

# A comparison of benign positional vertigo and stroke patients presenting to the emergency department with vertigo or dizziness

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## ABSTRACT

**Purpose:** To compare imaging utilization between patients presenting to the emergency department (ED) with vertigo and dizziness (VDS) who are diagnosed with stroke and benign paroxysmal positional vertigo (BPPV).  
**Methods:** All patients presenting to the ED with VDS (January 2014–June 2018) were identified. Those with a discharge diagnosis of stroke and BPPV were analyzed.

**Results:** 17,884 patients presented to with VDS. 452 were diagnosed with BPPV and 174 with acute stroke. 55.7% of stroke patients had at least one neurologic symptom beyond VDS, 63.8% had a positive neurologic exam, and 80.5% had either; 90.2% had at least one stroke risk factor (RF). 42.0% of BPPV patients received imaging, of which 24.7% had neurologic symptoms beyond VDS, 16.3% had neurologic exam findings, and 34.2% had either ( $P < 0.001$ , as compared to stroke). 43 patients (22.6%) lacked neurologic symptoms, exam findings, and stroke RFs; 40 had an adequate HINTS (head impulse, nystagmus, skew) exam. The most common imaging modality received by BPPV patients was plain CT Head (54.2%), followed by CT/CTA (43.7%), and MRI brain (26.3%). CT head was the initial imaging of choice in 44.7% and CT/CTA in 42.6%.

**Conclusions:** Imaging utilization in BPPV patients presenting with VDS is high. The profile of patients with BPPV that received imaging was substantially more benign than that of stroke patients (a quarter had no neurologic symptoms, exam findings, or stroke RFs). The HINTS exam was underutilized, and computed tomography was heavily utilized despite well-established limitations in diagnosing posterior circulation strokes. This study highlights the need for increased training in the HINTS exam, narrowing of the scope for computed tomography, and a higher threshold for imaging patients with isolated VDS.

## 1. Introduction

Vertigo and dizziness (VDS) are among the most common reasons for emergency department (ED) visits nationwide, representing approximately 4% of ED cases [1]. In the United States, a 2011 report estimated that > 3.9 million patients presented to the ED with VDS [2]. In certain cases, the cause of VDS is evident, but often dangerous pathologies are masked [3,4]. Furthermore, VDS possess a wide differential diagnosis, with one particular study describing 46 distinct diagnoses for 106 patients seeking treatment for dizziness [5]. Therefore, misdiagnosis is not unusual in VDS patients [6–8].

One of the most common causes of vertigo, Benign Paroxysmal Positional Vertigo (BPPV), constitutes 29.1% of VDS visits to

otolaryngologists and 16.3% to general practitioners [9]. It accounts for approximately 7% of ED visits for VDS [9]. Although causes of vertigo more commonly include BPPV, Meniere's disease, or vestibular migraine, given the potential of cerebrovascular disease to induce central vertigo, dangerous pathologies such as posterior circulation strokes and basilar occlusions are always in the back of a physician's mind when evaluating these patients [10–16]. VDS, thus, exemplify an intractable problem in emergency medicine: common chief complaints that infrequently signal catastrophic underlying etiologies.

With estimates that 3–5% of ED cases with dizziness are related to stroke, VDS create the perfect storm for high resource utilization [10]. One analysis found that spending on VDS reached \$4 billion dollars in 2011, with rising costs predominately related to rates of imaging [2].

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Due to the interest in efficiently identifying stroke patients among the VDS population in the ED, distinguishing peripheral and central vertigo remains highly controversial [17,18]. However, given the large amount of VDS patients presenting to the ED, imaging patients with a low suspicion for stroke can lead to exceptionally high expenditures.

Our study focused on comparing the resource utilization in BPPV patients presenting to the ED with VDS by comparing to stroke patients in the same population. Utilizing records of patients presenting to the ED with VDS to an academic institution over 4.5 years, we sought to 1) characterize BPPV patients in this population, 2) assess imaging usage in BPPV patients, and, 3) compare the BPPV population undergoing imaging with stroke patients presenting with VDS.

**2. Methods**

**2.1. Data source**

The electronic medical record was queried for all adult (age ≥ 18 years) patients who presented to the emergency department at our institution with a chief complaint of ‘vertigo,’ ‘dizziness,’ or ‘vertigo-recurrent’ and who had a primary discharge diagnosis of stroke or BPPV between January 1, 2014 and June 17, 2018.

**2.2. Data collection and description of variables**

The following information was obtained on each patient: demographics, admission and discharge times, disposition, medical history and discharge diagnoses (up to ten codes each, based on the *International Classification of Diseases, Tenth Revision, Clinical Modification [ICD-10-CM]*), vital signs, and imaging (based on *Current Procedural Terminology* codes). Imaging data regarding computed tomography (CT), CT angiography (CTA), and magnetic resonance imaging (MRI) of the head and neck were obtained. Both contrast and non-contrast sequences were included.

Patients with a primary discharge diagnosis of ischemic or hemorrhagic stroke were identified via ICD-10-CM codes I60-I63.9 (excluding subdural hematomas). BPPV was identified via codes H81.1-H81.13. For each stroke patient and each BPPV patient that received imaging, presenting symptoms, physical exam findings (including the head impulse, nystagmus, and skew [HINTS] and Dix-Hallpike exams), and imaging findings were obtained.

Stroke risk factors (RF) were identified in the patient’s medical history. The following were considered to be risk factors: cardiovascular (ICD-10-CM codes I20-I22.9, I24-I25.9) or risk-equivalent pathologies (peripheral arterial [I70.2-I70.399] and chronic kidney disease [N18.3-N18.6]) [19], history of stroke or transient ischemic attack (TIA) (I63-I63.9 and G45-G45.9) [20], hypertension (I10-I16.9) [21], diabetes (E08-E13.9) [22], dyslipidemia (hypcholesteremia, hyperlipidemia: E78-E78.49) [23], smoking [24], alcohol abuse [25], atrial fibrillation (I48.0-I48.2 and I48.91) [26], and age over 80 years [27].

Presenting symptoms were considered those listed in the “History of Present Illness” section of the initial ED physician’s note. Exam findings from both the initial ED evaluation and first available neurology consultation were considered positive. Neurologic symptoms beyond dizziness/vertigo were categorized as motor, sensory, visual (diplopia, blurry vision), auditory (hearing loss, tinnitus), or speech; exam findings were classified as motor, sensory, visual, ataxic, auditory or aphasic. Patients with equivocal CT imaging who could not undergo MRI were excluded. Patients who had stroke listed as the primary discharge diagnosis because of an older, known stroke from a previous admission were excluded. All cases with equivocal imaging findings were reviewed by a neuroradiologist to confirm the diagnosis of stroke.

**2.3. Statistical analysis**

Descriptive statistics were used to characterize patient

**Table 1**  
Baseline characteristics.

	Benign positional vertigo N = 452	Stroke N = 174	P-value
Mean age, years (SD)	58.1 (16.7)	67.8 (14.3)	< 0.001
Sex, no. (%)			< 0.001
Male	151 (33.4%)	93 (53.4%)	
Female	301 (66.6%)	81 (46.6%)	
Vital abnormalities, no. (%)			
High blood pressure (systolic ≥ 160 or diastolic ≥ 100 mmHg)	111 (24.6%)	93 (53.4%)	0.02
Hypoxemia (oxygen saturation ≤ 94%)	20 (4.4%)	9 (5.2%)	< 0.001
Tachycardia	23 (5.1%)	18 (10.3%)	0.68
Risk factors, no. (%)			
Age ≥ 80 years	52 (11.5%)	39 (22.4%)	0.001
Cardiovascular or equivalent	30 (6.6%)	29 (16.7%)	< 0.001
History of stroke/transient ischemic attack	26 (5.8%)	78 (44.8%)	< 0.001
Hypertension	187 (41.4%)	121 (69.5%)	< 0.001
Diabetes	60 (13.3%)	42 (24.1%)	0.001
Dyslipidemia	61 (13.5%)	38 (21.8%)	0.01
Atrial fibrillation	16 (3.5%)	16 (9.2%)	0.004
At Least one risk factor	241 (53.3%)	157 (90.2%)	< 0.001
Received in the ED, no. (%)			
Head Imaging of any kind	190 (42.0%)	173 (99.4%)	< 0.001
Computed tomography (head)	87 (19.2%)	81 (46.6%)	< 0.001
Computed tomography with angiography (head/neck)	83 (18.4%)	107 (61.5%)	< 0.001
Magnetic resonance imaging (brain)	50 (11.1%)	94 (54.0%)	< 0.001
Initial imaging study in ED, No. (%)			0.18
Computed tomography (head)	85 (18.8%)	72 (41.4%)	
Computed tomography with angiography (head/neck)	81 (17.9%)	88 (50.6%)	
Magnetic resonance imaging (brain)	24 (5.3%)	13 (7.5%)	

ED = emergency department.

characteristics as shown in Table 1. Differences in proportions and means were determined via Chi-square and student t-tests, respectively. Statistical analysis was conducted in SPSS 25 (IBM Corporation, Armonk, NY). Statistical significance was determined at P < 0.05. This study was approved by the Yale Institutional Review Board.

**3. Results**

**3.1. Baseline characteristics**

17,884 patients presented to the emergency department with a chief complaint of vertigo/dizziness over 4.5 years. The mean age was 55.1 years (standard deviation [SD] = 20.3) and 62.0% were female. 57.8% had at least one stroke risk factor, with a mean of 1.1. 28.6% (5121) of patients had relevant head/neck imaging in the emergency department. 17.0% (3034) received CT Head in the ED, 10.4% (1866) CTA Head/Neck, and 4.9% (875) MRI. CT Head (with or without contrast) was the initial imaging modality in 59.2% of those patients, while CTA Head/Neck and MRI were the first imaging modality in 36.4% and 4.7%, respectively.

**3.2. BPPV patients**

452 patients presenting with VDS had a primary discharge diagnosis of BPPV. The mean age was 58.1 years (SD = 16.7) and 66.6% were female (Table 1 displays baseline characteristics). Approximately half (53.3%) had at least one risk factor for stroke, with a mean number of RF’s of 0.96 (SD = 1.1). A minority of patients presented with vital abnormalities. 5.1% had tachycardia at admission, 4.4% hypoxemia

(oxygen saturation  $\leq 94\%$ ), and 24.6% had systolic blood pressure above 160 or diastolic above 100 mmHg.

### 3.3. Stroke patients

174 patients presenting with VDS and had a primary discharge diagnosis of stroke met inclusion criteria. The average age was 67.8 years (SD = 14.3) and 46.6% were female. 90.2% had at least one stroke risk factor. The mean number of RF's was 2.1 (SD = 1.2), which was significantly higher than the BPPV population ( $P < 0.001$ ). Stroke patients were more likely to be tachycardic (10.3% vs 5.1% for BPPV;  $P = 0.02$ ) and have systolic or diastolic pressures above 160 or 100 mmHg, respectively (54.1% vs 24.6% for BPPV;  $P < 0.001$ ). The percentage of hypoxemic patients was similar (5.2% vs 4.4%;  $P = 0.7$ ). 55.7% of stroke patients had at least one symptom beyond VDS on presentation, 63.8% had a positive neurologic finding on exam, and 80.5% had either of the two. The most common accompanying neurologic symptom was visual (25.9%) and the most common exam finding was ataxia (36.8%). 99.4% of stroke patients received imaging in the emergency department, although 2 patients were discharged without imaging and then imaged during a 2nd visit to the ED.

### 3.4. BPPV patients with imaging

190 BPPV patients, or 42.0% of patients with a discharge diagnosis of BPPV, had imaging in the ED. 65.8% had at least one stroke RF. The mean number of risk factors was 1.3 (SD = 1.3), significantly less than patients with stroke (mean = 2.1;  $P < 0.001$ ) but significantly more than BPPV patients who did not receive imaging (mean = 0.72;  $P < 0.001$ ) (see Fig. 1). As compared to the stroke population, BPPV

patients who received imaging had significantly fewer positive neurologic findings on history or physical. 24.7% had neurologic symptoms beyond VDS, 16.3% had neurologic exam findings, and 34.2% had either of the two ( $P < 0.001$ , as compared to stroke patients). 43 patients (22.6%) had zero risk factors and lacked neurologic symptoms and exam findings on presentation. 9 patients (4.7%) had vertical or bidirectional horizontal nystagmus. A minority of patients had documented tests of skew (42[22.1%]) or head impulse (44[23.2%]). Of patients with a skew test, 1 was positive. 45.2% of patients with a documented head impulse had an abnormal test (suggesting a peripheral etiology) while 54.8% had a normal exam (suggesting a central etiology). Of 40 patients with adequate HINTS documentation, the HINTS exam suggested a peripheral etiology in 14 (35.0%), but could not rule out a central source in 26 (65.0%).

The most common imaging modality received in the ED was plain CT Head (54.2%), followed by CT/CTA (43.7%), and MRI brain (26.3%). CT head was the initial imaging of choice in 44.7%, CT/CTA in 42.6%, and MRI in 12.6%. 99% of the imaging was unremarkable. Dissection was found in one patient and a partially thrombosed pseudoaneurysm in a second; otherwise, imaging was negative excepting vascular stenosis.

## 4. Discussion

In this study we identified patients with BPPV who presented with vertigo or dizziness to the ED of an academic institution over 4.5 years. We characterized the use of imaging in BPPV patients and compared the presenting symptoms and physical exam findings of BPPV patients receiving imaging to stroke patients.

### 4.1. Rates

The number of BPPV patients substantially outnumbered the number of stroke patients. There were two and a half times more patients with a discharge diagnosis of the former as compared to stroke patients. 1% of all VDS patients had a diagnosis of stroke versus 2.5% for BPPV. This is expected in light of literature-reported rates. The rate of stroke in the vertigo and dizziness population presenting to the ED is reported at or below 5% in most studies of the last two decades, while BPPV has been estimated, by one systematic review, to represent 7.4% of classified VDS presenting to the ED [9,10,16,28]. Of note, this study does demonstrate a slightly lower rate of stroke than others in the literature. Studies often include TIA with stroke when reporting rates, which is one potential explanation for the lower rate. Additionally, as noted in the methods, equivocal imaging in patients diagnosed with stroke was reviewed by a neuroradiologist, leading to the exclusion of many patients who were originally diagnosed with stroke in the ED. These exclusions further reduced the stroke rate for this study population.

### 4.2. Imaging usage in BPPV patients

42.0% of BPPV patients received imaging in the ED. The results of this study suggest that the use of imaging in BPPV exceeds the necessary amount. Numerous studies have demonstrated that the HINTS examination is a highly sensitive test for ruling out central causes of vertigo and avoiding imaging in patients presenting with VDS to the ED. [29–31] In the appropriate clinical context, the HINTS exam could obviate the need for imaging in patients with a peripheral exam or confirm the need for imaging/treatment in those with a central HINTS exam. Despite its potential, the HINTS exam was underutilized in our study population. Only 40 patients, or 21% of BPPV patients with imaging, had sufficient documentation to count as a full exam. The low usage of HINTS in the ED has been documented by other studies and represents an important area of improvement in the evaluation of VDS patients [32,33]. Increased awareness and training in the HINTS exam

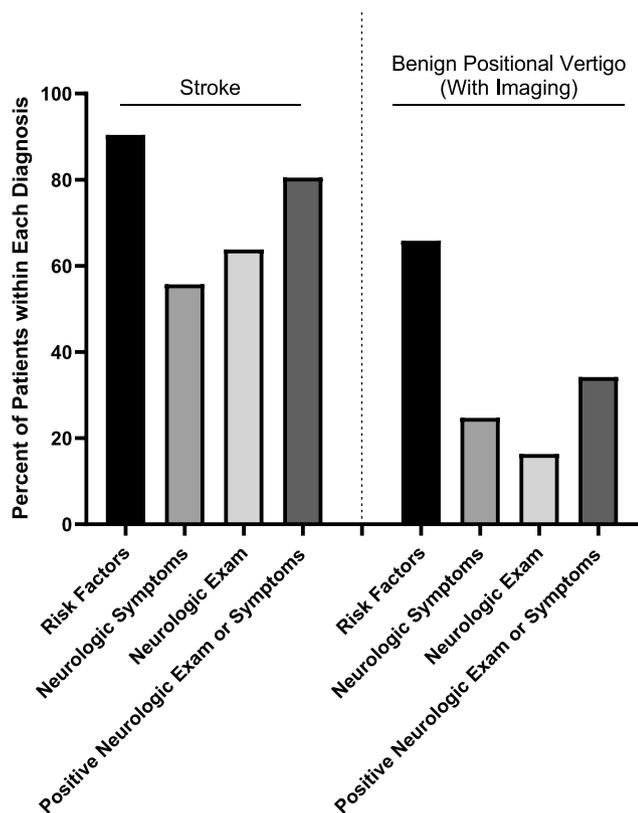


Fig. 1. Comparison of risk factors, symptoms and physical exam. The left group of columns represents stroke patients and the right group represents benign positional vertigo patients that received imaging. The percentage of patients with stroke risk factors and positive neurologic symptoms or exam findings beyond vertigo are shown.

for ED physicians is a potential avenue to reduce the large amount of imaging ordered for vertigo patients. Somewhat surprisingly, a number of BPPV patients who receiving imaging had a peripheral HINTS exam (abnormal head impulse, unidirectional/absent nystagmus, no skew). 8 of these 14 patients had no additional neurologic symptoms or positive neurologic exam findings. These cases represent gross misuse of imaging and underscore the need to address the issue of imaging overuse in VDS patients. Importantly, we do note that the HINTS exam is not a possibility in all patients; for example, it is contraindicated in patients with neck injuries.

Patients with BPPV who received imaging had a significantly smaller percentage of neurologic presentations as compared to stroke patients. Only 24.7% had neurologic symptoms beyond VDS as compared to 55.7% for stroke patients. The difference in positive neurologic exam findings was even greater, with only 16% of BPPV patients having a positive exam versus 64% for stroke patients. Finally, when combining both symptoms and physical examination, 81% of stroke patients had either of the two versus 34% for BPPV patients receiving imaging. The high percentage of isolated vertigo in the BPPV population that received imaging is striking. Although history and physical, especially in the absence of a peripheral HINTS exam, cannot rule out stroke alone, they should elevate the threshold for ordering imaging. Patients presenting with stroke generally have accompanying signs and symptoms. In our population, a minority of stroke patients (19%) had isolated VDS. Other studies have noted the small percentage of isolated vertigo among VDS stroke patients. A population-based study by Kerber et al. reported an isolated VDS rate of 17% in patients with stroke or TIA [16]. Importantly, < 1% of all patients presenting with isolated symptoms had a stroke or TIA in their population, although the vast majority of presentations were isolated vertigo. Therefore, it is likely that performing a thorough history and physical examinations for VDS patients can help reduce the rate of imaging usage. The history and physical can be used in combination with other aspects of the presentation to avoid the need for imaging. For example, it is highly unlikely that a patient with VDS and stroke would have no neurologic signs, additional neurologic symptoms, and stroke risk factors. This was true for only 1 stroke patient in our cohort. Despite this, 23% of BPPV patients with imaging had neither risk factors nor positive signs and symptoms suggestive of stroke. Another helpful adjunct, as already discussed, is the HINTS examination. A peripheral HINTS exam with an unremarkable general neurologic history and physical would certainly avoid the need for imaging in much of the VDS population.

#### 4.3. Imaging modality

The type of imaging utilized in most patients was unsuitable for the identification of posterior circulation strokes. Over half (54%) of BPPV patients that were imaged underwent plain head CT, and 44% received CT as the initial test to evaluate their VDS. The lack of sensitivity and specificity of plain CT in the diagnosis of posterior fossa stroke is well-established [34–39]. CT head suffers from considerable artifact caused by the bony posterior fossa and, therefore, all efforts should be made to image VDS patients with suspected stroke via MRI. Despite the low accuracy of CT, it continues to be the predominant imaging modality used in this population as evidenced by national, population-based studies [2].

Head CT with CTA is now often used in lieu of simple head CT to evaluate VDS patients, primarily to identify patients who have basilar artery occlusions and are candidates for thrombectomy. 44% of BPPV patients imaged received a CT/CTA, and 43% had CT/CTA as the first imaging modality. In addition to being exceedingly rare, basilar occlusions have not been well-studied as targets for endovascular intervention; trials examining thrombectomy in stroke generally exclude those in the posterior circulation [40]. Searching for basilar (or other posterior) occlusions hardly warrants the routine use of CTA in VDS patients, especially those with uncomplicated presentations. If

suspicion for stroke is high, MRI is capable of detecting strokes caused by basilar occlusions and is a better first choice in the VDS population.

While our study underscores the overuse of imaging in patients presenting with VDS to the ED, the underlying considerations for ordering imaging could not be elucidated. Ordering imaging may be a product of definite diagnostic criteria, but, in the absence of factors warranting clinical suspicion, imaging may be related to the practice of defensive medicine. Studies have shown that emergency medicine physicians are at risk of litigation, particularly when imaging is not obtained [41,42]. This may explain high rates of unnecessary imaging in the ED, especially with low sensitivity modalities such as CT, as supported by other studies [43,44]. Overuse of imaging in the ED may be as much a systemic issue as a consequence of clinical judgement.

Although our study highlights a large problem in the vertigo population presenting to the ED, we do admit that there is no easy solution. Firstly, we believe that there should be more emphasis on the HINTS exam for this population. Subspecialists can be made available via teleconsultation and/or ED physicians can be trained to perform the exam [30]. Secondly, there should be greater consideration given to the benefit of imaging. Stable patients who are presenting outside of the thrombolytic or thrombectomy window need not be imaged with CT in the ED. An MRI after admission or as an outpatient may suffice to identify stroke. Finally, if imaging is needed and the capability exists, patients should undergo MRI as opposed to CT if the goal is to diagnose stroke.

There were several limitations to this study. Firstly, the retrospective design prevents adequate control of confounders. We relied on discharge diagnoses from the ED to identify stroke and BPPV patients; any coding inaccuracies would affect our results. Differences in the evaluations of specific patients can also present inaccuracies. For example, some BPPV patients did not undergo as thorough of a neurologic exam as others, which would result in missed neurologic exam findings. Inadequate physician documentation results in the same limitation. Finally, diagnoses made in the ED may not be accurate, especially in borderline cases where a specialist is warranted.

## 5. Conclusions

Imaging utilization in benign positional vertigo patients presenting with VDS is high, with approximately half receiving imaging in the emergency department. The profile of patients with BPPV that received imaging was relatively benign compared to that of stroke patients; two-thirds had isolated VDS, as opposed to 19% for stroke patients; approximately one quarter of BPPV patients with imaging had neither risk factors, neurologic symptoms, nor positive neurologic exam findings. The HINTS exam was underutilized, but even some patients with a peripheral HINTS exam received imaging. Moreover, the choice of imaging was not appropriate. The initial imaging of choice in BPPV patients was overwhelmingly CT or CT/CTA, despite the well-established limitations of computed tomography in diagnosing posterior circulation stroke, which highlights an excessive use of computed tomography in the ED for VDS patients. This study emphasizes the need to address how VDS patients are evaluated in the ED, with increased training in the HINTS exam, narrowing of the scope for computed tomography, and a higher threshold for imaging patients with isolated VDS.

## Declaration of Competing Interest

The authors have no funding, financial relationships, or conflicts of interest to disclose.

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