

Developing an implementation intervention for managing acute vertigo in the emergency department

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ABSTRACT

Background There are evidence-based bedside tests for diagnosing acute vertigo, but no evidence-based strategies to support clinicians in implementing them. The purpose of this study was to design an implementation strategy for treating acute vertigo by examining current facilitators and barriers to using these tests in the ED using the principles of implementation science.

Methods A survey was developed using the Theoretical Domains Framework and Consolidated Framework for Implementation Research to examine barriers and facilitators for using HINTS+ (head impulse, nystagmus, test of skew, plus hearing) and Dix-Hallpike tests. The survey was sent to emergency clinicians (ECs) in a teaching hospital in London, UK, between May and September 2022. Semistructured interviews were conducted simultaneously, and data examined using direct content analysis. Implementation strategies were then selected based on the Expert Recommendations for Implementing Change framework.

Results Fifty-one ECs responded to the survey and six ECs volunteered for interview. Less than half reported using the bedside tests to make a diagnosis. The most common barriers were beliefs about complexity, a lack of supporting materials, memory, lack of skills and negative experiences. The interview data revealed negative beliefs about the necessity, validity, safety and practicality. There were also barriers in the ED environment (eg, lack of space). There was a strong perception that the current approach to managing acute vertigo needed to change and ECs view this as part of their professional role and responsibility. Based on clinician input, the authors selected strategies to improve diagnostic efforts, which included guidelines for training, developing vertigo champions, protocols, memory aids, audit and feedback.

Conclusion This study found several barriers to managing acute vertigo such as memory constraints, and inadequate supporting materials and training, although a robust desire for change. The implementation strategy's initial phase is described, which must now be tested.

INTRODUCTION

Dizziness and vertigo account for approximately 4% of chief symptoms¹ and 12% of neurological presentations² in the ED, but there are few areas of medicine where there is such divergence between generalist clinical practice and specialist expert opinion. Many patients with peripheral vestibular disorders, such as vestibular neuritis or benign paroxysmal positional vertigo (BPPV), undergo unnecessary imaging and/or hospitalisation and

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Vertigo is usually due to a benign disorder, but it is the most common symptom associated with misdiagnosis of stroke. The most recent evidence-based guidelines (GRACE-3) recommend that emergency doctors be trained to perform the bedside examination with an emphasis on eye movements; however, this only addresses a lack of knowledge, which is rarely the only barrier to behaviour change.

WHAT THIS STUDY ADDS

⇒ The study found that, in addition to lack of skills and training, the most common barriers were memory, previous negative experiences and beliefs about the challenging/subjective nature of the examination itself. Although clinicians had confidence in their ability to distinguish dangerous causes of vertigo, they seldom perform the recommended tests. Emergency clinicians believe managing acute vertigo is within their scope and are motivated to improve.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study outlines how to initiate the process of developing implementation strategies based on implementation science. This supports conducting larger-scale follow-up studies that assess diagnostic accuracy, with the potential to reduce costs and misdiagnosis related to acute vertigo.

do not receive appropriate treatment.³ Roughly 9% of cerebrovascular events are missed at initial ED presentation and the risks rise substantially when the only symptom is vertigo or dizziness.⁴ Although rare events, vertigo has thus been cited as a symptom deserving special attention in terms of reducing preventable misdiagnosis-related harms.⁵

Misdiagnosis is preventable since there are simple, quick, non-invasive bedside examination procedures that can accurately identify posterior circulation strokes.^{6,7} In clinical practice, however, key aspects of the clinical examination are rarely used and/or misinterpreted.⁸ This has led to a debate about transferring responsibility to specialists, although in reality, timely specialist examination is not feasible in most ED settings. Relying



on MRI is no better since it will miss one in five patients with posterior circulation stroke in the first 48 hours.⁹

We believe that it is beneficial to frame this as a failure of implementation. Implementation science refers to the study of ‘how’ to facilitate successful uptake of an evidence-based health intervention.¹⁰ The Society of Academic Emergency Medicine has recently published guidelines for acute dizziness and vertigo in the ED (GRACE-3), promoting bedside examinations including ‘HINTS+’ (head impulse, nystagmus, test of skew, plus hearing) and the ‘Dix-Hallpike test’ (DHT) by suitably trained clinicians.¹¹ Notwithstanding that most emergency clinicians (ECs) have not received training, additional barriers may exist that mean the GRACE-3 guidelines are difficult to implement in practice. While other studies have employed theory-based approaches to understand key behavioural determinants of clinicians following guideline-recommended care for specific conditions such as BPPV,¹² there is still a need to go on to develop explicit implementation strategies based on barriers and enablers for the entire vertigo examination if we are to bridge the evidence–practice divide.

Our aim was therefore to develop such an implementation strategy. Key stakeholders were identified in the ED and specialist services and their roles were categorised, drawing on the ‘Interactive Systems Framework for Dissemination and Implementation’.¹³ The ‘Knowledge to Action’ process map guided the authors through the various stages of the implementation design.¹⁴ Here, we report on two of those stages, specifically to (1) assess barriers that may impede implementation and strengths that can be used in the implementation effort, and (2) to select and tailor implementation strategies.

METHODS

Setting

The study was carried out in the ED of a large university teaching hospital in an urban area of London (UK), with 24-hour access to brain imaging and emergency medicine consultant presence. The survey and interviews were conducted between May and September 2022.

Participants

ED clinicians (emergency physicians and advanced clinical practitioners) were sent the survey via the ED group email. Staff were sent regular reminders via email, and posters were displayed in the department featuring a QR code. Responses were confidential and it was highlighted that this was not a test.

Patient and public involvement

No patient involved.

Survey

The questions and the data coding for the survey were developed using the constructs of the Theoretical Domains Framework (TDF)¹⁵ and Consolidated Framework for Implementation Research (CFIR)¹⁶ which ensured that all the potential behavioural change factors were considered (see online supplemental file 1). The questionnaire focused on the characteristics of the bedside examination and individual barriers to change. Barriers are defined as anything that impedes people or organisations from making a change, whereas facilitators are things that help people to make a change. The survey was developed by the first author and revised following feedback from all other authors, piloted and then administered online using Qualtrics. For the bedside examination, questions related to the ‘HINTS’

(head impulse, nystagmus, test of skew) and DHT, since these are key elements in most diagnostic algorithms including the latest GRACE-3 guidelines,¹¹ and we identified that most ECs were simply unaware of specific diagnostic algorithms such as Triage-TiTrATE and STANDING.^{17 18}

The CFIR¹⁶ outlines several ‘intervention’-level characteristics that affect people’s decision to adopt and their ability to implement those tests. These include the *source* (do people trust and believe the source of the evidence), the *evidence strength and quality* (what is the evidence and do people believe it), the *relative advantage* (is it better than what they are currently doing or another alternative), *complexity* (is it difficult or disruptive), *design quality* or *packaging* (the access to well-designed, easy-to-follow supporting materials), and *cost* considerations (the cost of implementing it). The other two characteristics are *adaptability* (the ability to make changes to make it fit the local context) and *trialability* (the ability to test it on a small scale), but these were considered later in the design phase.

Individual-level barriers were identified using the TDF,¹⁵ which provides characteristics within people that help or hinder them to make a change. The TDF individual-level constructs include *knowledge* (whether the person has the necessary knowledge), *skills* (do people have the skills to do the new behaviour), *memory/attention/decision processes* (do people remember to do something), *behavioural regulation* (is this a habitual behaviour), *environmental context and resources* (contextual factors that influence people’s decision to do something), *social influences* (the social behaviours such as peer pressure), *beliefs about capabilities* (are they confident they can do something), *beliefs about consequences* (do people believe that something good or bad will happen if they make this change), *social professional role and identity* (do people think this is part of their job or role) and *optimism/pessimism* (a general positive or negative expectation about the intervention), *intentions* (do people plan to do the intervention), *goals* (do you want to do something differently) and *emotions* (feelings associated with the change), and finally, *reinforcement* (positive or negative experiences).

Interviews

The final question of the survey asked whether they would be happy to be approached for interview. Those staff who volunteered their details were approached by the lead author (DH), who is a vestibular physiotherapist with additional university training in performing qualitative interviews and was not known to the staff, and were interviewed at a mutually convenient time. Interviews lasted between 20 and 30 min and were conducted and recorded over Microsoft Teams, with the participant’s permission, allowing direct transcription which was checked and amended against the recording by DH.

The interviews were semistructured, using a topic guide that was also based on individual and intervention-level constructs described above, as well as contextual-level barriers from the CFIR (see online supplemental file 2).

Data analysis

The results of the survey were analysed and presented using Microsoft Excel by the lead author. The questions that were negatively worded were reverse scored so that an ‘agree’/‘disagree’ response indicated the same type of response on every item.

The qualitative interview transcripts were analysed by the lead author (DH) using deductive content analysis,¹⁹ which allowed data to be analysed according to the predefined theoretical

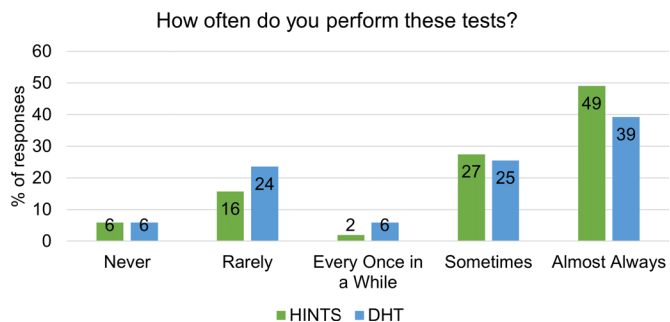


Figure 1 Self-reported test use. DHT, Dix-Hallpike test; HINTS, head impulse, nystagmus, test of skew.

frameworks described above and the responses to be directly mapped on to specific implementation strategies. Qualitative data were conducted using NVivo software. The first two authors (DH and HA) reviewed all transcripts and all authors discussed and agreed the themes, and a colleague who was not involved in the study conducted a validity check as recommended by Bengtsson.¹⁹

Selecting implementation strategies

Following the barriers and facilitators assessment, the implementation strategies were identified and selected using existing frameworks, mainly the Expert Recommendations for Implementing Change (ERIC).^{20,21} After matching the implementation strategies in ERIC to the list of barriers, they were then tailored into practical, actionable steps. All authors completed this in a series of meetings.

RESULTS

Characteristics of study subjects

The survey was sent to 110 clinicians, and 51 of them responded. These included 8 consultants, 4 physician associates, 14 senior middle grades, 14 junior middle grades, 7 foundation years trainees and 4 advanced clinical practitioners. The median number of patients with acute vertigo seen a month was four

(range 0–20). Only one individual reported not seeing any patients with vertigo in an average month.

Survey main results

Self-reported use was slightly higher for the HINTS examination than the DHT, but less than half of respondents self-reported always using either test when it would be recommended to do so (see figure 1).

The largest barriers relating to the bedside examinations were beliefs that they were too challenging (38%) and the lack of access to supporting materials (17%). There was strong support in favour of a new approach compared with current practice (74%) and a need to change (56%). There was general support for the evidence base for both the DHT and HINTS examination, but a high number of neutral/don't know responses indicated a general lack of awareness. The questionnaire responses can be seen in figure 2.

The largest individual-level barrier was memory, with 54% of respondents struggling to remember the sequence of testing (see figure 3). Only 39% had received training in the DHT and 33% had received training in HINTS. Thirty-one per cent had negative experiences performing Dix-Hallpike examinations, and 26% had negative experiences using HINTS. Only 18% of respondents were worried about missing a serious diagnosis and 63% felt confident in their capability to differentiate posterior circulation stroke from an acute unilateral vestibulopathy. There was slightly more optimism for (76%), and intention to use (79%), the HINTS over the Dix-Hallpike (56–61%, respectively). The majority (93%) of respondents expressed a desire to improve their ability to manage acute vertigo and felt that it was part of their professional role and responsibility in the ED.

Interview results

Six clinicians volunteered to be interviewed. Two were specialist trainee (ST) grades 1–2, three were specialist grades 3–4 and one was a consultant.

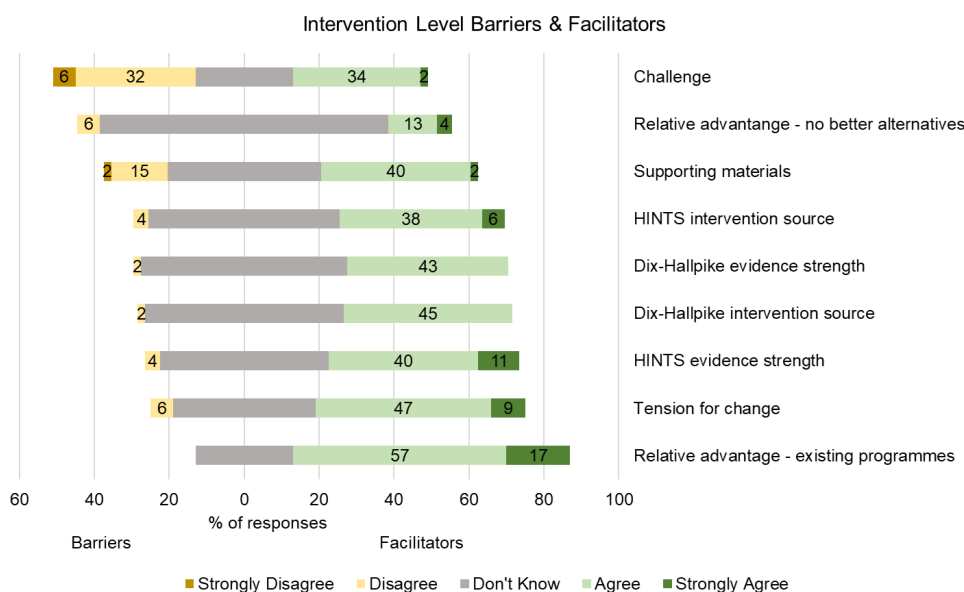


Figure 2 Diverging bars with 'don't know' responses split to show responses to test related level barriers and facilitators. Left of zero indicates negative answers corresponding to potential barriers, and right of zero indicates positive answers indicating facilitators. HINTS, head impulse, nystagmus, test of skew.

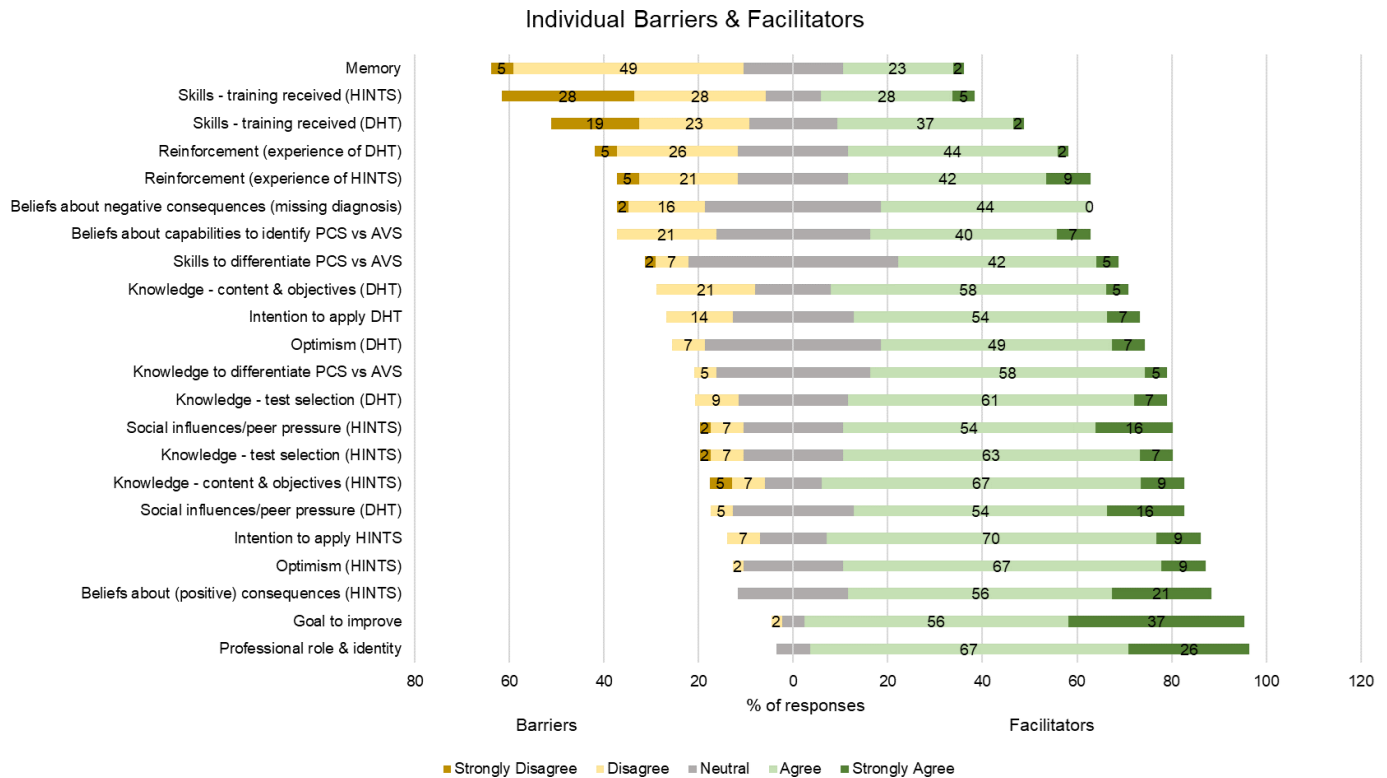


Figure 3 Diverging bars with 'neutral/don't know' responses split to show responses to individual-level barriers and facilitators. Left of zero indicates negative answers corresponding to potential barriers, and right of zero indicates positive answers indicating facilitators. AVS, acute vestibular syndrome; DHT, Dix-Hallpike test; HINTS, head impulse, nystagmus, test of skew; PCS, posterior circulation stroke.

Individual barriers

Participants lacked confidence in the use of HINTS and DHT. They tended to employ methods like history, pattern recognition, a general neurological examination and imaging. Not only did people have varying levels of familiarity with the tests, there were also some relevant misunderstandings.

I don't think a lot of people feel confident in it because we don't do it as much as we should, or we don't do it very regularly. (Interview 6, ST3)

Some participants had negative experiences doing the tests, maybe on the wrong patients or with unsatisfactory results, which made them less willing to employ them in the future.

Dix-Hallpike I have found in my experience isn't 100% reliable and also patients' tolerance of it is a lot less than that of the HINTS. (Interview 2, ST4)

Participants expressed negative emotional responses when confronted with a patient experiencing dizziness. Some of the fear was due to the beliefs about the consequences of missing a significant pathology, such as a stroke, which led to an increase in imaging. Some also cited a fear of litigation. Beliefs about causing or worsening neck injuries were another potential barrier.

It's in all honesty bit of a heart sink because I know that I find it very difficult, and I know that I get worried about missing more kind of serious pathology. Particularly sometimes when you have older patients as well. (Interview 6, ST3)

There was consistent dissatisfaction with status quo and desire to seek the best outcomes of care. However, there was one notable contribution from the consultant due to their perception that patients were not coming to harm.

...trying to differentiate...the vestibular conditions against stroke... we should be OK at. ... there's lots of evidence out there to say that we're not. And it's not just us, it's, I think it's emergency medicine as a specialty. (Interview 1, ST2)

I think the problem we have is nobody cares enough, OK? I think, because there isn't a problem, in the sense that it's, it's not like lethal diagnoses are being missed or misdiagnosed...But I don't think anyone cares, because I think mostly we are not missing strokes... but we don't know. (Interview 4, Consultant)

Memory was a consistent barrier, with participants having to rely on the internet to remember both the relevant steps and how to correctly interpret the tests.

I still sometimes do have to look it up and Google it again, just to go through my head of what's negative and what's positive. (Interview 2, ST4)

However, participants were optimistic in their ability to acquire the necessary skills, given adequate teaching. They all expressed a desire to improve their skills and knowledge. Additionally, all participants thought that the management of acute vertigo was congruent with their professional identity and role in the ED.

I absolutely think it's part of our responsibilities definitely...it's true medicine, it's history taking, examination, intervention and cure. If you can do it right. (Interview 1, ST2)

Test characteristics

Participants talked about how subjective the tests were and how hard it was to choose the right patient for the right test.

The problem is the HINTS is quite susceptible to misinterpretation. I've even seen stroke registrars misinterpret the use of it... (Interview 3, ST4)

This probably has a bad rap in that the general impression is that it's a bit subjective.... If you do an anaesthetic for the half of the chest then you know four minutes later that half of the chest is now anaesthetised. (Interview 4, Consultant)

A second barrier was the evidence source. Participants noted that the evidence for the HINTS assessment came from specialists rather than ED clinicians, diminishing their overall confidence.

There's definitely evidence that a HINTS exam is sensitive, and it is quite specific...But it hasn't been studied in the emergency department by emergency department clinicians. (Interview 1, ST2)

These techniques were seen as cost-effective and participants were able to identify advantages of having a clear algorithm of what to do.

I think what's really useful in the ED are those pathways ...It settles everybody down; it gives everybody more confidence. (Interview 5, GP ST1)

Context

Participants characterised the ED culture as entrepreneurial, with a strong emphasis on adaptability to change and learning. There was also substantial leadership engagement. Participants were able to provide examples of other effective pathways, because they had access to well-organised information via the hospital informatics system. There was a strong network of communication within the organisation.

The neuro or stroke registrar on call...usually really approachable and gives good advice and obviously I've spoken to the consultant in charge. (Interview 5, GP ST1)

Access to time and space was mentioned as a significant barrier, specifically the lack of access to a treatment couch for DHT and the difficulties in assessing hearing in a noisy ED setting. This led to leaving patients to perform diagnostic and therapeutic manoeuvres at home.

A&E is so busy at the moment...It can be very difficult to find the space. (Interview 6, ST3)

Table 1 summarises the combined results of the survey and interviews. Constructs have been recontextualised into specific statements (subheadings) to assist with selecting implementation strategies.

Selecting implementation strategies

Following the barriers and facilitators assessment, implementation strategies were selected among the authors. The full list of implementation strategies is provided in table 2.

DISCUSSION

This study proposes implementation strategies to manage acute vertigo in the ED based on a mixed-methods assessment of crucial barriers and enablers. ECs have negative beliefs about the complexity of vertigo examinations and lack of access to supporting materials. Memory, lack of skills and training, and negative reinforcement were the most endorsed individual barriers. ECs typically believe they can distinguish dangerous causes of vertigo, but they seldom perform the appropriate bedside examination, indicating a deeper lack of understanding.

The results are consistent with previous surveys that show ECs lack confidence in the HINTS examination.^{22–24} Similarly, these studies found negative beliefs about safety and patient tolerance, particularly with the head impulse, and concerns that the HINTS was not validated for use by ECs. However, data are starting

Table 1 Summary of barrier and facilitator results

Barriers	Facilitators
<p>Individual:</p> <ul style="list-style-type: none"> ▶ Knowledge <ul style="list-style-type: none"> Lack of knowledge Misconceptions ▶ Skills <ul style="list-style-type: none"> Vertigo protocols require a skilful examination Lack of available training ▶ Memory <ul style="list-style-type: none"> Vertigo protocols are difficult to remember ▶ Beliefs about consequences <ul style="list-style-type: none"> Vestibular examinations can cause neck pain ▶ Beliefs about capabilities <ul style="list-style-type: none"> Overconfidence in other aspects of the neurological examination ▶ Environmental context and resources <ul style="list-style-type: none"> Lack of space and access to equipment (eg, treatment couch) ▶ Negative reinforcement ▶ Previous bad experiences 	<ul style="list-style-type: none"> ▶ Optimism <ul style="list-style-type: none"> Potential benefits of vertigo protocols ▶ Goals <ul style="list-style-type: none"> A desire to improve the management of acute vertigo and improve knowledge ▶ Professional role and identity <ul style="list-style-type: none"> Distinguishing central vs peripheral vestibular causes of vertigo is part of my responsibility in the ED
<p>Intervention (bedside examination):</p> <ul style="list-style-type: none"> ▶ Complexity <ul style="list-style-type: none"> Vertigo examinations are difficult and require subjective interpretation ▶ Evidence source <ul style="list-style-type: none"> Not validated for use by ECs ▶ Supporting materials <ul style="list-style-type: none"> No access to current protocol or well-designed supporting materials ▶ Adaptability <ul style="list-style-type: none"> Perceived lack of adaptability of vertigo protocols to lack of space and resources ▶ Relative advantage <ul style="list-style-type: none"> Confidence in current practice to identify dangerous causes of vertigo 	<ul style="list-style-type: none"> ▶ Cost <ul style="list-style-type: none"> Vertigo protocols can be completed by the bedside Vertigo protocols can save money through less unnecessary investigations and hospital admission ▶ Relative advantage <ul style="list-style-type: none"> Vertigo protocols have the potential to improve the care of people with vertigo and dizziness
<p>Contextual:</p> <ul style="list-style-type: none"> ▶ Lack of existing policies and incentives ▶ Structural characteristics <ul style="list-style-type: none"> 24-hour access to imaging 	<ul style="list-style-type: none"> ▶ Culture <ul style="list-style-type: none"> Dynamic and entrepreneurial culture ▶ Implementation climate <ul style="list-style-type: none"> Tension for change, learning climate and compatible with organisational goals ▶ Readiness for implementation <ul style="list-style-type: none"> Leadership engagement, available resources and access to specialist knowledge and information

ECs, emergency clinicians.

to emerge that ECs can use HINTS and/or protocols such as 'STANDING', which shares overlap with the HINTS and DHT, to identify central causes of vertigo.^{25 26}

The findings are also consistent with qualitative research that cited prior bad experiences or forgetting how to conduct the DHT for BPPV as barriers to infrequent use.^{12 27} Since reinforcement is linked to associative learning, it follows that physicians require early supervision to produce good experiences.

Implementation efforts in relation to the management of acute vertigo have historically been very focused on capability, involving educating and training staff. Although these are helpful and necessary, data presented in this study suggest these alone would not be sufficient, since several other barriers exist that need to be considered.

The COM-B model of behaviour change suggests that for change to occur, individuals must have the *capability*,

Table 2 Implementation strategies selected based on the barriers and facilitators assessment

Strategy: identify and prepare 'vertigo champions'	
Related barriers: <ul style="list-style-type: none"> ▶ Overconfidence in stroke diagnosis ▶ Vertigo examinations are difficult and require subjective interpretation ▶ Lack of knowledge and misconceptions 	Actions: <ol style="list-style-type: none"> 1. Identify and prepare vertigo champions who dedicate themselves to supporting, marketing and driving through the implementation, overcoming indifference or resistance that the change may provoke in the organisation 2. Provide the vertigo champions with additional intensive training and proctored examinations to develop confidence in their capabilities 3. Stage implementation scale-up, starting with vertigo champions, to inform the training and education needs of other staff
Strategy: training	
Related barriers: <ul style="list-style-type: none"> ▶ Knowledge and beliefs about the intervention ▶ Skill ▶ Intervention source—not validated for use by ECs ▶ Negative reinforcement 	Actions: <ol style="list-style-type: none"> 1. Create and distribute educational materials (eg, guidelines) to improve knowledge 2. Hold and integrate meetings with ECs to improve knowledge and awareness 3. Have leadership declare the priority of acute vertigo and their commitment to seeing it implemented 4. Conduct competency-based training for all staff involved 5. Create learning collaboratives (eg, staff in similar roles, etc) for the purpose of shared training and building capacity 6. Provide ways for staff to directly observe other experienced people perform the examinations and shadow experts to gain positive reinforcement
Strategy: education	
Related barriers: <ul style="list-style-type: none"> ▶ Knowledge and beliefs about the intervention ▶ Lack of knowledge and misconceptions 	Actions: <ol style="list-style-type: none"> 1. Create and distribute educational materials (eg, posters) to correct misconceptions 2. Hold educational outreach meetings for ECs
Strategy: prepare protocol and pathways	
Related barriers: <ul style="list-style-type: none"> ▶ Intervention complexity ▶ Available resources ▶ Memory ▶ Knowledge ▶ Adaptability 	Actions: <ol style="list-style-type: none"> 1. Capture local expert knowledge and use expertise to develop protocol based on available evidence including GRACE-3 guidelines 2. Make the protocol easily accessible, with brief (summary) and full guidelines 3. Liaise with supporting networks (eg, radiology and stroke/neurology services) to get their buy-in and build capacity to support implementation. Potentially consider restricting the ability to order unnecessary testing when not indicated (eg, CTs for acute vertigo) 4. Use implementation team to determine how individuals can implement the protocol within the ED setting and promote adaptability 5. Establish a subacute vertigo pathway for patients to access an early neuro-otology opinion and vestibular rehabilitation
Strategy: memory aids; informatics-based decision aid application and print materials	
Related barrier: <ul style="list-style-type: none"> ▶ Memory 	Actions: <ol style="list-style-type: none"> 1. Produce educational materials such as BPPV decision and treatment posters 2. Develop reminder systems and documentation proformas (eg, through electronic patient records) to help ECs to recall information and/or prompt the performance of the new vertigo protocol and to document findings clearly
Strategy: audit and feedback	
Related barriers: <ul style="list-style-type: none"> ▶ Relative advantage ▶ Test overuse ▶ Knowledge ▶ Beliefs about consequences and capabilities 	Actions: <ol style="list-style-type: none"> 1. Change records systems (patient diagnostic codes on electronic patient records) to allow better capturing of information and assessment of implementation outcomes 2. Collect and summarise performance data, measuring and rewarding diagnostic quality and efficiency 3. Conduct cyclical, small tests of change and conduct ongoing training

BPPV, benign paroxysmal positional vertigo; ECs, emergency clinicians.

opportunity and *motivation*.²⁸ The data suggested that ECs have limited *capability* due to a lack of knowledge, skills, memory and decision processes. One example of a solution that targets memory-related components of capability is patient record templates, which have been found to greatly improve documentation of nystagmus.²⁹

The interviews also indicated that a busy ED's built environment can limit the *opportunity* to engage with elements of the bedside examination. ECs are however *motivated* in the sense that they want to improve patient care, want to manage acute vertigo differently and see this as part of their role. However, what demotivates them is the negative experience and fear of missing serious pathology. It is only when these three elements of the COM-B model are in place will people change their behaviour.

The only other published implementation intervention was developed by Kerber *et al.*³⁰ This was a BPPV-centric strategy, designed to increase the use of the DHT in the ED. However, the authors found this approach only marginally changed physician

behaviour since absolute rates of performing DHT were still low (3.5% of visits). However, the absolute rate of DHT is a flawed outcome, since DHT and HINTS are not interchangeable. Performing a DHT on the wrong patient is likely to lead to confusion and thus be a barrier due to negative reinforcement. Instead, evaluation strategies should prioritise diagnostic accuracy and efficiency.

It is important to exercise caution before generalising these findings. Theorists propose that organisational culture is among the most critical barriers.¹⁶ Hence, barriers and enablers might not be shared elsewhere, and the implementation strategies chosen here remain untested. Another related limitation was the relatively small sample size and response rate reducing the overall validity; however, this was addressed with team meetings with the implementation team and further discussions with ED staff. Staff were asked to complete the survey once, and while we could not prevent multiple submissions, we have no reason to believe this occurred and staff did not receive any incentive.

This study has highlighted the first step using implementation science to develop strategies aimed at barriers and facilitators that can assist ECs to assess and treat common causes of vertigo correctly. If successful, this could significantly cut costs while reducing misdiagnosis-related harm, particularly with regard to posterior circulation strokes and promoting early access to vestibular rehabilitation. Future studies are planned to evaluate this further within this ED.

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Barriers and Facilitators to Management of Acute Vertigo Survey

Welcome to the Acute Vertigo Implementation survey.

We know it is challenging to manage acute vertigo in the Emergency Department. We are interested in getting a wide range of opinions, on both the challenges (barriers) and facilitators (helpful factors) to managing this patient group. It should take less than 12 minutes. Please answer these questions as truthfully as possible, THIS IS NOT A TEST. Participation is voluntary and all the responses are anonymous. The results will be collated and may be submitted for publication.

Please direct any questions to your surveyor

Thank you for taking time to answer this survey!

How many patients with acute vertigo do you come across in a typical month? _____

Think about when you make a diagnosis of vestibular neuritis/labyrinthitis/vestibular syndrome. How often do you do the HINTS exam in these patients?

Never

Rarely

Every Once in a While

Sometimes

Almost Always

Not applicable

Think about when you make a diagnosis of BPPV /positional vertigo. How often do you do a Dix-Hallpike exam in these patients?

Never

Rarely

Every Once in a While

Sometimes

Almost Always

Not applicable

What is your job title?

Please indicate your level of agreement with the following statements about acute vertigo:

Indicate your agreement with this statement:

1 – STRONGLY DISAGREE:

2 – DISAGREE

3 – NEUTRAL

4 – AGREE

5 – STRONGLY AGREE

6 – DON'T KNOW

INTERVENTION CHARACTERISTICS

1. The research on HINTS is trustworthy (*intervention source*)
2. There is good evidence to support the use of HINTS in the ED (*evidence strength and quality*)
3. The research on the Dix-Hallpike test is trustworthy (*intervention source*)
4. There is good evidence to support the use of Dix-Hallpike in the ED (*evidence strength and quality*)
5. We need to change the way we are currently managing acute vertigo (*tension for change*)
6. Implementing an acute vertigo tool based on HINTS and Dix-Hallpike testing would be a better way of managing acute vertigo (*relative advantage*)
7. There are better alternatives to managing acute vertigo than the HINTS exam (*relative advantage*). If yes, please state here: _____
8. Managing acute vertigo examinations are too challenging (*complexity*)
9. There are helpful supporting materials available to help me manage acute vertigo (*design quality and packaging*)

Indicate your agreement with this statement:

1 – STRONGLY DISAGREE:

2 – DISAGREE

3 – NEUTRAL

4 – AGREE

5 – STRONGLY AGREE

INDIVIDUAL CHARACTERISTICS

Capability

1. I am aware of the content and objective of HINTS (**knowledge**)
2. I know when HINTS is appropriate (**knowledge**)
3. I know the steps and objectives of the Dix-Hallpike exam (**knowledge**)
4. I know when the Dix-Hallpike exam is appropriate (**knowledge**)
5. I know how to differentiate a posterior circulation stroke from an acute vestibular syndrome (**knowledge**)
6. I have received training on how to conduct a HINTS exam (**skills**)
7. I have received training on how to conduct a Dix-Hallpike (**skills**)
8. I have the necessary skills to differentiate a posterior circulation stroke from an acute vestibular syndrome (**skills**)
9. I sometimes forget the steps to take to examine acute vertigo (**memory, attention, and decision processes**)

Opportunity

10. Most colleagues who are important to me would approve of me conducting HINTS (**social influences**)
11. Most colleagues who are important to me would approve of me conducting Dix-Hallpike (**social influences**)

Motivation

12. I am confident that I can differentiate posterior circulation stroke from an acute vestibular syndrome (**beliefs about capabilities**)
13. If I use the HINTS exam, it will benefit my patients (**beliefs about consequences**)
14. If I do not rely on bedside examination for acute vertigo, I will miss a serious diagnosis (**beliefs about consequences**)
15. Distinguishing central versus peripheral vestibular causes of vertigo is part of my responsibility in the ED (**social/professional role and identity**)
16. I am optimistic about the benefit of HINTS (**optimism/pessimism**)
17. I am optimistic about the benefits of Dix-Hallpike (**optimism/pessimism**)
18. I will definitely use HINTS with the next patient with a suspected acute vestibular syndrome (**intentions**)
19. I will definitely use the Dix-Hallpike with the next patient with suspected BPPV (**intentions**)
20. I would like to improve my ability to manage acute vertigo (**goals**)
21. I have had good experiences with HINTS before (**reinforcement**)
22. I have had good experiences with Dix-Hallpike testing before (**reinforcement**)

Thank you for participating. Would you be willing to participate in a 30-minute qualitative interview about this subject? **Yes/No**

If so, please provide your email here: _____

Thank you for agreeing to be interviewed for this project. The interview will be recorded and transcribed, but you will be made anonymous. The results will be collated and may be published. This should be a short 20-minute interview.

This is not a test; we are interested in learning the barriers and enablers to managing people with acute vertigo in the ED. This is a flow diagram illustrating the steps to assessing acute vertigo that we would like to implement here (show flow diagram), please take a brief look.

Before we start do you have any questions about the interview? If not, I will now start recording.

Please state your job title:

Characteristics of Individuals

- How do you currently manage people with acute vertigo? (*Knowledge & Beliefs about the Intervention*)
- What do you know about the 'Triage TiTrATE' (HINTS + Dix-Hallpike) intervention or its implementation? (*Knowledge & Beliefs about the Intervention*)
- Do you think the intervention will be effective in your setting? Why or why not? (*Knowledge & Beliefs about the Intervention*)

Intervention Characteristics

- What kind of information or evidence are you aware of that shows whether the intervention will work in your setting? And how does this knowledge affect your perception of the intervention? If negative – what kind of supporting evidence or proof is needed about the effectiveness of the intervention to get staff on board? (*Evidence Strength & Quality*)
- Is there a strong need for this intervention? (Why or why not) (*Relative Advantage / Tension for Change*)
- How complicated is the intervention? Consider number of steps, whether it is a clear departure from previous practices, possible misconceptions etc. (*Complexity*)
- What supports, such as online resources, Apps, toolkits etc, are available to help you implement and use the intervention? (*Design Quality & Packaging*)

Inner Setting

- How would you describe the culture of your ED department? (*Culture*)
- To what extent are new ideas embraced and used to make improvements in your organization? Can you describe a recent example? (*Culture*)
- How do you typically find out about new information, such as new initiatives, accomplishments, issues, new staff? (*Networks & Communication*)
- When you have a challenging case of vertigo, who are your "go-to" people? (*Networks & Communication / Leadership Engagement*)

- What do other clinicians think of the intervention? What is the general level of receptivity in your organization to implementing the intervention?
(Implementation Climate)

Characteristics of Individuals (Part 2)

- What kind of training do you think you need to implement the intervention? Any examples of training already on offer? *(Availability of Knowledge & Information / Self Efficacy)*