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### Provider Training on Positional Maneuvers to Diagnose and Treat Benign Paroxysmal Positional Vertigo

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**PROVIDER TRAINING ON POSITIONAL MANEUVERS TO DIAGNOSE AND  
TREAT BENIGN PAROXYSMAL POSITIONAL VERTIGO**

A Thesis Presented to  
The Faculty of the School of Medicine  
Yale University

In Candidacy for the degree of  
Master of Medical Science

May 20, 2016

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## TABLE OF CONTENTS

<b>TITLE PAGE</b>	<b>i</b>
<b>TABLE OF CONTENTS</b>	<b>ii</b>
<b>LIST OF FIGURES</b>	<b>iv</b>
<b>LIST OF TABLES</b>	<b>v</b>
<b>ABSTRACT</b>	<b>vi</b>
<b>CHAPTER I: INTRODUCTION</b>	<b>1</b>
BACKGROUND	1
STATEMENT OF THE PROBLEM	3
GOALS AND OBJECTIVES	4
HYPOTHESIS	4
DEFINITIONS	5
REFERENCES	6
<b>CHAPTER II: REVIEW OF THE LITERATURE</b>	<b>8</b>
INTRODUCTION	8
LITERATURE SEARCH CRITERIA	8
REVIEW OF EMPIRICAL STUDIES BY OUTCOME VARIABLE	9
CLINICAL SKILL	10
KNOWLEDGE	14
CONFIDENCE	19
REVIEW OF RELEVANT METHODOLOGY	20
STUDY DESIGN	20
SAMPLE POPULATION	21
SAMPLE SIZE	21
OUTCOME MEASURES	22
CONFOUNDING VARIABLES	23
CONCLUSION	24
REFERENCES	25
<b>CHAPTER III: STUDY METHODS</b>	<b>26</b>
STUDY DESIGN	26
STUDY POPULATION AND SAMPLING	26
SUBJECT PROTECTION AND CONFIDENTIALITY	28
RECRUITMENT	28
STUDY VARIABLES AND MEASURES	29
DATA COLLECTION	31
POWER CALCULATION	34

<b>ANALYSIS</b>	<b>35</b>
<b>TIMELINE AND RESOURCES</b>	<b>36</b>
<b>REFERENCES</b>	<b>39</b>
<b><u>CHAPTER IV: CONCLUSION</u></b>	<b><u>40</u></b>
<b>ADVANTAGES AND STRENGTHS</b>	<b>40</b>
<b>DISADVANTAGES AND LIMITATIONS</b>	<b>41</b>
STUDY DESIGN LIMITATIONS	41
IMPACT LIMITATIONS	41
STATISTICAL OR DATA LIMITATIONS	42
<b>CONFOUNDING</b>	<b>43</b>
<b>CLINICAL AND PUBLIC HEALTH SIGNIFICANCE</b>	<b>44</b>
<b>REFERENCES</b>	<b>46</b>
<b><u>APPENDICES</u></b>	<b><u>47</u></b>
<b>APPENDIX A: ONLINE CONSENT FORM</b>	<b>47</b>
<b>APPENDIX B: GRADED DEMONSTRATION CHECKLIST</b>	<b>48</b>
<b>APPENDIX C: PRE-INTERVENTION QUESTIONNAIRE</b>	<b>49</b>
<b>APPENDIX D: POST-INTERVENTION QUESTIONNAIRE</b>	<b>52</b>
<b>APPENDIX E: POWER CALCULATION</b>	<b>54</b>
<b><u>BIBLIOGRAPHY</u></b>	<b><u>55</u></b>

## LIST OF FIGURES

<b>FIGURE 1.</b> VISUAL REPRESENTATION OF DISLODGED OTOLITHIC DEBRIS FROM THE UTRICLE ENTERING AND MOVING THROUGH THE POSTERIOR SEMICIRCULAR CANAL.....	2
<b>FIGURE 2.</b> FLOWCHART DESCRIBING THE SEQUENCE OF THE STUDY .....	27
<b>FIGURE 3.</b> USE OF THE DIX–HALLPIKE MANEUVER TO INDUCE NYSTAGMUS IN BENIGN PAROXYSMAL POSITIONAL VERTIGO INVOLVING THE RIGHT POSTERIOR SEMICIRCULAR CANAL. ....	33
<b>FIGURE 4.</b> EPLEY’S CANALITH-REPOSITIONING MANEUVER FOR THE TREATMENT OF BENIGN PAROXYSMAL POSITIONAL VERTIGO INVOLVING THE RIGHT POSTERIOR SEMI-CIRCULAR CANAL. ....	34
<b>FIGURE 5.</b> STUDY TIMELINE. ....	38

## **LIST OF TABLES**

<b>TABLE 1. LITERATURE REVIEW INCLUSION CRITERIA.....</b>	<b>9</b>
<b>TABLE 2. LEARNING OBJECTIVES FOR EACH GROUP.....</b>	<b>29</b>

## **ABSTRACT**

Dizziness and vertigo presentations comprise 2.5 percent of all emergency department visits, with benign paroxysmal positional vertigo being the most common type of vertigo in adults over the age of fifty. The Dix-Hallpike test and Canalith Repositioning Procedure are simple bedside maneuvers to effectively diagnose and treat this type of vertigo; however, many providers are uncomfortable or lack experience performing these maneuvers. We aim to compare the effectiveness of two different teaching strategies to improve the clinical skills of emergency department providers on these maneuvers. We will randomly assign 100 emergency medicine providers to either didactic or a combination of didactic and hands-on teaching on how to properly execute these maneuvers. Our study will inform health care personnel about the best method to train emergency medical providers to correctly perform the Dix-Hallpike test and Canalith Repositioning Procedure to diagnose and treat benign paroxysmal positional vertigo.

## **CHAPTER I: INTRODUCTION**

### **Background**

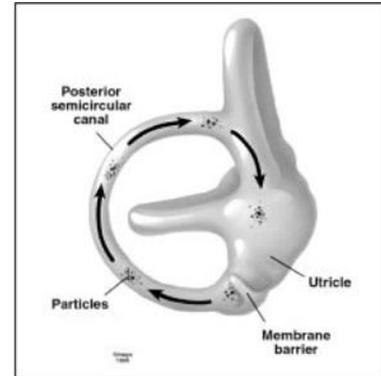
Over two million people present to the emergency department (ED) with a chief concern of dizziness, accounting for over 4% of all ED visits annually.<sup>2,3</sup> The term ‘dizzy’ is ambiguous and its meaning is often dependent on the patient’s interpretation.<sup>4</sup> Dizziness has been described as a spinning sensation, lightheadedness, fainting or something completely different altogether.<sup>3,5</sup>

To complicate matters further, the pathophysiology of ‘dizziness’ can be attributed to neurologic, cardiac, vestibular, psychiatric or metabolic abnormalities. As a result, various labs, tests, and expensive imaging are instinctively ordered by providers to narrow the differential and to help rule out the most harmful causes.<sup>6</sup> Undoubtedly, this practice results in an increase in healthcare costs, patient length of stay and patient exposure to pain, tests, and radiation. Research shows that the average cost of a patient presenting to the ED with dizziness ranges from \$1,000 to over \$2,000 per visit.<sup>6-8</sup> Ironically, the cost of imaging is the greatest contributory factor despite studies showing its ineffectiveness, low sensitivity, and low yield when used to rule-out stroke in patients who present with dizziness.<sup>6</sup> Furthermore, the unfortunate reality is that despite the rising costs associated with dizziness, misdiagnosis of this problem in the ED remains relatively common.<sup>9</sup>

The most common cause of dizziness is Benign Paroxysmal Positional Vertigo (BPPV), accounting for 20-40% of all cases.<sup>4,10</sup> BPPV has a lifetime prevalence of 2.4% and a one-year incidence of 0.6%.<sup>11</sup> It is more prevalent in females and patients over the age of 50.<sup>11,12</sup> The pathophysiologic process of BPPV is dislodged otolithic debris from

the utricle or saccule that becomes trapped in one of the semicircular canals of the inner ear. Movement of the head causes the otolithic debris to change position within the semicircular canal, which results in exaggerated movement of the endolymph and a false perception of rotation.<sup>10,13</sup> Although rare, it is possible for debris to enter the lateral or horizontal semicircular canals; however, 85-95% of all cases of BPPV originate in the posterior canal.<sup>14</sup> For the purpose of this study, involvement of the posterior canal will be assumed when discussing BPPV.

**Figure 1.** Visual representation of dislodged otolithic debris from the utricle entering and moving through the posterior semicircular canal.<sup>1</sup>



Despite what the name implies, BPPV can be a devastating illness and drastically affect quality of life for patients.<sup>5,8,9</sup> BPPV often presents abruptly and can be physically debilitating, resulting in many sufferers seeking treatment in the emergency department.<sup>15</sup> Symptoms include recurrent severe vertigo often with nausea and vomiting that correspond with head movement or positional changes. The simple movement of bending over to tie one's shoes or rolling over in bed can initiate an intense bout of vertigo.<sup>4,12,13</sup> Additionally, the rapid onset, frequency, and severity of these symptoms also put patients at an increased risk for falling.<sup>13</sup>

Although BPPV is both a common and debilitating disorder, it is also the easiest type of vertigo to effectively diagnose and treat using simple bedside maneuvers.<sup>8</sup> The Dix-Hallpike test (DHT) is a positional maneuver of a patient's head in order to diagnose posterior canal BPPV and to determine the affected side. A positive test elicits rotary nystagmus, a specific and reliable finding that is 70% effective at diagnosing BPPV.<sup>12,13</sup>

The Canalith Repositioning Procedure (CRP), commonly referred to as the Epley maneuver, is used to treat BPPV. The canalith repositioning procedure involves a series of specific positional changes of a patient in order to return the otolithic debris from the posterior canal back into the utricle or saccule. One study suggests that these maneuvers should not only be used as therapeutic tools specifically for BPPV but also as generalized diagnostic tools for all patients presenting with dizziness.<sup>7</sup> Using these maneuvers as a first line diagnostic test is timely, cost effective and harmless if in fact another etiology is present.<sup>7</sup> The effectiveness of CRP has been reported anywhere from 66% to 100% of the time.<sup>8,12,13,16,17</sup> These maneuvers are not only effective, they are also a non-invasive and inexpensive way to diagnose and treat BPPV.<sup>7-9,18,19</sup>

### **Statement of the Problem**

Recent studies conducted in both the U.S. and Germany show that a majority of patients suffering from BPPV sought medical help; however, the DHT and CRP were only conducted in a small percentage of all presenting patients.<sup>9,20</sup> The results of one study conducted in the U.S. showed that the DHT was only documented on 3.9% (137 of 3522) of all patients presenting with dizziness and only a slight improvement to 6.9% (2 of 29) was recorded for patients given a diagnosis of BPPV. Perhaps more concerning is that the CRP was documented in only 0.2% (8 of 3522) of all dizzy patients and only 3.9% (6 of 156) of those diagnosed with BPPV.<sup>20</sup> Despite extensive literature supporting these techniques, the use of the DHT and CRP are on the decline, specifically in the ED setting.<sup>20</sup> Overwhelmingly, the treatment approach among many providers is either symptomatically, using various medications, or through watchful waiting as BPPV is generally self-limiting over time.<sup>7,18</sup> Clearly, the incapacitating nature of this disorder and

its related healthcare costs, side effect profiles, and transient effect of medications do not make these superior treatment options. Numerous reasons have been proposed as to why the DHT and CRP are not widely used. One study suggest that although the positional maneuvers for diagnosing and treating BPPV are covered in emergency medicine textbooks, they fail to go into the necessary depth required to properly learn them.<sup>12</sup> Other studies suggest that primary care and ED providers may be less familiar with the treatment guidelines for BPPV because they were only published in specialty journals.<sup>14,21</sup> Regardless of the theories, a study using polling data directly from providers indicates that most are aware of the maneuvers but are simply uncomfortable performing them due to lack of knowledge and/or experience.<sup>22</sup>

### **Goals and Objectives**

The goal of this study is to compare the effectiveness of two teaching modalities to improve clinical skill for continuous medical education. The objective is to determine if didactic and hands-on teaching is more effective than didactic teaching alone to improve emergency department providers' clinical skill in performing the DHT and CRP. Depending on the outcome and its magnitude, this study may help shape future teaching methods in continuous medical education for assessing clinical skill. To the best of our knowledge, there have not been any studies that have looked at training modalities for emergency medicine providers on these techniques.

### **Hypothesis**

We hypothesize that emergency department providers who undergo a combination of didactic and hands-on teaching compared to didactic teaching alone will show an improvement of at least four points in the mean change from baseline on our

self-designed standardized checklist to assess clinical skill in performing the Dix-Hallpike test and canalith repositioning procedure.

### **Definitions**

*Emergency department providers:* Includes attending physicians, fellows, residents, PAs and APRNs currently working in adult emergency departments.

*Clinical Skill:* The ability to accurately perform and interpret the Dix-Hallpike test and Epley maneuver on a patient.

*Dix-Hallpike Test (DHT):* An assisted positional maneuver used to diagnose Benign Paroxysmal Positional Vertigo of the posterior canal.

*Canalith Repositioning Procedure (CRP):* An assisted positional maneuver used to treat Benign Paroxysmal Positional Vertigo of the posterior canal (also referred to as the Epley maneuver).

## References

1. Froehling DAD. The canalith repositioning procedure for the treatment of benign paroxysmal positional vertigo: a randomized controlled trial. *Mayo Clinic proceedings*. 07 2000;75(7):695-700.
2. Rising Annual Costs of Dizziness Presentations to U.S. Emergency Departments. *Academic emergency medicine*.20:689.
3. Stanton VA, Hsieh YH, Camargo CA, Jr., et al. Overreliance on symptom quality in diagnosing dizziness: results of a multicenter survey of emergency physicians. *Mayo Clinic proceedings*. Nov 2007;82(11):1319-1328.
4. Wipperman J. Dizziness and Vertigo. *Primary Care: Clinics in Office Practice*. 3// 2014;41(1):115-131.
5. Cappello MM. Dizziness and vertigo in a department of emergency medicine. *European journal of emergency medicine*. 12 1995;2(4):201.
6. Saber Tehrani ASAS. Rising annual costs of dizziness presentations to U.S. emergency departments. *Academic emergency medicine*. 07 2013;20(7):689-696.
7. Li JCJ. Cost-effective management of benign positional vertigo using canalith repositioning. *Otolaryngology--head and neck surgery*. 03 2000;122(3):334.
8. Von Brevern M. Benign paroxysmal positional vertigo: current status of medical management. *Otolaryngology--head and neck surgery*. 03 2004;130(3):381-382.
9. Neuhauser HK, Lempert T. Vertigo: Epidemiologic Aspects. *Semin Neurol*. // 15.10.2009 2009;29(05):473-481.
10. Hogue JD. Office Evaluation of Dizziness. *Primary Care: Clinics in Office Practice*. 6// 2015;42(2):249-258.
11. von Brevern MM. Epidemiology of benign paroxysmal positional vertigo: a population based study. *Journal of neurology, neurosurgery and psychiatry*. 07 2007;78(7):710-715.
12. Koelliker PP. Benign paroxysmal positional vertigo: diagnosis and treatment in the emergency department--a review of the literature and discussion of canalith-repositioning maneuvers. *Annals of emergency medicine*. 03 2001;37(4):392.
13. Kim J-SJS. Clinical practice. Benign paroxysmal positional vertigo. *The New England journal of medicine*. 03 2014;370(12):1138-1147.
14. Bhattacharyya NN. Clinical practice guideline: benign paroxysmal positional vertigo. *Otolaryngology--head and neck surgery*. 11 2008;139(5 suppl 4):S47-S81.
15. Chang AK. A Randomized Clinical Trial to Assess the Efficacy of the Epley Maneuver in the Treatment of Acute Benign Positional Vertigo. *Academic emergency medicine*. 09 2004;11(9):918-924.
16. Epley JM. The canalith repositioning procedure: for treatment of benign paroxysmal positional vertigo. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery*. Sep 1992;107(3):399-404.
17. Furman JM, Cass SP. Benign paroxysmal positional vertigo. *The New England journal of medicine*. Nov 18 1999;341(21):1590-1596.

18. Sacco RR, Burmeister DB, Rupp VA, Greenberg MR. Management of Benign Paroxysmal Positional Vertigo: A Randomized Controlled Trial. *The Journal of Emergency Medicine*. 4// 2014;46(4):575-581.
19. Kerber KA. Benign paroxysmal positional vertigo: opportunities squandered. *Ann NY Acad Sci*. Apr 2015;1343(1):106-112.
20. Kerber KAKA. Use of BPPV processes in emergency department dizziness presentations: a population-based study. *Otolaryngology--head and neck surgery*. 03 2013;148(3):425-430.
21. Fife TDT. Practice parameter: therapies for benign paroxysmal positional vertigo (an evidence-based review): report of the Quality Standards Subcommittee of the American Academy of Neurology. *Neurology*. 05 2008;70(22):2067-2074.
22. Polensek SHS. The challenges of managing vestibular disorders: a qualitative study of clinicians' experiences associated with low referral rates for vestibular rehabilitation. *International journal of clinical practice (Esher)*. 11 2009;63(11):1604-1612.

## **CHAPTER II: REVIEW OF THE LITERATURE**

### **Introduction**

Our background research of BPPV revealed both a problem and a gap in knowledge regarding the teaching of the positional maneuvers to diagnose and treat this condition. As a result, the research question of our proposed study asks whether supplementing hands-on teaching with didactic lecture is more effective than traditional didactic lecture alone in improving the skills, knowledge, and confidence of emergency medicine providers to diagnose and treat BPPV using the DHT and CRP. Before addressing this question, we conducted a systematic review of the most recent literature in order to understand the relationship between our population, independent variables, control and outcomes.

### **Literature Search Criteria**

The following databases were searched from December 2015 to May 2016 for relevant studies: BEME, EMBASE, Epub, ERIC and MEDLINE. The following terms were used in the literature search (with closely related words or acronyms): “vertigo OR benign paroxysmal positional vertigo,” and “Epley maneuver OR canalith repositioning,” “Dix-Hallpike,” "clinical competence" combined with "medical education," “program evaluation,” “teaching,” “knowledge OR confidence,” “didactic OR lecture,” and "hands-on OR interactive.” Additional studies were identified through the reference lists of included articles and searching relevant websites. Of note, inconsistent indexing of terms related to educational philosophy and doctrine of online databases made it nearly impossible to conduct a truly comprehensive literature search.

Our preliminary systematic search of the literature, found no research related to teaching specifically for the DHT or CRP. As a result, we expanded our search criteria to include comparing teaching methods for all clinical skills and/or procedures. The results were limited to scholarly journals and the English-language. Next, an initial review was conducted using the abstract of each article to ensure the content was applicable to our proposed study and that all inclusion criteria were met. Reviewed articles were selected for inclusion if they met the criteria outlined in Table 1.

**Table 1. Literature Review Inclusion Criteria**

<b>Scholarly Journals</b>
<b>English language</b>
<b>Study Design</b> – At least a 2-sample study design
<b>Study Population</b> – Medical providers and students*
<b>Independent Variable(s)</b> – Didactic and/or hands-on teaching of clinical skills or procedures <sup>#</sup>
<b>Outcome(s)</b> – Skill and/or knowledge and/or confidence

\*Limiting our population to emergency department providers was too restrictive; therefore, we expanded our inclusion criteria to include all medical providers and students.

<sup>#</sup>Limited data on teaching methods for the positional maneuvers associated with BPPV. We broadened the inclusion criteria to include all clinical skills or procedures.

---

### **Review of Empirical Studies by Outcome Variable**

The limited number of articles included in our literature review was the direct result of the heterogeneity within educational-based studies. With careful consideration we broadened certain aspects of our inclusion criteria while maintaining specificity of others, in order to capture the most relevant articles within a reasonable sample.

A systematic review conducted by O’Dunn-Orto *et al.*, 2012 about educational methods to teach medical trainees and physicians, musculoskeletal clinical skills with the

following outcomes of interest: patient outcomes, change in behavior, change in skills, change in knowledge and change in attitudes/perceptions.<sup>1</sup> The literature search resulted in 5089 articles where 24 met inclusion criteria, and only five compared interactive, small group learning to traditional didactic teaching.<sup>1</sup> This serves as an example of the difficulty related to attempting a comprehensive search of educational-based literature.

### ***Clinical Skill***

Three studies were reviewed assessing clinical skill as an outcome measure when comparing didactic and hands-on training versus didactic teaching alone. Of these three studies reviewed, all three concluded that a combination of didactic and hands-on teaching was more effective than didactic instruction alone at improving clinical skill.

Vogelgesang *et al.*, 2002 conducted a study comparing the effectiveness of three teaching methods on improving the skills of medical students and residents on aspirating and injecting the knee and shoulder. The traditional group learned the procedures throughout their rheumatology rotation based on patients requiring them.<sup>2</sup> The second group received a lecture about the techniques while the third group, referred to as the program group, received both a didactic lecture followed by an opportunity to practice the techniques using models.

The investigators for this study chose to use a random sample of participants to complete the baseline assessments, rather than having each participant completing both a pre- and post-assessment. They decided that there was not enough material to be tested to warrant a pre- and post-test.<sup>2</sup> Although the participants chosen to only complete the baseline assessments were randomly selected from the sample population, there remains potential that those selected were not truly representative of the sample. No statistical

analysis was reported to determine if there was a significant difference between these groups. The approximation of baseline data is a limitation of this study because it serves as the cornerstone by which all other data is compared.<sup>2</sup>

The difference in means was compared between groups to determine the effectiveness of the respective intervention on improving skill. Although the mean scores improved from baseline in every group (Baseline 16.33; Traditional 17.33; Lecture 20.50; Program 24.08), the program group performed notably better than the others ( $p < 0.05$ ) and had minimal variability between scores (SD = 1.31 and a range of 24-25 out of a possible 26).<sup>2</sup>

Participants were placed in an intervention group based on educational scheduling, rather than using random assignment.<sup>2</sup> Although no difference was found between groups in regards to level of training (i.e., medical students versus residents), other baseline characteristics between groups were not discussed.<sup>2</sup> The variability within the resident population to include year of training and medical specialty were neither controlled for, nor discussed in the article and could be a source of confounding.

The program group attended the same hour-long didactic session as the lecture group, and in addition, they also had the hour-long hands-on training using mannequins.<sup>2</sup> The additional time participants in the program group received may have influenced clinical skills more than the intervention itself.

Finally, the program group interacted with the mannequins twice, while the other groups interacted with them just once during the practical exam.<sup>2</sup> The extra time and increased familiarity with the mannequins may have contributed to higher scores on the practical exam.

Clark *et al.*, 2014, conducted a study similar in design to that of Vogelgesang *et al.*, 2002, and both studies reported similar results regarding clinical technique and skill. Clark *et al.*, 2014 randomly assigned 30 dental students to either video-based instruction, faculty-led hands-on training or a combination of the two, in order to compare changes in clinical technique of performing an oral and pharyngeal cancer examination.<sup>3</sup> Median scores from a baseline practical exam were compared against median scores from the post-intervention practical exam. Overall, there was a 20-point improvement between the pre- and post-clinical hands-on assessment.<sup>3</sup> The median difference in scores and inter-quartile range denoted in parentheses for the video group, hands-on group and combination group were 16 (11-18), 18 (14-21) and 24 (21-28) respectively.<sup>3</sup> Clinical exam scores improved in each training group; however, the combination-training group performed significantly better ( $p < 0.01$ ) than the video group and hands-on group.

This was the only study included from our literature search that used video-based instruction rather than traditional didactic lecture as the comparison group. Despite this difference, the results showed an improvement in clinical skill when hands-on instruction is used in combination with another teaching method rather than the alternate teaching method alone.

There were two main limitations of this study. First, although the sample size was small ( $n = 30$ ) the investigators were reassured based on the moderate difference between groups.<sup>3</sup> Achieving even a moderate difference with a small sample size is a potential predictor that the results are reproducible. Nonetheless, a larger sample size is needed to determine if the difference between each group is statistically significant.

Second, similar to Vogelgesang *et al.*, 2002, more time was dedicated to the combined intervention group compared to the others. It is possible that the significant improvement in scores of those randomized to the combination group could be attributed to total time spent rather than the method of teaching.<sup>3</sup> The investigators believe that the method of instruction was more influential in the increase in practical exam scores than time, but they also acknowledged that further research is needed to support their suspicion.<sup>3</sup>

Keim *et al.*, 2014 conducted a randomized control trial comparing the effect of didactic and hands-on teaching to didactic teaching alone on performing the Lachman test to diagnose an anterior cruciate ligament (ACL) tear using first-year medical students, physician assistant (PA) students and physical therapy (PT) students. All participants received the same anatomy review and in addition, those randomized to the hands-on group received an additional 15 minute session composed of a brief review followed by hands-on training using lightly embalmed cadavers.

The cadavers used in this study were methodically prepared by surgically releasing one ACL, while performing a partial sham operation on the other to serve as the control knee.<sup>4</sup> Upon completion, there were no visual differences between each knee.

A practical examination on the Lachman test using the lightly embalmed cadavers was used to assess clinical skill. Participants were graded based on the number of correctly completed steps using a checklist. After performing the Lachman test on each knee, the participants were asked to identify which knee exhibited a positive test (ACL tear).

There was statistically significant improvement in the number of correctly performed steps in the hands-on group compared to the control group ( $p < 0.0001$ ).<sup>4</sup> The hands-on group correctly performed a median of 9/9 steps correctly with an interquartile range (IQR) of 7 to 9. In comparison, the control group correctly performed a median of 5/9 steps correctly with an IQR of 3-6.<sup>4</sup>

In addition, the hands-on group was more likely to correctly identify a positive Lachman test.<sup>4</sup> A significant difference ( $p < 0.05$ ) was reported between groups on the number of correctly identified tests with the exception of the 2010-2011 medical students.<sup>4</sup> For that particular class, 9/14 (64%) students in the hands-on group correctly identified the torn ACL versus only 4/12 (33%) in the control group.<sup>4</sup> The difference was not statistically significant ( $p < 0.12$ ) purely due to the size of the sample. The overall sample size of this study was calculated based on 80% power; however, stratifying these results, decreased the size of the sample, and limited the power to detect a significant difference.

Similarly to the previous studies, the hands-on group received 15 additional minutes of instruction compared to the control and had additional exposure manipulating the cadavers. It is plausible that these factors could have accounted for at least some of the differences calculated between the groups.

### ***Knowledge***

Two of the four studies reviewed assessing knowledge when comparing didactic and hands-on training versus didactic teaching alone, reported statistically significant results indicating that a combination of didactic and hands-on teaching was more effective than didactic lecture alone at improving knowledge.

Wilson *et al.*, 2009, conducted a study comparing a traditional anatomy review laboratory to a clinical procedures laboratory to assess both general anatomy knowledge and clinical knowledge using a written exam. A pre-test was administered that was equally divided into general anatomy questions and clinical procedure questions.<sup>5</sup> Upon completion, each participant was given a clinical procedures syllabus and an anatomy syllabus outlining five different procedures and the relevant anatomy of each.<sup>5</sup> The participants then completed either the traditional anatomy review laboratory (control group) or the clinical procedures laboratory (experimental group). The five clinical procedures and relevant anatomical structures were taught to the control group using cadavers and models without actually demonstrating or conducting the procedures.<sup>5</sup> The experimental group learned the procedures and relevant anatomy by observing a demonstration and practicing each procedure on cadavers. After completing the laboratory exercises, both groups completed a post-test with identical knowledge assessment questions as the pre-test.

No significant difference of pre-test scores was detected between groups and both showed improvement in knowledge of general anatomy comparing pre- and post-tests. Comparing groups, there was a significant improvement in knowledge of general anatomy in the experimental group compared to the control group ( $p < 0.023$ ).<sup>5</sup> The experimental group had a 44% increase in knowledge compared to a 24% increase in the control group.

Comparing clinical knowledge between groups resulted in a more dramatic change. Again, there was no significant difference of pre-test scores between the groups; however, the control group actually had a reduction in average score between the pre-

and post-tests despite it being the same exam.<sup>5</sup> On the contrary, the experimental group showed a dramatic improvement in average of 35 percentage points. Overall, clinical knowledge decreased by 5% in the control group and increased by 87% in the experimental group ( $p < 0.001$ ).<sup>5</sup>

There were some significant design limitations of this study. First, participants were not randomized. Participants were able to choose if they wanted to be part of the control or experimental group, increasing the potential for selection bias.<sup>5</sup> An additional consequence was the unequal group sizes. The experimental group consisted of 48 participants compared to only 17 in the control group, which increases the probability of significant variability in baseline characteristics between groups and risk of confounding variables.<sup>5</sup>

The student to faculty ratio was different between groups. The ratio for the experimental group was 3:1 while the control group was 17:2.<sup>5</sup> The increased ratio of instructors per student may have facilitated learning and contributed to the results of the study.

In addition to clinical skill, Vogelgesang *et al.*, 2002 also assessed knowledge in their study comparing the effectiveness of three teaching methods to train medical students and residents on aspiration and injection techniques of the knee and shoulder. The three groups included a traditional group that learned the procedures by doing them on patients during their clinical rotation, a lecture group and a combination lecture and hand-on group.<sup>2</sup>

Knowledge was assessed by comparing scores of a pre- and post-intervention test. The investigators decided to use a small sample ( $n = 10$ ) of the sample population to

determine the baseline scores for the entire sample.<sup>2</sup> The mean baseline score on the written knowledge assessment was 32.5 points. Scores of the post-test were compared and the results showed an improvement in every group (Traditional 33.15; Lecture 37.75; Program 37.46).<sup>2</sup> Based on the data, didactic lecture as well as a combination of didactic lecture and hands-on teaching were superior to the traditional way of learning to increase knowledge on knee and shoulder joint aspirations and injections ( $p < 0.05$ ).<sup>2</sup> There was no difference detected comparing didactic lecture to the combination of didactic lecture and hands-on teaching, indicating that one was not superior to the other in regards to improving knowledge.

As previously mentioned, there are a number of limitations to this study that may have skewed the results. The lack of randomization and the possibility that the comparative baseline tests are not representative of the sample may influence the data. Additionally, the sample size used was small ( $n = 34$ ).<sup>2</sup> Sample size directly correlates with the power of a study. A power calculation was not discussed in the article; however, if the study was not powered sufficiently a difference may not be detected even if a difference exists.

Clark *et al.*, 2014's study assessed both general and clinical knowledge of the oral and pharyngeal cancer examination before and after participants were randomized to one of the three teaching methods: video-based, hands-on teaching, or a combination of the two.<sup>3</sup> The results of the study showed that each group scored higher overall on the knowledge post-test and had higher scores in each subset, general knowledge and clinical knowledge. Although scores improved within groups, no significant improvement was detected between the groups.<sup>3</sup> It is difficult to draw conclusions about knowledge from

this study because of the small sample size for similar reasons previously discussed. A follow-up study that is appropriately powered is needed to verify these results.

Keim *et al.*, 2014 also assessed knowledge in their randomized controlled trial comparing the effect of didactic and hands-on teaching to didactic teaching alone on diagnosing an anterior cruciate ligament (ACL) tear using the Lachman test.<sup>4</sup> The investigators assessed knowledge in two different ways. They used a post-test consisting of general knowledge questions and a diagram of which the structures of the knee were to be labeled by the participants as well as a knowledge self-assessment incorporated in a survey. The median score on the post-test in the combined teaching group was 14 (IQR 14-16) compared to a median of 13 (IQR 12-15) in the didactic teaching group. The difference between the groups was significant ( $p < 0.0001$ ).<sup>4</sup>

A survey conducted at the end of the study included a knowledge self-assessment specifically related to the teaching methods. A 5-point Likert scale corresponding with dichotomous scoring of either 1 (strongly agree or agree) or 0 (neutral, disagree, strongly disagree) was used.<sup>4</sup> Participants were asked to answer the following question using the 5-point Likert scale. The first question was for all participants and asked whether the lecture helped them understand the material.<sup>4</sup> Fifty three percent of the lecture only group and 52% of the combination group agreed with this statement.<sup>4</sup> The next question was directed only to the combination group, and asked if the hands-on training session helped them understand the material. Eighty four percent of the participants in that group agreed.<sup>4</sup>

A limitation in the design of this study was the time difference in which the medical students were given the post-test and survey compared to the PA and PT

students. The difference in the schedule for medical students compared to the PA and PT students resulted in the medical students taking the post-test and survey soon after completion of the intervention, whereas, the PA and PT students had to wait a month due to a scheduled holiday break.<sup>4</sup> Not only was a significant difference still found between the groups despite this design limitation, it helped show that the PA and PT students in the hands-on group were able to retain the information they learned.<sup>4</sup> The results of this study are less suspicious than others, because it was powered appropriately at 80%.<sup>4</sup>

### ***Confidence***

We reviewed two studies that looked at the impact of teaching methods on self-reported confidence. Both studies indicated a greater increase in confidence for participants who partook in the combination didactic and hands-on teaching curriculum.

In addition to clinical skill and knowledge, Vogelgesang *et al.*, 2002 also looked at confidence as an outcome of their study. Confidence was measured using a self-assessment scale ranging from 0 (not confident) to 10 (high level of confidence). They reported that confidence in performing a knee or shoulder aspiration or injection improved in all groups.<sup>2</sup> A comparison of confidence between groups indicated that participants in the lecture group and the program group (combination of lecture and hands-on teaching) reported being more confident in performing these techniques than participants in the traditional group (teaching based on patient need during clinical rotation).<sup>2</sup> Confidence levels of participants in the program group were the highest for every procedure but not deemed significant. This again, may be the result of an underpowered study.

Keim *et al.*, 2014 also looked at confidence as a third outcome variable.

Confidence was self-assessed using a traditional 5-point Likert scale that was graded using a dichotomous outcome, 1 (strongly agree or agree) or 0 (neutral, disagree, strongly disagree).<sup>4</sup> The didactic group and the combination didactic and hands-on group reported 18% and 23% confidence in correctly performing the Lachman test, respectively, after the didactic teaching.<sup>4</sup> Participants in the combination group reported a substantial increase and now, 69% of them were confident after attending the hands-on portion of the teaching.<sup>4</sup>

Generally, self-assessed measures are not the most accurate or reliable; however, it may be the only way to directly measure a variable like confidence. For these reasons, a difference in confidence reported between groups was never described as significant or insignificant in either study. Instead, both studies looked at confidence as a secondary outcome and used the results as a predictive measure for the other variables studied (i.e. clinical skill and knowledge).

## **Review of Relevant Methodology**

### ***Study Design***

Our literature search produced few randomized controlled trials (RCTs) comparing hands-on versus didactic teaching. Instead, our search resulted in numerous single-sample studies. Despite many of these studies sharing similar methodology, variables and outcome measures to our proposed study, they were eliminated from our review. The results of most of these studies were based solely on comparing pre- and post-tests within the same group; however, without a control group, a causal relationship could not be deduced; instead, only inferences could be made from the data.

Two of the four studies we reviewed were RCTs. The other two studies did not randomly assign their participants to groups. In one of the studies, participants selected which intervention group they wanted to be apart of based on scheduling.<sup>2</sup> The other study allowed participants to voluntarily choose their groups, resulting in 42 participants in the experimental group compared to only 17 in the control group.<sup>5</sup> The lack of randomization was a major limitation in those studies.

### ***Sample Population***

None of the studies included in our review shared the same population as our study. The sample populations of all the studies we reviewed were composed of students (i.e., Medical, PA, PT), residents or a combination of the two. Using students and/or residents as study participants is a convenient and effective way to compare new teaching models to the current standard used in medical school or residency programs, the appropriateness is dependent upon the content of teaching.

The sample population chosen for our study is specific to emergency department providers, because this is the population for which the content of the teaching will have the most impact. The purpose of our study in not to simply compare two teaching methods, instead, our primary outcome assesses clinical skill specific to diagnosing and treating BPPV.

### ***Sample Size***

Adequate sample size was a considerable limitation of most of the studies we reviewed. An adequate sample is required to sufficiently power a study in order to detect a difference between groups. Two of the studies reported no significant change in knowledge between the experimental and control group; however, the small sample sizes

of these studies may have resulted in insufficient power of the study to detect an actual significant change.<sup>2,3</sup> Only Keim *et al.*, 2014 described how they arrived at their sample size and justified it with 80% power, resulting in more reliable and reproducible data.

### ***Outcome Measures***

Article inclusion criteria for review required at least one of the following outcomes to be studied: Clinical skill, knowledge or confidence. Although each of the articles reviewed used similar methods to assess their outcome variable(s), a validated assessment tool was not used by any of them. All of the studies reviewed as well as our proposed study had to create content-specific assessment tools to measure our respective outcomes. No validated tool exists that can be universally applied to assess one of the aforementioned outcomes. As a result, in the same outcome is measured multiple ways using various study-dependent tools. This is a common problem trying to compare educational-based studies.

Khan and Coomarasamy, 2006, conducted a systematic review to determine the most effective methods of teaching and learning Evidence Based Medicine (EBM) by measuring the following outcomes: knowledge, skills, professional attitudes and behaviors and health outcomes.<sup>6</sup> Their data was compiled and summarized in a Hierarchy of Evidence Based Medicine, where interactive and clinically integrated teaching and learning activities ranked highest, followed by interactive, classroom based teaching and learning activities and didactic but clinically integrated teaching and learning activities, and finally, didactic and classroom or standalone teaching and learning activities ranked last.<sup>6</sup>

The heterogeneity of populations, teaching methods, outcome definitions, assessment tools and study quality among other factors prevented the comparison of effect size between studies.<sup>6</sup> Without establishing a quantifiable and objective measure to rank the effectiveness of the teaching and learning methods between studies, the results of this systematic review were based exclusively on the interpretation by the authors of the original articles. The interpretation of the data is subjective without true comparative analysis.

### ***Confounding Variables***

Prior knowledge and/or experience of study participants are common confounders in education-based studies. In addition, the amount of time elapsed since learning or practicing a skill is also a significant factor. A study population comprising both medical students and residents is very common in studies about medical education, despite the potential heterogeneity between these groups. The years of medical experience that separate a first year medical student and a fourth year resident based on the structure of medical education is substantial. Vogelgesang *et al.*, 2002 reported a negative, but non-significant, correlation between residents and medical students in their performance on both the written and practical examinations administered during the study.<sup>2</sup> There are many variables that may have influenced this result, but the investigators attributed it to the amount of time since the tested material was last taught or reviewed. They argued that the medical students were closer to their anatomy review; whereas, residents most likely have not reviewed anatomy since medical school.<sup>2</sup> Significant differences in clinical skill, knowledge and confidence may even exist between medical students or residents of the same class due to the variability of experience on clinical rotations.

Another common confounding variable is variation in time dedicated to each intervention. In all three of the studies assessing clinical skill, more time was dedicated to the experimental group than the control. A systemic review done by O'Dunn-Orto *et al.*, 2012, showed that four of five studies showed greater improvement of skill, knowledge and/or confidence in interactive, small group learning compared to didactic.<sup>1</sup> The discrepant article was an observational study, which found didactic teaching to be superior for the improvement of skills.<sup>1</sup> It was noted in the review, however, that the didactic group underwent 20 hours of instruction compared to only three hours allotted for the interactive, small group.<sup>1</sup> This variability makes it unclear whether the results were due to the teaching methods or length of instruction time.

### **Conclusion**

The general consensus in the literature is that supplementing a hands-on component with traditional didactic teaching is more effective than didactic teaching alone to improve clinical skill. Confidence was shown to improve as well; however, it was generally used as a predictor variable for the other outcomes rather than a measure in itself. There is conflicting literature as to which teaching method is superior for improving knowledge. Through the literature, a strong predication can be made about the expected direction of the outcome but it remains much more difficult to predict the magnitude of change. The heterogeneity of methodology, variables, measures and outcome definitions make the study data difficult to compare.

## References

1. O'Dunn-Orto A, Hartling L, Campbell S, Oswald AE. Teaching musculoskeletal clinical skills to medical trainees and physicians: A Best Evidence in Medical Education systematic review of strategies and their effectiveness: BEME Guide No. 18. *Med Teach*. 2012/02/01 2012;34(2):93-102.
2. Vogelgesang SA, Karplus TM, Kreiter CD. An instructional program to facilitate teaching joint/soft-tissue injection and aspiration. *J Gen Intern Med*. Jun 2002;17(6):441-445.
3. Clark NPNP. Comparative effectiveness of instructional methods: oral and pharyngeal cancer examination. *Journal of dental education*. 04 2014;78(4):622-629.
4. Keim Janssen SA, VanderMeulen SP, Shostrom VK, Lomneth CS. Enhancement of Anatomical Learning and Developing Clinical Competence of First-Year Medical and Allied Health Profession Students. *Anatomical Sciences Education*. 2014, 2015-02-06 2014;7(3):181-190.
5. Wilson AB, Ross C, Petty M, Williams JM, Thorp LE. Bridging the transfer gap: laboratory exercise combines clinical exposure and anatomy review. *Med Educ*. Aug 2009;43(8):790-798.
6. Khan KS. A hierarchy of effective teaching and learning to acquire competence in evidenced-based medicine. *BMC Med Educ*. 2006;6(1):no-pagination.

## **CHAPTER III: STUDY METHODS**

### **Study Design**

The study design will be a randomized single blind, parallel controlled trial to determine if hands-on teaching is a more effective method than traditional didactic teaching to improve the ability, knowledge and confidence of emergency medicine providers on performing positional maneuvers to diagnose and treat BPPV.

### **Study Population and Sampling**

The target population for this study is medical providers currently working in adult emergency departments. Our source population is limited to providers currently employed by emergency departments affiliated with Yale-New Haven Hospital (YNHH). A simple random sample of the source population will be used to obtain our study population.

To be included in this study, participants must be an attending physician, fellow, resident, PA or APRN who is currently employed and working in an adult emergency department affiliated with Yale-New Haven Hospital. In addition, all participants must provide voluntarily consent prior to the start of the study. Providers not currently employed and working in an adult emergency department affiliated with Yale-New Haven Hospital and students are excluded from participating in this study. Additionally, due to the epidemiology of BPPV, providers primarily working in pediatric emergency departments will also be excluded from the study.

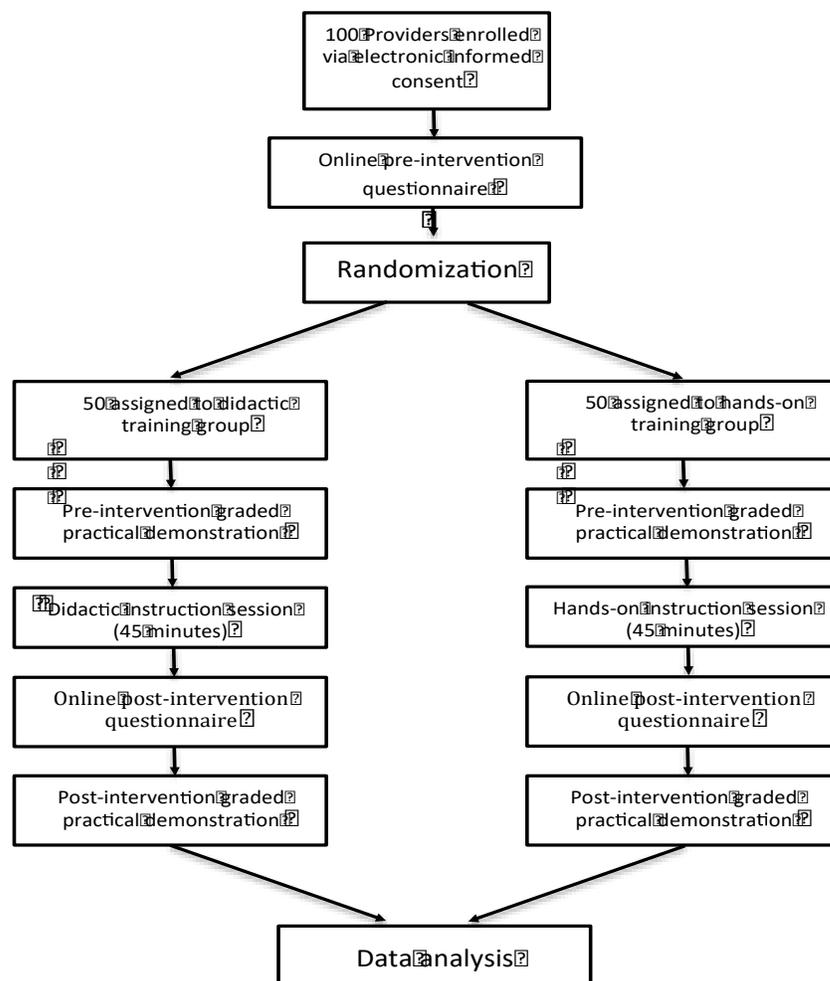
A comprehensive list of the names and email addresses of all emergency medicine providers employed by YNHH will be obtained through the hospital's Human Resources

Department. Those identified will be sent an email containing a brief description of the study, a consent form, and a link to complete the pre-intervention questionnaire (Appendix A). As stated in the consent, completion of the online questionnaire indicates consent to participate in the study. Reminder emails will be sent weekly until we confirm consent from 100 providers. The 100 participants will then be randomly allocated to either the control or intervention group.

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**Figure 2.** Flowchart describing the sequence of the study

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## **Subject Protection and Confidentiality**

Our study meets all criteria for educational research; therefore, we will file for exemption of review for approval by the Institutional Review Board (IRB) at Yale. To file for exemption, we will submit the required application form and checklist. The application will include a goals and description of our study, our source population, the type of data and information we will collect and a copy of our consent form given to our participants. Overall, our study poses little risk to participants and, therefore, will not require continued oversight of the IRB.

The consent form for our study (**Appendix A**) clearly outlines the following: Participation in our study is voluntary and participants can withdraw at any time without penalty. All data and personal information collected during the study will be used for research purposes only. Participant information will not be shared with outside parties nor will any identifiable information be published. There are no conflicts of interest to disclose among any of the investigators involved with this study.

## **Recruitment**

Those who meet the inclusion criteria of the study will be recruited via their Yale-New Haven Hospital email addresses provided by Yale's Human Resources Department. We do not anticipate a problem recruiting providers for this study despite not offering a tangible or monetary incentive to participants. Because our source population is derived from a teaching hospital, participation in research studies is very common and often encouraged. We expect that the educational basis of our study and the minimal time commitment will attract providers who are looking to improve their clinical skills and knowledge.

## **Study Variables and Measures**

The two teaching methods will serve as the independent variables of the study. The experimental group will be a combination of didactic and hands-on teaching, while the control group will consist of only traditional didactic teaching.

For the purpose of this study, didactic teaching for each group will consist of traditional lecture-based teaching with visual supplementation in the form of a PowerPoint presentation lasting about 30 minutes. One lecturer will cover the same content within the allotted time for both the control and experimental group. The groups will differ only in how the DHT and CRP are taught.

The instructors for the control group will teach the DHT and CRP by describing each step of the maneuvers using still images and photos. The experimental group will receive a live demonstration by the instructor using a volunteer and then pair up and demonstrate the maneuvers on each other under the supervision of the instructor. Each group will allotted 15 minutes for this portion of teaching.

**Table 2. Learning Objectives for Each Group**

<i>Upon completion of instruction, participants will:</i>
1. Be able to define 'vertigo.'
2. Know/understand the etiology, epidemiology and pathophysiology of BPPV affecting the posterior canal.
3. Be able to construct a differential diagnosis for a patient presenting with new onset, positional vertigo.
4. Understand what are considered effective and ineffective treatments for BPPV.
5. Know the indications and contraindications to performing the DHT or CRP.
6. Be able to correctly perform the DHT and CRP on a patient.
7. Be able to identify a positive versus a negative DHT.

The dependent variables this study will be measuring include clinical skill, knowledge, and confidence. Each of these variables will be assessed at baseline and after attending the teaching intervention to which the participant will be randomly assigned.

A graded practical demonstration will be conducted to measure clinical skill before teaching instruction (baseline assessment) and after teaching instruction. To our knowledge, no validated tool exists to assess the accuracy and completeness of performing either the DHT or CRP. As a result, we developed our own checklist to objectively assess each participant's clinical skill in performing the maneuvers (**Appendix B**). A patient vignette describing symptoms of BPPV precedes the checklist to indicate the reason for performing the DHT and CRP. The checklist outlines the necessary steps to correctly perform and interpret the DHT and CRP. The checklist is graded based on each step performed correctly by annotating 'yes' or 'no.' The completion of each correct step is equally weighted for a total of 17 potential points. Although not a validated measure, the checklist was developed using the BPPV Clinical Practice Guidelines published in the journal of Otolaryngology–Head and Neck Surgery in 2008.<sup>1</sup>

Again, to our knowledge, no validated tool exists to assess knowledge related to BPPV or the positional maneuvers. We created a pre-intervention questionnaire consisting of 14 questions (**Appendix C**). Questions 1-6 will not be graded but will be used to compare demographics, experience and current practices. Questions 7-13 are multiple-choice and will be used to assess knowledge. These questions cover the pathophysiology, indication, steps and physical findings of the DHT and CRP to diagnose and treat BPPV. Each of the questions to assess knowledge is equally weighted.

Question 14 measures confidence using a self-assessment 5-point Likert scale. Participants are asked how much they agree with the following statement: *I am confident that I can successfully conduct and interpret the Dix-Hallpike Test and perform the Canalith Repositioning Procedure (Epley maneuver) on a patient.* The Likert scale ranges from 1-strongly disagree, 2-disagree, 3-neutral, 4-agree and 5-strongly agree. The number corresponding to the participants' response will be used to numerically quantify the data for analysis.

The post-intervention questionnaire includes the same questions as the baseline questionnaire to assess a change in knowledge and confidence. In addition, two questions have been added to assess overall participant satisfaction with the teaching intervention they received and if they would recommend the training for other emergency department providers (**Appendix D**).

### **Data Collection**

Data for this study will be collected in two different ways. The voluntary consent form as well as the pre- and post-intervention questionnaires will be submitted electronically, whereas the pre- and post-intervention practical demonstration will be graded using the aforementioned standardized checklist.

An online platform will be used for the voluntary consent form as well as the pre- and post-intervention questionnaires. The ability to submit these study requirements online is not only convenient for participants, but allows the pre- and post-questionnaires to be structured in a way to most accurately assess knowledge. The questionnaire contains a series of multiple-choice questions that incrementally assess knowledge using a stepwise approach. The online platform will prevent participants from viewing and/or

changing answers to previous questions once submitted. This will add to the validity of the assessment tool to successfully measure knowledge rather than the participant's ability to find answers within previous questions.

Investigators will use a structured script and standardized checklist to gather data objectively for the pre- and post-intervention graded demonstration. The investigators of this portion of the study will be blinded as to which teaching intervention the participant was randomized.

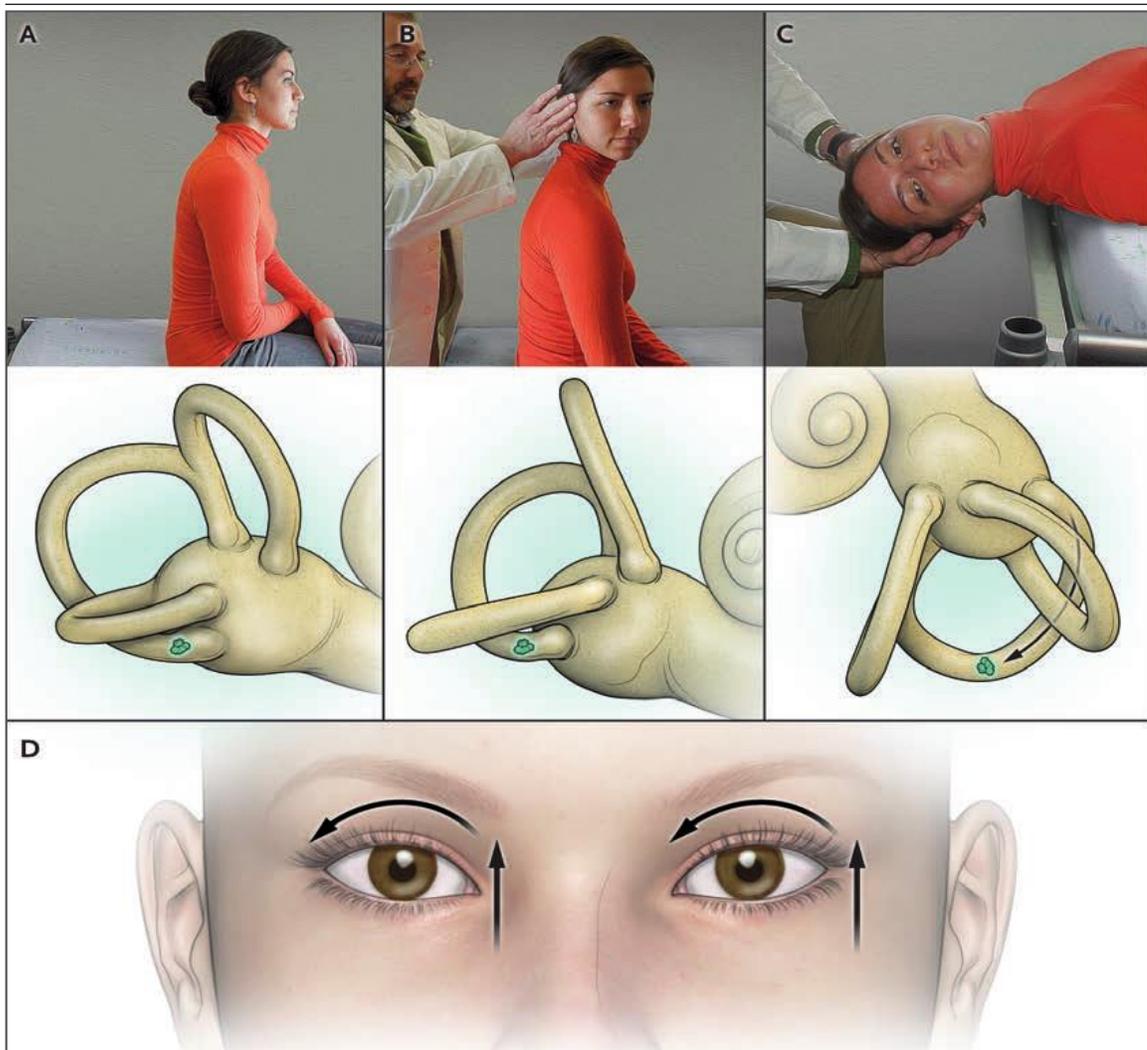
Participants will first receive instructions and be given an opportunity to ask questions prior to entering the exam room. The maneuvers will be conducted on a mock patient who is given specific instructions not to speak, but to only follow the directions of the participant. The investigator will observe the maneuvers through a one-way mirror in a separate room in order to minimize bias and test anxiety among the participants. Communication between the participants and the investigator will be facilitated through a two-way audio system. The demonstration will begin with the investigator reading a brief clinical scenario setting the stage of why the patient presents to the emergency department. At this point, the participant will verbally instruct and assist the volunteer through the maneuvers.

Upon completion of the DHT, the presence and type of nystagmus is the key physical exam finding to determine a positive or a negative test. This exam finding is impossible to accurately reproduce by a mock patient; therefore, the participant will be shown a recorded video of the eyes of a real patient exhibiting one of four possible scenarios. The patient's eyes in the video will either exhibit lateral nystagmus, vertical nystagmus, rotary nystagmus or the absence of nystagmus. At this point in the exam, the

participant will attempt to identify whether the DHT was positive or negative by the type of eye movement shown. No matter if the participant is correct, he or she will then be shown the video exhibiting rotary nystagmus, indicating a positive DHT and instructed to continue by performing the CRP.

**Figure 3. Use of the Dix–Hallpike Maneuver to Induce Nystagmus in Benign Paroxysmal Positional Vertigo Involving the Right Posterior Semicircular Canal.**

“With the patient sitting upright (Panel A), the head is turned 45 degrees to the patient’s right (Panel B). The patient is then moved from the sitting position to the supine position with the head hanging below the top end of the examination table at an angle of 20 degrees (Panel C). The resulting nystagmus would be upbeat and torsional, with the top poles of the eyes beating toward the lower (right) ear (Panel D).”<sup>2</sup> From Kim *et al.*, 2014.



**Figure 4. Epley’s Canalith-Repositioning Maneuver for the Treatment of Benign Paroxysmal Positional Vertigo Involving the Right Posterior Semi-circular Canal.**

“After resolution of the induced nystagmus with the use of the right-sided Dix–Hallpike maneuver (Panels A, B, and C), the head is turned 90 degrees toward the unaffected left side (Panel D), causing the otolithic debris to move closer to the common crus. The induced nystagmus, if present, would be in the same direction as that evoked during the Dix–Hallpike maneuver. The head is then turned another 90 degrees, to a face-down position, and the trunk is turned 90 degrees in the same direction, so that the patient is lying on the unaffected side (Panel E); the otolithic debris migrates in the same direction. The patient is then moved to the sitting position (Panel F), and the otolithic debris falls into the vestibule, through the common crus. Each position should be maintained until the induced nystagmus and vertigo resolve, but always for a minimum of 30 seconds.”<sup>2</sup> From Kim *et al.*, 2014.



**Power Calculation**

We used data from a study conducted by Vogelgesang *et al.*, 2002 to perform our power calculation (**Appendix E**). That particular study was chosen due to the similarities in methodology, independent variables and outcome measures to our study. Using pre- and post-test data from that study, we calculated a mean improvement of 3.58 points on

the practical examination for those assigned to the didactic and hands-on teaching group, compared to those assigned to the didactic teaching alone.<sup>3</sup> These data were used to run a two-tailed t-test for two-independent variables of common variance. We calculated a sample size of 90 participants (45 per group) using 80% power and an alpha level of 0.050 (**Appendix E**). In order to account for anticipated dropout or loss to follow-up, we increased our sample size to 100 study participants.

### **Analysis**

The baseline characteristic data collected from the pre-intervention questionnaire (**Appendix B**) are all categorical variables; therefore, we will use a chi-square test to compare the groups within our sample population. If our randomization process was successful, there will not be any significant differences in baseline characteristics between our experimental and control groups. Significance will be determined by a p-value <0.05.

We will assess clinical skill as the main outcome of our study by comparing the difference in means both within and between groups. Mean scores of the graded demonstration will be calculated for the control and experimental group, both pre- and post-intervention. A paired t-test will be used to compare pre- and post-test differences within each group and a student t-test will be used to compare pre- and post-test differences between groups. An average improvement of 3.6 points or higher in the experimental group compared to the control group will be deemed significant.

A change in knowledge and/or confidence will be analyzed as secondary outcomes using the same statistics.

## **Timeline and Resources**

This study will be broken down into five stages. Phase one will be the recruitment phase. This phase will involve identifying a random sample from a comprehensive list of all emergency medicine providers currently working in an adult emergency department affiliated with YNHH. These providers will be sent an email describing the purpose, goals, and participant requirements of the study as well as a consent form. A single link will be included in the email that will direct the potential participant to the pre-intervention questionnaire (**Appendix A**). Completion of the questionnaire will indicate the participant's informed consent. Additional reminder emails will be sent as needed in order to recruit more providers. Completion of this phase of the study will be dependent upon the time it will take to recruit successfully 100 participants. We anticipate that this phase will take about 1 month. All data collection will be handled by the co-PI for this phase of the study.

Phase two will require participants to complete the pre-intervention graded demonstration. This phase of the study will be conducted at the Yale Center for Medical Simulation (YCMS). The facility will be reserved for two weeks and each participant will be scheduled in overlapping 30-minute blocks in order to complete this portion of the study. Each participant will be required to sign up for a block using an online, shared calendar. Upon arriving at the facility, the first 15 minutes will be dedicated to instruction and questions while participants will have the remaining time to complete the demonstration. The limited number of observation exam rooms as well as participant availability and scheduling will be limiting factors of this phase. We will discuss

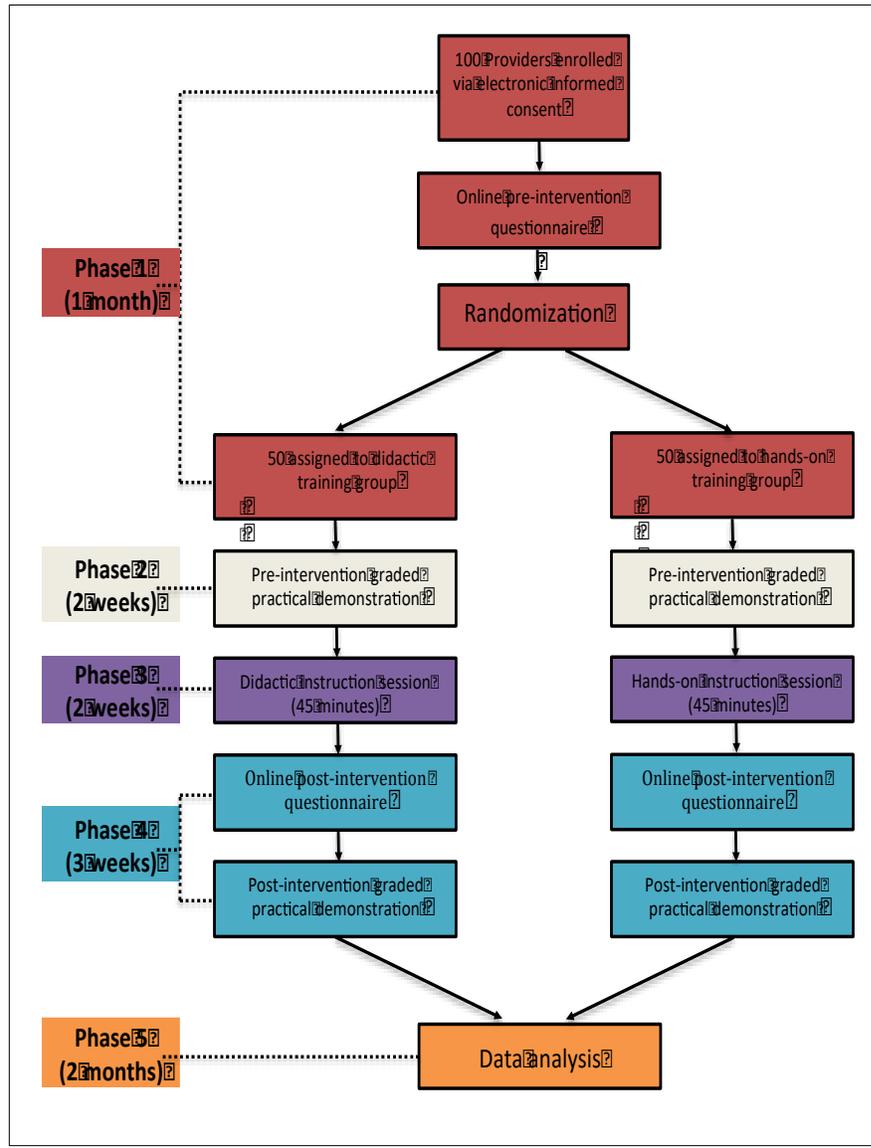
extended availability of the facility in the event that all participants are unable to complete this phase within the scheduled time.

During phase three, participants will attend either the combination didactic and hands-on teaching or the didactic teaching alone depending on which group to which they were randomized. A total of six sessions over a two week period will be scheduled for both the experimental and control group. Participants will be required to confirm their attendance to one of the six sessions via an online, shared calendar. The facility requirements for the control group include a room equipped with the means to project a Powerpoint presentation. Additional requirements for the hands-on teaching group include one stretcher for every two participants.

Phase four will include both the online post-intervention questionnaire and graded demonstration. The online questionnaire will be emailed to participants upon completion of the teaching intervention. Participants will self-schedule the post-intervention demonstration using an online shared calendar and the training will be conducted in the same way as phase two. Completion of this phase concludes the study requirements for the participants.

The final phase of the study is data analysis. This phase will primarily be run by a statistician with close oversight by the PI and co-PI. We have allotted 2 months to organize and analyze the data collected throughout this study.

**Figure 5. Study timeline.**



## References

1. Bhattacharyya NN. Clinical practice guideline: benign paroxysmal positional vertigo. *Otolaryngology--head and neck surgery*. 11 2008;139(5 suppl 4):S47-S81.
2. Kim J-SJS. Clinical practice. Benign paroxysmal positional vertigo. *The New England journal of medicine*. 03 2014;370(12):1138-1147.
3. Vogelgesang SA, Karplus TM, Kreiter CD. An instructional program to facilitate teaching joint/soft-tissue injection and aspiration. *J Gen Intern Med*. Jun 2002;17(6):441-445.

## **CHAPTER IV: CONCLUSION**

### **Advantages and Strengths**

Our study is the first randomized controlled trial comparing the effectiveness of two teaching methods on improving clinical skill, knowledge, and confidence in performing the DHT and CRP. Two major advantages of our study are the design and our effort to control for confounding variables. Our two-sample, randomized controlled trial design allows for strong internal and external validity.

We made a deliberate effort to control for several confounding variables. We purposely designed the training for the experimental and control groups to be identical in content and time, in order to isolate and measure the variable, hands-on versus non-hands-on teaching. We carefully designed our assessment tools to be as objective as possible in order to minimize bias and confounding. Our checklist used to assess the demonstration of the maneuvers was designed using the most up-to-date clinical practice guidelines on BPPV. Blinding investigators during this portion of the study is essential to help control for bias. Additionally, we decided to use the facilities at the Yale Center for Medical Simulation to reduce anxiety among participants by having the investigators observe and communicate with the participants from a separate room during the graded demonstration.

Finally, one strength not to be overlooked is that our experimental teaching method was designed to be flexible, affordable, and practical, in order for it to be easily implemented with minimal resources. Although the goal of our study is to determine if one teaching methods is superior to another, the purpose of our study is to implement this

teaching method to improve the clinical skills of emergency medicine providers on the DHT and CRP.

## **Disadvantages and Limitations**

### ***Study Design Limitations***

Voluntarily recruiting participants for a research study may result in selection bias and threaten the external validity of the study. We attempted to control for this through the careful wording used in our voluntary consent form. All necessary information was included on the consent form for potential participants to make informed decisions on whether or not to enroll in the study, without providing too many details about the study itself. The consent form did not specify the content of the teaching; rather just the methods of teaching that would be compared. We wanted to prevent providers volunteering to improve their skills and understanding of the DHT and CRP while detaching those who feel that they do not require additional training on these maneuvers.

### ***Impact limitations***

A disadvantage of our study is the didactic and hands-on teaching is specific to diagnosing and treating posterior canal BPPV. Although involvement of the posterior canal comprises 85%-95% of all cases, there are instances of horizontal canal involvement.<sup>1</sup> In these rare cases, the DHT and CRP are not effective in diagnosing or treating this type of BPPV.<sup>1</sup> There are also cases in which bilateral canals are affected or even multiple canals can be involved within the same ear. These scenarios are much less common, but pose difficulty in identifying the type of nystagmus present and selecting the appropriate treatment.<sup>2</sup>

Another limitation of our study is that it does not assess retention of clinical skill, knowledge, or confidence over time. The biggest predictor of retention of a new skill is adequate exposure to practicing that skill. This logic is the primary reason we excluded pediatric emergency medicine providers from our study. Benign Paroxysmal Positional Vertigo is very rare in the pediatric population; therefore, exposure would be minimal. Future studies should implement a one-month and six-month follow-up period to assess retention of skills, knowledge, and confidence after the intervention.

The fact that our study is conducted within a single healthcare system in a distinct geographic area may be considered a limitation. We would argue, however, that the source population from which our sample originates is well diversified and representative of emergency medicine providers across the country.

#### ***Statistical or Data Limitations***

The heterogeneity of educational research made it difficult to find a comparable study in design, assessment, and outcomes to ours. As a result, the study data we used to power our study and derive our sample size may not have been ideal. The source study did present statistically significant results; however, the sample size was small and the difference in means between groups may have been under or overestimated. Only a portion of the study sample rather than each participant was used to determine baseline assessment scores. No data were presented in the study to indicate whether or not this subpopulation was representative of the sample. The alternative to basing our sample size and power calculation on potentially skewed data would have been to base them on pure assumption.

A common limitation of educational-based studies, as previously discussed, is the lack of validated assessment tools. No assessment tool exists evaluating the skill, knowledge, and confidence of the DHT and/or CRP. We used similar methods to previous studies to assess our outcome variables; however, the content of those tools was specific to our study. Although, the use of non-validated tools to assess outcome variables may threaten external validity of the study, there were no alternatives.

### **Confounding**

We have identified a number of potential confounding variables, most of which can be controlled for with successful randomization. These confounding variables include prior knowledge and experience and test anxiety among participants.

The use of additional resources by study participants (i.e. textbooks, online resources and videos) is a potential confounder that could skew the data in either direction based on timing. If participants' baseline scores are elevated due to the use of additional resources, the difference in means of pre- and post-intervention scores will be less. Conversely, if a participant uses additional resources to improve their post-intervention scores, the difference in means will be artificially high. Despite the potential consequences of this confounding variable, we believe the likelihood of this occurrence is low due to the lack of incentive for participants to score higher on the assessments.

Another potential confounding variable is the impending variability among participants to complete each phase of the study. Participants are scheduled within the timeframe permitted for each phase based on availability. This method will inherently result in varying lengths of time between the intervention and post-intervention assessments. A participant who completes the post-intervention assessments soon after

completing the intervention may perform better than a participant who has a longer time between the intervention and the assessment. Although unavoidable due to facility limitations and participant availability, we have condensed the time allotted for each phase to ensure completion remains practical, while at the same time, minimizing the variation in time between the intervention and post-intervention assessments.

### **Clinical and Public Health Significance**

Benign Paroxysmal Positional Vertigo is not a rare disease. The lifetime prevalence of BPPV is 2.4% with a one-year incidence of 0.6% and an annual recurrence rate of 15%.<sup>2-4</sup> It is estimated that 8% of all individuals suffering from moderate to severe dizziness/vertigo is due to BPPV. The use of the word ‘benign’ is a misnomer when discussing the implications of this disease.<sup>3</sup> Although symptoms last about two weeks and generally resolve on their own, roughly 86% of patients report being unable to perform daily activities such as going to work, driving a car or even bending over to tie their shoes.<sup>4</sup> Despite undiagnosed and untreated BPPV being associated with increased risk of falls and decreased quality of life, only 8% of patients with BPPV are effectively treated.<sup>1,2,4,5</sup> Survey-based studies of physicians suggest that a lack of clinical skill, knowledge and confidence are to blame for the lack of treatment of this disease.<sup>5,6</sup> The goal of our study was to compare two educational models to teaching the DHT and CRP and address these shortcomings.

The outcome of this study will determine if hands-on teaching is more effective to improve the clinical skill of emergency medicine providers in performing the DHT and CRP used to diagnose and treat BPPV compared to the standard didactic instructional method currently used.

If our hypothesis is supported, the replication and implementation of our combined didactic and hands-on teaching may be generalized to all adult emergency medicine physicians, fellows, residents and mid-level providers. The next step would be to pilot this teaching method with both primary care providers and students.

If our teaching method proves successful among these populations, widespread implementation may begin to address the most concerning and overarching problems of increased healthcare costs, length of stay, unnecessary testing and/or radiation exposure and overall outcomes of patients with dizziness.

## References

1. Bhattacharyya NN. Clinical practice guideline: benign paroxysmal positional vertigo. *Otolaryngology--head and neck surgery*. 11 2008;139(5 suppl 4):S47-S81.
2. Kim J-SJS. Clinical practice. Benign paroxysmal positional vertigo. *The New England journal of medicine*. 03 2014;370(12):1138-1147.
3. Kerber KA. Benign paroxysmal positional vertigo: opportunities squandered. *Ann N Y Acad Sci*. Apr 2015;1343(1):106-112.
4. von Brevern MM. Epidemiology of benign paroxysmal positional vertigo: a population based study. *Journal of neurology, neurosurgery and psychiatry*. 07 2007;78(7):710-715.
5. Polensek SHS. The challenges of managing vestibular disorders: a qualitative study of clinicians' experiences associated with low referral rates for vestibular rehabilitation. *International journal of clinical practice (Esher)*. 11 2009;63(11):1604-1612.
6. Kene MVMV. Emergency Physician Attitudes, Preferences, and Risk Tolerance for Stroke as a Potential Cause of Dizziness Symptoms. *The western journal of emergency medicine*. 09 2015;16(5):768-776.

## Appendix A: Online Consent Form

Dear potential study participant,

You are being asked to be in a research study to compare the effectiveness of two teaching methods. You were selected as a possible participant because you were identified as an emergency medicine provider (attending, resident, fellow, PA or APRN) currently working in an adult emergency department affiliated with Yale-New Haven Hospital. We ask that you read this form and respond to this email with any questions before agreeing to be in the study.

The purpose of the study is to determine whether a combination of didactic and hands-on teaching is more effective than traditional didactic teaching alone to improve clinical skills.

If you agree to be in this study, you will be asked to do the following things:

- Complete a brief pre-intervention and post-intervention questionnaire
- Perform a clinical on a mock patient before and after formal teaching
- Attend a 45-minute clinical skill training session taught using either a combination of didactic and hands-on teaching or traditional didactic teaching alone.

Your participation in this research is strictly voluntary. You may refuse to take part in the study *at any time* without affecting your relationship with the investigators of this study, Yale University or Yale-New Haven Hospital. Your decision will not result in any loss or benefits to which you are otherwise entitled. You have the right not to answer any single question, as well as to withdraw completely from the study at any point during the process. Please note that all data will be used for research purposes only and will be strictly confidential. No one will ever associate your individual responses with your name.

**Your completion and submission of the questionnaire indicate your consent to participate in this research study.**

Please click here to [Take the Questionnaire](#).

If you have questions about your rights as a research subject, you may contact the Office for Human Research Protection Program, Human Subjects Committee, located at 25 Science Park, 3<sup>rd</sup> Floor, 150 Munson Street or via mail at PO box 208327, New Haven CT 06520-8327, (203) 785-4688, [human.subjects@yale.edu](mailto:human.subjects@yale.edu).

Thank you for participating in this important research project.

Sincerely,

John D'Agata, PA-SII  
Class of 2016  
Yale Physician Associate Program  
Co-Principal Investigator

Elias Michaelides, MD  
Associate Professor  
Pediatric Otolaryngology  
Principal Investigator

## Appendix B: Graded Demonstration Checklist

A 55 year-old female with no significant past medical history presents with episodic vertigo for the past 2 weeks. She had an initial episode of vertigo while lying down in bed and rolling over from her right to left side. She states that the vertigo “woke me up” and is described as a “room spinning” sensation. The episode lasted for seconds and resolved with keeping her head completely still. She had mild nausea, however no vomiting. The vertigo returned when she attempted to get out of bed to go the bathroom and worsened when she went to lie back down in bed. She also had episodes of vertigo when looking up and while bending over to put on her shoes. She has no symptoms with sitting. She denies any other focal, motor, sensory, or cranial nerve complaints associated with her vertigo. The patient denies any drug allergies and is not taking any medication. She denies tobacco, alcohol, or recreational drug use. Her exam is unremarkable and without any focal findings. You suspect this patient has right-sided posterior canal BPPV. Please demonstrate how you will attempt to diagnose and treat this condition using the Dix-Hallpike and Canalith Repositioning Procedure (Epley maneuver).

PROCEDURE	YES	NO
<b>Performing the Dix-Hallpike Diagnostic Procedure</b>		
1. Did the patient start in the upright/seated position on the exam table/bed?		
2. Did the examiner assist/instruct the patient to turn their head 45 degrees toward the RIGHT (affected side)?		
3. Did the examiner instruct the patient to keep their eyes open during the next maneuver?		
4. Did the examiner maintain the patient's head in the 45 degree position while quickly lowering the patient to the supine position, right ear down?		
5. Did the examiner assist/instruct the patient to slightly extend their neck (about 20 degrees)?		
6. After watching the video clip, did the examiner correctly identify whether the test was positive or negative?		
<b>Performing the Canalith Repositioning Procedure (Epley Maneuver)</b>		
7. Did the patient start in the upright/seated position on the exam table/bed?		
8. Did the examiner assist/instruct the patient to turn their head 45 degrees toward the RIGHT (affected side)?		
9. Did the examiner instruct the patient to keep their eyes open during the next maneuver?		
10. Did the examiner maintain the patient's head in the 45 degree position while quickly lowering the patient to the supine position, right ear down?		
11. Did the examiner assist/instruct the patient to slightly extend their neck (about 20 degrees)?		
12. Did the examiner have the patient remain in that position for 20-30 seconds?		
13. Did the examiner assist/instruct the patient to turn their head 90 degrees toward the unaffected side?		
14. Did the examiner have the patient remain in that position for about 20 seconds?		
15. Did the examiner assist/instruct the patient to reposition their body to the right lateral decubitus position in order to rotate their head another 90 degrees to the right such that the patient's head is nearly in the facedown position?		
16. Did the examiner have the patient remain in that position for 20-30 seconds?		
17. Did the examiner assist/instruct the patient to return to their original upright/sitting position?		
<b>Total 'Yes'</b>		

/17

Adapted from Bhattacharyya *et al.*, 2008.

## Appendix C: Pre-Intervention Questionnaire

Please answer the following questions to the best of your ability without the use of additional resources.

1. I am a(n):

- Attending
- Resident
- Fellow
- APRN
- PA

2. How many years have you worked in your current capacity as a healthcare provider?

- Less than 1 year
- 1-5 years
- 6-10 years
- Greater than 10 years

3. How many patients have you diagnosed with Benign Paroxysmal Positional Vertigo (BPPV) in the Emergency Department?

- 0
- 1-5
- 6-10
- More than 10

4. Have you ever performed the Dix-Hallpike test or Canalith Repositioning Procedure (Epley maneuver) on a patient?

- Yes
- No

5. Have you been trained in the Dix-Hallpike test or Canalith Repositioning Procedure (Epley maneuver) for treating BPPV?<sup>1</sup>

- Yes
- No

6. Have you treated BPPV patients with medications?<sup>1</sup>

- Yes
- No

7. All of the following are true regarding BPPV, EXCEPT:
- Most often occurs after age 40
  - Head trauma predisposes to BPPV
  - Follows an attack of vestibular neuritis
  - Male are affected more than females
8. What is the cause of vertigo associated with BPPV?
- Decreased amount of endolymph present in the inner ear
  - Otoconia present in one of the semicircular canals
  - Tumor pressing on cranial nerve VIII
  - Interruption of blood flow to the saccule of the inner ear
9. Which of the following is most beneficial to diagnose BPPV?
- MRI of the Brain
  - CT of head and Neck
  - Lumbar puncture
  - Dix-Hallpike Test
10. Which of the following determines a positive Dix-Hallpike test?
- Dizziness
  - Nystagmus
  - Tinnitus
  - Headache
11. Which type of nystagmus will the Canalith Repositioning Procedure (Epley maneuver) treat?
- Lateral nystagmus
  - Vertical nystagmus
  - Rotary nystagmus
  - All types of nystagmus
12. Rotary nystagmus is indicative of BPPV involving which canal?
- Posterior Canal
  - Horizontal Canal
  - Vertical Canal
  - Anterior Canal
13. Contraindications to performing the Dix-Hallpike test or Canalith Repositioning Procedure (Epley maneuver) include which of the following?<sup>2</sup>

- Severe disease of the cervical spine
- Unstable cardiac disease
- High-grade carotid stenosis
- All of the above

14. I am confident that I can successfully conduct and interpret the Dix-Hallpike Test and perform the Canalith Repositioning Procedure (Epley maneuver) on a patient.

- 1 Strongly Disagree
- 2 Disagree
- 3 Neutral
- 4 Agree
- 5 Strongly Agree

**References:**

1. Bashir K, Alessai GS, Salem WA, Irfan FB, Cameron PA. Physical maneuvers: effective but underutilized treatment of benign paroxysmal positional vertigo in the ED. *The American Journal of Emergency Medicine.* 1// 2014;32(1):95-96.
2. Koelliker PP. Benign paroxysmal positional vertigo: diagnosis and treatment in the emergency department--a review of the literature and discussion of canalith-repositioning maneuvers. *Annals of emergency medicine.* 03 2001;37(4):392.

**Answers:** (7) Male are affected more than females (8) Otoconia present in one of the semicircular canals (9) Dix-Hallpike Test (10) Nystagmus (11) Rotary nystagmus (12) Posterior Canal (13) All of the above

## Appendix D: Post-Intervention Questionnaire

Please answer the following questions to the best of your ability without the use of additional resources.

1. All of the following are true regarding BPPV, EXCEPT:
  - Most often occurs after age 40
  - Head trauma predisposes to BPPV
  - Follows an attack of vestibular neuritis
  - Male are affected more than females
  
2. What is the cause of vertigo associated with BPPV?
  - Decreased amount of endolymph present in the inner ear
  - Otoconia present in one of the semicircular canals
  - Tumor pressing on cranial nerve VIII
  - Interruption of blood flow to the saccule of the inner ear
  
3. Which of the following is most beneficial to diagnose BPPV?
  - MRI of the Brain
  - CT of head and Neck
  - Lumbar puncture
  - Dix-Hallpike Test
  
4. Which of the following determines a positive Dix-Hallpike test?
  - Dizziness
  - Nystagmus
  - Tinnitus
  - Headache
  
5. Which type of nystagmus will the Canalith Repositioning Procedure (Epley maneuver) treat?
  - Lateral nystagmus
  - Vertical nystagmus
  - Rotary nystagmus
  - All types of nystagmus
  
6. Rotary nystagmus is indicative of BPPV involving which canal?
  - Posterior Canal
  - Horizontal Canal
  - Vertical Canal

- Anterior Canal

7. Contraindications to performing the Dix-Hallpike test or Canalith Repositioning Procedure (Epley maneuver) include which of the following?<sup>1</sup>

- Severe disease of the cervical spine
- Unstable cardiac disease
- High-grade carotid stenosis
- All of the above

8. I am confident that I can successfully conduct and interpret the Dix-Hallpike Test and perform the Canalith Repositioning Procedure (Epley maneuver) on a patient.

- 1 Strongly Disagree
- 2 Disagree
- 3 Neutral
- 4 Agree
- 5 Strongly Agree

9. I am satisfied with the training I received.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

10. I would recommend this training for all emergency medicine providers.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

**References:**

1. Koelliker PP. Benign paroxysmal positional vertigo: diagnosis and treatment in the emergency department--a review of the literature and discussion of canalith-repositioning maneuvers. *Annals of emergency medicine*. 03 2001;37(4):392.

**Answers:** (1) Male are affected more than females (2) Otoconia present in one of the semicircular canals (3) Dix-Hallpike Test (4) Nystagmus (5) Rotary nystagmus (6) Posterior Canal (7) All of the above

## Appendix E: Power Calculation

Power and Precision 4 - [t-test for two independent samples with common variance]						
Group	Population Mean	Standard Deviation	N per Group	Standard Error	95% Lower	95% Upper
Didactic+Hands-On Mean Change from Baseline	7.8	6.0	45			
Didactic Mean Change from Baseline	4.2	6.0	45			
<b>Mean Difference</b>	3.6	6.0	90	1.26	1.10	6.10
Alpha= 0.050, Tails= 2				Power	<input type="text" value="80%"/>	

Power calculation conducted using Power and Precision Analysis Software (Biostat, Englewood, NJ, 4.0)

## **BIBLIOGRAPHY**

- Bashir K, Alessai GS, Salem WA, Irfan FB, Cameron PA. Physical maneuvers: effective but underutilized treatment of benign paroxysmal positional vertigo in the ED. *The American Journal of Emergency Medicine*. 1// 2014;32(1):95-96.
- Bhattacharyya NN. Clinical practice guideline: benign paroxysmal positional vertigo. *Otolaryngology--head and neck surgery*. 11 2008;139(5 suppl 4):S47-S81.
- Bloom BSBS. Effects of continuing medical education on improving physician clinical care and patient health: a review of systematic reviews. *International journal of technology assessment in health care*. 2005;21(3):380-385.
- Cappello MM. Dizziness and vertigo in a department of emergency medicine. *European journal of emergency medicine*. 12 1995;2(4):201.
- Chang AK. A Randomized Clinical Trial to Assess the Efficacy of the Epley Maneuver in the Treatment of Acute Benign Positional Vertigo. *Academic emergency medicine*. 09 2004;11(9):918-924.
- Clark NPNP. Comparative effectiveness of instructional methods: oral and pharyngeal cancer examination. *Journal of dental education*. 04 2014;78(4):622-629.
- Epley JM. The canalith repositioning procedure: for treatment of benign paroxysmal positional vertigo. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery*. Sep 1992;107(3):399-404.
- Fife TDT. Practice parameter: therapies for benign paroxysmal positional vertigo (an evidence-based review): report of the Quality Standards Subcommittee of the American Academy of Neurology. *Neurology*. 05 2008;70(22):2067-2074.
- Froehling DAD. The canalith repositioning procedure for the treatment of benign paroxysmal positional vertigo: a randomized controlled trial. *Mayo Clinic proceedings*. 07 2000;75(7):695-700.
- Furman JM, Cass SP. Benign paroxysmal positional vertigo. *The New England journal of medicine*. Nov 18 1999;341(21):1590-1596.
- Hogue JD. Office Evaluation of Dizziness. *Primary Care: Clinics in Office Practice*. 6// 2015;42(2):249-258.
- Keim Janssen SA, VanderMeulen SP, Shostrom VK, Lomneth CS. Enhancement of Anatomical Learning and Developing Clinical Competence of First-Year Medical and Allied Health Profession Students. *Anatomical Sciences Education*. 2014, 2015-02-06 2014;7(3):181-190.
- Kene MVMV. Emergency Physician Attitudes, Preferences, and Risk Tolerance for Stroke as a Potential Cause of Dizziness Symptoms. *The western journal of emergency medicine*. 09 2015;16(5):768-776.
- Kerber KA. Benign paroxysmal positional vertigo: opportunities squandered. *Ann N Y Acad Sci*. Apr 2015;1343(1):106-112.
- Kerber KAKA. Use of BPPV processes in emergency department dizziness presentations: a population-based study. *Otolaryngology--head and neck surgery*. 03 2013;148(3):425-430.
- Khan KS. A hierarchy of effective teaching and learning to acquire competence in evidenced-based medicine. *BMC Med Educ*. 2006;6(1):no-pagination.

- Kim J-SJS. Clinical practice. Benign paroxysmal positional vertigo. *The New England journal of medicine*. 03 2014;370(12):1138-1147.
- Koelliker PP. Benign paroxysmal positional vertigo: diagnosis and treatment in the emergency department--a review of the literature and discussion of canalith-repositioning maneuvers. *Annals of emergency medicine*. 03 2001;37(4):392.
- Li JCJ. Cost-effective management of benign positional vertigo using canalith repositioning. *Otolaryngology--head and neck surgery*. 03 2000;122(3):334.
- Neuhauser HK, Lempert T. Vertigo: Epidemiologic Aspects. *Semin Neurol*. // 15.10.2009 2009;29(05):473-481.
- O'Dunn-Orto A, Hartling L, Campbell S, Oswald AE. Teaching musculoskeletal clinical skills to medical trainees and physicians: A Best Evidence in Medical Education systematic review of strategies and their effectiveness: BEME Guide No. 18. *Med Teach*. 2012/02/01 2012;34(2):93-102.
- Polensek SHS. The challenges of managing vestibular disorders: a qualitative study of clinicians' experiences associated with low referral rates for vestibular rehabilitation. *International journal of clinical practice (Esher)*. 11 2009;63(11):1604-1612.
- Rising Annual Costs of Dizziness Presentations to U.S. Emergency Departments. *Academic emergency medicine*.20:689.
- Saber Tehrani ASAS. Rising annual costs of dizziness presentations to U.S. emergency departments. *Academic emergency medicine*. 07 2013;20(7):689-696.
- Sacco RR, Burmeister DB, Rupp VA, Greenberg MR. Management of Benign Paroxysmal Positional Vertigo: A Randomized Controlled Trial. *The Journal of Emergency Medicine*. 4// 2014;46(4):575-581.
- Stanton VA, Hsieh YH, Camargo CA, Jr., et al. Overreliance on symptom quality in diagnosing dizziness: results of a multicenter survey of emergency physicians. *Mayo Clinic proceedings*. Nov 2007;82(11):1319-1328.
- Vogelgesang SA, Karplus TM, Kreiter CD. An instructional program to facilitate teaching joint/soft-tissue injection and aspiration. *J Gen Intern Med*. Jun 2002;17(6):441-445.
- Von Brevern M. Benign paroxysmal positional vertigo: current status of medical management. *Otolaryngology--head and neck surgery*. 03 2004;130(3):381-382.
- Von Brevern MM. Epidemiology of benign paroxysmal positional vertigo: a population based study. *Journal of neurology, neurosurgery and psychiatry*. 07 2007;78(7):710-715.
- Wilson AB, Ross C, Petty M, Williams JM, Thorp LE. Bridging the transfer gap: laboratory exercise combines clinical exposure and anatomy review. *Med Educ*. Aug 2009;43(8):790-798.
- Wipperman J. Dizziness and Vertigo. *Primary Care: Clinics in Office Practice*. 3// 2014;41(1):115-131.