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Stroke in Pregnancy

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Disclosures

- *I have no relevant financial relationships or conflicts of interest to disclose.*

Learning Objectives

1. Identify pregnant and postpartum patients at elevated risk for stroke based on history, hypertensive disorders, thrombotic risk factors, and gestational timing.
2. Differentiate the major stroke subtypes encountered in pregnancy (ischemic stroke, intracerebral hemorrhage, and cerebral venous thrombosis).
3. Appropriately recognize acute neurological symptoms and initiate time-sensitive stroke evaluation pathway.
4. Select appropriate neuroimaging modalities based on maternal stability, fetal safety, and diagnostic yield.
5. Apply evidence-based principles for acute management and secondary prevention, including blood pressure control, antithrombotic therapy, thrombolysis and endovascular considerations.
6. Discuss maternal prognosis, recurrence risk, and long-term cardiovascular implications, and outline counseling strategies for future pregnancies and risk reduction.

Incidence and Timing

- 2022: stroke accounted for 1 in 12 death in women pregnant and postpartum
  - Incidence: **30 in 100,000 deliveries** (3x higher than non-pregnant women of similar age)
  - Incidence when high-risk comorbidities are present: **1 in 500 deliveries**
- Incidence of stroke in the general population is decreasing due to risk factor modification however **the incidence of maternal stroke is increasing**.

Risk Factors

- Vascular Risk Factors:
  - Hypertensive disorders of pregnancy
  - Smoking
  - Cardiac disease
  - Primary hypercoagulable states
- Significant health disparities by race and ethnicity at work in the US:
  - Black and Hispanic women at higher risk of stroke as well as stroke-associated in-hospital mortality.

Table 3. Medical Conditions and the Risk of Pregnancy-Related Stroke

	Odds Ratio
Cardiovascular	
Hypertension	6.1
Heart disease	13.2 ★
Hematologic	
Thrombophilia (including history of thrombosis and the antiphospholipid syndrome)	16.0 ★
Sickle cell disease	9.1
Anemia	1.9
Thrombocytopenia	6.0
Rheumatologic	
Lupus	15.2 ★
Endocrinologic	
Diabetes	2.5
Obesity	1.4
Neurologic	
Migraine headaches	16.9 ★
Lifestyle factors	
Alcohol and substance abuse	2.3
Smoking	1.9

Pathophysiology

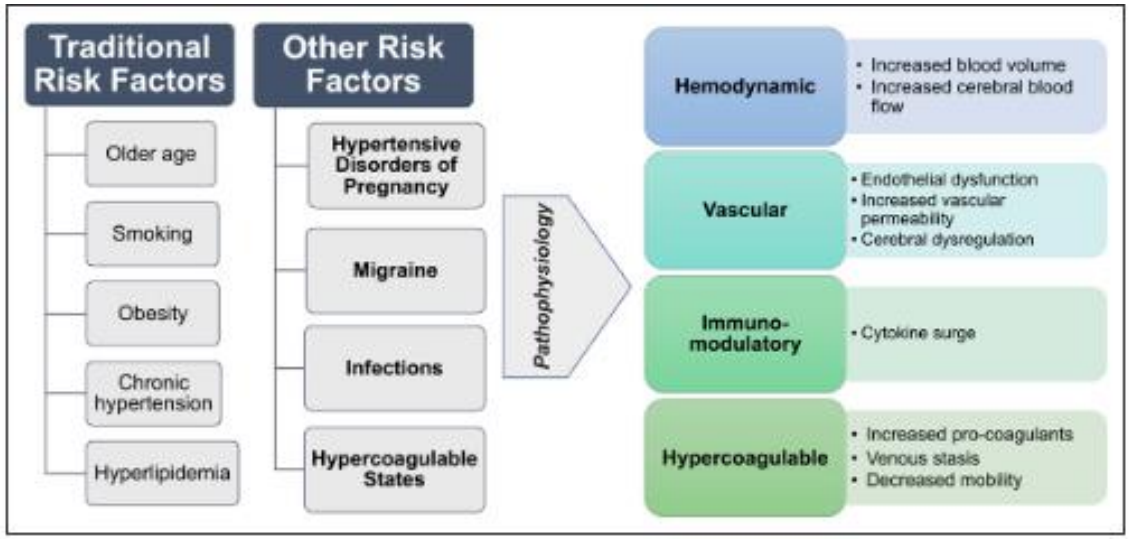

Figure 1. Risk factors and pathophysiology of maternal stroke. Risk factors for maternal stroke are traditional and other risk factors including hypertensive diseases of pregnancy, migraine, infections, and hypercoagulable states. The pathophysiological mechanisms implicated in maternal stroke involve hemodynamic, vascular, immunomodulatory, and hypercoagulable changes.

Algahtani, *et al*.: CVST in pregnancy and puerperium

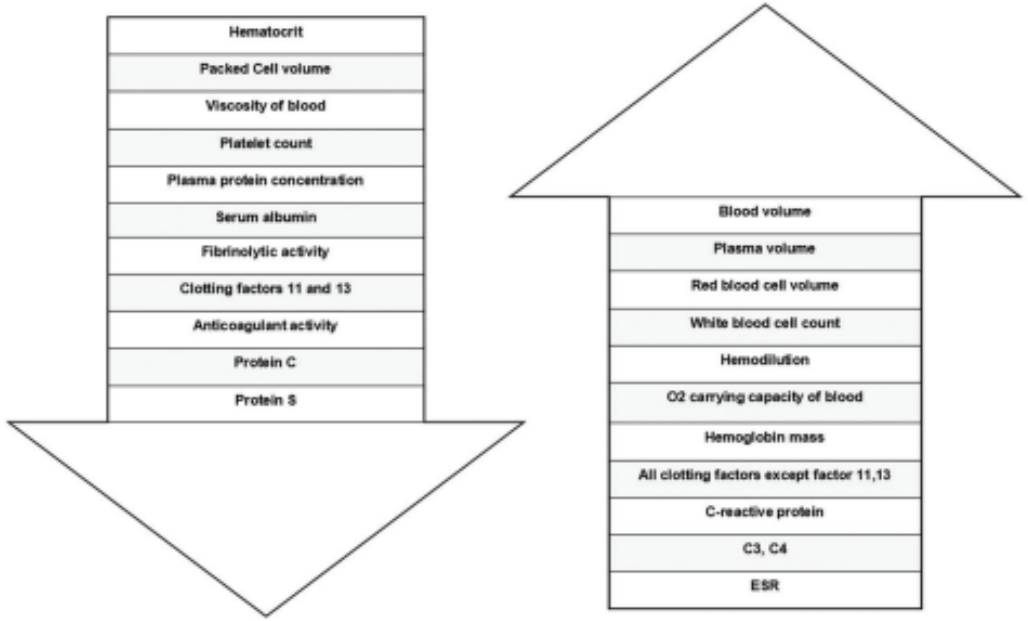

Figure 3: Physiological hematological changes during pregnancy and puerperium

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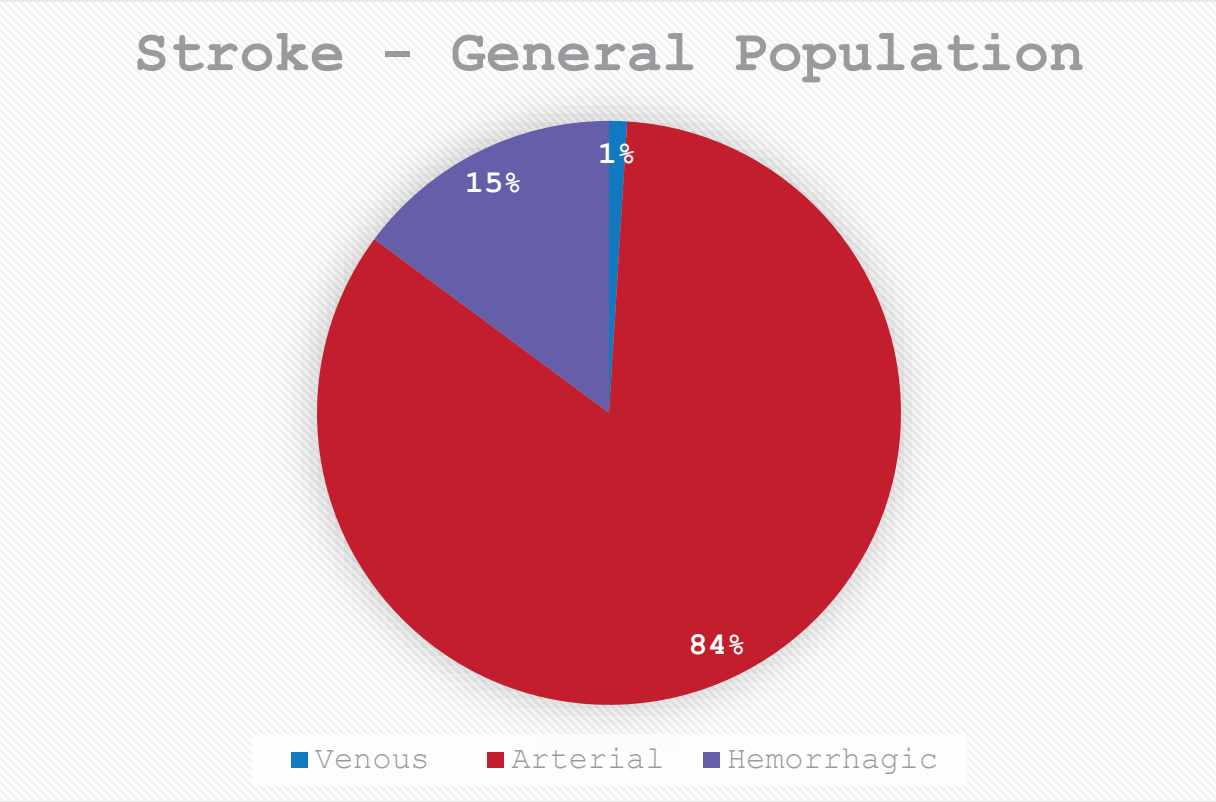
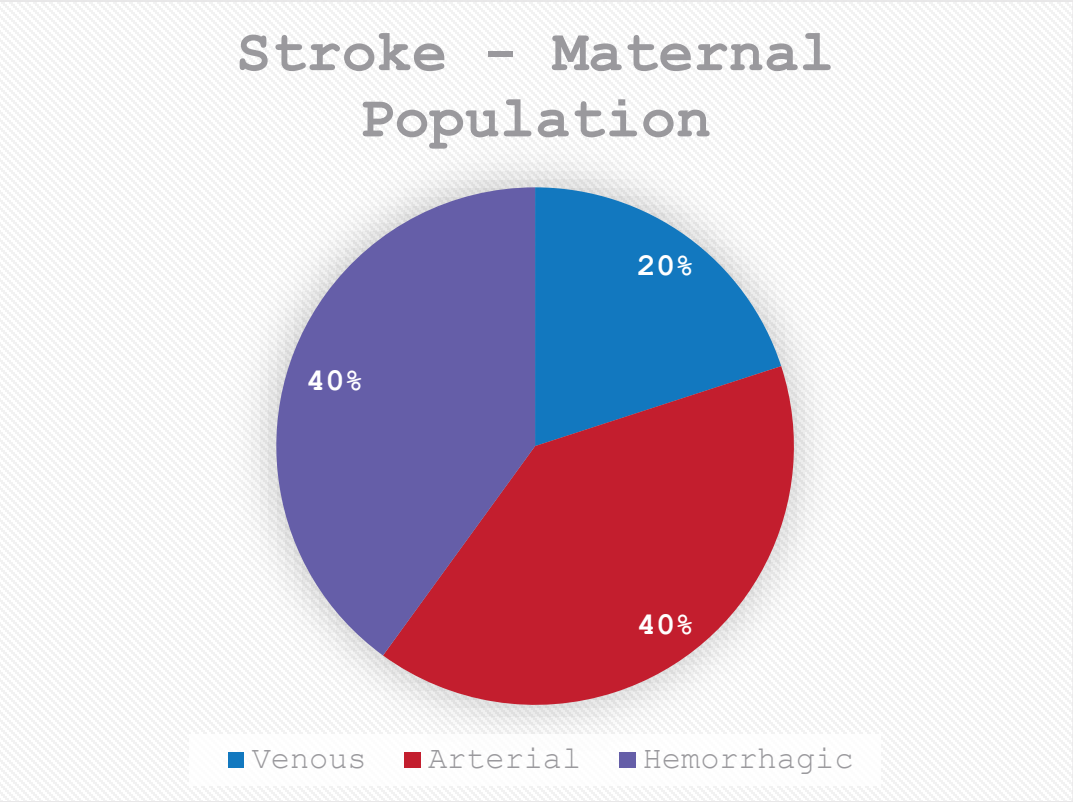
Different Strokes

RESEARCH ARTICLE | August 29, 2022 |

Incidence and Time Trends of Pregnancy-Related Stroke Between 2010 and 2018

The Nationwide CONCEPTION Study





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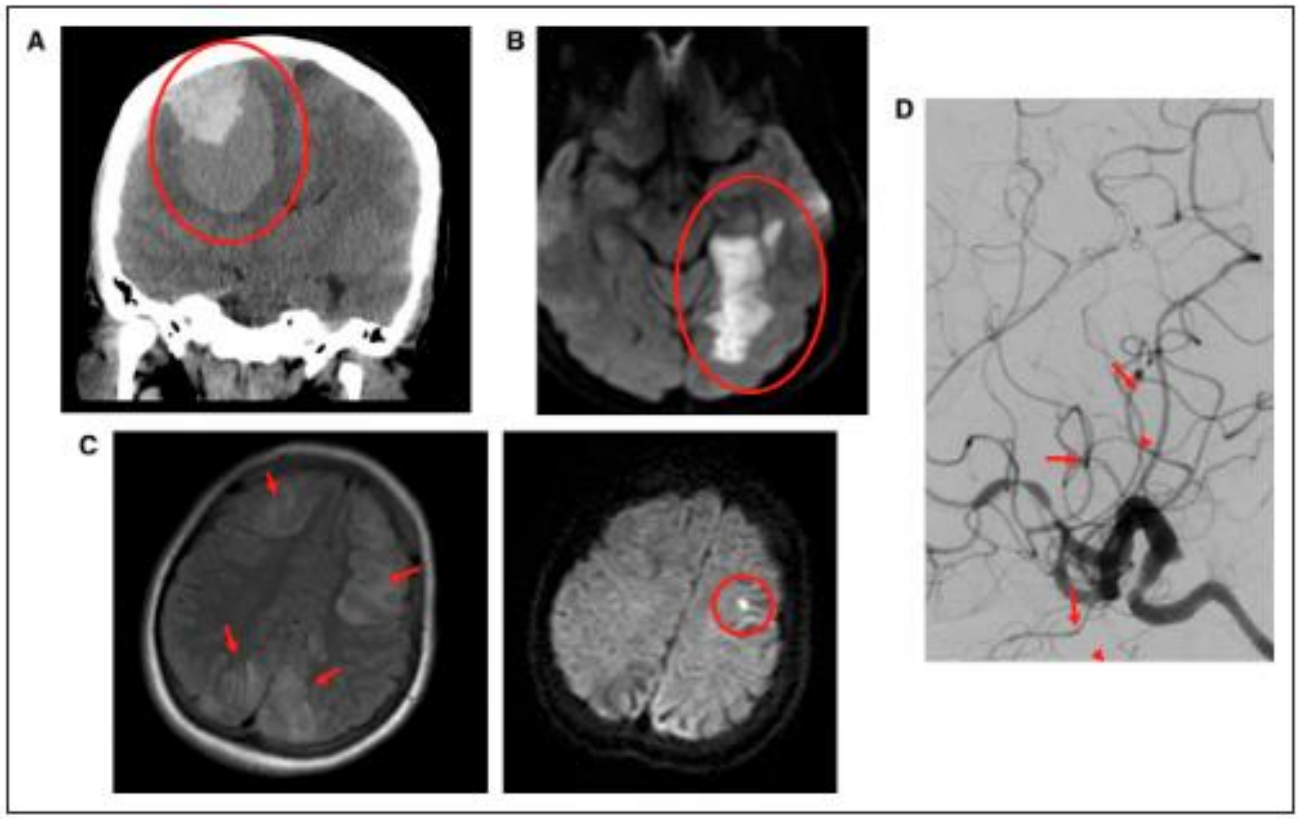
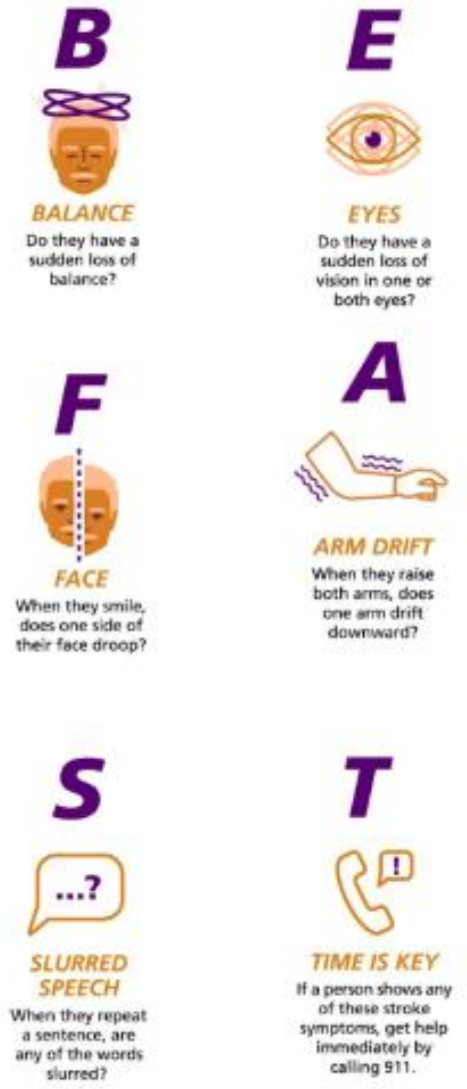
Different Strokes



A. ICH in patient with HELLP
B. Ischemic stroke in patient with VTE and patent PFO
C. PRES in patient with eclampsia
D. Vasospasm due to RCVS in patient with preeclampsia

EXAM CHANGE

- Abrupt change to level of consciousness
- Severe and sudden onset headache
- Language change – quality and/or content
- **FOCALITY**



In-House Stroke Algorithm

Inpatient RNs (including ICUs)
Identify patient with stroke symptoms (Use B.E.F.A.S.T.T.)
Text Page RAT Nurse
(Home Screen → Clinical Resources → Page RAT)
Notify / page the patient's primary provider / prepare patient for CT
Have vital signs, blood glucose, & last known well (LKW) / time of symptom onset

Rapid Assessment Team (RAT) RN

- Verify stroke symptoms (use B.E.F.A.S.T.T) and rule out reversible causes (i.e., hypoglycemia, sedation, etc.)
- Determine **last known well (LKW) / time of symptom onset** and **symptom discovery time** (i.e., when RN identified symptoms)
- Complete NIHSS assessment
- Delegate steps in the Stroke Guidelines to staff RN as needed to expedite the process

LKW 0-24 Hours Ago and BEFASTT (+):

- RAT RN / primary provider to activate a **Code Stroke**
- **NIHSS < 6**: provider order plain CT head without contrast
- **NIHSS ≥ 6:** provider order CTH, CT Perfusion, CTA head/neck

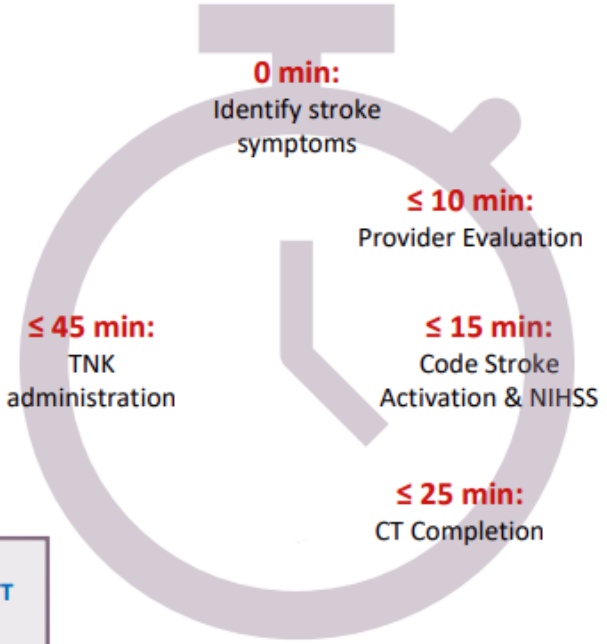
Acute Stroke Orders (For Code Stroke Activation Only)
STAT CBG, if receiving therapeutic anticoagulation STAT PT / INR, PTT
Brain imaging as above STAT
Inpatient (except ED Obs): 2nd floor CT scanner
1st Floor Observation (ED Obs): 1st floor CT Scanner

TNK / Neuro IR Candidate?

- **YES**
- **NO** → **Follow Stroke Guidelines / Provider Orders**

B.E.F.A.S.T.T. (new onset)
Balance – dizzy, ataxic, sudden loss of balance
Eyes – vision loss (one or both eyes); blurry vision
Face – evidence of facial drop
Arm – evidence of arm drift
Speech – slurred speech, changes in speech
Terrible Headache – compliant of sudden or severe headache
Time – time is key, activate RAT

Code Stroke Time Metrics



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Recommendations

The American College of Obstetricians and Gynecologists' Committee on Obstetric Practice makes the following recommendations regarding diagnostic imaging procedures during pregnancy and lactation:

- Ultrasonography and magnetic resonance imaging (MRI) are not associated with risk and are the imaging techniques of choice for the pregnant patient, but they should be used prudently and only when use is expected to answer a relevant clinical question or otherwise provide medical benefit to the patient.

- With few exceptions, radiation exposure through radiography, computed tomography (CT) scan, or nuclear medicine imaging techniques is at a dose much lower than the exposure associated with fetal harm. If these techniques are necessary in addition to ultrasonography or MRI or are more readily available for the diagnosis in question, they should not be withheld from a pregnant patient.

- The use of gadolinium contrast with MRI should be limited; it may be used as a contrast agent in a pregnant woman only if it significantly improves diagnostic performance and is expected to improve fetal or maternal outcome.

- Breastfeeding should not be interrupted after gadolinium administration.

Fetal Development and Radiation:

- Fetus most susceptible to radiation during organogenesis and early fetal period (2–15 wks)
- Noncancer health effects have not been detected at any stage of gestation after exposure to ionizing radiation < 0.05 Gy (5 rad)

Table 4. Estimated Fetal Radiation Doses from Common Diagnostic Imaging Tests

Test	*Fetal dose (Gy [rad])*
Computed tomography*	
Abdomen (10 slices)	0.00240 to 0.0260 (0.240 to 2.60)
Chest	0.0010 to 0.0045 (0.10 to 0.45)
Head	< 0.0005 (< 0.05)
Lumbar spine	0.035 (3.5)
Pelvis	0.00730 to 0.0460 (0.730 to 4.60)

All treatment decisions should be multi-disciplinary.

Acute Ischemic Stroke: Thrombolysis and Thrombectomy

Thrombolysis indication: disabling deficit within 4.5 hours of onset without evidence of hemorrhage on CT.

- Pregnancy is not a contraindication to TNK / tPA
- TNK / tPA should not cross the placenta due to molecular size
- Limited case reports suggest that thrombolytic use in early post-partum patients is associated with high risk of hemorrhage, need for transfusion, and possible need for surgery to control bleeding.

Thrombectomy indication: neurological deficit with associated large vessel occlusion within 24 hours of onset.

- Should not be withheld from pregnant patients due to concern for ionizing radiation or impact of contrast on the fetus.
- Abdominal shielding should be done to decrease exposure to the fetus.

Secondary Prevention: Ischemic Stroke

- Secondary stroke prevention is determined by the etiology of ischemic stroke.
- Non-pregnant population: most common etiology is large artery atherosclerosis and cardioembolism.
- Most common etiologies:
  - Cardioembolism:
    - Paradoxical embolism due to patent PFO or pulmonary shunt
    - Preexisting cardiac disease
    - Peripartum cardiomyopathy
  - Cervical artery dissection (HDP, postpartum)
  - Arterial vasospasm associated with RCVS
  - Arterial thrombosis due to thrombophilia

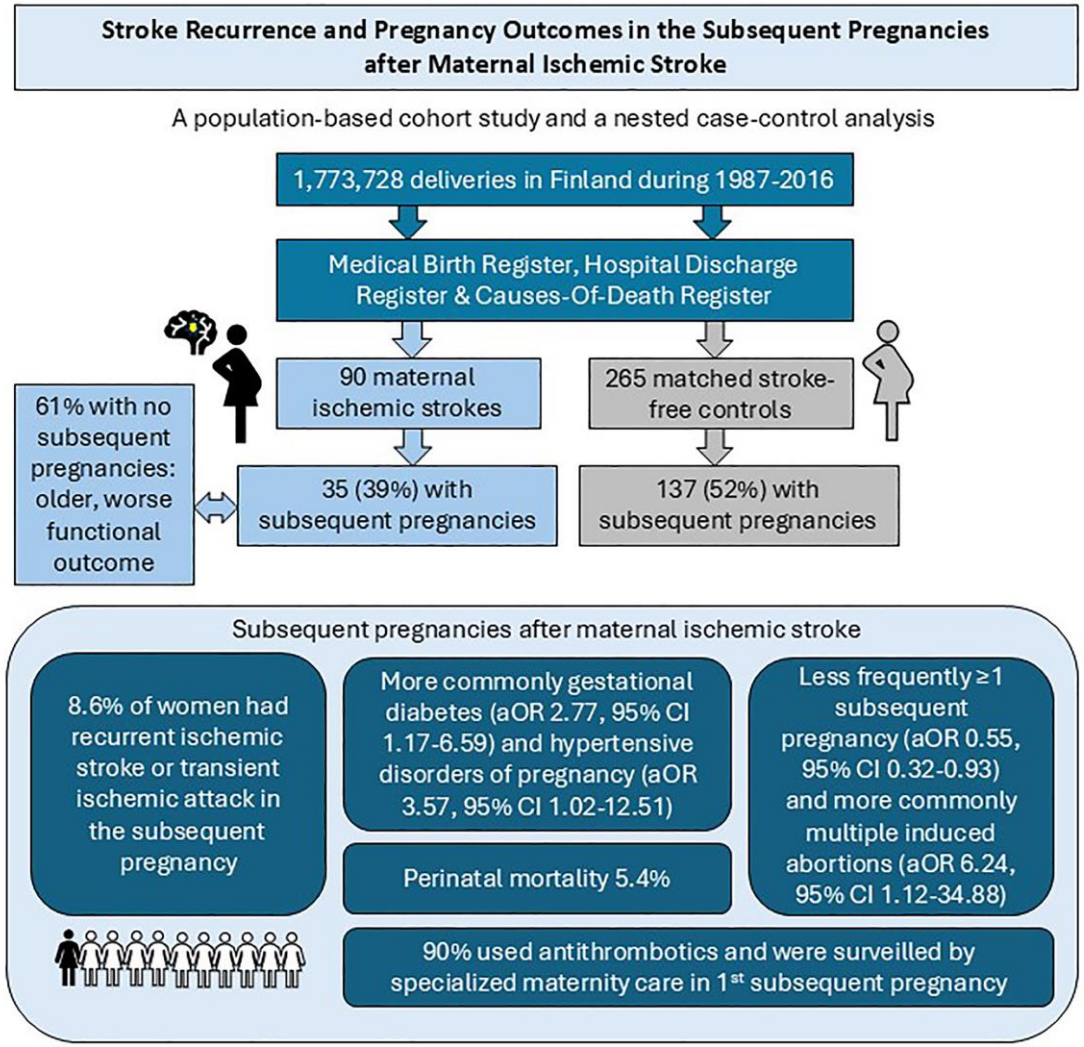
	During pregnancy[64–66]	During lactation[67]
Low-dose aspirin	Safe after 12 weeks of pregnancy; reasonable before this when used for secondary stroke prevention	Safe
Clopidogrel	Insufficient evidence of safety; consider on case-by-case basis depending on indication	Insufficient evidence of safety; consider on case-by-case basis depending on indication and monitor infant for bruising/bleeding
Ticagrelor	Insufficient evidence of safety	Insufficient evidence of safety
Low-molecular-weight heparin	Safe	Safe
Unfractionated heparin	Safe	Safe
Warfarin	Teratogenic, particularly between 6 and 12 weeks gestation; can consider in rare cases (eg, mechanical heart valve) after week 12, at doses <5 mg/d[68]	Safe
Dabigatran	Insufficient evidence of safety	Limited evidence of safety
Apixaban	Insufficient evidence of safety	Alternative drug preferred
Rivaroxaban	Insufficient evidence of safety	Limited evidence of safety
Cholesterol-lowering agents (statins)	Insufficient evidence of safety	Insufficient evidence of safety
Labetalol	Safe	Safe
Propranolol	Alternative drug preferred	Safe
Metoprolol	Alternative drug preferred	Safe
Atenolol	Contraindicated	Not recommended
Long-acting nifedipine	Safe	Safe
Verapamil	Safe	Safe
Methyldopa	Safe	Safe
Clonidine	Safe	Alternative drug preferred
Hydrochlorothiazide	Safe in chronic hypertension	Alternative drug preferred
Hydralazine	Safe	Safe
Angiotensin-converting enzyme (ACE) inhibitors	Contraindicated (teratogenic)	Safe: benazepril, captopril, enalapril, quinapril; all others: alternative therapy preferred
Angiotensin II receptor blockers (ARBs)	Contraindicated (teratogenic)	Limited evidence of safety for candesartan; for all others, alternative therapy preferred

[a] Risks and benefits of medications may vary depending on an individual patient's circumstances. All medications should be discussed with the patient's obstetrician or maternal-fetal medicine specialist, ideally before conception.

Prevention and Recurrence in Subsequent Pregnancies

Table 2. Secondary Preventive Medication and Follow-Up of the Patients With Maternal IS With Subsequent Pregnancies (Table view)

	Before first subsequent pregnancy, n=33	First subsequent pregnancy, n=33	Second subsequent pregnancy, n=12	Third subsequent pregnancy, n=6
Secondary preventive medication				
Antithrombotics	28 (84.8)	29 (87.9)	10 (83.3)	4 (66.7)
ASA only or combined*	26 (78.8)	22 (66.7)	8 (66.7)	3 (50.0)
Warfarin	<3 (<9.1)	0	0	0
LMWH only	<3 (<9.1)	7 (21.2)	<3 (<12.0)	<3 (<50.0)
ASA and LMWH	<3 (<9.1)	6 (18.1)	<3 (<12.0)	0
ASA changed to LMWH peripartum		5 (15.2)	3 (12.0)	0
Antithrombotics continued for ≥6 weeks postpartum		24 (72.7)	8 (66.7)	3 (50.0)
Antihypertensive medication	0	<3 (<9.1)	<3 (<12.0)	0
Antilipid medication	<3 (<9.1)	0	0	0
Diabetes medication	0	4 (12.1)	<3 (<12.0)	0
Oral	0	0	0	0
Injectable	0	4 (12.1)	<3 (<12.0)	0
Specialized maternity care follow-up visit		30 (90.1)	10 (83.3)	4 (66.7)
Prepregnancy counseling	11 (33.3)			



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Hemorrhagic Stroke: Acute Management

Intracranial Hemorrhage:

- Evaluate for underlying vascular lesions
- Control systolic blood pressure (initially SBP < 160, then SBP < 140)
- Reverse coagulopathy (HELLP?)

Subarachnoid Hemorrhage:

- Evaluate for aneurysm, secure via endovascular vs open surgery if aneurysm is found
- Target SBP < 140 until aneurysm is secured

If hemorrhage occurs within the context of preeclampsia, eclampsia or HELLP – emergent delivery may be indicated.

First line agents for blood pressure control: labetalol, methyldopa, long acting nifedipine.

RESEARCH ARTICLE | Originally Published 27 March 2024 |

Check for updates

Primary and Secondary Intracerebral Hemorrhage in Pregnant and Nonpregnant Young Adults by SMASH-UP Criteria

Mehriban Sariyeva, MD, Noora Haghighi, BS, Amanda Mitchell, BA, Whitney A. Booker, MD, MS, Nils H. Petersen, MD, PhD, Andrea

ICH in pregnant women: 4-fold higher odds of primary ICH compared to non-pregnant women.

- More multi-compartment and lobar hemorrhages
- More occurred in the post-partum period

Finnish study of maternal stroke identified 49 pregnant ICH patients 1987-2016:

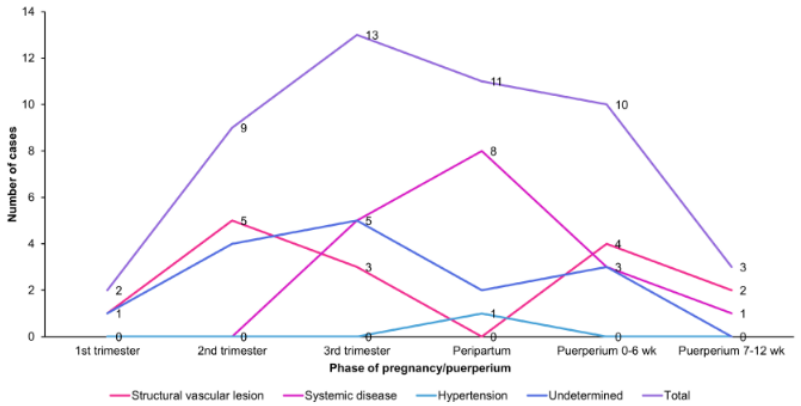

FIGURE 2 Intracerebral hemorrhage cases per pregnancy/puerperium period according to the SMASH-U (structural vascular lesion, medication, amyloid angiopathy, systemic disease, hypertension, undetermined) classification.

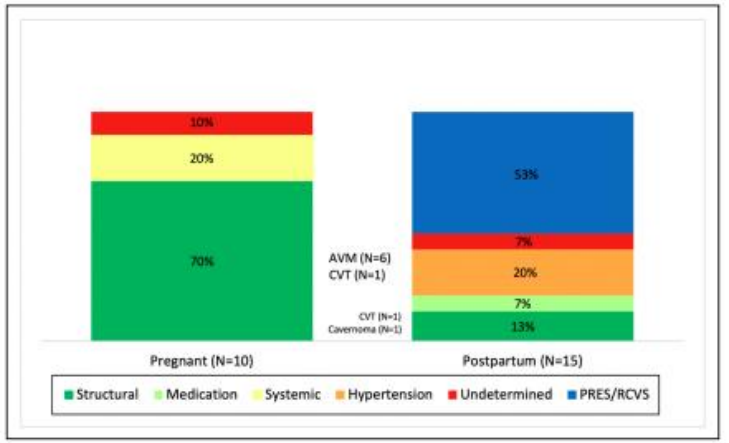

Figure 2. Specific ICH pathogenesis in pregnant and postpartum patients with P-ICH.

Comparison of ICH pathogenesis by SMASH-UP criteria between pregnant and postpartum patients. There were more structural lesions (primarily AVM rupture) in the pregnant group and primarily undetermined or PRES/RCVS pathogenesis in the postpartum group. Hypertensive disorders of pregnancy were present in 20% of patients in both groups. AVM indicates arteriovenous malformation; CVT, cerebral venous thrombosis; ICH, intracerebral hemorrhage; P-ICH, pregnancy-associated ICH; PRES, posterior reversible encephalopathy syndrome; RCVS, reversible cerebral vasoconstriction syndrome; and SMASH-UP, structural, medications, amyloid angiopathy, systemic, hypertension, undetermined, PRES/RCVS.

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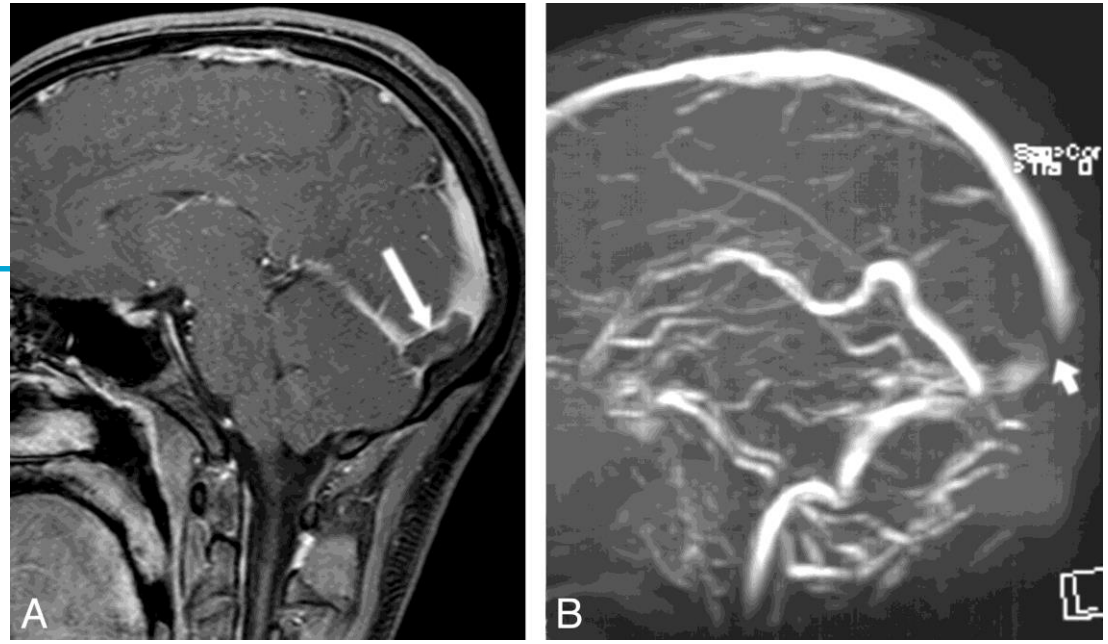
Cerebral Venous Thrombosis: Acute Management



Recognition can be difficult.

- Gradual ‘high-pressure’ headache, obtundation, seizure, vision changes.
- Imaging: MRI, CT Venogram, MRV.

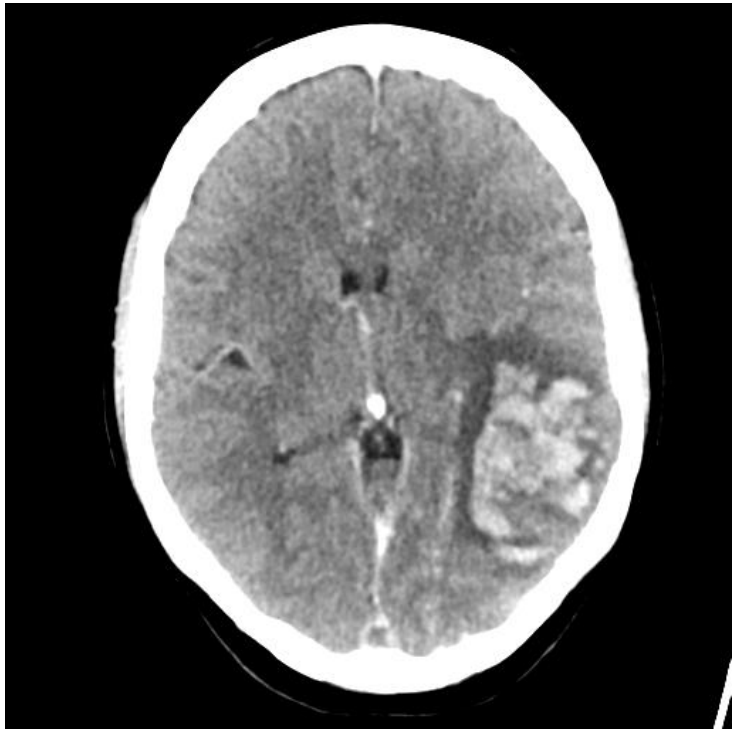
Treatment: Enoxaparin 1 mg/kg q12h throughout pregnancy is recommended over heparin infusion.

Thrombectomy can be considered.

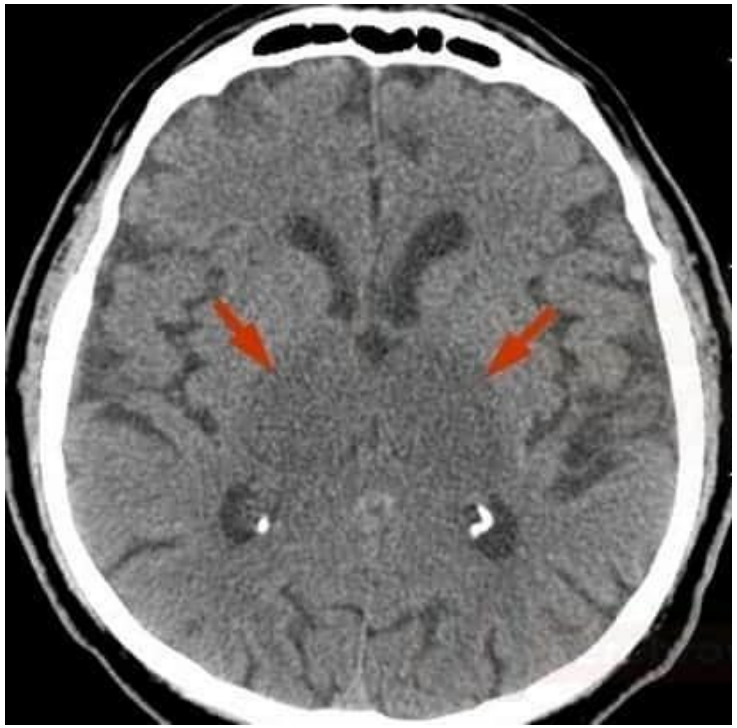
Recurrence risk is low, recommended to treat with enoxaparin during future pregnancies.

Cerebral Venous Thrombosis – Difficult to Predict

Empty Delta Sign



CVT + Infarct + Hemorrhagic transformation



CVT + Deep infarcts

Test Your Knowledge

37 yo G1P0 at 16w2d presents to the ED via EMS after acute onset dysarthria and left sided weakness at work 20 minutes prior. A code stroke is called en route. On arrival, she has sonorous respirations with GCS 5 (E1V1M3). She is intubated. What is the next best step?

HR 120 BP 210/100 RR 20

A. CT Head and CTA Head and Neck W/WO Contrast
B. MRI Brain WO Contrast
C. Start Nicardipine infusion to target SBP < 140
D. Start Labetalol infusion to target SBP < 140

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Systolic Blood Pressure Targets
Intracranial hemorrhage: Systolic < 160
Ischemic stroke + TNK candidate: Systolic < 180

Test Your Knowledge

41 yo G4P3 presents to OB triage at 37w5d with intractable severe headache, which is worse when laying down and bending over, blurry vision, and nausea/vomiting for the last 6 hours. Her only medical history is hypertension, controlled on Nifedipine. Her vitals are stable. What is the next best step?

A. Order an MRI Brain WO Contrast
B. Administer a migraine cocktail
C. Non-urgent neurology consult
D. Page RAT for Code Stroke evaluation

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Test Your Knowledge

41 yo G4P3 presents to OB triage at 37w5d with **intractable severe headache,** which is worse when **laying down and bending over**, **blurry vision**, and recurrent vomiting for the last 6 hours. Her only medical history is **hypertension**, controlled on Nifedipine. Her vitals are stable. What is the next best step?

High Risk / Concerning Features:

- Severe headache in a patient without a history of headaches
- Positional quality to the headache
- Persistent vomiting -> posterior fossa pathology and predisposes patient to being hemoconcentrated
- Advanced maternal age
- Hypertension history is a vascular risk factor
- Vision change

Nursing Pearls: RED FLAGS

- Focal Neurological Deficit
- Sudden and Severe Headache

Headache Red Flags:

- Lack of headache history
- Elevated blood pressure
- Focal neurological deficit
- Positional quality to headache

Test Your Knowledge

A 36 G4P4 patient presents to the clinic for pre-conception counseling. Her prior pregnancies were uncomplicated. Her history includes hypothyroidism, migraine headaches, diet-controlled pre-diabetes, and mild iron deficiency anemia due to heavy menses.

What is her highest vascular risk factor?

A. Advanced maternal age
B. Multiparity
C. Migraine headaches
D. Pre-diabetes

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Hematologic	
Thrombophilia (including history of thrombosis and the antiphospholipid syndrome)	16.0
Sickle cell disease	9.1
Anemia	1.9
Thrombocytopenia	6.0
Rheumatologic	
Lupus	15.2
Endocrinologic	
Diabetes	2.5
Obesity	1.4
Neurologic	
Migraine headaches	16.9
Lifestyle factors	
Alcohol and substance abuse	2.3
Smoking	1.9

Provider Take Home Points

- **Hypertensive disorders of pregnancy, cardiac disease, and coagulopathies** increase stroke risk.
- **Black women have roughly twice the risk of pregnancy-associated stroke and higher in-hospital mortality than white women**; Hispanic women also have increased risk, particularly in the presence of hypertensive disorders.
- **CT of the head and CTA of the head and neck** are reasonable studies when acute stroke is suspected in pregnant patients.
- **Management of pregnant and postpartum patients should be multidisciplinary**.
- **Thrombolysis and thrombectomy are not contraindicated in pregnancy**, although thrombolysis in the postpartum period may cause life-threatening hemorrhage.
- **Intracranial hemorrhage typically occurs in the peripartum and postpartum periods**, often in the setting of hypertensive disorders of pregnancy (HDP).
- **Cerebral venous thrombosis can be difficult to diagnose and requires anticoagulation** to prevent clot propagation.

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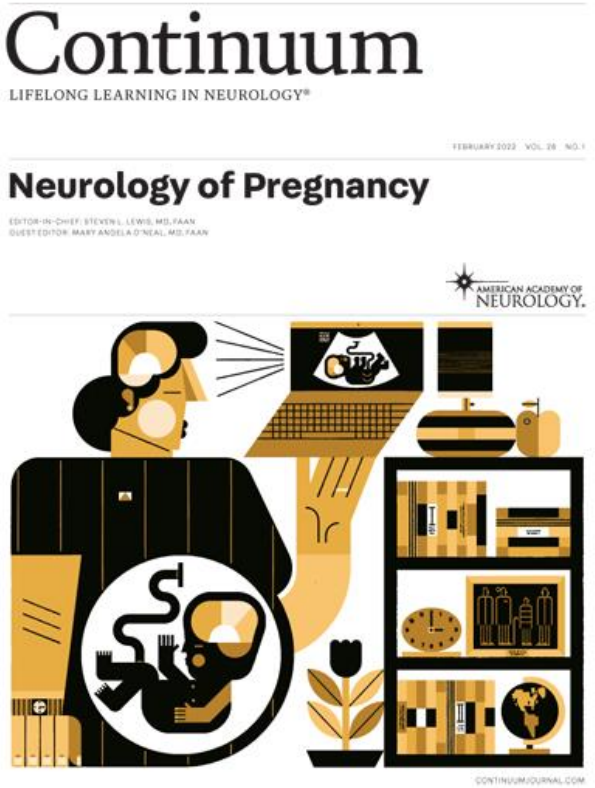

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