

# Journal Club:

## Surveillance neuroimaging and neurologic examinations affect care for intracerebral hemorrhage

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The article “Surveillance neuroimaging and neurologic examinations affect care for intracerebral hemorrhage”<sup>1</sup> is reviewed. This review focuses on the methods, results, limitations, and merits of the original article.

**BACKGROUND AND SIGNIFICANCE** Despite advances in medical care, the morbidity and mortality of intracerebral hemorrhage (ICH) remains high.<sup>2</sup> Early neurologic worsening occurs in about one-third of patients with ICH.<sup>3</sup> Delayed intraventricular hemorrhage (IVH) is common and independently associated with morbidity and mortality.<sup>4</sup> In the STICH trial, 26% of patients initially randomized to medical management subsequently required surgery, largely due to clinical/neurologic deterioration or hematoma expansion.<sup>5</sup> Neurocritical care reduces in-hospital mortality rates,<sup>6</sup> but the degree of surveillance necessary to improve outcomes remains unclear. Data are limited on surveillance imaging and clinical examinations in ICH, and the guidelines are not detailed on this issue.<sup>7</sup>

**HYPOTHESIS AND DESIGN** In this single-center prospective observational cohort study of 239 patients, the authors sought to evaluate whether surveillance neuroimaging and repeat neurologic examinations affect care in patients with ICH.<sup>1</sup> Identifying any method to improve patient outcomes is important given the high morbidity and mortality of ICH. Via extensive chart review, the authors stratified patients who underwent surgical intervention either at initial evaluation or later in the hospital course. In the latter group, the authors evaluated whether a change in neuroimaging or neurologic examination led to the intervention. A secondary analysis attempted to identify predictors of subsequent surgical intervention.

**METHODS** Patients with spontaneous ICH were prospectively enrolled over a 5-year period at a single academic center. Those with ICH secondary to trauma, structural lesions, hemorrhagic transformation of ischemic stroke, or vascular malformations were excluded.

Patients underwent noncontrast head CT (HCT) scans at intervals of 6, 24, and 48 hours after the initial brain imaging. After 48 hours, HCT was repeated on a daily basis for patients at high risk for deterioration.

An emergent HCT was performed outside of the sequence of scheduled repeat scans in patients with a change in status. The protocol was stopped or deferred in those patients too medically unstable to have a scan and in those for whom withdrawal of care had been decided.

The Glasgow Coma Scale (GCS) was performed at admission and on an hourly basis by a neuroscience nurse throughout the intensive care unit (ICU) stay, and the NIH Stroke Scale (NIHSS) was performed by a neuroscience nurse at admission and 12 hours after admission. A physician was notified of changes in neurologic status. In addition, all patients were examined at least twice daily by neurologists, neurosurgeons, or critical care physicians with experience in neurologic conditions. A certified examiner recorded the NIHSS score and the modified Rankin Scale (mRS) score at 14 days or at discharge (whichever came first). The mRS was repeated at 28 days and 3 months via a validated questionnaire.

Craniotomies for hematoma evacuation  $\pm$  decompression or ventriculostomies for hydrocephalus or IVH were recorded if performed. Craniotomies were typically performed in patients with either a large ( $>30$  mL) superficial lobar hemorrhage (with concern for life-threatening mass effect) or a cerebellar hemorrhage (with concern for brainstem compression or ventricular obstruction). Ventriculostomies were typically performed in patients with hydrocephalus or IVH and diminished level of consciousness. The chart was reviewed in each of these cases to identify what clinical and objective findings led to the intervention. If the intervention was performed as soon as able after the initial assessment, the case was judged as related to initial management. If the intervention was performed later, it was judged as either scan-initiated or examination-initiated. Analyses comparing scan-initiated vs examination-initiated interventions were performed using the Fisher exact test. To assess for predictors of subsequent surgical intervention, the authors identified variables associated with subsequent intervention on univariate analysis and then entered variables with  $p < 0.2$  into a logistic regression model to identify independent predictors. A threshold  $p$  value of 0.2 is commonly

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used for identifying potentially important variables for further multivariate analysis.

**RESULTS** Eighty-four patients (35% of the 239 patients) underwent 88 discrete surgical interventions, including 52 ventriculostomies, 21 craniotomies, and 11 craniotomies with concurrent ventriculostomies. Sixty-four (73%) of the interventions occurred due to the initial evaluation and 24 (27%) occurred due to subsequent evaluations. The median time in which the subsequent surgical interventions occurred was 15.9 hours (interquartile range 8.9–27.0) from symptom onset. Intervention was delayed in 3 cases (2 due to surrogate decision-making delay and 1 due to a logistical reason), and these cases were classified as initial management interventions due to intent of the medical team. Eleven (46%) of the subsequent interventions were scan-initiated and 13 (54%) were examination-initiated ( $p = 0.8$ ).

No demographic, radiologic, or clinical findings at the time of initial evaluation were independently associated with subsequent intervention on multivariate analysis. The ICH score was associated with a need for subsequent surgical intervention ( $p = 0.045$  in the univariate analysis, but  $p = 0.30$  in the multivariate). Delayed IVH ( $p = 0.005$ ) and hematoma expansion ( $p < 0.001$ ) on surveillance neuroimaging were associated with subsequent surgical intervention.

**INTERPRETATION** This study demonstrates that surveillance neuroimaging and serial neurologic examinations identified cases in which subsequent surgical intervention was indicated. The structured program led to subsequent surgical intervention in about 10% of the total number of enrolled patients. The study results are potentially applicable at both patient and health care systems levels. Possibilities range from alterations in neurologic ICU design (e.g., mobile CT scanners in the ICU) to workforce adjustments (e.g., additional neuroscience-trained nurses), among others.

There are limitations to this study. The study does not address how many patients had neuroimaging changes or examination changes or the proportion leading to subsequent surgical intervention. Outcomes are not reported. According to the methods, mRS was recorded at various intervals but the results are not reported. The number and timing of deaths in each category (no intervention, initial intervention, and subsequent intervention) would be interesting to evaluate in light of the “self-fulfilling prophecy” phenomenon.<sup>8</sup> A detailed examination of the outcomes exceeds the scope of the article, and the authors point out the objective of this study was not to determine the efficacy of the surgical interventions. ICH location (e.g., deep, lobar, or infratentorial) and stratification of ICH volumes by location are not reported. The authors do not

offer a hypothesis for why variables at initial presentation did not predict the need for delayed intervention. The authors also do not comment specifically on which examination instruments (GCS, NIHSS) prompted delayed interventions.

While repeat neurologic examinations are relatively easy to obtain with minimal cost and risk to the patient, repeat HCT scans increase the cost and radiation exposure to the patient. Relatively few HCTs led to a surgical intervention and, as the authors state, whether subsequent neurologic examination would have identified the deterioration requiring intervention is unknown, as is the impact of any delay.

This study demonstrates that a structured imaging and examination program can affect ICH care and is an important addition to the field. Whether the benefits outweigh the risks and costs of such a program requires further work.

### AUTHOR CONTRIBUTIONS

Stephanie Stahl: drafting/revising the manuscript, analysis/interpretation of data. Jason Mackey: revising the manuscript, analysis/interpretation of data.

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### DISCLOSURE

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