

CT HEAD? Reviewing the newest validation of the Ottawa Subarachnoid Hemorrhage Rule

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BACKGROUND

Headache is a common presentation, representing 1%–2% of all emergency department (ED) visits.^{1–3} Consequently, 1%–2% of the population has an intracranial aneurysm, and 1%–2% of patients presenting to the ED with concerning headaches will have a subarachnoid hemorrhage (SAH).^{3–5} In patients without a history of trauma, 80% of SAHs are caused by a ruptured intracerebral aneurysm; prognosis is poor, with a 25%–50% case fatality rate.^{3,4} Among survivors, 50% experience long-term neuropsychological effects. Rupture of an aneurysm was preceded by a sentinel leak in 10%–40% of patients, and the likelihood of death or disability is four times higher among patients who were misdiagnosed.^{3,4} Moreover, accurately diagnosing SAH can be challenging, as 41% of patients with SAH are alert when they present, and greater than 50% are oriented or without focal neurological deficits upon presentation.⁶ A clinical decision rule (CDR) would assist clinicians to identify patients with SAH without increasing unnecessary testing. Once derived, a CDR should be prospectively validated (ideally in a new clinical setting) before being widely implemented.⁷ The Ottawa SAH Rule is a CDR

Table 1. CT HEAD mnemonic for the Ottawa SAH Rule¹¹

C ollapse (witnessed loss of consciousness)
T hunderclap headache (instantly peaking pain)
H urt neck (neck pain or stiffness)
E xertional onset
A ge 40 years or older
D ecreased flexion of the neck on examination

that was previously derived⁸ and refined⁹ in separate patient cohorts. It was externally validated in a retrospective chart review in the United States.¹⁰ The CDR was designed to identify patients with acute non-traumatic headaches who require further investigation for SAH if one or more predictor variables are present (Table 1).

POPULATION STUDIED

The study was a prospective, multicentre validation study of the Ottawa SAH Rule. Consecutive patients presenting to six university-affiliated, Canadian tertiary-care hospitals from 2010 to 2014 were eligible for inclusion. The specific inclusion and exclusion criteria are summarized in Table 2.

STUDY DESIGN

The study authors planned to enrol 1,200 patients to detect approximately 75 SAHs. Physicians assessing the CDR variables were blinded to the outcome. Patients who met the criteria but were not included by the physician during their ED visit were termed “missed eligible.” Research staff extracted data from the medical records of these missed patients. The accuracy of the physicians’ interpretations of the predictor variables and

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Table 2. Inclusion and exclusion criteria for the Ottawa SAH Rule

Inclusion criteria	Exclusion criteria
16 years old or older	GCS < 15
Severe headache	Presenting after 14 days from onset
No (direct) head trauma within seven days	Recurrent headaches (3 or more similar headaches over a period of greater than six months)
Headache reaches peak intensity within one hour of onset	Already seen and worked up for SAH with a CT and lumbar puncture and returning with the same headache
Presenting alert	New focal neurologic deficits
	Papilledema
	Known cerebral aneurysm, previous SAH, brain neoplasm, ventricular shunt, or hydrocephalus

CT = computed tomography; GCS = Glasgow Coma Scale; SAH = subarachnoid hemorrhage.

CDR were assessed by a nurse who was also blinded to the outcome. Although assumed, it was not stated whether the radiologists were blinded to the predictor variables.

OUTCOME MEASURES

The outcomes were well defined *a priori* as SAH positive or negative. A positive diagnosis required that an SAH was visible on a computed tomography (CT) scan; xanthochromia in the cerebral spinal fluid (CSF) by visual inspection; or $>1 \times 10^6/L$ erythrocytes in the final tube, with an aneurysm or arteriovenous malformation on angiography. A negative diagnosis required a normal head CT and lumbar puncture. Patients who did not have both investigations were assumed to be SAH negative after a review of all medical and provincial coroners' records, as well as a validated structured follow-up phone call at one and six months.⁸

RESULTS

In this study, 1,153 patients were enrolled, and 590 were "missed eligible." Of those 1,153 patients who enrolled, eight were lost to follow-up and assumed to be SAH negative, and 67 patients were SAH positive (prevalence of 5.8%). Authors concluded that the Ottawa SAH Rule had a sensitivity of 100% (95% confidence interval [CI] 94.6–100) and specificity of 13.6% (95% CI 13.1–15.8) for diagnosing SAH that corresponded to a +LR 1.16 (95% CI 1.13–1.19) and –LR 0.

COMMENTARY

In this validation study, the Ottawa SAH Rule remained 100% (95% CI 94.6–100) sensitive for the detection of

SAH.^{8–10} With a –LR 0, the widespread adoption of the rule could result in lower missed rates of SAH, as compared with the currently estimated missed rate of 5.4% (95% CI 4.3–6.6).¹² This study was slightly underpowered with 1,153 patients. In addition, the eight patients who were lost to follow-up were assumed to be SAH negative. Although unlikely, both could result in a falsely elevated sensitivity for the CDR. It is not clear whether the 590 "missed eligible" patients were truly missed or whether they could represent a selection bias. However, the patient characteristics and prevalence of SAH were similar in both groups of patients.

With a low specificity of 13.6% (95% CI 13.1–15.8), this CDR could increase the SAH investigation rates, and an impact analysis would be required to confirm this issue. However, the authors did comment that despite the low specificity, the number of investigations remained unchanged in both the derivation study (85.7%)⁸ and this study (87%). The physicians' interpretations of the predictor variables were excellent, with a Kappa of 0.82 (95% CI 0.76–0.87). The presence of neck pain or stiffness had the most inter-observer disagreement. The physicians were uncomfortable applying the rule to only 9% of the patients, although no reasons were specified.

SAH is associated with significant morbidity and mortality,⁴ and establishing external validity is extremely important before this CDR can be widely adopted into practice.⁷ The derivation and prospective validation of the CDR were rigorously conducted according to strict methodology standards.⁷ Statistical methods used to construct and refine the rule were appropriately and accurately described.^{8,9} The consistently high sensitivity among the derivation, refinement, external validation, and prospective validation studies adds

strong internal validity to the CDR.⁸⁻¹⁰ Each of the six academic centres used in this study had previously participated in the derivation and refinement studies, but the initial recruitment for these studies was separated by more than 10 years, providing temporal validation.¹³ Although more than 150 physicians were involved, it is likely that they were familiar with the CDR from its development, and their comfort with the rule decreased the external validity for new centres. With that in consideration, the patients were drawn from a heterogeneous population, and the patients represented a wide spectrum regarding the severity of disease at final diagnosis. Moreover, the rule was externally validated in the United States in a retrospective study.¹⁰ This provides sufficient evidence that clinicians can use this CDR in a variety of settings, with confidence in its accuracy but with no certainty of improved outcomes. Future research should be directed toward performing an impact analysis to determine whether the rule changes physician behaviour, improves patient outcomes, reduces the number of investigations, or any combination of these issues.

Physicians should still consider other important risk factors for aneurysm rupture, including hypertension, smoking, alcohol abuse, sympathomimetic drug use, black race, and a Hispanic ethnic group before deciding to apply the CDR.⁴ If the CDR were positive, considering its low specificity, physicians should still consider other life-threatening diagnoses for a headache, such as meningitis, stroke, and tumours, that may require investigations other than a non-contrast CT.^{1,3,6}

SUMMARY

The Ottawa SAH Rule is a valid CDR that is 100% (95% CI 94.6–100) sensitive for helping to decide who requires further workup for SAH. It is unclear whether the application of this rule would either improve the current care of patients presenting to the ED with sudden onset of an acute non-traumatic headache or decrease unnecessary testing. Physicians who decide to wait for an impact analysis before incorporating the CDR into their practice should, at the very least,

consider the predictor variables in their decision-making process.⁷

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