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Improved aneurysmal subarachnoid hemorrhage outcomes: A comparison of 2 decades at an academic center

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Abstract

Objective: Management of aneurysmal subarachnoid hemorrhage (aSAH) has evolved over the past 2 decades, including refinement of neurosurgical techniques, availability of endovascular options, and evolution of neurocritical care; their impact on SAH outcomes is unclear.

Design/Methods: Prospectively collected data of patients with aSAH admitted to Johns Hopkins Medical Institutions between 1991 and 2009 were analyzed. We compared survival to discharge and functional outcomes at initial clinic appointment postdischarge (30-120 days) in patients admitted between 1991 and 2000 (phase 1 [P1]) and 2000 and 2009 (phase 2 [P2]), respectively, using dichotomized Glasgow Outcome Scale (good outcome: Glasgow Outcome Scale 4-5).

Results: A total of 1134 consecutive patients with aSAH were included in the analysis (P1 46.4%, P2 53.6%). There were higher rates of poor grade Hunt and Hess (P1 23%, P2 28%; $P < .05$), admission Glasgow Coma Scale score lower than 8 (P1 14%, P2 21%; $P < .005$), known medical comorbidites (P1 54%, P2 64%; $P = .005$), associated intraventricular hemorrhage (P1 47%, P2 55%; $P < .05$), and older population (P1 51.5%, P2 53.5%; $P < .05$) in P2. Good outcomes were more common in P2 (71.5%) compared with P1 (65.2%), with 2-fold adjusted odds of good outcomes after correction for various confounding factors ($P < .001$).

Conclusions: Our institutional experience over 2 decades confirms that patients with aSAH have shown significant outcome improvements over time.

1. Introduction

Subarachnoid hemorrhage (SAH) accounts for 5% of all strokes and affects approximately 30 000 Americans every year [1-3]. Outcomes for patients with SAH have been much poorer than for those with ischemic strokes, with

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population-based mortality rates reported as high as 45% with significant morbidity among survivors [4-8]. Advances in the management of aneurysmal SAH (aSAH) including refinement of neurosurgical techniques, availability of endovascular options, and evolution of neurocritical care have led to improved outcomes, especially in high-volume centers [9-17].

Based on a recent meta-analysis, Rosen and Macdonald [18] reported survival from aSAH at around 65%, which represents an increased survival of 17% over the past 3 decades. The same group reported that two thirds of aSAH survivors regained functional independence, with half having cognitive impairments and only a third resuming the same work as before the event. Published data from another university-based high-volume center reported mortality rates for SAH admissions of around 20%, with as many as half of the poorest-grade SAH (grade V) surviving to discharge [13]. Compared with mortality statistics, data regarding functional outcomes among survivors have been much harder to come by.

As a large university-based tertiary care referral center, patients with aSAH are referred to us from emergency departments (EDs) of other hospitals statewide and are transferred to 1 of our neuroscience intensive care units at either of our 2 institutions that provide subspecialized care for this patient population (Johns Hopkins Hospital, Johns Hopkins Bayview Medical Center). This is in addition to SAH patients who are admitted from our institutional EDs. Over the past 2 decades, close to 1500 patients were admitted after nontraumatic subarachnoid hemorrhage to 1 of our neurointensive intensive care units. Cerebral angiography was initially performed to visualize the aneurysm and, if positive, was followed by neurosurgical or endovascular intervention to secure the aneurysm, with monitoring and medical management of various complications related to SAH such as vasospasm, myocardial stunning, cerebral salt wasting, seizure, hydrocephalus, and intracranial hypertension [5,19–28]. The objective of our analysis was to elucidate if SAH outcomes have, in fact, improved at our institution(s) over the past 2 decades with the evolution of SAH management over this period.

2. Methods

We retrospectively reviewed patient-related data from a prospectively collected database of patients with aSAH admitted to Johns Hopkins Medical Institutions between 1991 and 2009. Patients with SAH secondary to other causes such as trauma, arteriovenous malformation, brain tumors, dural arteriovenous fistulas (AVFs), arterial dissections, and other causes including those possibly of venous etiology (perimesencephalic SAH, angiogram negative) were excluded. We compared in-hospital mortality and functional outcomes at first clinic appointment postdischarge (30-120 days) in patients admitted between 1991 and 2000 (phase 1 [P1]) and between 2000 and 2009 (phase 2 [P2]), respectively, using dichotomized Glasgow Outcome Scale (GOS). Good outcome was defined as GOS scores 4 to 5. There was no set defined time for follow-up appointments, which was based on the individual neurosurgeon's preference, but all patients who were followed up in an outpatient setting were seen at their first follow-up between 30 and 120 days post-SAH.

In certain cases, no follow-up records were available, in which case GOS upon discharge was used in place of outpatient examination for assessing GOS. This was done so as to not exclude the sickest patients, who were typically unable to follow up at the clinic because they were in nursing homes or skilled nursing facilities, thereby allowing for our patient population to be more truly representative of the SAH population admitted to the hospital. Patients who died were assigned the worst score for follow-up outcomes (GOS score, 1).

The impact of other admission factors known to affect outcomes based on other publications on this subject such as age, Hunt and Hess grade, admission Glasgow Coma Scale (GCS), major medical comorbidities (coronary artery disease, congestive heart failure, hypertension, diabetes mellitus, chronic obstructive pulmonary disease, stroke, liver cirrhosis, renal failure, cancer), and radiologic factors like intraventricular hemorrhage (IVH) and hydrocephalus [4-7,18,26,28-32] was analyzed as well. These potential confounding factors were compared in the 2 patient populations studied to assess for differences in baseline characteristics. The unpaired t test was used when data were normally distributed, and non-parametric tests (Mann-Whitney U test, Kruskal Wallis test) used when data were not normally distributed. Dichotomous variables were compared with outcome using the chi squared test, with the Fischer's exact test result reported where appropriate. For simplification purposes, "major medical comorbidities" was subcategorized into 3 groups: 0, no comorbidities; 1, single major medical comorbidity; and 2, 2 or more major medical comorbidities. Using SPSS, "Statistical Package for the Social Sciences version 18.0 (SPSS Statistics, Chicago, IL, USA)", the potential impact of each of the admission factors including the period of admission (P1/P2) on in-hospital mortality and functional outcomes was studied. All impacting factors were then included in multiple logistic regression analysis, excluding factors that exhibited collinearity.

We also compared other factors that could potentially lead to differences in outcomes such as aneurysm rerupture rates, delayed ischemic neurologic deficit based on computed tomography (CT)–evident infarcts, and the availability of endovascular coiling as a treatment option. Aneurysm rerupture has been shown to significantly increase case fatality [21]. Delayed ischemic neurologic deficits related to vasospasm have been shown to impact morbidity [29,37], and the publication of the results of the International Subarachnoid Aneurysm Trial suggests that endovascular coiling [14] may be superior in a select patient population.