

Pathophysiology of Syncope

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Mass Fainting at Rock Concerts NEJM 1994;332;1721



METHODS - Infirmity interview of 40 of the 4000 people who fainted during a concert by New Kids on the Block

What is wrong with this younger generation?



Case #3 - 55yoWM from Mount Airy, NC with first episode of syncope during shaving

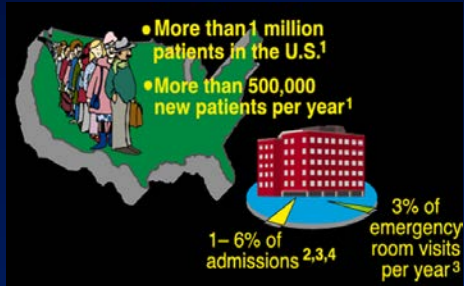
Section I: Prevalence and Impact

The Significance of Syncope

The only difference between syncope and sudden death is that in one you wake up.¹

¹ Engel GL. Psychologic stress, vasodepressor syncope, and sudden death. *Ann Intern Med* 1978; 88: 403-412.

The Significance of Syncope



¹ National Disease and Therapeutic Index on Syncope and Collapse, ICD-9-CM 780.2, IMS America, 1997
² Blanc J-J, L'her C, Youza A, et al. Eur Heart J. 2002; 23: 815-820.
³ Day SC, et al. AM J of Med 1982
⁴ Kapoor W. Evaluation and outcome of patients with syncope. Medicine 1990;69:160-175.

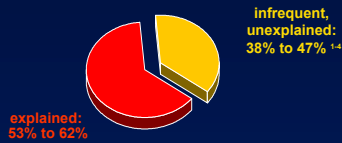
Syncope Reported Frequency

Individuals <18 yrs	15%
Military Population 17- 46 yrs	20-25%
Individuals 40-59 yrs*	16-19%
Individuals >70 yrs*	23%

Brignole M, Alboni P, Benditt DG, et al. Eur Heart J. 2001; 22: 1256-1306.

*during a 10-year period

The Significance of Syncope



- 500,000 new syncope patients each year⁵
- 170,000 have recurrent syncope⁶
- 70,000 have recurrent, infrequent, unexplained syncope¹⁻⁴

¹ Kapoor W. Med 1990;69:160-175. ⁴ Kapoor W, et al. N Eng J Med. 1983;309:197-204.
² Silverstein M, et al. JAMA. 1982;248:1185-1189. ⁵ National Disease and Therapeutic Index, IMS America, Syncope and Collapse #780.2, Jan 1997-Dec 1997.
³ Martin G, et al. Ann Emerg Med. 1984;12:499-504. ⁶ Kapoor W, et al. Am J Med. 1987;83:700-708.

Section II:

Etiology

Definition

- Sudden and brief loss of consciousness associated with a loss of postural tone, from which recovery is spontaneous

Syncope:

A Symptom...Not a Diagnosis

- Self-limited loss of consciousness and postural tone
- Relatively rapid onset
- Variable warning symptoms
- Spontaneous complete recovery

Syncope: Etiology

Neurally-Mediated	Orthostatic	Cardiac Arrhythmia	Structural Cardio-Pulmonary	Non-Cardio-vascular
1	2	3	4	5
<ul style="list-style-type: none"> • Vasovagal • Carotid Sinus • Situational <ul style="list-style-type: none"> ➢ Cough ➢ Post-micturition 	<ul style="list-style-type: none"> • Drug Induced • ANS Failure <ul style="list-style-type: none"> ➢ Primary ➢ Secondary 	<ul style="list-style-type: none"> • Brady <ul style="list-style-type: none"> ➢ Sick sinus ➢ AV block • Tachy <ul style="list-style-type: none"> ➢ VT ➢ SVT • Long QT Syndrome 	<ul style="list-style-type: none"> • Aortic Stenosis • HOCM • Pulmonary Hypertension 	<ul style="list-style-type: none"> • Psychogenic • Metabolic e.g. hyperventilation • Neurological
24%	11%	14%	4%	12%

Unknown Cause = 34%

DG Benditt, UM Cardiac Arrhythmia Center

Section III:

Diagnosis and Evaluation Options

Syncope Diagnostic Objectives

- Distinguish 'True' Syncope from other 'Loss of Consciousness' spells:
 - Seizures
 - Psychiatric disturbances
- Establish the cause of syncope with sufficient certainty to:
 - Assess prognosis confidently
 - Initiate effective preventive treatment

Initial Evaluation (Clinic/Emergency Dept.)

- Detailed history
- Physical examination
- 12-lead ECG
- Echocardiogram (as available)

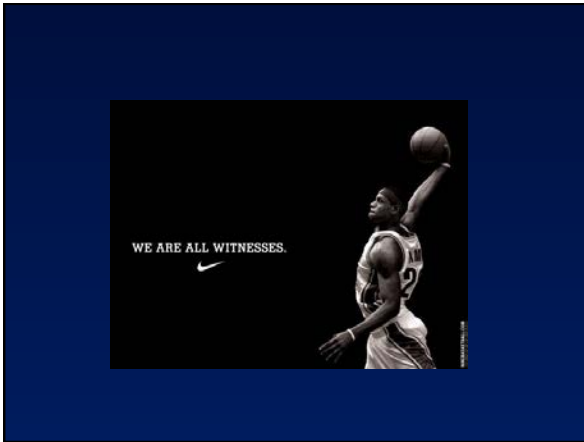
Syncope Evaluation and Differential Diagnosis

History – What to Look for

- Complete Description
 - From patient and observers
- Type of Onset
- Duration of Attacks
- Posture
- Associated Symptoms
- Sequelae

Distinguishing Syncope

- Dizziness, presyncope, and vertigo
 - No LOC or loss of postural tone
- "Drop attacks"
 - Lead to falls without loss of consciousness
 - Sometimes sign of vertebrobasilar TIA (15%)
- Precipitants/Prodromal Symptoms
 - LOC precipitated by pain, exercise, micturition, defecation, or stressful event usually syncope
 - Sweating, nausea = syncope
 - Aura = Seizure
 - Disorientation/ LOC > 5 minutes usually seizure rather than syncope



Conventional Diagnostic Methods/Yield

Test/Procedure	Yield (based on mean time to diagnosis of 5.1 months ⁷)
History and Physical (including carotid sinus massage)	49-85% ^{1,2}
ECG	2-11% ²
Electrophysiology Study without SHD*	11% ²
Electrophysiology Study with SHD	49% ²
Tilt Table Test (without SHD)	11-87% ^{4,5}
Ambulatory ECG Monitors:	
• Holter	2% ⁷
• External Loop Recorder (2-3 weeks duration)	20% ⁷
• Insertable Loop Recorder (up to 14 months duration)	65-88% ^{6,7}
Neurological † (Head CT Scan, Carotid Doppler)	0-4% ^{4,6,8,10}

¹ Kapoor, et al. N. Eng. J. Med. 1983. ² Kapoor, JAMA, 1992. ³ Day S, et al. Am J Med. 1982; 73: 15-23.
⁴ Kapoor, Am J Med. 1991. ⁵ Pappas, Circulation. 1995. ⁶ Dabron P, et al. PACE. 1999; 22 (part II): 702. ⁷ Structural Heart Disease MRI (not subject)
⁸ Linder, et al. Am J Med. 1997. ⁹ From: Cardiology Clinics, 1997. ¹⁰ Eagle K, et al. The Yale J Biol and Medicine. 1983; 58: 1-8.

- ## 12-Lead ECG
- Normal or Abnormal?
 - Acute MI
 - Severe Sinus Bradycardia/pause
 - AV Block
 - Tachyarrhythmia (SVT, VT)
 - Preexcitation (WPW), Long QT, Brugada
 - Short sampling window (approx. 12 sec)

- ## Carotid Sinus Massage
- Site:
 - Carotid arterial pulse just below thyroid cartilage
 - Method:
 - Right followed by left, pause between
 - Massage, NOT occlusion
 - Duration: 5-10 sec
 - Posture – supine & erect

- ## Carotid Sinus Massage
- Outcome:
 - > 3 sec asystole and/or 50 mmHg fall in systolic blood pressure with reproduction of symptoms =
Carotid Sinus Syndrome (CSS)
 - Contraindications
 - Carotid bruit, known significant carotid arterial disease, previous CVA, MI last 3 months
 - Risks
 - 1 in 5000 massages complicated by TIA

Ambulatory ECG

Method	Comments
Holter (24-48 hours)	Useful for infrequent events
Event Recorder	<ul style="list-style-type: none"> ■ Useful for infrequent events ■ Limited value in sudden LOC
Loop Recorder	<ul style="list-style-type: none"> ■ Useful for infrequent events ■ Implantable type more convenient (ILR)
Wireless (internet) Event Monitoring	In development

Head-up Tilt Test (HUT)

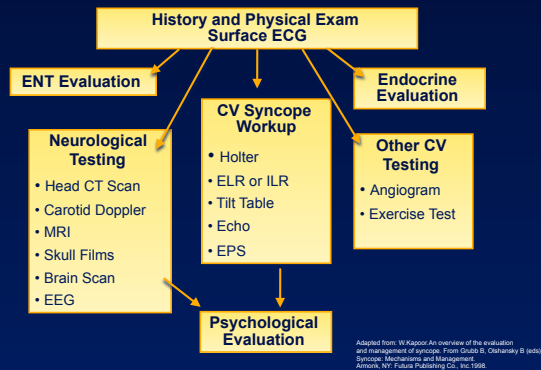
- Unmasks Vasovagal syncope susceptibility
- Reproduces symptoms
- Patient learns VVS warning symptoms
- Physician is better able to give prognostic / treatment advice



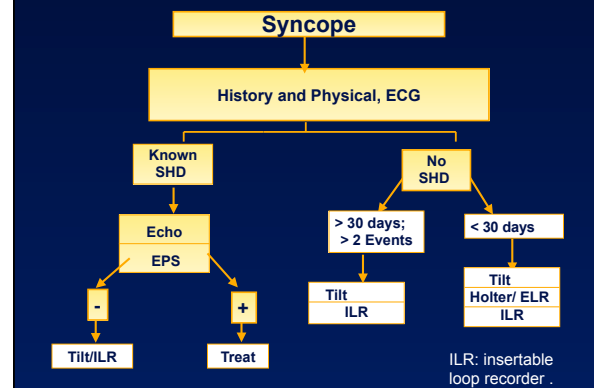
Electroencephalogram

- Not a first line of testing
- Syncope from Seizures
- Abnormal in the interval between two attacks – Epilepsy
- Normal – Syncope

Unexplained Syncope Diagnosis



Typical Cardiovascular Diagnostic Pathway



Mass Fainting at Rock Concerts NEJM 1994;332;1721

- All were girls between 11-17 YO
- 40% reported having lost consciousness
- Many still breathing rapidly backstage during interview
- Reported combination provoking factors
 - sleeplessness during previous night
 - fasting since early AM while waiting in line
 - long periods of standing
 - hyperventilation (vasoconstriction)
 - Valsalva-like pressure
- Interpretation - ROCK-CONCERT SYNCOPE
 - multifactorial pathophysiology
 - Preventive guidelines - sleep, sit, eat, keep cool, stay out of the crowd

Section IV:

Specific Conditions

Neurally-Mediated Reflex Syncope (NMS)

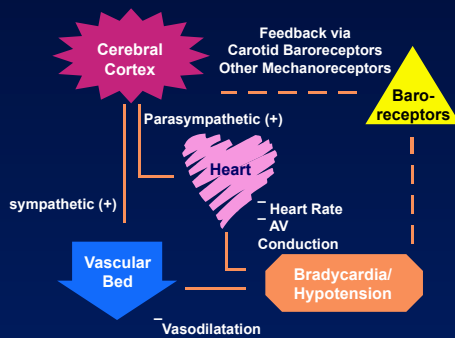
- Vasovagal syncope (VVS)
- Carotid sinus syndrome (CSS)
- Situational syncope
 - > post-micturition
 - > cough
 - > swallow
 - > defecation
 - > blood drawing
 - > etc.

NM Reflex Syncope: Pathophysiology

- Multiple triggers
- Variable contribution of vasodilatation and bradycardia



NMS – Basic Pathophysiology



Etiology of CSS



Carotid Sinus

- Sensory nerve endings in the carotid sinus walls respond to deformation
- “Deafferentation” of neck muscles may contribute
- Increased afferent signals to brain stem
- Reflex increase in efferent vagal activity and diminution of sympathetic tone results in bradycardia and vasodilation

Carotid Sinus Hypersensitivity(CSH)

- Abnormal response to CSM
- Absence of symptoms attributable to CSS
- CSH reported frequent in ‘fallers’ (Kenny)

CSH \neq CSS

Management Strategies for VVS

- Optimal management strategies for VVS are a source of debate
 - > Patient education, reassurance, instruction
 - > Fluids, salt, diet
 - > Tilt Training
 - > Support hose
- Drug therapies
- Pacing
 - > Class II indication for VVS patients with positive HUT and cardioinhibitory or mixed reflex

Principal Causes of Orthostatic Syncope

- Drug-induced (very common)
 - diuretics
 - vasodilators
- Primary autonomic failure
 - multiple system atrophy
 - Parkinsonism
- Secondary autonomic failure
 - diabetes
 - alcohol
 - amyloid
- Alcohol
 - orthostatic intolerance apart from neuropathy

Syncope Due to Arrhythmia or Structural CV Disease: General Rules

- Often life-threatening and/or exposes patient to high risk of injury
- May be warning of critical CV disease
 - Aortic stenosis, Myocardial ischemia, Pulmonary hypertension
- Assess culprit arrhythmia / structural abnormality aggressively
- Initiate treatment promptly

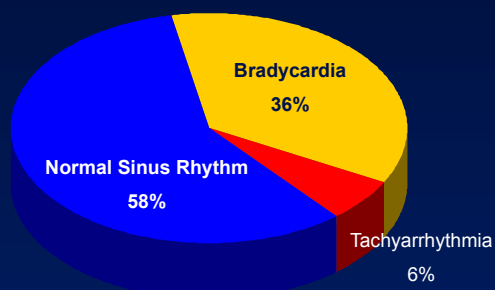
Principal Causes of Syncope due to Structural Cardiovascular Disease

- Acute MI / Ischemia
 - Acquired coronary artery disease
 - Congenital coronary artery anomalies
- HOCM
- Acute aortic dissection
- Pericardial disease / tamponade
- Pulmonary embolus / pulmonary hypertension
- Valvular abnormalities
 - Aortic stenosis, Atrial myxoma

Syncope Due to Cardiac Arrhythmias

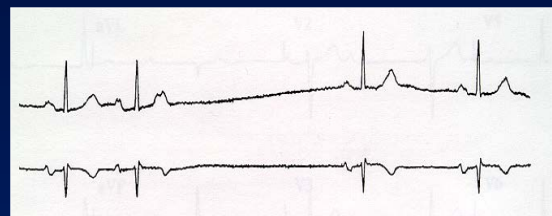
- Bradyarrhythmias
 - Sinus arrest, exit block
 - High grade or acute complete AV block
- Tachyarrhythmias
 - Atrial fibrillation / flutter with rapid ventricular rate (e.g. WPW syndrome)
 - Paroxysmal SVT or VT
 - Torsades de pointes

Rhythms During Recurrent Syncope



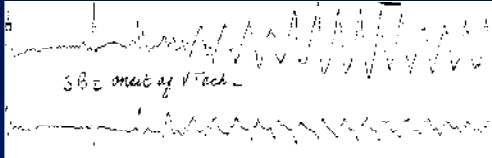
Krahn A, et al. Circulation. 1999; 99: 406-410

AECG: 74 yr Male, Syncope Sinus pause



From the files of DG Benditt, UM Cardiac Arrhythmia Center

Syncope: Torsades



From the files of DG Benditt, UM Cardiac Arrhythmia Center

Drug-Induced QT Prolongation

- Antiarrhythmics
 - Class IA ...Quinidine, Procainamide, Disopyramide
 - Class III...Sotalol, Ibutilide, Dofetilide, Amiodarone, (NAPA)
- Antianginal Agents
 - (Bepridil)
- Psychoactive Agents
 - Phenothiazines, Amitriptyline, Imipramine, Ziprasidone
- Antibiotics
 - Erythromycin, Pentamidine, Fluconazole
- Nonsedating antihistamines
 - (Terfenadine), Astemizole
- Others
 - (Cisapride), Droperidol

Treatment of Syncope Due to Bradyarrhythmia

- Class I indication for pacing using dual-chamber system wherever adequate atrial rhythm is available
- Ventricular pacing in atrial fibrillation with slow ventricular response

Treatment of Syncope Due to Tachyarrhythmia

- Atrial Tachyarrhythmias;
 - AVRT due to accessory pathway – ablate pathway
 - AVNRT – ablate AV nodal slow pathway
 - Atrial fib^o – Pacing, linear / focal ablation, ICD selected pts
 - Atrial flutter – Ablation of reentrant circuit
- Ventricular Tachyarrhythmias;
 - Ventricular tachycardia – ICD or ablation where appropriate
 - Torsades de Pointes – withdraw offending Rx or ICD (long-QT/Brugada)
- Drug therapy may be an alternative in many cases

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⁵ Krahn, *Circulation*, 1995.

⁶ Benson F, et al. *PACE*, 1999; 22 (part 1): 792.

⁷ Lincoff, et al. *Ann Int Med*, 1997.

⁸ Krahn, *Cardiology Clinics*, 1997.

⁹ Kapoor, *Medicine*, 1990.

¹⁰ Eagle K, et al. *The Yale J Biol and Medicine*, 1983; 58: 1-6.

¹¹ Structural Heart Disease MRI not studied

Conclusion

Syncope is a common symptom, often with dramatic consequences, which deserves thorough investigation and appropriate treatment of its cause.

