



# 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  $\geq$  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 peri-operative 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  $\beta$ -blockers

# PERIOPERATIVE MEDICATION MANAGEMENT

## 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

# ANESTHESIA & VENTILATION

## VENTILATION 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 → ↓ incidence of death & major pulmonary complications (& possibly peri-operative hypoxemia)
- → 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