JOHNS HOPKINS
MEDICINE

**Department of Neurology**

# Johns Hopkins Tele-Dizzy Service

**Is your head spinning from seeing all those difficult dizzy cases?**

*Call "Tele-Dizzy" -- it's like the Poison Control line, but to tackle your worst vertigo woes.*

**Stuck? Call 1-833-DIZZYDX**

***Nobody likes dizziness… except us.***

# Transforming Diagnosis of Acute Dizziness in the ED: A Brief Introduction to Johns Hopkins Tele-Dizzy

## Demonstrated Clinical Need

***Diagnostic Errors and Harms: A Public Health Crisis***

- Diagnostic errors lead to an estimated 800,000 permanent disabilities and deaths in America each year.[1]
- The estimated costs of these disabilities and deaths to US society are $200 billion to $1 trillion per year.[2]
- Annual US healthcare waste associated with these errors is probably $50-100 billion or more.[3-6]

***The Stroke Imperative***

- Stroke is the number one cause of serious misdiagnosis-related harms, affecting roughly 100,000 per year.[1]
- Stroke is also the top cause of malpractice payouts in the emergency department (ED).[7]
- Strokes are not missed in the ED when they are obvious; they are missed when they are subtle or atypical.[7] The number one risk factor for missing a stroke diagnosis is a clinical presentation with dizziness or vertigo.[8]

***The Dizziness Imperative***

- Dizziness affects 15-20% of adults each year[9] and leads to nearly 5 million ED visits annually.[10]
- Length of stay[11] and costs of care[12] are disproportionately higher in dizziness, but much of this is waste.[5]
- Best evidence-[13,14] and guideline-supported[15] bedside diagnostic care for ED dizziness is rarely applied.[16]

## Brief Introduction to Tele-Dizzy

**Tele-Dizzy** is a clinical subspecialty teleconsultation service. After excluding clear "brain attack" suspects (e.g., weakness, speech problems), ED patients with dizziness or vertigo are referred for remote consultation to help distinguish common inner ear diseases from dangerous strokes that can result in serious patient harms[17] and major malpractice lawsuits.[18] The consultation is based on evidence-based eye movement exams proven to be more accurate than MRI scans.[14]

The consultation begins when local personnel record a 10-15–minute eye movement test battery using an FDA-approved, portable video-oculography (VOG) device.[19] Recordings are sent digitally (asynchronously, in near real-time) to a Johns Hopkins vestibular neurologist. Within an hour, the consultant neurologist recommends a diagnosis and management plan to the ED team (Figure 1). As needed, the vestibular specialist interacts directly with either the physician or patient.

## Goals of Tele-Dizzy Implementation

1) **Enhance quality of care for patients**
   a. Avoid missed "dizzy" strokes
   b. More accurate inner ear diagnoses
   c. Deliver specific inner ear treatments
   d. Improve patient satisfaction
2) **Increase satisfaction for clinicians**
   a. Offload difficult cases
   b. Opportunity to learn new skills
3) **Improve workflow efficiency**
   a. Decrease wasteful testing
   b. Reduce ED length of stay (LOS)
   c. Prevent inappropriate admissions
4) **Benefit institutional bottom line**
   a. Decrease malpractice risk
   b. Competitive advantage/marketing

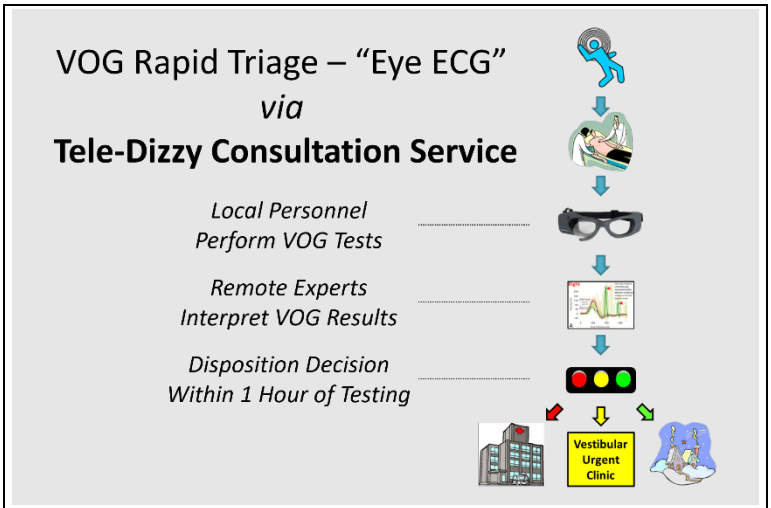


**Figure 1. Overview of Tele-Dizzy consultation concept.**
*Abbreviations: ECG, electrocardiogram; VOG, video-oculography.*

## Why is dizziness worthy of our time and attention?

Dizziness (spatial disorientation) and vertigo (false motion or spinning)[20] are common vestibular (balance) symptoms.[9] Dizziness exacts its toll on individual patients through fear, falls, fractures, and loss of function.[21] About 36 million Americans are affected annually,[22] leading to 4.8 million US emergency department (ED) visits per year.[10] The most common causes are inner ear diseases, but the underlying cause can be stroke. Accurate diagnosis in patients with dizziness or vertigo separates those requiring hospitalization for dangerous causes (particularly stroke) from those who do not (mainly inner ear diseases that need treatment but usually not hospital admission).

Current diagnosis can miss strokes[8,23-28] and is often inaccurate[16] or unhelpful[29] for inner ear diseases. Patients whose strokes are missed often have "atypical" symptoms that are not classic symptoms such as motor weakness or trouble speaking.[8,30] Vestibular strokes (i.e., presenting as dizziness or vertigo) are most likely to be missed.[8,23-28] Women, racial/ethnic minorities, and younger populations are at greater risk of missed stroke and suffering related harms.[8,31]

The more than 1 million with inner ear causes[32] should be diagnosed and treated at the bedside via proven techniques.[15] Instead, 35%[10] undergo low-yield[11,33,34] stroke imaging by brain computed tomography (CT), approximately 70-80% are misdiagnosed,[16] and more than 95% are incorrectly treated.[29] Prompt diagnosis and treatment can improve health-related quality of life (HRQoL),[35,36] avoid unnecessary irradiation,[37] and decrease out-of-pocket costs for patients.[38]

### A correct diagnosis in this context is critically important to patients, clinicians, and other major stakeholders.

- Patients and families care because a misdiagnosis can cause harm by delaying or missing effective treatment—whether a missed chance to resolve debilitating dizziness symptoms,[35,36] prevent consequences such as falls and fractures,[39-41] or even miss an opportunity to treat acute stroke[42] and prevent a disabling outcome.[17,43]
- Clinicians care because diagnosing dizziness is hard,[16] ED physicians are committed to improving diagnostic performance,[44] bedside techniques are unfamiliar,[16,29,45-50] and deciding on imaging is a key issue.[44,45]
- Payers care because neuroimaging in dizziness is expensive,[12] rates vary by site,[51] is often inappropriate,[52] and leads to an estimated ~$1 billion in annual waste.[5,12,32]
- Risk managers care because missed ED stroke is a leading cause of malpractice claims.[7]
- Public health officials care because annually ~100,000 die or are disabled from missed stroke,[1] it is the most common ED diagnostic error causing serious harms,[7] and the rate of misdiagnosis is rising.[53] As a result, a measure of missed stroke in ED dizziness was recently endorsed as a national quality metric.[54]

## What are the goals of practice transformation toward diagnostic excellence for dizziness?

Tele-Dizzy will help you transform your ED diagnostic practice for evaluating dizziness and vertigo (Figure 2), aligning your diagnostic approach with a 2023 emergency medicine clinical practice guideline[15] and setting your institution up to become a national leader as a new national quality metric monitoring missed stroke in dizziness[54] is rolled out.

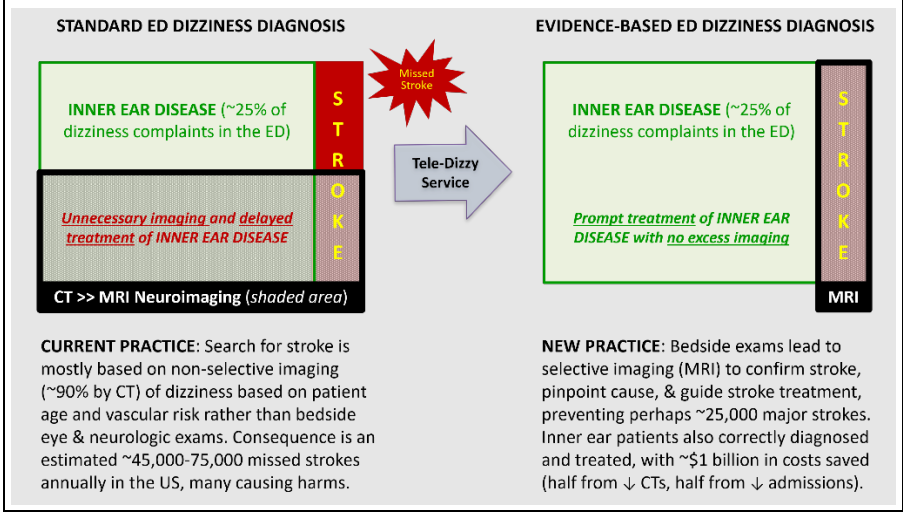


**Figure 2. Goals for ED clinical practice transformation**. Standard practice in diagnosing dizziness rests largely on CT to search for stroke in older patients with vascular risk factors. **Current practice can be risky for stroke patients because CT is ineffective for diagnosing vestibular strokes**. Young patients (or older ones without vascular risk factors) with strokes as the cause may be sent home untreated after falsely reassuring CT results, sometimes leading to death or disability. **Current practice is also suboptimal for inner ear patients because CT carries radiation risks**. Inner ear diseases are more common among older patients with stroke risk factors, so imaging is overused in inner ear diseases. **Specialist eye exams via teleconsultation will increase patient safety by rapidly identifying strokes otherwise missed**, directing earlier stroke treatments. More patients with inner ear disease will be correctly diagnosed and treated, **preventing harmful radiation exposure for >1 million individuals nationally, while avoiding long diagnostic delays and failed post-ED care transitions**.

## How has Tele-Dizzy performed thus far?

Tele-Dizzy has been implemented for both clinical care and research. Results from initial clinical deployment at Johns Hopkins Hospital are shown in Table 1 and reveal impressive improvements in diagnostic accuracy and decreases in inappropriate neuroimaging. Provider satisfaction has been extremely high (93% of ED physicians are "very satisfied" and "strongly agree that Tele-Dizzy has improved quality of care for dizzy patients").

**Table 1. Results of Tele-Dizzy pilot program at Johns Hopkins Hospital (n=287 teleconsults)**

| Category | Parameter | Baseline* | Tele-Dizzy | Improvement | p-value ($\chi^2$) |
|---|---|---|---|---|---|
| Diagnostic yield | Specific vestibular diagnosis rate | 77 (20.6%) | 163 (56.8%) | ↑ 276% | P<0.001 |
| | Stroke diagnosis rate | 1 (0.3%) | 20 (7.0%) | ↑ 2,506% | P<0.001 |
| | Non-diagnosis rate | 235 (62.8%) | 86 (30.0%) | ↓ 52% | P<0.001 |
| Test utilization | Neuroimaging (CT or MRI) | 198 (52.9%) | 70 (24.4%) | ↓ 54%† | P<0.001 |
| Patient outcomes | Excess 30-day stroke hospitalizations | 0.1%‡ | 0 (0.0%)‡ | ↓ 100%‡ | NA |

** Baseline rates for diagnostic accuracy and test utilization are from 374 ED patients with a presenting symptom of dizziness (seen outside of Tele-Dizzy consultation hours) who had mention of "nystagmus" in notes and were matched on the variables age, sex, and ED triage acuity.*
*† CT scans were reduced by 96% (from 49.2% to 1.7%, p<0.001) and MRIs for patients without strokes were unchanged (15.5% vs. 15.7%, p=0.95).*
*‡ Baseline 30d stroke hospitalizations are calculated using a long-term average (not using the relatively small, matched comparator population for Tele-Dizzy). The Tele-Dizzy value is based on actual patients seen at the Johns Hopkins Hospital—thus far, there have been zero stroke returns.*

Our recently completed AVERT randomized clinical trial (NCT02483429), the results of which will be published in 2025, found experts interpreting VOG eye movements tripled overall diagnostic accuracy versus ED usual care.

New clinical and research deployments at partner health systems will be launched by early 2025.

## What is the process to implement Tele-Dizzy at a new institution?

The main thing your ED will need to do is provide a workforce of technicians (or nurses, physicians assistants, etc.) who will perform VOG testing. This means local "champions" (superusers) will be trained and help maintain this local workforce. Our Johns Hopkins team will help provide the initial training for your champions (roughly two half days) plus feedback on their first 10 cases (for assessment of competence and quality assurance for these superusers).

Overall, there are several logistical work streams essential to the clinical deployment:

1) Equipment procurement and information technology clearance/integration
2) Technician "champion" training on VOG equipment and eye movement test battery
3) Johns Hopkins physician licensure, credentialing, and provider enrollment
4) Clinical services and related legal agreements with Johns Hopkins
5) Outcomes and analysis plan to assess impact of service delivery

Each aspect will be tailored to your local context. These work streams will all be completed in partnership between your local team and the Johns Hopkins Tele-Dizzy implementation team. They take approximately 6 months to complete.

## Ready to get started?

We are happy to meet to discuss the Tele-Dizzy program, answer specific questions, or provide demonstrations. Once a decision to deploy is made, our team will set up a recurring meeting to ensure progress toward implementation.

Please reach out to the Tele-Dizzy team at teledizzy@jh.edu to learn more or initiate the process.

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