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Original Research Article

HOSPITAL-ACQUIRED COMPLICATIONS OF ANEURYSMAL SUBARACHNOID HEMORRHAGE

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ABSTRACT

Background: *Aneurysmal subarachnoid hemorrhage (aSAH) is a life-threatening neurological emergency with high rates of morbidity and mortality. Despite advancements in diagnostic and therapeutic strategies, hospital-acquired complications remain a significant contributor to adverse outcomes in aSAH patients. Understanding the frequency and pattern of these complications is essential for improving patient care and outcomes.* ***Objective:*** *To assess the frequency of hospital-acquired complications in patients with aSAH and to compare the findings with existing literature to identify areas for potential improvement in patient management.* ***Study Design:*** *Descriptive observational study.* ***Setting:*** *Neurology Department, Fouji Foundation Hospital, Rawalpindi, Pakistan.* ***Duration of Study:*** *The study was conducted* from 11-09-2024 to 11-03-2025. ***Methods:*** *A total of 107 patients aged 18 to 75 years with confirmed aneurysmal subarachnoid hemorrhage were included. The diagnosis was based on clinical presentation and neuroimaging. Data collected included patient demographics, aneurysm characteristics, and the incidence of hospital-acquired complications. Complications observed included hydrocephalus, mechanical ventilation requirement, symptomatic vasospasm, and delayed cerebral ischemia (DCI). Descriptive statistics were applied using SPSS software to analyze the data.* ***Results:*** *The mean age of patients was 46.29 ± 16.86 years, with females comprising 53.3% of the cohort. The most common hospital-acquired complications were hydrocephalus (51.4%), need for mechanical ventilation (42.1%), symptomatic vasospasm (34.6%), and delayed cerebral ischemia (DCI) (20.6%).* ***Conclusion:*** *Hospital-acquired complications are prevalent among patients with aSAH, particularly hydrocephalus, symptomatic vasospasm, and DCI, which significantly influence clinical outcomes. These findings emphasize the need for early identification and proactive management of complications to improve prognosis and reduce morbidity in aSAH patients. Further studies with a larger sample size and multicenter data are recommended for broader applicability.*

Keywords: Aneurysmal Subarachnoid Hemorrhage, Hydrocephalus, Vasospasm, Delayed Cerebral Ischemia, Mechanical Ventilation, Endovascular Coiling, Surgical Clipping

INTRODUCTION

Aneurysmal subarachnoid haemorrhage (aSAH) is characterized by bleeding in the subarachnoid space, which is a consequence of the rupture of an intracranial aneurysm. aSAH accounts for only 2–5% of all stroke cases, with the global incidence declining from 10.2 per person-year in 1980 to 6.1 in 2010. This decline shows significant differences based on region, age, and sex. The global reduction in aSAH incidence aligns with a worldwide drop in hypertension prevalence and smoking rates (1). The incidence of aSAH increases with age and is 1.3 times more common in women than in men. Although there have been significant improvements in the prognosis of aSAH in recent years, 12% of patients do not survive until they reach the hospital, and the case-fatality rate within 90 days for those admitted with aSAH is approximately 30% (2, 3).

Critical elements impacting negative functional results and mortality encompass prior brain injury, rebleeding of a ruptured aneurysm, and the occurrence of delayed cerebral ischemia. Prompt diagnosis, referral to specialized facilities, methods to prevent rebleeding, and hemodynamic management to ensure organ perfusion in the initial phase after aSAH can improve the chances of positive outcomes (4-6). Access to high-volume centers, characterized by managing at least 35 patients annually, is associated with enhanced functional outcomes after aSAH (7).

The initial management of patients includes mechanical ventilation and intubation for comatose individuals to protect the airway and improve ventilation. Neuroimaging techniques, such as non-contrast head CT, confirm the diagnosis. If results are negative, additional procedures like digital subtraction angiography, lumbar puncture, and CT angiography may be performed. These methods also inform subsequent interventions, including aneurysm treatment strategies and the need for cerebrospinal fluid diversion. Additionally, it is essential to address hemodynamic instability and reverse coagulopathy (8, 9). A study indicated that the hospital-acquired complications of aneurysmal subarachnoid hemorrhage included hydrocephalus (58.2%), mechanical ventilation (48%), symptomatic vasospasm (36.5%), and delayed cerebral ischemia (23.2%) (10).

Although there have been advancements in medical and surgical treatment, aSAH continues to be a complicated and possibly catastrophic disorder with substantial rates of morbidity and mortality. Due to the paucity of literature on this subject locally, this study aims to determine the hospital-acquired complications of aneurysmal subarachnoid hemorrhage. The findings of this study will be helpful for our clinicians to improve the quality of patient care, provide specific interventions, accurately predict outcomes, and allocate healthcare resources effectively. An extensive investigation that examines the complications that occur during aSAH hospital stays can offer valuable knowledge about categorizing risk, detecting issues early on, implementing preventive measures, and adopting multidisciplinary management methods. Ultimately, this can result in improved outcomes and better patient-centered care for individuals with aSAH.

METHODOLOGY

This research was conducted as a descriptive study within the Neurology Department of Fouji Foundation Hospital in Rawalpindi [11-09-2024—11-03-2025]. The sample size was determined by incorporating specific parameters to ensure statistical reliability. Prior literature derived an anticipated frequency of hospital-acquired complications, specifically delayed cerebral ischemia, at 23.2%. With a 95% confidence level and an absolute precision of 8%, the calculated

sample size amounted to 107 participants. A non-probability consecutive sampling technique was used to select participants who met the predefined criteria.

Patients aged between 18 and 75 years who were diagnosed with aneurysmal subarachnoid hemorrhage as confirmed through clinical presentation and diagnostic imaging were included. The diagnosis rested on the presence of symptoms such as photophobia seizures and focal neurological deficits corroborated by computed tomography (CT) scans demonstrating hyperdense blood in the subarachnoid space involvement of the Sylvian Fissure and Basal Cisterns and specific aneurysm characteristics such as location (anterior or posterior) size (greater than 10 mm) and treatment modality (endovascular coiling or surgical clipping). Patients with confounding conditions such as brain tumors, brain abscesses, hereditary hemorrhagic telangiectasia, cardiovascular disease, end-stage renal disease, non-aneurysmal subarachnoid hemorrhage, or severe pulmonary disease were dropped from the study.

The data collection process commenced after securing approval from the hospital's ethical committee, and informed written consent was secured. A detailed history regarding diabetes, hypertension, and smoking was recorded for each individual. Throughout 2 to 4 weeks following the diagnosis of aneurysmal subarachnoid hemorrhage, patients were evaluated for hospital-acquired complications, including hydrocephalus, mechanical ventilation, symptomatic vasospasm, and delayed cerebral ischemia as defined by specific clinical and diagnostic criteria. This assessment was overseen by a consultant with at least five years of post-fellowship experience, ensuring rigorous and consistent evaluation. A structured proforma was used to document each patient's details, capturing demographic information, clinical findings, and complication outcomes.

SPSS 23 was deployed for analysis. Categorical variables such as gender, the presence of hospital-acquired complications (hydrocephalus, mechanical ventilation, symptomatic vasospasm, and delayed cerebral ischemia), diabetes, hypertension, smoking status, aneurysm location, size, and treatment type were summarized through frequencies and percentages. Age, weight, height, and body mass index (BMI) were presented as mean with standard deviation. Stratification was applied to account for potential effect modifiers, including demographics, comorbidities, and clinical parameters. Following stratification, statistical significance was evaluated using the Chi-square/Fisher's exact test as appropriate, with a 5% significance level guiding the interpretation of results.

RESULTS

The average age of our patients was 46.29 ± 16.858 years, while their mean body mass index stood at 25.6352 ± 1.55397 kg/m². Regarding gender distribution, 50 participants were male, 46.7% of the group, and 57 were female, accounting for 53.3% (Figure 1).

Looking at the clinical characteristics, hypertension was present in 42 individuals, which translates to 39.3%, while 65 (60.7%) participants did not have this condition. Smoking was reported by 26 people, representing 24.3%, with the remaining 81 (75.7%) identifying as non-smokers. Diabetes affected 37 participants, equating to 34.6%, while 70 (65.4%) were free of this diagnosis. Regarding the location of the aneurysm, 87 cases were anterior, comprising 81.3%, and 20 were posterior, making up 18.7%. Aneurysms measuring 10 mm or larger were observed in 81 (75.7%) individuals, while 26 (24.3%) participants had smaller aneurysms. Treatment-wise, 73 patients underwent endovascular coiling, 68.2%, and 34 had surgical clipping, representing 31.8% (Table 2). Turning to the hospital-acquired complications, hydrocephalus emerged in 55 participants, affecting 51.4%. Mechanical ventilation was required for 45 individuals, which is 42.1%. Symptomatic vasospasm occurred in 37 cases, amounting to 34.6%. Lastly, delayed cerebral ischemia was noted in 22 individuals, representing 20.6% (Table 3). We did not find any notable associations of the hospital-acquired complications with demographics, comorbidities, and clinical parameters.

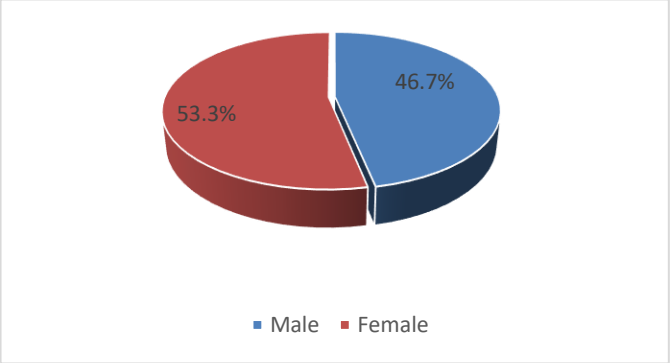

Figure 1: Gender distribution

Table 1: Comorbidities and clinical parameters

Comorbidities and clinical parameters		Frequency	%
Hypertension	Yes	42	39.3%
	No	65	60.7%
Smoking	Yes	26	24.3%
	No	81	75.7%
Diabetes	Yes	37	34.6%
	No	70	65.4%
Location	Anterior	87	81.3%
	Posterior	20	18.7%
Aneurysmal size >= 10mm	Yes	81	75.7%
	No	26	24.3%
Treatment	Endovascular Coiling	73	68.2%
	Surgical Clipping	34	31.8%

Table 2: Hospital-acquired complications

Hospital-acquired complications		Frequency	%
Hydrocephalus	Yes	55	51.4%
	No	52	48.6%
Mechanical ventilation	Yes	45	42.1%
	No	62	57.9%
Symptomatic vasospasm	Yes	37	34.6%
	No	70	65.4%
Delayed cerebral ischemia	Yes	22	20.6%
	No	85	79.4%

DISCUSSION

Our cohort's mean age was 46.29 years, which is slightly lower than Roquer et al.'s, who reported a mean age closer to 55 years. This indicates that our patient population may be younger than those typically reported in the literature. This difference in age distribution may influence complication rates, as younger patients often have fewer pre-existing conditions that exacerbate the risk of complications (10).

Hypertension, a well-established risk factor for aSAH and its complications, was observed in 39.3% of our patients, which is relatively comparable to findings by Roquer et al., where hypertension prevalence ranged from 40-50%. However, smoking rates in our cohort were lower (24.3%) than the reported 30-40% in Psychogios et

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al. 's study (11). This discrepancy could partially explain differences in vasospasm incidence.

Our study's distribution of aneurysm location and treatment modality aligns with previously published findings, where anterior circulation aneurysms were significantly more common than posterior circulation aneurysms (81.3% vs. 18.7%). Similarly, a preference for endovascular coiling (68.2%) over surgical clipping (31.8%) is by contemporary trends emphasizing less invasive approaches when feasible (12).

Hydrocephalus was observed in 51.4% of our patients, a rate somewhat lower than the 58.2% reported by Roquer et al.10 This could be due to differences in the criteria used for diagnosis, the timing of assessment, or variations in patient management. Mechanical ventilation was required in 42.1% of our patients, which is again slightly lower than the 48.4% observed by Roquer et al.10 Given that mechanical ventilation is associated with higher mortality and poorer long-term outcomes, a lower incidence in our cohort might suggest better initial neurological status or more effective early intervention strategies.

Symptomatic vasospasm occurred in 34.6% of our cases aligning closely with reported ranges of 20 to 30% as reported by Daou et al.[12] However the reported delayed cerebral ischemia (DCI) incidence of 20.6% in our cohort is slightly lower than the 30% found by Lee et al. (13) While subtle this difference could have implications for long-term functional outcomes. DCI remains one of the strongest predictors of poor prognosis, and any reduction in its incidence may translate into better survival and functional recovery rates.

Although pneumonia, electrolyte disturbances, and cardiac complications were not explicitly mentioned in our dataset, these factors play crucial roles in the overall complication profile of aSAH. Roquer et al. reported pneumonia in 23.5% of patients, and sodium disturbances, particularly hyponatremia, affected up to 33.3% of patients, potentially contributing to increased neurological deterioration (10).

One of the most striking observations in our study is the relatively lower rate of delayed cerebral ischemia. This may suggest effective vasospasm management strategies such as aggressive hydration, nimodipine use, and early recognition of neurological decline. Additionally, our cohort had a higher proportion of endovascularly treated patients, which has been associated with a lower incidence of vasospasm compared to surgical clipping (10).

From a clinical perspective, our findings support the broader literature and offer some unique insights. The relatively lower incidence of complications such as DCI and mechanical ventilation may suggest superior perioperative and intensive care management. Further investigation into the specific management protocols employed in our center could help identify best practices that may contribute to these positive trends.

In summary, our study provides valuable insights into hospital-acquired complications of aSAH, aligning with established literature and highlighting some potentially advantageous trends in patient outcomes. A deeper exploration of management strategies, particularly in preventing DCI and reducing the need for prolonged ventilation, could further refine best practices in aSAH care.

CONCLUSION

In conclusion, hospital-acquired complications in aSAH, including hydrocephalus, vasospasm, and DCI, remain significant contributors to morbidity. Our results align with the existing literature, though a lower incidence of DCI and mechanical ventilation suggests potential benefits of early intervention approaches. Further research into optimizing vasospasm management and reducing respiratory complications could improve outcomes. Implementing standardized protocols for fluid management, nimodipine administration, and early mobilization may help mitigate these risks.

DECLARATIONS

Data Availability Statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department Concerned. (REF NO 831/RC/FFH/RWP)

Consent for publication

Approved

Funding

Not applicable

CONFLICT OF INTEREST

The authors declared an absence of conflict of interest.

AUTHOR CONTRIBUTION

MURAD KHAN (Resident Neurology)
Conception of Study, Development of Research Methodology Design, Data Collection, Study Design, manuscript Review, and final approval of manuscript.
HUSNAIN HASHIM (Assistant Professor)
Manuscript revisions, critical input.
ABDUL WAHAB (Resident Neurology)
Literature review
ZAHOOR AHMAD (Resident Neurology)
Literature review

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