Scholars Journal of Medical Case Reports
Abbreviated Key Title: Sch J Med Case Rep
ISSN 2347-9507 (Print) | ISSN 2347-6559 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

Anesthesiology

Acute Neurological Manifestations in Pregnant and Postpartum Women: A Multidisciplinary Approach to Diagnosis and Management

Amine BELGHITI[1*], Hamza HAFIANI[1], Aziz BENAKROUT[1], Mustapha BENSGHIR[1], Jawad KOUACH[2], Moulay Elmehdi El HASSANI[2], Khalil ABOUELALAA[1]

[1]Department of Anesthesiology and Intensive Care, Mohammed V Military Teaching Hospital, Faculty of Medicine and Pharmacy Mohammed V University, Rabat, Morocco
[2]Department of Gynecology and Obstetric, Mohammed V Military Teaching Hospital, Faculty of Medicine and Pharmacy Mohammed V University, Rabat, Morocco

DOI: https://doi.org/10.36347/sjmcr.2025.v13i01.001 | **Received:** 24.11.2024 | **Accepted:** 31.12.2024 | **Published:** 02.01.2025

***Corresponding author:** Amine BELGHITI
Department of Anesthesiology and Intensive Care, Mohammed V Military Teaching Hospital, Faculty of Medicine and Pharmacy Mohammed V University, Rabat, Morocco

Abstract **Case Series**

Acute neurological manifestations during pregnancy and the postpartum period present significant clinical challenges that can profoundly affect maternal and fetal health. This article explores the critical need for a multidisciplinary approach to diagnosis and management, emphasizing the importance of early recognition of symptoms such as severe headaches, seizures, and focal neurological deficits. Common complications, including eclampsia, cerebral venous thrombosis, and idiopathic intracranial hypertension, are discussed in detail, highlighting their potential for serious outcomes if not promptly addressed. Through a review of six illustrative cases, the article underscores the diverse range of neurological complications that can arise postpartum, from thrombotic events to endocrine dysfunctions. Each case exemplifies the necessity for vigilant monitoring and timely intervention, showcasing the roles of obstetricians, neurologists, and other specialists in providing integrated care. Advances in diagnostic imaging and evolving treatment protocols are also examined, along with safety considerations for both mother and fetus. Ultimately, this article aims to enhance awareness among healthcare providers regarding the complexities of managing acute neurological symptoms in pregnant and postpartum women, advocating for collaborative strategies that prioritize optimal health outcomes for both mothers and their infants.

Keywords: Acute neurological symptoms – pregnancy – postpartum - multidisciplinary approach – diagnosis – management - therapeutic options – maternal fetal health.

INTRODUCTION

Acute neurological symptoms during pregnancy and the postpartum period represent critical clinical challenges that can significantly impact both maternal and fetal health. The unique physiological and hormonal changes that occur during pregnancy, along with an increased susceptibility to various neurological conditions, necessitate heightened awareness and prompt intervention by healthcare professionals. Conditions such as eclampsia, which can lead to seizures and hypertensive crises, and idiopathic intracranial hypertension, characterized by increased intracranial pressure without an identifiable cause, are among the most concerning neurological complications during pregnancy [1,2]. Moreover, postpartum headaches can signal serious underlying conditions, including cerebral venous sinus thrombosis or pituitary apoplexy, making accurate diagnosis essential to prevent severe complications such as stroke or long-term neurological deficits [3].

This population presents unique challenges for healthcare providers due to the complex interplay between obstetric and neurological care. The overlapping symptoms of pregnancy-related changes such as headaches, visual disturbances, and altered consciousness can often lead to misdiagnosis or delayed treatment of serious neurological disorders [4]. Furthermore, the need to consider fetal safety during the management of neurological conditions complicates treatment strategies, requiring clinicians to balance maternal health and fetal well-being carefully [5]. The limited available evidence regarding the safety and efficacy of various pharmacological and non-

pharmacological interventions during pregnancy further compounds these challenges [6,7].

The purpose of this article is to provide a comprehensive overview of acute neurological symptoms during pregnancy and the postpartum period, focusing on their clinical significance, potential underlying causes, and implications for management. The objectives include identifying key neurological conditions prevalent in this population, discussing the diagnostic challenges faced by clinicians, and outlining effective treatment strategies that prioritize both maternal and fetal health.

Case 1:

A 27-year-old primiparous woman, with no notable medical history and no prior use of estrogen-progestin contraception, delivered two weeks prior by cesarean section under spinal anesthesia. The cesarean was necessitated by acute fetal distress related to umbilical cord abnormalities, following an otherwise well-monitored and normal pregnancy brought to term.

Upon discharge, she was prescribed a prophylactic course of low-molecular-weight heparin (LMWH) at a preventive dose of 4,000 IU/day for two weeks.

Two weeks post-discharge, the patient presented to the emergency department at the Mohammed V Military Hospital in Rabat with symptoms of vertigo, headache, and vomiting, which quickly escalated into a generalized tonic-clonic seizure.

On admission, clinical examination revealed an afebrile, eupneic patient with a Glasgow Coma Scale (GCS) score of 13, indicating persistent vertigo and neck stiffness. Her capillary blood glucose was 1.7 g/dL. Initial laboratory tests, including a full blood count and inflammatory markers (CRP), were normal, as was a lumbar puncture. Electrocardiography (ECG) and chest X-ray showed no abnormalities. Given her presentation, a cranial CT scan was performed, revealing a cerebromeningeal hemorrhage with a pattern suggesting thrombophlebitis of the left transverse sinus (Figure 1).

During her stay in the emergency department, the patient's neurological status deteriorated, with a rapid decline in consciousness (GCS dropping from 13 to 8) and the onset of anisocoria. She was subsequently intubated, ventilated, and sedated with midazolam and fentanyl. Antiepileptic treatment was initiated with sodium valproate and phenobarbital. An EEG confirmed a subclinical status epilepticus and showed generalized brain slowing, indicating diffuse cerebral distress.

Following an intravenous bolus of 50 IU/kg, she was started on a continuous intravenous infusion of unfractionated heparin at a rate of 500 IU/kg/day. She was transferred to the intensive care unit for further management. Infectious screenings, along with immunological tests for antinuclear and antiphospholipid antibodies, returned negative results.

On the second day of hospitalization, neurological examination revealed anisocoria, and a transcranial Doppler ultrasound showed elevated velocities in all intracranial vessels, indicating intracranial hypertension (ICH). A subsequent MR angiography revealed progression of the thrombosis to the superior, inferior, right, and left transverse sinuses, along with a left temporo-parieto-occipital ischemic region, cerebromeningeal hemorrhage, and signs of early left temporal herniation—confirming worsening of the initial intracerebral bleeding and thrombosis despite anticoagulation therapy (Figure 2).

Given the concurrent worsening of thrombosis and bleeding, the decision was made, in consultation with the Radiology and Neurosurgery teams, to continue intravenous sodium heparin infusion with a target activated clotting time (ACT) of 1.5 to 2.5 times baseline, while keeping the patient sedated.

The antiepileptic therapy was continued as previously prescribed.

The coagulation profile (proteins C, S, and AT III), drawn upon admission, was normal. Subsequently, the patient's neurological status improved over the course of her stay, with sedation discontinued on day 7, enabling extubation and transition to oral anticoagulation with a vitamin K antagonist. Upon discharge, her GCS score was 15/15, although anisocoria and left-sided ptosis persisted. Follow-up MR angiography showed a reduction in the size of the hemorrhagic edema and partial recanalization of the posterior third of the superior sagittal sinus, with persistent thrombosis of the left lateral sinus. The normal coagulation profile and negative etiological workup led us to consider postpartum status and recent spinal anesthesia as potential contributing factors to the development of this case of cerebral venous thrombosis.

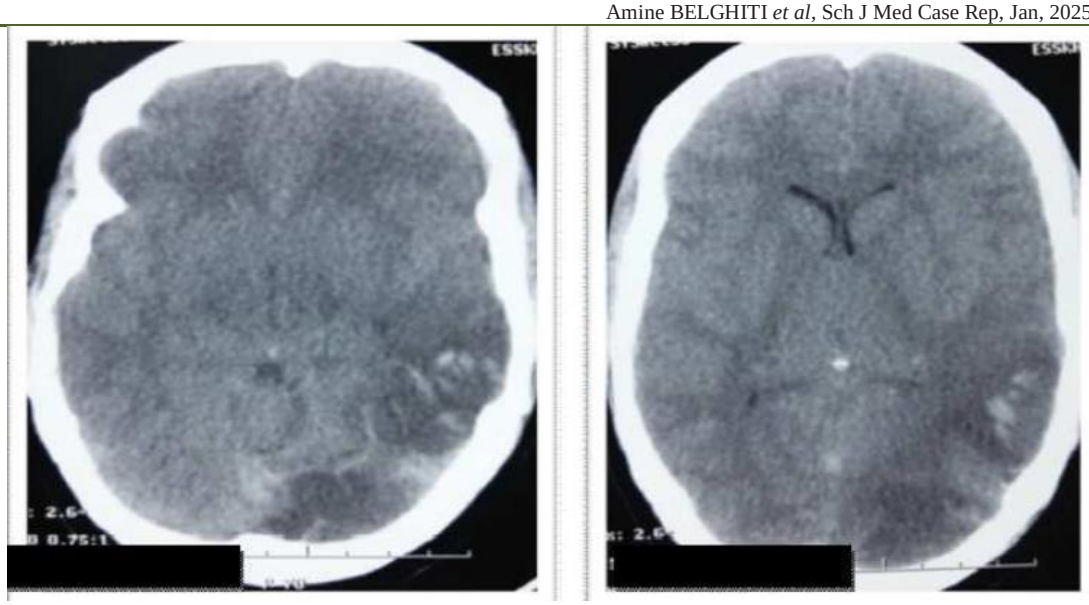


Figure 1: CT scan (axial view) showing cerebromeningeal hemorrhage with a pattern suggesting thrombophlebitis of the left transverse sinus

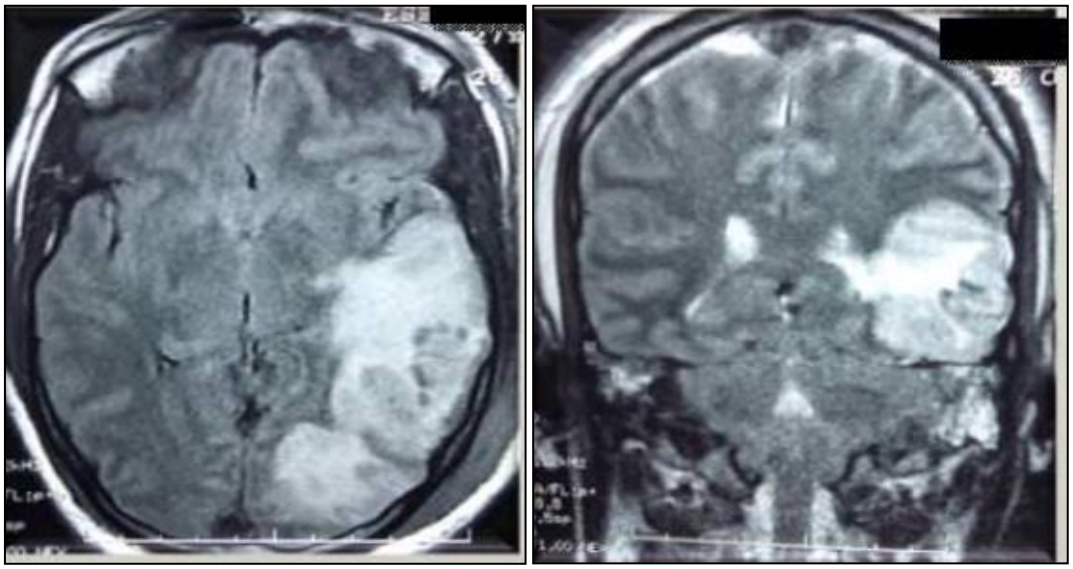


Figure 2: MRI (FLAIR axial and T2 coronal views) - Left temporo-parietal ischemic region with evidence of left transverse sinus thrombosis and early temporal herniation

Case 2:

A 22-year-old patient, primigravida Primipara, with no notable medical history, was hospitalized at 32 weeks of gestation (WG) for preterm labor due to a urinary tract infection. Her condition improved under antibiotic therapy and tocolysis with nicardipine. At 36 WG, she underwent a cesarean section under spinal anesthesia due to dynamic dystocia following labor induction. Upon admission, the patient was in good general health, with a blood pressure of 140/85 mmHg and mild edema in the lower extremities. Urinalysis for protein was negative, and the remainder of the obstetric exam was unremarkable. The perioperative and immediate postpartum periods were uneventful, and the patient was discharged on postoperative day 4.

Eight days postpartum, the patient presented to the emergency department with neurosensory symptoms, including helmet-like headaches, dizziness, and dyspnea. Upon admission, she experienced generalized convulsive seizures and was immediately treated with Midazolam, Phenobarbital, and Valproate. Post-seizure examination revealed a temperature within normal limits, a Glasgow Coma Scale (GCS) score of 13, no neurological deficits, a pulse of 120 bpm, and blood pressure of 170/100 mmHg. Pulmonary examination revealed tachypnea at 42 breaths per minute, bilateral basal crackles, and frothy white secretions. Her oxygen saturation was 88% on a high-concentration mask. A chest X-ray demonstrated diffuse bilateral alveolar-interstitial syndrome, while ECG and troponin levels were normal. The patient was managed with non-invasive ventilation, intravenous Furosemide, and

Magnesium Sulfate, resulting in respiratory, neurological, and hemodynamic improvement. EEG revealed short-lived diffuse paroxysmal activity. Cerebral CT, lumbar puncture, and additional lab work were unremarkable. Brain MRI revealed bilateral asymmetric cortico-subcortical hyperintensities in the parietal regions, capsulo-lenticular areas, and heads of the caudate nuclei, suggestive of posterior reversible encephalopathy syndrome (PRES). (Figure 3) She was started on anticoagulation with prophylactic low-molecular-weight heparin (LMWH) and continued anticonvulsant therapy with Valproate. The patient's clinical course was marked by the resolution of symptoms, with a follow-up EEG at ten days showing no abnormalities. She was discharged on day 10 without recurrence of symptoms. At an 8-week follow-up, both clinical and radiological assessments were normal.

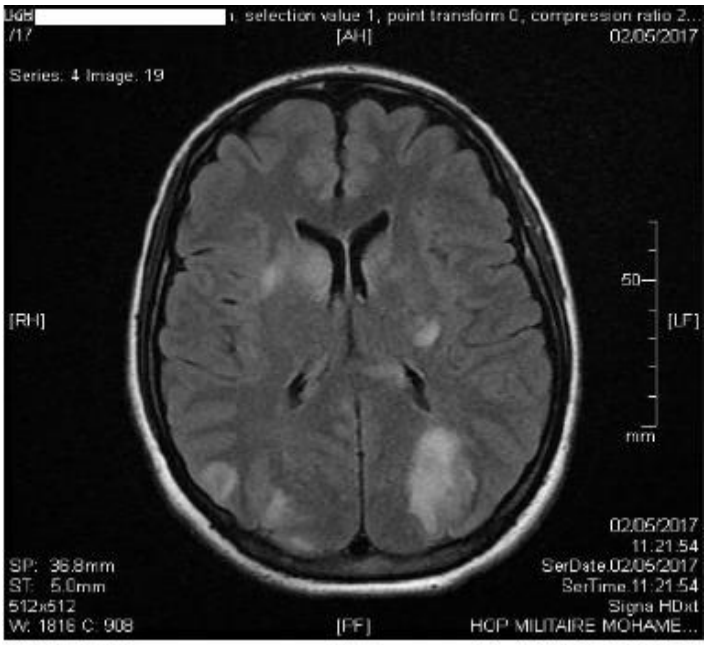


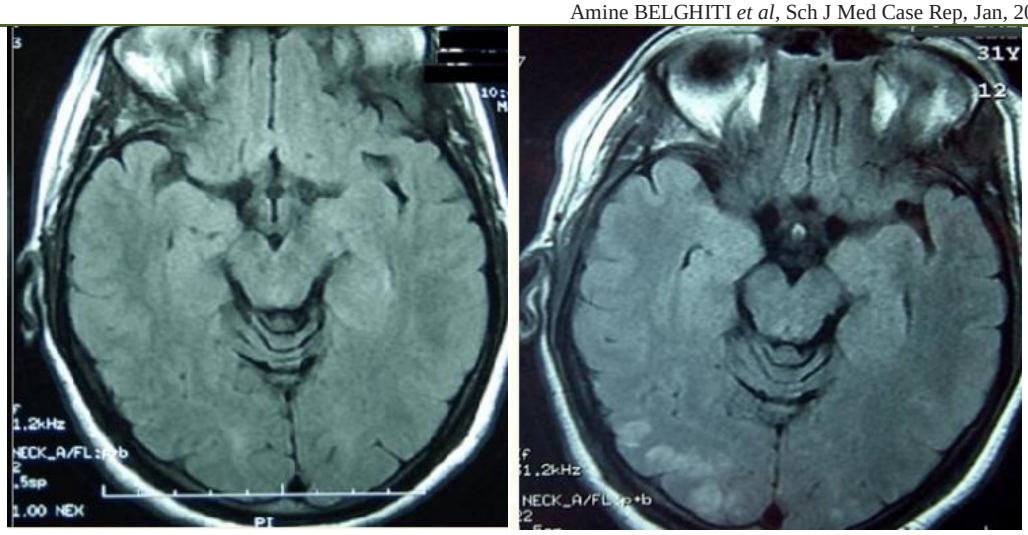
Figure 3: Axial Brain MRI, FLAIR sequence: Bilateral asymmetric cortico-subcortical hyperintensities observed in the parietal regions, capsulo-lenticular areas, and heads of the caudate nuclei

Case 3:

A 31 year-old primiparous patient at 33 weeks of gestation, with no notable medical history, was admitted to the ICU following convulsive episodes. She initially presented to the gynecology-obstetrics department with worsening edema and neurosensory symptoms, notably headaches. Upon clinical examination, the patient was conscious, with a Glasgow Coma Scale (GCS) score of 15, normal breathing, blood pressure at 150/100 mmHg, heart rate at 81 bpm, and symptoms including headaches, pitting edema in the lower limbs with generalized infiltration, and normal deep tendon reflexes. Given these findings, a diagnosis of preeclampsia was established, with further assessment indicating mild intrauterine growth restriction and unremarkable laboratory results.

In the first three hours, the patient's condition worsened, marked by confusion followed by a tonic-clonic seizure with blood pressure measured at 130/80 mmHg and urinary incontinence. Following stabilization, an emergency cesarean section was performed, resulting in the delivery of a stillborn, and the patient was subsequently transferred to the surgical ICU for further management.

At ICU admission, the patient was intubated, ventilated, and sedated. After setup, monitoring, and warming, she was extubated at 6 hours post-operation. Postoperative evaluation revealed anemia, which was managed with a transfusion of two units of packed red blood cells. The rest of the postoperative workup was within normal limits. She was treated with Magnesium Sulfate and Nicardipine at standard therapeutic doses. A cerebral MRI (Figure 4a): revealed hyperintensity on T2 and FLAIR sequences involving the cerebral cortex, as well as the parietal and occipital subcortical regions. indicating posterior reversible encephalopathy syndrome (PRES). The patient's condition improved both clinically and biochemically under antiepileptic therapy. A follow-up MRI one month later showed complete resolution of the parietal lesions. (Figure 4b)



a **b**

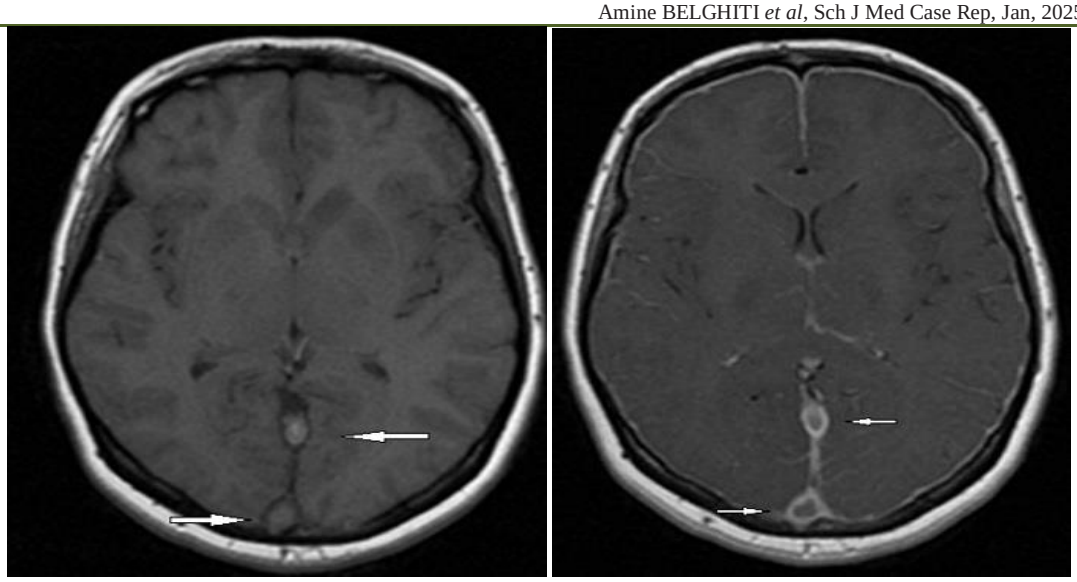
Figure 4: a - Brain MRI revealed hyperintensity on T2 and FLAIR sequences involving in the parietal and occipital subcortical regions. b: The follow-up brain MRI performed 4 months later, demonstrating the resolution of the cerebral lesions

Case 4:

A 30-year-old multiparous woman with no notable medical history and no prior exposure to estrogen-progestin therapy, delivered vaginally at term following an uneventful third pregnancy.

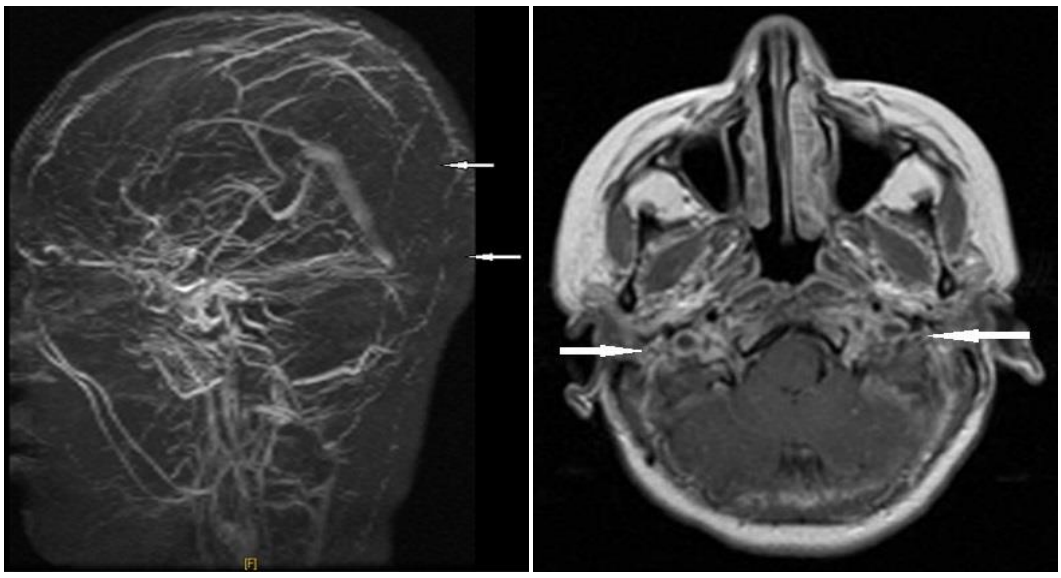
In the immediate postpartum period (Day 4), she developed diffuse postural headaches, hyperalgesic ophthalmoplegia, inflammatory neck pain, and fever. Her clinical course rapidly deteriorated with progressive neurological decline, including altered consciousness and signs of intracranial hypertension. This necessitated intubation, mechanical ventilation, and admission to the intensive care unit (ICU). At her ICU admission, the patient was febrile at 39.6 °C, sedated, and mechanically ventilated. A bilateral exophthalmos associated with eyelid edema but no goiter was observed. Laboratory investigations revealed leukocytosis at 13,800/mm³ with neutrophilic predominance, a significant inflammatory syndrome (CRP at 285 mg/L) without anemia or thrombocytopenia, and normal thyroid function tests. Infectious workups, including blood cultures, throat swabs, and viral serologies (hepatitis B and C, HIV, EBV, CMV, Herpes, and parvovirus B19), were negative, as were immunological tests (antinuclear and antiphospholipid antibodies). A non-contrast brain CT and contrast-enhanced cervico-thoraco-abdomino-pelvic CT were unremarkable. Lumbar puncture revealed clear cerebrospinal fluid with low cellularity (8 WBC/mm³ and 70 RBC/mm³), normal protein and glucose levels, sterile culture, and negative soluble antigen testing.

Her condition worsened, with the emergence of papilledema on fundoscopy, prompting. The MRI revealed, in addition to diffuse cerebral edema and bilateral Grade II exophthalmos, the presence of two lenticular lesions and involvement of the head of the caudate nucleus, showing hypointensity on T1-weighted images and hyperintensity on T2 and FLAIR sequences. The right transverse and superior sagittal sinuses (Figure 5a) were highlighted, with peripheral contrast enhancement after gadolinium injection (Figure 5b), showing thrombus formation within the sinuses and the development of an extensive collateral circulation (Figure 6a). These MRI findings were consistent with cerebral venous thrombosis extending to the jugular bulbs (Figure 6b. Urgent management included an intravenous bolus of 50 IU/kg of unfractionated heparin, followed by continuous infusion at 500 IU/kg/day (25,000 IU/24 hours), combined with 120 mg/day of predisolone for three days. This treatment led to significant clinical improvement within the first 24 hours, allowing for a gradual weaning from mechanical ventilation. At Day 45, radiological findings had resolved, confirming a complete recovery.



a **b**

Figure 5: a. Unenhanced cross-sectional (T1T) brain MRI showing tharombosis of the right and superior longitudinal sinuses b. Cross-sectional brain MRI with gadolinium injection showing thrombosis of the right and superior longitudinal sinuses appearing in T2 hypersignal



a **b**

Figure 6: a. Venous MRI angio sequence: non-visibility of the right and superior longitudinal sinuses b. Transverse T1 image with gadolinium showing the extension of thrombosis to the gulf of the jugular veins

Case 5:

A 27 year-old woman, gravida 2 para 1, with one living child from a previous term vaginal delivery, presented at 36 weeks of gestation with one week of jaundice and decreased fetal movements. She was admitted to the Mohammed V Military Teaching Hospital, where she was alert, with conjunctival jaundice, a blood pressure of 150/90 mmHg, and proteinuria on urinalysis. Fetal heart tones were absent, and ultrasound confirmed intrauterine fetal demise with no signs of placental abruption. Laboratory findings were significant for severe hepatic cytolysis (ASAT/ALAT 10x normal values), cholestasis (total bilirubin 123 mg/dL, predominantly direct), coagulopathy (PT 38%, fibrinogen 0.51 g/L, elevated D-dimers), renal dysfunction (creatinine 22 mg/dL, oliguria), and thrombocytopenia. Abdominal ultrasound revealed hepatic steatosis without biliary dilation.

Labor was induced, and the patient delivered a stillborn vaginally. Following delivery, she developed massive postpartum hemorrhage (estimated blood loss >2 liters) and rapidly deteriorated into disseminated intravascular coagulation (DIC). This was evidenced by worsening anemia (HGB 7.9 g/dL), thrombocytopenia (platelets 92,000), prolonged clotting times (PT and aPTT), and low fibrinogen. Initial management included transfusion of 3 units of packed red blood cells (RBCs),

6 units of fresh frozen plasma (FFP), and 10 units of platelets, as well as fluid resuscitation to correct hypovolemia and enhance diuresis. Despite these measures, the bleeding persisted, leading to hypotension (90/40 mmHg), tachycardia, confusion, and oliguria.

The patient was transferred to the intensive care unit (ICU) in critical condition for advanced management. On ICU admission, she was hemodynamically unstable and required vasopressors (norepinephrine) to maintain blood pressure. Mechanical ventilation was initiated due to hypoxemia and respiratory fatigue. Sedation was achieved using midazolam, and analgesia was maintained with fentanyl to ensure patient comfort and facilitate ventilatory compliance. Arterial blood gases revealed metabolic acidosis with hypoxia, requiring high levels of positive end-expiratory pressure (PEEP) to optimize oxygenation. Continuous renal replacement therapy (CRRT) was prepared due to the risk of worsening acute kidney injury, although this was avoided with aggressive fluid resuscitation and diuretic therapy.

In the ICU, the patient received massive transfusion protocol, including a total of 9 units of RBCs, 22 units of FFP, and 20 units of platelets over the first 48 hours. Tranexamic acid (1 g every 8 hours for 48 hours) was administered to stabilize clot formation, along with oxytocin and prostaglandin analogs to ensure uterine contraction. Antibiotitherapy (Augmentin 1 g three times daily) were initiated to prevent infectious complications. Serial coagulation profiles showed gradual improvement in fibrinogen, platelets, and clotting times. By day three, the bleeding had ceased, and vasopressors were weaned off as hemodynamics stabilized.

Despite improvement in hemostasis, the patient experienced persistent anemia due to ongoing hemolysis, requiring additional transfusions. Hepatic and renal function gradually normalized, with bilirubin levels decreasing and creatinine levels improving. However, the patient developed symptoms of hypoglycemia, hyponatremia, and recurrent headaches. Endocrine workup revealed severe adrenal insufficiency with low cortisol levels, gonadotrophins (LH 0.00 IU/L, FSH 0.06 IU/L), and mild hyperprolactinemia (12 IU/L). Brain MRI Magnetic Resonance Image scanning of the brain revealed ischemic lesions in the pituitary gland (necrosis) suggesting that the pituitary dysfunction was due to Sheehan's syndrome (Figure 7).

Management of Sheehan's syndrome was initiated with hydrocortisone (40 mg/day) for adrenal insufficiency, levothyroxine (25 µg/day) for secondary hypothyroidism, and supportive electrolyte correction with potassium and sodium supplementation. Proton pump inhibitors (PPIs) were prescribed for gastric protection. Hormonal replacement therapy led to stabilization of her endocrine status, with resolution of hypoglycemia and improvement in energy levels.

By day seven, the patient was extubated and weaned off sedation. A multidisciplinary team, including intensivists, obstetricians, and endocrinologists, monitored her progress closely. After 10 days in the ICU, she was transferred back to the gynecology ward in stable condition. Follow-up included ongoing hormonal replacement therapy and outpatient endocrinological consultation.

This case illustrates the life-threatening complications of postpartum hemorrhage, including DIC, multi-organ dysfunction, and endocrine failure, requiring rapid diagnosis and aggressive ICU management. Early identification and treatment of Sheehan's syndrome were pivotal in preventing long-term complications and ensuring recovery.

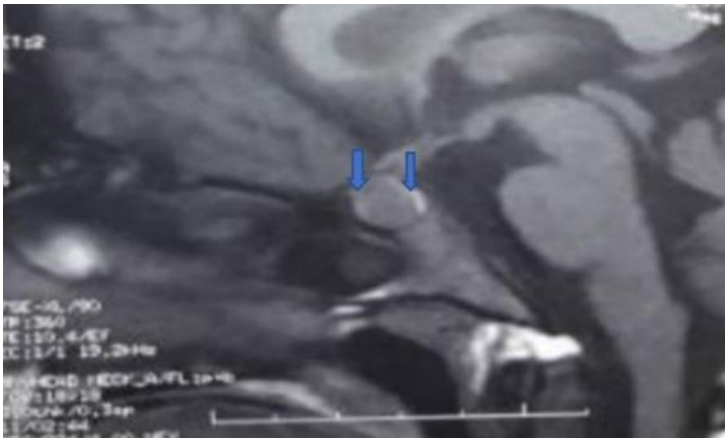


Figure 7: Magnetic Resonance Image scanning of the brain revealed ischemic lesions in the pituitary gland (necrosis)

Case 6:

A 30-year-old woman, 55 days postpartum, was admitted to the Intensive Care Unit (ICU) of the military hospital for the management of severe intracranial hypertension syndrome. The patient, a previously healthy primipara with no significant medical history,

experienced a dramatic onset of symptoms in the immediate postpartum period.

Her clinical presentation began with excruciating, progressive frontal headaches that were refractory to analgesics, accompanied by persistent nausea, vomiting, and photophobia. Within days, she developed significant visual disturbances, including bilateral vision loss and diplopia, alongside worsening confusion and lethargy, raising concerns for a life-threatening neurological condition.

Upon ICU admission, neurological examination revealed severe papilledema (stage 3), bilateral ptosis, and complete ophthalmoplegia of the right eye due to sixth cranial nerve palsy. The patient also exhibited signs of altered mental status, with a Glasgow Coma Scale (GCS) score of 11/15, primarily due to disorientation.

Urgent neuroimaging, including magnetic resonance angiography, identified extensive thrombosis of the right lateral sinus, extending into the ipsilateral internal jugular vein. Additionally, a large suprasellar lesion, consistent with a pituitary macroadenoma, was incidentally discovered (figure 8). This lesion, although non-secreting, likely contributed to the compression of adjacent structures, exacerbating the intracranial hypertension.

Laboratory investigations ruled out hormonal abnormalities, including thyroid dysfunction (TSH 2.3 µIU/mL, free T4 1.2 ng/dL), hyperprolactinemia (prolactin 25 ng/mL), and diabetes insipidus (serum osmolality 280 mOsm/kg, sodium 138 mmol/L). Coagulation studies showed no thrombophilia (antithrombin III 90%, protein C 110%, protein S 95%), but inflammatory markers were elevated, including CRP at 56 mg/L and D-dimer at 3,500 ng/mL, consistent with an acute thrombotic process. Hemoglobin was slightly decreased at 11.5 g/dL, reflecting mild postpartum anemia.

The patient was immediately started on therapeutic anticoagulation with low-molecular-weight heparin and high-dose intravenous methylprednisolone to control inflammation and reduce edema. Aggressive measures to manage intracranial hypertension were initiated, including head elevation, osmotic therapy with intravenous mannitol, and close monitoring of her neurological status.

Over the following days, the patient showed gradual improvement, with a reduction in headache intensity and stabilization of her visual symptoms. Repeat imaging confirmed partial resolution of the venous thrombosis. Once stabilized, she was transferred to the Neurosurgery Department for definitive management of the pituitary macroadenoma via transsphenoidal resection, which was performed successfully.

The patient's postoperative recovery was uneventful, and she was discharged from the ICU in stable condition with close outpatient follow-up. This case highlights the critical nature of postpartum cerebral thrombophlebitis, which can present with rapidly progressive, life-threatening complications. Prompt recognition, multidisciplinary management, and ICU-level care are essential to achieving favorable outcomes in such cases.

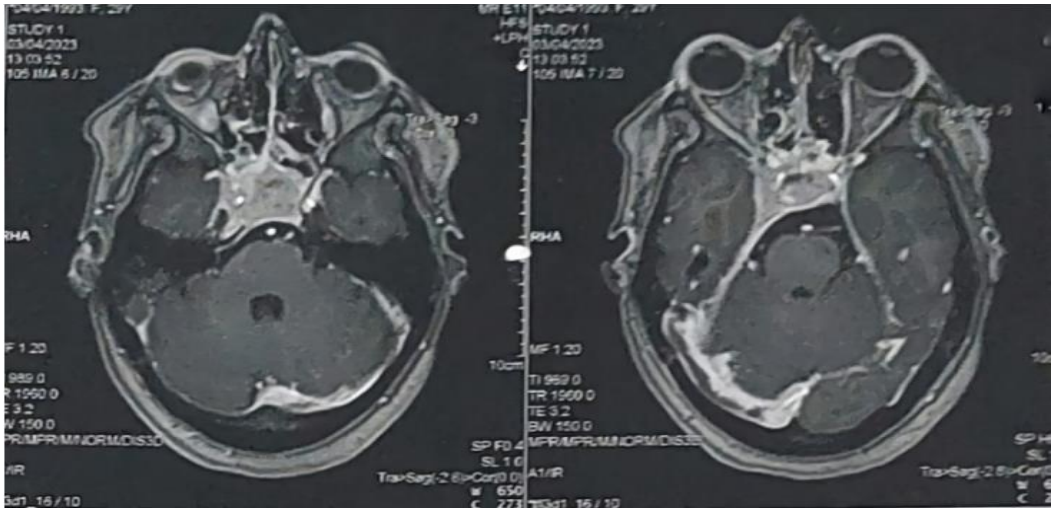


Figure 8: MRI Findings: Thrombosis of Right Lateral Sinus with Extension into the Ipsilateral Internal Jugular Vein and Pituitary Macroadenoma Extending into the Right Cavernous Sinus

DISCUSSION

The six cases presented illustrate a range of serious postpartum complications that underscore the necessity for vigilant monitoring and prompt intervention in postpartum care.

In the first case the 27-year-old woman developed cerebral venous thrombosis after a cesarean section, leading to seizures and altered consciousness. Despite prophylactic anticoagulation, her neurological status deteriorated, necessitating intensive care management. Imaging revealed cerebromeningeal hemorrhage and thrombosis, emphasizing the risk of thrombotic events in postpartum patients. Continuous monitoring and aggressive anticoagulation therapy ultimately led to her recovery, highlighting the importance of timely intervention.

The second case involved a 22-year-old woman presented with PRES eight days postpartum following a cesarean section. Her symptoms included severe headaches and seizures, confirmed by MRI. This case illustrates the need to recognize Posterior Reversible Encephalopathy Syndrome (PRES)as a potential complication in postpartum women, particularly those with hypertension. Successful management with anticonvulsants and supportive care demonstrates the effectiveness of early intervention in reversing neurological deficits.

In the third case, a 31-year-old woman diagnosed with severe preeclampsia suffered convulsions after delivery. The urgency of managing hypertensive disorders in pregnancy was highlighted by her rapid deterioration, requiring emergency cesarean delivery. The subsequent development of PRES necessitated intensive monitoring and treatment with magnesium sulfate. This case underscores how quickly preeclampsia can escalate postpartum, requiring immediate recognition and intervention.

The fourth case described a 30-year-old multiparous woman experienced rapid neurological decline due to cerebral venous thrombosis shortly after delivery. Her condition required intubation and mechanical ventilation, illustrating the severity of this complication. Timely recognition of intracranial hypertension and initiation of anticoagulation therapy were critical for her recovery, emphasizing the need for vigilance in monitoring postpartum patients.

In the fifth case a 27-year-old woman who developed Sheehan's syndrome following massive postpartum hemorrhage. The importance of recognizing endocrine complications from severe blood loss was evident as she presented with adrenal insufficiency and pituitary dysfunction. A multidisciplinary approach was crucial for her management, including hormonal replacement therapy to stabilize her endocrine function.

Lastly, the sixth case involved a 30-year-old woman developed severe intracranial hypertension due to thrombosis alongside an incidental pituitary macroadenoma. This case highlights the complexity of postpartum complications where multiple factors contribute to a patient's deteriorating condition. Successful management involved both therapeutic anticoagulation and surgical intervention for the macroadenoma.

Collectively, these cases demonstrate that postpartum complications can manifest in diverse forms, ranging from thrombotic events to endocrine dysfunctions. They underscore the critical need for vigilant monitoring, prompt recognition, and multidisciplinary management involving obstetricians, neurologists, intensivists, and endocrinologists. Each case serves as a reminder that healthcare providers must remain alert to potential serious complications arising in the immediate postpartum period to ensure optimal outcomes through early intervention and tailored approaches.

i. OVERVIEW OF ACUTE NEUROLOGICAL SYMPTOMS DURING PREGNANCY AND POSTPARTUM

Acute neurological symptoms during pregnancy and the postpartum period are significant clinical concerns due to their potential impact on maternal and fetal health. Various studies indicate that the incidence of neurological disorders in these periods is notably higher than in the general population

The incidence of neurological disorders during pregnancy and the postpartum period is significant. A study from Lady Harding Medical College reported an overall incidence of 584 per 100,000 deliveries, comprising 353 per 100,000 for primary and 230 per 100,000 for secondary neurological disorders [8].

Specific conditions include:

- **Cerebral Venous Thrombosis (CVT):** Accounts for 27% to 57% of pregnancy-related strokes, primarily occurring in the third trimester or shortly after delivery [9].
- **Ischemic Stroke**: Ranges from 3.5 to 5 per 100,000 pregnancies, representing a notable portion of strokes in younger women [10].
- **Reversible Cerebral Vasoconstriction Syndrome (RCVS)**: Affects approximately 7-9% of postpartum patients, although exact incidence rates are unclear [11].

Common neurological disorders observed include:

- **Primary Disorders**: Epilepsy and CNS infections such as meningitis and encephalitis.
- **Secondary Disorders**: Hepatic Encephalopathy (HE), which carries high mortality rates, particularly when it occurs late in pregnancy or postpartum [8], and complications from preeclampsia and eclampsia that can lead to seizures and stroke [11].

ii. CLINICAL PRESENTATION AND DIAGNOSTIC APPROACH

A Clinical Presentation

Acute neurological symptoms during pregnancy and the postpartum period pose significant challenges and can dramatically impact both maternal and fetal health. Common acute neurological symptoms include severe headaches, seizures, and focal neurological deficits. These symptoms require a nuanced understanding and prompt evaluation, given the physiological and hormonal changes that occur during pregnancy.

Common Acute Neurological Symptoms

- **Severe Headaches:** Severe headaches are one of the most frequently reported acute neurological symptoms among pregnant women. They can manifest as migraines, tension-type headaches, or cluster headaches. In the context of pregnancy, these headaches may be exacerbated by factors such as hormonal fluctuations, increased blood volume, and stress [12]. However, it is crucial to differentiate benign headaches from those that may indicate serious underlying conditions. For instance, new-onset severe headaches or a significant change in the pattern of chronic headaches could signify more severe conditions such as preeclampsia, eclampsia, or cerebral venous sinus thrombosis (CVST) [13]. The presence of "red flag" symptoms, including headaches that are sudden in onset, particularly severe, or associated with neurological deficits, necessitates immediate medical evaluation to rule out life-threatening conditions [14].
- **Seizures:** Seizures during pregnancy present another critical area of concern. While seizures can arise from various etiologies, including metabolic disturbances or structural abnormalities, in pregnant individuals, they frequently indicate eclampsia or exacerbations of pre-existing epilepsy. Eclampsia, characterized by seizures occurring in the context of preeclampsia, can lead to significant morbidity for both mother and fetus if not promptly treated [15]. Pregnant patients may present with convulsions that are either generalized or focal, requiring immediate evaluation to identify the underlying cause and initiate appropriate management. In non-pregnant populations, the evaluation of seizures often includes a comprehensive workup to identify the etiology; similarly, in pregnant patients, this approach is essential to ensure timely and appropriate care.
- **Focal Neurological Deficits:** Focal neurological deficits, such as weakness, sensory loss, or speech difficulties, can indicate serious conditions such as stroke or multiple sclerosis exacerbations. During pregnancy, the risk of stroke is increased due to factors such as hypercoagulability and increased blood volume [13]. While strokes in the general population may be associated with certain risk factors, such as hypertension or diabetes, pregnant individuals often experience atypical presentations. For instance, while classic stroke symptoms may include sudden onset weakness or difficulty speaking, a pregnant woman may present with altered mental status or nonspecific symptoms, which can delay diagnosis and treatment [16].

B Differentiation between typical and atypical Presentations

The differentiation between typical and atypical presentations of neurological symptoms in pregnant and postpartum women is critical. Pregnancy alters the presentation of many neurological disorders. For example, a stroke may present with atypical symptoms such as confusion or altered consciousness rather than the classic unilateral weakness or facial droop commonly seen in non-pregnant patients [11]. The physiological changes associated with pregnancy, such as changes in blood volume, increased intracranial pressure, and hormonal shifts, may mask classic neurological symptoms or mimic other conditions [17].

Furthermore, the overlapping nature of pregnancy-related symptoms can complicate diagnosis. Symptoms such as nausea, fatigue, and mood changes are common during pregnancy and can obscure more severe neurological conditions. Therefore, healthcare providers must maintain a high index of suspicion and carefully assess any neurological complaints in pregnant patients to prevent delays in diagnosis and treatment [11].

iii. DIAGNOSTIC APPROACH

The diagnostic evaluation of acute neurological symptoms in pregnant and postpartum women must be systematic and thorough. Key components of the diagnostic approach include comprehensive history-taking, thorough physical examinations, imaging studies, and laboratory tests.

A Clinical evaluations

A detailed medical history is paramount, focusing on the onset, duration, and characteristics of symptoms. Specific inquiries should address prior neurological conditions, obstetric history, family history of neurological disorders, and the presence of any associated symptoms, such as hypertension or visual changes [13].

During the physical examination, a thorough neurological assessment is crucial. This includes evaluating cognitive function, motor and sensory responses, coordination, and cranial nerve function. Additionally, the physical examination should

incorporate an assessment of vital signs and a cardiovascular examination, as conditions such as preeclampsia may present with elevated blood pressure and neurological symptoms [14].

B Imaging techniques

Imaging plays a vital role in diagnosing neurological conditions. The two most commonly utilized imaging modalities are:

- **MRI (Magnetic Resonance Imaging)**: MRI is the preferred method for evaluating brain structure due to its superior resolution and safety profile during pregnancy. It is instrumental in identifying conditions such as cerebral hemorrhages, lesions associated with multiple sclerosis, and CVST [18]. Its non-invasive nature makes it suitable for use in pregnant patients, allowing for a thorough assessment of neurological conditions without exposing the fetus to ionizing radiation.
- **CT Scans (Computed Tomography)**: CT scans are often employed in emergency settings, particularly when rapid assessment is required. They are effective in evaluating acute intracranial pathology, such as hemorrhages or strokes. While there is a small risk of radiation exposure, the rapid availability and ability to identify life-threatening conditions often justify their use in critical situations [19]

C Importance of coagulation evaluation

Pregnancy is associated with an increase in procoagulant factors such as factor VII, factor VIII, factor X, and fibrinogen, while anticoagulant factors like protein S are reduced. This results in a heightened risk of thrombotic events, including CVST, which occurs more frequently in pregnant women due to these changes combined with factors like venous stasis and hormonal fluctuations [20, 21].

The levels of fibrinogen can rise significantly, often exceeding normal diagnostic thresholds for thromboembolism by the end of pregnancy1. Additionally, the D-dimer level increases throughout pregnancy, complicating the interpretation of standard coagulation tests like prothrombin time (PT) and activated partial thromboplastin time (aPTT), which may not accurately reflect the coagulation status in pregnant women.

In pregnant patients presenting with neurological symptoms, especially those suspected of CVST or eclampsia, timely evaluation of coagulation parameters is crucial. CVST can manifest with various neurological symptoms and may be misdiagnosed if clinical suspicion is not high. Advanced neuroimaging techniques are essential for confirming the diagnosis [21, 22]. Early intervention with anticoagulation therapy can significantly improve outcomes [21].

iv. MANAGEMENT STRATEGIES

The management of acute neurological symptoms during pregnancy requires a careful balance between therapeutic efficacy and the safety of both the mother and fetus. Given the unique physiological and hormonal changes that occur during pregnancy, therapeutic strategies must be tailored to address these challenges while ensuring optimal outcomes. This chapter provides an overview of the therapeutic options available for pregnant women experiencing neurological symptoms, highlights safety considerations for both mother and fetus, and emphasizes the role of multidisciplinary care in optimizing management strategies [23].

A Overview of therapeutic options

1. Medications

- **Antiepileptic drugs (AEDs):** For pregnant women with a history of epilepsy or those experiencing seizures during pregnancy, the management of seizures is paramount. Traditional AEDs such as lamotrigine and levetiracetam are often preferred due to their favorable safety profiles in pregnancy [24]. Newer AEDs, while effective, require careful consideration of their teratogenic potential. The goal is to control seizures while minimizing risks to the developing fetus. Pregnant women should be counseled on the importance of maintaining therapeutic drug levels and potential side effects, as inadequate seizure control can lead to maternal and fetal complications, including injury during seizures and hypoxia [24, 25].
- **Pain Management:** Severe headaches, including migraines, may necessitate pharmacological intervention. Acetaminophen is generally considered safe during pregnancy and can be used for headache relief [26, 27]. However, non steroidal anti-inflammatory drugs (NSAIDs) are typically avoided, especially during the third trimester, due to potential risks such as premature closure of the ductus arteries us and fetal renal impairment [28]. It is crucial to provide comprehensive counseling regarding the safe use of medications for headache management, taking into account individual patient circumstances.
- **Antihypertensives:** In cases where neurological symptoms are secondary to hypertensive disorders, management strategies must focus on controlling blood pressure to prevent complications such as stroke or eclampsia. Medications such as labetalol, nifedipine, and methyldopa are commonly used in this context, as they have established safety profiles during pregnancy [29, 30]. Close monitoring of blood pressure and maternal-fetal well-being is essential in optimizing treatment strategies for hypertensive crises [30].

2. Emergency procedures

In severe cases where neurological symptoms progress or fail to respond to medical management, emergency interventions may be warranted. For instance, In cases of hemorrhagic strokes or cerebral venous sinus thrombosis, surgical interventions such as craniotomy or endovascular procedures may be necessary. The decision to proceed with these surgical interventions requires careful consideration of several critical factors. In the context of surgical interventions during the postpartum period, considerations include gestational age, which affects the timing and complexity of surgery due to risks to both mother and fetus; fetal status, which is critical in assessing whether to proceed with surgery given potential impacts on fetal health; and potential risks, as each surgical option carries inherent dangers that must be carefully weighed against the benefits of stabilizing the mother's condition [31]. Surgical interventions for neurological emergencies, particularly in cases of hemorrhagic strokes, primarily include craniotomy and endovascular procedures. A craniotomy involves opening the skull to access the brain, allowing for the removal of blood clots, evacuation of hematomas, and repair of damaged blood vessels, especially in severe bleeding scenarios or complications like aneurysms and arteriovenous malformations (AVMs) [32, 33]. In contrast, endovascular procedures are minimally invasive techniques that utilize catheters to manage vascular issues by placing stents or coils to reinforce or occlude affected blood vessels [34, 35]. These approaches are chosen based on the specific medical condition, with craniotomy offering direct access for extensive issues and endovascular methods providing a lower-risk alternative for vascular management.

3. Fetal monitoring

The management of neurological complications during pregnancy and the postpartum period necessitates a comprehensive approach that includes fetal monitoring. This is particularly critical when maternal neurological symptoms suggest potential risks to fetal well-being, such as compromised placental perfusion or other obstetric complications. Fetal monitoring is essential in cases where maternal neurological conditions may affect the fetus. Two primary methods for assessing fetal health are: **Non-Stress Tests (NSTs)**: These tests measure fetal heart rate in response to movements, providing insight into fetal well-being. **Biophysical Profiles (BPPs): BPPs** offer a more comprehensive assessment, evaluating not only fetal heart rate but also factors like breathing, movement, muscle tone, and amniotic fluid levels. Both NSTs and BPPs are critical tools in high-risk pregnancies. They help detect signs of fetal distress, guide delivery decisions, and monitor conditions such as preeclampsia or intrauterine growth restriction (IUGR) [36].

During acute management, fetal monitoring should be integrated into care plans. Non-stress tests (NSTs) and biophysical profiles (BPPs) can provide critical information regarding fetal well-being, especially when maternal neurological symptoms raise concerns for compromised placental perfusion or other obstetric complications [36]. The interplay between maternal and fetal health must be a priority in any therapeutic approach.

4. Safety considerations for both mother and fetus

The safety of both mother and fetus is paramount when implementing management strategies for acute neurological symptoms. Understanding the teratogenic risks associated with medications is essential.

When treating acute neurological symptoms, the potential teratogenic effects of medications must be weighed against the risks posed by untreated maternal conditions. For instance, discontinuing necessary treatments for conditions like epilepsy can lead to severe maternal complications that may adversely affect fetal health [37]. While some AEDs are associated with increased risks of major congenital malformations and neurodevelopmental issues, uncontrolled seizures can pose significant risks to both mother and fetus. Therefore, the use of AEDs must be carefully managed, often involving the lowest effective doses and the fewest number of medications [38].

Additionally, Interventions aimed at safeguarding maternal health during pregnancy must be meticulously timed to mitigate potential adverse effects on the fetus. As pregnancy progresses, particularly into the third trimester, procedures such as cesarean sections or imaging studies become increasingly complex and risky. This period is critical since fetal development is nearing completion, and the likelihood of preterm labor escalates [39].

Early initiation of antenatal care is essential, ideally between 4 to 8 weeks of gestation, with regular follow-ups throughout the pregnancy [40]. This proactive approach allows for effective management of potential complications, ultimately reducing risks for both mother and fetus. In the third trimester, however, any necessary interventions must be carefully evaluated against the heightened risks of preterm labor and fetal distress. For instance, managing severe hypertension or pre-eclampsia may require interventions that could adversely affect fetal well-being if not appropriately timed [40].

While prioritizing maternal health is essential, it is equally important to carefully consider the timing and nature of medical interventions to minimize risks to the fetus, particularly in the later stages of pregnancy. As gestation progresses, especially during the third trimester, the complexity and potential risks associated with procedures increase. Therefore, a strategic approach to timing interventions is necessary to balance maternal health needs with fetal safety. This approach ensures that interventions are not only effective but also conducted at

optimal times to reduce the likelihood of adverse outcomes for both mother and child.

v. IMPORTANCE OF A MULTIDISCIPLINARY TEAM

Multidisciplinary collaboration is essential in managing acute neurological symptoms in pregnant and postpartum women, as it significantly enhances diagnostic and treatment processes. This approach integrates the expertise of various specialists, including obstetricians, neurologists, emergency doctors, intensivists, and radiologists, to effectively rule out serious conditions such as eclampsia and cerebral venous sinus thrombosis (CVST) [23].

1. **Comprehensive Evaluations:** Pregnant women presenting with acute neurological symptoms require thorough assessments to address both obstetric and neurological concerns. Emergency doctors play a crucial role in the initial evaluation and stabilization of these patients, while intensivists are vital for managing severe cases that may require intensive monitoring and intervention. This multidisciplinary framework ensures that all potential causes of the symptoms are considered, leading to more accurate diagnoses [41].
2. **Tailored management plans:** Each patient's situation is unique, necessitating individualized management strategies. Neurologists provide insights into the neurological implications of symptoms, while obstetricians focus on maternal-fetal aspects of treatment. The collaboration among these specialists allows for tailored management plans that prioritize both maternal health and fetal safety, ensuring optimal outcomes for both [11, 41, 42].
3. **Improved outcomes:** Research indicates that a multidisciplinary approach in tertiary care settings significantly improves maternal and fetal outcomes. Timely interventions facilitated by this collaboration can effectively mitigate risks associated with neurological complications during pregnancy [11, 43, 44]. For instance, coordinated care has been shown to enhance the management of complex cases involving pre-existing conditions or new neurological symptoms arising during pregnancy.
4. **Coordination of Care:** Effective communication among specialists is vital for managing complex cases. Regular multidisciplinary meetings or outpatient clinics improve coordination, allowing for shared decision-making that actively involves patients in their care plans. This collaborative environment fosters a more integrated approach to treatment, where all team members are aligned on the patient's needs and goals [11,23,45]
5. **Addressing Challenges:** The management of neurological disorders during pregnancy can be complicated by factors such as hormonal changes and the exacerbation of pre-existing conditions. A multidisciplinary team is well-equipped to navigate these challenges through vigilant monitoring and prompt referrals to specialized care as needed [45,46]. By incorporating insights from emergency physicians and intensivists, the team can provide a robust response to acute neurological events, ultimately improving maternal and neonatal health outcomes.

The involvement of a multidisciplinary team is paramount in the diagnostic process for acute neurological symptoms in pregnant and postpartum women. Collaboration among obstetricians, neurologists, radiologists, and emergency care providers enhances the diagnostic approach and ensures comprehensive management plans tailored to individual patients [11, 23, 46]. Each member of the team brings unique expertise that contributes to a more accurate diagnosis and better patient outcomes. For instance, obstetricians can provide insight into the maternal-fetal implications of neurological disorders, while neurologists can offer specialized assessments and management option.

Recognizing and effectively diagnosing acute neurological symptoms in pregnant and postpartum women requires a thorough understanding of common symptoms, a keen awareness of atypical presentations, and a systematic diagnostic approach that incorporates detailed evaluations, appropriate imaging, and laboratory testing. The collaboration of a multidisciplinary team is essential to navigate the complexities of these cases, ensuring optimal care for both the mother and fetus [47, 48].

CONCLUSION

managing acute neurological manifestations in pregnant and postpartum women necessitates a multidisciplinary approach to ensure effective diagnosis and treatment. Neurological complications can significantly affect both maternal and fetal health, making early recognition of symptoms like severe headaches and seizures critical. Conditions such as eclampsia and cerebral venous thrombosis highlight the need for integrated care from obstetricians, neurologists, and other specialists.

Advancements in neuroimaging and evolving medication guidelines have improved treatment options, allowing for safer management of pre-existing neurological disorders during pregnancy. By fostering collaboration among healthcare providers, we can enhance maternal outcomes and navigate the complexities of neurological issues in this vulnerable

population, ultimately ensuring better health for both mothers and their infants.

In conclusion, the management of acute neurological symptoms in pregnant women requires a comprehensive approach that encompasses tailored therapeutic options, careful consideration of safety for both mother and fetus, and the integration of a multidisciplinary care model. By prioritizing collaboration and individualized care, healthcare providers can optimize outcomes for mothers and their infants, ensuring that both receive the best possible care during this critical time.

Methods Use of large language models (LLMs)

In conducting this review, we employed Large Language Models (LLMs), specifically ChatGPT, developed by OpenAI. LLMs were utilized to generate text in sections where comprehensive analysis or discussion was required, such as the introduction, discussion, and conclusion. It's important to note that LLMs function as AI-driven text generation tools and do not constitute traditional authorship. Consequently, the text generated by LLMs was reviewed and edited by the authors to ensure accuracy, coherence, and alignment with the objectives and scope of this review

Declarations

Conflict of interest: The authors declare that there are no conflicts of interest.

Consent

As per international standard or university standard, patient's consent has been collected and preserved by the authors.

Ethical approval

As per international standards or university standards written ethical approval has been collected and preserved by the author(s).

Competing Interests: Authors have declared that no competing interests exist.

Authors' contributions

This work was carried out in collaboration among all authors. Authors AB and HH conceptualized the research work, did data curation, software work, performed the methodology validation and wrote the original draft, reviewed and edited. Author JC, MC and ME did data curation, visualization, performing the methodology, writing, reviewing and editing. Authors AB and KA supervised, validated, wrote, reviewed and edited the manuscript. All authors read and approved the final manuscript.

REFERENCES

1. Godoy, D. A., Robba, C., Paiva, W. S., & Rabinstein, A. A. (2022). Acute intracranial hypertension during pregnancy: special considerations and management adjustments. *Neurocritical care*, 1-15. doi: 10.1007/s12028-021-01333-x. Epub 2021 Sep 7. PMID: 34494211; PMCID: PMC8423073.
2. Scott, C., & Kaliaperumal, C. (2022). Idiopathic intracranial hypertension and pregnancy: a comprehensive review of management. *Clinical Neurology and Neurosurgery*, *217*, 107240. doi: 10.1016/j.clineuro.2022.107240. Epub 2022 Apr 13. PMID: 35461091.
3. Janvier, A. S., & Russell, R. (2022). Postpartum headache–diagnosis and treatment. *BJA education*, *22*(5), 176-181. doi: 10.1016/j.bjae.2021.12.004. Epub 2022 Feb 23. PMID: 35496646; PMCID: PMC9039472.
4. Macgregor, E.A. (2014). Headache in pregnancy. Continuum (Minneap Minn). 20(1 Neurology of Pregnancy):128-47. doi: 10.1212/01.CON.0000443841.40933.9e. PMID: 24492815; PMCID: PMC10563971.
5. Zafarmand, S., Javanmardi, H., Ameri, M., Maneshi, M., Mansouri-Mehrabadi, S., Zolghadrasli, Y., ... & Borhani-Haghighi, A. (2019). Evaluation of the neurological complaints during pregnancy and postpartum. *Galen Medical Journal*, *8*, e1616. doi: 10.31661/gmj.v8i0.1616. PMID: 34466537; PMCID: PMC8343816.
6. Malaiyandi, D., James, E., Peglar, L., Karim, N., Henkel, N., & Guilliams, K. (2021). Neurocritical care of the pregnant patient. *Current treatment options in neurology*, *23*, 1-24. doi: 10.1007/s11940-021-00676-2. Epub 2021 Jun 21. PMID: 34177249; PMCID: PMC8214980.
7. Maqbool, R., Maqbool, M., Zehravi, M., & Ara, I. (2021). Acute neurological conditions during pregnancy and their management: a review. *International Journal of Adolescent Medicine and Health*, *33*(6), 357-366. doi: 10.1515/ijamh-2021-0084. PMID: 34420267.
8. Gupta, S., Rohatgi, A., Sharma, S. K., & Gurtoo, A. (2006). A study of neurological disorders during pregnancy and puerperium. *Annals of Indian Academy of neurology*, *9*(3), 152-157 | DOI: 10.4103/0972-2327.27657
9. Ferraz, Z., Parra, J., Areia, A. L., Vasco, E., & Moura, P. (2017). Acute onset neurological disorders during pregnancy: a literature review. *Revista Brasileira de Ginecologia e Obstetrícia*, *39*(10), 560-568. doi: 10.1055/s-0037-1604058. Epub 2017 Jun 26. PMID: 28651292; PMCID: PMC10309368.
10. Hosley, C. M., & McCullough, L. D. (2011). Acute neurological issues in pregnancy and the peripartum. *The Neurohospitalist*, *1*(2), 104-116. doi: 10.1177/1941875211399126. PMID: 23983844; PMCID: PMC3726078
11. Merlino, L., Matys, V., Crognale, A., D'Ovidio, G., Della Rocca, C., Porpora, M. G., ... & Piccioni, M. G. (2023). Neurological complications in pregnancy

and the puerperium: Methodology for a clinical diagnosis. *Journal of Clinical Medicine*, *12*(8), 2994. doi: 10.3390/jcm12082994. PMID: 37109329; PMCID: PMC10141482.

12. Janvier, A. S., & Russell, R. (2022). Postpartum headache–diagnosis and treatment. *BJA education*, *22*(5), 176-181. doi: 10.1016/j.bjae.2021.12.004. Epub 2022 Feb 23. PMID: 35496646; PMCID: PMC9039472.
13. Miller, E. C., & Vollbracht, S. (2021). Neurology of preeclampsia and related disorders: an update in neuro-obstetrics. *Current pain and headache reports*, *25*, 1-12. doi: 10.1007/s11916-021-00958-z. PMID: 33825997; PMCID: PMC10069269.
14. Wijeratne, T., Wijeratne, C., Korajkic, N., Bird, S., Sales, C., & Riederer, F. (2023). Secondary headaches-red and green flags and their significance for diagnostics. *Eneurologicalsci*, 100473. doi: 10.1016/j.ensci.2023.100473. PMID: 37456555; PMCID: PMC10339125.
15. Akre, S., Sharma, K., Chakole, S., & Wanjari, M. B. (2022). Eclampsia and its treatment modalities: a review article. *Cureus*, *14*(9). doi: 10.7759/cureus.29080. PMID: 36249647; PMCID: PMC9555679.
16. Kroopnick, A. J., & Miller, E. C. (2024, August). Approach to Altered Mental Status in Pregnancy and Postpartum. In *Seminars in Neurology*. Thieme Medical Publishers, Inc. doi: 10.1055/s-0044-1788977. Epub 2024 Aug 16. PMID: 39151911.
17. Soma-Pillay, P., Nelson-Piercy, C., Tolppanen, H., & Mebazaa, A. (2016). Physiological changes in pregnancy: review articles. *Cardiovascular journal of Africa*, *27*(2), 89-94. doi: 10.5830/CVJA-2016-021. PMID: 27213856; PMCID: PMC4928162
18. Gatta, G., Di Grezia, G., Cuccurullo, V., Sardu, C., Iovino, F., Comune, R., ... & Viola, L. (2021). MRI in pregnancy and precision medicine: a review from literature. *Journal of personalized medicine*, *12*(1), 9. doi: 10.3390/jpm12010009. PMID: 35055324; PMCID: PMC8778056.
19. Wiles, R., Hankinson, B., Benbow, E., & Sharp, A. (2022). Making decisions about radiological imaging in pregnancy. *bmj*, *377*. doi: 10.1136/bmj-2022-070486. PMID: 35470230; PMCID: PMC9036096.
20. Yoon, H. J. (2019). Coagulation abnormalities and bleeding in pregnancy: an anesthesiologist's perspective. *Anesthesia and pain medicine*, *14*(4), 371-379. doi: 10.17085/apm.2019.14.4.371. PMID: 33329765; PMCID: PMC7713810.
21. Algahtani, H., Bazaid, A., Shirah, B., & Bouges, R. N. (2022). Cerebral venous sinus thrombosis in pregnancy and puerperium: A comprehensive review. *Brain Circulation*, *8*(4), 180-187. doi: 10.4103/bc.bc_50_22. PMID: 37181848; PMCID: PMC10167849.
22. Roeder, H. J., Lopez, J. R., & Miller, E. C. (2020). Ischemic stroke and cerebral venous sinus thrombosis in pregnancy. *Handbook of clinical neurology*, *172*, 3-31. doi: 10.1016/B978-0-444-64240-0.00001-5. PMID: 32768092; PMCID: PMC7528571.
23. Brussé, I. A., Kluivers, A. C., Zambrano, M. D., Shetler, K., & Miller, E. C. (2020). Neuro-obstetrics: A multidisciplinary approach to care of women with neurologic disease. *Handbook of clinical neurology*, *171*, 143-160. doi: 10.1016/B978-0-444-64239-4.00007-2. PMID: 32736747; PMCID: PMC7528572.
24. Antiepileptic drugs in pregnancy. Drug Ther Bull. 2021 Jul;59(7):99. doi: 10.1136/dtb.2021.000018. Epub 2021 Apr 8. PMID: 33832945.
25. Mari, L., Placidi, F., Romigi, A., Tombini, M., Del Bianco, C., Ulivi, M., ... & Izzi, F. (2022). Levetiracetam, lamotrigine and carbamazepine: which monotherapy during pregnancy?. *Neurological Sciences*, *43*(3), 1993-2001. doi: 10.1007/s10072-021-05542-2. Epub 2021 Sep 1. PMID: 34468899; PMCID: PMC8860795.
26. Woodbury, M. L., Cintora, P., Ng, S., Hadley, P. A., & Schantz, S. L. (2024). Examining the relationship of acetaminophen use during pregnancy with early language development in children. *Pediatric research*, *95*(7), 1883-1896. https://doi.org/10.1038/s41390-023-02924-4
27. Sznajder, K. K., Teti, D. M., & Kjerulff, K. H. (2022). Maternal use of acetaminophen during pregnancy and neurobehavioral problems in offspring at 3 years: A prospective cohort study. *PLoS One*, *17*(9), e0272593. doi: 10.1371/journal.pone.0272593. PMID: 36170224; PMCID: PMC9518858.
28. D'Ambrosio, V., Vena, F., Scopelliti, A., D'Aniello, D., Savastano, G., Brunelli, R., & Giancotti, A. (2023). Use of non-steroidal anti-inflammatory drugs in pregnancy and oligohydramnios: a review. *The Journal of Maternal-Fetal & Neonatal Medicine*, *36*(2), 2253956. https://doi.org/10.1080/14767058.2023.2253956
29. Lewey, J., Beckie, T. M., Brown, H. L., Brown, S. D., Garovic, V. D., Khan, S. S., ... & Mehta, L. S. (2024). Opportunities in the postpartum period to reduce cardiovascular disease risk after adverse pregnancy outcomes: a scientific statement from the American Heart Association. *Circulation*, *149*(7), e330-e346. doi: 10.1161/CIR.0000000000001212. Epub 2024 Feb 12. PMID: 38346104; PMCID: PMC11185178.
30. Garcia, J. E., Mulrenin, I. R., Nguyen, A. B., Loop, M. S., Daubert, M. A., Urrutia, R., & Lee, C. R. (2023). Antihypertensive medication use during pregnancy in a real-world cohort of patients diagnosed with a hypertensive disorder of pregnancy. *Frontiers in Cardiovascular Medicine*, *10*, 1225251. doi: 10.3389/fcvm.2023.1225251. PMID: 37485273; PMCID: PMC10360165.
31. Zeleke, M. E., Chekol, W. B., Kasahun, H. G., Mekonnen, Z. A., Filatie, T. D., Melesse, D. Y., ... & Admass, B. A. (2024). Perioperative management

of surgical procedure during pregnancy: a systematic review. *Annals of Medicine and Surgery*, *86*(6), 3432-3441. doi: 10.1097/MS9.0000000000002057. PMID: 38846888; PMCID: PMC11152784.

32. Cauldwell, M., Rudd, A., & Nelson-Piercy, C. (2018). Management of stroke and pregnancy. *European Stroke Journal*, *3*(3), 227-236. doi: 10.1177/2396987318769547. Epub 2018 Apr 12. PMID: 31008353; PMCID: PMC6453206
33. Richardt, A., Aarnio, K., Korhonen, A., Rantanen, K., Verho, L., Curtze, S., ... & Ijäs, P. (2024). Acute recanalization therapy for ischemic stroke during pregnancy and puerperium. *Journal of Neurology*, 1-11. https://doi.org/10.1007/s00415-024-12313-4
34. Elgendy, I. Y., Gad, M. M., Mahmoud, A. N., Keeley, E. C., & Pepine, C. J. (2020). Acute stroke during pregnancy and puerperium. *Journal of the American College of Cardiology*, *75*(2), 180-190. https://doi.org/10.1016/j.jacc.2019.10.056
35. Korhonen, A., Verho, L., Aarnio, K., Rantanen, K., Saaros, A., Laivuori, H., ... & Ijäs, P. (2023). Subarachnoid hemorrhage during pregnancy and puerperium: a population-based study. *Stroke*, *54*(1), 198-207. doi: 10.1161/STROKEAHA.122.039235. Epub 2022 Nov 2. PMID: 36321452.
36. Umana, O.D., Vadakekut, E.S. & Siccardi, M.A. (2024). Antenatal Fetal Surveillance. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan–. PMID: 30725808.
37. Cragan, J. D., Friedman, J. M., Holmes, L. B., Uhl, K., Green, N. S., & Riley, L. (2006). Ensuring the safe and effective use of medications during pregnancy: planning and prevention through preconception care. *Maternal and Child Health Journal*, *10*, 129-135. doi: 10.1007/s10995-006-0102-2. Epub 2006 Jul 19. PMID: 16850277; PMCID: PMC1592140.
38. Tomson, T., Battino, D., Bromley, R., Kochen, S., Meador, K. J., Pennell, P., & Thomas, S. V. (2019). Management of epilepsy in pregnancy: a report from the International League Against Epilepsy Task Force on Women and Pregnancy. *Epileptic Disorders*, *6*(6), 497-517. doi: 10.1684/epd.2019.1105. PMID: 31782407.
39. Morton, A. (2022). Pregnancy complicated by neurological and neurosurgical conditions–The evidence regarding mode of delivery. *Obstetric Medicine*, *15*(1), 11-18. doi:10.1177/1753495X211000176
40. Lassi, Z. S., Mansoor, T., Salam, R. A., Das, J. K., & Bhutta, Z. A. (2014). Essential pre-pregnancy and pregnancy interventions for improved maternal, newborn and child health. *Reproductive health*, *11*, 1-19. doi: 10.1186/1742-4755-11-S1-S2. Epub 2014 Aug 21. PMID: 25178042; PMCID: PMC4145858.
41. Renukesh, S., & Rai, L. (2016). Neurological disorders complicating pregnancy-focus on obstetric outcome. *Journal of Clinical and Diagnostic Research: JCDR*, *10*(12), QC06. doi: 10.7860/JCDR/2016/19839.8955. Epub 2016 Dec 1. PMID: 28208940; PMCID: PMC5296513.
42. Venkatesan, C., Cortezzo, D., Habli, M., & Agarwal, S. (2024, April). Interdisciplinary fetal neurology care: Current practice, challenges, and future directions. In *Seminars in Fetal and Neonatal Medicine* (p. 101523). WB Saunders. doi: 10.1016/j.siny.2024.101523. Epub 2024 Apr 10. PMID: 38604916.
43. Chang, K. J., Seow, K. M., & Chen, K. H. (2023). Preeclampsia: Recent advances in predicting, preventing, and managing the maternal and fetal life-threatening condition. *International journal of environmental research and public health*, *20*(4), 2994. https://doi.org/10.3390/ijerph20042994
44. Chase, C. M., & Sullivan, C. (2010). Neurocritical illness during pregnancy and puerperium. *Handbook of Neurocritical Care: Second Edition*, 523-531. https://doi.org/10.1007/978-1-4419-6842-5_33
45. Debrah, A. F., Adebusoye, F. T., Shah, M. H., Awuah, W. A., Tenkorang, P. O., Bharadwaj, H. R., ... & Mykolayivna, N. I. (2023). Neurological disorders in pregnant women in low-and middle-income countries—Management gaps, impacts, and future prospects: A review perspective. *Women's Health*, *19*, 17455057231210265. doi: 10.1177/17455057231210265. PMID: 37955275; PMCID: PMC10644749.
46. Sharma, D. D., Chandresh, N. R., Javed, A., Girgis, P., Zeeshan, M., Fatima, S. S., ... & Mylavarapu, M. (2024). The Management of Preeclampsia: A Comprehensive Review of Current Practices and Future Directions. *Cureus*, *16*(1). doi: 10.7759/cureus.51512. PMID: 38304688; PMCID: PMC10832549.
47. Logue, O. C., George, E. M., & Bidwell III, G. L. (2016). Preeclampsia and the brain: neural control of cardiovascular changes during pregnancy and neurological outcomes of preeclampsia. *Clinical science*, *130*(16), 1417-1434. doi: 10.1042/CS20160108. PMID: 27389588; PMCID: PMC4958371.
48. Wiles, R., Hankinson, B., Benbow, E., & Sharp, A. (2022). Making decisions about radiological imaging in pregnancy. *bmj*, *377*. doi: 10.1136/bmj-2022-070486. PMID: 35470230; PMCID: PMC9036096.