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Mini Review article

Vertigo and dizziness in the elderly

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Vertigo and dizziness in the elderly

Lara Fernandez, Hayo A Breinbauer and Paul Hinckley Delano

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Abstract

The prevalence of vertigo and dizziness in people aged more than 60 years reaches 30%, and due to aging of world population, the number of patients is rapidly increasing. The presence of dizziness in the elderly is a strong predictor of falls, which is the leading cause of accidental death in people older than 65 years. Balance disorders in the elderly constitute a major public health problem, and require an adequate diagnosis and management by trained physicians. In the elderly, common causes of vertigo may manifest differently, as patients tend to report less rotatory vertigo and more nonspecific dizziness and instability than younger patients, making diagnosis more complex. In this mini review, age-related degenerative processes that affect balance are presented. Diagnostic and therapeutic approaches oriented to the specific impaired system, including visual, proprioceptive, and vestibular pathways are proposed. In addition, presbystasis -the loss of vestibular and balance functions associated with aging-, benign paroxysmal positional vertigo, and stroke (in acute syndromes) should always be considered.

Keywords: dizziness, presbystasis, vertigo, falls, elderly, aging.

60 **Introduction**

61 The terms dizziness and vertigo cover a variety of symptoms regarding disorders of
62 spatial orientation and motion perception, such as the illusion of rotatory motion (classical
63 rotatory vertigo) or the feeling of unsteadiness, which can affect objectively the ability to achieve
64 a stable gaze, posture and gait (Jonsson *et al.*, 2004). Altogether they represent a common and
65 serious issue in the elderly, where its prevalence reaches 30% beyond 60 years of age (Jonsson *et*
66 *al.*, 2004; Barin and Dodson, 2011), while rising to 50% beyond 85 years (Jonsson *et al.*, 2004).

67 The sole presence of dizziness in the elderly is a strong predictor of falls (Agrawal *et al.*,
68 2009). Moreover the presence of abnormal balance tests increases the risk of hip and wrist
69 fractures (Ekvall Hansson and Magnusson, 2013). Injuries related to falls lead to mobility
70 restriction and loss of independence, and increase the fear of falling, which also predicts
71 subsequent falls (Barin and Dodson, 2011). In addition, falls are the leading cause of accidental
72 death in persons older than 65 years (Kannus *et al.*, 1999), while dizziness is one of the strongest
73 contributors to the disability burden after age 65 (Mueller *et al.*, 2014).

74 Although the majority of these patients present benign balance disorders, (Tuunainen *et*
75 *al.*, 2012; Batuecas-Caletrio *et al.*, 2013; Piker and Jacobson, 2014), in the elderly, common
76 causes of vertigo may manifest differently, with a more confusing constellation of symptoms, as
77 patients tend to report less rotatory vertigo and more nonspecific dizziness and instability than
78 younger patients presenting with the same condition (Piker and Jacobson, 2014). Underlying this
79 phenomenon is the progressive multimodal impairment of balance, including the loss of
80 vestibular and proprioceptive functions, and the impairment of central integration of these and
81 other sensory inputs associated with aging, which may also be called, presbystasis,
82 presbyequilibrium or multisensory dizziness (Tuunainen *et al.*, 2011; Tuunainen *et al.*, 2012;
83 Ekvall Hansson and Magnusson, 2013). In addition, the skeletal muscle strength and mass are
84 reduced with aging, increasing the risk of fall-related injuries in elderly patients (Woo and Kim,
85 2014).

86 On the other hand, a small number of patients harbor a serious and potentially life-
87 threatening cause, mainly associated with stroke, and this risk of more serious diagnoses
88 increases with age (Dagan *et al.*, 2012; Saber Tehrani *et al.*, 2014). Altogether, vertigo, dizziness,
89 and balance disorders in the elderly constitute a major public health issue, which needs adequate

management by trained physicians. This mini review presents recent advances in the diagnosis and management of dizziness in elderly patients.

Pathophysiology of balance in the elderly

Age-related degeneration of different neural structures affects balance, including the vestibular receptors, central vestibular neurons, the cerebellum, and visual and proprioceptive pathways. The number of hair cells in the vestibular organs and the number of fibers in the superior and inferior vestibular nerves decrease with age (Johnsson, 1971; Richter, 1980; Merchant *et al.*, 2000). From a functional perspective, age-related deficits appear to be larger on semicircular canals, followed by saccular function, while the utriculus remains less affected (Agrawal *et al.*, 2013b; Davalos-Bichara and Agrawal, 2014; Li *et al.*, 2015). A steady asymmetrical decrease in the ability of sensing angular rotation with age has been reported, as assessed by video head impulse testing (vHIT) of the vestibulo-ocular reflex (VOR) (Agrawal *et al.*, 2013a; Ekvall Hansson and Magnusson, 2013; Li *et al.*, 2015). This fact is associated with a loss of dynamic visual acuity due to the inability to compensate fast head rotations with corrective eye movements, thus assuring a steady image over the retina (Ishigaki and Miyao, 1994). However, while on the acute phase of vestibular loss this may cause intense rotatory vertigo (due to a sudden vestibular asymmetry), on elderly patients the slow onset of these chronic impairments would not manifest with vertigo. Instead, they complain about movement intolerance, instability, and insecure gait, particularly when sudden turns are needed, as there is an incapability of processing these movements properly. This may also explain the observed lack of rotatory vertigo in elderly patients with benign paroxysmal positional vertigo (BPPV) (Batuecas-Caletrio *et al.*, 2013).

Nevertheless, while "active" vestibular symptoms may be milder or shifted towards instability, functional balance performance and disequilibrium phenomena are actually more severe. The sole presence of VOR asymmetry (which may present in elderly patients without history of an acute vestibular syndrome, and not rarely in the form of bilateral vestibulopathy) is a significant predictor of falling (Ekvall Hansson and Magnusson, 2013; Tuunainen *et al.*, 2014). In addition, compensation phenomena after vestibular loss are weakened in elderly patients, for example, impairment after vestibular neuritis is harsher on the elderly (Fujimoto *et al.*, 2014).

Behind this lies degeneration of multiple non-vestibular subsystems. For instance, the medial vestibular nucleus, important in vestibular compensation due to its commissural fibers, shows lower neuron density in healthy older adults (Alvarez *et al.*, 1998). There is also a mean loss of cerebellum Purkinje cells of about 2.5% per decade (Yesmin *et al.*, 2011). Vibration and touch thresholds, the ability to detect position and direction of joint movements, and muscle strength also deteriorate with age (Barin and Dodson, 2011). Visual accommodation, depth perception, and the ability to suppress nystagmus by visual fixation is diminished due to aging of the oculomotor system with increased saccade latency, and reduced eye tracking velocity (Barin and Dodson, 2011).

Similarly, elderly patients with chronic pathological asymmetric vestibular evoked myogenic potentials (VEMP) or deviated subjective visual vertical (SVV) tests, do not report dizziness or vertigo as significant symptoms, which may relate to central compensation occurring from the beginning of this slow onset of vestibular function. (Tourtillott *et al.*, 2010; Davalos-Bichara and Agrawal, 2014; Sun *et al.*, 2014; Li *et al.*, 2015). This scenario leads to no pathological symptoms at all. Therefore, it is still controversial whether presbystasis by itself should be always considered pathological or not.

In summary, in order to maintain balance, the brain uses all available sensorial cues from vestibular, visual, and proprioceptive inputs, which in turn are integrated by the central nervous system to execute adequate motor responses. In this manner, age-related balance deterioration does not appear to behave as a unique standardized phenomenon, but the opposite: it seems to be extremely variable from patient to patient (Agrawal *et al.*, 2013a; Agrawal *et al.*, 2013b; Davalos-Bichara and Agrawal, 2014; Sun *et al.*, 2014). Moreover, minor new or acute impairments can affect disproportionately their capacity to cope difficult equilibrium scenarios, as every sensory modality may already be partially deteriorated. Current knowledge is moving towards determining which abnormalities in balance testing relate to higher risk of falling, and towards a balance disorder "profile" of selective impairments which, as we propose, may guide a target-specific treatment (Alrwaily and Whitney, 2011; Cabrera-Kang and Tusa, 2013; Deveze *et al.*, 2014). While asymmetric, severe, and multimodal balance impairments due to aging are likely to cause symptomatology per se, the magnification and distortion of the symptom spectrum

149 of specific pathologies by presbystasis is perhaps more common. All these factors should be
150 taken into account in the diagnosis and management of elderly patients.
151
152 **Diagnosis of dizziness in the elderly**
153 Reaching a complete, meaningful and treatment-oriented diagnosis in elderly dizzy
154 patients remains an important challenge for even the most experienced clinician. Obtaining a
155 good clinical history can be a tough task. It has been reported than more than half of elderly
156 patients with balance disorders are vague, inconsistent, or contradictory in describing their
157 symptoms (Newman-Toker *et al.*, 2007). Besides, there is not a single symptom that can predict
158 with specificity the underlying causes of dizziness, and most of the times elderly patients have
159 more than one cause of dizziness (Lawson *et al.*, 1999; Kerber *et al.*, 2006). Moreover, caloric
160 test responses depend on several factors that could be affected by age, such as ear canal volume,
161 temporal bone thickness, and blood supply to the temporal bone (Enrietto *et al.*, 1999). Several
162 studies have found that caloric responses tend to increase in middle age with a peak between 50
163 and 70 years, and then decline modestly thereafter (Bruner and Norris, 1971; Mulch and
164 Petermann, 1979).
165 A systematic assessment of balance should be achieved in this type of patient, for which
166 recent technological developments are of great assistance. The impairment of each of the three
167 semicircular canals can be examined by means of vHIT (MacDougall *et al.*, 2009) procuring a
168 reliable, objective, and quantitative value for VOR. Ocular and cervical VEMPs give equally
169 reliable information over utricular and saccular function independently (Brantberg, 2009). The
170 non-vestibular proprioceptive and visual sensory components of balance and their central
171 integration in overall equilibrium performance can be thoroughly assessed by dynamic computed
172 posturography (Soto-Varela *et al.*, 2014). Altogether these tests provide an objective assessment
173 of every component and subsystem of balance, allowing specific profiling of patients (Curthoys
174 *et al.*, 1995; Curthoys, 2012).
175 Besides HIT, the SVV bucket test and modified Romberg and Fukuda tests represent low
176 complexity alternatives for the same assessment, and may be used to develop simple, low-cost
177 and quick screening procedures (Agrawal *et al.*, 2013a; Cohen *et al.*, 2014). SVV by means of
178 bucket test may even provide sensible assessment of utricular components beyond VEMP

179 contributions (Sun *et al.*, 2014). Head-shaking nystagmus and dynamic visual acuity testing
180 among others constitute bedside, fast, inexpensive, and easy to interpret vestibular tests for VOR
181 (Tuunainen *et al.*, 2012; Ekvall Hansson and Magnusson, 2013; Davalos-Bichara and Agrawal,
182 2014). Testing for postural hypotension, joint position sense, and gait disorders can also
183 contribute to assess non-vestibular components in a bedside low-cost manner, contributing to
184 designing an integral but component-specific treatment.

185 A particular scenario exists in acute onset of severe dizziness or vertigo: an acute
186 vestibular syndrome, where ruling out stroke is critical, particularly in the elderly. The HINTS
187 assessment protocol (head impulse test, nystagmus directionality, and test of skew) can be
188 performed at the bedside, with high sensitivity and specificity to diagnose stroke in an acute
189 vestibular syndrome (Kattah *et al.*, 2009). This three-step bedside oculomotor examination has
190 shown better sensitivity than early magnetic resonance imaging (MRI). MRI can give a false
191 negative result in vertebrobasilar stroke (Oppenheim *et al.*, 2000), and is not always readily
192 available (Edlow *et al.*, 2008). A full description of the management of acute vertigo in the
193 elderly is beyond the scope of this mini-review, further readings can be obtained elsewhere
194 (Newman-Toker *et al.*, 2013 ; Saber Tehrani *et al.*, 2014).

195 Also of note is positional testing for BPPV. This clinical entity accounts for one in every
196 three causes of dizziness in the elderly. With a simple diagnosis–treatment scheme (even in the
197 absence of rotatory symptoms), testing should be performed routinely (Batuecas-Caletrio *et al.*,
198 2013). Consequently, to seek a precise diagnosis, it seems to be mandatory to obtain a good
199 clinical history and perform thorough neuro-otologic bedside examination, including postural
200 testing, while the majority of patients may benefit from vestibular tests, and stroke assessment
201 protocols for an acute balance disorder.
202
203 **Etiology**
204 The majority of diseases that cause dizziness in any age group become more prevalent in
205 older individuals. This can be explained by the cumulative probability of exposure or by age-
206 related changes that make the elderly more susceptible to these pathologies (Lo and Harada,
207 2013). A summary of the main causes of dizziness in the elderly is shown in Table 1.
208

209 **Management of elderly patients with dizziness**

210 As with younger patients, disease-specific therapies should be provided, such as
211 repositioning maneuvers for BPPV and rehabilitation exercises for vestibular hypofunction.
212 Nevertheless, special consideration is needed for elderly. A flowchart for the management of
213 these patients is proposed in Figure 1. A high level of suspicion for BPPV should be maintained.
214 In dubious cases, treatment attempts should be preferred, given diminished symptomatology and
215 the safety and simplicity of reposition maneuvers (Bhattacharyya *et al.*, 2008).

216 In acute syndromes, stroke should always be ruled out by HINTS. Vestibular suppressants
217 should be tapered quickly, due to their inhibitory effect on central compensation (Strupp and
218 Brandt, 2009). Although steroids have been proven to diminish functional loss over time, they
219 may not contribute to acute symptomatic relief (Strupp *et al.*, 2004). Steroids side effects, should
220 be carefully considered before administration, particularly on this age group.

221 Current knowledge advises the initiation of vestibular rehabilitation (VR) as soon as
222 possible after an acute vestibular syndrome (Cabrera-Kang and Tusa, 2013; Deveze *et al.*, 2014).
223 VR works as a catalyzer and enhancer of central compensation on the basis of three principles:
224 adaptation (rearrangement of VOR networking), substitution (strengthening of non-vestibular
225 components of balance), and habituation (increase of sensory thresholds).

226 Chronic dizziness derived from previously acquired vestibular loss (vestibular neuritis,
227 bilateral vestibulopathy among others) has good results with VR, particularly in terms of
228 independence and quality of life, although it may need longer and more intensive therapy (Jung *et*
229 *al.*, 2009; Alrwaily and Whitney, 2011). Moreover, VR is indicated in presbystasis, whereas the
230 objective is to reduce symptoms or decrease the risk of falling (Cabrera-Kang and Tusa, 2013;
231 Deveze *et al.*, 2014; Huang *et al.*, 2014). In addition, if there are deficits in lower extremity
232 muscle strength, specific therapies directed to locomotor dysfunctions should be indicated (Howe
233 *et al.*, 2011). Proper balance characterizations may help in designing more specific and efficient
234 interventions. For instance a patient lacking postural stability will require postural- and gait-
235 focused therapy. Care should be taken in focusing therapy on ongoing symptoms rather than
236 solely on testing abnormalities, as certain patients could require other treatments prior to benefit
237 from VR, such as in the case of vestibular migraine, or visually induced dizziness, among others.

238 Importantly, spontaneous compensation strategies differ among patients (half of the
239 population tend to rely on visual cues while the other half rely on postural information),
240 supporting the need for customized rehabilitation programs (Deveze *et al.*, 2014). Computerized
241 dynamic posturography seems to allow such a characterization, while being a reliable objective
242 measurement of the "amount" of unbalance and risk of falling, and monitoring progress (Deveze
243 *et al.*, 2014).

244 Initiatives using Internet resources and mobile devices to support adherence and the
245 realization of rehabilitation exercises at home have been developed (Geraghty *et al.*, 2014; Huang
246 *et al.*, 2014). Other balance-improving treatments being currently explored include biofeedback
247 devices worn all day, which give tactile or acoustic cues when the center of gravity is being lost,
248 allowing the patient to react accordingly (Horak *et al.*, 2015). In severe cases of bilateral VOR
249 loss and inadequate compensation strategies, the role of vestibular implants (devices similar in
250 their concept to cochlear implants) is beginning to be explored, and interventions have already
251 been made in the first patients with satisfying functional outcomes (Pelizzone *et al.*, 2014).
252
253 **Conclusions**

254 Dizziness in the elderly remains a difficult subject, given the underlying factor of
255 vestibular impairment due to aging in the form of presbystasis. The diagnostic and therapeutic
256 approach must be multi-systemic and oriented to the visual, proprioceptive, and vestibular
257 systems. BPPV and stroke (particularly in acute syndromes) should always be considered, given
258 the frequency of the first and the severity of the latter.

259 Current vestibular testing allows a complete characterization of balance function and its
260 deficits, and is becoming useful as a guide to planning treatment, where a cause-specific
261 pathology is present, or presbystasis is the sole issue. Under this last condition, VR should be
262 considered in the elderly where no other plausible balance disorder is suspected, in order to treat
263 a probably symptomatic presbystasis. Here, resolution of symptomatology would confirm the
264 assumed working hypothesis of presbystasis, while lack of progress would lead to further
265 exploration of less common causes.

266 Future challenges on the subject include the further determination of vestibular
267 impairment profiles and their specific VR alternatives, in order to achieve the shortest and most

efficient therapy possible. However, research should also focus on preventive efforts to avoid falls. The threshold between what may be considered non-significant vestibular abnormalities and those correlating with a higher risk of falling should be better explored. This will inevitably lead to the establishment of a reasonable battery of (hopefully, bedside, low-cost, easy to interpret) examinations designed to rule out unacceptable risk for falling, in the fashion of the HINTS protocol for stroke.

Acknowledgments

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Table 1. Etiology of dizziness and vertigo in the elderly	
Peripheral vestibular	Benign paroxysmal positional vertigo Vestibular neuritis Bilateral vestibular loss Late-onset Meniere's disease or decompensation (Barin, 2011), Labyrinthitis Occlusion of the Anterior Vestibular Artery (Pardal Refoyo et al., 1998)
Central nervous system	Vestibular migraine (Furman, 2015) Transient ischemic attack of vertebrobasilar artery (Paul et al., 2013) Stroke Neurodegenerative disorders (Strupp et al., 2014) Downbeat and upbeat nystagmus syndromes (Strupp et al., 2014)
Cardiovascular (Barin, 2011)	Arrhythmia Postural hypotension Congestive heart failure Heart valve failure
Medications (Shoair et al., 2011)	Antihypertensive Benzodiazepines Hypnotics Anxiolytics Antiepileptic
Multimodal balance disorder	Presbystasis (Tuunainen et al., 2011)
Others	Primary and secondary neoplasia (breast and prostate) (Gloria-Cruz et al., 2000; Alvo et al., 2012) Somatoform vertigo and psychiatric dizziness (Staab, 2006) Musculoskeletal system disorders Propioception and somatosensory loss

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459 FIGURE 1| **Proposed flowchart for the management of dizziness in elderly patients.** An
460 accurate anamnesis and physical examination will determine further vestibular, neurological, or
461 cardiovascular tests. Patients with chronic vertigo should be evaluated with Dix – Hallpike
462 maneuvers. After that, and depending on the available resources, office or laboratory tests help to
463 estimate the risk of falling and define the balance profile to guide the management of these
464 patients. On the other hand, every acute patient should be evaluated with the HINTS protocol.
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FACULTAD DE MEDICINA
UNIVERSIDAD DE CHILE

CERTIFICADO DE DISPONIBILIDAD PRESUPUESTARIA

Lo dispuesto en el Decreto N° 2075 de 2015, certifico que, a la fecha del presente documento 19 de Junio del 2015, la Facultad de Medicina de la Universidad de Chile cuenta con presupuesto para el financiamiento del siguiente Servicio y/o producto de: pago por publicación de un artículo en Revista Internacional., solicitado por el Proyecto Fundación Puelma – Programa Fisiología, según centro ejecutante Nº 560167, cuyo monto es U$ 875.00 (ochocientos setenta y cinco mil dólares) más gastos de transferencia bancaria. (Solicitud N° 487777).

CLAUDIO OYANEDEL VEGA

Director Económico y de Gestión Institucional

Facultad de Medicina

CNV/SJP/ ccv

FACULTAD DE MEDICINA
UNIVERSIDAD DE CHILE

Solicitud: 487777

TERMINOS DE REFERENCIA PARA TRATOS DIRECTOS

I. SERVICIO O PRODUCTO A ADQUIRIR

El Proyecto Fundación Puelma – Programa Fisiología, perteneciente a la Facultad de Medicina de la Universidad de Chile, requiere el servicio de pago por publicación de un artículo en Revista Internacional. Lo anterior, se fundamenta en lo señalado por el Dr. Paul Delano Reyes., Investigador Principal Proyecto Fundación Puelma – Programa Fisiología, según fecha 09 Junio de 2015.

II. CAUSAL DE TRATO DIRECTO

Que, según lo indicado se configura la causal establecida en el N°7 letra K del artículo 10 del Reglamento de la ley de compras; esto es "Cuando se trate de la compra de bienes y/o contratación de servicios que se encuentren destinados a la ejecución de proyectos específicos o singulares, de docencia, investigación o extensión, en que la utilización del procedimiento de licitación pública pueda poner en riesgo el objeto y la eficacia del proyecto de que se trata. En estos casos, las entidades determinarán por medio de una resolución, disponible en el Sistema de información, los procedimientos internos que permitan resguardar la eficiencia, transparencia, publicidad, igualdad y no discriminación arbitraria en esta clase de adquisiciones", y la indicada en el Art. 3 N°3 y N°10 de la resolución 300 de 2010, de la Universidad de Chile.

III. MONTO DE LA CONTRATACIÓN Y/O ADQUISICIÒN

El monto de la adquisición con la empresa Frontiers Media SA es de U$ 875.00 (ochocientos setenta y cinco mil dólares) más gastos de transferencia bancaria.

IV. CONTRAPARTE TÉCNICA

La contraparte Técnica será el Dr. Paul Delano Reyes., Investigador Principal Proyecto Fundación Puelma – Programa Fisiología

V. REQUISITO Y CONDICIONES PARA EL PAGO

La Facultad realizará el pago en una cuota, según previa recepción conforme del producto o servicio y V°B° de la contraparte técnica.

VI. PLAZO Y EJECUCIÓN

- El plazo máximo de entrega por parte del proveedor inmediata, previa aceptación de orden de compras.
- El lugar de entrega será: Av. Independencia # 1027.

VII. ESPECIFICACIONES TECNICAS DEL PRODUCTO Y/O SERVICIO.

- Publicación de artículo: "Vertigo and dizziness in the elderly".