

# Primary Intraventricular Hemorrhage: Clinical Characteristics and Outcomes

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*Background:* Primary intraventricular hemorrhage (IVH) in adults is a rare neurologic disorder. The typical course, etiology, complications, and outcomes have not been well established. *Materials and Methods:* Consecutive patient records with a diagnosis of intracerebral hemorrhage admitted between May 2009 and June 2014 at a tertiary care center were retrospectively reviewed. Subjects were included in the study cohort if all neurologists and the radiology report agreed that the subject had an isolated IVH. Patients with intraparenchymal hemorrhage, subarachnoid hemorrhage, malignancy with hemorrhagic components, and hemorrhagic transformation of ischemic stroke were excluded. The electronic medical record, imaging report, and imaging studies were reviewed. *Findings:* Of 1692 cases reviewed, 33 (1.9%) had primary IVH. The most common presenting symptoms included altered mental status (48.5%), headache, (39.4%), and nausea (24.2%). In 36.3%, hypertension was found to be a contributing factor; 27.2% were attributed solely to hypertension. Vascular abnormalities were the primary etiology in 21.3% of patients. When observing outcomes, 61.8% were discharged home or to rehab, whereas 20.5% died or were placed in hospice care. A higher Graeb score was associated with an increased likelihood of death or hospice (8 versus 5,  $P = .02$ ) *Conclusion:* This study is one of few to describe the etiology, contributing factors, and outcomes of primary IVH. As in prior studies, hypertension was a contributing factor, and vascular lesions were less common than expected. More research is necessary to further define the course and characteristics of this rare type of intracerebral hemorrhage. **Key Words:** Intraventricular hemorrhage—outcome—intracranial hemorrhage—arteriovenous malformation—cerebral angiography—hydrocephalus—Graeb score.

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## Introduction

Primary intraventricular hemorrhage (IVH), defined as a nontraumatic intracranial hemorrhage confined to the ventricular system and immediate parenchymal ependymal lining, is a rare and poorly understood neurological disease.<sup>1-3</sup> Unlike the more commonly seen secondary IVH, which occurs as a consequence of intraparenchymal or subarachnoid hemorrhage into the ventricular system, primary IVH accounts for only 3.1% of all nontraumatic central nervous system hemorrhages.<sup>1</sup> Due to the rarity of primary IVH, the etiology, treatment, and prognosis still remain unclear.

In this study, we sought to better define the clinical characteristics of primary IVH to provide insight into the risk factors and prognosis of this high-risk, poorly understood disease.

## Materials and Methods

We conducted a retrospective chart review of patients with a diagnosis of intracerebral hemorrhage (ICH) consecutively admitted to a tertiary care center between May 2009 and June 2014. Four neurologists (K.E., B.S., S.S., S.C.) reviewed the images captured in the initial head computed tomography (CT) scan for each patient admitted with ICH. Patients found to have intraparenchymal, subarachnoid, or subdural hemorrhage, malignancy with hemorrhage, or hemorrhagic transformation of an ischemic stroke on initial CT scan were excluded. Magnetic resonance imaging (MRI) was reviewed when available. Primary IVH was defined as blood present only in the lateral ventricles, third ventricle, and/or fourth ventricle with no parenchymal hemorrhage. The interpretation of the study neurologist was then compared to the conclusion of the interpreting neuroradiologist and the clinical impression of the attending vascular neurologist involved in the subject's care during their hospital admission. Images for all potential cases were ultimately reviewed by S.S. and S.C., who are board-certified attending vascular neurologists. Subjects were included in the study if there was unanimous consensus among the study neurologists that the subject had primary IVH and no report by neuroradiology of a parenchymal component.

Gender, age, length of stay, presenting symptoms, pre-existing medical conditions, presumed etiology as determined by the on-service vascular neurologist, imaging, and outcomes were extracted from the subjects' medical records. Graeb scores were calculated based on visual inspection of initial CT imaging.<sup>4</sup> Coagulopathy was defined as international normalized ratio (INR)  $\geq 1.5$  or platelet count  $< 100,000$ . Good outcome was defined as discharge to home or to acute rehab. Descriptive statistics were performed using SPSS version 19 (Chicago, IL). A literature review was also conducted to identify all prior publications of patients with intraventricular hemorrhage, using the key words "primary intraventricular hemorrhage" and excluding articles written in a language other than English and those with 5 cases or less. This review was conducted using Ovid, Scopus, and PubMed. This study was conducted with the approval of the local institutional review board.

## Results

Of 1692 patients admitted with ICH during the study period, 33 (1.9%) were diagnosed with primary IVH. If a patient had IVH with a history of fall at ictus or being

found down, but with no skull fracture or other external signs of injury apart from minor lacerations not requiring sutures, they were included; those with clear signs of trauma, with concomitant subdural hemorrhage, skull fractures, temporal contusions, or with other internal injuries were excluded. There were 1659 patients excluded after review of imaging revealed either primary parenchymal hemorrhage with IVH (the most common exclusion criteria), an arteriovenous malformation causing parenchymal hemorrhage with IVH, or metastatic lesions causing parenchymal hemorrhage with IVH. The mean age of the patients was 56.8 years old (range of 20-88, interquartile range 25). Less than half of the patients were male (42.4%), and the average length of stay was 11 days. Nineteen patients (57.5%) presented within the first 6 hours from symptom onset, with 2 (6.1%) additional patients presenting within 12 hours and the remainder within 24 hours (4, 12.1%) or later (8, 24.2%). Approximately two-thirds of the patients had a history of hypertension (64%), whereas diabetes (30.3%) and hyperlipidemia (18.8%) were also prevalent. Nine patients (27.2%) were on anticoagulation prior to admission, all of whom were taking warfarin. Of the 9 patients on anticoagulation, 8 were given fresh frozen plasma (FFP) and vitamin K on presentation (4 intravenous, 2 intramuscular, 2 unspecified; 5 received additional vitamin K orally); 3 patients received recombinant factor VIIa (NovoSeven, Novo Nordisk) on arrival to Rush. The patient who was not reversed had multiple mechanical valves and presented with an INR of 2.3. Most patients (91%) were transfer patients; data on initial Glasgow Coma Scale (GCS), systolic blood pressure, and coagulation studies at initial presentation to any facility were available for 24 (GCS, 72%), 31 (systolic blood pressure, 94%), and 25 (coagulation studies, 76%), respectively. Clinical characteristics are listed in [Table 1](#).

The most common clinical presentations were altered mental state (48.5%), headache (39.4%), nausea (24.2%), and vomiting (21.2%) ([Table 1](#)). Approximately 1 out of 10 (9.1%) had a history of minor trauma (fall, found down with lacerations) preceding discovery of primary IVH, although none had trauma to the head that could have been considered a contributing factor to IVH. Half of the patients exhibited hydrocephalus and required an extra-ventricular drain; nearly a quarter (24.2%) required a ventricular peritoneal shunt.

Twelve patients (36.4%) had a computed tomography angiogram (CTA) as the primary vascular imaging modality, 13 patients (39.3%) had both CTA and catheter angiogram, and 3 patients (9.1%) had catheter angiogram alone ([Table 2](#)). Of the remaining 5 patients without vessel imaging, 2 had clinical signs of transtentorial herniation prior to or shortly after arrival, 2 had renal insufficiency and pursued palliative care shortly after arrival due to coexistent advanced dementia or multiple other medical comorbidities, and 1 had IVH due to shunt repositioning. Sixteen patients (48.5%) had an MRI, although

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