

IMPROVING THE DIAGNOSIS AND MANAGEMENT OF BENIGN PAROXYSMAL
POSITIONAL VERTIGO IN A RURAL HEALTHCARE SETTING

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ABSTRACT

Benign paroxysmal positional vertigo (BPPV) is a condition characterized by brief spinning episodes that occur with a rapid change in head position. Although considered benign, BPPV can have many personal, social, health, and financial implications. Yet, providers in a variety of settings are frequently mismanaging the condition leading to incomplete resolution of symptoms, decreased quality of life, reduced productivity, and increased healthcare spending.

This study sought to better understand why providers fail to follow current evidence-based BPPV guidelines and the impact BPPV-specific education could have on improving their practices. Questionnaires assessing BPPV-specific knowledge as well as inquiring about provider barriers to following guidelines were distributed to 11 providers in a rural Colorado mountain town. A 45-minute education session was then presented to providers in order to update them on current recommendations. Following the education, similar questionnaires reassessing provider knowledge of BPPV guidelines were disseminated. Results showed an improvement in provider knowledge as evidenced by an increase in the percentage of correct response scores following the education session compared to pre-education. Additionally, providers identified difficulty in interpreting nystagmus patterns as well and remembering how to perform the various maneuvers as major barriers to guidelines adherence. Future BPPV education should focus on these two barriers to ensure better guidelines adherence.

In order to evaluate long-term practice changes following the intervention, a 16-month retrospective chart analysis was performed in a small rural emergency department where three of the participating providers from the education session worked. Results from the chart analysis were inconclusive due to a scarcity of patient encounters during the post-intervention period. Future studies should be performed with a larger participation pool and longer analysis period to

better evaluate the effectiveness of BPPV-specific education on improving provider practices.

The ultimate goals of providing BPPV education are to promote a quicker resolution of patient's symptoms, improve their quality of life, reduce unnecessary healthcare spending, while still allowing for appropriate provider compensation.

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DEDICATION

This dissertation project is dedicated to my fiancé Jordan Flage. Jordan, without your love, patience, and unconditional support, I could not have survived this demanding program. Thank you for being there every step of the way. I would also like to make a dedication to my future in-laws who were an integral part of this whole process. Lon and Lynette Flage, thank you for feeding me, housing me, and providing me transportation even when the weather was less than optimal. I could not have completed this program without you. It truly does take a village.

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LIST OF ABBREVIATIONS

AAO-HNS.....	American Academy of Otolaryngology- Head and Neck Surgery
AC-BPPV.....	Anterior Canal Benign Paroxysmal Positional Vertigo
BPPV	Benign Paroxysmal Positional Vertigo.
CRM.....	Canalith Repositioning Maneuvers
CT.	Computerized Tomography
CPT	Current Procedural Terminology
DHM	Dix-Hallpike Maneuver
DNP	Doctor of Nursing Practice
EMR.....	Electronic Medical Record
GABA	Gamma-Amino Butyric Acid
HINTS.....	Head Impulse Nystagmus Test of Skew
ICD-10	International Statistical Classification of Diseases-10
IRB.....	Institutional Review Board
LC-BPPV	Lateral Canal Benign Paroxysmal Positional Vertigo
MRI.....	Magnetic Resonance Imaging
NDSU.....	North Dakota State University
PC-BPPV	Posterior Canal Benign Paroxysmal Positional Vertigo
SRT	Supine Roll Test

CHAPTER ONE. INTRODUCTION

Background and Significance

The term positional vertigo is used to describe brief spinning episodes that occur with a rapid change in head position (Bhattacharyya et al., 2017; Hilton & Pinder, 2014; Hunt, Zimmermann, & Hilton, 2012). When these episodes occur repeatedly, the condition is formally referred to as benign paroxysmal position vertigo or BPPV (Bhattacharyya et al., 2017). BPPV is one of the most common peripheral vestibular disorders with a lifetime prevalence of 2.4% and a one-year incidence of 0.6%. BPPV occurs twice as often in women than in men and its prevalence increases with age (von Brevern et al., 2007). Most cases are idiopathic, however, the female gender, advanced age, osteoporosis, head trauma, and a history of underlying inner-ear disorders may predispose an individual to BPPV development (Yang, Kim, Lee, & Park, 2017).

BPPV is often considered benign due to the self-limiting nature of the condition as well as the lack of central nervous system involvement. However, BPPV also has many personal, social, and health implications (Neuhauser et al., 2008). Additionally, the diagnosis and treatment of BPPV places a significant financial burden on our healthcare system, with an estimated cost of \$2684.74 per affected individual (Li, Li, Epley, & Weinberg, 2000). As a result, the American Academy of Otolaryngology- Head and Neck Surgery (AAO-HNS) created guidelines to assist clinicians in the accurate diagnosis and treatment of BPPV (Bhattacharyya et al., 2017). Yet, many providers in a variety of settings continue to treat BPPV improperly partially due to a lack of familiarity with current recommendations and limited experience in performing the diagnostic and canalith repositioning maneuvers (CRM) (Kerber et al., 2017; Meurer et al., 2018). With improper management, BPPV sufferers may experience an incomplete resolution of symptoms,

decreased quality of life and reduced productivity while leading to an overall increase in healthcare spending (Benecke, Agus, Kuessner, Goodall, & Strupp, 2013)

Problem Statement

Research has implicated lack of provider familiarity with and experience in BPPV management as a major barrier to guideline adherence. Therefore, providing BPPV-specific education may increase provider confidence and encourage evidence-based practices (Bhattacharyya et al., 2017). As a result, a practice improvement project was implemented in a small rural mountain town for local emergency, specialist, and primary care providers to better familiarize them with current evidence-based BPPV guidelines and improve their confidence and self-efficacy in performing diagnostic and repositioning maneuvers.

Purpose

The purpose of this project was to educate rural providers regarding current evidence-based guidelines on the diagnosis and management of BPPV in order to increase guideline adherence and develop provider self-efficacy with hopes of improving patient outcomes.

Objectives

- Develop and deliver an education session on BPPV diagnosis and management to local emergency, specialist, and primary care providers in a rural Colorado mountain town
- Compile and distribute printed illustrations of the Dix-Hallpike Maneuver (DHM), Supine Roll Test (SRT), Epley and Lempert maneuvers, and a dizziness algorithm for clinicians to use as a reference in practice
- Disseminated pre-and post-education questionnaires to assess BPPV- specific knowledge, comparing scores following the education to pre-education scores

- Perform a 12-month pre-intervention retrospective chart analysis on emergency department patients in a rural Colorado hospital to assess for frequency of the DHM, radiographic imaging, CRMs, and the prescription of vestibular suppressant medication in patients with a discharge diagnosis of vertigo, BPPV, and/or peripheral vertigo.
- Perform a 4-month post-intervention retrospective chart analysis on emergency department patients in a rural Colorado hospital to assess for frequency of the DHM, radiographic imaging, CRMs, and the prescription of vestibular suppressant medication in patients with a discharge diagnosis of vertigo, BPPV, and/or peripheral vertigo.

CHAPTER TWO. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Literature Review

Anatomy and Physiology of the Inner Ear

The inner ear houses the peripheral vestibular system of body. This system functions to maintain balance, equilibrium, and proprioception which allows for control of body posture and coordinated eye movement (Casale & Gupta, 2018). There are multiple structures of significance involved in the peripheral vestibular system some of which include the three semicircular canals and their respective cristae and cupulae. The semicircular canals are the main structures involved in angular acceleration or rotational movement and include the anterior, lateral/horizontal, and posterior semicircular canals that are positioned orthogonally to one another to detect head movement in a three-dimensional plane (Hilton & Pinder, 2014; Hunt et al., 2012). The canals contain a membranous layer comprised of a highly potassium-rich fluid known as endolymph. The movement of endolymph, as seen with rotational head movement, produces pressure on the crista, a structure enveloping hair bundles and nerve fibers within a gelatinous medium known as the cupula located proximally to each semicircular canal (Casale, & Gupta, 2018). The stimulation of hair cells and nerve fibers creates an impulse that is sent through the vestibular nerves, combines with the cochlear nerve, and enters the brain at the brainstem (Casale, & Gupta, 2018; Hilton & Pinder, 2014; Hunt et al., 2012). When the rotational acceleration ceases, the hair cells return to their normal position in preparation for further sensory impulses (Casale, & Gupta, 2018).

Additional structures involved in the vestibular system include the utricle and saccule located proximal to the canals. These two structures allow for the detection of tilting and linear acceleration/deceleration movements, with the utricle detecting horizontal movement and the

sacculle detecting vertical movement (Casale, & Gupta, 2018). Both organs contain an epithelium known as the macula which contains sensory hair cells imbedded in a gelatinous membrane known as the otolithic membrane. Atop of the membrane is a cluster of calcium carbonate crystals that are commonly referred to as otoliths. The collection of otoliths makes the otolithic membrane significantly heavier than its surrounding structures. This weight discrepancy makes the membrane shift in response to tilting of the head, stimulating the hair cells within the membrane, and beginning the cascade of nerve impulses to the brain. These impulses provide the brain information as to where the head is in space (Purves et al., 2001).

Pathophysiology of BPPV

The exact cause of BPPV is not fully understood, however, two main theories on BPPV pathogenesis exist. The first theory describes a phenomenon known as canalithiasis, when either an otolith or particles of an otolith (otoconia) dislodge from the utricle or sacculle and enter into one of the three semicircular canals. The presence of otolith within a canal causes abnormal inertial changes to the endolymph, inappropriately activating the hair cells and subsequent nerve fibers within the cupula, and creating the sensation of movement (Chen, Cho, Lee, & Hu, 2018; González-Aguado, Domènech-Vadillo, de Sande, Guerra-Jiménez, & Domínguez-Durán, 2018; Hunt et al., 2012). These inertial changes seen with BPPV explain why symptoms are generally felt after rapid head repositioning versus while at rest. The second theory is known as cupulolithiasis which hypothesizes that otoconia dislodge from the utricle or sacculle, similarly to the canalithiasis theory, but adhere to the cupula instead of flowing freely within the endolymph. This increase in density makes the cupula more sensitive to gravity and more easily displaced. The displacement of the cupula causes an increase in endolymph movement and the subsequent activation of hair fibers and nerve cells producing vertiginous symptoms (Chen et al., 2018;

Rodrigues, Ledesma, de Oliveira, & Bahamad Júnior, 2018; von Brevern et al., 2007). Of the two theories, the canalithiasis theory appears to be the more widely accepted given that repositioning maneuvers, used to replace floating otoconia back onto the utricle/sacculle, have been found to be successful (Balatsouras, Koukoutsis, Fassolis, Moukos, & Apris, 2018).

Presentation and Differential Diagnoses

BPPV typically presents with a sudden onset of instability and/or spinning following a rapid change in head position. Patients commonly describe feeling fine upon awakening but became symptomatic after rolling over in bed. BPPV episodes generally last less than one minute and can occur multiple times per day for days, weeks, or even months. BPPV may or may not have associated nausea and vomiting and will not present with hearing loss or tinnitus (Bhattacharyya et al., 2017; Chen et al., 2018; Hilton & Pinder, 2014; Hunt et al., 2012; Talmud, & Edemekong, 2019). BPPV has no other associated neurological findings including sensory, motor, or cerebellar deficits such as ataxia (Abes et al., 2011; Bhattacharyya et al., 2017). Finally, symptomatic BPPV generally tests positive on the DHM as evidence by torsional upward-beating nystagmus on the affected side in posterior canal BPPV or horizontal nystagmus seen during the SRT in lateral canal involvement (Bhattacharyya et al., 2017; Perez-Vasquez, & Franco- Gutierrez, 2017).

Several other benign disorders can mimic BPPV and, therefore, symptoms should be thoroughly investigated. Vertigo that has a gradual onset and involves persistent spinning regardless of head movement is inconsistent with the diagnosis of BPPV. Some benign conditions to consider with this presentation include labyrinthitis or vestibular neuritis especially in the presence of a viral prodrome (Abes et al., 2011; Bhattacharyya et al., 2017). The two can be further distinguished by the presence of hearing loss or tinnitus which is consistent with

acoustic nerve involvement suggesting labyrinthitis. In the absence of a viral prodrome, Meniere's disease and acoustic neuroma should be on the differential (Abes et al., 2011). Migraines should be considered as a cause of vertigo in individuals who have a migraine history and have other migrainous symptoms including unilateral headache, photo/phonophobia, and preceding aura in at least half of the vertiginous episodes (Bhattacharyya et al., 2017; Labuguen, 2006). Finally, cervicogenic vertigo can be distinguished by the onset of vertigo with turning or tilting of the neck and is usually caused by faulty somatosensory inputs or vascular compression related to cervical degeneration or injury (Abes et al., 2011; Bhattacharyya et al., 2017; Hunt et al., 2012; Labuguen, 2006).

When individuals present with persistent vertigo, serious etiologies such as a cerebellar stroke, multiple sclerosis, and tumors also need to be considered. This is especially the case in the setting of other neurological deficits in which case a more comprehensive assessment such as the HINTS (Head Impulse, Nystagmus, and Test of Skew) exam may be indicated (Abes et al., 2011; Talmud, & Edemekong, 2019). Specifically, the presence of severe imbalance or ataxia, dysarthria, dysphagia, Horner's syndrome, downward beating nystagmus on the Dix-Hallpike, direction-changing nystagmus, or baseline nystagmus without provocation should all raise suspicion for a central etiology (Abes et al., 2011; Bhattacharyya et al., 2017). Failure of symptoms to respond to CRMs or vestibular rehab should prompt the clinician to pursue radiological testing (Bhattacharyya et al., 2017).

BPPV in the elderly

BPPV is classically more common in the elderly, occurring almost 7 times more frequently in individuals 60 years of age and older (Fujimoto et al., 2018; von Brevern et al., 2007). The increasing rate of BPPV in older individuals is thought to be related to osteoporosis

and the subsequent dysfunction in calcium metabolism. This dysfunction leads to insufficient calcium mineralization of otoconia resulting in fragmentation and dislodgment (Balatsouras et al., 2018; Yang et al., 2017). Other proposed mechanisms include higher calcium levels in the endolymph leading to the inability to dissolve dislodged otoconia (Fujimoto et al., 2018; Vibert, Kompis, & Hausler, 2003). Additionally, the number of nerve hair fibers decreases with age which is thought to be the reason for a functional decline of the peripheral vestibular systems with aging (Fujimoto et al., 2018; Rauch, Velazquez-Villasenor, Dimitri, & Merchant, 2001).

Not only do older individuals have a higher incidence of BPPV, the resulting consequences tend to be more detrimental in later life. Older individuals can present with atypical and poorly discernable symptoms making the diagnosis of BPPV more challenging (Balatsouras et al., 2018; Fujimoto et al., 2018; Johkura, Momoo, & Kuroiwa, 2008; Oghalai et al., 2000; Piker & Jacobson; 2014). Older individuals can also have a more prolonged course of symptoms that is less responsive to repositioning maneuvers (Batuecas-Caletrio et al., 2013; Fujimoto et al., 2018). Older populations tend to have a higher incidence of depression and subsequent social isolation linked to BPPV symptoms (Oghalai et al., 2000). Finally, the greatest risk to older adults is the risk of injury related to falls as falls are the number one cause of accidental death in persons older than 65 (Balatsouras et al., 2018; National Council on Aging [NCOA], n.d.). Falls, and the subsequent fear of falling, can also alter activities of daily living (ADL) and decrease quality of life. Additionally, families of older individuals who have fallen may develop resultant caregiver burden leading to more missed workdays and an overall decrease in productivity (Bhattacharyya et al., 2017; Oghalai et al., 2000).

Implications of BPPV

Personal, social, and financial implications

Although BPPV is self-limiting, the often-debilitating dizziness can have major implication for BPPV sufferers (Bhattacharyya et al., 2017; Hilton & Pinder, 2014). Vertigo and the resultant fear of exacerbating the vertigo can have considerable effects on ADLs (Neuhauser et al., 2008). Quality of life indicators have been found to be significantly diminished in BPPV patients compared to control subjects without the condition (Benecke et al., 2013; Bhattacharyya et al., 2017). In a large community-based study, one-fifth of subjects avoided leaving their home due to fear of becoming symptomatic (Neuhauser et al., 2008; von Brevern et al., 2007). Additionally, a well-established link exists between depression and anxiety and BPPV symptoms (Oghalai, Manolidis, Barth, Stewart, & Jenkins, 2000; von Brevern et al., 2007). Finally, studies have shown that the vast majority of working individuals who suffer from vertiginous symptoms experience a decline in workload and an increase in number of missed workdays (Benecke et al., 2013; von Brevern et al., 2007). In one large international study, participants had as many as 14 missed workdays in a three-month period depending on severity of the symptoms (Benecke et al., 2013).

The healthcare burden

Beyond the personal cost that many individuals suffer, there is a tremendous financial burden placed on our healthcare system related to the diagnosis and management of BPPV. Within the United States, we spend an average of \$2684.74 per affected individual or about 2 billion dollars per year on medical expenses (Li et al., 2000). This excessive spending can be partially attributed to the ambiguity associated with certain vertigo presentations especially in the elderly who have contributing comorbidities and are at greater risk for polypharmacy

(Balatsouras et al., 2018; Piker & Jacobson, 2014). The uncertainty of diagnosing BPPV has been shown to lead to unnecessary laboratory and radiological testing in over half of the BPPV cases (Bhattacharyya et al., 2017; Wang, Yu, Song, Su, & Yin, 2014). Additionally, multidisciplinary referrals are not uncommon creating unnecessary delays in treatment, increased healthcare costs, and further burdening primary care, specialist, and emergency providers (Benecke et al., 2013; Bhattacharyya et al., 2017; Neuhauser et al., 2008).

Current Guidelines

In 2017, the American Academy of Otolaryngology- Head and Neck Surgery (AAO-HNS) released updated clinical practice guidelines on improving the diagnosis and management of BPPV. A total of 13 recommendations were made with specific emphasis on improving patient outcomes and decreasing healthcare spending by performing diagnostic maneuvers, reducing unnecessary radiography, increasing the utilization of canalith repositioning maneuvers, and decreasing the use of vestibular suppressants (Bhattacharyya et al., 2017). These four topics will be discussed in greater detail below.

Diagnosing posterior canal BPPV with the Dix-Hallpike maneuver

The first step in the diagnoses of BPPV is obtaining a detailed history. If patient complains of short spinning episodes that are associated with rapid changes in head position and deny hearing loss or other neurological deficits, then there can be a reasonable suspicion for BPPV (Bhattacharyya et al., 2017; Hilton & Pinder, 2014; Hunt et al., 2012; If, however, vertigo is persistent irrespective of head movement, if there is associated hearing loss or tinnitus, or additional neurological symptoms, then further investigation into other peripheral and/or central causes may be necessary (Abes et al., 2011; Talmud, & Edemekong, 2019). If the history is consistent with BPPV, the next step would be to perform the DHM, the gold standard in the

diagnosis of posterior-canal BPPV (PC-BPPV) (Meurer et al., 2018; Talmud, & Edemekong, 2019). The DHM is performed with the patient in the seated upright position on a table or examination bed. The patient's head is then turned 45 degrees to one side and the patient is laid down rapidly until his/her head hangs off the table approximately 20 degrees. The eyes are then observed for nystagmus (Bashir, Pathan, Farook, Khalid, & Zayed, 2017; Bhattacharyya et al., 2017; Hilton & Pinder, 2014; Hunt et al., 2012; Traboulsi & Teixido, 2017). There may be a 5-20 second latency period before the nystagmus can be observed (Bhattacharyya et al., 2017; Hilton & Pinder, 2014; Hunt et al., 2012). The presence of nystagmus indicates a positive test and the direction of nystagmus provides a clue as to the involved ear and its respective canal (Bhattacharyya et al., 2017; Traboulsi & Teixido, 2017).

The vast majority of BPPV cases involve the posterior canal (Alimoğlu, Altın, Açıklın, & Yaşar, 2018; Bhattacharyya et al., 2017; Hilton & Pinder, 2014; Hunt et al., 2012; Parnes, Agrawal, Atlas, 2003). PC-BPPV can be identified using the DHM which would elicit an upward-beating torsional nystagmus toward the affected ear. The nystagmus generally lasts sixty seconds or less and is often fatigable, decreasing in severity or ceasing all together on repeated testing (Abes et al., 2011; Bhattacharyya et al., 2017; Hilton & Pinder, 2014; Hunt et al., 2012; Talmud, & Edemekong, 2019). The lateral canal may also be affected but does not generally present with nystagmus on the DHM. If symptoms are consistent with BPPV but patient has no distinguishable nystagmus, then lateral canal BPPV (LC-BPPV) should be tested by observing for the presence of horizontal nystagmus on the SRT (Bhattacharyya et al., 2017; Fife, 2009; Parnes et al., 2003). The anterior canal may also be involved but is extremely rare accounting for less than 5% of cases (Bhattacharyya et al., 2017; Parnes et al., 2003). Anterior canal BPPV (AC-BPPV) may present as downward-beating torsional nystagmus on the DHM, however, the

diagnosis of AC-BPPV should be made with extreme caution as brainstem and cerebellar strokes may also presents with this form of nystagmus (Bhattacharyya et al., 2017; Fife, 2009; Oh et al., 2018). Finally, in rare cases, no nystagmus is visualized during the DHM, but the patient complains of subjective vertigo when positioned toward the affective ear. This phenomenon is thought to occur as a result of nystagmus fatigability or due to a decreased neuronal signal that is able to elicit vertigo but is not strong enough to stimulate the vestibulo-ocular pathway that causes nystagmus (González-Aguado et al., 2018; Haynes et al., 2002).

The DHM is considered a safe and reliable method in diagnosing the majority of cases of BPPV. However, certain exclusion criteria should be considered before performing the maneuver. Clinicians should avoid performing the DHM or CRMs on individuals with cervical abnormalities such as severe rheumatoid arthritis, ankylosing spondylitis, kyphosis, Down's syndrome, or history of spinal cord injury (Bhattacharyya et al., 2017; Humphriss, Baguley, Sparkes, Peerman, & Moffat, 2003; Swartz & Longwell, 2005). Additionally, morbidly obese patients may be particularly at risk during the maneuver due to airway obstruction while lying flat. Providers may also find it difficult to safely support obese patients when taking them from a sitting to lying position (Bhattacharyya et al., 2017). Finally, if there is any concern for vertebrobasilar injury or any other vascular injury based on history or mechanism of injury, the DHM should be avoided (Bhattacharyya et al., 2017; Humphriss et al., 2003; Swartz & Longwell, 2005).

Avoidance of radiographic imaging when history and physical are consistent with BPPV

Radiographic imaging such as computerized tomography (CT) and/or magnetic resonance imaging (MRI) have little utility in the diagnosis of BPPV. If patient presentation is consistent with BPPV, there are no other neurological deficits, and the DHM elicits the expected

presentation of nystagmus, then the AAO-HNS recommends deferring radiographic imaging (Bhattacharyya et al., 2017). CT scans provides inadequate detail of the inner ear and therefore play no role in the diagnosis of peripheral processes (Sharma et al., 2018). MRI of the head and auditory canals provide superior visualization of the inner ear but are costly and provide no additional diagnostic advantage (Bhattacharyya et al., 2017; Sharma et al., 2018). However, if the presentation is atypical and suspicion exists for other central or peripheral cause of vertigo, an MRI would be the diagnostic test of choice due to its higher sensitivity compared to CT (Sharma et al., 2018).

Initial treatment of PC-BPPV with canalith repositioning maneuvers

Once a diagnosis of BPPV has been made and the affected canal identified, the initial treatment should include the performance of a CRM. CRMs have been found to be 6.5 more effective in treating BPPV symptoms and converting to a negative DHM compared to controls (Bhattacharyya et al., 2017; Prim-Espada, de Diego-Sastre, & Pérez-Fernández, 2010). Many studies have demonstrated that the CRM of choice in PC-BPPV is the Epley maneuver. The Epley takes the patient through a series of four positions in hopes of dislodging the otolith out of the posterior canal and repositioning it back into the vestibule (Abes et al., 2011; Alimoğlu et al., 2018; Bhattacharyya et al., 2017; Cetin et al., 2018). The maneuver begins with the patient seated upright on a table or examination bed. The patient's head is turned 45 degree to the affected side as determined by the DHM. Supported, the patient is then laid down rapidly until his/her head hangs off the edge of the table with 20 degrees of neck extension. That position is maintained for 20-30 seconds. The patient's head is then turned 90 degrees to the opposite side and that position is held for 30 seconds. The patient is then again turned another 90 degrees, likely placing him/her in a lateral decubitus position, and that position held for 30 seconds.

Finally, to complete the maneuver, the patient is sat back up (Alimoğlu et al., 2018; Bhattacharyya et al., 2017; Hunt et al., 2012).

There is a strong body of evidence and greater than 20 years of supporting data to encourage the use of the Epley maneuver in patients diagnosed with PC-BPPV (Bhattacharyya et al., 2017). In a 2014 Cochrane review, the Epley maneuver was found to be considerably more effective than sham maneuvers or other controls in treating BPPV symptoms (Alimoğlu et al., 2018; Bhattacharyya et al., 2017; Hilton & Pinder, 2014; Hunt et al., 2012). The Epley was also particularly effective at converting a positive to negative DHM (Hilton & Pinder, 2014).

Multiple studies, including randomized control trials, have reported the Epley maneuver to be up to 80% effective after one maneuver with increasing effectiveness on subsequent maneuvers (Alimoğlu et al., 2018; Kim & Zee, 2014, Maranhão, Whitney, & Maranhão-Filho, 2018; von Brevern et al., 2006). Finally, studies have found the Epley to have a positive impact on physical, functional, and emotional quality of life indicators (Bhattacharyya et al., 2017; Pereira, Santos, & Vople, 2010).

Avoidance of vestibular suppressants in the treatment of BPPV

Often, well-intentioned clinicians treat BPPV-related dizziness and subsequent nausea and vomiting with a group of medications broadly termed vestibular-suppressants (Bhattacharyya et al., 2017; Hain & Uddin, 2003). Vestibular suppressants are drugs used to reduce vertiginous symptoms such as spinning, motion sickness, nausea, and/or vomiting and include three classes: antihistamines, benzodiazepines and anticholinergics (Bhattacharyya et al., 2017). These medications, among many others, can be helpful in a variety of peripheral and central causes of vertigo such as Meniere's disease, vestibular neuritis, migraines, and stroke where symptoms can be persistent and often debilitating. Antihistamines work by suppressing

the central emetic centers in the brain, reducing the nausea and vomiting frequently seen with vertigo. Benzodiazepines have multiple properties related to their inhibitory effect on the gamma-amino butyric acid (GABA) system. In dizziness, benzodiazepines work by reducing the subjective spinning sensation. Finally, anticholinergic medications work by mitigating the neural and visual mismatch that can commonly occur with motion sickness (Bhattacharyya et al., 2017).

Current evidence-based guidelines recommend against the routine use of vestibular suppressants in the management of BPPV, however. Vestibular suppressants have a myriad of side effects which are considerably more problematic in older adults who suffer from disproportionately higher rates of BPPV (von Brevern et al., 2007). Antihistamines, benzodiazepines, and anticholinergics all have cognitive suppressive effects which, coupled with comorbid dementia, poor vision, and decreased mobility, significantly increases the risk of falling in the elderly. Antihistamines can cause drowsiness, difficulty with coordination, blurred vision, and dry mouth (Jáuregui et al., 2006). Benzodiazepines can have serious effects on cognition and coordination (Bhattacharyya et al., 2017; Hartikainen, Lönnroos, & Louhivuori, 2007). Finally, anticholinergic medications have been found to effect psychomotor speed, visuospatial memory, recall, and visuospatial construction (Ancelin et al., 2006). Given the numerous side effects of vestibular suppressant medications and the availability of non-pharmacological treatment for BPPV, routine vestibular suppressant use is not recommended (Bhattacharyya et al., 2017).

Barriers to Following Guidelines

Despite the availability of comprehensive BPPV guidelines, many providers continue to inappropriately manage the condition. Studies have shown that providers in variety of settings perform unnecessary radiographic imaging, prescribe vestibular suppressants, and fail to perform

bedside maneuvers on patients that present with symptoms consistent with BPPV (Bashir, et al., 2017; Kerber et al., 2017; Meurer et al., 2018; Newman-Toker, Camargo, Hsieh, Pelletier, and Edlow, 2009). This mismanagement may be a result of a lack of familiarity with current recommendations, little confidence and experiences with the DHM and interpreting nystagmus, negative past experiences performing maneuvers, or some combination of the three (Bashir, et al., 2017; Kerber et al., 2017; Meurer et al., 2018; Newman-Toker et al., 2009). As a result, providers have promoted improvements in BPPV processes (Meurer et al., 2018). One international study surveying over 1100 emergency physicians, ranked vertigo management within the top three priority topics that would benefit from a clinical decision-making tool (Eagles et al., 2008; Meurer et al., 2018).

With limited familiarity with BPPV guidelines and minimal experience in performing bedside maneuvers identified as the main culprits in BPPV mismanagement, educating clinicians on current evidence-based guidelines may improve adherence (Bashir, et al., 2017; Kerber et al., 2017; Newman-Toker et al., 2009). Qualitative studies using provider input have identified areas of focus for BPPV-specific education. BPPV education should cover current recommendations, review patterns of nystagmus, and allow for the performance of the Dix-Hallpike and the Epley maneuvers. Providers may also benefit from resources that are brief and easily accessible such as algorithms or other decision-making tools (Kerber et al., 2017; Newman-Toker et al., 2009). Nystagmus patterns should be reviewed with video examples to help visualize expected and unexpected findings. Finally, training should incorporate hands-on practice to allow providers to perform the Dix-Hallpike and Epley maneuvers in a controlled setting (Kerber et al., 2017).

Theoretical Framework

The Iowa Model-Revised

The Iowa Model is a framework used to help guide evidence-based practice and research development (Iowa Model Collaborative, 2017). From its origination in 1990's, it has been instrumental in assisting clinicians and scholars from around the world to integrate research into clinical practice. The model provides a step-by-step approach to the evidence-based process and begins with the identification of triggering issues such as the emergence of new data or an identified need within an organization. Next, the model calls for the development of a purpose statement with subsequent consideration of the issue's priority within healthcare today. Assuming the priority exists, a team should then be formed to begin the systematic approach of collecting data and synthesizing evidence. If the research is strong and supports the need for practice change, then a pilot execution plan can be created. The pilot should include protocols and implementation plans, a consideration of resources and constraints, a development of evaluation methods, and the collection of post-pilot data. Data from the pilot can then be evaluated to assess suitability for larger scale integration. If the change is found to be appropriate, then the involvement of key stakeholders can begin the process of full integration within an organization. A monitoring system should also be developed to assure quality outcomes throughout the process. Once the aforementioned steps are completed, the results can be disseminated (Figure 1) (Iowa Model Collaborative, 2017).

The Iowa Model has multiple decision points that allow for review and consideration of the EBP process. The first decision point is identifying whether the topic is a priority to the implementing organization. This is an important step because a low priority topic or one that is incongruent with an organization's mission will be less likely to receive the necessary resources

to create practice change. At this point in the process, an alternative issue or topic can be considered. The next decision point addresses whether or not sufficient evidence exists to support this change. This step is fundamental to the evidence-based process as it requires a strong body of evidence to support change. If the evidence is insufficient then further research will need to be conducted. The final decision point considers whether this change is appropriate for integration into practice. This step evaluates whether the outcomes of the pilot were achieved and if implementation should proceed on a larger scale. If the pilot was unsuccessful or had unexpected results, alternative options should be considered and the project should be redesigned (Iowa Model Collaborative, 2017). Figure 1 illustrates how the revised Iowa Model was used for this project.

Figure 1

Using the Iowa Model to Improve BPPV Management

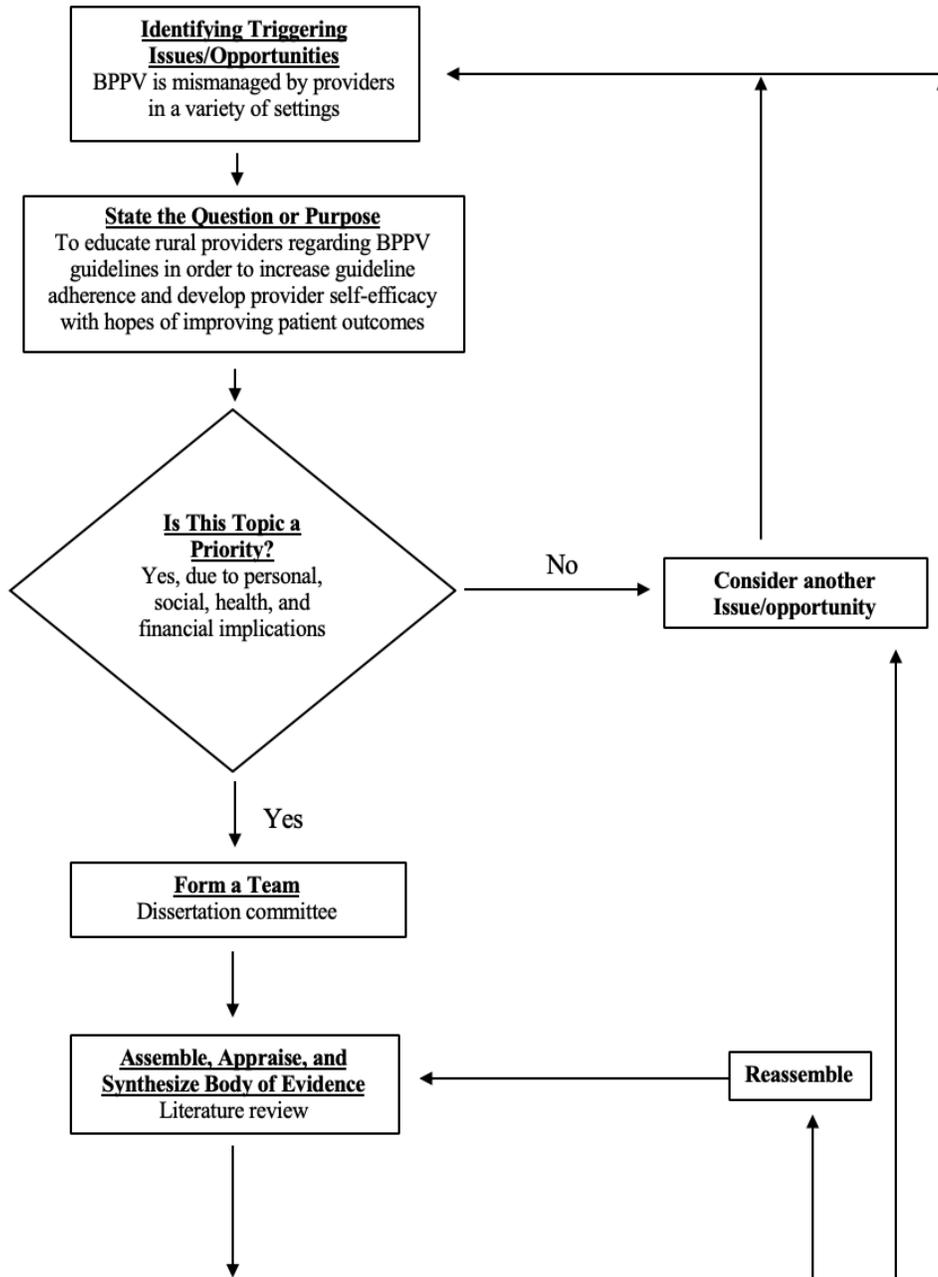
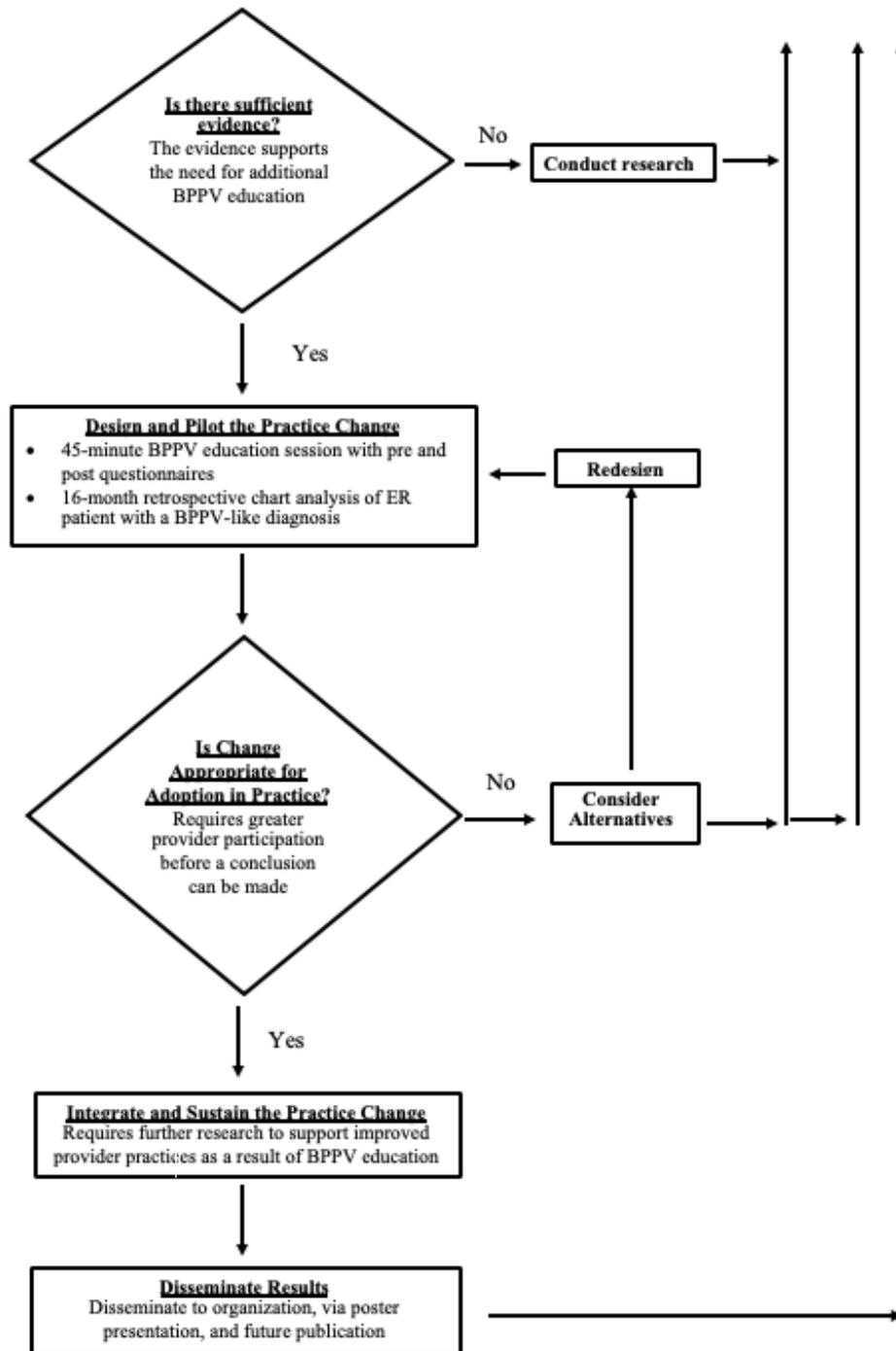


Figure 1. Using the Iowa Model to Improve BPPV Management (continued)



Note. Using the Iowa Model to Improve Benign Paroxysmal Positional Vertigo Management. Used/reprinted with permission from the University of Iowa Hospitals and Clinics, copyright 2015. For permission to use or reproduce, please contact the University of Iowa Hospitals and Clinics at 319-384-9098.

The Adult Learning Theory- Andragogy

In the 1970's, Malcom Knowles developed a learning theory based on the concept of andragogy or adult learning which provided a foundation for understanding the motivations of adult learners (Palis & Quiros, 2014). The theory is based on five assumptions of the adult learner: self-concept, experiences, readiness to learn, orientation to learning, and motivation. The assumption behind self-concept is that adults are independent and self-directed so that new information should be presented in a more engaging rather than passive manner. Adult learners also have a myriad of past experiences that will shape how he/she absorbs new material. An adult's readiness to learn is based on the applicability of the newly acquired information to an individual's goals with more applicable concepts being better received. The orientation of an adult learner shifts from future-based concepts to more current information that will help with the management of day-to-day tasks. Finally, the adult learner is internally driven to acquire new knowledge rather than externally motivated (Palis & Quiros, 2014; Pappas, 2013).

Using the adult learning theory of andragogy to improve BPPV management

The five assumptions of adult learners were used as a foundation for the implementation of the BPPV education session. The assumption that adults have a strong self-concept implies that they are self-directed rather than passive learners. Adult learners are engaged and active participants in their learning processes (Palis & Quiros, 2014). With this assumption in mind, the BPPV education session included multiple opportunities to engage providers and test their knowledge throughout the presentation. The presentation allowed time for hands-on experience with performing the Dix-Hallpike and Epley maneuvers. Additionally, the providers in attendance came from a variety of backgrounds with their own unique experiences, therefore, the session reserved time for discussion, sharing of personal experiences, and questions. The

provider's readiness to learn and his/her orientation to learning was addressed by the applicability of BPPV management to daily practice. Ideally, providers were driven by the need to improve their management of a commonly seen condition. Finally, the provider's internal motivation to obtain more knowledge and improve guidelines adherence drove their attendance at the education session.

CHAPTER THREE. METHODS

Project Design and Implementation

This practice improvement project consists of two major components: 1) a 45-minute BPPV-specific education session presented to emergency, specialist, and primary care providers working in Summit County, Colorado with pre-and post-education questionnaires assessing provider knowledge on the topic and 2) a 16-month retrospective chart analysis of patients visiting a Summit County emergency department comparing emergency provider management of BPPV prior to and following the education session. An emergency department was chosen after multiple studies specifically implicated emergency providers in the mismanagement of BPPV, supporting the need for BPPV-specific education within emergency medicine (Bashir, et al., 2017; Eagles et al., 2008; Kerber et al., 2017; Meurer et al., 2018). An informal needs-assessment was performed by approaching the medical director of a Summit County emergency department who agreed that providers in the aforementioned facility would benefit from BPPV-specific education.

Nurse practitioners, physicians, physician assistants, and naturopaths working in or near Summit County, Colorado were personally invited to attend a BPPV-specific education session based on convenience sampling of those individuals with whom the researcher had personal contact with. Approximately 20 providers were approached with special emphasis on those providers who work in areas where BPPV is commonly seen such as the emergency department and primary care. The session was held in an informal environment at a local brewery on a weekend evening, when providers were more likely to have time off and, therefore, attend. A private room within the brewery was reserved at no additional cost. Providers were incentivized to attend the session with an offering of one free beverage/food ticket at the brewery.

The session began with the administration of a baseline paper questionnaire to the providers in attendance. The questionnaire contained demographic questions, questions evaluating familiarity with BPPV guidelines, provider-identified barriers to following guidelines, and options for resources that providers may find useful. Following the education session, a post-intervention questionnaire was disseminated that reassessed familiarity with BPPV guidelines, appraisal of the overall quality of the presentation, and an evaluation of the likelihood of changing provider practices (Appendix A and B).

Once the questionnaires were completed and collected, the education session began. The content was presented in PowerPoint format and projected onto a large screen for all participants to see. The content of the session covered anatomy and physiology of the inner ear, BPPV pathophysiology, differential diagnoses including a special emphasis on the HINTS exam to rule out central etiologies, implication of BPPV, highlights from evidence-based guidelines on BPPV management, a demonstration of the DHM, SRT, Epley, and Lempert maneuvers, and options for procedural billing. The HINTS exam and the various nystagmus patterns were thoroughly reviewed by presenting YouTube videos of symptomatic patients. Based on research recommendations, there were also printed handouts with illustrations of the DHM and SRT as well as the Epley and Lempert maneuvers obtained from the AAO-HNS guidelines. An algorithm for the assessment of the dizzy patient obtained from the American Academy of Family Physicians was also provided. Time was allotted for providers to practice the maneuvers.

To assess the effectiveness of the education session on promoting long-term practice change, a retrospective chart analysis was performed in a Summit County, Colorado emergency department. Three of the 11 providers who attended the session were emergency physicians at that facility. The chart analysis included patients visiting the emergency department between

October 12, 2018- February 12, 2020 covering emergency visits one year prior to and four-months post-education to evaluate for any significant change in provider practices. Inclusion criteria involved any patient over the age of 18 with a discharge diagnosis of BPPV, BPPV-right, BPPV- left, vertigo, and/or peripheral vertigo. Exclusion criteria included any patient under the age of 18 and/or whose symptoms were inconsistent with a BPPV presentation based on chart analysis. Charts were reviewed for four major components including the performance of the DHM in the diagnosis of BPPV, the utilization of radiographic imaging in reaching a diagnosis, the performance CRMs in the treatment of BPPV, and the prescription of vestibular suppressants such as benzodiazepines and/or antihistamines upon discharge.

Institutional Review Board

North Dakota State University (NDSU) granted Institutional Review Board (IRB) approval on September 20, 2019 classifying the project as exempt under category four criteria ii (Appendix C). Additional IRB approval was required from the organization given the need to access patient health records. IRB approval was granted on December 10th, 2019 (Appendix D).

Project Evaluation

Objective One

The first object was to deliver a BPPV-specific education session to providers in a rural Colorado mountain town. This objective was completed on October 12, 2019 at a local brewery in Frisco, Colorado. The details of the session are described above under “project design.”

Objective Two

The second objective was to compile and disseminate printed illustrations of the DHM, SRT, Epley, and Lempert maneuvers as well as a dizziness algorithm for clinicians to use as a reference in practice. Handouts were distributed during the education session.

Objective Three

The third objective was to disseminate pre-and post-education questionnaires and to compare results following the education to pre-education scores. Prior to the presentation, participating providers responded to a pre-education survey assessing familiarity with BPPV guidelines. The survey consisted of demographic questions regarding provider-type, years of practice, and field of specialty. There were also five multiple-choice questions pertaining to the specifics of current BPPV guidelines from the AAO-HNS. Lastly, there was a question regarding provider-identified barriers to following guidelines and a question on which resources providers would find most helpful in improving their practices. Following the session, providers received a post-education survey to reevaluate their knowledge of BPPV guidelines. The five knowledge-based questions were identical from the pre-education surveys and were used as the primary evaluation tool to assess for significant change in guideline familiarity as a result of the intervention. The post-education survey also included three questions on the quality and usefulness of the education (Appendix A and B).

Objective Four

The fourth objective included a 12-month pre-intervention retrospective chart analysis on patients visiting the emergency department in a rural Colorado hospital. An EPIC electronic medical record (EMR) analyst was consulted for assistance in creating a report of emergency department patients that met specific criteria needed for data collection. A report template was created to include any patient visiting the emergency department at the aforementioned facility between October 12, 2018 and October 12, 2019 with a discharge diagnosis of BPPV, BPPV-right, BPPV- left, vertigo, or peripheral vertigo. The report could only be run in 30-day intervals therefore 12 separate reports were created. Provider notes, imaging and laboratory results, and

after visit summaries were reviewed for four specific criteria: the use of DHM in the diagnosis of BPPV, the utilization of CT/MRI in ruling out central causes of vertigo, the use of CRMs to treat BPPV, and the prescription of vestibular suppressants, specifically benzodiazepines and antihistamines, upon discharge from the emergency department. The presence of all four criteria were recorded in an excel spreadsheet.

Objective Five

The final objective was to perform a 4-month post-intervention retrospective chart analysis on emergency department patients at the same facility between October 12, 2019 and February 12, 2020. Again, a report was run to identify patients visiting the emergency department that were diagnosed with BPPV, BPPV- right, BPPV- left, vertigo, or peripheral vertigo. The same four criteria i.e. the use of DHMs, radiographic imaging, CRMs, and the prescription of vestibular suppressant medication were recorded in an excel spreadsheet as per the specifics of objective 4. Additionally, the presence or absence of the diagnosing provider at the education session was also recorded. The rate of all four criteria post-intervention were compared to rates pre-intervention to assess for a significant change in provider practices following the BPPV education session.

CHAPTER FOUR. RESULTS

Pre- and Post-Education Questionnaires

Pre-Intervention Questionnaires

Objective three was met by the dissemination of pre- and post-education questionnaires to providers participating in the education session. Surveys were distributed and collected on paper and results were later transcribed into Google Forms for interpretation. A total of 11 pre-education surveys were completed. The majority of participants were nurse practitioners (36%) followed closely by physician assistants (27%). The remaining participants were split between Medical Doctors, Doctor of Osteopathic Medicine, and Naturopaths. None of the advance practice providers present at the education session worked in the emergency department where the intervention was implemented but three of the four physicians did. Almost half of participants had between 0-5 years of experience and the predominant field represented was family and/or internal medicine (Figure 2).

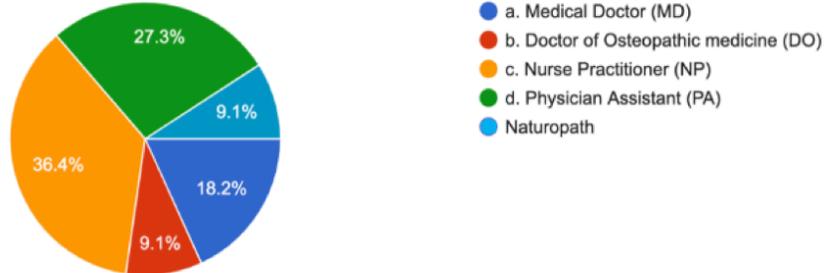
Regarding the knowledge-based questions, the majority of participants were familiar with BPPV presentation, the DHM as the primary diagnostic tool, and the Epley maneuver as the chief modality in the treatment of BPPV. However, two participants correctly identified nystagmus patterns in posterior canal BPPV (18%) and results regarding medication use in the treatment of BPPV were split between Meclizine and no medications at all (45% and 55% respectively). The average score of correct answers from the pre-intervention questionnaire was 61.8% (Figure 3). Finally, the majority of participants felt that remembering *how* to perform the various maneuvers was the major barrier to performing them and results on how to improve guidelines adherence were split across the board (Figure 4).

Figure 2

Participant Demographic Information

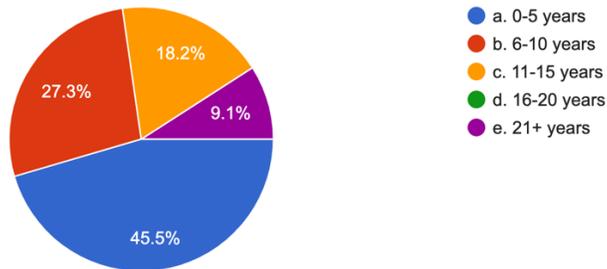
1. What are your credentials?

11 responses



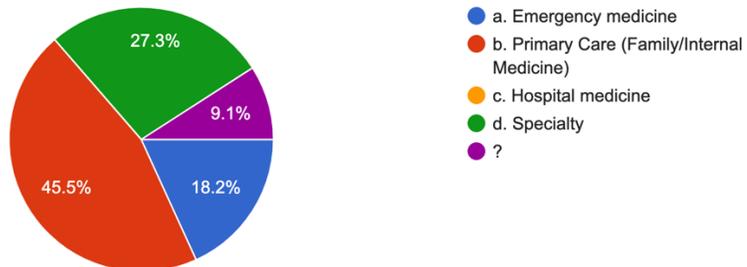
2. How many years have you been practicing in your current role?

11 responses



3. What is your primary field of practice?

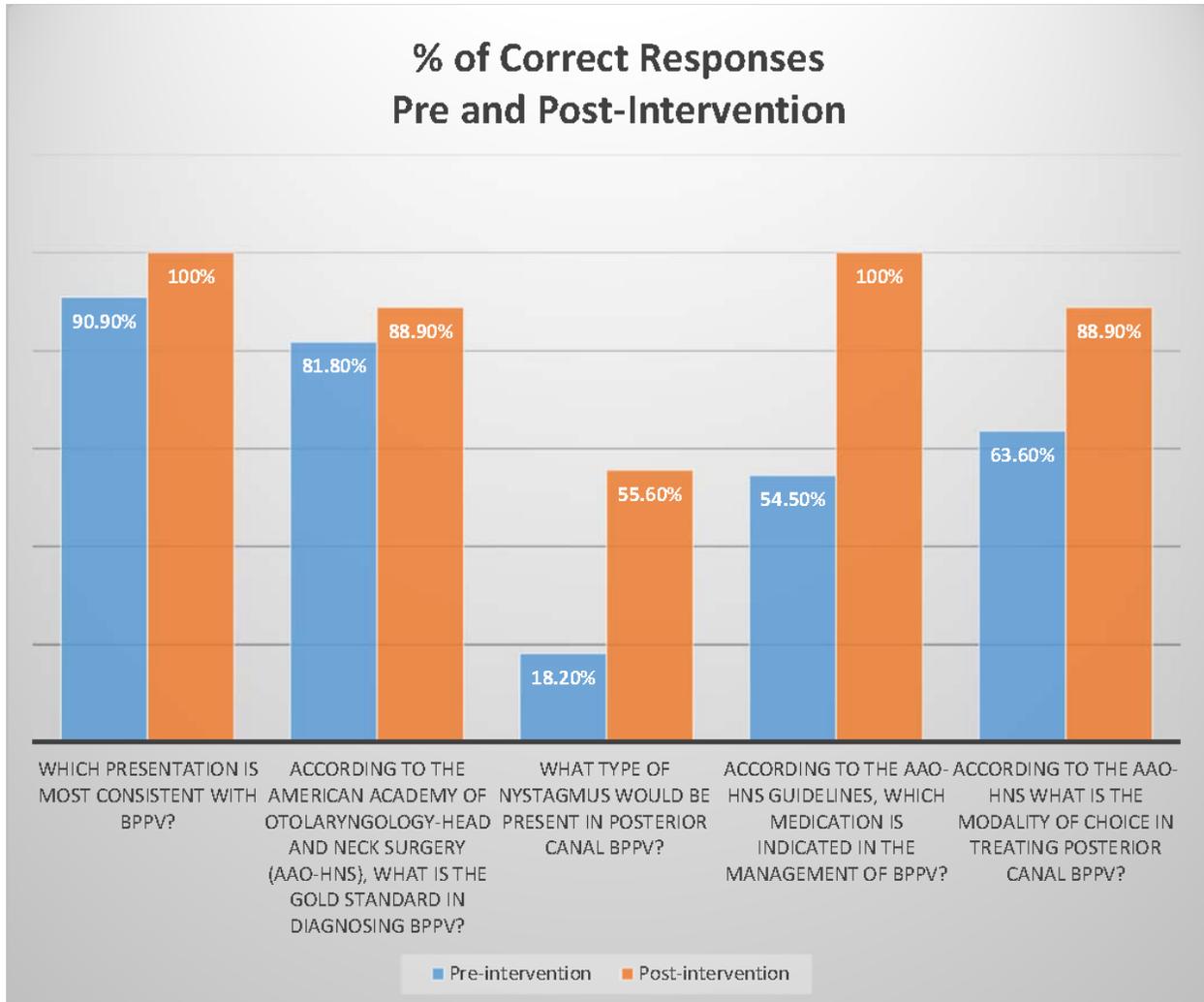
11 responses



Note. Pre-intervention participant demographic information

Figure 3

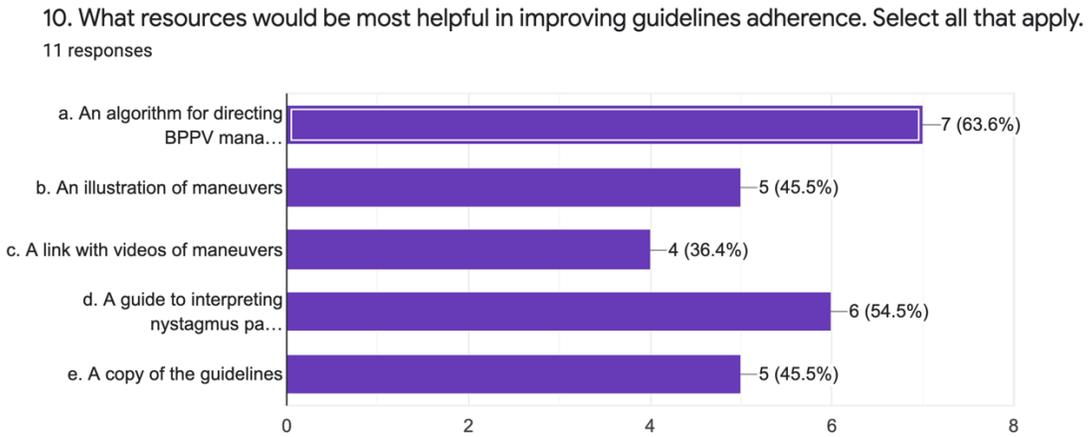
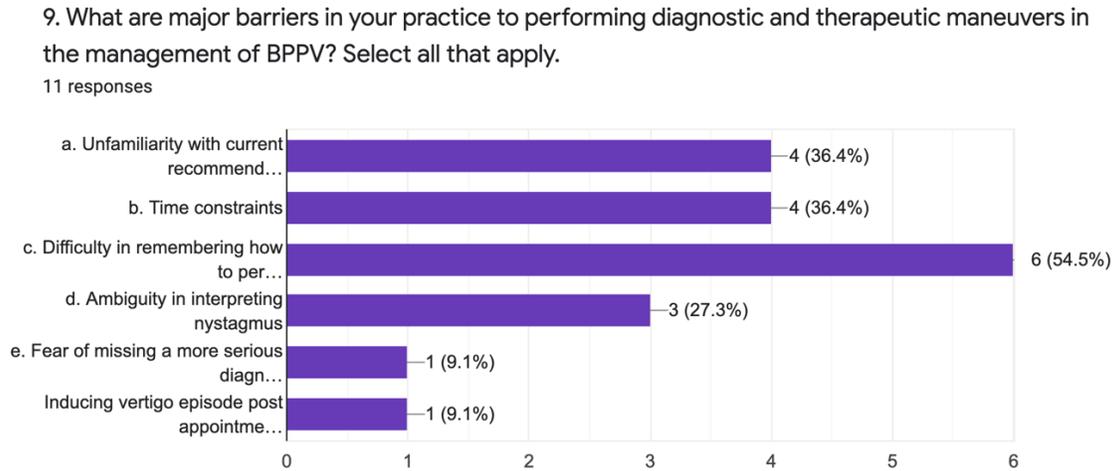
Pre- and Post-Intervention Knowledge Questionnaires



Note. Graphic representation of percentage of correct response pre-intervention compared to post-intervention.

Figure 4

Barriers and Resources in Guideline Adherence



Note. Pre-intervention responses on barrier to performing diagnostic and therapeutic maneuvers and resources participants find helpful.

Post-intervention Questionnaires

The knowledge-based questions from the pre-intervention questionnaire were repeated post- intervention to evaluate for change in the understanding of the proper management of BPPV. Following the presentation there were nine questionnaires submitted compared to the 11 pre-intervention. Overall, there was an increase in the percentage of correct answers post-intervention compared to pre-intervention. Of note, there was an overall improvement in the area that most providers struggled with- identifying nystagmus patterns. About half of participants, 56%, identified the appropriate nystagmus patterns in posterior canal BPPV compared to 18% pre-intervention (Figure 3). The average number of post-intervention correct responses was 86.7%, an improvement from 61.8% pre-intervention.

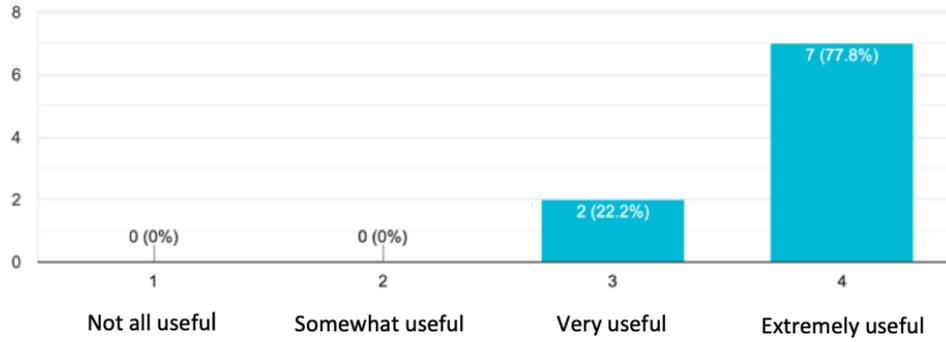
The majority of participants (78%) found the presentation to be extremely useful. All participants, 100%, rated the quality of the presentation as excellent and the majority (78%) of participants were extremely likely to make practice changes as a result of the presentation (Figure 5). Finally, participants were provided space to add any additional comments. The bulk of the comments were mostly positive feedback regarding the session; however, the videos and algorithms were identified by several participants as being particularly helpful.

Figure 5

Quality and Effectiveness of the Presentation

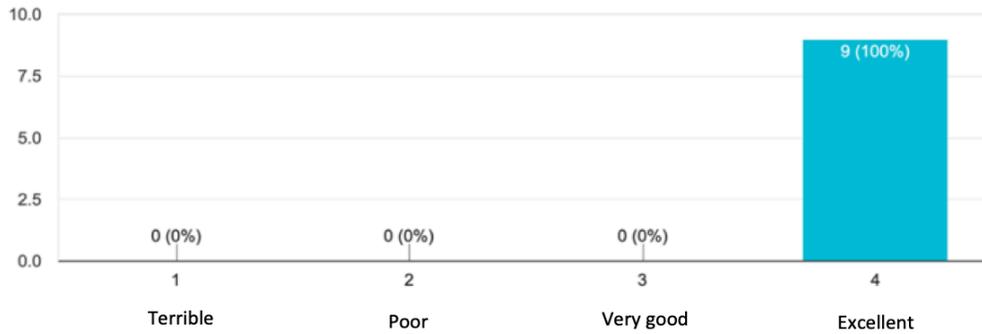
6. How useful was this presentation in helping you understand the basics of BPPV and current practice recommendations?

9 responses



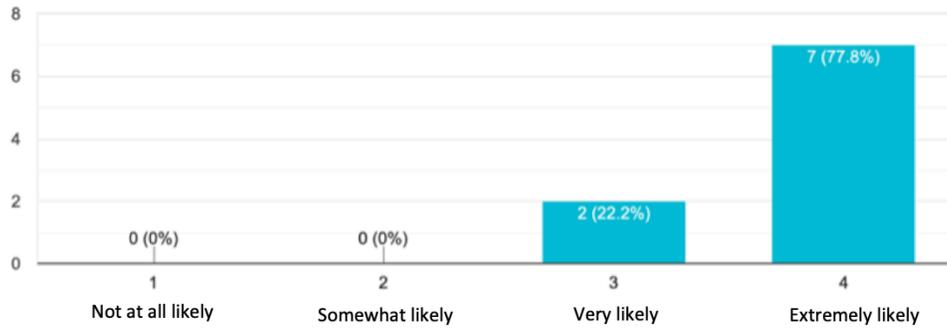
7. How would you rate the overall quality of the education session?

9 responses



8. How likely are you make changes to your current practices?

9 responses



Note. Provider rated usefulness, quality, and impact of presentation

16-month Retrospective Chart Analysis

Objectives four and five were met by the performance of a 12-month pre-intervention and 4-month post-intervention retrospective chart analysis of emergency department patients visiting a rural Colorado hospital diagnosed with vertigo, peripheral vertigo, or BPPV. A total of 44 patient encounters were reviewed within a 16-month analysis period. Ten charts were excluded on the basis of the patient presentations being inconsistent with diagnosis of BPPV. Therefore, the total number of encounters analyzed were N=34, 29 (85%) of which were in the pre-intervention period while 5 (15%) were post-intervention. Additionally, the rate of patient encounters was 2.4 patients/month in the pre-intervention period and 1.3 patients/month in the post-intervention period. Of note, one provider, 20% of patient encounters, in the post-intervention group attended the education session. Both pre- and post-intervention periods had two encounters each involving the use of the DHM in the diagnosis BPPV. Given the difference in the number of encounters pre-intervention compared to post-intervention, the rate in which the DHM was performed varied considerably at 7% versus 40% respectively. Similarly, both pre- and post-intervention periods consisted of the use of CRMs during one encounter resulting in a frequency of 3% pre-intervention versus 20% post-intervention. Three of the total patient encounters involved the provision of the modified Epley maneuver handout at discharge rather than the performance of the CRM in the department. These three encounters did not meet criteria for performing the maneuver and were not counted as a positive result. Almost half of the pre-intervention visits did not include radiographic imaging in reaching a diagnosis compared to 60% post-intervention. Finally, 34% of encounters did not result in a discharge prescription of vestibular suppressant medications versus 20% post-intervention. Overall, not a single patient

encounter prior to or post-intervention incorporated all four diagnostic or management criteria emphasized in the current BPPV guidelines (Table 1) and (Table 2).

Table 1*Pre-Intervention Chart Analysis Results*

Pre- Intervention Patient Encounter	Presence of Provider at Education Session	Dix-Hallpike Maneuver	Radiographic Imaging	Canalith Repositioning Maneuver	Rx for Vestibular Suppressants at Discharge	% of Criteria Met
1						0%
2			X		X	50%
3			X			25%
4			X		X	50%
5	X					0%
6			X		X	50%
7					X	25%
8			X		X	50%
9					X	25%
10						0%
11	X				X	25%
12			X		X	50%
13	X		X			25%
14					X	25%
15	X					0%
16						0%
17						0%
18	X					0%
19			X			25%
20			X			25%
21			X			25%
22					X	25%
23			X			25%
24		X	X	X		75%
25	X	X	X			50%
26	X					0%
27	X		X			25%
28						0%
29						0%
Total %	28%	7%	48%	3%	34%	

Note. Chart analysis results of pre-intervention guidelines adherence

Table 2*Post-Intervention Chart Analysis Results*

Post-Intervention Patient Encounter	Presence of Provider at Education Session	Dix-Hallpike Maneuver	Radiographic Imaging	Canalith Repositioning Maneuver	Rx for Vestibular Suppressant at Discharge	% of Criteria Met
1		X	X			50%
2	X		X	X		50%
3			X			25%
4					X	25%
5		X				25%
Total %	20%	40%	60%	20%	20%	

Note. Chart analysis results of post-intervention guidelines adherence

CHAPTER FIVE. DISCUSSION AND RECOMMENDATION

Summary and Synthesis

Several key findings were identified during analysis of the pre- and post-education questionnaires. First, there appeared to be a general knowledge of the existence of the DHM and its use in the diagnosis of BPPV, however, there was a poor understanding of how to interpret nystagmus patterns during the maneuver. Knowledge of nystagmus interpretation improved following the education session from 18% to 56%, however, pattern interpretation continued to be an area of struggle for almost half of the providers. These results are consistent with the literature that revealed that providers find nystagmus patterns to be difficult to interpret, creating a major deterrent in performing the DHM (Bashir, et al., 2017; Kerber et al., 2017; Meurer et al., 2018; Newman-Toker et al., 2009). Additionally, at least half of the providers felt a guide to nystagmus interpretation would assist them in better following guidelines further reinforcing these results. Moreover, half of providers in the pre-education session would have prescribed Meclizine in the treatment of BPPV vs no medications at all. Although the correct responses improved from 55% to 100% following the education session, this may indicate that prescribing vestibular suppressants in the treatment of BPPV is a common practice. Overall, there appeared to be an improvement in the knowledge and understanding of the evidence-based BPPV guidelines following the education session (86.7%) compared to pre-education (61.8%). However, there was a two-participant discrepancy in the number of pre-education (11) compared to post-education participants (9) which may have skewed results.

In the pre-intervention questionnaire, the majority of providers felt that remembering how to perform the various maneuvers was a major barrier to performing them. This difficulty is likely multifactorial but may be related to inadequate training and/or scarcity in the number of

patients seen with BPPV. Post-intervention results also indicated that providers would find a variety of resources helpful in improving guideline adherence, however, BPPV algorithms and nystagmus guides were found to be the most useful. These results are consistent with current qualitative research that recognized decision-making tools and a nystagmus pattern reviews as beneficial in improving provider management of BPPV (Kerber et al., 2017; Newman-Toker et al., 2009).

The 16-month retrospective chart analysis was performed to evaluate for improvements in provider practice as a result of the education session. Of note, only three of the 11 participants from the education session work at the emergency department where the chart analysis was performed. The addition of providers from outside of the emergency department was done to broaden the participant base and educate providers working in areas where BPPV is frequently encountered. Furthermore, there was a discrepancy between rate of encounters in the 12-months pre-intervention (2.4 patients/month) compared to the 4-months post-intervention (1.3 patients/month). This difference may be related to the seasonal nature of the hospital which sees peak patient volumes in January through April, limiting the number of patients seen in the first 2-3 months of the post-intervention period. Only a single patient encounter during the post-intervention period involved a provider that attended the education session. During this single encounter, the provider did not use radiographic imaging and performed the Epley maneuver yet did not perform the DHM and sent the patient home with a vestibular suppressant. The lack of applicable encounters during the post-intervention period impedes the formation of any sort of conclusion as to the impact the intervention had on practice improvement. Additionally, the discrepancy in the 29 pre-education versus 5 post-education encounters makes interpretation challenging.

Despite the lack of conclusions formed as a result of the retrospective chart analysis, some important themes can be extrapolated. First, few patient encounters in both the pre- and post-intervention periods involved the performance of the DHM despite a patient presentation that is consistent with BPPV. Even fewer of all patient encounters involved the use of the Epley maneuver. These results demonstrate that providers in this particular emergency department fail to perform diagnostic and therapeutic maneuvers despite the strong body of evidence that supports their use in the management of BPPV. Regarding radiographic imaging, about half of all patient encounters did not involve the use of radiographic imaging in diagnosing BPPV and about a quarter of encounters resulted in no vestibular suppressants prescribed at discharge. Although the number of these encounters is not trivial, no inference can be made as to whether providers were following guidelines (since most did not follow other recommendations from the same guidelines), or whether they simply felt imaging and medications were unnecessary. Finally, of the 34 patient encounters evaluated, not a single encounter demonstrated the use of all four criteria recommended in current BPPV guidelines. The results of this 16-month chart analysis support the current literature that despite the availability of current evidence-based guidelines on the diagnosis and management of BPPV, providers are failing to follow them (Bashir, et al., 2017; Kerber et al., 2017; Meurer et al., 2018; Newman-Toker, Camargo, Hsieh, Pelletier, and Edlow, 2009).

Recommendations

Recommendations for Practice

There are numerous benefits to patients, providers, and the healthcare system as whole if providers incorporate evidence-based practices in their management of BPPV. First, if providers familiarize themselves with interpreting nystagmus patterns and translating them into therapeutic

maneuvers, patients may experience a resolution of their symptoms in 80% of cases after the performance of a single CRM. The likelihood of symptom resolution increases with the performance of subsequent maneuvers (Alimoğlu et al., 2018; Kim & Zee, 2014, Maranhão, Whitney, & Maranhão-Filho, 2018; von Brevern et al., 2006). If patients could be treated with one maneuver performed at the time of their visit, they may experience more rapid improvement in their quality of life, fewer delays in returning to work, and a decrease in the potential for injury related to falls. Furthermore, becoming proficient in these maneuvers will help reduce healthcare spending from potentially unnecessary diagnostic imaging and referrals to physical therapy or ear, nose, and throat specialists. Finally, providers can bill for CRMs with the use of current procedural terminology (CPT) code 95992. This code is reimbursable by Medicare if associated with a BPPV diagnosis at approximately \$35- \$55 per maneuver (Centers for Medicare & Medicaid Services [CMS], 2020).

Similar studies involving BPPV education and chart analyses should be performed in the future, however, should involve a greater number of participating providers. Prospective studies may be able to better form a conclusion as to whether BPPV education as well as reference guides can have a significant impact on improving provider practices. These studies should include participants that both attend the education session and provide patient care in the department of implementation. Finally, the chart analysis period prior to and post-education should involve similar timeframes to allow for a better comparison of results. Overall, there is a potential for a great deal of knowledge to be gained from future studies.

Recommendations for the Organization

Given that two of the major organizational pillars are excellence and stewardship, it would behoove the organization to educate providers on current BPPV guidelines in order to

promote evidence-based practices and reduce unnecessary cost and harm associated with radiographic imaging and vestibular suppressants. Providers would benefit from a review and return demonstration of exam techniques that help rule out central etiologies of vertigo such as the HINTS exam, which can also assist in reducing unnecessary imaging. This recommendation can be accomplished by providing similar education sessions within the organization during provider meetings or scheduled education times or by advertising CME opportunities in the form of vestibular workshops or online courses. Education should be delivered to providers in areas where BPPV is likely to be encountered such as the emergency department and primary care practices. Finally, handouts from the AAO-HNS BPPV guidelines can be distributed to participants for use as a quick reference in practice.

Dissemination

Project findings will be disseminated to the organization by submitting the executive summary to the Systems Director of Research Operations and Cancer Registry. The director can then review the document and decide if the organization would benefit from the findings of this research. This project will also be presented as a virtual poster presentation through the North Dakota State University website. Finally, given the utility of the data collected, research results as well as a large portion of the literature review will be considered for submission for publication to the Otolaryngology Head and Neck Nursing Journal as well as to the Advanced Emergency Nursing Journal.

Strengths and Limitations

This project has several major strengths to acknowledge. First, the educational intervention was quite comprehensive and focused on the vast majority of areas that both qualitative and quantitative research recommended covering in provider education. These areas

included the four major guideline recommendations: the use of the DHM in the diagnosis of BPPV, avoiding the use of radiographic imaging, performing CRMs in the treatment of BPPV, and refraining from prescribing vestibular suppressants. Furthermore, the education session had a lengthy review of nystagmus patterns by presenting videos to help providers visualize the described patient presentations. This increased emphasis on nystagmus patterns was based on the knowledge that nystagmus patterns interpretation is an area within which many providers struggle. The education session included demonstrations of the DHM, SRT, Epley, and Lempert maneuvers all of which are useful for providers to see in person. Finally, providers were given algorithms for approaching the dizzy patient, a copy of current AAO-HNS guideline recommendations, and visual depictions of the four major maneuvers discussed. The quality of presentations was further reinforced with exclusively positive feedback from all participants. Another strength is that the retrospective chart analysis was an excellent approach to identifying true practice change as a result of the intervention. Although pre- and post-questionnaires are a good way to test short-term memory, reviewing patient encounters post-intervention is a more accurate depiction of a deeper understanding of the educational content.

Despite the overall quality of the content and project design, there were some major limitations within the data collection. First, as previously mentioned, given the discrepancy in pre-education compared to post-education encounters, it is virtually impossible to make a conclusion regarding the effectiveness of the education on long-term practice change. Additionally, the vast majority of participants in the education session did not work as providers in the emergency department where the chart analysis was performed making the correlation between the education session and practice changes extremely difficult. Furthermore, charts were identified based on the diagnoses of vertigo, BPPV, BPPV-left, BPPV- right and peripheral

vertigo. Given the innumerable options for International Statistical Classification of Diseases-10 (ICD-10) coding, it's possible that some patient encounters of BPPV were missed. Finally, some providers documented minimally, especially in the history of present illness, making the conclusions as to the type of vertigo the patient is experiencing extremely difficult. This fact may have resulted in an overestimation of the true cases of BPPV seen during the 16-month analysis period.

Conclusion

Research has shown that providers in a variety of settings are ineffectively managing BPPV despite the availability of evidence-based guidelines (Bashir, et al., 2017; Kerber et al., 2017; Meurer et al., 2018; Newman-Toker, Camargo, Hsieh, Pelletier, and Edlow, 2009). This project further reinforced this reality. Specifically, interpreting nystagmus patterns and recalling how to perform the various maneuvers have been identified as major barriers to following guidelines. Reviewing nystagmus patterns, providing demonstrations the maneuvers, and offering quick references guides for practitioners to use in practice may be beneficial in improving guideline adherence. By properly managing BPPV, providers may improve the health or their patients, reduce unnecessary healthcare spending, while still being able to bill for their efforts. Future studies with longer analysis periods and greater number of participants should be performed to evaluate whether BPPV-specific education can improve provider practices. These findings can also be applicable to the Doctor of Nursing Practice (DNP) role. DNPs practice with an overarching principle of evidence-based medicine. As a result, it essential that DNPs follow current guidelines on the diagnosis and management of BPPV to further promote the excellence of the profession.

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APPENDIX A. PRE-EDUCATION PROVIDER QUESTIONNAIRE ON BPPV

MANAGEMENT

Personal Information

1. What are your credentials?
 - a. Medical Doctor (MD)
 - b. Doctor of Osteopathic medicine (DO)
 - c. Nurse Practitioner (NP)
 - d. Physician Assistant (PA)
 - e. Other

2. How many years have you been practicing in your current role?
 - a. 0-5 years
 - b. 6-10 years
 - c. 11-15 years
 - d. 16-20 years
 - e. 21+ years

3. What is your primary field of practice?
 - a. Emergency medicine
 - b. Family practice (Family/ Internal Medicine)
 - c. Hospital medicine
 - d. Specialty
 - e. Other

BPPV Diagnosis and Management

4. Which presentation is **most** consistent with BPPV?
 - a. Intermittent vertigo and tinnitus
 - b. Persistent vertigo following a viral prodrome
 - c. Vertigo with associated headache and vision changes
 - d. Vertigo with associated ataxia and tremors
 - e. Short episodes of vertigo that occur with rapid head movement

5. According to the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS), what is the gold standard in diagnosing BPPV?
 - a. Non-contrast CT
 - b. Dix-Hallpike maneuver
 - c. Otologic exam
 - d. Epley maneuver
 - e. Assessing for horizontal nystagmus

6. What type of nystagmus would be present in posterior canal BPPV?
 - a. Up-beating vertical
 - b. Down-beating vertical
 - c. Horizontal
 - d. Up-beating torsional
 - e. Down-beating torsional

7. According to the AAO-HNS guidelines, which medication is indicated in the management of BPPV?
 - a. Meclizine
 - b. Diazepam
 - c. Dimenhydrinate
 - d. Domperidone
 - e. No medications are indicated in the treatment of BPPV

8. According to the AAO-HNS what is the modality of choice in treating posterior canal BPPV?
 - a. Vestibular suppressant medication
 - b. Epley maneuver
 - c. Vestibular rehab
 - d. Postural restrictions
 - e. Dix-Hallpike maneuver

Additional Questions

9. What are major barriers in your practice to performing diagnostic and therapeutic maneuvers in the management of BPPV? **Select all that apply.**
 - a. Unfamiliarity with current recommendations
 - b. Time constraints
 - c. Difficulty in remembering how to perform maneuvers
 - d. Ambiguity in interpreting nystagmus
 - e. Fear of missing a more serious diagnosis
 - f. Other: _____

10. What resources would be most helpful in improving guidelines adherence. **Select all that apply.**
 - a. An algorithm for directing BPPV management
 - b. An illustration of maneuvers
 - c. A link with videos of maneuvers
 - d. A guide to interpreting nystagmus patterns
 - e. A copy of the guidelines
 - f. Other: _____

APPENDIX B. POST-EDUCATION PROVIDER QUESTIONNAIRE ON BPPV
MANAGEMENT

BPPV Diagnosis and Management

1. Which presentation is **most** consistent with BPPV?
 - a. Intermittent vertigo and tinnitus
 - b. Persistent vertigo following a viral prodrome
 - c. Vertigo with associated headache and vision changes
 - d. Vertigo with associated ataxia and tremors
 - e. Short episodes of vertigo that occur with rapid head movement

2. According to the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS), what is the gold standard in diagnosing BPPV?
 - a. Non-contrast CT
 - b. Dix-Hallpike maneuver
 - c. Otologic exam
 - d. Epley maneuver
 - e. Assessing for horizontal nystagmus

3. What type of nystagmus would be present in posterior canal BPPV?
 - a. Up-beating vertical
 - b. Down-beating vertical
 - c. Horizontal
 - d. Up-beating torsional
 - e. Down-beating torsional

4. According to the AAO-HNS guidelines, which medication is indicated in the management of BPPV?
 - a. Meclizine
 - b. Diazepam
 - c. Dimenhydrinate
 - d. Domperidone
 - e. No medications are indicated in the treatment of BPPV

5. According to the AAO-HNS what is the modality of choice in treating posterior canal BPPV?
 - a. Vestibular suppressant medication
 - b. Epley maneuver
 - c. Vestibular rehab
 - d. Postural restrictions
 - e. Dix-Hallpike maneuver

Additional Questions

6. How useful was this presentation in helping you understand the basics of BPPV and current practice recommendations?
 - a. Not at all useful
 - b. Somewhat useful
 - c. Very useful
 - d. Extremely useful

7. How would you rate the overall quality of the education session?
 - a. Terrible
 - b. Poor
 - c. Very good
 - d. Excellent

8. How likely are you make changes to your current practices?
 - a. Not at all likely
 - b. Somewhat likely
 - c. Very likely
 - d. Extremely likely

9. Please provide any additional comments here:

APPENDIX C. NDSU IRB APPROVAL



September 20, 2019

Dr. Mykell Barnacle
Department of Nursing

Re: IRB Determination of Exempt Human Subjects Research:
Protocol #PH20048, "Improving the Diagnosis and Management of Benign Paroxysmal Positional Vertigo in a Rural Healthcare Setting"

Co-investigator(s) and research team: Liya Rodovskaya
Date of Exempt Determination: 9/20/2019 Expiration Date: 9/19/2022
Study site(s): Summit County, Colorado
Sponsor: n/a

The above referenced human subjects research project has been determined exempt (category # 2(i), 4(ii)) in accordance with federal regulations (Code of Federal Regulations, Title 45, Part 46, Protection of Human Subjects). This determination is based on the revised protocol submission (received 9/19/2019).

Please also note the following:

- If you wish to continue the research after the expiration, submit a request for recertification several weeks prior to the expiration.
- The study must be conducted as described in the approved protocol. Changes to this protocol must be approved prior to initiating, unless the changes are necessary to eliminate an immediate hazard to subjects.
- Notify the IRB promptly of any adverse events, complaints, or unanticipated problems involving risks to subjects or others related to this project.
- Report any significant new findings that may affect the risks and benefits to the participants and the IRB.

Research records may be subject to a random or directed audit at any time to verify compliance with IRB standard operating procedures.

Thank you for your cooperation with NDSU IRB procedures. Best wishes for a successful study.
Sincerely,

A handwritten signature in purple ink that reads "Kristy Shirley".

Kristy Shirley, CIP, Research Compliance Administrator

For more information regarding IRB Office submissions and guidelines, please consult https://www.ndsu.edu/research/for_researchers/research_integrity_and_compliance/institutional_review_board_irb/. This Institution has an approved FederalWide Assurance with the Department of Health and Human Services: FWA00002439.

INSTITUTIONAL REVIEW BOARD

NDSU Dept 4000 | PO Box 6050 | Fargo ND 58108-6050 | 701.231.8995 | Fax 701.231.8098 | [ndsu.edu/irb](https://www.ndsu.edu/irb)

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APPENDIX D. CHI IRB APPROVAL



FWA Number: FWA 00019514
OHRP IRB Number: IRB00009715

DATE: December 10, 2019
TO: Liya Rodovskaya
PROJECT TITLE: [1519303-1] Improving the Diagnosis and Management of Benign Paroxysmal Positional Vertigo in a Rural Healthcare Setting
SUBMISSION TYPE: New Project - Ceding Request
ACTION: Request to Cede IRB Review APPROVED
EFFECTIVE DATE: December 10, 2019
REVIEW TYPE: Administrative Review

Thank you for your submission to the Catholic Health Initiatives Institute for Research and Innovation Institutional Review Board (CHIRB). The CHIRB has APPROVED your request to rely upon the North Dakota State University IRB.

The reviewer acknowledges the Investigator's plan to record deidentified data on a personal computer. The reviewer requests the Investigator work closely with the Project Mentor and Centura IT to assure appropriate data security safeguards are in place for this study.

Please note the following:

1. **It is your responsibility to obtain any additional local institutional or departmental required approvals prior to initiating your study**
2. **You must submit a modification request to CHIRB when there is a change in personnel working on this study.**
3. **You must notify the CHIRB when the study is closed at the North Dakota State University IRB**
4. **You must notify the CHIRB when the North Dakota State University IRB makes a determination of an Unanticipated Problem involving risks to subjects or others, serious or continuing noncompliance, or suspension or termination of IRB approval**

If you have any questions at any time, please feel free to contact the CHIRB at 1-844-626-2299 or CHIRB@CatholicHealth.net. Please include your project title and reference number in all correspondence with the CHIRB so that we can best assist you

Thank you.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Catholic Health Initiatives Institute for Research and Innovation Institutional Review Board (CHIRB)'s records.

Executive Summary

Improving the Diagnosis and Management of BPPV in a Rural Healthcare Setting



Recommendations

Providers should familiarize themselves with BPPV guidelines and focus on diagnostic and canalith repositioning maneuvers because:

- ⇒ Performing canalith repositioning maneuvers (CRM) at the time of visit can improve patient's symptoms in 80% of cases after a single maneuver
- ⇒ Performing CRMs can allow patients to return to work and their normal lives sooner while reducing their risk of injury related to falls
- ⇒ Performing diagnostic and CRMs can reduce the rate of costly diagnostic imaging and referrals to physical therapy or ear, nose, and throat specialists
- ⇒ Providers can bill for CRMs using the CPT code 95992 with reimbursement rates around \$35-\$55 per maneuver.

Introduction

Benign paroxysmal positional vertigo or BPPV is a condition characterized by intermittent spinning episodes that occur with a rapid change in head position. Although BPPV is often considered benign, it has many personal, social, health, and financial implications. Yet, providers in a variety of settings often mismanage the condition resulting in incomplete resolution of symptoms, decreased quality of life, reduced productivity, and an overall increase in healthcare spending.

Purpose

The purpose of this project was to educate rural providers regarding current evidence-based guidelines on the diagnosis and management of BPPV in order to increase guideline adherence and develop provider self-efficacy with hopes of improving patient outcomes.

Project Design and Implementation

- A 45-minute education session was presented to emergency, specialist, and primary care providers working in Summit County, CO that covered a wide array of BPPV-specific content. Knowledge on the topic was evaluated using pre- and post-education questionnaires.
- A 16-month retrospective chart analysis on patients visiting a Summit County emergency department was also performed and compared provider management of BPPV prior to and following the education session by evaluating the following:
 - ⇒ The performance of diagnostic maneuvers
 - ⇒ The utilization of radiographic imaging
 - ⇒ The performance canalith repositioning maneuverers
 - ⇒ The prescription of vestibular suppressants upon discharge

Results and Conclusion

Results from the pre- and post-education questionnaires demonstrated an overall improvement in the understanding of BPPV guidelines as evidence by an increase in the percentage of correct responses following the education session (86.7%) compared to pre-education (61.8%). The majority of participants found the information to be quite useful and anticipated making practice changes as a result. Unfortunately, no conclusion could be made as to the impact this education session had on improving long-term practices.

Qualitative results were consistent with current literature that identified difficulty in interpreting nystagmus patterns and recalling how to perform the various maneuvers as major barriers to following guidelines. By addressing barriers and providing BPPV-specific education, providers can improve the health of their patients, reduce unnecessary healthcare costs, and still bill for the additional effort.

Recommendation for Future Studies

Future studies should be performed to evaluate the effectiveness of BPPV-specific education on long-term provider practices. A similar study should include a larger participation pool and longer analysis period to evaluate for lasting change.