

Is this Subarachnoid Hemorrhage Significant? A National Survey of Neurosurgeons

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ABSTRACT: Background: Previously all subarachnoid hemorrhage (SAH) patients were admitted, whereas now patients with angiography may be discharged. **Objective:** To survey neurosurgeons to determine current practice and what constitutes a clinically significant subarachnoid hemorrhage. **Methods:** We surveyed all neurosurgeons listed in the Canadian Medical Directory. We used a modified Dillman technique with up to five mailed surveys plus a pre-notification letter. Neurosurgeons rated the significance of 13 scenarios of subarachnoid hemorrhage. Scenarios varied from aneurysmal subarachnoid hemorrhage to patients with isolated xanthochromia in cerebrospinal fluid. Each scenario was rated for clinical significance using a 5-point scale [1(always) to 5(never)]. **Results:** Of the 224 surveyed, 115 neurosurgeons responded. Scenarios with aneurysms requiring intervention, arteriovenous malformations, death or any surgical intervention all had median responses of 1 (IQR 1, 1). Scenarios having xanthochromia and few red blood cells in cerebrospinal fluid with negative computerized tomogram (CT) and angiography had median responses of 3 (IQR 1, 4). Scenarios with perimesencephalic pattern on CT with negative angiography had median of 3 (IQR 2, 4). Scenarios where patient is discharged from the emergency department had median of 4 (IQR 3, 5). **Conclusion:** Subarachnoid hemorrhages due to aneurysms or arteriovenous malformations causing death or requiring surgical intervention are always clinically significant. Other types of non-aneurysmal subarachnoid hemorrhages had inconsistent ratings for clinical significance. These survey results highlight the need for further discussions to standardize the diagnosis of what constitutes a clinically significant subarachnoid hemorrhage and what care should be afforded to these patients.

RÉSUMÉ: Cette hémorragie sous-arachnoïdienne est-elle significative au plan clinique? Une enquête nationale auprès des neurochirurgiens.
Contexte : Antérieurement, tous les patients atteints d'une hémorragie sous-arachnoïdienne (HSA) étaient hospitalisés alors que maintenant certains patients qui ont subi une angiographie peuvent retourner à la maison. **Objectif :** Cette enquête auprès des neurochirurgiens visait à déterminer quelle est la pratique actuelle et ce qui constitue une HSA significative au plan clinique. **Méthode :** Nous avons fait une enquête auprès de tous les neurochirurgiens inscrits dans le Canadian Medical Directory. Nous avons utilisé la technique de Dillman modifiée comportant jusqu'à 5 questionnaires envoyés par la poste ainsi qu'une lettre de préavis. Les neurochirurgiens devaient évaluer l'importance de l'HSA dans 13 scénarios préétablis. Les scénarios allaient d'une HSA anévrysmale à une xanthochromie isolée du liquide céphalo-rachidien (LCR). La signification clinique de chaque scénario était évaluée au moyen d'une échelle à 5 niveaux (1 = toujours, 5 = jamais). **Résultats :** Cent quinze des 224 neurochirurgiens ont répondu à l'enquête. La réponse médiane pour tous les scénarios comportant un anévrysme qui nécessitait une intervention, des malformations artérioveineuses, le décès ou toute intervention chirurgicale était de 1 (intervalle interquartile 1, 1). La médiane pour les scénarios comportant de la xanthochromie et quelques globules rouges dans le LCR et une tomographie et une angiographie négatives était de 3 (IQR 1, 4). La médiane pour les scénarios comportant un tableau périmésencéphalique à la tomographie ainsi qu'une angiographie négative était de 3 (IQR 2, 4). La médiane pour les scénarios où les patients obtenaient leur congé du service d'urgence était de 4 (IQR 3, 5). **Conclusion :** Les hémorragies sous-arachnoïdiennes causées par des anévrysmes ou des malformations artérioveineuses entraînant la mort ou nécessitant une chirurgie sont toujours significatives au plan clinique. L'évaluation de l'importance clinique des autres types d'HSA non anévrysmales était plus variable. Les résultats de cette enquête soulignent la nécessité de se pencher davantage sur la standardisation du diagnostic de l'HSA significative au plan clinique et sur ce en quoi devrait constituer le traitement de ces patients.

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Non-traumatic subarachnoid hemorrhage arises when blood leaks from a cerebral blood vessel into the subarachnoid space (space between two membrane layers of the brain and spinal cord which contains cerebrospinal fluid).¹⁻⁴ The mortality associated with aneurysmal subarachnoid hemorrhage is high, with a case fatality rate of between 32% to 67%.⁵ However, patients with small non-aneurysmal bleeds have been reported to have good prognoses.⁶⁻⁸

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While all patients with subarachnoid hemorrhages, regardless of etiology have historically been admitted to hospital, this trend appears to be changing. Patients diagnosed with non-aneurysmal subarachnoid hemorrhage are sometimes discharged home directly from the emergency department following normal cerebral angiography. However, this practice does not appear to be consistent. It is not currently known how comfortable neurosurgeons are in classifying a subarachnoid hemorrhage as not clinically significant and thus explaining why some patients are discharged from hospital with a subarachnoid hemorrhage. Defining what a clinically significant subarachnoid hemorrhage is may allow improved standardization in the management of subarachnoid hemorrhage patients. A definition of clinically significant subarachnoid hemorrhage is also needed to allow researchers to focus more on this subgroup of subarachnoid hemorrhages.⁸⁻¹⁰

The goal of this study was to characterize which subarachnoid hemorrhages are clinically significant according to Canadian neurosurgeons and to identify subtypes of subarachnoid hemorrhages where there is a significant discrepancy in opinions explaining the aforementioned variations in practice.

METHODS

Study Design and Setting

We conducted a self-administered postal survey of all neurosurgeons listed in the Canadian Medical Directory.¹¹ We

used a modified Dillman's tailored design method for survey design and administration (pre-survey notification, and up to five survey attempts).¹² This study was coordinated by the Clinical Epidemiology Program of the Ottawa Hospital Research Institute between September 2007 and March 2008 and approved by The Ottawa Hospital Research Ethics Board. All 241 neurosurgeons listed in the Canadian Medical Directory on September 1, 2007 were surveyed. Neurosurgeons returning their surveys who reported they were not practicing neurosurgery were excluded.

Survey Content

Survey participants received a two page questionnaire consisting of 22 questions. The survey instrument was developed by the authors and revised following the feedback received after pretesting on five local neurosurgeons.

Neurosurgeons were asked "***Do you consider the following non-traumatic subarachnoid hemorrhages (SAH) to be 'clinically significant'? Assume that all test results or procedures described are known***". Respondents were then presented with a series of 13 scenarios and asked to indicate whether they would consider the subarachnoid hemorrhage to be clinically significant using a five point Likert scale (always, most of the time, some of the time, almost never, never). A summary of the scenarios related to the clinical significance of a non-traumatic subarachnoid hemorrhage is given in Figure 1. Neurosurgeons were subsequently asked demographic questions.

- a) Aneurysmal SAH requiring clipping
- b) Aneurysmal SAH requiring coiling
- c) Aneurysmal SAH requiring stent
- d) SAH resulting in death
- e) Non-aneurysmal SAH requiring any surgical or supportive intervention (intubation, shunt, operation)
- f) SAH resulting from arteriovenous malformation (AVM)
- g) SAH, non-AVM, non aneurysmal but not typical perimesencephalic pattern, with one or more normal cerebral angiograms and ultimately requiring no intervention
- h) CT negative with normal CTA, MRA or cerebral angiogram and LP positive for xanthochromia only (no RBCs)
- i) CT negative with normal CTA, MRA or cerebral angiogram and LP positive for xanthochromia with some RBCs ($<1000 \times 10^6/L$)
- j) CT negative with normal CTA, MRA or cerebral angiogram and LP positive for xanthochromia with a small number of RBCs ($<100 \times 10^6/L$)
- k) Perimesencephalic pattern on CT, normal CTA, MRA or cerebral angiogram requiring no intervention
- l) Tiny aneurysm present (i.e. $<3\text{mm}$) on angiography with normal CT, and LP with no RBCs and no visible xanthochromia
- m) Any SAH where you feel comfortable sending the patient home from the emergency department

Figure 1: Summary of the scenarios provided in the survey instrument provided to neurosurgeons regarding non-traumatic subarachnoid hemorrhages.

Table 1: Neurosurgeon demographic, professional and practice characteristics

Characteristics	Number of Responses (%) N = 115
Mean age in years (SD)	49.0 (11.2)
Range	31-80
Male (N=113)	109 (96.5)
Practice setting (N=111)	
Teaching hospital	98 (88.3)
Non-teaching hospital	13 (11.7)
Mean years of clinical practice (SD) (N=111)	16.0 (11.0)
CT scanner available (N=111)	
24 hours a day	110 (99.1)

Survey Administration

All participants received a pre-notification letter which described the study and requested their participation. One week later, a second contact included 1) a cover letter describing the study, assuring confidentiality of responses and providing instructions for completion of the survey, and 2) the survey

instrument. Non-responders were sent a minimum of four reminder letters including additional survey instruments, which were sent at four to five week intervals. All postal surveys included a business reply pre-addressed envelope. No incentives were provided.

All data was entered into an electronic Excel database (Microsoft Corp, Redmond, WA). Single data entry was used. Analysis was then performed using SAS v. 9.1 (SAS Institute Inc. Cary, NC, USA).

Analysis and Sample Size Calculation

Our primary outcome measures were the proportions of respondents who considered each scenario to constitute a clinically significant subarachnoid hemorrhage, defined as a rating of “always” or “most of the time”. Analysis included proportions, together with 95% confidence intervals employing the finite population correction, for the entire cross-section. We also calculated the median rating, with interquartile range for each scenario.

All neurosurgeons in Canada listed in the directory were surveyed. This choice was made given the relatively small size of the target population, and the desire to minimize sampling error and improve generalizability of results to all neurosurgeons in Canada. The sampling frame included 241 neurosurgeons. This is close to the 260 practicing neurosurgeons reported by the Canadian Medical Association report on Canadian physician statistics.^{13,14} We calculated that with an anticipated response rate of 50% (based on similar surveys administered to emergency physicians), a 95% two-sided confidence interval

Table 2: Neurosurgeon Rating of Clinical Significance When Asked “Do you consider the following non-traumatic subarachnoid hemorrhages (SAH) to be “clinically significant?” for Each Scenario on a 5 Point Scale. (1=Always; 5=Never)

Scenario	Median (IQR)*	% always or most of the time	95% Confidence Interval
a) Aneurysmal SAH requiring clipping	1 (1-1)	96.5	94.1-98.9
b) Aneurysmal SAH requiring coiling	1 (1-1)	96.5	94.1-98.9
c) Aneurysmal SAH requiring stent	1 (1-1)	93.6	90.3-96.8
d) SAH resulting in death	1 (1-1)	92.9	89.6-96.3
e) Non-aneurysmal SAH requiring any surgical or supportive intervention (intubation, shunt, operation)	1 (1-1)	88.6	84.5-92.7
f) SAH resulting from arteriovenous malformation (AVM)	1 (1-1)	91.2	87.5-94.8
g) SAH, non-AVM, non aneurysmal but not typical perimesencephalic pattern, with one or more normal cerebral angiograms and ultimately requiring no intervention	2 (1-3)	57.3	50.8-63.8
h) CT negative with normal CTA, MRA or cerebral angiogram and LP positive for xanthochromia only (no RBCs)	3 (1-3)	49.6	43.1-56.1
i) CT negative with normal CTA, MRA or cerebral angiogram and LP positive for xanthochromia with some RBCs (<1000 x 10 ⁶ /L)	3 (1-4)	46.0	39.5-52.5
j) CT negative with normal CTA, MRA or cerebral angiogram and LP positive for xanthochromia with a small number of RBCs (<100 x 10 ⁶ /L)	3 (1-4)	42.0	35.5-48.4
k) Perimesencephalic pattern on CT, normal CTA, MRA or cerebral angiogram requiring no intervention	3 (2-4)	32.7	26.6-38.8
l) Tiny aneurysm present (i.e. <3mm) on angiography with normal CT, and LP with no RBCs and no visible xanthochromia	3 (3-4)	21.3	15.8-26.7
m) Any SAH where you feel comfortable sending the patient home from the emergency department	4 (3-5)	14.0	9.4-18.7

around the most conservative estimate for a finite population proportion of 50%, would have a margin of error of ± 6.3 .

RESULTS

We had an overall response rate of 51.3% (115/224). The numerator represents all returned surveys, while the denominator represents all surveys sent, less those returned because subjects failed to meet inclusion criteria i.e. not practicing and did not answer questions (17 surveys; $241-17 = 224$ in the denominator).

Physician demographic, professional and practice setting characteristics are summarized in Table 1. Respondents were primarily male and had a mean age of 49.0 years. Almost all neurosurgeons worked at teaching hospitals. Virtually all respondents reported having 24 hour access to computed tomogram (CT) scanners.

Table 2 provides the proportions and 95% confidence intervals for each of the 13 scenarios, together with the median response and interquartile range. Figure 2 displays the distribution of respondents in each of the response categories for each scenario. Respondents were very consistent in considering scenarios A-F (aneurysm requiring operative management, arteriovenous malformation, any subarachnoid hemorrhage resulting in death, intubation, requiring a shunt or other operative procedure) as being always clinically significant. The results for scenarios H-J (normal CT with subarachnoid hemorrhage diagnosis made with xanthochromia with small to no blood in

cerebrospinal fluid analysis) were less consistent with a median of respondents rating these as being sometimes significant and the lower quartile saying that these are almost never clinically significant. Respondents rated typical perimesencephalic bleeds (scenario K) with negative angiography as being sometimes significant, however over 25% of respondents rated these as being almost never significant. Small aneurysms (<3mm) with no evidence of blood on CT and with a negative lumbar puncture (scenario L) were rated with a median of being sometimes significant but the lower quartile rated these as almost never clinically significant. Finally, any subarachnoid hemorrhage in which the patient was discharged directly from the emergency department following testing had a median response of almost never clinically significant with the lower quartile rating these patients as never being clinically significant.

DISCUSSION

This survey is the first national study of neurosurgeons, assessing the clinical significance of different clinical presentations of non-traumatic subarachnoid hemorrhage. As expected, we found that the vast majority of Canadian neurosurgeons considered subarachnoid hemorrhages with aneurysms requiring intervention, arteriovenous malformation, death or that required any intervention, as highly clinically significant events. Perimesencephalic bleeds were of less clear significance as was blood on the CT scan without obvious cause

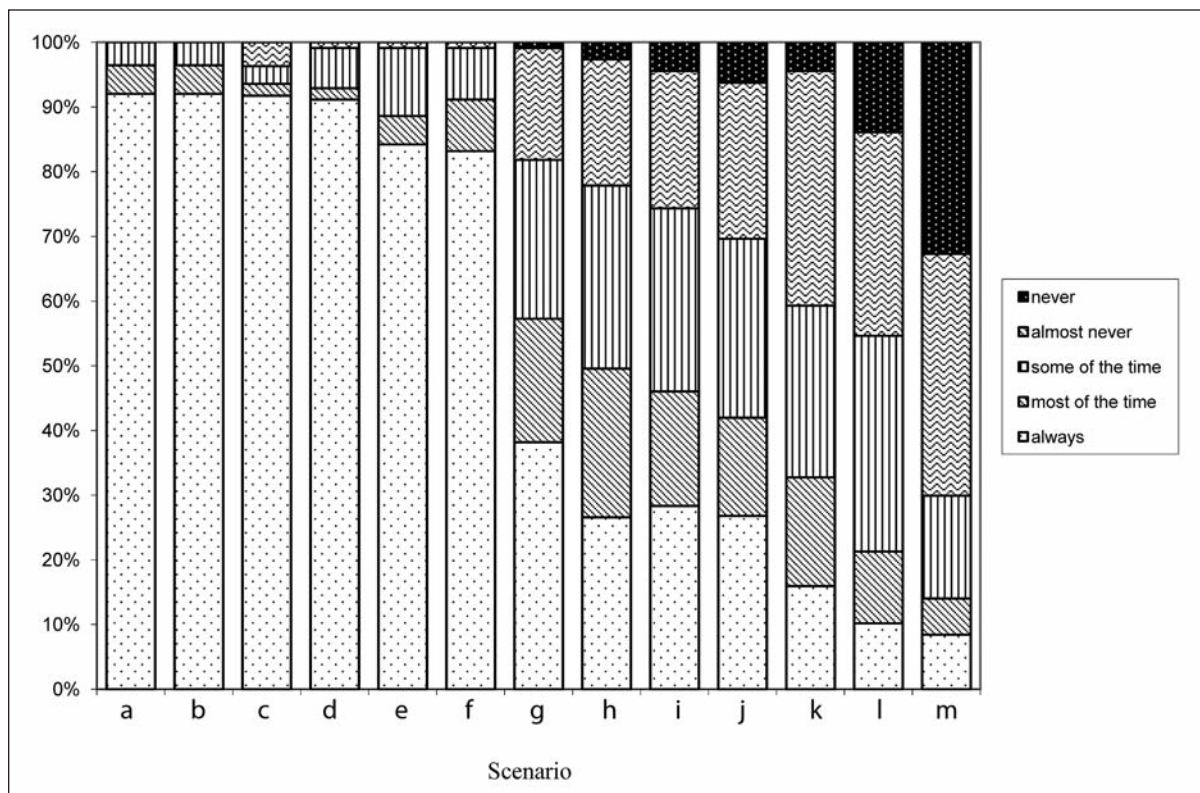


Figure 2: Distribution of Responses for Each Scenario.

on angiography. Over 25% of respondents described these as being almost never clinically significant. Subarachnoid hemorrhages diagnosed on the basis of xanthochromia with small amounts of red blood cells (i.e. $<1,000 \times 10^6/L$) were considered almost never clinically significant by over 25% of respondents. Patients with small aneurysms (i.e. $<3\text{mm}$) with otherwise negative work ups (i.e. likely not a true subarachnoid hemorrhage, but rather an incidental aneurysm) were considered to be sometimes to always significant in just over half of respondents, but also considered almost never to be clinically significant in over 25% of respondents. Finally, patients sent home from the emergency department with a diagnosis of subarachnoid hemorrhage, following testing, were considered by most respondents to not be clinically significant. Given the availability of cerebral angiography, more patients are being discharged directly home from the emergency department with negative angiography with small bleeds on CT or on the basis of xanthochromia on lumbar puncture.

No previous studies were identified which assessed the clinical significance of subarachnoid hemorrhage. Greebe and colleagues compared the mortality of patients diagnosed with a perimesencephalic subarachnoid hemorrhage to the expected adjusted mortality and found these patients had a normal life expectancy.⁷ Another study by Kang and colleagues followed patients with non-aneurysmal subarachnoid hemorrhages for at least one year.⁶ They found acute complications were more frequent in patients with non-perimesencephalic patterns of subarachnoid hemorrhage and these were more frequent in larger bleeds (i.e. greater Fisher score) with more severe clinical presentations (i.e. higher Hunt and Hess scores).^{6,15,16} Beyond the acute period, they found patients with normal angiography did well at one year.⁶ We conducted an international survey of emergency physicians one year prior to this survey.¹⁷ In this survey the emergency physician respondents had a median required sensitivity of 99% for diagnosing subarachnoid hemorrhage in neurologically intact patients with new severe headache. Given that this is the patient population which is most likely to have a non-clinically significant subarachnoid hemorrhage, emergency physicians may be demanding an unnecessarily high sensitivity for any such clinical decision rule. It may be appropriate to require this degree of sensitivity for aneurysmal, arteriovenous malformations and any other subarachnoid hemorrhage which requires an intervention.

We believe that this study has several strengths. It is the first survey that attempts to define what constitutes a clinically significant subarachnoid hemorrhage, based on the clinical judgement of neurosurgeons. We surveyed the entire population of neurosurgeons so as to minimize sampling error. We utilized a series of up to five contacts to maximize our response rates, included return envelope with prepaid postage, and pre-tested our survey with practicing neurosurgeons before finalizing.

LIMITATIONS

We acknowledge that our study has several potential limitations. We likely had a small amount of coverage bias (i.e. neurosurgeons that are part of our target population, all Canadian neurosurgeons, who never had a chance to respond), given that not all physicians in the target population may be listed in the directory. We attempted to assess this error by cross-referencing

our results with the published statistics from the Canadian Medical Association, which identified 260 practicing neurosurgeons in Canada in 2007, with a median age between 45-54, 93.1% of whom were male.^{13,14} The age and sex distribution in this population is very similar to that in our sample as is the overall number of neurosurgeons in the country. Hence, while our response rate is relatively low, we believe that the sample is representative of our target population.¹⁸ Our response is similar to previous physician studies. The average response rate for published physician surveys has been shown to be 52-54%.^{19,20}

There may be some measurement error in the answers provided by the respondents. This measurement error could arise from listing the cases generally from most severe to less severe. Randomly ordering of case severity would have minimized this potential error. We did not ask neurosurgeons if they were subspecialty vascular neurosurgeons or general neurosurgeons. This may have contributed to increased variation given that vascular neurosurgeons may be the ones actually caring for subarachnoid hemorrhage patients at some sites. Hence this may result in some increased variation in responses, although the magnitude of this is likely relatively small.

The questions regarding blood on CT could also have been misinterpreted, given that we did not specify the exact location or quality of blood on the CT. This lack of precision may have resulted in increased variation of responses. Finally, we grouped angiography together (CTA, MRA and catheter angiography) when in fact these tests are often interpreted differently by neurosurgeons. While digital subtraction catheter angiography is considered to be the gold standard, with an estimated sensitivity of 85.2% for aneurysms less than 3mm in size and 100% for aneurysms greater than 3mm.²¹ CTA with modern scanners (12 or more slices) is reported to have an overall sensitivity of at least 98.3% ranging from 90.2% to 96.3% for aneurysms less than 3mm and increasing up to 100% for detecting aneurysms greater than 8mm in size.^{21,22} MRA is reported to have a sensitivity of 98.3% for detecting aneurysms.²³ Despite these reported similar findings, many practicing neurosurgeons will interpret these tests very differently. Collating these three different testing modalities together may have increased the variation in responses for these questions.

IMPLICATIONS FOR CLINICAL CARE

Our survey identified that non-aneurysmal subarachnoid hemorrhages are rated inconsistently in clinical significance by our respondents. This may translate into inconsistent approaches to management, ranging from discharge from the emergency department following angiography to others admitting and observing patients. While the available evidence points to a good short and long term prognosis for patients who are clinically well, with relatively small bleeds on CT, it appears that there remain significant differences in opinion regarding the clinical significance of these subtypes of subarachnoid hemorrhages and how to optimally care for these patients.

IMPLICATIONS FOR FUTURE RESEARCH

Our survey identified that all subarachnoid hemorrhages are potentially not of equal importance. This survey may help design

subsequent studies that will focus on clinically important subarachnoid hemorrhages. Future studies could survey neurosurgeons in other countries where current practice patterns differ from Canada. Perhaps optimal future research would include a prospective study directed at assessing actual patient outcomes for each of the given scenarios.

CONCLUSIONS

Subarachnoid hemorrhage due to aneurysms requiring surgical intervention or arteriovenous malformations, those causing death and those requiring any surgical intervention are always clinically significant. Other types of non-aneurysmal subarachnoid hemorrhages have inconsistent ratings of clinical significance ranging from 'always significant' to 'not clinically significant' by Canadian neurosurgeons. These survey results highlight the need for further discussions among neurosurgeons to standardize the diagnosis of what constitutes a clinically significant subarachnoid hemorrhage.

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AUTHOR CONTRIBUTIONS

The author contributions were as follows: Jeffrey Perry conceived the idea and prepared the manuscript, Marlène Mansour and Cheryl Symington conducted the study and helped revise the manuscript, Monica Taljaard provided statistical assistance, and revised the manuscript. Ian Stiell assisted with the study design and revised the manuscript. There are no conflicts of interest to declare.

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