Neuroimaging Protocol in Patients Presenting with Spontaneous Intracerebral Hemorrhage

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Introduction

While lacking evidence based recommendations, most institutions must evaluate spontaneous intracerebral hemorrhages (sICH) for hematoma expansion (HE). If unrecognized, it can be a devastating complication. However, because of the lack of general recommendations for serial imaging, many hospitals, including Thomas Jefferson, have arbitrarily instituted 6 hour an 24 hour stability head CT's to evaluate for HE.

In our project, we examine the impact of this imaging protocol on the safety and quality of patient care and provide revised recommendations for imaging in sICH at Thomas Jefferson University Hospital and Jefferson Hospital for Neuroscience.

Analysis of non contrast head CT resource utilization and impact on patient safety

-Cost of non contrast HCT: some of the widest variability in medicine with ranges quoted $200-$1200 depending on location and provider.

-Radiation of single HCT: 2 mSv, comparable to 8 months of background radiation

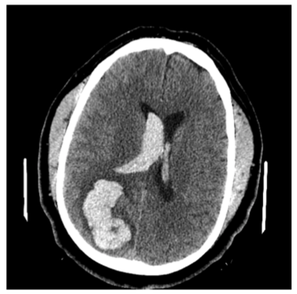
-Time to obtain HCT: approximately 45-60 minutes, including 30 minutes of critically ill patient time outside of ICU room in transport/moving patient/scanning. There are many studies concern the dangers of moving critically ill patients off the unit for radiology studies. Many ICH patients may be unstable/medically complex and extra scans may be dangerous.

-Personnel use: nurse, transport versus nursing technologist, respiratory therapist (if patient intubated), CT technologist, radiologist. Nursing personnel are responsible for other patients in ICU that require other nurses to take on additional patients to cover while off the unit. This requires immense coordination the entire nursing team to pool together the resources to safely obtain the scan.

Methods

We examined patients over two years at our institution presenting with sICH. To be analyzed, patients required a minimum of two computed tomography scans after admission. Determination of sICH volume was calculated via the *ABC/2* method. The primary outcome was HE, defined as >33% or a >6cc increase from the baseline scan. This definition of HE was derived from several previous studies in literature to be consistent with prior literature but also attempt to provide a sensitive definition consistent with HE that is also clinically significant.

Examples of HCT with various characteristics examined as risk factors for HE. The left HCT has IVH, irregular clot shape, and volume > 30 mL. The right HCT shows volue > 30 mL and fluid level within hemorrhage.



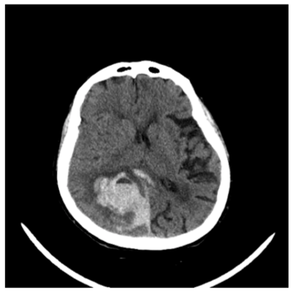


Table 1: Rates of hematoma expansion in for various ICH characteristics
ICH – Intracerebral hemorrhage
IVH – Intraventricular hemorrhage

	Rates of expansion for various ICH characteristics
Initial volume >30mL	53.3% (32/60)
Temporal lobe	36.4% (8/22)
Irregular shape	46.2% (24/52)
Fluid level present	80% (12/15)
IVH present	31.2% (24/77)
ICH score >1	42.7% (32/75)
None of the above	15.4% (10/55)

Results:

194 patients met criteria for inclusion (52.6% men, mean age 67.89±15.48). HE occurred in 29.7% patients, and 19.1% of those underwent intervention. The initial volume of patients who experienced a HE (40.1±31.8cc) was significantly larger than those without a HE (21.6±26.2cc; p<0.001). Additionally, frontal lobe ICH, irregularly shaped hemorrhage, radiographic fluid level, and higher ICH score were also significant univariate predictors of HE. However, age, temporal lobe ICH, being on an antithrombotic agent, intraventricular hemorrhage, elevated INR or hypertension on arrival were not correlated with HE. Multivariable analysis demonstrated that fluid level (OR 8.14, p=0.002) and greater initial volume (OR 1.02, p=0.007) were significant predictors of HE, while ICH/GCS scores were not. Clinical deterioration was strongly correlated with HE (OR 3.08, p=0.003), remaining significant even after controlling for ICH score on admission (p=0.017).

Proposed CT Protocol for sICH:

Based on 194 patients presenting to Thomas Jefferson with sICH, we have determined that the ICH is unlikely to expand if none of the following variables are present:

Large volume, irregularly shaped hemorrhage, radiographic fluid level, elevated ICH score.

In addition, patients with temporal ICH and IVH and patients that traditionally are at higher risk for need for surgical intervention in the form of ventriculostomy and/or decompressive hemicraniectomy.

Finally, clinically deterioration was strongly associated with HE.

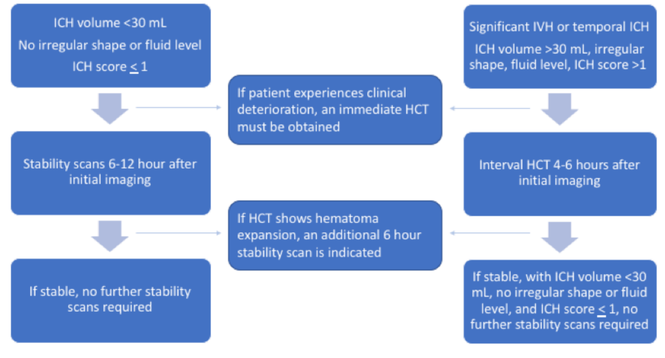
As a result, we propose the following:

sICH with volume less than 30 mL, no irregular shape or fluid level, and ICH score of 1 or less may receive stability scans 6-12 hour after initial imaging. If stable, no further stability scans are required. Patients with these factors should receive a stability scan 4-6 hours after initial imaging.

Patients with significant IVH or temporal ICH may receive short interval HCT 4-6 hour after initial imaging. If stable and the above risk factors for HE are absent, no further stability scans are required.

If any patient experiences clinical deuteriation, an immediate HCT must be obtained.

If any HCT shows hematoma expansion, a 6 hour stability scan is indicated.



Future directions:

This process should be verified within our hospital to ensure that is is sensitive enough to ensure patient safety but also to calculate savings on HCT, personnel time spent, and radiation dosing patients are spared by a less frequent, more data driven approach to serial imaging in sICH.