Acute vestibular syndrome – stroke vs. neuritis

PD Dr. med. Alexander A. Tarnutzer
Department of Neurology
University Hospital Zurich
EAN Spring School 2018
Staré Splavy, Czech Republic

Background

- Acute vertigo or dizziness
  - 3.3 to 4.4% of all ED consultations \( \rightarrow \) \~4.3 million consultations per year in the US
  - Annual costs of about 4 billion USD
- Broad differential diagnosis across many specialties. No single diagnosis makes up more than 5-10% of all cases.
- Isolated vertigo/dizziness \( \rightarrow \) complicates DDx
- Often imaging (CCT, CTA, MRI) with low diagnostic impact ordered.

\( \rightarrow \) Systematic approach is essential!

Misdiagnosis of stroke on ED

- The ED is a high-risk site for preventable errors.\(^1\)
- Among adverse events in the ED deemed negligent, most are diagnostic failures.\(^2\)
- Studies suggest that ED misdiagnoses may be unevenly distributed and disproportionate for neurologic conditions (deaths due to cerebrovascular events vs. myocardial infarction (45% vs. 1%, \( p<0.001 \)).\(^3,4\)
- Among major diagnostic errors reported by physicians, stroke is the fourth most common.\(^5\)

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Misdiagnosis of stroke on ED II

- Estimated prevalence of an initial misdiagnosis in the preceding 30 days: 1.2% to 12.7% of all hospital stroke admissions.\(^1\)
- Disproportionally higher odds for patients presenting with dizziness (OR=1.99, 95%-CI=1.03-3.84).\(^2\)
- Posterior- than ante: p<0.001.

\( \rightarrow \) Presenting symptoms may be an important predictor of misdiagnosis.

The dizzy patient – differential diagnosis on the ED

- Most frequent cases (based on several studies)
  - Neuro-otological diagnoses (peripheral and central) (13-34%)
  - Other neurological disorders (5-11%)
  - Cardiovascular disease including arrhythmia (4-21%)
  - Psychiatric disorders (2-14%)
  - Non-cardiovascular, internal-medicine related causes (8-28%)

Four-layer framework of the international classification of vestibular disorders

Six categories of vestibular syndromes

<table>
<thead>
<tr>
<th>Timing and trigger-based vestibular syndromes</th>
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<tbody>
<tr>
<td><strong>Obligate triggers</strong> Present</td>
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<tr>
<td>New, episodic</td>
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<tr>
<td>New, continuous</td>
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<tr>
<td>Chronic, persistent</td>
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</table>

Abbreviations: t-EVS, triggered episodic vestibular syndrome; s-EVS, spontaneous episodic vestibular syndrome; t-AVS, traumatic/toxic acute vestibular syndrome; s-AVS, spontaneous acute vestibular syndrome.

Structured history taking

- **Duration and frequency** of the single attacks?
- **Onset** of the attacks (abrupt vs. slowly)?
- **Provocation factors**?

A systematic approach to acute vertigo and dizziness

Structured history taking

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Duration and frequency of attacks

Typical duration of a single episode

Abbreviations: BPPV = benign paroxysmal positional vertigo; CPV = central positional vertigo; PFL = perilymph fistula; SSCDS = superior semicircular canal dehiscence syndrome; VP = vestibular paroxysmia.
Provocation factors

- Head inclination or reclination, turning over in bed, standing up / lying down
  → benign paroxysmal positional vertigo (BPPV)
- (fast) standing up
  → orthostatic hypotension
- Valsalva maneuver, acoustic stimuli
  → superior canal dehiscence syndrome
- Busy places (shopping centers, railway stations...)
  → functional dizziness ("psychogenic dizziness")
- None
  → Menière's disease, cardiac arrhythmia, epileptogenic vertigo, (migraine)

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  → Focal-neurologic signs, hearing loss, tinnitus?

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  → Drug history (antidepressants, AED, sedatives, diuretics, antihypertensive drugs)?
  → Accompanying diseases (z.B. neoplasms, multiple sclerosis, diabetes mellitus, depression)?
  → head or neck trauma?
Acute and persistent vertigo or dizziness

Acute vestibular syndrome (AVS)

- Vertigo or dizziness for more than 24 hours accompanied by
  - Nausea/Vomitus
  - (head) motion intolerance
  - Nystagmus
  - Gait imbalance
- ~250'000 – 500'000 patients with AVS per year in US emergency departments
- Vertebrobasilar ischemia in ~25 ±15%.

AVS – differentiation peripheral vs. central

Most important central causes*

- Vertebrobasilar ischemia (79%)
- Multiple sclerosis (11%)
- Cerebellar Bleeding (4%)

AVS – clues to central origin

- Obvious focal-neurological deficits (e.g. diplopia, hemiataxia, hemiparesis)
- Disproportionality of symptoms (e.g. severe gait imbalance and mild nausea)
- Sudden onset
- Presence of vascular risk factors
- Accompanying craniovertebral pain (→ cerebellar bleeding, vertebral artery dissection?)
- Repetitive prodromal episodes over weeks to months.

AVS – clues to central origin

Clinical examination for suspected AVS

Obvious focal-neurological findings (including examination of gait and eye movements)

- Vertical or torsional nystagmus
- Eye muscle palsy (3-4-6, INO, gaze-paretic)

Only 64% sensitivity for stroke

Subtle ocular motor signs: H.I.N.T.S.

98% sensitivity for stroke
Subtle ocular motor signs: H.I.N.T.S. to I.N.F.A.R.C.T.

- 3 components "H.I.N.T.S." battery
  - Horizontal Head Impulse Test (h-HIT)
  - Nystagmus
  - Test of skew

Fascicular and nuclear lesions of the vestibular nerve

Nystagmus: periphal vs. central AVS?

H.I.N.T.S: head-impulse test

H.I.N.T.S: gaze-evoked nystagmus

H.I.N.T.S: Skew deviation
Lacunar strokes – H.I.N.T.S. vs. MRI

<table>
<thead>
<tr>
<th>Table 2: Neuroimaging and sonomicrometry assessment in small vs large strokes presenting AVS</th>
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<tr>
<td>Symmetrical AVS</td>
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<td>Asymmetrical AVS</td>
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Alterations in AVS: acute meningeal syndrome (HINTS) – basal impulsion, nystagmus, test of skew.
*All strokes were confirmed by MRI.*

Saber Tehrani et al. (2014) Neurology. 83:169-173

ABCD2-risk stratification for patients with acute dizziness/vertigo

<table>
<thead>
<tr>
<th>Five-item ABCD2 risk score</th>
<th>Stroke findings: risk score ≥ 4</th>
</tr>
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<tbody>
<tr>
<td>Age</td>
<td>B systolic: 140 or diastolic ≥ 90</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>C unilateral weakness = 2, speech disturbance without weakness = 1, any other symptom = 0</td>
</tr>
<tr>
<td>Duration of symptoms</td>
<td>D: &lt;10 min = 0; 10–59 min = 1, &gt;60 min = 2</td>
</tr>
<tr>
<td>Diabetes</td>
<td>D: present = 1</td>
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H.I.N.T.S. vs. ABCD2

Grading truncal ataxia (n=114, 72 pAVS, 42 cAVS)
- Grade 1 → mild to moderate imbalance with walking independently
- Grade 2 → severe imbalance with standing, but cannot walk without support
- Grade 3 → falling at upright posture

Grade 3 found only with central AVS
- Grade 2 or 3 → 92.9% sensitivity and 61.1% specificity for AICA/PICA stroke


Quantification of ataxia – a valuable alternative to the H.I.N.T.S.?

The video-head-impulse test: useful in the ED?

Büki and Tarnutzer 2013. Vertigo and dizziness. ONL, Oxford University Press
Summary AVS predictors for central origin

- Normal head-impulse test (HIT) → central (ischemic) origin (PICA, less often AICA)
- Testing for gaze-evoked nystagmus and skew deviation increases sensitivity of the HIT to 98%.
- H.I.N.T.S. have higher sensitivity to exclude stroke than early (first 24-48h) MRI with diffusion weighted imaging (DWI)
- MRI (including DWI) may be negative in first 24-48h in up to 20% and up to 50% for small (lacunar) strokes.

AVS cases

Interaction appreciated!

44-year-old male patient

Current medical history:
- Acute vertigo accompanied by nausea, vomiting, gait imbalance and intense sweating since this morning.

Relevant findings from clinical examination:
- Neurologic examination:
  - No obvious focal neurologic deficits (no eye muscle palsies, no limb palsies, no sensory loss, no aphasia)
- Targeted neuro-otolotic examination:
  - Torsional horizontal spontaneous nystagmus to the left (Alexander grade II) without increase during fixation suppression
  - Bedside head impulse test to the right with very few catch-up saccades, normal on repetition.
  - No skew deviation, no gaze-evoked nystagmus, no hearing loss
  - Examination of stance and gait not possible due to his overall medical condition.

Brain MRI

→ Acute ischemic stroke in the right PICA territory

Cervical spine MRI with fat suppression

Dissection of the right vertebral artery

Case 2 – what is the key finding here?

- Fast-phase Alternating

Courtesy of Alexander Tarnutzer, MD
Brain MRI 24h after symptom onset

Case 3

- 81-year old female patient with vertigo, gait imbalance, headache and nausea since three days.
- On exam: peripheral facial palsy on the right side and abnormal head-impulse test to the right.
- Diagnostic work-up: brain MRI „normal” → diagnosed and treated as acute peripheral vestibulopathy
- Disease course: Increase in headache, drop in GCS from 15 to 7.

Case 3 – dangerous peripheral AVS

A: head CT → SAH prepontine right side
B: DSA → AICA aneurysm (arrow) with accompanying AVM (arrow with star)
C/D: brain MRI before rupture → aneurysm (arrow) detectable
E: head CT → after coiling of the aneurysm. Arrow points to the coils.

Distal AICA aneurysm!

Wilms et al. (2016) J Stroke Cerebrovasc Dis

Case 3 – dangerous peripheral AVS

- Additional cranial nerve deficits besides the vestibulocochlear never is a red flag!
- Without clear signs for zoster oticus (V2V → Ramsey Hunt syndrome → Vesicles in the external auditory canal/at the ear) → incompatible with the diagnosis vestibular neuropathy
- Imaging (focus on the cerebello-pontine angle) and joint evaluation with neuroradiology
- Up to 50% of all AICA aneurysms become symptomatic BEFORE rupture!