

# Barriers and Facilitators Affecting Implementation of a Clinical Decision aid for the Diagnosis of Acute Aortic Syndrome: A Qualitative Study

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## Research

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# Abstract

## Background:

Acute aortic syndrome (AAS) is an uncommon, life-threatening emergency that is frequently misdiagnosed. The Canadian clinical practice guidelines for the diagnosis of AAS were developed to improve patient outcomes and include a clinical decision aid designed to facilitate clinician decision-making. The objective of this study was to prospectively identify barriers and facilitators among physicians prior to implementation of the decision aid.

## Methods:

We conducted semi-structured interviews with emergency room physicians working at five sites distributed between urban academic and rural settings. We used purposive sampling, contacting physicians until data saturation was reached. Interview questions were designed to understand potential barriers and facilitators to decision aid uptake and use. Responses were analysed according to the Theoretical Domains Framework, and overarching themes describing these barriers and facilitators were identified.

## Results:

A majority of interviewees anticipated that the decision aid would support clinical decision making and risk stratification. Potential facilitators identified included guideline validation and publication and endorsement by peers.

Barriers to implementation and application of the aid included the fact that the use of D-dimer and knowledge of the rationale for its use in the investigation of AAS were not widespread. The complexity of the decision aid and insufficient specificity of D-dimer were also identified as potential barriers to use.

## Conclusion:

Physicians were amenable to using the AAS decision aid to support clinical decision-making and to reduce resource use. The barriers identified should be addressed prior to implementation in order to support decision aid uptake and use.

## Contributions To The Literature

- Emergency physicians were interviewed to prospectively identify barriers and facilitators to the implementation of a decision aid developed to facilitate the diagnosis of acute aortic syndrome (AAS).
- Findings can be used to inform tailored strategies for implementation of decision aids used in emergency departments.

- ffective implementation of the decision aid may promote better outcomes and reduce unnecessary testing among patients being investigated for AAS.

## Background

Acute aortic syndrome (AAS) refers to a group of life-threatening aortic pathologies including aortic dissection, intramural hematoma and penetrating atherosclerotic ulcer. This uncommon but potentially lethal condition is challenging to diagnose.<sup>1</sup> The low incidence of the condition, varied presenting symptoms, and lack of a standard diagnostic pathway has led to a misdiagnosis rate as high as 38%.<sup>2-4</sup>

In order to address the difficulties in the diagnosis of AAS, Ohle *et al.* developed clinical practice guidelines for the diagnosis of AAS, including a decision aid for risk stratification (see Additional file 1).<sup>5</sup> The purpose of the aid is to support clinical decision making in cases of suspected AAS, thereby minimizing diagnostic delays, misdiagnoses, and unnecessary advanced imaging.

Guidelines are only useful if incorporated into clinical practice. Implementation of guidelines can be improved if the educational intervention addresses barriers to implementation and promotes behaviours or attitudes that will facilitate uptake. Interviewing end-users regarding the barriers and facilitators to guideline implementation is increasingly recognized as a crucial part of implementation planning and has been used to inform and evaluate strategies for maximizing the uptake of guidelines and decision aids.<sup>6,7</sup> These data were analysed systematically using the Theoretical Domains Framework (TDF), an integrative framework based on behavioural change theory that can be used to identify barriers and facilitators to behavioural change.<sup>8-10</sup> It integrates existing theories of behavioural change theories into a single framework for assessing barriers to behavioural change and informing intervention design.

The TDF approach has been used in a variety of studies investigating barrier and facilitators to integration of evidence-based practices into practice in emergency departments and other areas.<sup>11-13</sup> Data generated using this approach can be used to inform implementation strategies in order to maximize uptake of and adherence to guidelines and clinical decision aids, and studies have employed this approach to both established guidelines and prior to clinical trials.<sup>7,14</sup>

## Aim

The aim of this study was to assess the current practice of a broad range of emergency physicians, and to use the theoretical domains framework to examine the barriers and facilitators to incorporating the clinical practice guideline recommendations into their practice.

## Methods

### Participants and setting:

Participants were a purposive sample of practicing emergency room physicians from three academic centers and two rural emergency departments in Ontario, representing prospective AAS decision aid validation study sites and a variety of levels of experience (Table 1). Based on prior studies a predicted sample size of 8–12 participants was estimated; interviews continued until no new themes had emerged for two consecutive interviews.<sup>6,12,13</sup> The Health Sciences North Research Ethics board approved this research, and results are reported according to the Standards for Reporting of Qualitative Research (SRQR) guidelines.<sup>15</sup>

Table 1  
Demographic information of ER physicians interviewed

		N
Sex	Male	7
	Female	2
Practice setting	Full time urban academic	6
	Part time urban and rural	3
Years in practice	< 5	4
	5–9	2
	10–14	0
	> 15	3
Mean # ER shifts per week	< 3	2
	3–4	5
	> 4	2

## Interview procedure:

Interviews were conducted using a semi-structured approach (Additional file 2). All interviews were conducted by CD, a non-clinician research assistant, by telephone between July and October, 2019. Interviews were audio recorded, transcribed verbatim and anonymized. The interview began with a detailed review of the decision aid and was followed by a series of open-ended questions designed to elicit the thoughts, beliefs and opinions regarding barriers and facilitators to implementing the decision aid. Interviews took between 25 and 50 minutes to conduct.

## Data analysis:

Data analysis involved an iterative process of reviewing data and coding utterances into TDF domains. A mixed deductive and inductive approach was taken, with reviewers noting general themes across interviews throughout the process of coding statements into TDF domains.

The first interview was coded collaboratively by the authors in order to establish a shared understanding of TDF domains and their definitions and to develop the initial codebook.<sup>8,9</sup> Throughout the coding process, coding criteria were continuously reviewed and refined as described in the codebook (Additional file 3). Subsequent interviews were coded independently and reviewed cooperatively, with discrepancies being resolved through discussion.

Coded utterances were then grouped into belief statements that represented similar responses across interviewees. Belief statements were generated by one reviewer (CD) and verified by another (RO), and supporting verbatim quotes are provided. Frequencies for each belief statement were compiled with each one being counted only once per interview.

## Results

Nine semi-structured interviews were conducted with practicing ER physicians (Table 1).

122 utterances were coded into the 14 TDF domains, thirteen of which were identified as potentially influencing decision aid uptake and accurate use. No utterances were coded into the domain Intention; all physicians expressed some degree of interest in adopting the decision aid, and a variety of rationales were given for the stated intention to adopt or delay adopting the aid; these were coded to the domain that best captured the specific reasoning. Belief statements generated from these utterances described barriers and facilitators to decision aid implementation (Table 2) and to accurate application (Table 3). Within this data, six overarching themes were identified.

Table 2  
Themes describing barriers and facilitators to decision aid implementation

TDF DOMAIN	SPECIFIC BELIEF	BARRIER OR FACILITATOR	REPRESENTATIVE QUOTES (interviewee, quote)	N
Knowledge	I need to see the evidence supporting the tool before adopting it into practice	B	"it's not clear to me that a zero on this score is associated with less than 5% chance of acute aortic syndrome. And then the same applies to each subsequent risk tier." (5, 2)  "I think a validation of study of the decision aid would have to be done to convince people to use it, as opposed to using it off the bat with no validation study. But if the validation study was showing its utility then I think I would be amenable to using it." (7, 5)	6
	I am not convinced of the utility of D-dimer in screening for AAS	B	"Do I d-dimer all of them [moderate risk]? I can't say that I do. I probably do other tests that would decrease my suspicion before doing a d-dimer." (4, 7)	5
	The tool aligns with my understanding of the evidence for AAS risk factors	F	"I can't think of any additional factors that would prompt me to investigate for dissection other than what we already listed...it's easy because it already fits with my mental model of aortic dissection." (1, 4)	4
	The tool must be validated before I would use it	B	"You wonder about defensibility, as it is, especially ... without, like, something like a randomized control trial to support it." (6, 9)	3
Behavioural regulation	Integrating new information into practice can be cognitively challenging	B	"I would like to see evidence that stimulant use and hypertension are/are not important risk factors for AAS...sometimes it's just hard to unlearn those things" (6, 6)	1
Social influences	A decision tool helps justify clinical decisions to colleagues	F	"Yeah, for sure [a decision tool can] help make your case; speaking to other consultants and talking about 'hey, have you heard of this new guideline that is actually supported by a bunch of other radiologists or vascular surgeons.'" (2, 8)	2

TDF DOMAIN	SPECIFIC BELIEF	BARRIER OR FACILITATOR	REPRESENTATIVE QUOTES (interviewee, quote)	N
	Decision tools support shared decision-making with patients	F	"I might say 'we can do a d-dimer, and if it's negative [...] we've essentially ruled it out'. And it would be nice to be able to give them a number to say 'if your d-dimer is negative, in a population of 100 people who are presenting similarly to you, only 0.5 percent of people are missed', or whatever that number might be. I think for the patient to be engaged in that conversation, I need those numbers or I need the evidence to be able to have that conversation with them." (5, 10)	2
	More likely to use a tool when it has been endorsed by peers	F	<p>"Getting the stuff published is usually successful, particularly study that are published in decent journals, and decent meaning, respected journals." (3, 12)</p> <p>"Getting CAEP to endorse a set of rules is very influential in getting them incorporated, you know, when a group of emergency positions...a group that represents emergency physicians in Canada publishes the stuff, discusses it and says this is a standard of care—that's obviously very influential." (3, 11)</p> <p>"The fact that my colleagues aren't also using it. I recently sort of polled like, a handful of people, and none of them are using d-dimer except for one, um, to help rule out aortic dissection in, like, low to medium risk patients. That is always a cause for concern—when you are doing something that is different than your colleagues." (6, 8)</p>	5
Environmental context and resources	The decision aid will not be used because CTs are readily available	B	"I don't think, honestly, they're going to be going for a decision aid, they're going to say, get me the CT, because it's so easy for us." (8, 2)	1
	A decision tool will benefit small centers in particular because it may reduce the need for patient transport	F	"A decision rule that prevents people from needing complex investigations can be super useful particularly if you don't work in a major center." (3, 2)	3

TDF DOMAIN	SPECIFIC BELIEF	BARRIER OR FACILITATOR	REPRESENTATIVE QUOTES (interviewee, quote)	N
Reinforcement	I am more likely to use the tool if it is shown to reduce resource use	F	"in the rural facility this is a really important opportunity to minimize transfer. So the effect on my practice, based on where the patient's hanging out, whether we're in [rural community] or something, I lose a nurse, I lose my physician assistant, if I send my patient out for CT scan." (9,10)	2
Social/professional role and identify	Clinical gestalt outperforms guidelines in clinical decision making	B	"I think a lot of times too with these decision aids, a lot of times it gets shown that clinical gestalt and experience is worth just as much as those, or perform just as well." (8, 1)	2
Beliefs about capabilities	Guidelines facilitate my decision making	F	"If I am uncertain and the patient is in a moderate risk category, then I would, I like the idea. I like the way this decision will makes you perhaps do a D dimer first as a screening test for CTA." (3, 5)	5
Beliefs about consequences	The decision tool is likely to be very sensitive	F	"In all honesty I think your decision aid will make people happy, because it's going to be hard to miss people, I think" (8, 6)	2
	Decision tool will lead to an increase in imaging	B	"I think this may be one of these decision aids that will lead to increased testing, because it's very easy to have one of the symptoms you're talking about." (8, 9)  "That heightened my concern about having a lot of positive d-dimers that then result in CT aortas being done... I would be worried that there would be a lot of false positives, which would lead to a lot more imaging being done." (5, 9)	7
Emotion	A clinical decision tool can help reduce anxiety around decision-making in AAS	F	"Cause right now I'm relying on my clinical gestalt. So it would be nice to have an evidence based tool to support my clinical decision making." (5, 13)	2
Optimism	Some cases of AAS will be missed even using the tool	B	"Even if that same patient like my colleague had the other day came in again, I would probably be fooled again." (1, 15)	2

TDF DOMAIN	SPECIFIC BELIEF	BARRIER OR FACILITATOR	REPRESENTATIVE QUOTES (interviewee, quote)	N
Goals	A decision tool will improve my ability to risk-stratify patients	F	"And I think the dimer offers me one more step to be able to risk-stratify these patients. Because otherwise, you either don't do the test or you do the test- like the CT-and it's kind of like, well, we have another option now. " (9, 14)	2

Table 3  
Themes describing barriers and facilitators to accurate application of decision aid

<b>TDF DOMAIN</b>	<b>SPECIFIC BELIEF</b>	<b>BARRIER OR FACILITATOR</b>	<b>REPRESENTATIVE QUOTES (interviewee, quote)</b>	<b>N</b>
Knowledge	Need to clarify whether age-adjusted d-dimer is used	B	Is there a discussion regarding cut off for the actual value of the D dimer? Are they age-adjusted?" (4, 2)	2
Skills	Physician vary in their ability to obtain physical exam findings required for tool	B	"What I don't have is this clinical skill, and I don't think probably anybody in our department has the ability (or it would be very rare) to be able to measure aortic regurgitation or insufficiency." (1, 1)	4
Memory, attention and decision processes	The decision aid is too complicated to memorize and requires an app	B	"It has to be published and ... on MD calc. That would be useful. I don't think this is a tool you can memorize." (4, 5)	3
	The tool is not presented clearly	B	"I get a little lost at first because the way you score each one is different" (1, 3)  "When you pick up any kind of clinical decision rule we want to know if the patient's meeting the inclusion criteria to begin with. CT head rule is a great example of that right? ... it's a little misleading because it actually doesn't tell you who to apply the rule to. So not getting it confused with the components of the rule versus who to even apply the rule to." (2, 2)	4
	The decision tool is easy to use	F	"It's relatively easy to use, I mean the exclusions are very straightforward, that's not hard to manage." (9, 3)	2
Environmental context and resources	Results of a D-dimer are fast and may accelerate care	F	"That's one of the advantages we have in our rural hospital, is that we have point of care testing, because we don't have lab 24/7." (9, 11)	2
	Waiting for a D-dimer may delay care	B	"One of the barriers, perhaps you could say, is the delay between investigating and getting a result." (3, 6)	2
	Required information may be unavailable	B	"A lot of this information we either don't have, or we just have to assume." (9, 5)	2

TDF DOMAIN	SPECIFIC BELIEF	BARRIER OR FACILITATOR	REPRESENTATIVE QUOTES (interviewee, quote)	N
Reinforcement	I will not order a D-dimer in patients for whom I suspect D-dimer will be positive for other reasons	B	"the patients I think are going to have a positive d-dimer for ten other reasons: I'm just going to go ahead and CT them... usually I just pull the trigger and make my day easier and order the scan upfront." (1, 13)	4
Beliefs about capabilities	Additional training/clarification is needed to use the tool.	B	"And I would hope that people are not saying, Oh, this person's blood pressure is 180 and they have some abdominal pain, therefore they go to CT. And I don't think that's the rule's intent." (3, 7)	2
Beliefs about consequences	Subjectivity in the tool may lead to over-testing.	B	"is there potential that we will start over-investigating? Because a lot of patients will, for example, describe that their pain is severe, and so that automatically gives them, you know, one point...I think that severe pain requires a sort of a clinical judgment call." (5, 3)  "One of my colleagues... CT scans a lot of people who I don't necessarily think need it. So [they are] always going to say 'aortic dissection is the most likely diagnosis' whereas my cognitive bias is going to say 'well, I think it's probably not' ... We're coming to a different conclusion from the same tool." (1, 6)	4

## I. Barriers and facilitators to implementation of the decision aid

### a) Decision-making support

Relevant TDF domains: Beliefs about capability, Emotion, Goals, Optimism, Social influences, Social/professional role and identity

Interviewees were largely receptive to the development of a clinical decision aid for AAS. The reasons included a belief that the aid was likely to reduce the number of missed cases of AAS, in part by forcing clinicians to consider the diagnosis more often, and the potential for D-dimer to safely reduce imaging rates by effectively risk-stratifying them prior to CT. Other perceived benefits of an evidence-based aid included reducing clinician anxiety, justifying clinical decisions (such as imaging orders) to colleagues, and aiding in shared decision making with patients.

The relative advantage of evidence-based decision aids over clinical gestalt was controversial, with some physicians stating their conviction that such aids are preferable, particularly for less experienced clinicians. Others expressed the belief that clinical gestalt is generally superior to decision aids, or that such tools are best used to supplement or guide clinical decision making rather than replacing it.

## **b) Awareness of the evidence**

### ***Relevant TDF domains: Knowledge; Behavioural regulation***

A major theme was whether scoring criteria and follow-up investigation aligned or did not align with individual practice or understanding of the evidence. While many interviewees felt that the scoring tool was comprehensive, others felt that certain criteria were overvalued or undervalued relative to what they had learned or experienced in practice, emphasizing the need to review the evidence prior to adopting the decision aid. One physician noted the additional role of cognitive biases in inhibiting practice change, commenting that as new evidence emerges that contradicts what was taught in medical school, “sometimes it’s just hard to unlearn those things” (Respondent 6).

An important barrier for physicians was concern about the effectiveness of D-dimer as a screening tool in AAS. Several were unaware of this potential application for the test, and the majority of respondents expressed reservations regarding the specificity and/or sensitivity of D-dimer, stating that they would need to see the adequacy of these measures demonstrated in a validation study prior to adopting the decision aid into practice. The primary concern was that the test was insufficiently specific, with many patients likely to have elevated D-dimer levels for other reasons.

## **c) Social influences on the probability of adopting the decision aid**

### ***Relevant TDF domains: Social influences***

A number of physicians stated that they were more likely to use the decision aid if it were published in a high-quality, peer-reviewed journal, endorsed by a professional body such as the Canadian Association of Emergency Physicians, as well as by other stakeholders involved in the treatment of AAS. The uptake of the aid by departmental colleagues was also an important facilitator, and the role of recent graduates or clinician-researchers in introducing new practices to a department was also noted as being a key influence: “A lot of the guys have been around a while; a lot of the information we’re getting is from young physicians that are training” (Respondent 3).

## **d) Consequences of decision aid use**

*Relevant TDF domains: Beliefs about consequences, Optimism, Reinforcement, Environmental context and resources.*

Several physicians felt that the decision aid was likely to increase the number of D-dimers ordered, and given its perceived lack of specificity, this would invariably lead to an increase in CT scanning. “I envision a lot of patients scoring one...and I would be concerned that a fair amount of people will be getting the dimer” (Respondent 4).

Physicians also identified positive potential consequences of decision aid use including a reduction in number of CT scans and consequently lower resource use and radiation exposure. In rural contexts, this could reduce the need for patient transport to obtain imaging along with associated costs and loss of accompanying ER staff, which strains rural emergency department capacity and workflow.

## **II. Barriers and facilitators to accurate application of the decision aid**

### **a) Ability to acquire required necessary data**

#### **Relevant TDF domains: Skill; Environmental context and resources**

Some physicians expressed concern about their own ability or that of others to assess certain physical exam findings. One physician self-identified as being unable to measure aortic insufficiency and three others observed that proficiency in the use of PoCUS varied among practitioners, and that this would impact the score generated by the decision aid. It was also noted that incomplete patient histories might similarly limit scoring accuracy; for example, patients may be unaware of the existence or nature of a pre-existing heart murmur or aortic valve disease.

The timing of D-dimer test results varied among institutions and influenced the probability of following the decision aid. Some physicians were concerned that delays in D-dimer results were such that they might not wait to order a CT. On the other hand, at two rural facilities point of care D-dimer results were available immediately, such that clinicians viewed this step as a means of accelerating care for patients at risk of AAS.

### **b) Ease of use**

#### **Relevant TDF domains: Knowledge, Memory, attention and decision processes; Beliefs about capabilities, Beliefs about consequences**

Physicians were divided in their response to the complexity of the decision aid. Some reported that they found the aid straightforward and easy to use, while others commented generally or on specific elements of the aid that they found unclear. A common theme was that the decision aid was too long to memorize, and that a mobile app would be required for effective use. In particular, several respondents found it challenging to remember which criteria determined inclusion and which were scored under physical exam findings, and two mentioned the importance of featuring inclusion criteria prominently at the top of the tool, noting that this was a barrier to the use of existing decision aids. There was also concern that the subjectivity within the decision aid (specifically with regards to pain severity and probability of alternate diagnosis) was likely to promote increased testing, suggesting that further clarification and training is required to accurately use the decision aid.

## Discussion

Acute aortic syndrome is a dangerous and difficult to diagnose condition for which a new, evidence-based clinical decision aid has been developed.<sup>16</sup> In this study, we identified the barriers and facilitators likely to influence the implementation of the AAS clinical decision aid, with the goal of pre-emptively addressing barriers and reinforcing enabling factors. Using the theoretical domains framework to guide our analysis of physician responses allows the barriers identified to be linked to the specific interventions most likely to facilitate behaviour change: that is, decision aid uptake and use.<sup>17,18</sup>

Guidelines can reduce practice variation and improve outcomes, but their utility depends upon successful implementation in practice. Adherence to guidelines varies considerably within the emergency department.<sup>19</sup> Tailored interventions that address prospectively identified barriers may improve adherence to guidelines.<sup>20,21</sup>

## Facilitators to decision aid uptake and use

Key facilitators included the role of evidence-based decision tools in supporting clinical decision making (beliefs about capability, emotion, goals) and endorsement of the decision aid by professional organizations and department peers (social influences). Overall, physicians responded positively to the development of a decision aid for AAS because of the catastrophic nature of the condition and the diagnostic challenge it presents. The majority felt that the aid was likely to improve risk stratification and support clinical decision making, including in discussions with patients and colleagues. Adoption of the tool by peers was also identified as a motivating factor; modelling by a physician champion may improve success of the intervention.<sup>13,22</sup> Endorsement of the decision aid by other stakeholders and professional bodies publication in a high-quality journal were all viewed as important prerequisites for widespread decision aid uptake, as has been shown previously for implementation of guidelines in general.<sup>18</sup>

## Barriers to decision aid uptake and use

The central barriers identified included factors that limited clinician capability (the capacity to adopt and use the decision aid, including sufficient knowledge and skill) and motivation to adopt the decision aid.<sup>17</sup> In particular, respondents reported a lack of familiarity with the evidence underlying the aid (knowledge) and concerns regarding the complexity of the decision aid (memory, attention and decision making) as well as its specificity (beliefs about consequences).

Physicians cited a lack of familiarity with the evidence base of the decision aid as being an important barrier to uptake, and several expressed concerns about their ability to accurately apply the decision aid even after reviewing it in detail. Knowledge of the scientific rationale and pre-implementation skills training have repeatedly been cited as enablers to implementation of new guidelines and decision aids in the ER and other contexts.<sup>6,23,11</sup> Effective dissemination of the decision aid is crucial and should include publication in presentation of the guidelines in a variety of media, high quality journals and educational meetings within the department. These challenges can also be addressed by thorough pre-

implementation training, continuing medical education (CME) credits and by providing a supporting appraisal of the evidence alongside the decision aid.

The complexity of the decision aid was another concern, particularly in a busy emergency department. Indeed, studies of other decision aids have shown that they are often used incorrectly in practice, being applied in patients that do not meet inclusion criteria used in validation studies or adding steps that were not included in the validated decision aid.<sup>6,24</sup> Evidence suggests that even relatively simple decision rules in common practice are difficult to remember.<sup>24</sup> Environmental restructuring, such as facilitated access to copies of the tool, an app, or local adaptation of the tool (e.g. by integrating the decision aid into charts), is therefore another means of supporting practice change.

Finally, beliefs about consequences represented both a motivating force for physicians, who identified the potential for a reduction in number of CT scans and need for patient transports as potential benefits, as well as an important barrier. There was widespread concern that both the decision aid criteria and the D-dimer would be insufficiently specific, causing an increase in imaging along with its attendant risks to patients and impedance to workflow. While physicians were confident about the likely sensitivity of the tool, there was near universal concern that testing could increase as a result of low specificity. Use of the decision aid was expected to result in higher rates of D-dimer screening, which would in turn lead to an increase in imaging orders as the result of false-positive D-dimer results. Thus, in addition to validation studies investigating sensitivity and specificity of the decision aid, evidence required regarding the effect of decision aid use on imaging orders would also be helpful. Notably, a pilot implementation of a clinical decision aid for AAS incorporating D-dimer found a non-significant increase in D-dimer ordering but no increase in CT ordering (Ohle *et al.* in review).

## Strengths And Limitations

The strengths of this study included the use of a theoretical framework to guide analysis of interview responses. Interviewees were selected from multiple institutions and represented diverse levels of experience and demographics in both urban and rural settings.

The limitations of the study included a relatively small sample size, though we ensured thematic saturation was reached by conducting an additional two interviews after no new themes emerged. Interview questions were not designed to address specific theoretical domains, which may cause certain domains to be underrepresented in the data if they did not come up spontaneously. However, our approach increased the chances of identifying those barriers and facilitators that were the most salient to emergency physicians. Finally, given that the investigation was conducted prior to decision aid distribution and implementation, it is possible that unforeseen barriers will arise despite the attempt to address them *a priori*.

## Conclusions

Physicians were amenable to using the AAS decision aid due to its potential to support clinical decision-making and reduce resource utilization in a difficult to diagnose and lethal condition. Key barriers identified included the need for additional education and training prior to decision aid implementation, and concern about specificity of the decision tool criteria and D-dimer. These barriers should be addressed prior to decision aid implementation.

## **Declarations**

## **Competing interests**

The authors declare that they have no conflicts of interest.

## **Ethics approval and consent to participate**

The Health Sciences North Research Ethics board approved this research.

## **Consent for publication**

Not applicable.

## **Availability of data and materials**

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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## **Authors contributions**

Dr. Dmitriew was responsible for analysis and manuscript preparation. Dr. Ohle was responsible for study design, analysis, oversight, and manuscript editing.

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