risk factors of postoperative stroke, most notably recent or remote stroke history, and communicate such risk to patients and clinical care teams.



Informed Consent



“ High-stroke risk, such risk should be communicated to patients and clinical care teams ”

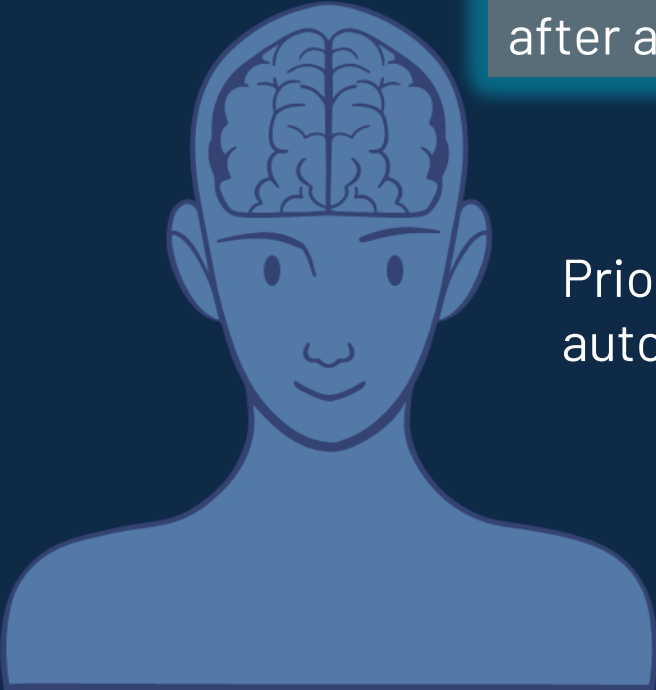




Timing of Elective Surgery After Stroke



“Consider delaying elective surgical for at least 9 months after a prior stroke”



Prior stroke may impaired cerebrovascular autoregulation and chemoregulation for months to years



Timing of Elective Surgery After Stroke



- The highest risk within the first 3 months after prior ,stabilized by 9 months.
- Incidence of major cardiovascular events was temporally increased in parallel with recurrent stroke risk.
- Likely beneficial to identify the cause .



Management of Anticoagulant Drugs

Risk Category	Mechanical Heart Valve	Atrial Fibrillation	Venous Thromboembolism
High	Mitral valve prosthesis; caged-ball or tilting disk aortic prosthesis; stroke or TIA within 6 mo	CHA ₂ DS ₂ -VASc score ≥ 6 ; stroke or TIA within previous 3 mo; rheumatic valvular heart disease	VTE within 3 mo; severe thrombophilia*
Moderate	Bileaflet aortic valve prosthesis and at least one of the following risk factors: atrial fibrillation, previous stroke or TIA, hypertension, diabetes, congestive heart failure, age > 75 y	CHA ₂ DS ₂ -VASc score 4-5 or previous stroke or TIA > 3 mo before	VTE within 3 to 12 mo; nonsevere thrombophilia†; recurrent VTE; active cancer
Low	Bileaflet aortic valve prosthesis and no other risk factors for stroke	CHA ₂ DS ₂ -VASc score 2-3 (assuming no previous stroke or TIA)	VTE > 12 mo previous and no other risk factor

“For patients on **vitamin K anticoagulants** (eg, warfarin), stop medication **5 days** preoperatively, and consider **bridging** anticoagulation only for those with **moderate-high** thromboembolic risk”

Management of Anticoagulant Drugs

Vitamin K antagonist therapy, bridging is recommended only in high-risk situations:

- Mechanical heart valve
- High CHA₂DS₂-VASc scores⁵⁶ (generally ≥ 6)
- Recent (within 3 month) thromboembolism
- History of thromboembolism while on anticoagulation
- Known cardiac thrombus
- Rheumatic valve disease



Management of Anticoagulant Drugs



“For patients on **Direct oral anticoagulants**, administer last dose **2 to 3 days** preoperatively and resume **1 to 3 days** postoperatively based on clinical risk factors and bleeding risk. Avoid heparin bridging ”

Category	High Bleeding Risk Procedure	Low Bleeding Risk Procedure
High thromboembolic risk		
Warfarin	Give last dose 6 d before operation, bridge with LMWH or UFH, resume 24 h postoperatively	Give last dose 6 d before operation, bridge with LMWH or UFH, resume 24 h postoperatively
Direct oral anticoagulants	Give last dose 3 d before operation,* resume 2-3 d postoperatively	Give last dose 2 d before operation,* resume 24 h postoperatively
Intermediate thromboembolic risk		
Warfarin	Give last dose 6 d before operation, determine need for bridging by clinician judgment and current evidence, resume 24 h postoperatively	Give last dose 6 d before operation, determine need for bridging by clinician judgment and current evidence, resume 24 h postoperatively
Direct oral anticoagulants	Give last dose 3 d before operation,* resume 2-3 d postoperatively.	Give last dose 2 d before operation,* resume 24 h postoperatively
Low thromboembolic risk		
Warfarin	Give last dose 6 d before operation, bridging not recommended, resume 24 h postoperatively	Give last dose 6 d before operation, bridging not recommended, resume 24 h postoperatively
Direct oral anticoagulants	Give last dose 3 d before operation,* resume 2-3 d postoperatively	Give last dose 2 d before operation,* resume 24 h postoperatively

*In patients with CrCl <50 mL/min on dabigatran, the last dose should be given 3 days before the procedure for low bleeding risk surgery, and 4 to 5 days before the procedure for high bleeding risk operation.

CrCl indicates creatinine clearance; LMWH, low-molecular-weight heparin; UFH, unfractionated heparin.

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Management of Antiplatelet Drugs

- **Aspirin** reduced the risk of mortality or nonfatal MI (primary composite outcome) in those with prior percutaneous coronary intervention.



- “Prior percutaneous coronary intervention, a continuation of aspirin may reduce perioperative mortality and MI risk”.
- Insufficient evidence to determine aspirin mitigates stroke risk

Management of Antiplatelet Drugs

POISE-2 TRIAL

- “ **Aspirin** before surgery and throughout the early postsurgical period had no significant effect on the rate of a composite of death or nonfatal myocardial infarction but increased the risk of major bleeding. ”
- **No difference in stroke** or TIA risk between groups
- Risk of major perioperative **bleeding** was significantly higher in patients receive aspirin (P=0.007)

Potential benefits of aspirin must be weighed against risk of major perioperative hemorrhage



Bleeding Risk Category**Type of Surgery/Procedure**

High risk

Intracranial or spinal surgery
 Major vascular surgery (aortic aneurysm repair, aortofemoral bypass)
 Major urologic surgery (prostatectomy, bladder tumor resection)
 Major orthopedic surgery (hip/knee joint replacement)
 Lung resection surgery
 Intestinal anastomosis surgery
 Permanent pacemaker or internal defibrillator placement
 Selected procedures: colonic polypectomy of large polyp, endoscopic retrograde cholangiopancreatography with sphincterotomy, kidney biopsy
 Other intra-abdominal surgery
 Other intrathoracic surgery
 Other orthopedic surgery
 Other vascular surgery
 Selected procedures: colonic polypectomy of small polyp, prostate bionsv. cervical bionsv

Moderate risk

Bleeding Risk Category	Type of Surgery/Procedure
High risk	Intracranial or spinal surgery Major vascular surgery (aortic aneurysm repair, aortofemoral bypass) Major urologic surgery (prostatectomy, bladder tumor resection) Major orthopedic surgery (hip/knee joint replacement) Lung resection surgery Intestinal anastomosis surgery Permanent pacemaker or internal defibrillator placement Selected procedures: colonic polypectomy of large polyp, endoscopic retrograde cholangiopancreatography with sphincterotomy, kidney biopsy
Moderate risk	Other intra-abdominal surgery Other intrathoracic surgery Other orthopedic surgery Other vascular surgery Selected procedures: colonic polypectomy of small polyp, prostate biopsy, cervical biopsy
Low risk	Laparoscopic cholecystectomy Laparoscopic inguinal hernia repair Noncataract ophthalmologic procedures Coronary angiography Gastroscopy or colonoscopy (with/without biopsy) Selected procedures: thoracentesis, paracentesis, arthrocentesis, bone marrow aspiration, and biopsy
Very low risk (anticoagulation interruption not required)	Single tooth extraction or teeth cleaning Skin biopsy or selected skin cancer removal Cataract removal

Of note, bleeding risk also relates to the consequences of bleeding rather than the mere volume of blood loss.
 CrCl indicates creatinine clearance.
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Role of Preoperative Beta-blockers and Statins in Perioperative Stroke



(1) **Avoid** initiating **Beta-blocker** therapy in the **immediate** preoperative setting.

The POISE Trial

- Beta-blockade initiation in the immediate preoperative setting **beta-blocker-naive patients** to the administration of extended-release metoprolol.

Results : Beta-blockade was associated with an increased risk of nonfatal stroke .



Role of Preoperative Beta-blockers and Statins in Perioperative Stroke



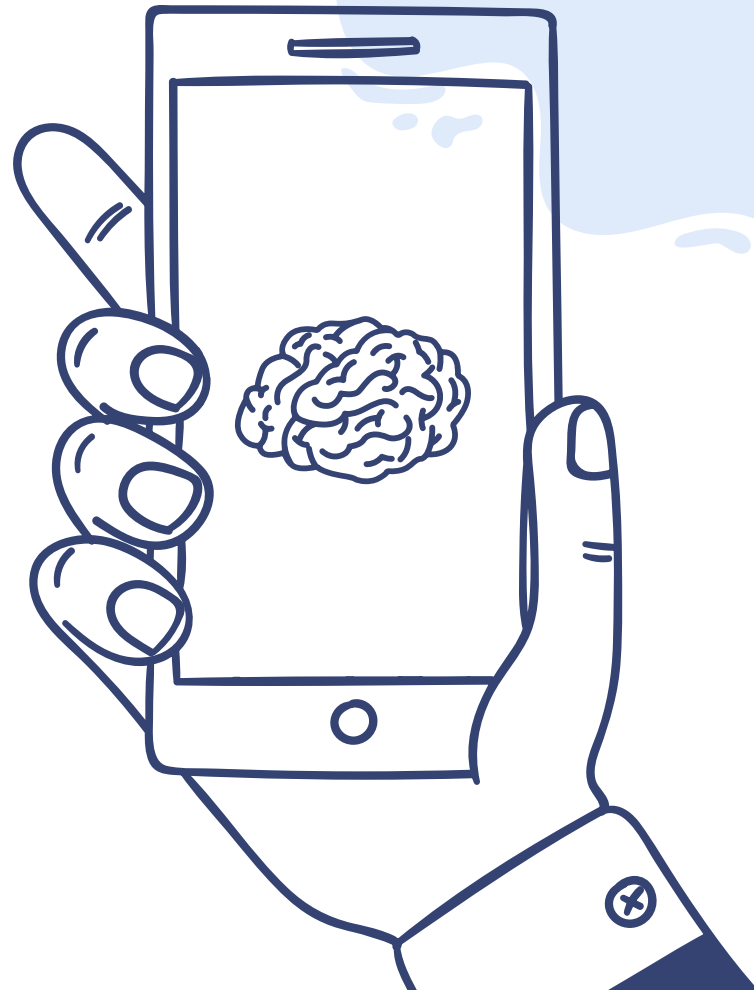
(2) Continue **Beta-blockers** and **Statins** throughout the perioperative period in patients already taking them.

- **Jørgensen et al** : “ The incidence of nonfatal stroke was **not** significantly increased in patients on chronic beta-blocker therapy ”.
- Perioperative statin use was significant **reductions** all-cause **mortality** and both cardiovascular and noncardiovascular morbidity.
- Perioperative statin use was **not** associated with perioperative **stroke** or TIA.



03

INTRAOPERATIVE GUIDELINE



Intraoperative Management in Relation to Stroke risk

01

Anesthetic
technique

02

Blood pressure
management

03

Ventilation
strategy

04

Hemorrhage/
Blood transfusion

05

Glycemic
management

06

Intraoperative
Beta-blockade

Anesthetic Technique

RA

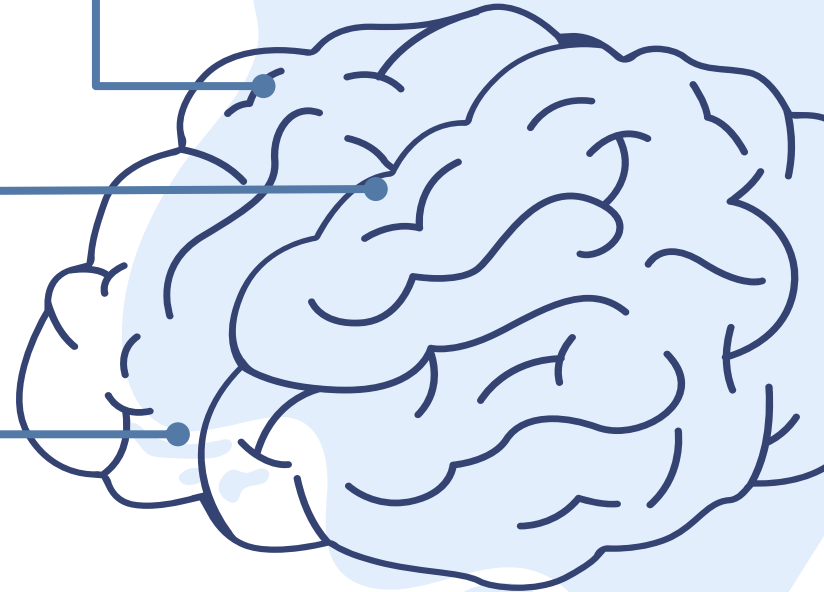
A particular surgery, regional anesthetic techniques reducing stroke risk, effect is likely to be small.

Propofol or Inhalational

Can be used for maintenance techniques, there does not difference in relation to stroke risk.

Nitrous oxide

Safe across broad surgical populations



Blood Pressure Management

- 1) No specific thresholds are recommended to reduce stroke risk, an effect of relative hypotension cannot be excluded based on current evidence.
- Intraoperative hypotension has been cited as a cause of postoperative stroke.
- Hypotension was measured as MAP < 70 mmHg.
- MAP > 30% below baseline was associated with postoperative stroke (unclear clinical significance).



Blood Pressure Management

- 2) For surgery in the beach chair position, BP measurement should be performed on the nonoperative upper arm (as opposed to lower extremity) and consideration BP gradient between the brachial artery and brain.

- Postural hypotension may also play a role in stroke after noncardiac surgery.
- MAP may be 12 to 24 mm Hg lower in the brainstem compared with the nonoperative upper extremity.

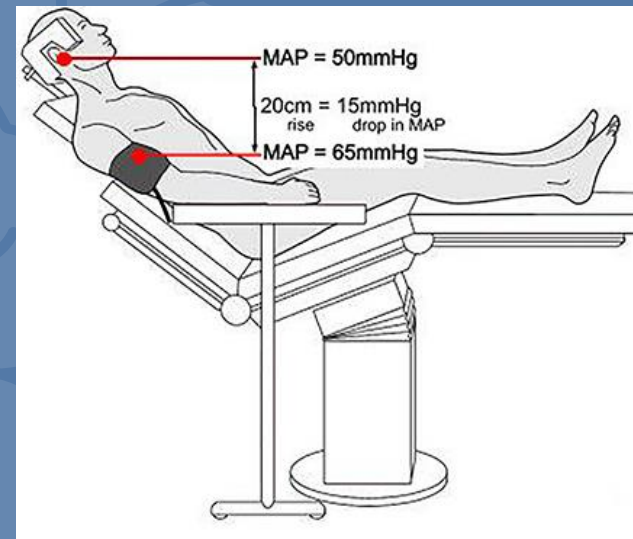


Blood Pressure Management



- 3) Induced hypotension for shoulder surgery in the beach chair position should caution, especially in patients at risk for stroke.

- Relationship between mild hypotension and end-organ injury (including : acute kidney injury , MI ,and mortality)



Respiratory Physiology and Cerebrovascular Reserve

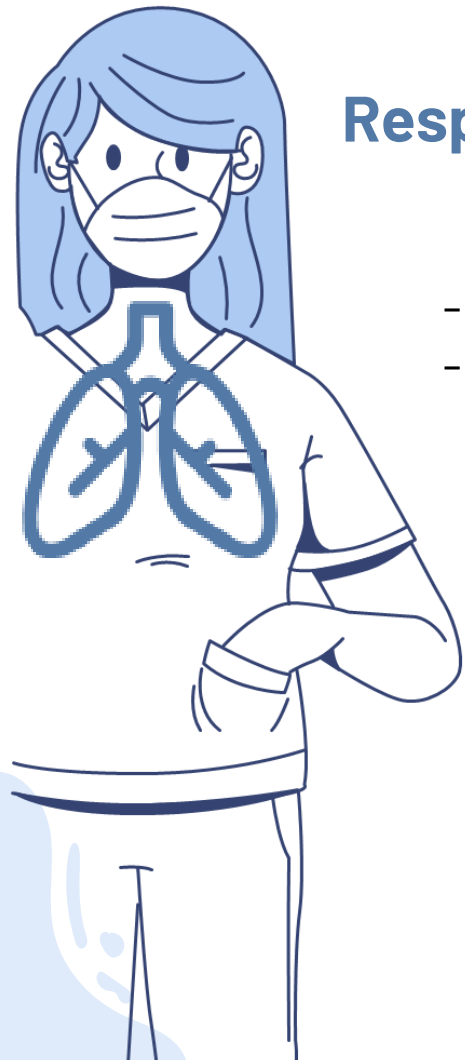


- **Normocapnia** is associated with improved outcomes.
- **Hypocapnia** increases cerebrovascular resistance, and maximal resistance may be achieved with $\text{PaCO}_2 = 30$ mm Hg.
- **Hypercapnia** may also impair cerebral blood flow.
- Combination of reduced cerebrovascular inflow (eg, hypotension) and impaired vasodilatory reserve (mediated by hypocapnia or hypercapnia), may create for **hypoxic-ischemic injury**.

Respiratory Physiology and Cerebrovascular Reserve

- Patients with preexisting cerebrovascular disease,
- PaCO₂ may be relevant for cerebrovascular perfusion, with derangements in PaCO₂ reducing cerebrovascular reserve, in the setting of hypotension and/or stenocclusive disease.

“ In patients at high risk of perioperative stroke, maintaining normocapnia may prevent further risk of cerebrovascular compromise”



Hemorrhage and Blood Transfusion



Intraoperative hemorrhage and Transfusion

- Associated with perioperative stroke.
- Predispose to Cerebral hypoxic-ischemic injury.
- **TXA** reduce blood loss and transfusion requirements without increased stroke risk.



Transfuse packed red blood cells

- Optimize physiological oxygen delivery.
- Increase stroke risk via pathways: RBC aggregation, increased thrombogenic potential, and impaired microcirculation.

Hemorrhage and Blood Transfusion



- Postoperative **hemoglobin ≤ 9 g/dl** : reduced cardiac output, combined with impaired Beta2- mediated cerebrovascular vasodilatation, may reduce CBF and oxygen delivery.



- Patients taking a beta-blocker, relatively high transfusion threshold (hemoglobin 9.0 g/dL) may reduce perioperative stroke risk

Glycemic Management

Perioperative stroke is associated with an elevated fasting blood sugar.

Hyperglycemia in this setting be indicative of stroke severity rather than the cause of injury.

Nonoperative stroke in the community demonstrated **no** benefit of **intensive therapy**.



Glycemic Management

1) Treat hyperglycemia to maintain serum glucose between **130 and 180 mg/dL** .

2) Intensive efforts to maintain tight control of serum glucose (e.g. <130 mg/dL) may result in hypoglycemia and related adverse events.



Intraoperative Beta-blockade

- Metoprolol, as a relatively nonselective Beta1-antagonist, may reduce brain tissue oxygenation by impairing Beta2-mediated cerebral vasodilation in mice.

- Intraoperative metoprolol has been associated with perioperative stroke; alternative intraoperative beta blockers may be reasonable for **avoiding** an increased risk of stroke.

04

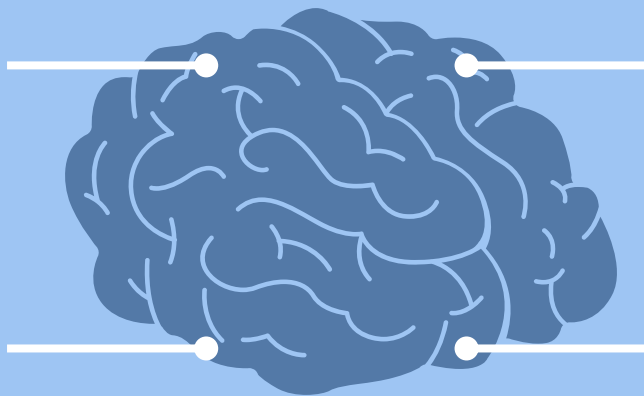
POSTOPERATIVE GUIDELINES



POSTOPERATIVE GUIDELINES

**1. Stroke Team,
Networks, and Triage**

**2. Assessing
Stroke**



**3. Acute Interventions
for Ischemic Stroke**

**4. Supportive Care
for Acute Ischemic
Stroke Patients**

Stroke Team, Networks, and Triage

- Rapid recognition, communication, and timely management.

“ An organized protocol for emergency evaluation of surgical patients with suspected perioperative stroke is Recommended ”



A hand is holding a large sheet of brain MRI scans. The scans are arranged in a grid, showing various cross-sections of the brain. A blue speech bubble is overlaid on the right side of the image, containing the text "Assessing Stroke". The background is a light blue gradient.

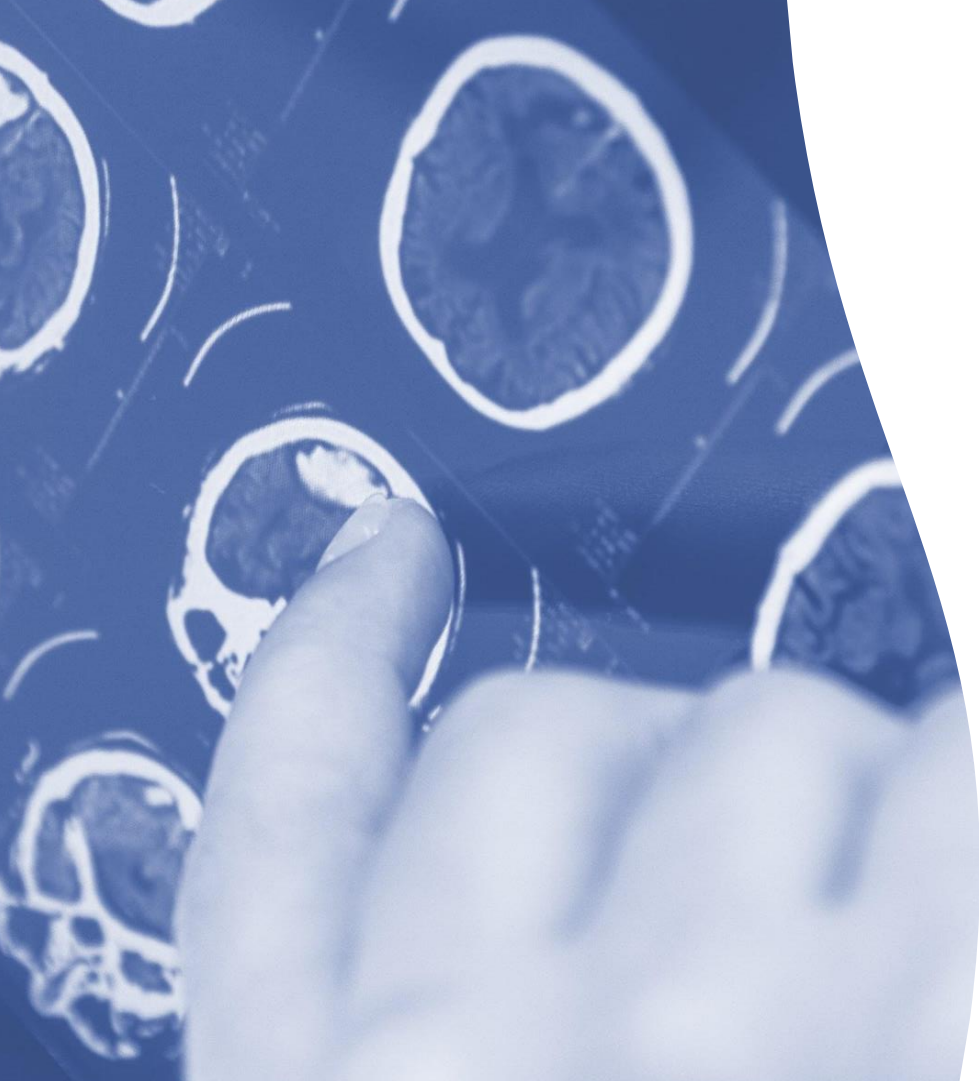
Assessing Stroke

Assessing Stroke

1. Currently available clinical assessment tools (eg, mNIHSS) are **not** recommended for routine screening given the high likelihood of false-positive results
2. A targeted postoperative evaluation, which focuses on signs and symptoms of large-vessel occlusion, may be reasonable in high-risk patients
3. Neither serum-based biomarkers nor neurophysiological monitoring are recommended for clinical detection of perioperative cerebral ischemia.

Assessing Stroke

- 4. Emergency imaging of the brain is recommended before initiating any specific therapy to treat acute postoperative stroke.**
- 5. For suspected large-vessel occlusion, CT angiography and diffusion/perfusion imaging should be obtained urgently for consideration of endovascular therapy.**

A hand is pointing at a brain scan image, which is part of a larger graphic on the left side of the slide. The scan shows several cross-sections of a brain, with one section highlighted in white. The background is a dark blue color with a subtle pattern of brain scan slices.

Acute Interventions for Ischemic Stroke

Acute Interventions for Ischemic Stroke



- Identification of a hemorrhagic stroke with head **CT**.
- **Interventions** for acute ischemic stroke, such as **rtPA** or **mechanical thrombectomy**, should be considered with a multidisciplinary team.
- Risk/benefit depending on the patient, severity and location stroke, and type of surgical intervention.
- rtPA is the standard therapy for thrombotic strokes, but **contraindicated** in intracranial or spinal surgery within 3 months.
- Time window for intervention may be as long as **24 hours**.

Acute Interventions for Ischemic Stroke



- (1) Multidisciplinary** discussion regarding the benefits of intravenous rtPA versus risks of hemorrhage for the surgical patient with an acute ischemic stroke.
- (2) Patients with large-vessel occlusion should receive mechanical thrombectomy **as soon as possible** if criteria are met .

Supportive Care for Acute Ischemic Stroke Patients



- 1) Baseline electrocardiogram and troponin assessments.
- 2) Cardiac telemetry monitoring is recommended to detect potentially deleterious arrhythmias for at least the first 24 hours.
- 3) In patients who receive rtPA (IV or intraarterial) or undergo mechanical clot retrieval, SBP > 180 mm Hg and DBP > 105 mm Hg should be treated with antihypertensive drugs such as labetalol or nicardipine.



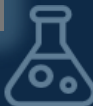
Supportive Care for Acute Ischemic Stroke Patients



(4) Relative hypotension should be avoided in acute ischemic stroke patients, though optimal BP targets have not been established.

5) Aspirin is recommended within 24-48 hours after stroke onset. The administration is delayed until at least 24 hours in patients treated with IV alteplase .

6) Supplemental oxygen should be provided to maintain oxygen saturation $> 94\%$.



Supportive Care for Acute Ischemic Stroke Patients

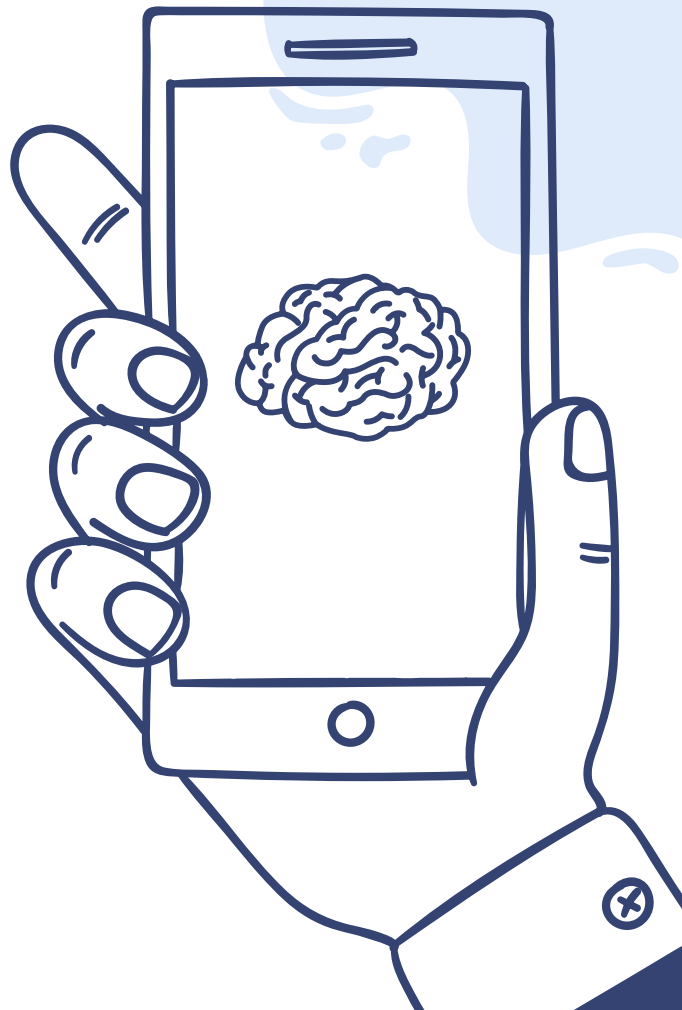


- 7) Tracheal intubation and mechanical ventilation are recommended in patients with decreased consciousness (GCS<8) or bulbar dysfunction that causes a compromise of respiration .
- 8) Both hypoglycemia and hyperglycemia should be treated with a goal of 140 to 180 mg/dL .



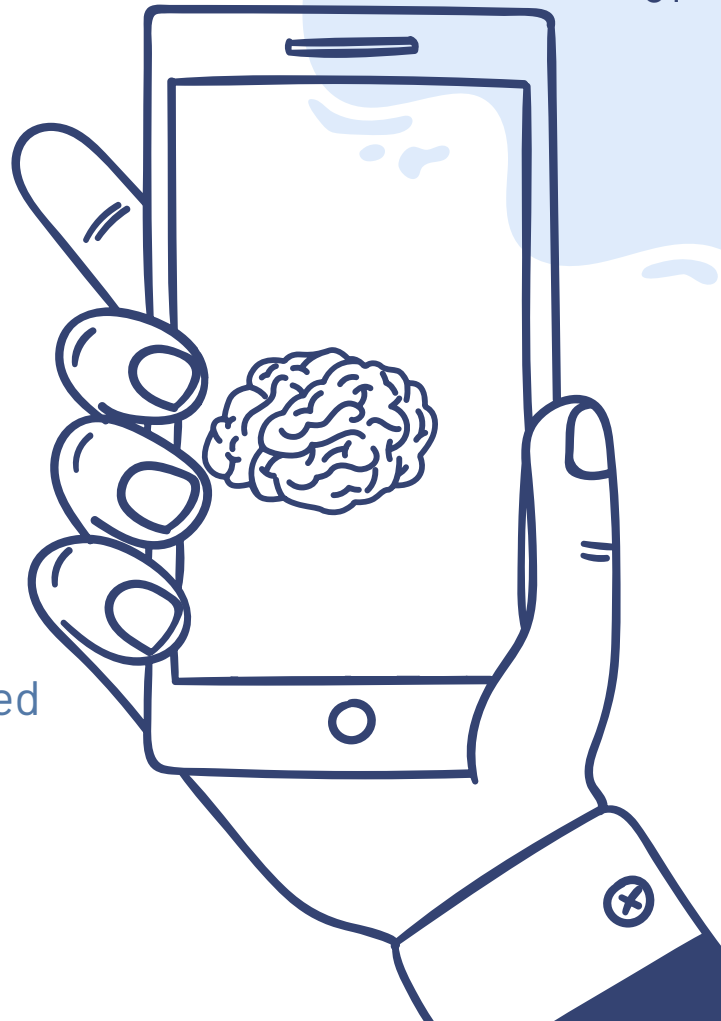
CONCLUSION

- **Stroke** is a potentially devastating complication for surgical patients.
- Age, prior cerebrovascular disease history, and renal dysfunction are all **risk factors** .
- Elective surgeries should be deferred until at least **9** months.
- Anticoagulation, bridging therapy should be reserved for **moderate-to-high-risk** patients.

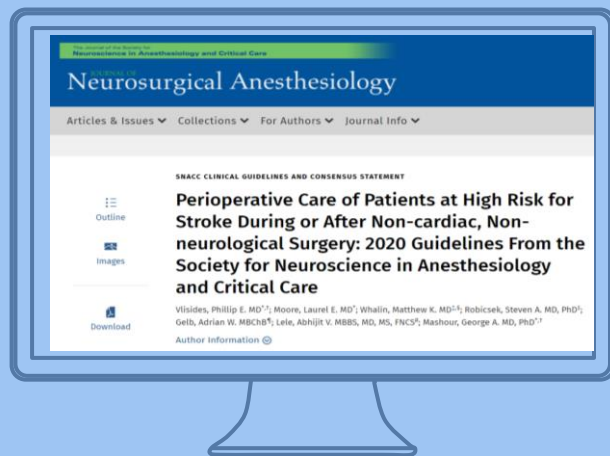


CONCLUSION

- Neither clinical assessment tools nor serum-based biomarkers are currently recommended for routine screening.
- Stroke is suspected, however, urgent **neuroimaging**.
- **Multidisciplinary** protocols should also be implemented for the triage and management.



REFERENCE



1. Phillip E. Vlisides, MD, Laurel E. Moore, MD, Matthew K. Whalin, MD, Steven A. Robicsek, MD, PhD, || Adrian W. Gelb, MBChB, Abhijit V. Lele, MBBS, MD, MS, FNCS, and George A. Mashour, MD, PhD Perioperative Care of Patients at High Risk for Stroke During or After Non-cardiac, Non-neurological Surgery: 2020 Guidelines From the Society for Neuroscience in Anesthesiology and Critical Care J Neurosurg Anesthesiol 2020;32:210-226.
2. Phillip E. Vlisides, M.D., Laurel E. Moore, M.D Stroke in Surgical Patients Anesthesiology 2021; 134:480-92.

THANK YOU



