

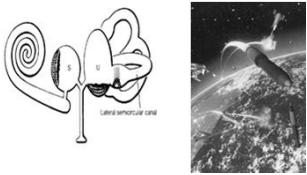
## Vestibular disorders Recognition and Medical Management

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## The ear is an inertial navigation device

- Semicircular Canals are rate sensors.
- Otoliths (utricle and saccule) are linear accelerometers
- Bilateral symmetry means redundant design.

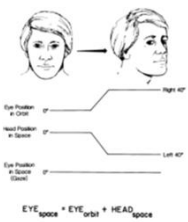



## Lecture plan

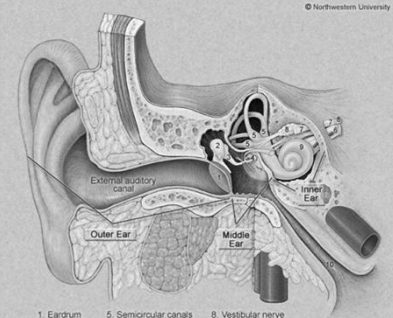
1. Review of anatomy/physiology
2. Medical treatments of vertigo
3. Vestibular disorders one by one.

## Vestibular Reflexes

- VOR: Vestibulo-ocular reflex
- VSR: Vestibulospinal reflex

## Important Ear Structures



© Northwestern University

1. Eardrum
5. Semicircular canals
8. Vestibular nerve
2. Malleus
6. Auditory nerve
9. Cochlea
3. Incus
7. Facial Nerve
10. Eustachian tube
4. Stapes

## Vestibular symptom patterns

- Nystagmus (imbalance between ears)
- Oscillopsia (low gain to one or both sides)
- Motion sickness (overly sensitive to conflict between ear/eye/somatosensation)

### Vestibular Nystagmus –result of imbalance in VOR

1. One whole side – lateral/rotatory
2. One horizontal canal → lateral nyst.
3. One vertical canal – mixed vertical/rotatory
4. Pure vertical or torsional – usually central

OCCULT

SHOW

A

RAC + LAC + I  
 RAC + RHC + I  
 RAC + RHC + I

### Vestibular nystagmus from one vertical canal Vertical/Torsion –posterior canal

(c) 2005 Timothy C. Hain, M.D.

### How to examine for Spontaneous Nystagmus

- Frenzel Goggles (best)
- Ophthalmoscope (good –but backwards)
- Gaze-evoked nystagmus (use Alexander’s law)
- Sheet of white paper (Ganzfeld – German for complete field)

### Downbeating Nystagmus (Central)

### Vestibular Nystagmus – from one horizontal canal

OCCULT

SHOW

A

RAC + LAC + I  
 RAC + RHC + I  
 RAC + RHC + I

### Upbeating Nystagmus (Central)

Torsional Nystagmus  
(Central)



Part 2

Drugs used to treat dizziness

Oscillopsia



Processes we might try to treat  
with medications

- Vertigo and nystagmus
- Motion sickness, emesis
- Compensation for vestibular loss
- Migraine

Patients with complete Bilateral  
loss have no VOR.

Processes we might NOT try to  
treat with medications


- Low VOR gain such as ototoxicity
- BPPV (best managed with physical treatments)
- Malingers (legitimate treatment facilitates their fraud)

### Main drug categories for vertigo/nystagmus

- Anticholinergic
- GABA agonists
- Everything else

### Anticholinergic side effects (Locoweed poisoning)

- Confusion (similar to drug induced Alzheimer's)
- Dry mouth, loss of sweating
- Urinary hesitancy/stoppage. Constipation
- Blurry vision
- Cardiac conduction block
- Addiction with dizziness on withdrawal



*Oxytropis lambertii*

### Anticholinergics

CC(=O)OCCN(C)C


- Block central and peripheral ACH
- Reduce vertigo and nausea from peripheral vertigo
- Reduce central nystagmus (in very high doses)
- Numerous interesting side-effects →

### H1-antihistamines with strong anticholinergic properties

- meclizine (Antivert, Bonine)
- dimenhydrinate (Dramamine)
- diphenhydramine (Benadryl)

**Antihistamines must cross BB barrier -- i.e. OTC fexofenidine, loratidine, cetirizine do not work for dizziness**


### Scopolamine Muscarinic antagonist



- Scopolamine (Transderm-Scop patch)
- Transderm does not require ingestion (but many other oral GI drugs do same thing – Levsin and Robinul for example).
- Apply every 3 days to skin surface
- Withdrawal syndrome and CNS side effects limit use

### Antihistamine side effects

- Sleepiness
- Weight gain

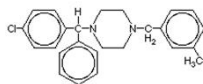


### Anticholinergic side effects

- Dry mouth and eyes
- Constipation
- Confusion

### meclizine (Antivert, Bonine)

- 12.5 TID or 25 TID. Lasts about 8 hours. Available OTC.
- Limitation is sedation and anticholinergic side effects
- Pregnancy: category B. May be best drug



C<sub>20</sub>H<sub>27</sub>ClN<sub>2</sub>



### Dosing: beer scale 1 glass of beer =

- 2 mg of diazepam (Valium)
- 0.5 mg of lorazepam (Ativan)
- 0.5 mg of clonazepam (Klonopin)



### GABA agonists (benzodiazepines)

- Modulate inhibitory transmitter GABA
- Reduce vertigo and nausea from peripheral vertigo
- Reduce nystagmus
- Sedation, addiction limit usefulness
- ? May impede compensation (strangely, no evidence in humans for this)

### Benzodiazepines

- Should discourage benzodiazepines whenever practical (this does not always work).
- Benzodiazepines to discourage especially
  - Large doses of any benzodiazepine
  - Alprazolam (xanax) (high addiction)
  - Valium in 5mg+ doses (high addiction)

### Benzodiazepines

- Valium (diazepam, “Mothers little helper”)
- Ativan (lorazepam)
- Klonopin (clonazepam)



### Benzodiazepines Bottom line

Extremely useful drugs for symptoms  
Treat dizziness and anxiety  
Dependency is the big problem

## Diuretics

- Dyazide and Maxide (Hctz+triamterine)
  - Menieres
- Diamox (acetazolamide)
  - Menieres
  - Migraine
  - Periodic ataxia
- Lasix
  - Not a good idea – causes hearing loss and hypokalemia

## Emesis



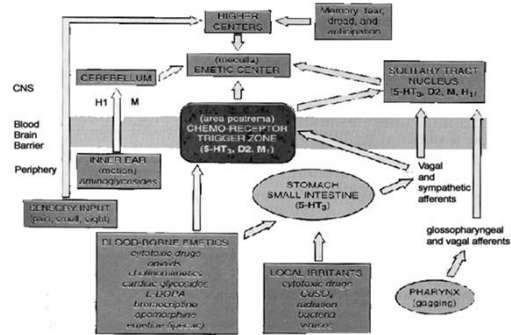
FIGURE 1.—Egyptian lady vomiting.

Source: Nasa vestibular symposium  
<http://ix.nasa.gov/search.jsp?R=19740010641&q=-N%3D4294924209%2B4294946827>

## Drugs of unclear utility

- Beta-histidine (Serc) →
- Baclofen (occasionally useful)
- Alternative medications
  - Vertigo-HEEL (homeopathic)
  - Ginkgo-Biloba (very weak evidence)

## Vomiting is complex



## Betahistidine (Serc)

- FDA position is that it is a placebo
- Readily available from compounding pharmacies, including Walgreens
- Weak H1 agonist and H3 blocker (which results in some Histamine agonism)
- Author's experience – Useful for motion intolerance and Meniere's.


\*Kingma H, Bonink M, Meulenbroeks A, Konijnenberg H. Dose-dependent effect of betahistidine on the vestibulo-ocular reflex: a double-blind placebo controlled study in patients with paroxysmal vertigo. Acta Otolaryngologica 117(5):641-6, 1997

## Drugs used for treatment of emesis

- MOST IMPORTANT**
- 5-HT<sub>3</sub> antagonists
  - Dopamine blockers
  - Anticholinergics (OTC)
  - H1 antihistamines
  - Benzodiazepines

**odansetron (Zofran)**  
5HT3 receptor antagonist

- Dose: 8 mg PO. MLT form is fast acting, regular 8mg SL is cheaper.
- Category B in pregnancy (probably safe)




**Dr. Hain's drug of choice to use prior to nauseating PT session.**  
**Generic non-MLT is available (\$.35/pill)**


## Compensation

**Commonly used phenothiazine antiemetics**  
dopamine blockers

prochlorperazine (Compazine)  
5, 10 and 25 mg forms, including rectal suppositories. Pregnancy -- unknown



promethazine (Phenergan).  
12.5, 25, 50 mg forms, including rectal suppositories. 12.5 BID prn oral dose typical. Pregnancy Cat. C





## Compensation -- subtypes

- **Static compensation** – recovery from tone imbalance (vertigo).
  - Largely automatic and not likely to be modified by drugs.
- **Dynamic compensation (oscillopsia)** – readjust gain.
  - Takes some time, modifiable by medications.

**Commonly used phenothiazine antiemetics**  
dopamine blockers

- Powerful drugs
- Major side effects
- Use if you have a big vomiting problem

## Compensation -- goal

- Facilitate compensation for static vestibular lesions or central problems. (i.e. vestibular neuritis, bilateral loss)

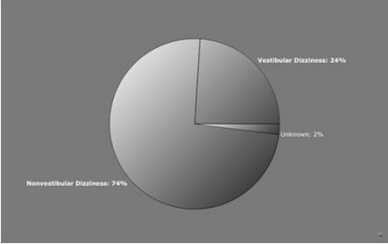
### Drugs that accelerate dynamic compensation (in animals)

- Amphetamines
- Bromocriptine (Dopamine agonist)
- ACTH (adreno-corticotrophic hormone)
- Caffeine

Modified from Brandt, 1991

### Epidemiology of Dizziness

Vestibular is about 1/4



29.5% lifetime prevalence of dizziness or vertigo  
7% lifetime prevalence of vestibular vertigo, 1-year prevalence is 5.2%

Neuhauser et al, Neurology 65:898-904 2005

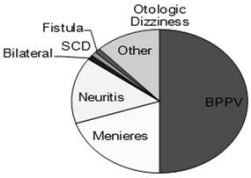
### Drugs that retard dynamic compensation in animals

- Phenobarbital (sedative, barbituate)
- Dopamine antagonists (e.g. Lisuride, Thorazine)
- ACTH antagonists (e.g. steroids). Steroids seem to help in people !
- Diazepam, (GABA agonist, Valium).

Modified from Brandt, 1991

### Otologic (Ear) Dizziness

- BPPV (benign paroxysmal positional vertigo) -- about 50% of otologic, 20% all
- Meniere's disease -- about 20%
- Vestibular neuritis and related conditions (15%)
- Bilateral vestibular loss (about 1%)
- SCD and Fistula (rare but worth knowing)



## Part 3

### Causes of Dizziness and their treatment

### Positional Vertigo

The most common syndrome

- **Benign Paroxysmal Positional Vertigo (BPPV) -- bed spins**
  - Orthostatic hypotension (dizzy upright)
  - Central positional nystagmus (dizzy everywhere)
  - Low CSF pressure syndrome (dizzy upright)



## Benign Paroxysmal Positional Vertigo (BPPV)

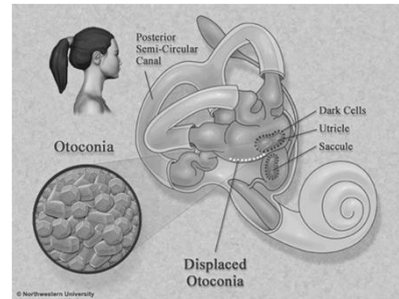
61 Y/O man slipped on wet floor.

LOC for 20 minutes.

In ER, unable to sit up because of dizziness

Hallpike Maneuver: Positive

BPPV Mechanism: Utricular debris migrates to posterior canal



## Positional Vertigo Dix-Hallpike Maneuver



## BPPV treatment

- Medication (e.g. Antivert/zofran) – minor benefit
  - May avoid vomiting by pretreating
- Excellent response to PT
- Surgery – canal plugging if rehab fails (need more rehab after plug). Rarely done.



## Benign Paroxysmal Positional Vertigo (BPPV)

- 20% of all vertigo, roughly 2% population/year
- Brief and strong
- Provoked by change of head position
- Definitely diagnosed by Hallpike test

## Unilateral Vestibular

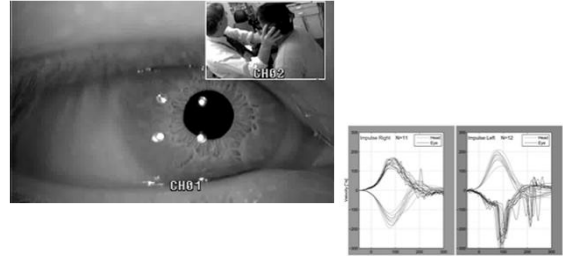
- Vestibular Neuritis/Labyrinthitis (common)
- Meniere's disease (unusual, 1/2000 prevalence)
- Acoustic Neuroma (rare)
- Vestibular paroxysmia (not sure how common)

### Vestibular Neuritis: Case

56 y/o woman began to become dizzy after lunch. Dizziness increased over hours, and consisted of a spinning “merri-go-round” sensation, combined with unsteadiness.

Vomiting ensued 2 hours later, and she was brought by family members to the ER.

### HIT test should be positive



### Vestibular Spontaneous Nystagmus seen with video Frenzel Goggles

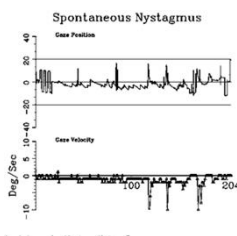


### Vestibular Neuritis -- rx

- Disturbance of unknown cause (Viral ? Vascular) involving vestibular nerve or ganglion
- Off work -- usually 2 weeks. Sometimes 2 mo.
- Symptomatic Rx (meclizine, phenergan, benzodiazepine)
- Rehab if still symptomatic after 2 months.
- These patients can and do still get BPPV !



### Vestibular Spontaneous Nystagmus recorded on ENG (Electronystagmography)



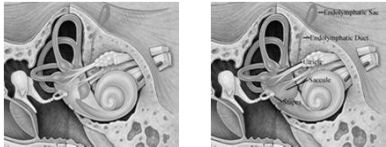
### Meniere's Disease

- Prosper Meniere
  - Fluctuating hearing
  - Episodic Vertigo
  - Fluctuating (roaring) Tinnitus
  - Aural Fullness
- About 1/2000 people in population
- Chronic condition – lasts lifetime



### Etiology of Meniere's (Dogma)

- Dilation and episodic rupture of inner ear membranes (Endolymphatic Hydrops)
- As endolymph volume and pressure increases, the utricular/saccular and Reissner's membranes rupture, releasing potassium-rich endolymph into the perilymph causing cochlear/vestibular paralysis



### Otolithic Crises of Tumarkin

- Drop attacks
- Go from upright to on floor in fraction of second
- No LOC
- Very dangerous
- Destructive treatment is best



### Meniere's disease – symptoms

- Progressive hearing loss -- usually go deaf
- Episodic vertigo – out of commission for several days
- Ataxia – gradually increases over years
- Visual sensitivity →



### Treatments of Menieres

- Medical management
  - Low sodium, betahistine
- Bad rehab candidate while fluctuating
- Surgery
  - Low dose gentamicin treatment works 85%
  - High dose gentamicin treatment (overkill)
- Rehab useful post destructive treatment

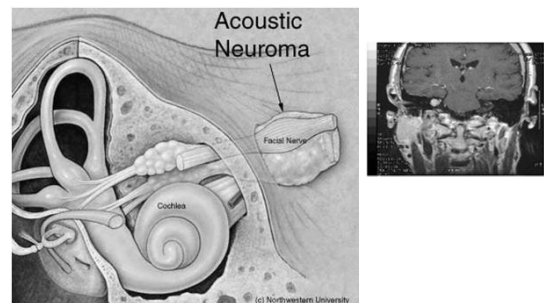
Hain TC, Ostrowski T. Unsteady Influence. Menieres disease. Advances for directors in rehabilitation October 2007,51-51

### Visual Sensitivity is common

- Sensory integration disorder – upweight vision, downweight everything else
- Grocery store, Omnimax, Target, etc
- Typical of disorders with intermittent vestibular problems

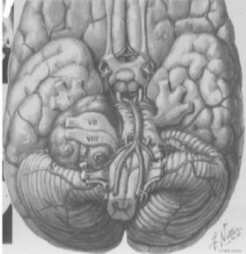


### Acoustic Neuroma




### Acoustic Neuroma

- Rare cause of unilateral vestibular loss
- Generally also deaf on one side
- Slowly progressive – little or no vertigo



### Clinical Diagnosis of MVC

- Quick spins
- May have nystagmus on hyperventilation
- Response to anticonvulsant
- No rehab potential



### Treatment of Acoustic Neuroma

- Watchful waiting (about 25%)
- Operative removal (about 50%) – losing ground
- Gamma Knife (about 25%) – gaining ground because effective and noninvasive.
- Good rehab candidate after surgery.

### Bilateral Vestibular Loss

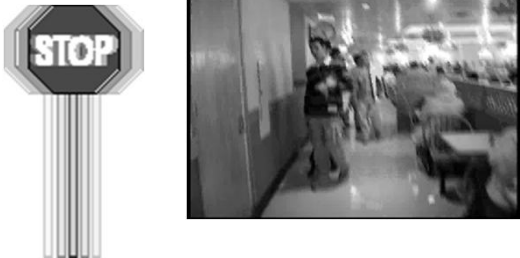
A stewardess developed a toe-nail infection. She underwent course of gentamicin and vancomycin. 12 days after starting therapy she developed imbalance. 21 days after starting, she was “staggering like a drunk person”. Meclizine was prescribed. Gentamicin was stopped on day 29. One year later, the patient had persistent imbalance, visual symptoms, and had not returned to work. Hearing is normal. She unsuccessfully sued her doctor for malpractice.

### Vestibular Paroxysmia (AKA microvascular compression)

- Irritation of vestibular nerve
- Quick spins, tilts, dips
- Motion sensitivity
- May follow 8<sup>th</sup> nerve surgery, Gamma knife treatment, acoustic neuroma



### SYMPTOMS OF BILATERAL VESTIBULAR LOSS

- OSCILLOPSIA




### SYMPTOMS OF BILATERAL VESTIBULAR LOSS

- ATAXIA

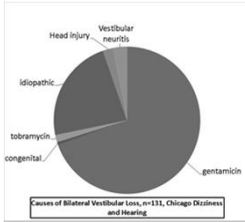
### Dynamic Illegible 'E' test (DIE test)

- Distance vision with head still
- Distance vision with head moving
- Normal: 0-2 lines change.
- Abnormal: 4-7 lines change



### Bilateral Vestibular Loss Causes:

- Ototoxicity !
- Bilateral forms of unilateral disorders (e.g. bilateral vestib neuritis)
- Congenital (e.g. Mondini malformation)
- idiopathic

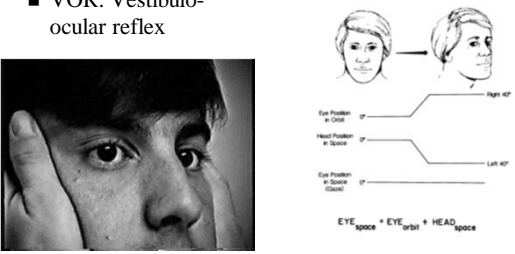


Causes of Bilateral Vestibular Loss, n=131, Chicago Doctors and Hearing

Hain, TC, Czerchi M, Yacovino DA. Bilateral Vestibular Loss. In Seminars in Neurology (ed Fife). 2013.

### Rapid Dolls failed

- VOR: Vestibulo-ocular reflex



EYE<sub>space</sub> = EYE<sub>orbit</sub> + HEAD<sub>space</sub>

### DIAGNOSIS IS EASY

- History of recent IV antibiotic medication
- Eyes closed tandem Romberg is positive
- Dynamic illegible 'E' test (DIE) failed

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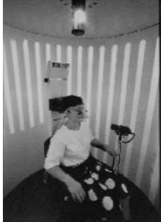
### LABORATORY DIAGNOSIS

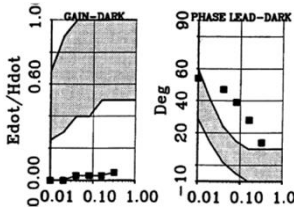
Everything should be "dead"

- ENG
- Rotatory chair
- VEMP (may remain in bilateral v. neuritis)

### DIAGNOSIS Continued


- Rotatory chair confirms diagnosis but requires cooperation





### Perilymph Fistula and SCD (superior canal dehiscence)

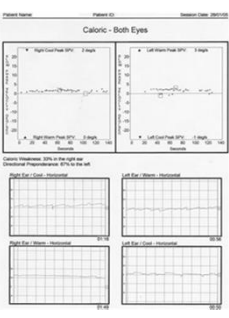
Fluctuating conditions  
No rehab until after surgery



- Superior Canal Dehiscence

### DIAGNOSIS Continued

- ENG shows little or no response




### Case: WS

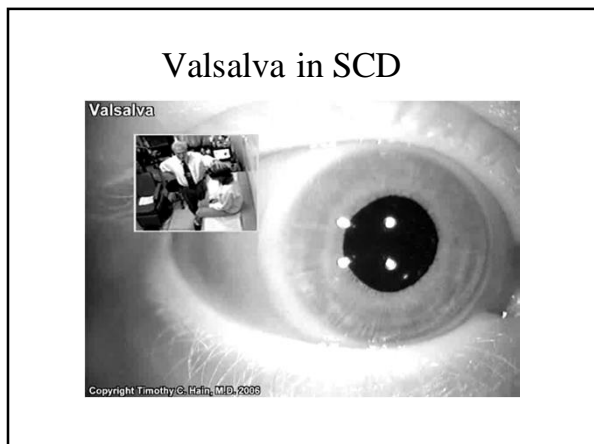
Retired plastic surgeon, with impaired hearing related to war injuries, found that when he went to church, when organ was playing, certain notes made him stagger. His otolaryngologist noted that during audiometry (with hearing aid in), certain tones reliably induced dizziness and a mixed vertical/torsional nystagmus. This “Tullio’s phenomenon” could be easily reproduced experimentally. MRI scan was normal.

### Treatment Bilateral

- No medical management (other than avoiding more damage)
- Outstanding rehab candidate
- Be prepared for a deposition

### Tullio in SCD





- ### Diagnosis of SCD
- History of sound and pressure sensitivity
  - Valsalva test is easiest bedside test
  - Temporal bone CT scan (0.6 mm, axial reformatted into oblique planes)
  - VEMP: Vestibular evoked myogenic potentials (screen with amplitude, then do threshold)



### Case: KF

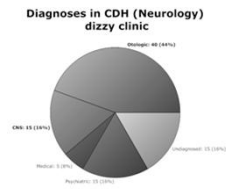
- After SCUBA diving, a young woman developed vertigo, aural fullness and tinnitus for 1 year.
- Symptoms were worsened by tragal pressure and straining. Surgery was performed.

- ### Superior Canal Dehiscence
- Etiology:
    - Congenital bone defect (2% ?)
    - Trauma may exacerbate
  - Treatment:
    - Do nothing
    - Surgical
      - > Plug
      - > Resurface
- 

A large round window fistula was found and symptoms completely resolved after a second surgery.

## Recap of diagnoses

- Otologic (30-50%) – BPPV, Menieres, VN.
- CNS (5-30%) – CVA, Migraine
- Medical (5%-30%) Orthostatic, drug
- Psychiatric (15-50%)
- Undiagnosed (15%)



## More details

Hain, T.C. Approach to the patient with Dizziness and Vertigo. Practical Neurology (Ed. Biller), Lippincott-Raven

## More movies

[www.dizziness-and-hearing.com](http://www.dizziness-and-hearing.com)