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Diagnosis is a team sport – partnering with allied health professionals to reduce diagnostic errors:

A case study on the role of a vestibular therapist in diagnosing dizziness

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Abstract

Background—Diagnostic errors are the most common, most costly, and most catastrophic of medical errors. Interdisciplinary teamwork has been shown to reduce harm from therapeutic errors, but sociocultural barriers may impact the engagement of allied health professionals (AHPs) in the diagnostic process.

Methods—A qualitative case study of the experience at a single institution around involvement of an AHP in the diagnostic process for acute dizziness and vertigo. We detail five diagnostic error cases in which the input of a physical therapist was central to correct diagnosis. We further describe evolution of the sociocultural milieu at the institution as relates to AHP engagement in diagnosis.

Results—Five patients with acute vestibular symptoms were initially misdiagnosed by physicians and then correctly diagnosed based on input from a vestibular physical therapist. These included missed labyrinthine concussion and post-traumatic benign paroxysmal positional vertigo (BPPV); BPPV called gastroenteritis; BPPV called stroke; stroke called BPPV; and multiple sclerosis called BPPV. As a consequence of surfacing these diagnostic errors, initial resistance to physical therapy input to aid medical diagnosis has gradually declined, creating a more collaborative environment for ‘team diagnosis’ of patients with dizziness and vertigo at the institution.

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Conclusions—Barriers to AHP engagement in ‘team diagnosis’ include sociocultural norms that establish medical diagnosis as something reserved only for physicians. Drawing attention to the valuable diagnostic contributions of AHPs may help facilitate cultural change. Future studies should seek to measure diagnostic safety culture and then implement proven strategies to breakdown sociocultural barriers that inhibit effective teamwork and transdisciplinary diagnosis.

Keywords

Diagnosis; diagnostic errors; dizziness; misdiagnosis; physical therapy specialty; vertigo

Introduction

Diagnostic errors are the most common, most costly, and most catastrophic of medical errors [1–4]. A recent national academy of medicine (NAM, formerly Institute of Medicine [IOM]) report on Improving Diagnosis in Healthcare estimated that every American will experience at least one diagnostic error in his/her lifetime, sometimes with devastating consequences such as permanent disability or death [5]. Building on patient safety principles developed in tackling therapeutic errors, the NAM committee placed strong emphasis on teamwork to improve diagnosis, making their first overall recommendation to “facilitate more effective teamwork in the diagnostic process among health care professionals, patients, and their families” [5]. In this, they specifically called out interprofessional collaboration around diagnosis to include nurses, therapists, and other allied health professionals:

“The diagnostic process hinges on successful intra- and interprofessional collaboration among health care professionals, including primary care clinicians, physicians in various specialties, nurses, pharmacists, technologists, therapists, social workers, patient navigators, and many others. Thus, all health care professionals need to be well prepared and supported to engage in diagnostic teamwork. The roles of some health care professionals who participate in the diagnostic process have been insufficiently recognized... nurses are often not recognized as collaborators in the diagnostic process, despite their critical roles in ensuring communication, care coordination, and patient education; monitoring a patient’s condition; and identifying and preventing potential diagnostic errors.” [5]

Medical diagnosis is historically and legally considered a physician’s responsibility. Allied health professionals (AHPs) such as nurses, speech language pathologists, and physical therapists (PTs) are often prohibited from making medical diagnoses as part of the legal definitions of their respective scopes of practice. Although certain diagnostic “rights” are granted to some AHPs such as nurse practitioners and physician assistants (PAs), strong sociocultural constraints may limit their role in diagnosis (e.g. only narrowly-defined “nursing diagnoses” or assessment of “minor” medical symptoms). There are reasons to believe, however, that this antiquated view of medical diagnosis needs to change.

First, diagnostic reasoning is already a core job responsibility for most AHPs, even if it is referred to by some other term, such as “triage” or “assessment of functioning”. When a nurse “triages” a patient in the emergency department (ED) or decides whether to call the surgeon to evaluate an ill-appearing post-operative patient, he uses symptoms and signs to

determine a patient's level of illness. When a speech pathologist determines the physiologic nature of a swallowing deficit, she uses pathophysiologic principles to determine the nature of dysfunction. When a vestibular PT identifies which semicircular canals require treatment in benign paroxysmal positional vertigo (BPPV), he uses physical diagnosis skills to differentiate one vestibular disorder from another. These are all examples of applied diagnostic reasoning that drive management or therapy, whether we acknowledge it or not.

Second, AHPs often spend more time with a patient than the physician. They may see patients repeatedly to check on them as inpatients or follow them routinely over time as outpatients. This means that AHPs often have greater exposure to the range of patient symptoms, disease course, and response to therapy, all of which may offer additional insights into the patient's underlying condition. Failure to integrate this knowledge of the patient's medical condition into patient care for the purposes of diagnosis needlessly reduces the quality of care and may perpetuate misdiagnoses.

Finally, as medical knowledge becomes increasingly subspecialized, many AHPs now have considerably more expertise than their physician counterparts within their narrow domains of practice. One such domain is the evaluation and treatment of dizziness and vertigo, in which vestibular PTs are often called to evaluate and treat patients with BPPV and other inner ear disorders. Dizziness and vertigo lead to more than 12 million medical visits each year in the US [6, 7]. As dizziness and vertigo are among the most misunderstood and commonly misdiagnosed symptoms in all of medicine [8–15], it is not uncommon for referred patients to have been misdiagnosed. Failure to effectively leverage AHP expertise to improve patient care may lead directly to misdiagnosis.

In this article we describe a series of five cases presenting dizziness or vertigo in which initial physician diagnoses were not supported by the results of detailed vestibular examinations performed by a vestibular PT. The input provided by the therapist to the physicians resulted in changes in final diagnoses, and consequently, changes in the care that was delivered. We discuss the immediate implications of this case series for optimizing diagnosis of patients with dizziness and vertigo, as well as the broader issue of engaging AHPs in diagnosis across a range of conditions.

Methods

This qualitative case study describes an ongoing interaction between a vestibular PT (DBT – “Dana”), a neurological subspecialist in vestibular disorders (DENT – “David”), and Dana's experience with several groups of physicians in a single medical center from 2011 to 2016. As part of this institutional case study, we report a retrospective, nonconsecutive case series of patients presenting with acute dizziness or vertigo who were initially misdiagnosed by physicians and later correctly diagnosed after consideration of examination findings made by the vestibular PT. We also describe the sociocultural changes that have gradually occurred at the medical center with respect to the value placed on physical therapy vestibular examination findings to help with accurate diagnosis. These changes have been coincident with (and perhaps the result of) a series of formal and informal interactions between the PT and physicians as well as mid-level providers. Note that we have deliberately manipulated

case demographics to minimize the risk of individual patient or physician discovery by readers. This study was evaluated by the WakeMed Health and Hospitals Institutional Review Board (IRB) and was determined to be exempt from formal IRB review (IRBNet#745256-1).

The PT, with over 24 years' experience and a certificate of competency in vestibular rehabilitation, has pursued extensive study of neurological and vestibular disorders, including assessment of acute dizziness and vertigo in the ED and acute care setting. The subspecialist neuro-otologist has completed neurology residency (4 years), followed by fellowships in neuro-ophthalmology (1 year) and neuro-otology (2 years). The focus of his clinical practice and research is improving diagnostic accuracy and reducing diagnostic error for patients presenting to the ED with acute dizziness or vertigo. He has a total of over 20 years' experience since graduating medical school.

The medical center is a large, acute care trauma center and tertiary care hospital. The PT interacts with a mix of physicians and mid-level providers, most commonly hospitalists and internal medicine residents, neurologists and neurological PAs, trauma surgeons and surgical PAs, and cardiology PAs. ED consultation requests for vestibular physical therapy services are usually generated by the hospitalist or neurology practitioners, but sometimes by ED staff. Once patients have been admitted to observation or inpatient status, referrals may be generated by any of the above-listed providers, or may be prompted by other physical or occupational therapists identifying the need for vestibular evaluation during routine therapy sessions.

Results

Interaction between medical subspecialist and vestibular PT

Dana first reached out to David in 2011, after having read one of his articles describing a novel bedside method (called 'HINTS') for differentiating strokes from inner ear diseases using eye movement exams in patients presenting acute dizziness and vertigo [16]. The original email, included as an online supplement, makes clear the fundamental dilemma that Dana faced as an AHP. She stated, "As a PT, diagnosis is not within the scope of my practice, and I avoid any documentation that would insinuate diagnosis. I will, in verbal conversations with physicians, at their requests, give them my opinion, based on objective examination findings. I have referred to the HINTS article on several occasions, in hopes of finding physicians who are aware of its huge implications. Most are not aware of the article and do not routinely implement the recommended exam techniques mentioned". David replied to Dana, and an ongoing channel of communication was opened. Dana would periodically discuss difficult vestibular cases with David, but also difficult interactions with other providers. Some were skeptical of her knowledge base or questioned her authority to provide them with diagnosis-relevant clinical information. David served as a mentor and remote "physician champion" to support her work in local culture change.

Misdiagnosed cases

We use as illustrations here five cases demonstrating diagnostic errors that were prevented by a clarified “team” approach to diagnosis of these patients. These five are representative of a multitude of cases at the medical center where vestibular assessments provided by vestibular PTs have provided substantive information to assist with diagnosis. In all cases, the initial medical diagnosis changed after the medical practitioner and treating team considered input from the physical therapy assessment. One case was admitted and discharged by the trauma service (Case 1). Four cases were admitted and discharged by hospitalists (Cases 2, 3, 4, 5) and two of those cases included the addition of neurology consultation for therapeutic intervention following a correctly identified diagnosis (Cases 4, 5). The cases illustrate a range of errors for both benign and dangerous vestibular disorders (Table 1), with corresponding implications for both diagnostic costs (test overuse) and patient safety (health outcomes). The outcome of this team diagnostic process in each case resulted in effective treatment for the conditions ultimately correctly diagnosed, timely discharge from the acute care setting, and patient satisfaction that their primary symptoms were being addressed.

Case #1: A young adult fell off the back of a truck, sustaining head trauma—A head computed tomography (CT) obtained in the ED was negative for brain bleed, contusion, or edema. High-resolution CT of the temporal bones showed all inner ear structures intact. The patient’s primary complaint was vertigo. The initial diagnoses by the trauma physician were occipital and right mastoid fractures, along with concussion. The PT’s evaluation, including the evidence-based HINTS [16–20] eye exam, revealed subtle direction-fixed left-beating nystagmus with mildly abnormal right horizontal head-impulse test but no vertical skew deviation on alternate cover test, suggesting an acute right traumatic vestibulopathy. Right ear hearing loss was noted on the finger rub test. The patient also had symptoms and signs of BPPV in all three right semicircular canals on positional testing. The PT treated the patient’s BPPV successfully using a sequence of multiple different canalith repositioning maneuvers. All of the positional testing for BPPV was negative on the second day. The patient was independently ambulating without assistive devices and demonstrated only very subtle high-level balance deficits, but was not deemed to be at risk for falls. The patient was given vestibular exercises to continue after discharge. The PT spoke with the trauma PA about the exam findings, adding the following new diagnoses: acute right cochleo-vestibulopathy (likely from labyrinthine concussion, which cannot be detected by CT) and multi-canal post-traumatic BPPV, treated effectively by evidence-based canalith repositioning maneuvers [21, 22]. A plan was made for outpatient audiogram to assess the degree of hearing loss.

Case #2: An elderly patient with mild dementia was admitted with symptoms of intractable nausea and vomiting—The patient was diagnosed with gastroenteritis by the admitting hospitalist. During a routine physical therapy evaluation, the patient’s family member mentioned that the patient had been experiencing intermittent vertigo and dizziness. The patient was found to have symptoms and signs consistent with a right posterior canal BPPV on Dix-Hallpike testing, which was treated with a single canalith repositioning maneuver [21, 22]. The patient had significant vegetative symptoms (i.e.

nausea and dry heaving, diaphoresis) at the time of treatment. The PT spoke with the attending hospitalist and conjectured that the nausea and vomiting were symptoms related to BPPV. The hospitalist agreed to progress the patient to a regular diet, and the patient tolerated the diet with no further nausea and vomiting. The next day, the patient was asymptomatic and walking well with the family as per the reported baseline. A repeat Dix-Hallpike test was negative for vertigo or nystagmus. The final diagnosis by the treating physicians was BPPV, not gastroenteritis.

Case #3: A middle-aged adult was admitted with nausea, vomiting, and vertigo—The initial hospitalist internal medicine team diagnosis was stroke. Magnetic resonance imaging (MRI) brain was negative for acute changes. The PT's evaluation revealed symptoms and signs consistent with right horizontal and posterior canal BPPV. The patient reported a lifelong history of a tendency toward motion sensitivity. At the time of the initial PT's evaluation, the patient was having significant vegetative symptoms. The patient was initially only able to walk 25 feet and required significant assistance. After 2 days of treatment with multiple canalith repositioning maneuvers, the patient had complete resolution of the right posterior canal BPPV and partial resolution of the right horizontal canal BPPV. At the time of discharge, the patient was walking 100 feet with only stand-by guarding without assistive devices. The patient was discharged with a prescription for outpatient vestibular rehabilitation to continue BPPV treatment. PT examination findings and treatment results were discussed directly with the medicine team on both days directly following physical therapy sessions. The final diagnosis by the physician team was BPPV.

Case #4: A middle-aged patient presented with symptoms of nausea, vomiting, and vertigo—The hospitalist initially diagnosed the patient with BPPV. The patient was unable to fully participate in the initial physical therapy evaluation the next morning due to constant, severe vertigo and nausea. The PT's interview of the patient revealed a history of head and neck trauma during a work-related incident a few weeks prior. The patient endorsed a few episodes of intermittent vertigo and right ear tinnitus since the trauma, and also confirmed right ear tinnitus at the time of the interview. The physician was notified immediately by phone of the PT's concern for serious diagnosis, given the patient's trauma history and constant (non-episodic) vertigo, two important markers of stroke risk [17, 23]. Based on the PT's concern and the PT's assertion that the signs and symptoms exhibited by the patient were not consistent with BPPV, the physician ordered neuroimaging [MRI and magnetic resonance angiogram (MRA)], which revealed right vertebral artery dissection and right cerebellar stroke, the final diagnoses. Neurology was consulted and prescribed anticoagulant medication. There was no stroke progression or worsening. The patient's gait and balance improved over the next few days of acute hospital physical therapy treatment. The patient was transferred to an inpatient rehabilitation hospital for ongoing therapy prior to discharge home.

Case #5: A young adult presented to the ED reporting sudden onset vertigo, nausea, vomiting and unsteady gait 4 days prior, with continued feeling of unsteady gait and mild vertigo upon presentation to the ED—The ED physician ordered a CT scan of the head, which was normal. The ED staff handed the patient over to

the hospitalist, who called the vestibular PT and asked that the patient be assessed for BPPV. The PT's evaluation revealed subtle neurologic signs not noted on prior physician examinations, including mild balance deficits, subtle left facial and right plantar foot numbness, and mild left tongue deviation. The HINTS exam, also performed by the PT, revealed direction-changing horizontal nystagmus in right and left gaze, normal horizontal head-impulse test bilaterally, and no vertical skew deviation on alternate cover test. The PT's assessment stated concern for central vestibular deficit based on HINTS results [20] and other exam findings. Based on the PT's vestibular evaluation, which the PT discussed immediately with the physician by phone, the physician ordered a brain MRI, which revealed multiple bilateral cerebral hemisphere and brainstem lesions consistent with multiple sclerosis, the final diagnosis. The patient was admitted and received IV steroid treatments per recommendations of the Neurology team, with plans for outpatient neurology follow-up. At the time of discharge, the patient was independently ambulating without assistive devices. The patient had residual subtle high-level balance deficits, but was not at risk for falls. The patient was given a home balance exercise program.

Sociocultural and structural changes in 'team diagnosis' over time at the medical center

The climate of discourse between Dana and the local referring providers was initially very strained. Some practitioners dismissed her comments when she suggested that objective clinical findings were incompatible with the initial medical diagnosis. Due to widely accepted sociocultural norms with respect to physician-AHP interactions, she has felt it necessary to tread very lightly or back down on many occasions. These interactions have often placed Dana in an ethical and moral bind, trapping her between sociocultural practice constraints and an ethical and personal obligation to help her patients. Despite continued resistance to optimal collaboration by some providers, she feels that the environment has improved and more practitioners are becoming receptive, as she and her team of PTs who perform vestibular evaluations and treatments continue to demonstrate the value of their input. Dana's ability to rely on David as a physician mentor and sounding board was an important facilitator in her success, especially in the early years of this transformation, when resistance was particularly strong.

There was a major nodal point in transforming the sociocultural milieu. This occurred when Dana presented at medical grand rounds to an audience consisting of mostly physicians, discussing the clinical assessment and treatment of patients presenting with acute vestibular symptoms. Many recognized at that point the valuable contribution of the physical therapy vestibular evaluation in achieving accurate diagnoses in these patients. Another breakthrough came when she was asked to present at a morbidity and mortality case conference. In this case (Case 4), the patient was initially misdiagnosed by physicians as having BPPV but, because of Dana's attention to relevant history and symptoms, was correctly diagnosed with a stroke due to vertebral artery dissection.

Over the past few years, the nature of the discourse and interaction between Dana (along with her vestibular physical therapy team) and the treating physicians has changed substantially. A number of physicians have begun to rely on input from the physical therapy vestibular assessment more proactively, rather than waiting for the therapists to retroactively

notify them that their medical diagnosis might be incorrect [e.g. by requesting consultation to “evaluate & treat” rather than requesting “PT for Epley” (i.e. a specific treatment maneuver for BPPV)]. Some physicians have even allowed Dana to educate them at the bedside in vestibular clinical skills, and have begun to incorporate vestibular exam skills into practice when admitting patients with vertigo and dizziness. One such physician reported that she was able to correctly identify an abnormal central (neurological) eye sign finding in a patient with a negative brain MRI. The physician, realizing that the exam indicated central vestibular pathology despite the negative MRI, ordered an MRA, which showed vertebral artery dissection. The physician indicated that prior to being educated by Dana in how to execute the HINTS exam, this would have been a patient whose negative MRI and symptomatology (vague lightheadedness, headache), would have led her to diagnose a benign condition such as migraine or inner ear disease, preventing her from seeking out more dangerous causes.

Over several years, Dana has been able to successfully build trusting relationships with many physician colleagues, who now routinely consider and use her clinical findings to inform subsequent diagnostic or management decisions. Some of the changes Dana has noted in her clinical practice setting are shown in Table 2.

Discussion

The role of vestibular PTs in diagnosis of dizziness and vertigo

In this case study, we have described the evolving role of an AHP (a vestibular PT) in diagnosis of a single problem (dizziness/vertigo) at a single-center. This case study reinforces and illustrates three domain-specific points that have been made previously in the literature: (1) misdiagnosis of dizziness by frontline physicians is a common problem [14, 15]; (2) many vestibular physical (or occupational) therapists are highly experienced in this domain [24] (often more so than generalist or even specialist physicians), publishing articles [25, 26] and teaching courses [27] almost identical to those for physicians specializing in dizziness or vertigo; (3) vestibular PTs must currently play a ‘shadow’ role in diagnosis, because of both scope-of-practice legal constraints and related sociocultural barriers [28]. The importance of these issues are underscored by the high frequency of the problem (>12 million doctor visits per year in the US [6, 7]), the dearth of subspecialty physicians in the US focused on diagnosing vestibular disorders (est. <250), and the greater numbers of PTs with relevant sub-discipline training (est. >4000). These issues point to the need for a dedicated effort to deliberately engage vestibular PTs as part of a team diagnostic process in dizziness and vertigo.

Historically, physical therapy practice acts in most states have expressly prohibited medical diagnosis. Though most PTs strive to avoid frank medical diagnosis, some find themselves in the position of providing vital information that influences diagnosis. Many PTs have developed strong physical examination and interview skills, coupled with high levels of anatomy and physiology knowledge, in their chosen areas of expertise. In many cases, PTs are able to recognize when clinical findings and history are (or are not) consistent with the physician’s initial medical diagnosis. Effective communication and teamwork between PTs and medical practitioners in these cases may help to increase the likelihood of accurate

diagnosis, and subsequently, appropriate treatment interventions. A ‘team diagnosis’ approach can be very effective if the physician(s) or mid-level practitioner(s) involved in the patient’s care ascribe to a problem-solving model that includes physical therapy evaluation and input from other AHPs, as illustrated in this case study.

The role of all AHPs in diagnosis, more generally

These domain-specific points described here may generalize to other clinical circumstances, in which AHPs, by virtue of their specialized training and roles in assessing patient function, are well-equipped to diagnose certain symptoms or conditions (sometimes even more so than the physicians legally responsible for diagnosis). Other examples include the following: (1) a speech therapist’s role in diagnosing uncommon causes of dysphonia, such as myasthenia gravis [29]; (2) an audiologist’s role in diagnosing the underlying cause of tinnitus [30]; and (3) a nurse’s role in risk assessment and early diagnosis of venous thromboembolism [31]. Unfortunately, in our experience, while AHPs are now often included in treatment planning, it is relatively rare in clinical practice to see physicians willing to routinely engage AHPs in differential diagnostic discussions or decisions regarding further diagnostic testing.

In countering our contention of generalization beyond dizziness, some might claim that diagnosis of dizziness and vertigo is truly a special case. Diagnosis of dizziness and vertigo is an acknowledged problem for frontline physicians around the world, who have rated the issue of when to obtain neuroimaging for patients looking for serious neurologic causes a top priority for development of clinical decision rules [32]. Numerous studies have identified knowledge gaps [9, 10, 33], evidence-practice gaps [11, 13, 14], frequent diagnostic errors [12, 34, 35], and poor patient outcomes, such as missed strokes [36–38]. By contrast, vestibular PTs are extensively trained in these topics [28], not generally covered in medical school or residency. However, dizziness is not unique in this regard. For example, similar issues have been identified for diagnosis of visual symptoms, including recognition of critical findings in the optic fundus, such as papilledema [39]. This is a skill not well taught (or learned) in medical school [40], and that carries forward to critical missed diagnoses in frontline clinical practice settings, such as the ED [39]. By contrast, optometrists are extensively trained in recognition of papilledema and differentiation of mimics [41].

Recommendations for “transdisciplinary team diagnosis”

The purpose of this manuscript is not to recommend that we supplant physician diagnoses with AHP diagnoses (or even that we specifically supplant physician diagnoses of dizziness with vestibular PT diagnoses of dizziness), but to highlight that barriers to effective “team diagnosis” (Table 3) are important patient safety risks. In therapeutic domains, communication and teamwork have been identified as critical patient safety factors [42]. Studies have recently begun to appear that demonstrate benefits of teamwork for diagnostic safety [43]. Some advantages of engaging AHPs in the diagnostic process can be found in Table 3.

There is a rich tradition of thinking of diagnosis as largely a solo activity of the master physician clinician (e.g. the American TV show “House”), but, as articulated by Don

Berwick, former president of the Institute for Health-care Improvement, “Genius diagnosticians make great stories, but they don’t make great health care. The idea is to make accuracy reliable, not heroic” [44]. And it is likely that at least some portion of that reliability will derive from leveraging the whole team (including patients [45]) and effective sharing of information and knowledge to improve accuracy of diagnosis. While “multidisciplinary” teams have been engaged in cancer diagnosis for decades, these teams are primarily composed of different physician specialties [46]. Interdisciplinary (rather than multispecialty) teams that engage AHPs as partners in diagnosis are uncommon, in our experience. Truly transdisciplinary [47] (Table 4) team diagnosis, which creates a unity of intellectual frameworks beyond the disciplinary perspectives, is likely very rare in current clinical practice.

There are obviously important legal scope-of-practice barriers to full integration of AHPs in clinical diagnosis. Many AHPs are prohibited by law from officially rendering medical diagnoses, or constrained to using only a narrowly constructed diagnostic framework. It is unrealistic to imagine these legal regulations will change quickly (if at all), but this is probably not necessary for effective team diagnosis, as there is no prohibition on AHPs sharing opinions with physicians. Instead, what is critical to overcome are logistical and sociocultural barriers to effective team diagnosis. Specifically, (1) AHPs should be engaged early and deliberately in clinical situations where their diagnostic expertise could benefit the patient; (2) methods or venues to effectively communicate for the purpose of true transdisciplinary “team diagnosis” should be developed; and (3) sociocultural change should be deliberately cultivated.

This third point, strongly recommended in the NAM report on Improving Diagnosis in Healthcare [5], bears some emphasis, in that the culture change required is for both physicians and AHPs. Physicians will need to initiate a respectful dialog with AHPs to solicit their input regarding diagnosis, and AHPs will need to move beyond fears of overstepping their “station” by sharing diagnostic information with physicians. For example, it is notable that articles written for PTs discussing diagnosis often assiduously emphasize that diagnosis is outside the PT’s scope of practice... while at the same time describing how to diagnose and treat benign positional vertigo and other vestibular disorders [48]. The international consensus curriculum for vestibular PTs is no exception, explaining that therapists should “evaluate, treat, and manage care of patients with vestibular disorders” and be educated regarding “the process of differential diagnosis based on the history, analysis of eye movements, evaluation of sensory impairment... and other signs and symptoms, although actually making a diagnosis is outside the scope of practice...” [28]. Culture change around diagnosis will not be easy, but, fortunately, there are prior successful models of how it may be accomplished. Table 5 draws some explicit parallels between team therapy and team diagnosis, using specific examples [49, 50].

Finally, as a case study, these findings are hypothesis generating, and suggest there may be value in more formally studying the role of AHPs in the diagnostic process. Only a handful of prior studies have looked at the impact of personnel changes on diagnostic safety, representing the least well-studied class of interventions to reduce diagnostic error [51]. To our knowledge, only one research study has directly examined the role of AHPs in diagnosis

(a single-center randomized trial showing no difference in emergency nurse practitioners' accuracy to that of junior doctors) [52]. Future research should specifically study the impact of engaging vestibular PTs in diagnosing dizziness and vertigo, and, more generally, the impact of engaging AHPs in diagnosis across a wide range of conditions.

Limitations

This was a qualitative, self-report study from a single care provider, dealing with a single clinical problem, at a single institution. The case sample is small, and may not be representative. Results may not generalize to other providers, problems, or settings.

Conclusions

High-quality diagnosis should be considered a team sport. Those who fail to treat it as such do so at their own peril, with potentially devastating consequences for their patients. In the specific case of dizziness and vertigo, it should be routine practice to engage knowledgeable vestibular PTs in the diagnostic process, especially when appropriate medical subspecialty expertise is not immediately available (which is most of the time).

Barriers to AHP engagement in “team diagnosis” include sociocultural norms that establish medical diagnosis as something reserved only for physicians. Drawing attention to the valuable diagnostic contributions of AHPs may help facilitate cultural change. We must break down sociocultural barriers to engaging AHPs in team diagnosis, in order to help minimize the risks of physician misdiagnosis. Engagement of physician champions may facilitate change. Future studies should measure diagnostic safety culture and implement proven strategies to breakdown sociocultural barriers that inhibit effective teamwork and transdisciplinary diagnosis. The impact of AHPs on diagnostic accuracy should be studied across a wide range of problems.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Diagnostic process and diagnosis label failures in five cases presenting dizziness/vertigo.

Case #	Initial incorrect diagnosis	Correct/additional diagnosis	Misdiagnosis type ^a	Diagnostic process error stage ^b
1	None	Traumatic BPPV, right cochleo-labyrinthine concussion	Low quality	2, 3
2	Gastroenteritis	BPPV	Low quality, high cost	1, 2, 3
3	Stroke	BPPV	Low quality, high cost	1, 2, 3, 4
4	BPPV	VAD, stroke	Dangerous	1, 2, 3, 4
5	BPPV	Multiple sclerosis	Low quality	1, 2, 3, 4

BPPV, benign paroxysmal positional vertigo; VAD, vertebral artery dissection.

^a Misdiagnosis type=dangerous (emergent condition called non-urgent/benign); high cost (non-urgent called emergent with resulting unnecessary testing), low quality (one non-urgent condition mistaken for another; missed second non-urgent diagnosis).

^b Diagnostic process error stages are defined as 1. data gathering (history); 2. data gathering (physical examination); 3. case formulation; 4. test ordering; and 5. test interpretation.

Table 2

Sociocultural changes and improved patient outcomes noted over time through interaction between an AHP (vestibular PT) and medical colleagues around diagnosis of patients with dizziness.

1	Increased recognition by medical staff of potential vestibular pathology in patients presenting with dizziness
2	Increased recognition of the contribution of a functional vestibular assessment by an appropriately trained PT in assisting medical staff to reach an accurate diagnosis, including medical diagnoses (e.g. stroke)
3	Increased recognition of the effectiveness of appropriately trained PTs in treating BPPV
4	PT consults now often ordered with designation of “vestibular evaluation and treatment” (rather than “treat BPPV”) so that patients are assessed, diagnosed, and treated by appropriately trained PT staff
5	Decreased length of stay due to more timely diagnosis and treatment when appropriately trained PT staff are consulted
6	Increased patient/caregiver satisfaction that the chief complaint is being addressed and managed appropriately
7	Increased appropriate referrals to outpatient vestibular rehabilitation

BPPV, benign paroxysmal positional vertigo; PT, physical therapist.

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Table 3

Primary barriers to and advantages of engaging AHPs in the diagnostic process.

Primary barriers to engaging AHPs in diagnosis	Primary advantages of engaging AHPs in diagnosis
<ul style="list-style-type: none">– Logistical (e.g. many clinics separate AHPs from physicians in the outpatient setting, segregating diagnosis by physicians from treatment by AHPs)– Regulatory/scope of practice (e.g. nursing codes of ethics and legal constraints prevent them from rendering medical diagnoses; the same is true of many other AHP groups)– Sociocultural (e.g. hierarchical structure of physician-AHP relationships in which diagnosis is perceived as a skill ‘beyond’ AHPs)	<ul style="list-style-type: none">– Often greater availability, access, or affordability (e.g. there are more than 10 times more vestibular PTs than neuro-otologists)– More time with the patient (e.g. nurses caring for post-operative patients on an inpatient surgical ward are with patients for extended periods and can note deterioration over time or change from baseline when physicians may not)– Specialized expertise in diagnosis (e.g. speech-and-language pathologists in the evaluation and treatment of swallowing disorders)

AHP, allied health professional; PT, physical therapist.

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Table 4

Definitions of key terms related to teamwork, listed from least to most collaborative [47].

•	Intradisciplinary: working within a single discipline
•	Crossdisciplinary: viewing one discipline from the perspective of another
•	Multidisciplinary: people from different disciplines working together, each drawing on their disciplinary knowledge
•	Interdisciplinary: integrating knowledge and methods from different disciplines, using a real synthesis of approaches
•	Transdisciplinary: creating a unity of intellectual frameworks beyond the disciplinary perspectives

Table 5

Parallels between proven culture change for therapeutic safety and those anticipated in the future for diagnostic safety, using specific exemplars.

Stage in safety culture and teamwork transformation	Now: Therapeutic (CLABSI) [49, 50]	Future: Diagnostic (missed stroke in acute dizziness and vertigo)
Safety leaders introduce team concept for safer care with a specific issue where there are known errors and harmful outcomes	ICU nurses completely unwilling to even consider ‘interfering’ with ICU physicians inserting a central venous catheter (“How can we tell a physician how to do their job?”)	ED nurses completely unwilling to even consider ‘interfering’ with ED physician diagnostic processes (“How can we tell a physician how to do their job?”)
Appeal to patient-centeredness by safety leaders (“If the patient’s health is your ‘north star’, how can you stand by and knowingly watch another provider do things likely to harm the patient?”)	ICU nurses consider the possibility of engaging the physician around catheter insertion protocols, but fear repercussions given the hierarchical relationships	ED nurses consider the possibility of engaging the physician around dizziness diagnosis protocols, but fear repercussions given the hierarchical relationships
Top-level leadership buy-in and support from the outset (Department or Division Director plus local Unit Director or Manager – “If any physician gives you the slightest trouble, you call me right then, even if it is 2 AM, and I will make it clear to them what I expect.”)	ICU nurses begin intervening when physicians do not follow sterile precautions checklists during line insertion – “Doctor, shouldn’t we use a full-body sterile drape, as in the protocol?” (it is not important that nurses do not know how and are not allowed to insert a central line themselves)	ED nurses begin intervening when physicians do not follow diagnosis protocol for dizziness – “Doctor, is someone going to examine the patient’s eyes before ordering neuroimaging, as in the protocol?” (it is not important that nurses do not know how and are not allowed to diagnose dizziness themselves)
Feedback enhances individual and team calibration (adjusting their approach to diagnosis using prior performance in diagnostic accuracy as a guide), as well as creating greater teamwork and camaraderie	ICU teams monitor rates of catheter-related sepsis and engage in transdisciplinary team processes to create new interventions that reduce catheter sepsis even further; success creates a virtuous cycle	ED teams monitor rates of dizziness and stroke misdiagnosis and engage in transdisciplinary team processes to create new interventions that reduce misdiagnosis even further; success creates a virtuous cycle

CLABSI, catheter-line-associated blood stream infection, a healthcare associated infection.