

## Abstract

Each year, the U.S. spends over \$4 billion on ER visits for evaluation of dizziness [1]. Benign paroxysmal positional vertigo (BPPV) is a common cause of dizziness that can easily be diagnosed by observing characteristic eye movements during the Dix-Hallpike test (DHT). The DHT is easily performed, however, interpretation requires more advanced training. Consequently, it is rarely performed in emergency departments [2], and instead, patients often undergo costly imaging tests. We evaluated whether video recordings of DHT could be assessed telemedically. Dizzy patients underwent objective vestibular testing, but also had videos of their eye movements recorded via a smartphone during the DHT. The videos were remotely reviewed by two otolaryngologists for BPPV screening and were compared to objective and in-person exam findings. Overall, 30 dizzy patients were evaluated with 7 cases of BPPV. The sensitivity for diagnosing BPPV via a smartphone recording of eye movements of the DHT was 92.86% with a specificity of 100% and a NPV of 97.87%. Our initial proof-of-concept study shows that remote diagnosis of BPPV is possible with high specificity. Since the DHT is easily taught, having an otolaryngologist interpret the resulting eye movements remotely may increase usage of the test and may lead to cost savings.

## Introduction

Each year the U.S. spends over \$4 billion on emergency room visits for evaluation of dizziness. A very common cause of dizziness is benign paroxysmal positional vertigo (BPPV), which can easily be diagnosed by observing characteristic eye movements during the Dix-Hallpike test (DHT).

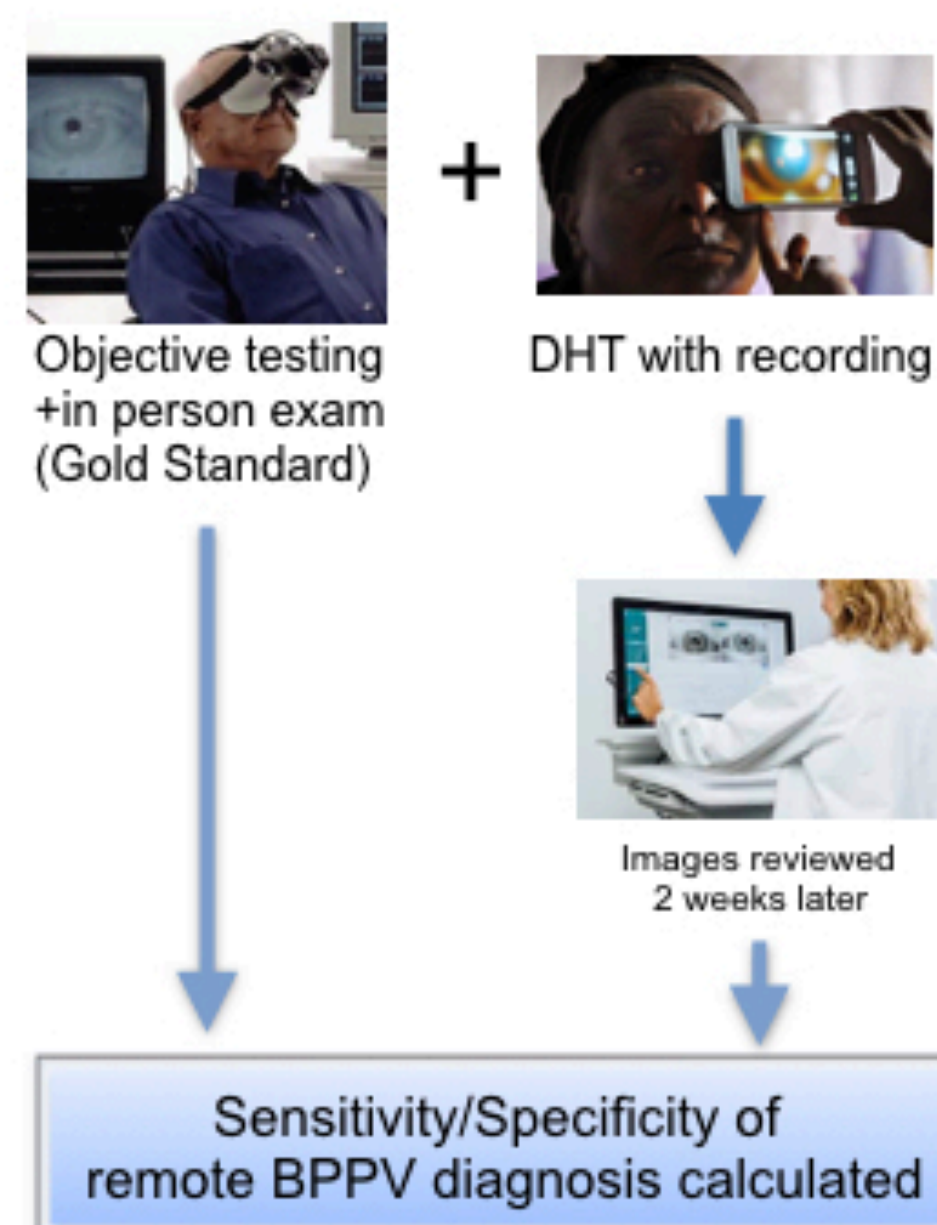
While the DHT is straightforward to perform, interpretation of the resulting eye movements typically requires more training. Consequently, recent surveys show the DHT is rarely performed in emergency departments [2], and patients are often subjected to costly imaging tests instead. With the rise of high-deductible insurance plans, this can place a significant burden on patients for an easily diagnosable disease.

We aim to evaluate whether telemedical videos of eye movements during DHT could allow a remote otolaryngologist to accurately diagnose BPPV. In the future, remote consults could help to avoid unnecessary imaging and create significant cost savings.

## Methods and Materials

Dizzy patients underwent objective vestibular testing, including audiogram, videonystamography, video head impulse testing, balance plate testing, and evaluation by a neuro-otologist. Subsequently, these patients underwent a DHT while a physician recorded eye movements via a smartphone on a HIPAA-compliant messaging application. These videos were remotely reviewed on a smartphone by two otolaryngologists for BPPV screening. Remote diagnosis was compared to the initial gold standard diagnosis by in-person and objective examination.

### Study Design



## Results

30 dizzy patients were evaluated; 7 had BPPV. The sensitivity of remote diagnosis was 92.86%, with a specificity of 100% and a NPV of 97.87%.

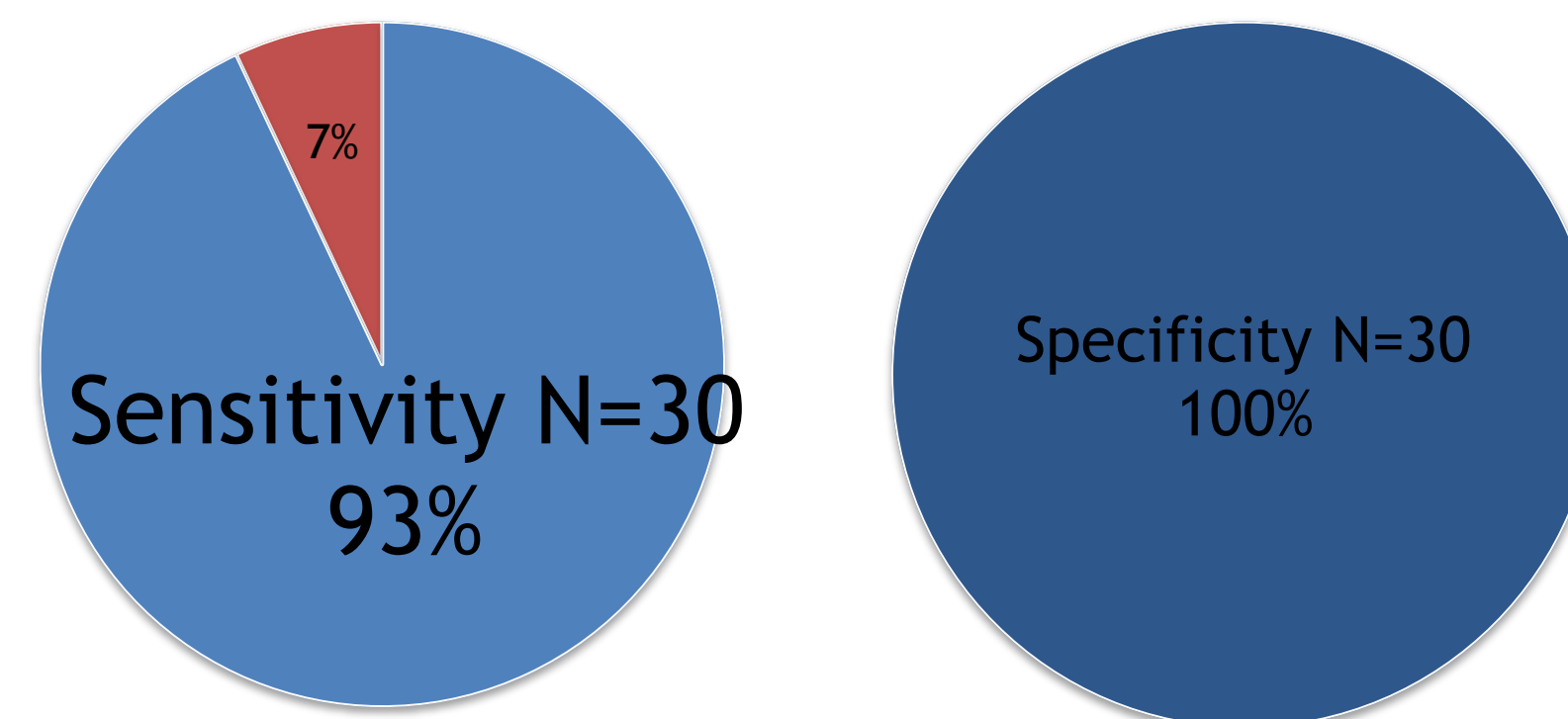


Figure 1: Sensitivity and Specificity of remote diagnosis of BPPV via video of DHT

## Discussion

Within our small sample size, a number of patients who were referred for an evaluation of their dizziness had initially undergone a CT or MRI in the emergency department to evaluate their complaint of dizziness.

Our initial proof of concept study found that for a small sample size, remote diagnosis of BPPV via telemedical consults is possible with high specificity. Based on the specificity, it is appears unlikely that a trained otologist or neurologist reviewing videos of ocular findings of a DHT would misdiagnose a more concerning cause of dizziness as BPPV. Thus, this could easily serve as a screening tool to quickly triage dizzy patients into those requiring more costly work-up and those who do not.

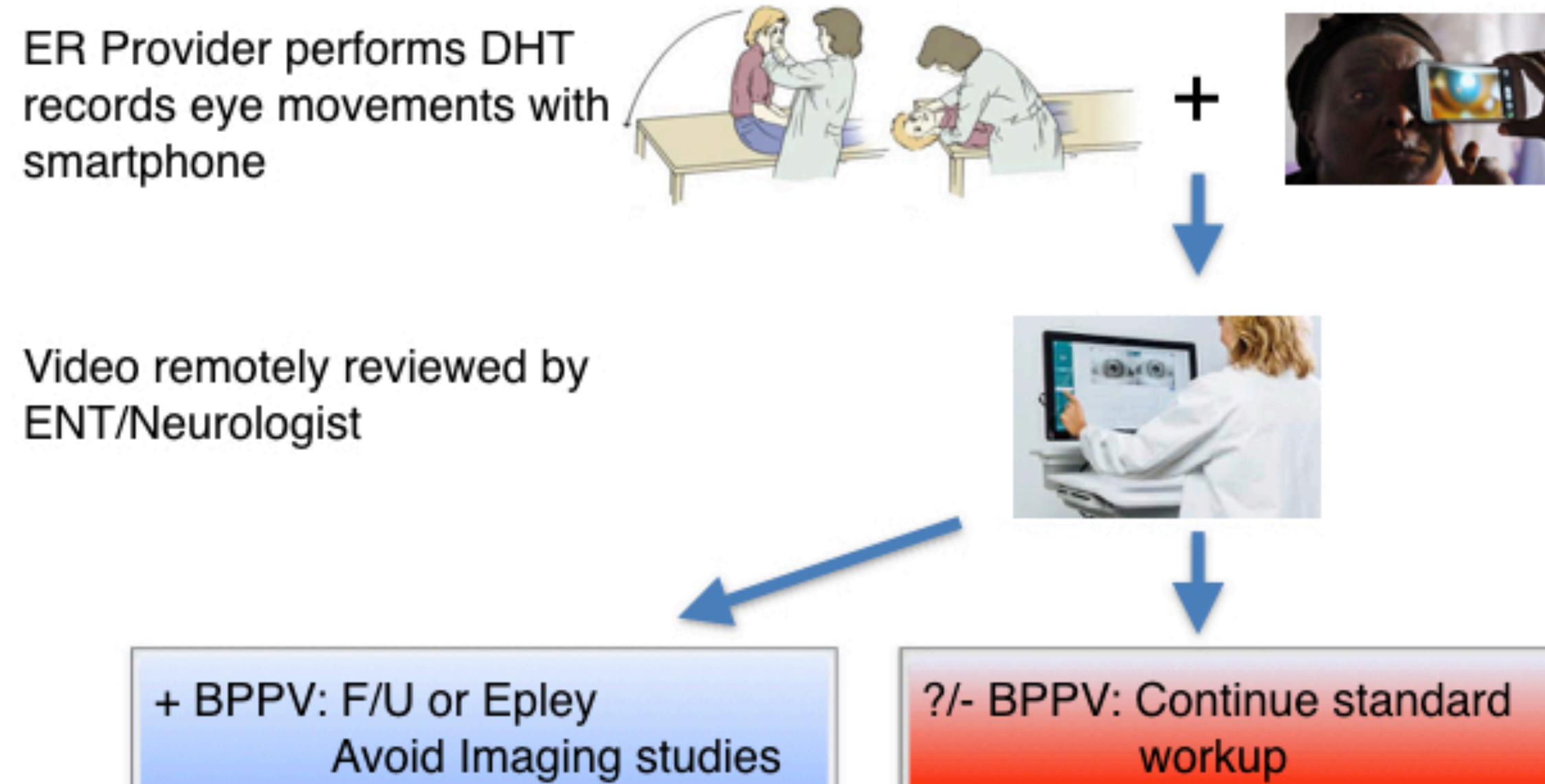
While other authors have suggested using video-oculography [3] or educational algorithms [4] to help distinguish benign versus concerning causes of dizziness, the barriers to adoption of these methods are the cost of equipment and ER workflow. However, due to the prevalence of HIPAA-compliant texting applications and the ubiquity of smartphones, adoption of smartphone-based video consults into an ER workflow is feasible. This is supported by a recent survey of worldwide ER physicians, which found that many wanted assistance with evaluating and distinguishing causes of dizziness [5]. While academic centers may have neurologists or otolaryngologists on call, rural and community centers could gain access to these specialists through telemedical means.

Since the DHT is easily taught, having an otolaryngologist interpret the resulting eye movements remotely may increase usage of the test and may lead to cost savings.

## Conclusions

Further studies on a larger sample size are required before adoption, however, our proof-of-concept study suggests that telemedical consults for remote screening and diagnosis of BPPV are feasible.

### Telemedical BPPV Consult: Clinical Application



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