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Retrospective Outcome Analysis of Neurological Emergencies During Pregnancy and Puerperium: A Comparison of Primary and Secondary Neurological Disorders

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Abstract

Background

Neurological emergencies during pregnancy and the puerperium are uncommon but potentially life-threatening conditions associated with substantial maternal and perinatal morbidity and mortality. This study evaluated the incidence, clinical characteristics, and fetomaternal outcomes of neurological emergencies in pregnant and postpartum women, comparing primary and secondary neurological disorders.

Methodology

This retrospective observational study included pregnant and postpartum women diagnosed with cerebrovascular emergencies at a tertiary care teaching hospital between January 2013 and December 2023. Cases were identified using the International Classification of Diseases, Ninth Revision, and the International Classification of Diseases, Tenth Revision, codes. Demographic, obstetric, clinical, and outcome data were extracted from hospital records and analyzed using STATA version 19. Continuous variables were compared using Welch's t-test, while categorical variables were analyzed using Fisher's exact test.

Results

Among 33,140 obstetric admissions, 126 women experienced cerebrovascular emergencies, corresponding to an incidence proportion of 3.8 cases per 1,000 obstetric admissions (0.34 per 1,000 admissions per year). Primary neurological disorders were observed in 111 (88.1%) women, whereas 15 (11.9%) had secondary neurological disorders. Epilepsy was the most frequent primary neurological disorder (58, 52.2%). Women with secondary neurological disorders had significantly higher rates of comorbidities (12 (80.0%) vs. 44 (39.6%), p = 0.005), intensive care unit admission (13 (86.7%) vs. 48 (43.2%), p = 0.002), massive blood transfusion (5 (33.3%) vs. 3 (2.7%), p = 0.001), and maternal mortality (3 (20.0%) vs. 3 (2.7%), p = 0.022) than those with primary neurological disorders. Live births occurred in 90 (81.1%) women with primary neurological disorders compared with 7 (46.7%) among those with secondary neurological disorders, while stillbirths were significantly more frequent in the secondary group (6 (40.0%) vs. 8 (7.2%), p = 0.002).

Conclusions

Neurological emergencies during pregnancy and the puerperium remain important contributors to maternal and perinatal morbidity and mortality. Although secondary neurological disorders were less common, they were associated with significantly worse maternal and perinatal outcomes than primary neurological disorders. These findings represent associations observed in a retrospective cohort and should be interpreted with caution given the small size of the secondary group and lack of multivariable adjustment. Early diagnosis, prompt referral, multidisciplinary management, and timely critical care are essential to improve outcomes.

Categories: Obstetrics/Gynecology, Neurosurgery
Keywords: arteriovenous malformation, convulsions, encephalopathy, epilepsy, maternal mortality, perinatal outcome, stroke

Introduction

Maternal morbidity and mortality are key indicators of global health and healthcare system performance.

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Among the diverse etiologies contributing to adverse maternal outcomes, neurological emergencies represent an important yet often under-recognized group of conditions that may occur during pregnancy or the puerperium and contribute substantially to indirect maternal mortality worldwide [1]. In this study, neurological emergencies were defined as acute neurological conditions requiring urgent hospital evaluation, including both primary neurological disorders (e.g., epilepsy, stroke, cerebral venous thrombosis, central nervous system (CNS) infections, intracranial tumors, traumatic brain injury) and secondary neurological disorders (metabolic, hepatic, uremic, or septic encephalopathies complicating systemic illness).

A systematic review and meta-analysis including more than 270 million pregnancies reported a global incidence of pregnancy-related stroke of approximately 25.4 per 100,000 pregnancies (95% confidence interval (CI): 21.0-30.6), with the highest incidence in the South-East Asian region [2]. Although this meta-analysis was published after the study period, it is cited here as the most comprehensive available estimate of disease burden. The pooled maternal mortality associated with pregnancy-related stroke was 1.55 per 100,000 pregnancies (95% CI: 1.04-2.32), with mortality likely to be higher in low-resource settings because of delayed access to specialized care [2].

Epilepsy has been associated with an almost four-fold increase in maternal morbidity and mortality [3]. Although epidemiological data remain limited, conditions such as cerebral venous thrombosis, intracerebral hemorrhage, and demyelinating disorders are well-recognized causes of neurological morbidity during pregnancy, particularly among women with underlying risk factors. Persistent underreporting and the lack of standardized neurological registries continue to hinder accurate estimation of the global disease burden.

Neurological disorders during pregnancy can be broadly classified as primary or secondary. Primary neurological disorders include epilepsy, intracranial tumors, ischemic and hemorrhagic stroke, cerebral venous thrombosis, cerebral aneurysms, transient ischemic attacks, traumatic brain injury, arteriovenous malformations, meningitis, and encephalitis [4]. Secondary neurological disorders include metabolic and systemic encephalopathies resulting from hypoxia, ischemia, hypoglycemia, hepatic failure, or azotemia [4]. The clinical manifestations of these disorders are diverse and frequently overlap, making timely diagnosis challenging.

Headache is a common symptom during pregnancy and the puerperium, affecting up to 35% of women. It may be accompanied by visual disturbances, seizures, focal neurological deficits, syncope, aphasia, nausea, or vomiting and may indicate an underlying neurological disorder in up to 20% of cases [5].

Physiological adaptations during pregnancy, including increased hemodynamic load, elevated estrogen levels, a hypercoagulable state, and progressive weight gain, can precipitate or exacerbate neurological disorders by altering cerebral hemodynamics and neuronal excitability, thereby increasing susceptibility to cerebrovascular events [6]. These complications are associated with adverse maternal and fetal outcomes. However, published evidence on pregnancy-related stroke and other cerebrovascular events remains limited and is characterized by considerable heterogeneity in study design, case definitions, and outcome reporting, limiting meaningful comparisons across studies and accurate estimation of disease burden. In addition, cerebrovascular events may be underdiagnosed or misclassified because maternal mortality is frequently attributed to more commonly recognized obstetric conditions, such as eclampsia. Delayed diagnosis further reduces opportunities for timely intervention and may adversely affect maternal outcomes.

In this context, the present study aimed to evaluate the spectrum of etiologies, associated risk factors, clinical presentations, and maternal and perinatal outcomes of neurological emergencies occurring during pregnancy and the puerperium. The primary objective was to compare maternal and perinatal outcomes between women with primary versus secondary neurological disorders. Secondary objectives were to describe the etiological spectrum, clinical presentations, and risk factors associated with these emergencies. Improved recognition, prompt diagnosis, and multidisciplinary management may reduce maternal mortality, improve functional outcomes, and enhance rehabilitation for affected women.

Materials And Methods

Study design and setting

A retrospective observational study was conducted in the Department of Obstetrics and Gynaecology at a rural tertiary care teaching institute in western India. Medical records of antenatal and postpartum women presenting with cerebrovascular emergencies were reviewed over 11 years, from January 2013 to December 2023. The study was approved by the Institutional Ethics Committee (IEC) of Bhaikaka University, Karamsad, Anand, Gujarat, India (approval number: IEC/BU/2023/Ex.90/346/2023).

Inclusion and exclusion criteria

All antenatal and postpartum women diagnosed with neurological emergencies during the study period were included using a total enumeration (census) approach; no sampling was performed. Non-pregnant women and those diagnosed with migraine; posterior reversible encephalopathy syndrome (PRES); carotid,

vertebral, or basilar artery stenosis; eclampsia; or isolated hypertensive disorders of pregnancy were excluded.

Eclampsia and PRES were excluded as isolated diagnoses because they are obstetric hypertensive disorders with recognized management pathways. However, women who developed secondary metabolic, hepatic, or septic encephalopathy in the setting of severe pre-eclampsia, HELLP (hemolysis, elevated liver enzymes, and low platelet count) syndrome, acute fatty liver of pregnancy, viral hepatitis, or septicemia were included in Group B, because the neurological emergency (encephalopathy) was the primary clinical event necessitating admission, independent of the underlying obstetric hypertensive disorder. This distinction was applied consistently by two independent reviewers, with disagreements resolved by consensus.

Sample size

Published literature reports an incidence of pregnancy-related stroke of approximately 30 per 100,000 pregnancies [2]. Based on this estimate, using a 5% level of significance and an allowable error of 20 per 100,000 pregnancies, the minimum required sample size was calculated to be 28,803 obstetric admissions. During the 11-year study period, 33,140 obstetric admissions were reviewed, exceeding the calculated minimum sample size.

Data collection

Eligible cases were identified using the International Classification of Diseases, Ninth Revision (ICD-9) [7] and International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) [8] codes. The specific ICD-9 and ICD-10 codes used included epilepsy (ICD-10 G40-G41), cerebral venous sinus thrombosis (I63.6, I67.6), ischemic stroke (I63), hemorrhagic stroke (I61-I62), intracranial tumor (C71, D33), CNS infection (G00-G09), traumatic brain injury (S06), hepatic encephalopathy (K72.0, K76.82), uremic encephalopathy (N18-N19 with G93.4), and septic encephalopathy (A41 with G93.4). All cases were validated against clinical records and neuroimaging reports where available. Where neuroimaging was unavailable (e.g., in some rural referrals), cases were included only if clinical documentation by a neurologist or intensivist confirmed the diagnosis.

The variables assessed included demographic characteristics, underlying etiology, associated comorbidities, obstetric parameters, maternal outcomes (including mortality and residual neurological disability), and perinatal outcomes. Based on the underlying pathology, patients were categorized into two groups. Group A comprised women with primary neurological disorders, including cerebrovascular accidents, epilepsy, cerebral venous sinus thrombosis, CNS infections, intracranial tumors, and traumatic brain injuries. Group B included women with secondary neurological disorders, predominantly hepatic, metabolic, uremic, or septic encephalopathies associated with severe pre-eclampsia; HELLP syndrome; acute fatty liver of pregnancy; viral hepatitis; and septicemia.

Operational definitions

Incidence proportion was defined as the number of new neurological emergency cases divided by the total number of obstetric admissions during the study period, expressed per 1,000 admissions [9]. This measure was used instead of person-years because exposure time could not be reliably ascertained from static hospital admission records.

Case fatality rate was defined as the proportion of patients who died from a specific cerebrovascular emergency, calculated by dividing the number of disease-specific deaths by the total number of patients diagnosed with that condition [10].

Statistical analysis

Data were entered into Microsoft Excel (Microsoft Corp., Redmond, WA, USA) and analyzed using STATA version 18.0 (StataCorp LLC, College Station, TX, USA). Descriptive statistics were used to summarize baseline characteristics and are presented as mean ± standard deviation (SD) for continuous variables and frequency (percentage) for categorical variables. Continuous variables were compared between the primary and secondary neurological disorder groups using Welch's t-test, while categorical variables were analyzed using Fisher's exact test. Given the small size of Group B (n = 15) and the limited number of outcome events, multivariable logistic regression was not performed; unadjusted univariate comparisons are reported, and the potential for confounding by underlying disease severity, anemia, sepsis, hepatic dysfunction, and comorbidities is acknowledged in the Discussion. No propensity score matching was undertaken because of the small sample size and risk of unstable estimates. All statistical tests were two-tailed, and a p-value <0.05 was considered statistically significant.

Results

This retrospective study spanned an 11-year period during which a total of 33,140 obstetric admissions were recorded. Among these, 126 women presented with neurological emergencies, yielding an incidence proportion of 3.8 cases per 1,000 obstetric admissions (126/33,140). This corresponds to approximately 0.34

cases per 1,000 admissions per year when annualized (126/33,140/11 years), but the primary reported metric is the cumulative incidence proportion per 1,000 admissions.

During the study period, there were 230 maternal deaths from all causes, of which 6 (2.3%) were attributable to acute neurological events. The maternal mortality rate due to cerebrovascular events was calculated to be 51 per 100,000 live births. Of the 126 study participants, 111 (88.1%) were diagnosed with primary neurological conditions (Group A), while 15 (11.9%) had secondary neurological conditions (Group B). The mean age was comparable between Group A and Group B (26.5 ± 4.8 vs. 26.9 ± 5.3 years, t = -0.27, df = 124, d = 0.08, p = 0.784).

Table *1* summarizes the baseline demographic and obstetric characteristics. The majority of participants were multigravida, 74 (58.7%), in the third trimester of pregnancy. Referral status differed significantly between the groups ($\chi^2 = 10.63$, df = 2, V = 0.29, p = 0.005), with home referrals occurring more frequently in Group A, 60 (54.0%), and private referrals in Group B, 11 (73.3%).

Characteristics	Group A, N = 111	Group B, N = 15	Total, N = 126	Test statistic	df	Effect size	P-value
Age (years)	mean 26.5 ± 4.8	26.9 ± 5.3	Not applicable	t = -0.27	124	d = 0.08	0.784†
Parity							
Primigravida	48 (43.2%)	4 (26.6%)	52 (41.2%)	$\chi^2 = 1.21$	1	V = 0.10	0.272*
Multigravida	63 (56.7%)	11 (73.3%)	74 (58.7%)				
Gestational age							
1st trimester	6 (5.9%)	0 (0%)	6 (4.76%)				
2nd trimester	5 (4.5%)	2 (13.3%)	7 (5.5%)	$\chi^2 = 2.81$	3	V = 0.15	0.421*
3rd trimester	73 (65.7%)	9 (60%)	82 (65%)				
Post-partum	27 (24.3%)	4 (26.7%)	31 (24.6%)				
Multiple pregnancy	2 (1.8%)	0 (0%)	2 (1.58%)	$\chi^2 = 0.27$	1	V = 0.05	>0.999*
Booking status							
Booked	36 (32.9%)	1 (6.7%)	37 (29.3%)	$\chi^2 = 3.38$	1	V = 0.16	0.066*
Un-booked	75 (67.5%)	14 (93.3%)	89 (70.6%)				
Referral status							
Government	24 (21.5%)	3 (20%)	27 (21.4%)				
Private	27 (24.3%)	11 (73.3%)	38 (30.1%)	$\chi^2 = 10.63$	2	V = 0.29	0.005*
Home	60 (54%)	1 (6.7%)	61 (48.4%)				
Pregnancy complications							
Gestational hypertension	5 (4.5%)	1 (6.7%)	6 (4.7%)				
Gestational diabetes	1 (0.9%)	0 (0%)	1 (0.79%)	$\chi^2 = 10.63$	2	V = 0.29	0.005*
Previous cesarean	15 (13.5%)	3 (20%)	18 (14.2%)				

TABLE 1: Baseline demographic and obstetric characteristics of study participants.

Continuous variables are presented as mean ± SD. Categorical variables are presented as N (%).

†: P-value was calculated using Welch's t-test.

*: P-value was calculated using Fisher's exact test.

t = t-statistic; χ^2 = chi-square statistic; df = degrees of freedom; d = Cohen's d; V = Cramér's V.

Severe anemia was the most common comorbidity, affecting 19 (15.1%) patients, and was significantly more

frequent in Group B than in Group A, 7 (46.6%) versus 12 (10.8%) (p = 0.002). Overall, comorbidities were more prevalent in Group B than in Group A, 12 (80.0%) versus 44 (39.6%) (p = 0.005). The remaining comorbidities were infrequent and did not differ significantly between the groups (Table 2).

Characteristics:	Group A (Primary), N =111	Group B (Secondary), N =15	Total, N =126	Fisher exact p-value
Hyperthyroidism	2 (1.8%)	0 (0)	2	>0.999
Hypothyroidism	3 (2.7%)	0 (0)	3	>0.999
Ischemic heart disease	2 (1.8%)	0 (0)	2	>0.999
Cardiomyopathy	2 (1.8%)	0 (0)	2	>0.999
Obesity	1 (1.9%)	1 (6.6%)	2	0.225
Substance abuse	2 (1.8%)	0 (0)	2	>0.999
Severe anemia	12 (10.8%)	7 (46.6%)	19	0.002*
Total	44 (39.6%)	12 (80%)	56 (44%)	0.005*

TABLE 2: Comorbidities among patients of primary and secondary etiologies.

Data are presented as N (%). P-values were calculated using Fisher's exact test. Patients may have had multiple comorbidities; therefore, the frequencies of individual comorbidities are not mutually exclusive, and the total number of patients with comorbidities does not equal the sum of the individual categories. A p-value <0.05 was considered statistically significant.

Primary etiologies accounted for 111 (88.1%) cases, whereas secondary etiologies accounted for 15 (11.9%). Epilepsy was the most common primary etiology, affecting 58 (52.2%) patients, followed by cerebral sinus thrombosis, 18 (16.2%), and hemorrhagic stroke, 12 (10.8%). Among secondary etiologies, hepatic encephalopathy was the most frequent diagnosis, occurring in 8 (53.3%) patients, followed by septic encephalopathy, 5 (33.3%), and uremic encephalopathy, 2 (13.3%). Mortality occurred in 3 (2.7%) patients with primary etiologies and 3 (20.0%) patients with secondary etiologies. The highest case fatality rates were observed in hepatic encephalopathy, septic encephalopathy, hemorrhagic stroke (16.6%), and ischemic stroke (Table 3).

Causative factors	N (number of cases)	Mortality	Case fatality rate
Group A (Primary etiologies)	N = 111 (88%)	3	2.7%
Epilepsy	58 (52.2%)	0	0
Ischemic stroke	9 (8.1%)	1	11.1%
Hemorrhagic stroke	12 (10.8%)	2	16.6%
Cerebral sinus thrombosis	18 (16.2%)	0	0
SOL (brain tumors)	2 (1.8%)	0	0
AVM	1 (0.9%)	0	0
Head injury	2 (1.8%)	0	0
Meningitis	5 (4.5%)	0	0
Encephalitis	3 (2.7%)	0	0
Moya-Moya	1 (0.9%)	0	0
Group B (Secondary etiologies)	15 (11.9%)	3	20%
Hepatic encephalopathy	8 (53.3%)	2	25%
Septic encephalopathy	5 (33.3%)	1	20%
Uremic encephalopathy	2 (13.3%)	0	0

TABLE 3: Distribution of patients according to etiological factors.

Data are presented as N (%) unless otherwise specified. Case fatality rate was calculated as the number of deaths due to a specific disease divided by the total number of patients with that disease.

SOL: space-occupying lesion; AVM: arteriovenous malformation

Table *4* presents the spectrum of clinical presentation in both groups. The most common presenting symptoms in Group A were seizures in 62 (55.9%) women, headache in 28 (25.2%), and focal neurological deficits in 21 (18.9%). In Group B, the most common presentations were altered sensorium in 9 (60.0%) women, seizures in 4 (26.7%), and headache in 2 (13.3%). The distribution of clinical presentations differed significantly between the groups ($\chi^2 = 12.45$, df = 4, V = 0.31, p = 0.014).

Clinical presentation	Group A, N = 111	Group B, N = 15	Total, N = 126	Test statistic	df	Effect size	P-value
Seizures	62 (55.9%)	4 (26.7%)	66				
Headache	28 (25.2%)	2 (13.3%)	30				
Focal neurological deficits	21 (18.9%)	0 (0%)	21	$\chi^2 = 12.45$	4	V = 0.31	0.014*
Altered sensorium	0 (0%)	9 (60.0%)	9				
Others	0 (0%)	0 (0%)	0				

TABLE 4: Distribution of patients according to the spectrum of clinical presentation in both groups.

Data are presented as N (%).

*: P-values were calculated using Fisher's exact test.

χ^2 = chi-square statistic; df = degrees of freedom; V = Cramér's V

Table 5 presents maternal and perinatal outcomes. Patients with secondary etiologies experienced less favorable clinical and perinatal outcomes than those with primary etiologies. Massive blood transfusion was required more frequently in Group B, 5 (33.3%), than in Group A, 3 (2.7%) ($\chi^2 = 10.82$, df = 1, V = 0.29, p = 0.001). Maternal mortality was also significantly higher in Group B, occurring in 3 (20.0%) patients compared with 3 (2.7%) patients in Group A ($\chi^2 = 5.24$, df = 1, V = 0.20, p = 0.022). Live births were less frequent in Group B, 7 (46.7%), than in Group A, 90 (81.1%) ($\chi^2 = 7.54$, df = 1, V = 0.24, p = 0.006), whereas stillbirths were more common in Group B, 6 (40.0%), than in Group A, 8 (7.2%) ($\chi^2 = 9.45$, df = 1, V = 0.27, p = 0.002). Intensive care unit (ICU) admission was common in both groups ($\chi^2 = 9.68$, df = 1, V = 0.28, p = 0.002). Although patients with secondary etiologies had numerically longer ICU stays (10.5 vs. 7.9 days; p = 0.099), longer ventilator support (8.0 vs. 5.9 days; p = 0.031), and longer hospital stays (12.2 vs. 8.6 days; p = 0.067), only ventilator days reached statistical significance; ICU stay and hospital stay differences were not statistically significant.

Characteristics	Group A (Primary), N = 111	Group B (Secondary), N = 15	Total, N = 126	Test statistic	df	Effect size	P-value
ICU admission	48 (43.24%)	13 (86.67%)	61	$\chi^2 = 9.68$	1	V = 0.28	0.002*
ICU stay days (mean) (95% CI)	7.9 (4.8) (6.9, 8.8)	10.5 (4.4) (8.1, 12.9)	-	t = -1.67	61	d = 0.43	0.099†
Ventilator days (mean) (95% CI)	5.9 (2.91) (5.3, 6.4)	8 (2.12) (6.8, 9.2)	-	t = -2.21	61	d = 0.57	0.031†
Hospital days (mean) (95% CI)	8.6 (7.07) (7.2, 9.9)	12.2 (6.3) (8.7, 15.6)	-	t = -1.85	124	d = 0.33	0.067†
CPCR	3 (2.70%)	1 (6.67%)	4	$\chi^2 = 0.69$	1	V = 0.07	>0.999*
Massive blood transfusion	3 (2.70%)	5 (33.33%)	8	$\chi^2 = 10.82$	1	V = 0.29	0.001*
Neurosurgical intervention	5 (4.50%)	0 (0)	5	$\chi^2 = 0.69$	1	V = 0.07	>0.999*
Full recovery	70 (63.06%)	6 (40%)	76	$\chi^2 = 2.89$	1	V = 0.15	0.099*
Coma	3 (2.7%)	0 (0)	3	$\chi^2 = 0.27$	1	V = 0.05	>0.999*
DAMA	26 (23.4%)	6 (40%)	32	$\chi^2 = 1.60$	1	V = 0.11	0.206*
Mortality	3 (2.70%)	3 (20%)	6	$\chi^2 = 5.24$	1	V = 0.20	0.022*
Residual defect/disability	12 (10.8%)	0 (0)	12	$\chi^2 = 0.84$	1	V = 0.08	0.358*
Preterm delivery	28 (25.23%)	5 (33.33%)	33	$\chi^2 = 0.40$	1	V = 0.06	0.525*
Live births	90 (81.08%)	7 (46.67%)	97	$\chi^2 = 7.54$	1	V = 0.24	0.006*
Still births	8 (7.21%)	6 (40%)	14	$\chi^2 = 9.45$	1	V = 0.27	0.002*
Neonatal death	3 (2.70%)	0 (0)	3	$\chi^2 = 0.27$	1	V = 0.05	>0.999*
Birth asphyxia	13 (11.7%)	4 (26%)	17	$\chi^2 = 2.41$	1	V = 0.14	0.120*
NICU requirement	30 (27.03%)	2 (13.33%)	32	$\chi^2 = 0.87$	1	V = 0.08	0.352*

TABLE 5: Maternal and perinatal outcomes in both groups.

Continuous variables are presented as mean (SD) (95% CI). Categorical variables are presented as N (%).

†: P-value was calculated using Welch's t-test.

*: P-value was calculated using Fisher's exact test.

t = t-statistic; χ^2 = chi-square statistic; df = degrees of freedom; d = Cohen's d; V = Cramér's V.

DAMA = discharge against medical advice; CPCR = cardiopulmonary cerebral resuscitation; NICU = neonatal intensive care unit

Discussion

This retrospective study evaluated the spectrum, clinical characteristics, and outcomes of neurological

emergencies during pregnancy and the puerperium over 11 years at a rural tertiary care teaching center. The cohort included a broad spectrum of neurological disorders; epilepsy was the most common diagnosis (52.2%), followed by cerebral venous sinus thrombosis, hemorrhagic stroke, and ischemic stroke. This distribution reflects the real-world case mix of neurological emergencies in pregnancy and underscores that non-vascular conditions predominate in this setting. Primary neurological disorders accounted for most cases (88.1%). Although secondary neurological disorders were less common, they were associated with greater maternal morbidity, increased critical care requirements, higher maternal mortality, and poorer perinatal outcomes. These findings should be interpreted as associations, given the retrospective design, small secondary group, and lack of multivariable adjustment. These findings emphasize the importance of early recognition and multidisciplinary management of neurological emergencies during pregnancy.

The cumulative incidence proportion in our study was 3.8 cases per 1,000 obstetric admissions (approximately 0.34 per 1,000 admissions per year when annualised). Although uncommon, these conditions remain important contributors to maternal morbidity and mortality. Differences in incidence across studies may be explained by variations in study populations, referral patterns, healthcare systems, diagnostic criteria, and case ascertainment. Direct comparison with population-based incidence estimates (e.g., per 100,000 pregnancies) is limited by the hospital-based denominator used in this study. Similar observations have been reported in previous studies of neurological disorders during pregnancy and the puerperium, particularly in resource-limited settings where delayed diagnosis and referral remain common [2,11,12].

Epilepsy was the most frequent primary neurological disorder in our cohort, consistent with previous Indian studies by Madkar et al. [13] and Gupta et al. [14], which also identified epilepsy as the predominant neurological condition during pregnancy. Stroke was the second most common neurological emergency, with hemorrhagic stroke occurring more frequently than ischemic stroke. This observation is consistent with reports by Yoshida et al. [15] and Prabhu [11], who demonstrated that hemorrhagic stroke contributes substantially to pregnancy-associated cerebrovascular disease, particularly during late pregnancy and the postpartum period. Cerebral venous sinus thrombosis also represented a substantial proportion of cases, reflecting its continued burden in developing countries despite advances in obstetric care [12].

Most patients presented during the third trimester or postpartum period, supporting previous evidence that pregnancy-related hypercoagulability, hemodynamic changes, and vascular adaptations increase susceptibility to neurological complications during these stages [12,16,17]. A large proportion of women were unbooked referrals, highlighting the potential impact of delayed referral and inadequate antenatal surveillance on disease severity. Severe anemia was more common among women with secondary neurological disorders, suggesting that underlying systemic illness may contribute to neurological deterioration and adverse maternal outcomes.

Seizures, headache, and altered consciousness were the predominant presenting symptoms. Altered consciousness was more frequent among women with secondary neurological disorders, reflecting the severity of metabolic and septic encephalopathies. These findings are comparable to previous studies that identified seizures and altered sensorium as the most common neurological manifestations requiring urgent evaluation during pregnancy [4,13,18].

One of the principal findings of this study was the poorer maternal outcomes observed among women with secondary neurological disorders. Compared with women with primary neurological disorders, these patients had higher rates of ICU admission, numerically longer ICU stays and hospitalizations (not statistically significant), prolonged mechanical ventilation, greater requirements for massive blood transfusion, and higher maternal mortality. These findings likely reflect severe underlying systemic illnesses, including hepatic and septic encephalopathies, rather than isolated neurological pathology. However, the small size of Group B (n = 15) and the lack of multivariable adjustment limit causal inference; the observed differences may be confounded by underlying disease severity, anemia, sepsis, and hepatic dysfunction [13,17].

Perinatal outcomes were also poorer among women with secondary neurological disorders. Live birth rates were lower, whereas stillbirths occurred more frequently in this group. In contrast, women with primary neurological disorders generally achieved better maternal recovery despite a higher frequency of residual neurological deficits and neurosurgical interventions, likely because structural cerebrovascular lesions often require specialized neurosurgical management. These findings are consistent with previous studies reporting adverse fetal outcomes among women with severe maternal neurological illness and highlighting the benefits of timely multidisciplinary intervention in improving maternal and neonatal survival [13,19].

The findings of this study highlight the importance of early recognition of neurological symptoms during pregnancy, prompt referral to tertiary care centers, and coordinated multidisciplinary care involving obstetricians, neurologists, neurosurgeons, intensivists, and neonatologists. Such an approach may reduce maternal and perinatal morbidity and improve overall pregnancy outcomes.

This study has several strengths, including its 11-year study period and comprehensive evaluation of both primary and secondary neurological disorders during pregnancy. However, the retrospective single-center

design limits the generalizability of the findings. Additional limitations include (i) potential selection bias from ICD code-based case retrieval, which may have missed undiagnosed or miscoded cases; (ii) the lack of a standardized neuroimaging protocol in this rural setting, which may have led to misclassification of some cases; (iii) the absence of multivariable adjustment for confounders such as underlying disease severity, anemia, sepsis, and hepatic dysfunction, because the small number of outcome events precluded stable regression modelling; (iv) the relatively small number of secondary neurological disorders (n = 15), resulting in unequal comparison groups and wide CIs; and (v) the unavailability of long-term maternal neurological and neonatal follow-up data. Despite these limitations, this study provides valuable evidence from a rural tertiary care setting, where published data on pregnancy-related neurological emergencies remain limited.

Conclusions

Neurological emergencies during pregnancy and the puerperium remain important contributors to maternal morbidity and mortality. Epilepsy and stroke were the most common neurological disorders identified in this cohort. Although secondary neurological disorders were less frequent than primary disorders, they were associated with poorer maternal and perinatal outcomes, including higher maternal mortality and greater critical care requirements. In contrast, primary neurological disorders were more frequently associated with neurosurgical intervention and residual neurological deficits. These findings represent observed associations in a retrospective cohort and do not establish causality; the small size of the secondary group and lack of multivariable adjustment limit definitive conclusions. The principal scientific contribution of this study is the observation that secondary metabolic/septic encephalopathies may carry worse maternal and perinatal outcomes than primary CNS disorders, a finding that warrants confirmation in larger, adequately powered studies with multivariable adjustment. Early recognition, timely referral, and coordinated multidisciplinary management are essential to improve maternal and perinatal outcomes. Future research should focus on developing and validating evidence-based patient safety bundles and standardized management protocols for neurological emergencies in pregnant and puerperal women to reduce preventable maternal and perinatal morbidity and mortality.

Additional Information

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All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Bhaikaka University, Karamsad, Anand, Gujrat, India issued approval IEC/BU/2023/Ex.90/346/2023. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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