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## Clinical Practice Paper



### CLINICAL GUIDELINES FOR THE EMERGENCY DEPARTMENT EVALUATION OF SUBARACHNOID HEMORRHAGE

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**Abstract—Background:** Subarachnoid hemorrhage (SAH) is frequently caused by the rupture of an intracranial aneurysmal vessel or arteriovenous malformation, leading to a cascade of events that can result in severe disability or death. When evaluating for this diagnosis, emergency physicians have classically performed a noncontrast computed tomography (NCCT) scan, followed by a lumbar puncture (LP). Recently, however, as CT technology has advanced, many studies have questioned the necessity of the LP in the SAH diagnostic algorithm and have instead advocated for noninvasive techniques, such as NCCT alone or NCCT with CT angiogram (CTA). **Objective:** The primary goal of this literature search was to determine the appropriate emergency department (ED) management of patients with suspected SAH. **Methods:** A MEDLINE literature search from October 2008 to June 2015 was performed using the keywords *computed tomography AND subarachnoid hemorrhage AND lumbar puncture*, while limiting the search to human studies written in the English language. General review articles and single case reports were omitted. Each of the selected articles then underwent a structured review. **Results:** Ninety-one articles were identified, with 31 papers being considered appropriate for analysis. These studies then underwent a rigorous review from which recommendations were developed. **Conclusions:** The literature search supports that NCCT followed by CTA is a reasonable

approach in the evaluation of ED patients with possible SAH. © 2016 Elsevier Inc.

**Keywords—**subarachnoid hemorrhage; headache; lumbar puncture; computed tomography; angiogram; CTA; NCCT

#### INTRODUCTION

Subarachnoid hemorrhage (SAH) is frequently associated with significant morbidity and mortality, especially when the diagnosis is missed (1,2). Unfortunately, initial presenting symptoms of this disease are frequently subtle and often overlap with more common and more benign headaches. Up to 2% of all emergency department (ED) visits are related to headache, while approximately 1%–3% of these headaches are caused by SAH (3). SAH is thought to present as a sudden headache, maximal at onset, and dissimilar to previous headaches. Other high-risk characteristics include age older than 40 years, neck pain, witnessed loss of consciousness, and onset with exertion (4,5). Clinical decision rules that include these high-risk findings have been proposed to help identify SAH patients (6,7). If the appropriate history and symptoms are present, the classic teaching is to perform a noncontrast computed tomography (NCCT) scan of the head, followed by a lumbar puncture (LP) if the NCCT does not show clear

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evidence of SAH (8–10). If the LP shows no signs of xanthochromia (visual or spectrophotometric) or elevated red blood cells, then one can safely exclude SAH as a diagnosis, with very few exceptions (11–13).

However, there are some barriers to obtaining a diagnostic LP. Providers often encounter difficulties with this procedure due to patient body habitus or previous lumbar procedures. Traumatic LP can obscure results and frequently lead to nondiagnostic studies (14). In addition, patient reluctance to go through a procedure that they perceive as invasive and painful can lead to a failure to perform the procedure. Given these patient and provider difficulties surrounding the LP when evaluating for SAH, other strategies have been presented that often forego these issues, including NCCT alone and NCCT combined with computed tomography angiogram (CTA) of the brain (15). The purpose of this paper is to review the available medical literature on these diagnostic modalities and to offer evidence-based recommendations for a safe approach for the diagnosis or ruling out of SAH.

## METHODS

A structured literature review was performed using MEDLINE and was limited to studies that were published in the English language between October 2008 and June 2015. Search terms included *computed tomography AND subarachnoid hemorrhage AND lumbar puncture*. Two emergency physicians analyzed the abstract of each identified article to determine which ones should be pulled for more detailed review, based upon the suspected relevance to the topic of interest. If either physician felt the study had relevance, the full article was pulled for review. Studies included for the final, detailed review were limited to randomized controlled trials, prospective trials, retrospective cohort trials, and systematic reviews. General review articles and single case reports were not included for formal review.

Each of the selected articles underwent a Grade of Evidence Review. Two or more of the study authors performed a detailed review of each selected article. The level of the evidence was assigned a grade using the

definitions shown in Table 1 and were based on reference focus, specific research design, and methodology.

All selected articles were also assigned a Quality Ranking based on quality of the design and methodology. This includes Design Consideration (i.e., focus, model structure, presence of controls) and Methodology Consideration (actual methodology utilized). The definitions of the Quality Ranking scores are shown in Table 2.

## RESULTS

Through this structured review, 91 abstracts were identified, 43 of which were thought to be relevant by the reviewers and were pulled for detailed formal review. Of these articles, 12 were commentary or single case reports and were therefore excluded from analysis. Among the final 31 articles, we identified 1 relevant clinical trial as well as 5 systematic reviews (Tables 3 and 4).

### CT/LP

Performing a CT scan of the head, followed by an LP if the CT scan is negative, has historically been the most common diagnostic pathway in the ED for the evaluation of SAH. A large prospective cohort study reported this testing strategy to be 100% sensitive and to have a negative predictive value of 100% (35). Similarly, in a meta-analysis of >800 patients with negative CT/LP results who were followed for at least 1 year, none went on to develop an SAH (30). The inclusion of LP after a negative CT has been shown to identify clinically significant SAH, especially when presentation is delayed (17).

Its sensitivity notwithstanding, LP has some drawbacks, leading some providers to forego the procedure altogether (16,22,33). The procedure is somewhat painful, time consuming, and may be difficult, especially in patients who are overweight, uncooperative, or in those with a history of spine surgery (36). Patients may be reluctant to undergo the procedure because they view it as invasive. There are also potential risks to performing an LP, such as prolonged post-LP headaches and the rare severe complication of epidural hematomas.

**Table 1. Definitions of the Grades of Evidence of the Articles**

Grade	Definition
A	Randomized clinical trials or meta-analyses (multiple clinical trials) or randomized clinical trials (smaller trials), directly addressing the review issue
B	Randomized clinical trials or meta-analyses (multiple clinical trials) or randomized clinical trials (smaller trials), indirectly addressing the review issue
C	Prospective, controlled, nonrandomized, cohort studies
D	Retrospective, nonrandomized, cohort or case-control studies
E	Case series, animal/model scientific investigations, theoretical analyses, or case reports
F	Rational conjecture, extrapolations, unreferenced opinion in literature, or common practice

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