PERIOPERATIVE NEUROLOGIC EVALUATION & MANAGEMENT TO LOWER RISK OF ACUTE STROKE IN NON-CARDIAC, NON-NEUROLOGIC SURGERY

A Scientific Statement from the American Heart Association/American Stroke Association

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The American Academy of Neurology (AAN) affirms the value of this statement as an educational tool for Neurologists

Endorsed by the American Association of Neurological Surgeons/Congress of Neurological Surgeons (AANS/CNS)
PREOPERATIVE EVALUATION & MANAGEMENT
PERIOPERATIVE STROKE

DEFINITION
• Embolic, thrombotic, or hemorrhagic cerebrovascular event
• Motor, sensory, or cognitive dysfunction ≥ 24 hours
• Occurring intra-operatively or within 30 days after surgery

INCIDENCE
• 0.1-1% in non-cardiac, non-neurologic surgery
  • With 5M pts. undergoing non-cardiac surgery in US each year, 25K may experience perioperative stroke!
• Higher risk with vascular & neurosurgical operations
• From 2004 to 2013, despite overall decrease in major adverse cardiovascular & cerebrovascular events, rate of perioperative stroke increased from 0.52% to 0.77% (Smilowitz et al)
SILENT CEREBRAL ISCHEMIA

- Acute ischemic events not clinically apparent
- Usually discovered from brain imaging (e.g. MRI)
- NOT benign—associated with:
  - Cognitive decline
  - ↑ risk of stroke
  - ↑ mortality
- Incidence may be as high as 10% in non-cardiac surgery
PERIOPERATIVE STROKE

RISK FACTORS

• Advancing age
• Renal disease
• Prior TIA/stroke
• Emergency surgery
• Certain surgical procedures (e.g. thoracic, head & neck, vascular)
PERIOPERATIVE STROKE

PREOPERATIVE RISK STRATIFICATION

• Numerous tools for cardiovascular risk available (e.g., ACS Surgical Risk Calculator, Myocardial Infarction and Cardiac Arrest calculator, Revised Cardiac Risk Index, CHADS2)

• American College of Surgeons surgical risk calculator (ACS-SRC) and MICA risk calculator offered best predictive accuracy (Wilcox et al, 2019)

• Web-based ACS-SRC (https://riskcalculator.facs.org/RiskCalculator) suggested to find those who could benefit from targeted interventions
PRE-OP STROKE PREVENTION STRATEGIES

TIMING OF SURGERY AFTER STROKE

• → Defer elective, non-cardiac surgery at least 6 mos. (and possibly 9 mos.) after prior stroke

  • Elective non-cardiac surgery within 3 mos. of prior stroke at highest risk of ischemic stroke
  • Emergency non-cardiac surgery within 3 mos. of stroke increased odds of stroke >20X! (Christiansen *et al*, 2017)
PRE-OP STROKE PREVENTION STRATEGIES

EXTRACRANIAL CAROTID STENOSIS

• → Pts. with symptomatic (in last 6 mos.) high-grade stenosis (>70%) should be strongly considered for endarterectomy or stenting
• → Symptomatic pts. with moderate stenosis (50-69%) should also be considered, IF the surgical risk <6%
• No clear recommendations for asymptomatic pts.
PRE-OP STROKE PREVENTION STRATEGIES

PATENT FORAMEN OVALE

• Increased risk and severity of perioperative stroke
  • In patients undergoing total hip arthroplasty, peri-op stroke risk 29x greater compared to controls (Perfetti et al, 2017)

• ➔ Further study needed to determine best management
PERIOPERATIVE MEDICATION MANAGEMENT

BETA-BLOCKERS

• Reduce perioperative adverse cardiac events
• But pre-op metoprolol results in ↑ stroke rates & ↑ mortality vs. placebo (POISE trial, 2008)
  • Further trials have shown mixed results with other β-blockers
ANTITHROMBOTIC THERAPY

• Balancing thromboembolic risk with perioperative bleeding risk
• American College of Surgeons (ACS) published guidelines in 2018 with management recommendations for three tiers of thromboembolic risk
INTRAOPERATIVE MANAGEMENT
BLOOD PRESSURE MANAGEMENT

• Goal of anesthesia is to maintain adequate end-organ perfusion to vital organs

• No ability to directly measure blood flow to some organs (e.g. brain), so BP used as surrogate

• Episodes of ↓BP very common during surgery
  • Mean arterial pressure (MAP) falls >20% below baseline in up to 90% of surgical cases (Bijker et al, 2007)
BLOOD PRESSURE MANAGEMENT

- ↓BP may be modifiable risk factor for perioperative stroke
- Increasing evidence linking intraoperative hypotension with myocardial injury, kidney injury, death
- But most evidence linking to perioperative strokes not very strong
  - Exception is POISE trial (2008), which linked metoprolol to 2x stroke rate & ↑mortality
- →Consider maintaining MAP >70 mmHg intraoperatively to decrease stroke risk
  - Still need more data (e.g., upcoming POISE-III trial)
  - Also need to avoid extremes of ↑BP
PERIOPERATIVE GOAL-DIRECTED THERAPY

• Instead of just BP targets, goal-directed therapy aims to optimize global perfusion

• Trials have generally shown fewer complications with goal-directed therapy, but no conclusive benefit on mortality

• No definite benefit on stroke risk shown
  • Possibly due to low incidence of perioperative stroke
  • Future studies could focus on silent cerebral infarcts, which have higher incidence
PERIOPERATIVE BLOOD TRANSFUSION MANAGEMENT

• Confusing picture in which anemia is a risk factor for stroke in the general population, but this association is NOT seen in patients undergoing non-cardiac surgery
  • Additionally, anemia not associated with higher stroke risk despite significantly higher risk of cardiac & respiratory complications, as well as death

• Complicating this issue are multiple studies showing that patients receiving perioperative blood transfusions have worse clinical outcomes
PERIOPERATIVE BLOOD TRANSFUSION MANAGEMENT

• Suggest blood transfusions if:
  • Hb <8 g/dL, for patients with elevated stroke risk, including those with prior strokes or pre-existing cerebrovascular disease
  • Hb <9 g/dL, for those patients with acute perioperative stroke or known cerebrovascular insufficiency from severe carotid stenosis/occlusion
  • Weigh against non-infectious transfusion hazards in highest-risk pts. (e.g., transfusion-associated circulatory overload)
ANESTHESIA & VENTILATION

CHOICE OF ANESTHETIC TECHNIQUE

• Current evidence suggests general anesthetic agents are neither neuroprotective or neurotoxic

• Insufficient evidence to favor regional anesthesia/analgesia over general anesthesia to reduce perioperative stroke risk
VENILATION STRATEGIES

• Little empirical evidence showing association between ventilation technique and stroke risk

• There is substantial evidence, however, showing hyperventilation & hypocapnia lead to reduced cerebral blood flow

• Also, protective lung ventilation with lower tidal volumes $\rightarrow$ ↓ incidence of death & major pulmonary complications (& possibly peri-operative hypoxemia)

• $\rightarrow$ Consider protective lung ventilation to improve overall perioperative outcomes
IDENTIFICATION & TREATMENT OF PERIOPERATIVE STROKE
RECOGNITION OF STROKE

CHALLENGES

• ~1/2 of all perioperative strokes occur within 24 hrs. after surgery, leading to difficulties recognizing stroke:
  • Residual anesthetic effects
  • Use of opioids & psychoactive meds
  • Non-focal neurological symptoms
• In-hospital strokes have poorer clinical outcomes compared to the community
• In-hospital stroke patients are less likely to receive thrombolytic therapy & more likely to have delayed imaging

• → Consider routine neurologic assessments in PACUs (Post-anesthesia care units)
EMERGENT EVALUATION (“CODE STROKE”)

→ Establish a “stroke code” protocol which involves a rapid response stroke team, to allow for immediate assessment & management of in-hospital perioperative suspected stroke patients

• Purpose is to identify patients eligible for thrombolysis or thrombectomy as soon as possible, and to determine optimal interventions by a multidisciplinary team
ACUTE STROKE TREATMENT

ENDOVASCULAR THERAPY IN PERIOPERATIVE STROKE

• Advantages:
  • Mechanical thrombectomy (MT) does not require anticoagulation. (Because of risk of surgical bleeding, patients with perioperative stroke often ineligible for IV alteplase)
  • MT is superior to IV alteplase alone for treatment of large vessel occlusion (LVO) strokes

→ Patients suspected of LVO stroke should undergo immediate CT angiography & possible CT perfusion to determine if patient is candidate for MT as well as thrombolysis
→ Current guidelines support MT in patients with LVO within 6 hours of symptom onset to significantly increase likelihood of improved functional outcomes
→ Time window of eligibility may extend to 24 hours if there is favorable brain perfusion imaging (DAWN & DEFUSE-3 trials, 2018)

• Limited evidence on use of MT in perioperative setting
ACUTE STROKE TREATMENT

THROMBOLYTIC THERAPY IN PERIOPERATIVE STROKE

• Intracranial or intraspinal surgery in last 3 months is **absolute** contraindication

• Small studies have shown that IV alteplase resulted in ↑ surgical site hemorrhages, but no major complications
  • Surgical site hemorrhage more likely in more recent (rather than later) surgery

• Recent evidence demonstrates that patients with favorable imaging treated with IV alteplase in an extended-time window (>4.5 hours from last known well) are more likely to have a favorable neurological outcome (mRS 0-1)

• Limited evidence on use of extended-window IV alteplase in the perioperative setting
ACUTE STROKE TREATMENT

EMERGENT TREATMENT OPTIONS IN PERIOPERATIVE STROKE

• All patients suspected of having a stroke should undergo rapid assessment by a stroke team and urgent brain imaging, including vessel imaging and perfusion studies when appropriate

• → If LVO present, MT preferred for eligible patients

• → In addition, cautiously consider IV alteplase for eligible patients following an individualized risk/benefit determination by the multi-disciplinary team