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Blood Can Be Very Bad: CT Interpretation for the EM Physician

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Case Presentation

An emergency physician evaluates a 67 year old female with headache, alteration in mental status, and weakness of the L upper and lower extremities. The patient receives a CT scan in order to exclude a cerebral hemorrhage. The physician looks at the CT and attempts to detect any notable pathology that will influence management.

What should the EM physician assess when evaluating the head CT?

Is there a systematic way in which the CT should be evaluated?

How can intracerebral hemorrhage accurately be excluded?

CT neuroimaging is a universally utilized diagnostic modality for patients who present with stroke and suspected intracerebral hemorrhage. Although CT interpretation by radiologists is most often available 24/7, it is still important that the emergency physician be able to quickly review the head CT in order to establish a provisional diagnosis. This skill allows necessary diagnostic and therapeutic activities to occur in parallel, shortening the time to critical therapies.

Key Clinical Questions and Learning Points

Describe the appearance and maturation process for blood on a CT scan:

Acute hemorrhage is bright white (hyperdense) on a head CT scan (once it clots). Blood can be expected to maintain it's bright white appearance for up to a week, at which point it usually takes-on an isodense (to brain) appearance. Blood can be expected to have a hypodense appearance after 2 weeks. The exact timing of these changes depends to a great extent on clot thickness (thicker = longer to change). This is because macrophages work on the clot from the outside towards the middle, digesting the hemoglobin moiety.

Describe the appearance and epidemiology of subarachnoid hemorrhage:

Subarachnoid hemorrhage describes any blood in a CSF space (other than the ventricles). Hyperdensity is noted primarily in the cisterns (particularly the suprasellar cistern, where the circle of willis is located), but can be located in any subarachnoid CSF space. 75%-80% of all SAH is aneurismal, but it can also occur with trauma, tumor, AVM, vasculitis, or dural malformations. The etiology is unknown in approximately 15% of cases.

What is the sensitivity of CT scanning for SAH?

Unfortunately, the answer is that "it depends". It depends on how much blood is present, what generation scanner is being used, who is interpreting the scans, the time since the bleed occurred, and even the hemoglobin level of the blood.

There have been a number of studies that have tried to definitively answer this question, but none (in my opinion) have clearly delineated the answer. Depending on which studies you put your faith in, the CT scan sensitivity for blood is as follows:

95-98% through 12 hours
90-95% at 24 hours
80% at 3 days
50% at 1 week
30% at 2 weeks

When can the clinician expect to see CT changes indicative of ischemic infarction?

While subtle signs of infarction can be seen on CT 2-4 hours after the onset of symptoms (e.g. insular ribbon sign), this is variable, and definite signs cannot be counted-on for 12-24 hours after symptom onset. Edema and mass effect from ischemic infarct will be maximal at 3-5 days following event.

What are some expected complications of aneurismal SAH?

The most common associated short-term complication of SAH is hydrocephalus, which develops in 20% of patients with aneurysmal SAH. The most common (and feared) longer-term complication is cerebral vasospasm, which usually does not appear for 7-10 days following event.