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What is This?
Rapid Systematic Review of Normal Audiometry Results as a Predictor for Benign Paroxysmal Positional Vertigo

Paul M. Dorresteijn, MSc¹,²*, Norbertus A. Ipenburg¹,²*, Kathryn J. Murphy¹,²*, Michelle Smit¹,²*, Jonna K. van Vulpen¹,²*, Inge Wegner, MD¹,³, Inge Stegeman, PhD¹,³, and Wilko Grolman, MD, PhD¹,³

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Abstract

Objective. To evaluate whether absence of hearing loss on pure-tone audiometry (PTA) is reliable as a diagnostic test for predicting benign paroxysmal positional vertigo (BPPV) in adult patients with vertigo.

Data Sources. PubMed, Embase, and the Cochrane Library.

Methods. A systematic literature search was conducted on December 10, 2013. Relevant publications were selected based on title, abstract, and full text. Selected articles were assessed for relevance and risk of bias using predetermined criteria. Prevalence and the positive and negative predictive value (PPV and NPV) were extracted.

Results. Of 603 retrieved publications, 1 article with high relevance and moderate risk of bias was included. In this study, the prevalence of BPPV was 28%. The PPV of hearing loss assessed by PTA was 31% (95% CI, 17-49) and the NPV was 73% (95% CI, 61-83). The absence of hearing loss on PTA decreased the risk of BPPV by 1%.

Conclusion and Recommendation. There is insufficient high-quality evidence regarding the diagnostic value of the absence of hearing loss, assessed by PTA, for predicting BPPV in adult patients with vertigo.

Keywords

BPPV, benign paroxysmal positional vertigo, vertigo, pure-tone audiometry, hearing loss, systematic review

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Background

Benign paroxysmal positional vertigo (BPPV) is the most common cause of vertigo.¹ Of all patients with vertigo, 17% to 42% are diagnosed with BPPV.²-⁴ The prevalence of BPPV is higher in older patients.⁵ Vertiginous episodes in BPPV are induced by head movements and are accompanied by a characteristic paroxysmal positional nystagmus.¹ These episodes can be provoked by the Dix–Hallpike maneuver. This is also the reference test for diagnosing BPPV.⁶ Unlike other vestibular disorders, BPPV does not entail additional hearing loss in patients.⁷ However, many BPPV patients show signs of presbycusis or other forms of preexisting hearing loss.⁸ The prevalence of hearing loss in BPPV patients ranges from 18% to 95%.⁸-¹³ According to the American Academy of Otolaryngology—Head and Neck Surgery Foundation’s 2008 BPPV Clinical Practice Guideline,⁷ audiometry is not required to diagnose BPPV. Nonetheless, pure-tone audiometry (PTA) is frequently obtained in patients with vertigo.¹⁴

The aim of this rapid systematic review is therefore to evaluate whether absence of hearing loss on PTA is reliable as a diagnostic test for predicting BPPV in adult patients with vertigo.

Methods

A rapid systematic review of the available evidence was performed. Whereas traditional systematic reviews typically take a minimum of 6 months to 1 year to complete, a rapid review accelerates the process while maintaining a systematic approach.
Search and Selection

A systematic literature search in PubMed, Embase, and the Cochrane Library was conducted. Relevant synonyms for the search terms PTA and BPPV were used (Table 1). Two authors (K.J.M. and J.K.V.) excluded duplicate titles and independently screened titles and abstracts of the retrieved records for inclusion. Studies reporting original data on the diagnostic value of PTA in adult patients with BPPV were included. Only reports of original study data were included; systematic reviews, opinion papers, animal studies, and case reports were excluded (see Figure 1 for selection criteria). Five independent reviewers (P.M.D., N.A.I., K.J.M., M.S., and J.K.V.) screened full texts of eligible articles using the same criteria. Additionally, PubMed and Web of Science were searched for related articles, and references of the selected articles were hand-searched for titles not identified by our initial search. Initial disagreements were solved by discussion; hence, selection is based on full consensus.

Study Assessment

Remaining records were assessed for their relevance and risk of bias by 5 of the authors (P.M.D., N.A.I., K.J.M., M.S., and J.K.V.) using predefined criteria (see Table 2 for assessment criteria). Relevance concerned the applicability of the study findings for answering the research question and involved the evaluation of (1) patients, (2) the index test, and (3) outcomes. Studies were classified as having a high relevance if they complied with all 3 criteria and moderate if they satisfied 2 of the criteria; the remainder were classified as low relevance. Assessment of risk of bias involved evaluation of the extent of selection and information bias, using the Cochrane Collaboration’s tool for assessing risk of bias. Assessment of risk of bias involved evaluation of (1) the reference test, (2) blinding, standardization of both (3) the index test and (4) the evaluation of outcomes, (5) selective reporting, and (6) completeness of reported data. If studies complied with all of these criteria, they were classified as having a low risk of bias. Studies

Table 1. Search for Studies on the Diagnostic Value of Hearing Loss, Assessed by PTA, in Diagnosing BPPV in Patients with Vertigo (Date of Search: December 10, 2013).

<table>
<thead>
<tr>
<th>Database</th>
<th>Search</th>
<th>Hits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embase</td>
<td>((vertigo:ab,ti AND positional:ab,ti) OR (recurrent:ab,ti AND dizziness:ab,ti AND benign:ab,ti) OR (benign:ab,ti AND Paroxysmal:ab,ti AND positional:ab,ti) OR (benign:ab,ti AND paroxysmal:ab,ti AND vertigo:ab,ti) OR (recurrent:ab,ti AND vertigo:ab,ti AND benign:ab,ti) OR (vertigo:ab,ti AND paroxysmal:ab,ti AND positional:ab,ti) OR (benign:ab,ti AND positional:ab,ti AND vertigo:ab,ti) OR (benign:ab,ti AND paroxysmal:ab,ti AND dizziness:ab,ti) OR ‘Familial Vestibulopathy’:ab,ti OR ‘postural vertigo’:ab,ti OR ‘benign paroxysmal positional vertigo’/exp OR ‘episodic vertigo’/exp OR ‘positional vertigo’/exp OR ‘paroxysmal vertigo’/ab,ti OR ‘episodic vertigo’/ab,ti OR BPPN/ab,ti OR cupulolithiasis/ab,ti OR canalolithiasis/ab,ti OR canalithiasis/ab,ti) AND (‘hearing examination’:ab,ti OR ‘hearing test’:ab,ti OR ‘hearing tests’:ab,ti OR PTA:ab,ti OR audio*:ab,ti OR ‘auditory test’:ab,ti OR ‘auditory tests’:ab,ti OR ‘hearing loss’:ab,ti OR ‘hearing test’/exp)</td>
<td>531</td>
</tr>
<tr>
<td>The Cochrane Library</td>
<td>((vertigo AND positional) OR (recurrent AND dizziness AND benign) OR (benign AND paroxysmal AND positional) OR (benign AND paroxysmal AND vertigo) OR (recurrent AND vertigo AND benign) OR (vertigo AND paroxysmal AND positional) OR (benign AND paroxysmal AND dizziness) OR “Familial Vestibulopathy” OR “postural vertigo” OR BPPV OR “paroxysmal vertigo” OR “episodic vertigo” OR BPPN OR cupulolithiasis OR canalolithiasis OR canalithiasis) AND (“hearing examination” OR “hearing test” OR “hearing tests” OR PTA OR “auditory test” OR “auditory tests” OR “hearing loss” OR audiometry OR audiometric OR audiogram OR audiograms OR audiology)</td>
<td>17</td>
</tr>
</tbody>
</table>
were classified as having a moderate risk of bias if they satisfied at least 3 criteria, and the remainder were classified as high risk of bias. When an item of the study assessment was reported, it was classified as either “satisfactory” or “unsatisfactory.” When an item was not reported, it was rated “unclear.” Initial discrepancies between independent reviewers were resolved by discussion and reported results are based on full consensus. Studies with either or both low relevance and high risk of bias were excluded from further review.

Data Extraction
Five authors (P.M.D., N.A.I., K.J.M., M.S., and J.K.V.) independently extracted descriptive data considering the study population, the index test, and the reference test from the included studies. The true-positive, false-positive, true-negative, and false-negative test results were extracted to enable calculation of the prevalence, the positive and negative predictive values (PPV and NPV respectively), and the added diagnostic values.

Results
Search and Selection
A total of 954 titles were retrieved. Titles and abstracts of 603 unique studies were screened (Figure 1). After screening the full text of 19 articles, 1 article


patients with vertigo were included. Selective reporting was an issue because included patients with incomplete diagnostic workup were excluded from further analysis. The Dix-Hallpike maneuver was used as the reference test in all patients. It was not mentioned at what frequencies PTA was performed. Blinding of patients and investigators for results of PTA was also not mentioned. The extracted data of this study are described in Table 3 and Table 4.

Discussion
Although absence of hearing loss in vertiginous patients, assessed by PTA, is generally considered a useful finding in diagnosing BPPV, this rapid systematic review shows that evidence supporting this belief is lacking. In the study by Somefun et al,


Figure 1. Flowchart for selection of studies on the diagnostic value of hearing loss, assessed by pure-tone audiometry, in diagnosing benign paroxysmal positional vertigo (BPPV) in patients with vertigo (date of search: December 10, 2013).
<table>
<thead>
<tr>
<th>Study (Year)</th>
<th>No. of Patients</th>
<th>Study Design</th>
<th>Relevance</th>
<th>Risk of Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Somefun et al (2010)</td>
<td>102</td>
<td>Cross-sectional</td>
<td>Patients a</td>
<td>Reference Test d</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Index Test b</td>
<td>Blinding e</td>
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<td></td>
<td></td>
<td></td>
<td>Outcome c</td>
<td>Standardization (I)f</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>Standardization (R)g</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Selective Reporting h</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Complete Data i</td>
</tr>
</tbody>
</table>

- Patients: $\bullet$ = adult patients with vertigo; $\circ$ = patients diagnosed with BPPV, other.
- Index test: $\bullet$ = PTA; $\circ$ = other.
- Outcome: $\bullet$ = BPPV as determined by Dix-Hallpike maneuver; $\circ$ = other.
- Reference test: $\bullet$ = Dix-Hallpike maneuver performed in all patients; $\circ$ = Dix-Hallpike maneuver not performed in all patients, reference test other than Dix-Hallpike maneuver; ? = unclear, no information provided.
- Blinding: $\bullet$ = adequate blinding of both patients and outcome assessor for results of PTA and Dix-Hallpike maneuver; $\circ$ = only patients blinded or no blinding; ? = unclear, no information provided.
- Standardization (I) of index test (PTA): $\bullet$ = yes; $\circ$ = no; ? = unclear, no information provided.
- Standardization (R) of reference test (Dix-Hallpike maneuver): $\bullet$ = yes; $\circ$ = no; ? = unclear, no information provided.
- Selective reporting: $\bullet$ = adequate sample selection; $\circ$ = inadequate sample selection; ? = unclear, no information provided.
- Completeness of outcome data: $\bullet$ = below 10% missing data; $\circ$ = 10% or more missing data; ? = unclear, no information provided.
Confidence intervals are broad, leading to an uncertainty of the effect for the research question. This study has some major limitations. First, all initially included patients who did not complete the full diagnostic workup were excluded from further analysis. This may have led to selective dropout of patients. One explanation might be that patients who did not experience hearing loss did not see the point of undergoing a PTA. Assuming that these patients did indeed not have hearing loss, this would have led to an overestimation of the percentage of patients with hearing loss. However, individuals with hearing loss might be afraid to see the diagnosis confirmed, leading to an underestimation of the number of patients with hearing loss. Second, the article did not state how the PTA was performed in every subject. It is unclear whether this led to information bias. In the article, an extended specification of several types of hearing loss was given. However, the degree of sensorineural hearing loss was not stated. It was also not mentioned whether the investigators of the Dix-Hallpike maneuver were blinded for the results of PTA. This might have influenced the assessment of the maneuver. The generalizability of the study could also be a point of discussion. It is unclear whether the results of this Nigerian study can be generalized to other populations.

To our knowledge, this is the first publication reviewing the diagnostic value of hearing loss, assessed by PTA, in diagnosing BPPV in adult patients with vertigo. Strengths of this rapid systematic review include the comprehensive and extensive search for evidence and the independent quality assessment. Furthermore, this topic is clinically relevant, because of the high prevalence of BPPV and the fact that PTA is frequently performed in patients with vertigo.1-4 Unfortunately, we could only use 1 article to answer our research question. Most research in this field has a follow-up design,10,11,17-19 including patients with BPPV instead of undiagnosed patients with vertigo.8,9,12,20 Their audiogram data could therefore not be used to calculate predictive values.

## Conclusion and Recommendation

Although absence of hearing loss, assessed by PTA, is in general considered to be an indicator for BPPV, there is insufficient evidence to support this statement. Our literature review yielded 1 article, with a moderate risk of bias, to answer our research question. The findings of this article suggest that the absence of hearing loss on PTA slightly decreases the probability of BPPV. However, this article had a small effect size with broad confidence intervals and therefore unsubstantial statistical power to answer our research question. More research is therefore needed. We suggest a large prospective cross-sectional study to investigate the use of PTA in diagnosing BPPV among adults with vertigo. Researchers should be blinded for the outcome of PTA, and diagnostic workup should be completed in all patients.

## Author Contributions

Paul M. Dorresteijn, writing, data collection, data analysis, interpretation, drafting and revision, approval final version; Norbertus A. Ipenburg, writing, data collection, data analysis, interpretation, drafting and revision, approval final version; Kathryn J. Murphy, writing, data collection, data analysis, interpretation, drafting and revision, approval final version; Michelle Smit, writing, data collection, data analysis, interpretation, drafting and revision, approval final version; Jonna K. van Vulpen, data analysis and interpretation, drafting and revision, approval final version; Inge Wegner, data analysis, interpretation, drafting and revision, approval final version; Inge Stegeman, data analysis, interpretation, drafting and revision, approval final version; Wilko Groelman, design, drafting and revision, approval final version, supervision.

## Disclosures

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References