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NEUROCRITICAL CARE SOCIETY

ORIGINAL WORK

Practice Variation in the Diagnosis of Aneurysmal Subarachnoid Hemorrhage: A Survey of US and Canadian Emergency Medicine Physicians

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Abstract

Background and Aims: Spontaneous subarachnoid hemorrhage (SAH) from a brain aneurysm, if untreated in the acute phase, leads to loss of functional independence in about 30% of patients and death in 27–44%. To evaluate for SAH, the American College of Emergency Physicians (ACEP) Clinical Policy recommends obtaining a non-contrast brain computed tomography (CT) scan followed by a lumbar puncture (LP) if the CT is negative. On the other hand, current evidence from prospectively collected data suggests that CT alone may be sufficient to rule out SAH in patients who present within 6 h of symptom onset while anecdotal evidence suggests that CT angiogram (CTA) may be used to detect aneurysms, which are the probable cause of SAH. Since many different options are available to emergency physicians, we examined their practice pattern variation by observing their diagnostic approaches and their adherence to the ACEP Clinical Policy.

Methods: We developed, validated, and distributed a survey to emergency physicians at three practice sites: (1) Stanford Healthcare, California, (2) Intermountain Healthcare (five emergency departments), Utah, and (3) Ottawa General Hospital, Toronto. The survey questions examined physician knowledge on CT and LP's test performance and used case-based scenarios to assess diagnostic approaches, variation in practice, and adherence to guidelines. Results were presented as proportions with 95% CIs.

Results: Of the 216 physicians surveyed, we received 168 responses (77.8%). The responses by site were: (1) ($n=38$, 23.2%), (2) ($n=70$, 42.7%), (3) ($n=56$, 34.1%). To the CT and LP test performance question, most physicians indicated that CT alone detects > 90% of SAH in those with a confirmed SAH [$n=150$ (89.3%, 95% CI 83.6–93.5]. To the case-based questions, most physicians indicated that they would perform a CTA along with a CT [$n=110$ (65.5%, 95% CI 57.8–72.6)], some indicated a LP along with a CT [$n=57$, 33.9% 95% CI 26.8–41.6)], and a few indicated both a CTA and a LP [$n=16$, 9.5%, 95% CI 5.5–15.0]. We also observed practice site variation in the proportion of physicians who indicated that they would use CTA: (1) ($n=25$, 65.8%), (2) ($n=54$, 77.1%), and (3) ($n=28$, 50.0%) ($p=0.006$).

Conclusions: Survey responses indicate that physicians use some or all of the imaging tests, with or without LP to diagnose SAH. We observed variation in the use of CTA by site and academic setting and divergence from ACEP Clinical Policy.

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Introduction

Spontaneous subarachnoid hemorrhage (SAH) is a neurological emergency that most commonly results from an aneurysmal bleed into the subarachnoid space. The classical presentation is an instantly peaking thunderclap headache and other symptoms such as neck pain and/or loss of consciousness. It is crucial that emergency physicians recognize these symptoms early and perform the appropriate diagnostic testing and interventions to reduce the adverse consequences of SAH [1]. Adverse consequences are usually due to vasospasm and rebleeding following sentinel bleeds from the aneurysm. This ischemic damage to the brain results in loss of functional independence in about 30% of patients and death in 27–44% of patients [2–4].

The current diagnostic approach recommended by American College of Emergency Physicians (ACEP) Clinical Policy for evaluation of patients presenting with symptoms suggestive of SAH is non-contrast computed tomography (CT) followed by lumbar puncture (LP) if the non-contrast CT imaging is negative for bleeding. However, contemporary evidence shows that technological advances in CT non-contrast imaging have resulted in very high sensitivity for SAH, specifically within the first 6 h of SAH symptom onset [2]. Therefore, the need for LP in early presenters is being widely debated in the emergency medicine community. In addition, anecdotal evidence shows that CT angiogram (CTA) is being increasingly preferred as a diagnostic test due to its non-invasive technique [5]. Given the differences between the clinical policy and the more recent studies, we sought to examine the diagnostic approaches, variation in practice patterns, and emergency physicians' adherence to the ACEP Clinical Policy.

Using a survey design, we assessed physician knowledge on imaging and LP test performance. We also used case-based scenarios to assess their practice pattern, variation, and adherence to clinical policy.

Methods

Survey Design and Development

A cross-sectional survey was developed and distributed to emergency physicians using REDCap, a secure electronic data collection tool. Survey questions were developed to assess physicians' knowledge of test performance and their use of different diagnostic approaches for SAH. Survey questions and case-based scenarios were developed through literature reviews and collaborating with emergency physicians practicing in both academic and community settings. Face validity was tested in a separate test group of four emergency physicians to understand whether the survey measured practice variation. The survey was revised based on physician feedback. The institutional review boards of the participating sites approved this study.

Survey Domain One

Knowledge of Test Performance (Defined as Sensitivity and Specificity)

We created five questions to assess physicians' knowledge of the test performance for the diagnosis of SAH. We asked physicians to estimate CT's sensitivity (to the nearest 10%) within 6 h from symptom onset and 6 to 12 h from symptom onset. We asked physicians to estimate sensitivity and specificity of xanthochromia (both visible and spectrophotometric analysis). We defined sensitivity and specificity of CT and xanthochromia as follows: Sensitivity is defined as the presence of blood on CT images, in those with a final diagnosis of SAH. Specificity is defined as the absence of blood on CT images, in those without a final diagnosis of SAH. Sensitivity is defined as the presence of yellow discoloration of the cerebrospinal fluid (CSF), in those with a final diagnosis of SAH.

Specificity is defined as the absence of yellow discoloration of the CSF, in those without a final diagnosis of SAH. We compared the physician responses to the best available evidence for the different diagnostic tests (see Table 2). We wanted to preserve the clinical standards at each site, so we did not define the method for determining xanthochromia.

Survey Domain Two

Case Scenarios

In total, six cases were developed to examine the preferred diagnostic approach to SAH. All of the cases were designed to represent a variety of patient presentations such as history of SAH, anticoagulant and antiplatelet use, and migraine-type headache (for a summary of the cases, see Supplemental Tables). Five of the six cases included patients presenting within 6 h of symptom onset. Of these five cases, one tested the identification of high-risk clinical features for SAH that were derived from the Ottawa SAH Rule [6] and four assessed physicians' diagnostic approach to SAH.

Study Population

The target population was emergency physicians between the age of 20 and 80 years at the following three sites: (1) Stanford Healthcare, California, (2) Intermountain Healthcare [five hospitals], Utah, and (3) The Ottawa Hospital, Ottawa Ontario.

Survey Distribution

A survey link with an electronic consent was distributed over a 5-month period to emergency physicians practicing in seven emergency departments at three sites. We did not collect any identifying information in the survey. To increase the response rates, we sent four reminders over a 5-month period following the initial survey.

Data Analysis

We used descriptive statistics to examine the participants' survey responses. We also analyzed physician responses to each case by practice site, academic setting (academic or non-academic/community), and years of clinical practice (experience level). All of the cases involving patients with symptoms within 6 h of onset were analyzed as a subgroup. Differences in grouped data were analyzed using Chi-squared or Fisher's exact test as appropriate. Analyses were done using STATA 15/SE (StataCorp, LP College Station, TX).

Results

Participant Demographics (Table 1)

The survey was distributed to 216 emergency physicians. Of those, we received 168 (78% response rate) completed surveys from physicians practicing at the three sites. Among the emergency physicians who responded, 38 (22%) were practicing at Site 1, 70 (42.7%) at Site 2, 56 (34.1%) at Site 3, and four did not identify their practice site. Of the respondents, 95 (59.0%) identified their primary practice setting as academic, while the remaining 66 (41.0%) identified their practice setting as non-academic/community. Of the respondents, 43 (25.6%) indicated that they were in clinical practice for less or equal to 5 years, 39 (23.2%) indicated that they were in clinical practice between 6 and 10 years, 56 (33.3%) indicated that they were in clinical practice between 11 and 20 years, and 30 (17.9%) were in clinical practice over 20 years.

Knowledge of Test Performance (Sensitivity and Specificity)

Finding 1 Most physicians indicated that CT non-contrast imaging is able to detect aneurysmal bleeding with high accuracy. However, we observed some differences in response by site, academic setting, and experience level.

Of the 168 responses, 150 (89.3%, 95% CI 83.6–93.5) participants indicated that non-contrast CT has high sensitivity (defined as 91–100%) for SAH within 6 h

Table 1 Demographics of survey participants by practice site

Participant characteristics	Site 1	Site 2	Site 3	Total	*p* value
Number (%)	38 (23.2)	70 (42.7)	56 (34.1)	168[b]	
Sex (%)					
Male	21 (55.3)	54 (77.1)	36 (64.3)	114 (67.9)	
Female	17 (44.7)	16 (22.9)	20 (35.7)	54 (32.1)	0.054
Age (%)					
21–30	1 (2.6)	2 (2.9)	3 (5.4)	6 (3.6)	
31–40	20 (52.6)	22 (31.4)	23 (41.1)	67 (39.9)	
41–50	9 (23.7)	30 (42.9)	18 (32.1)	59 (35.1)	
51–60	3 (7.9)	14 (20.0)	8 (14.3)	25 (14.9)	
>60	5 (13.2)	2 (2.9)	4 (7.1)	11 (6.5)	0.115
Years since completion of residency training (%)					
≤5 years	9 (23.7)	12 (17.1)	21 (37.5)	43 (25.6)	
6–10 years	12 (31.6)	18 (25.7)	8 (14.3)	39 (23.2)	
11–20 years	11 (28.9)	26 (37.1)	17 (30.4)	56 (33.3)	
>20 years	6 (15.8)	14 (20.0)	10 (17.9)	30 (17.9)	0.158
Primary care setting					
Academic	35 (94.6)	5 (7.4)[a]	54 (100.0)	95 (59.0)	
Non-academic/community	2 (5.4)[a]	63 (92.6)	0 (0.0)	66 (41.0)	<0.001

[a] Physicians may work at multiple sites

[b] Four respondents did not report practice site

of symptom onset. Although the overall response was overwhelmingly in favor of high test performance, we observed statistically significant differences in physicians' response by site, academic setting, and experience level. The proportion of physicians indicating higher sensitivity by site was 35 (92.1%) in California, 56 (80%) in Utah, and 55 (98.2%) in Canada (p value = 0.009) (see Table 2—knowledge as evidenced by physicians' response on test performance). This proportion was also lower for physicians practicing at non-academic institutions 54 (81.8%) versus academic institutions 90 (94.7%). The difference in responses by experience level is: 41 (95.4%) physicians who completed residency within 5 years, 37 (94.9%) between 6 and 10 years, 48 (85.7%) between 11 and 20 years, and 24 (80.0%) in over 20 years (p = 0.041).

Finding 2 A moderate number of physicians indicated that CT non-contrast imaging detects aneurysmal bleeding with less accuracy after 6 h of symptom onset. We observed differences in response by site and academic setting (see Table 2).

Of the 168 responses, 100 (60.2%, 95% CI 52.4–67.7) respondents indicated that non-contrast CT has a lower sensitivity (defined as 81–90%) for SAH between 6 and 12 h of symptom onset. The number/proportion of physicians indicating lower sensitivity by site was 20 (52.6%) in California, 38 (55.9%) in Utah, and 40 (71.4%) in Canada (p value = 0.002) (see Table 2). The number/proportion of physicians practicing at non-academic institutions were n = 35(54.7%) versus academic institutions n = 61 (64.2%) (p = 0.004).

Finding 3 Few physicians indicated that xanthochromia detects aneurysmal bleeding with high accuracy (see Table 2).

Only 68 (40.7%, 95% CI 33.2–48.6%) respondents indicated that xanthochromia has a high sensitivity (defined as 91–100%) for SAH after 6 h of SAH symptom onset. The proportion of physicians indicating a high sensitivity was 13 (34.2%) in California, 26 (37.7%) in Utah, and 29 (51.8%) in Canada (p value = 0.181).

Finding 4 Most physicians were able to list the high-risk clinical features of SAH. However, only half of the physicians indicated that they use validated clinical rules in their practice (see Table 3).

In response to the question on use of clinical features that indicate high-risk features suggestive of SAH, 164 physicians (97.6%) indicated instantly peaking headache, 150 (89.3%) indicated neck stiffness on examination, 147 (87.5%) indicated onset during exertion, 85 (50.6%) indicated age, and 18 (10.7%) selected other features (see Table 3). Of those who selected "other," loss of consciousness was indicated as a high-risk feature. Additionally, 60 (35.7%) physicians indicated vomiting as a clinical feature.

Table 2 Physician response on test performance by site

Characteristics	Site 1	Site 2	Site 3	Total	*p* value
Sensitivity[a] of non-contrast CT within 6 h (%)					
91–100	35 (92.1)	56 (80.0)	55 (98.2)	146 (89.0)	
81–90	3 (7.9)	10 (14.3)	0 (0.0)	13 (7.7)	
71–80	0 (0.0)	2 (2.9)	1 (1.8)	3 (1.8)	
≤ 70	0 (0.0)	2 (2.9)	0 (0.0)	2 (1.2)	0.009
Sensitivity of non-contrast CT between 6 and 12 h (%)					
91–100	7 (18.4)	23 (33.8)	4 (7.1)	35 (21.1)	
81–90	20 (52.6)	38 (55.9)	40 (71.4)	100 (60.2)	
71–80	5 (13.2)	5 (7.3)	9 (16.1)	20 (12.1)	
≤ 70	6 (15.8)	2 (2.9)	3 (5.4)	11 (6.6)	0.002
Sensitivity[b] of xanthochromia after 6 h (%)					
91-100	13 (34.2)	26 (37.7)	29 (51.8)	68 (40.7)	
81-90	6 (15.8)	13 (18.8)	13 (23.2)	33 (19.8)	
71–80	6 (15.8)	14 (20.3)	7 (12.5)	28 (16.8)	
≤ 70	13 (34.2)	16 (23.2)	7 (12.5)	38 (22.7)	0.181
Specificity[c] of xanthochromia after 6 h (%)					
91–100	17 (47.2)	29 (42.6)	27 (48.2)	74 (45.1)	
81–90	11 (30.6)	18 (26.5)	15 (26.8)	46 (28.1)	
70–80	2 (5.6)	11 (16.2)	8 (14.3)	22 (13.4)	
< 70	6 (16.7)	10 (14.7)	6 (10.7)	22 (13.4)	0.784
Sensitivity[d] of spectrophotometry after 6 h (%)					
91–100	18 (48.7)	46 (67.7)	39 (69.6)	104 (63.0)	
81–90	8 (21.6)	15 (22.1)	9 (16.1)	34 (20.6)	
71–80	8 (21.6)	5 (7.3)	2 (3.6)	16 (9.7)	
≤ 70	3 (8.1)	2 (2.9)	6 (10.7)	11 (6.7)	0.043
Number of LP needed to diagnose one case of SAH (%)					
1 in 50	13 (34.2)	16 (23.5)	20 (35.7)	49 (29.7)	
1 in 100	12 (31.6)	28 (41.2)	18 (32.1)	60 (36.4)	
1 in 250	7 (18.4)	15 (22.1)	13 (23.2)	36 (21.8)	
1 in 500	6 (15.8)	9 (13.2)	3 (5.4)	18 (10.9)	
Other	0 (0.0)	0 (0.0)	2 (3.6)	2 (1.2)	0.355

CT computed tomography, *LP* lumbar puncture, *SAH* spontaneous subarachnoid hemorrhage

[a] We define sensitivity as the presence of blood in CT images in those with a final diagnosis of subarachnoid hemorrhage

[b] We define sensitivity as the presence of blood in CSF in those with a final diagnosis of subarachnoid hemorrhage

[c] We define specificity of the test as absence of xanthochromia in those who do not have subarachnoid hemorrhage

[d] We define sensitivity as the presence of blood in CSF in those with a final diagnosis of subarachnoid hemorrhage

Table 3 High-risk SAH features as reported by physicians

Risk features	Practice site				
	Site 1	Site 2	Site 3	Total	*p* value
Age (%)					
Yes	14 (36.8)	31 (44.3)	39 (69.6)	85 (50.6)	
No	24 (63.2)	39 (55.7)	17 (30.4)	83 (49.4)	0.002
Instantly peaking pain (%)					
Yes	36 (94.7)	68 (97.1)	56 (100.0)	164 (97.6)	
No	2 (5.3)	2 (2.9)	0 (0.0)	4 (2.4)	0.215
Vomiting (%)					
Yes	17 (44.7)	27 (38.6)	15 (26.8)	60 (35.7)	
No	21 (55.3)	43 (61.4)	41 (73.2)	108 (64.3)	0.172
Neck stiffness on exam (%)					
Yes	32 (84.2)	61 (87.1)	53 (94.6)	150 (89.3)	
No	6 (15.8)	9 (12.9)	3 (5.4)	18 (10.7)	0.21
Onset during exertion (%)					
Yes	32 (84.2)	59 (84.3)	56 (100.0)	147 (87.5)	
No	6 (15.8)	11 (15.7)	4 (7.1)	21 (12.5)	0.297
Other					
Yes	4 (10.5)	4 (5.7)	8 (14.3)	18 (10.7)	
No	34 (89.5)	66 (94.3)	48 (85.7)	150 (89.3)	0.272

Clinical features derived from SAH Ottawa Rule

SAH Spontaneous subarachnoid hemorrhage

In response to the question on use of clinical decision rules to identify high-risk patients, only 90 (54.9%) physicians reported that they use clinical decision rules. Of those who reported that they use clinical rules, 51(57.95%) of physicians were from Canada. When we explored differences by site, academic setting, and experience level, the only statistically significant findings were by academic setting; 65 (69.2%) physicians from academic and 21 (33.3%) from non-academic settings indicated that they would use a clinical decision rule in diagnosis of SAH ($p < 0.001$).

Finding 5 A high number of physicians indicated that they use CTA to investigate the SAH. We observed differences in CTA use by site and academic setting (see Table 4 and Supplemental Tables).

For the four case presentations within 6 h of symptom onset, 65.5% (95% CI 57.8–72.6) indicated that they would do a CTA after a negative CT in at least one case, 33.9% (95% CI 26.8–41.6) indicated that they would do an LP in at least one case, and 9.5% (95% CI 5.5–15.0) indicated that they would perform both CTA and LP (see Table 4). Among physicians who chose CTA, we observed a difference in response between sites, 25 (65.8%) physicians from Site 1, 54 (77.1%) from Site 2, and 28 (50.0%) from Site 3 (p value = 0.006). We also observed differences in response by setting, i.e., 52 (54.7%) respondents were from the academic site and 51 (77.3%) from non-academic setting (p value = 0.003). We did not observe a significant difference in response between experience levels.

Finding 6 Practice variation versus primary setting between the US cohort and the original cohort (see Supplemental Tables).

After excluding the Canadian site, we reanalyzed the data for differences between US academic and community sites. We observed the following results. While there was a loss in statistical significance in cases 2

Table 4 Diagnostic testing preferences via case-based scenarios[a]

Case[a]: Key clinical finding	Diagnostic testing preferences as indicated by survey participants				
	No imaging	Non-contrast CT only	CT followed by CTA if CT negative	CT followed by LP	CT followed by both CTA and LP
Case 2: Complicated migraines	20 (11.9)	80 (47.6)	30 (17.9)	33 (19.6)	5 (3.0)
Case 3: Antiplatelet	12 (7.1)	86 (51.2)	57 (33.9)	11 (6.6)	2 (1.2)
Case 4: History of SAH	6 (3.6)	30 (17.9)	87 (51.8)	34 (20.2)	11 (6.5)
Case 5: Anticoagulant[a]	6 (3.6)	12 (7.1)	113 (67.3)	34 (20.2)	3 (1.8)
Case 6: Gradual Onset	155 (92.3)	8 (4.8)	3 (1.8)	1 (0.6)	1 (0.6)
Within 6 h of symptom onset	155 (92.3)	117 (69.6)	110 (65.5)	57 (33.9)	16 (9.5)

Since physicians chose more than one diagnostic test, the total will not add up to the final count; therefore, we will not add a total column

CT computed tomography, *CTA* computed tomography with angiography, *LP* lumbar puncture, *SAH* spontaneous subarachnoid hemorrhage

[a] After 6 h of symptom onset

and 3, we saw a trend toward statistical significance between the US sites in cases 4 and 5.

In summary, we noted a strong agreement among physicians on CT performance within 6 h, a moderate agreement among physicians on CT performance after 6 h, and a poor agreement among physicians on xanthochromia performance. We also noted a statistically significant difference in physicians' response by practice site and academic setting to the survey question on CT performance. Similarly, we observed that a large number of physicians favored CTA but the results differed by site and academic setting. We also observed loss of statistical significance in CT/CTA preferences after exclusion of Canada, showing that Canada exerted a strong influence on the findings observed within academic sites.

Discussion

Our case scenarios explored physician diagnostic approaches to SAH and adherence to ACEP 2008 Clinical Policy, identified five key findings. First, a majority of physicians indicated that non-contrast CT imaging is a reliable diagnostic tool when considering SAH within 6 h of symptom onset. This is supported by two studies that reported that non-contrast CT is highly sensitive within 6 h of symptom onset. Perry et al. [7] conducted a prospective cohort study across 11 different emergency departments in Canada and concluded that CT within 6 h of symptom onset had a 100% sensitivity. In another meta-analysis study, pooled estimates showed a sensitivity of 100% for non-contrast CT within 6 h [2]. In contrast to this study, two recent studies reported lower sensitivities—less than a 100% in a matched case control study and 91% in a recent literature review [5, 8]. Even though our physician cohort indicated that non-contrast CT imaging is a reliable diagnostic approach within 6 h of SAH symptom onset, there is no clear consensus in the literature on the sensitivity of non-contrast CT imaging within 6 h of SAH symptom onset. Therefore, a future study should be designed to validate the 6-h CT rule in a national sample of SAH patients in the USA [9].

The second key finding was that more than a third of our physicians reported high test performance (91–100% sensitivity) for CT after 6 h of symptom onset which is similar to the results of the Canadian study which reported high sensitivity (93%) [7]. In contrast, a recent meta-analysis reported a 89% sensitivity after 6 h [2]. Similarly, physicians reported a high sensitivity for visible xanthochromia after 6 h from symptom onset of SAH [1]. A recent prospective cohort study by Perry et al. reported a 97% sensitivity, while a meta-analysis reported a 85% sensitivity for visible xanthochromia [2, 10]. We believe that the difference in the reported sensitivities is probably due to the differences in study designs, settings and imaging techniques in the published studies included in the meta-analysis, when compared to the prospective cohort study. Overall, these findings show that there is no clear consensus in the literature on xanthochromia test performance for detection of SAH, although the large majority of physicians in our study consider it reliable.

Our third finding was that only half of the physicians reported using the clinical rules to identify high-risk features of SAH. The benefit of using the SAH rule is to reduce the use of non-contrast imaging i.e., if a patient does not have any of the high-risk clinical features, the study does not recommend CT non-contrast imaging since the risk of SAH is very low. Within our survey participants, a moderate number of Canadian physicians reported using the clinical rules that were developed and validated at their site, to identify the high-risk features. A recent study by one of the study investigators (JP) reported a much higher uptake (95%) of the SAH clinical rule [11]. The possible reasons for the differences could be regional differences and local implementation efforts that may have promoted higher uptake of the SAH clinical rule, thereby influencing our study results.

The final key finding of our study was the higher than expected CTA use in our physician sample. Relative to Ottawa' response rate, Stanford and Intermountain reported higher levels of CTA for patients with a negative non-contrast CT. This is supported by recent data that reported very high sensitivity (98%) for aneurysm detection [5]. However, some of the pitfalls of CTA are detection of incidental aneurysms, unnecessary interventions such as clipping or coiling of incidental aneurysms, and radiation associated with these procedures. Defensive medicine practices could also be contributing to this higher than expected use of CTA. Due to these reasons and also due to lack of scientific data on effectiveness of CTA, the current clinical policy for emergency physicians does not recommend CTA as a diagnostic test for SAH detection. We agree with the comment that practices may be driven by many factors. We may have also seen a decline in response to using LP due to patient-related problems with the use of LP, difficulty using an LP, and it is post-dural effects on the patients. This may have contributed to the heterogeneity between the sites.

Limitations

We acknowledge that our study has some limitations. First, our survey was limited to three practice sites that included two academic hospitals and four community hospitals in urban and suburban settings. We did not include any rural hospitals or hospitals in under-resourced settings, and therefore, the results may not be generalizable to those communities. Second, the test performance reported in recent studies is based on the advanced imaging techniques and scanners. While we believe that our study sites are likely to have advanced imaging techniques and scanners, we did not collect this information in our survey. Therefore, we are unable to comment on the contributions of the available resources to the physician response. Third, although we tested the face validity in a small cohort of emergency physicians, we did not provide the participants with an opportunity to comment on the survey validity. Furthermore, the physician responses were to case scenarios only and may not be as accurate a representation of their clinical practice.

Additionally, in finding 6 we observed a change in the statistical significance by primary practice setting when we excluded Canada. Furthermore, we looked at the practice variation between the original cohort and the US cohort only. We observed that there was a preference for non-contrast CT in the original cohort in cases 2 and 3. However, the US cohort demonstrated a preference for additional non-invasive imaging such as CTA or magnetic resonance angiogram.

Conclusions

Our results indicate a strong agreement among physicians on non-contrast CT imaging performance. Nonetheless, we observed that physicians prefer to use newer imaging techniques like CTA. This finding varied by practice setting and indicates a divergence from current ACEP Clinical Policy. In future studies, we will compare the effectiveness of newer imaging techniques with traditional diagnostic approach and disseminate the results to inform guideline development for emergency physicians.

Electronic supplementary material
The online version of this article (https://doi.org/10.1007/s12028-019-00679-7) contains supplementary material, which is available to authorized users.

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Authors' Contributions
AK contributed to data analysis, manuscript writing and editing. KN contributed to data analysis and manuscript writing. ALB contributed to building the survey instrument on REDCap and manuscript editing. MW contributed to project development. JB, JJP contributed to project development and manuscript editing, PG contributed to project development, data analysis and manuscript editing. MAK contributed to data analysis and manuscript editing.

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The authors confirm that there are no known conflicts of interest associated with this publication.

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