

# Syncope and Noninvasive EP Testing

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# Goals of this Presentation

- Definition, prevalence and statistics relating to syncope
- History and physical exam tips to help find the cause of syncope
- Diagnostic testing useful for evaluation
  - Non-invasive monitoring
  - Tilt table test, EP study
- Treatment options for patients with syncope

# syn-co-pe

\[ sɪŋkə-( )pē, sɪn

## Noun

1. A spontaneous loss of consciousness caused by insufficient blood to the brain.
2. (phonology) the loss of sounds from within a word (as in `fo'c'sle' for `forecastle').
3. An elision or retrenchment of one or more letters or syllables from the middle of a word; as, ne'er for never, ev'ry for every.
4. A fainting, or swooning.
5. A pause or cessation; suspension.

# Syncope - Medline Search 2002

352 citations - English language

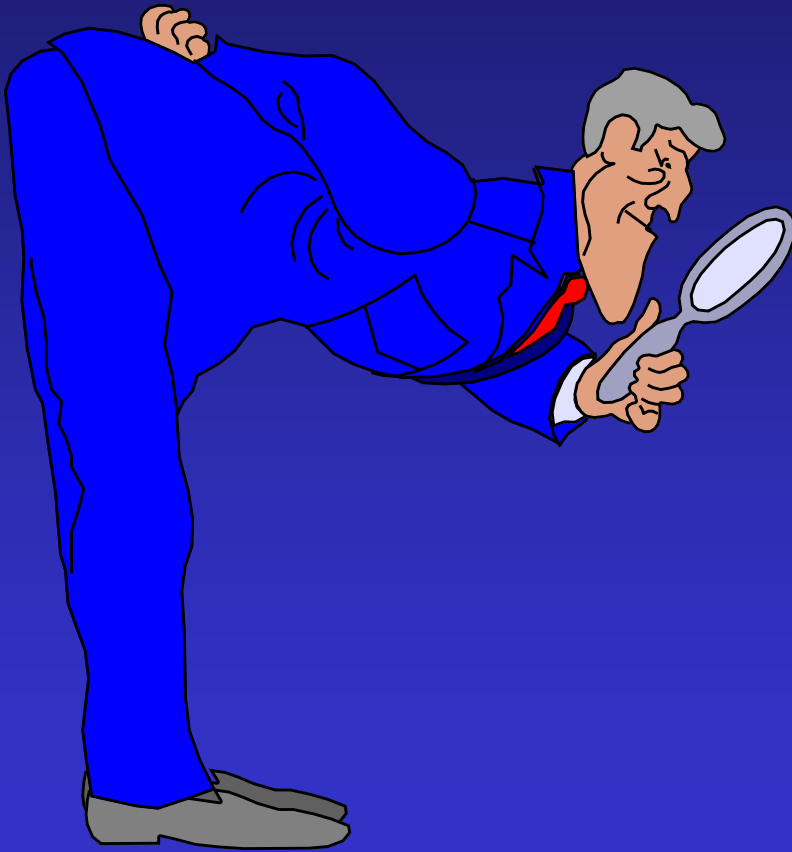
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# Syncope Statistics

- 3% of ER visits
- 6% of general medical admissions
- Framingham Study
  - 3.0% of men, 3.5% of women
  - age > 75, annual incidence - 6%
  - increased mortality in pts. with CV disease
- Injury occurs in 1/3 of pts
- 50% of pts. - no diagnosis made

# Diagnostic Evaluation



- History
- Physical exam
- Electrocardiogram

# Medical History



# “Syncope”

- Fainted
- Passed out
- Fell out
- Blacked out
- Went out
- Lost consciousness
- Had a spell
- Had a seizure
- Had an attack
- Lost it
- Hit the dirt
- Hit my head
- Fell out of bed
- Kiss the ground

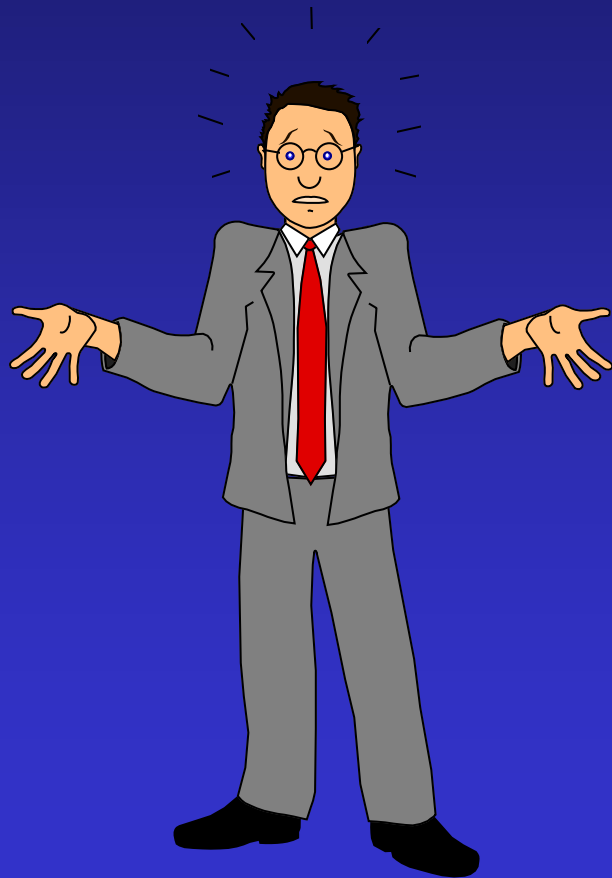
# General History

- Age now and at onset of symptoms
- Cardiac history
- Other medical history
- Medications
- Family history of arrhythmias or sudden death

# Syncope History

- Event situation
  - driving, standing, urinating, coughing
- Mode of onset
- Associated symptoms
- Feeling after awakening
- Witnessed
- Frequency

# Syncope



“Those who suffer frequent and severe fainting often die suddenly.”

- Hippocrates, 1000B.C.

# Medication History

- Drugs that cause hypotension
- Drugs that affect sinus/AV node
  - B-blockers, Ca<sup>++</sup> channel blockers
  - Theophylline, B-agonists
- Drugs that prolong QT
- Illicit drugs - cocaine, barbiturates
- Drug errors - papaverine/propafenone,  
chlorpropamide/chlorpromazine

# Drugs that Prolong QT Interval

- IA antiarrhythmics
- IC antiarrhythmics
- III antiarrhythmics
- Tricyclic antidepressants
- Cisapride
- Bepridil
- Arsenic
- Erythromycin
- Clarithromycin (Biaxin)
- Sparfloxacin
- Methadone
- Pentamidine
- Haloperidol
- Droperidol
- Halofrantrine

# Physical Examination

- General appearance
- Carotid examination
- Carotid sinus massage
- Cardiac exam
  - palpation of dilated heart
  - Murmur of MR/TR/AI
  - murmur of AS

# EKG and Rhythm Strip

- Sinus rhythm
- PAC's, PVC's
- Delta wave
- PR interval
- LVH, LAE
- Q waves
- QT interval

# “High Risk” for Arrhythmias

- Strongly positive family history
- Elderly
- Organic or Structural Heart Disease
  - myocardial infarction
  - dilated cardiomyopathy
  - valvular heart disease
  - hypertrophic cardiomyopathy
  - arrhythmogenic RV dysplasia

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# Treadmill Exercise Test

- Useful for the diagnosis of syncope associated with exercise
- Abnormal echocardiogram
- More likely to be positive for the diagnosis of syncope in patients with outflow gradient - especially for a dynamic outflow gradient

# AHA/ACCF Scientific Statement

## AHA/ACCF Scientific Statement on the Evaluation of Syncope

From the American Heart Association Councils on Clinical Cardiology, Cardiovascular Nursing, Cardiovascular Disease in the Young, and Stroke, and the Quality of Care and Outcomes Research Interdisciplinary Working Group; and the American College of Cardiology Foundation  
In Collaboration With the Heart Rhythm Society

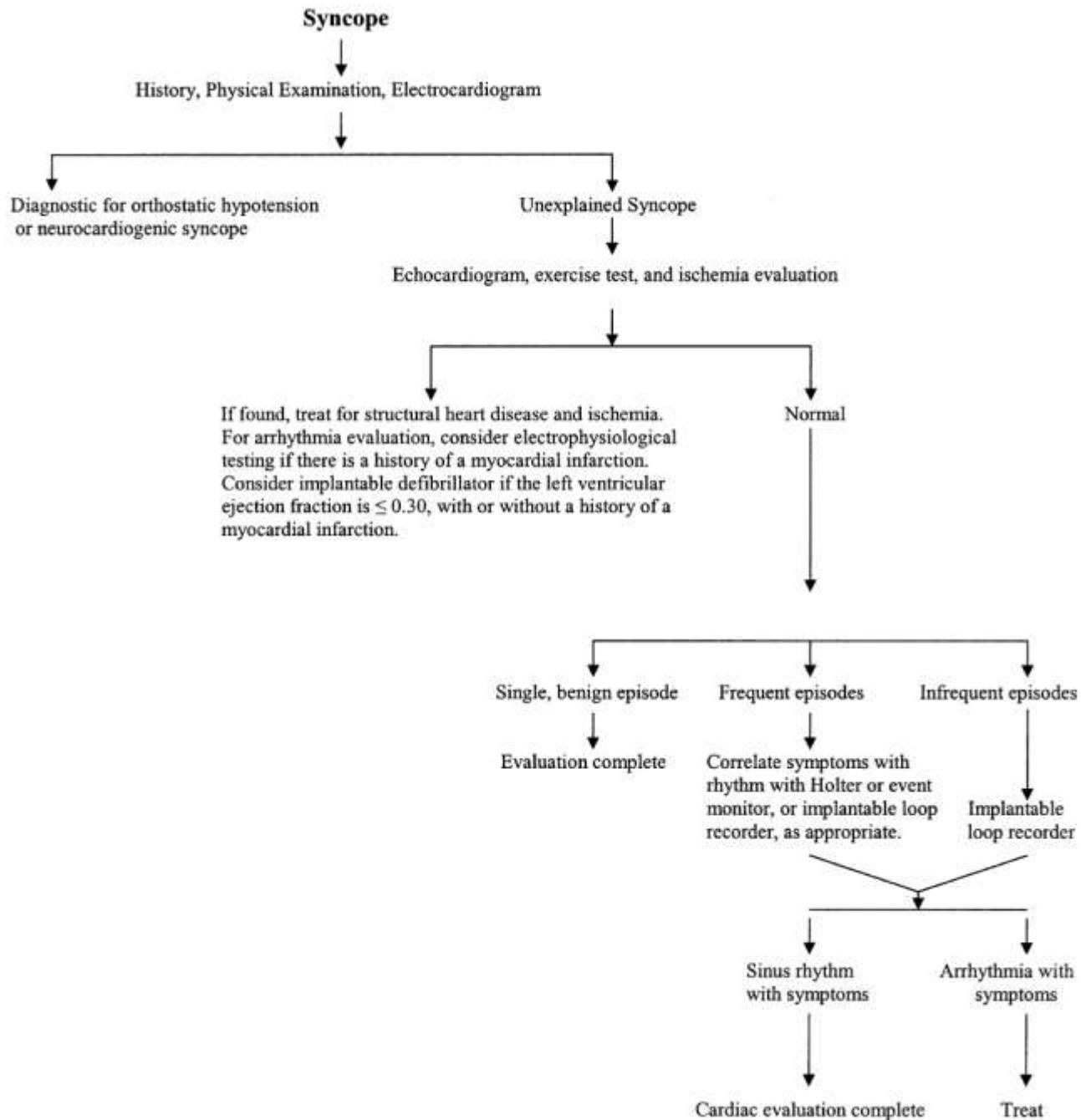
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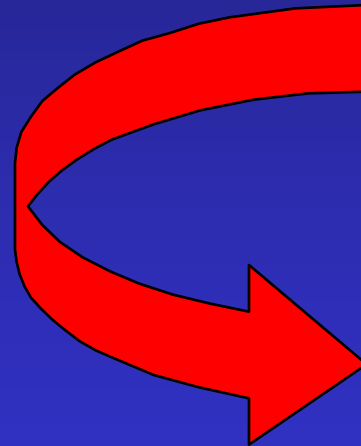
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JACC 2006;47:473-84



# What next?

- If echocardiogram is unrevealing
- Family history is not worrisome
- Monitoring in hospital is unrevealing



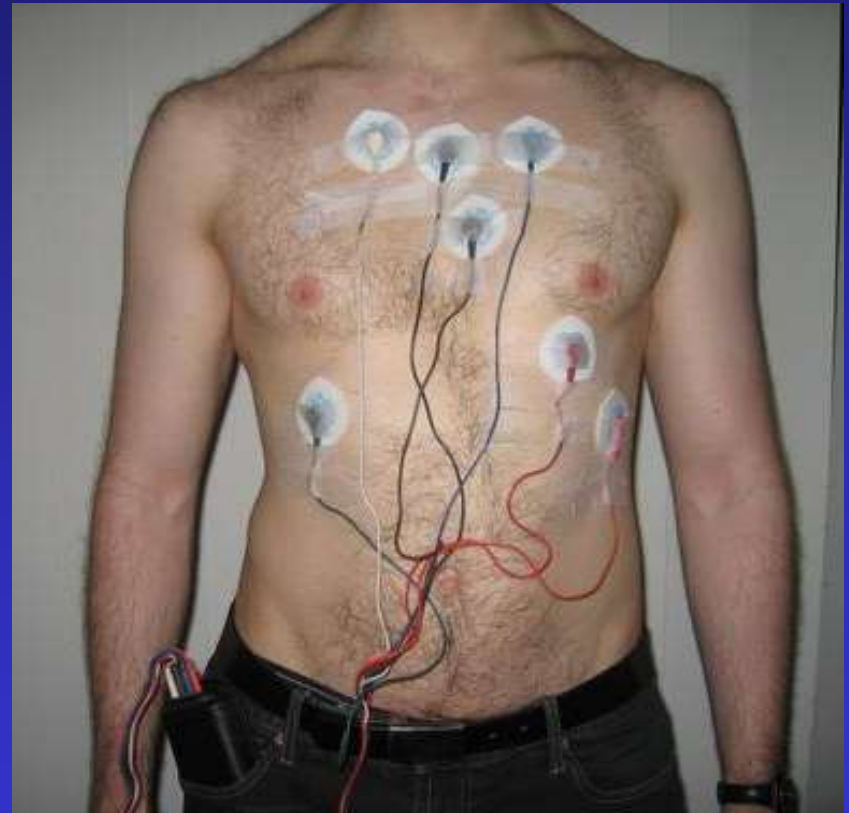
- EP study – Provoking arrhythmias
- Recorder - Monitoring for arrhythmias

# Documentation of an Arrhythmia

- Holter monitoring
- Event recorder
- Looping monitoring
- Continuous ambulatory monitoring
- Implantable loop recorder
- Treadmill exercise testing
- Tilt table testing
- Electrophysiologic study

# Holter Monitor

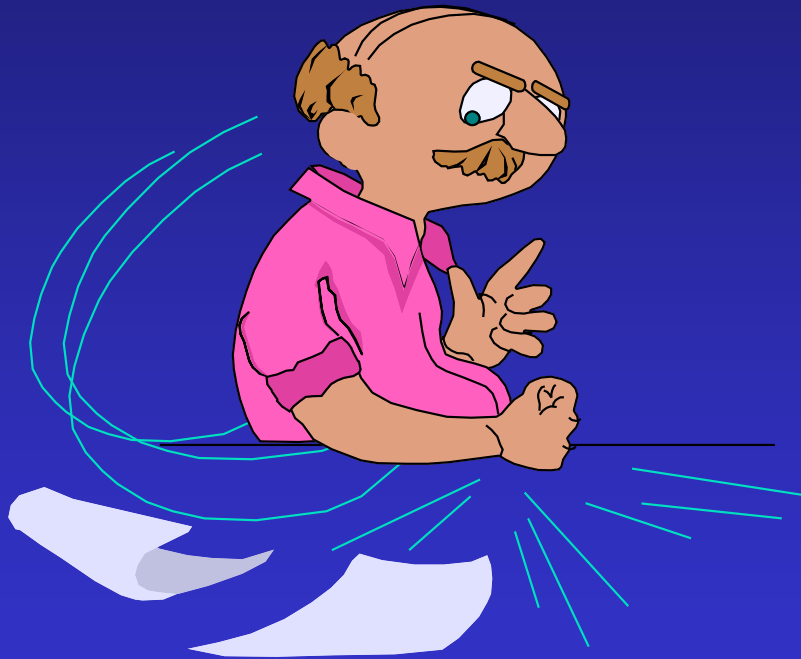
- 24 or 48 hours of continuous ECG monitoring
- 20-25% exhibit symptoms (usually not arrhythmic)
- “Foot prints”
  - sinus bradycardia, NSVT, short runs of atrial arrhythmias, sinus pauses



# Holter and Syncope

- DiMarco and Philbrick (1990 Annals)
  - 7 retrospective studies
  - 4 - 30% patients had asymptomatic arrhythmias considered significant
  - direct relation between symptoms and recorder in only 22% of patients
- Linzer et al. (1991)
  - 15% diagnostic yield of Holters in syncope

# The Verdino Philosophy of the Holter Monitor



The best way one can assure a patient will have no palpitations or episodes of syncope for a 24 hour period is to place a Holter monitor on them!

# Holter Monitoring for Pts with Permanent Atrial Fibrillation



- Holter monitor during ADL
- What about the patient seen in your office in afib with HR in 60's?
  - Great rate control
  - ? HR is 180's with minimal activity

# Assessing Rate Control for Patients with Atrial Fibrillation

- Seen in doctor's office with HR in 90's
- Has calcium channel blocker increased, beta-blocker and digoxin added
- Goes home and feels fatigued
- What to do?

# Zio Patch

- Features
  - Single-use
  - Up to 7 days of ECG recording
  - Small, lightweight, water-resistant
  - 100% of every device is recycled
- Benefits
  - The extended monitoring time beyond the 24 – 48 hours Holter
  - Small size can increase compliance
  - Single-use devices may limit the risk of transmitting infections



# Cardiac Event Monitors

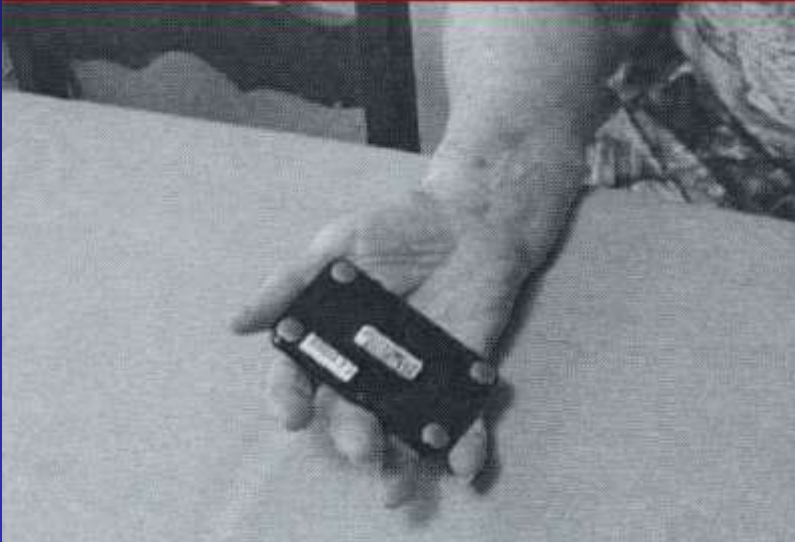


# Cardiac Event Recorders

## Looping versus Non-looping



# Non-Looping Event Recorders



# Event Recorder (Non-looping)

- Extended duration of possible monitoring
- High degree of specificity (patient activated)
- Need not be continually worn
- Inability to capture initiation preceding the event
- May not be applied to the chest during an episode of syncope
- Useful for patients with palpitations

# Non-looping “Wristwatch”



# Looping Event Recorder



# Looping Event Recorder

- Extended duration of possible monitoring
- High degree of specificity (patient activated)
- Ability to capture the initiation of the episode
- Cumbersome to continuously wear
- Discomfort of applying patch electrodes to the chest on a daily basis
- Useful for syncope where patient awakens fairly quickly

# Zio Event Card



- World's only single-use, pager-sized looping ECG recorder
- Can be worn up to 30 days
- Patient simply presses "RECORD" when an event is experienced
- Transmit the event to the iNCC by telephone
- The profile of a credit card and weighing less than 2 oz.- the least obtrusive device on the market
- Single use- simply return the device to iRhythm for 100% recycling
- Two options to wear the device: belt clip and lanyard
- 24-hour customer support

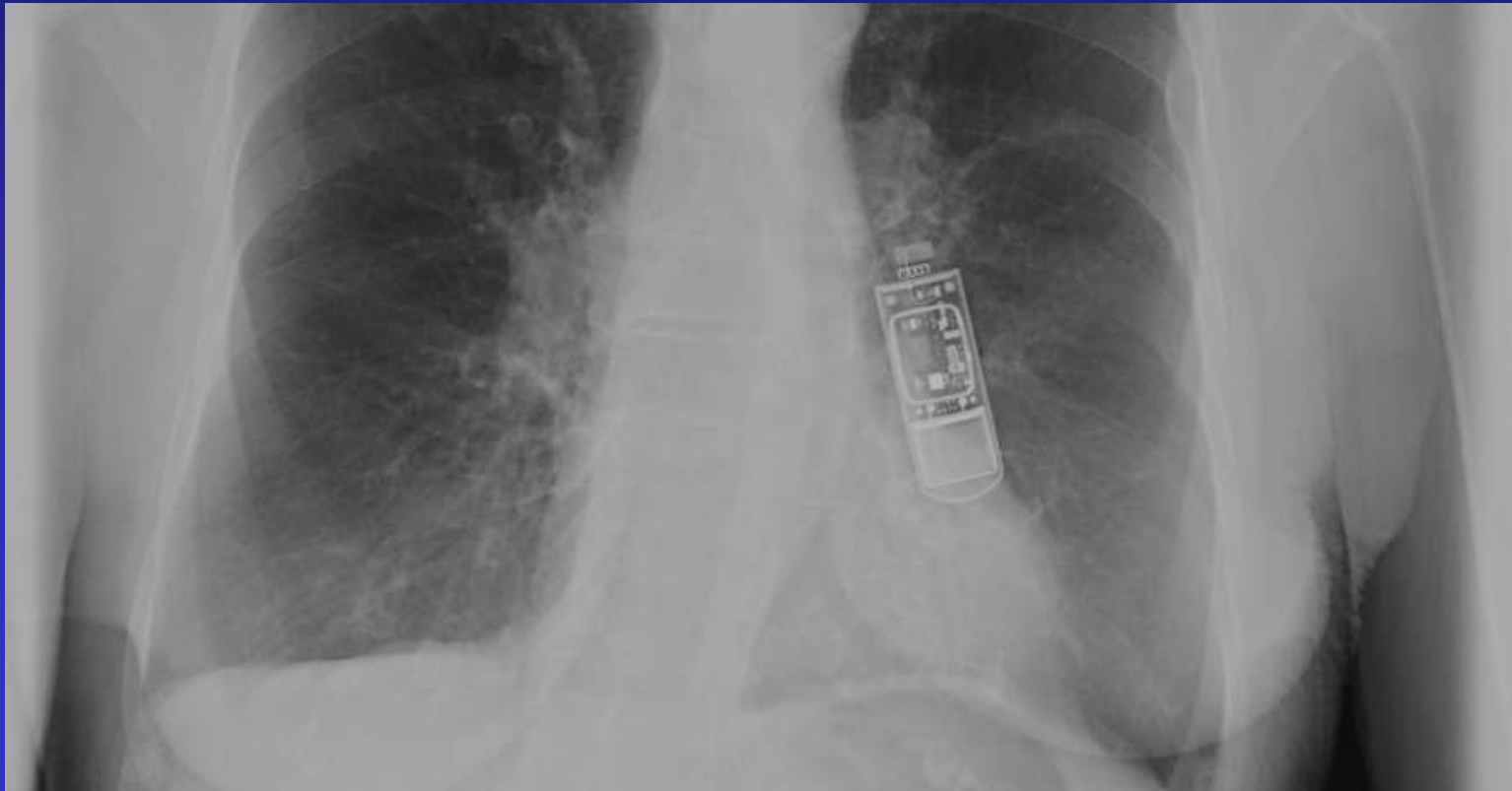
# Continuous Looping with Automatic Detection Recorders

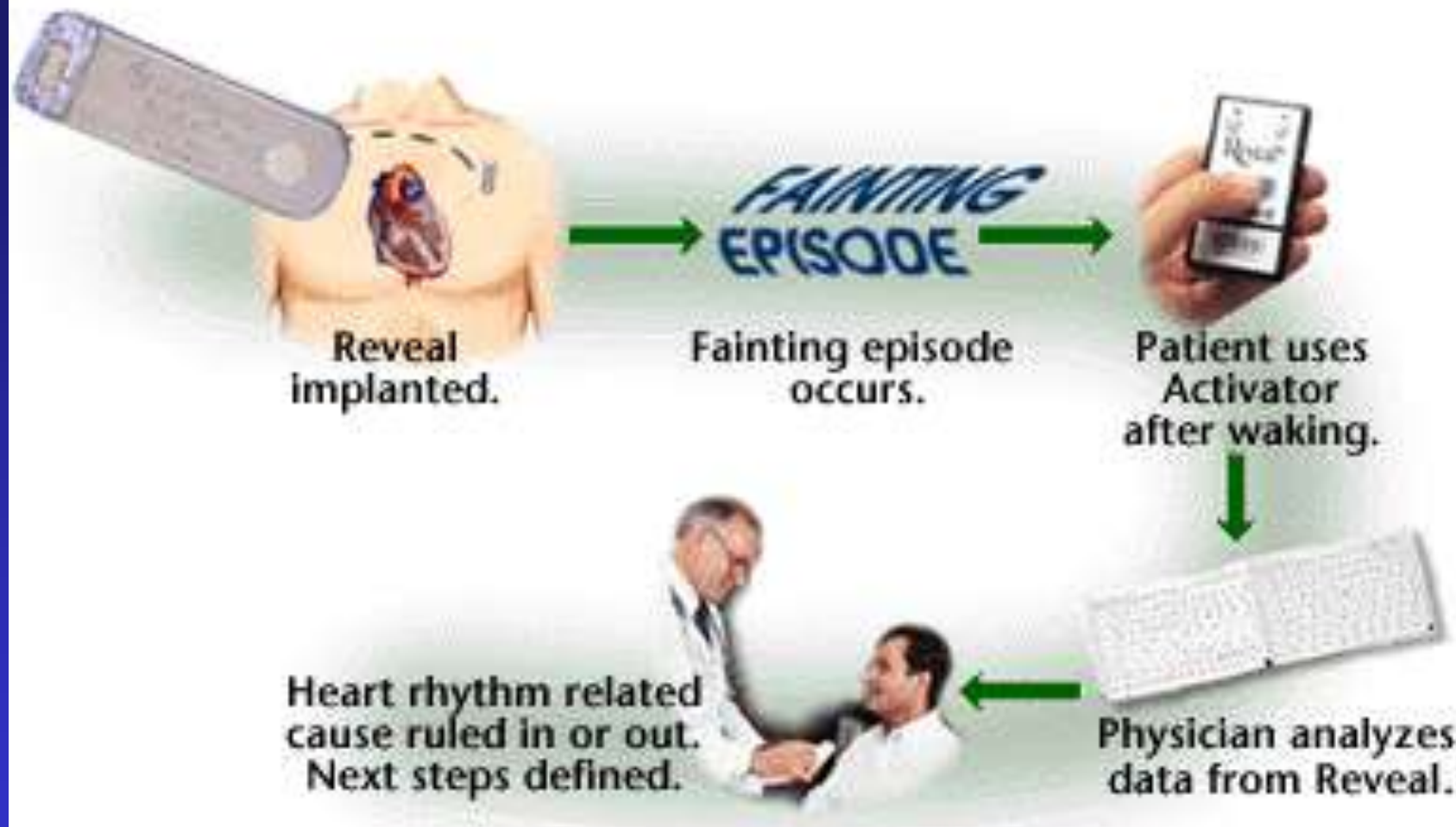


# Implantable Loop Recorder



# Chest X- ray





# Implantable Loop Recorder

- 16 pts with negative Holter, Tilt & EPS
- 15 (94%) syncope 4.4 ± 4.2 months
- Diagnosis made in all 15 pts
  - 5 sinus arrest
  - 2 AV block
  - 1 ventricular tachycardia
  - 1 SVT
  - 6 non-arrhythmic

» Krahn et al. Circulation 1999;92:1819-24

# Data from the Reveal Investigators

- 85 pts, 10.5 ± 4.0 month follow up
- symptoms recurred in 58 pts (2.3 mo.)
- 42% pts had an arrhythmia
  - bradycardia in 18, tachycardia in 3
- no adverse effects with recurrent sxs
- no sudden deaths
- 8 pts. unable to freeze events
- 3 pocket infections

» Krahn et al. Circulation;1999;99:406-10

# Ambulatory ECG Monitors

	<u>Weight (g)</u>	<u>Duration</u>	<u>Cost</u>
Holter	448	1-2 d.	\$353
Event	30-52	14-30 d.	\$185
Loops			
External	100	14-30 d.	\$185
Implant.	17	30-540 d.	\$3000

- Zimetbaum - Ann Int Med 1999;130:848-56

# Cost Implications

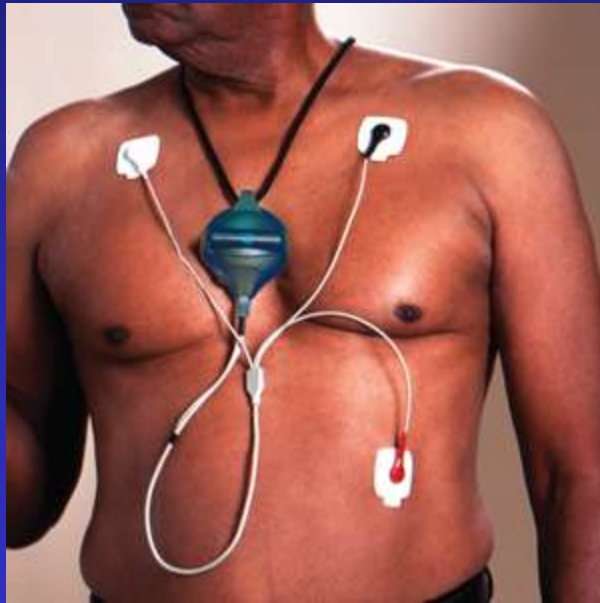
- Cost of investigation of syncope in 24 pts prior to ILR insertion - \$7584 per pt.
- After ILR, a diagnosis was obtained in 21 of 24 pts (88%)
- Cost of therapy \$2452, followed by cost of care \$596 over 30 10 months

» Krahn et al. Am Heart J 1999;137:870-7

# Newer Technologies

- Continuous looping recorder with automatic recording capabilities
- Ambulatory continuous telemetry
- Implantable recorders with continuous telemetry

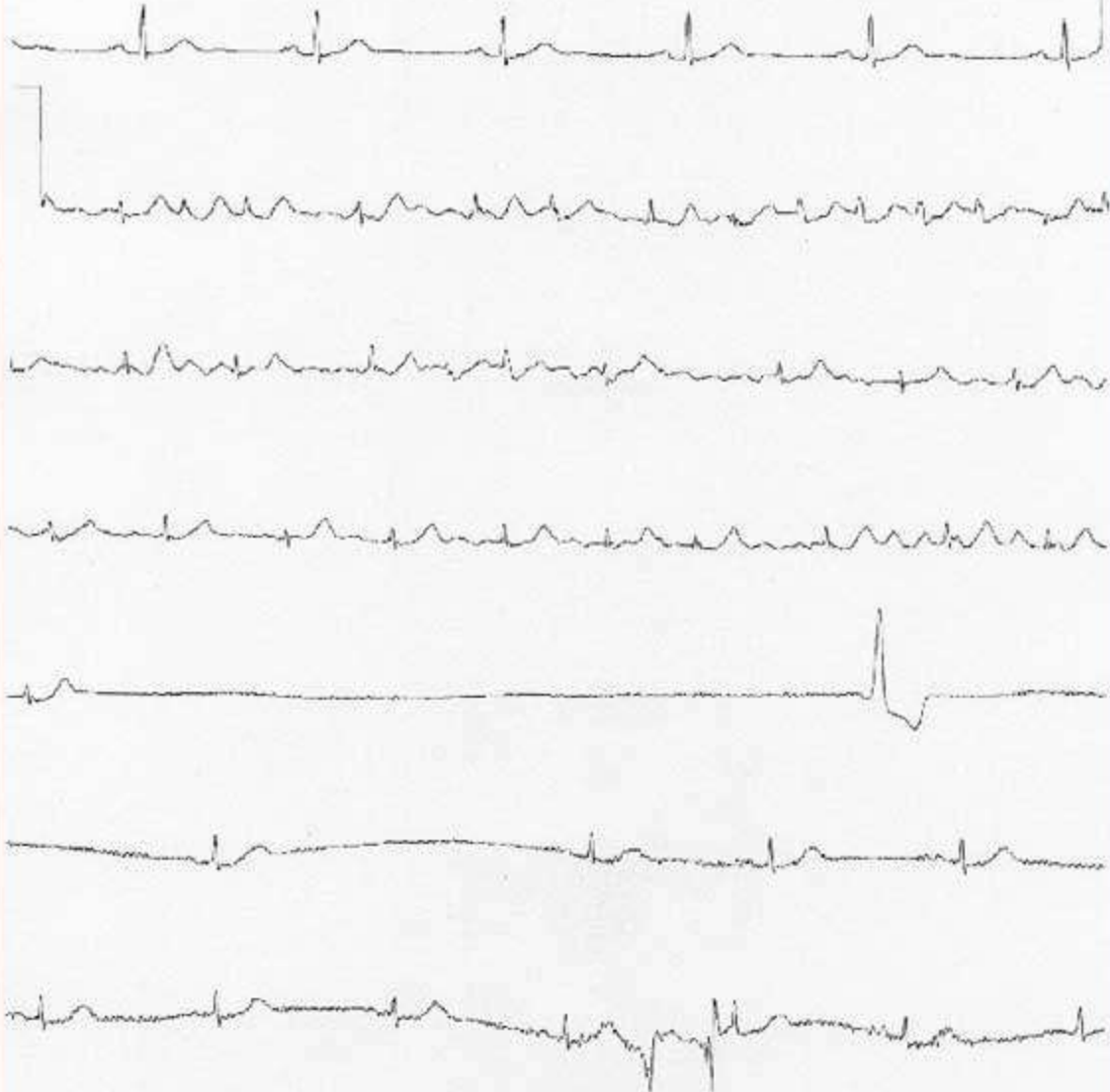
# Ambulatory Continuous Monitoring



# Implantable Continuous Monitoring



02

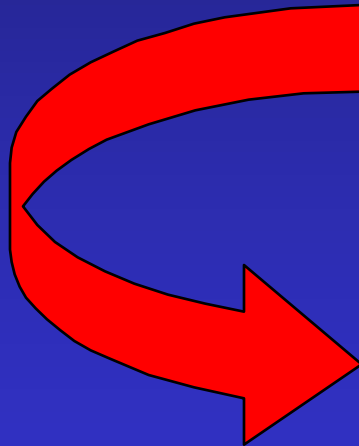
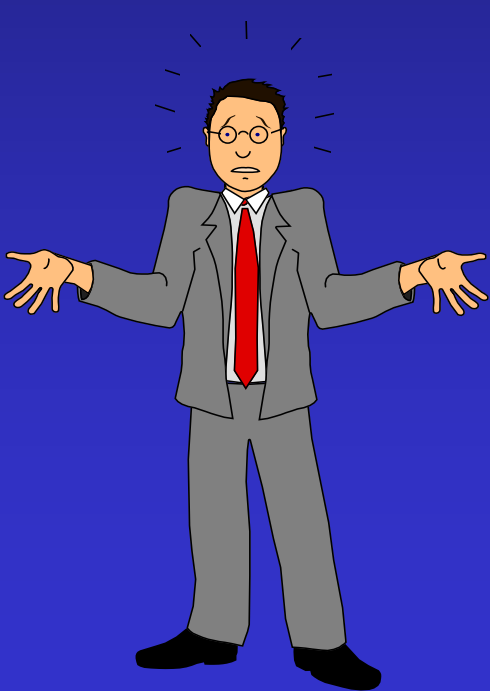


# Sinus Rhythm

- Does the patient know how to use the monitor?
- If yes -
  - Non-arrhythmic
  - Neurologic
  - Psychologic

# Bradyarrhythmias

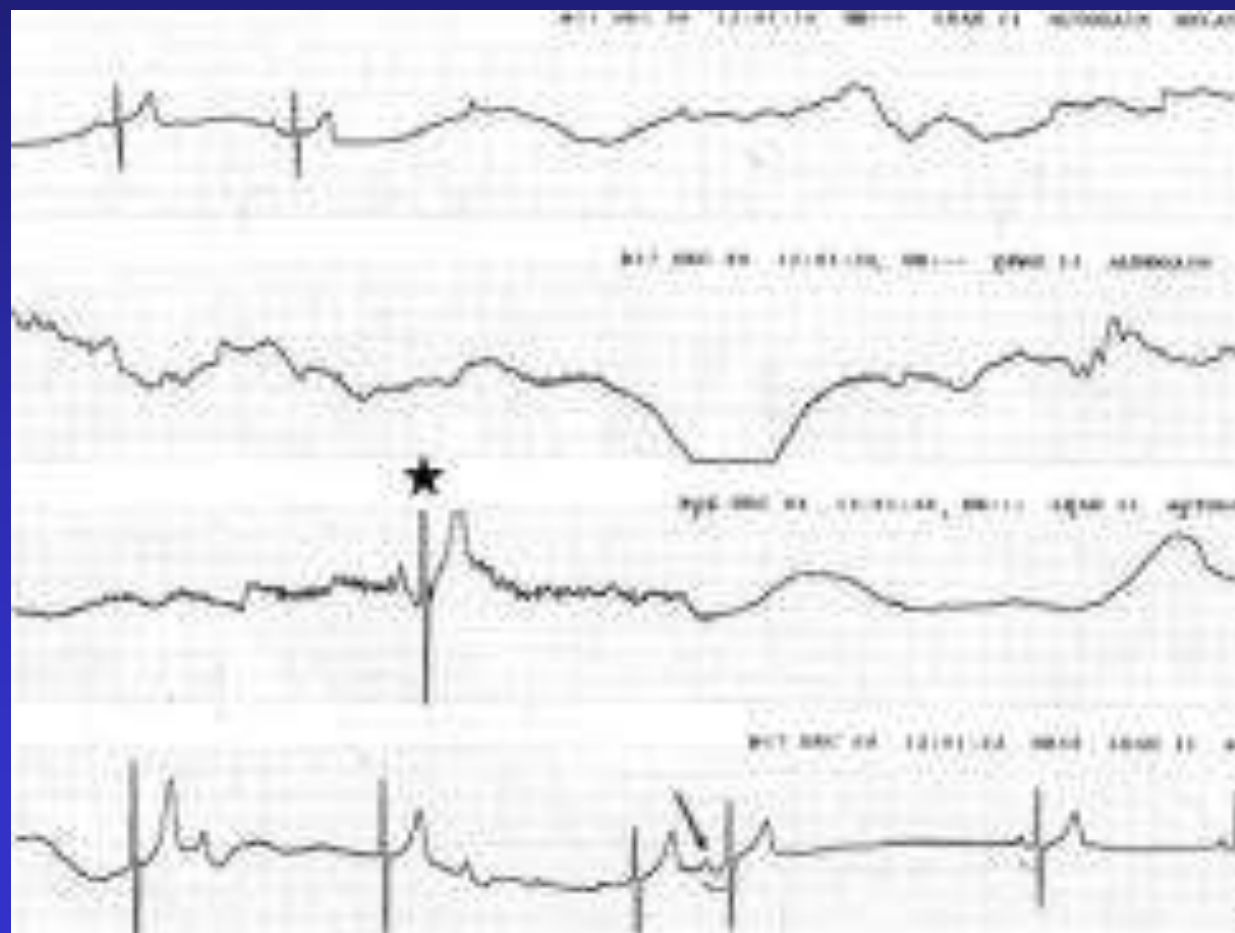
- Sinus node dysfunction
- Heart block



- Permanent pacemaker

# Two exceptions to the rule . . .

- Medication history
- If sinus bradycardia and heart block both occur together



# “SVT”

- Atrial flutter
- Atrial tachycardia
- AV nodal reentrant tachycardia
- AV reentrant tachycardia using a concealed bypass tract
- Sinus node reentry

SVT is a rare cause of syncope.  
But you should not forget . . .

- Elderly
- Cardiomyopathy
- Post-conversion pause

# “SVT”

Atrial flutter

Ectopic atrial  
tachycardia

AV nodal reentrant  
tachycardia

AV reentrant  
tachycardia

Sinus node reentry

Drugs

AV nodal drugs

Antiarrhythmics



Catheter ablation

# Wide Complex Tachycardia

## SVT with aberrancy or VT

Normal heart -

SVT with aberrancy

RVOT VT

Belhassen's VT

Drugs

Calcium or Beta  
blockers

AA drugs

Ablation



Abnormal heart –

Ventricular tachycardia

Ventricular tachycardia

Ventricular tachycardia

SVT with aberrancy

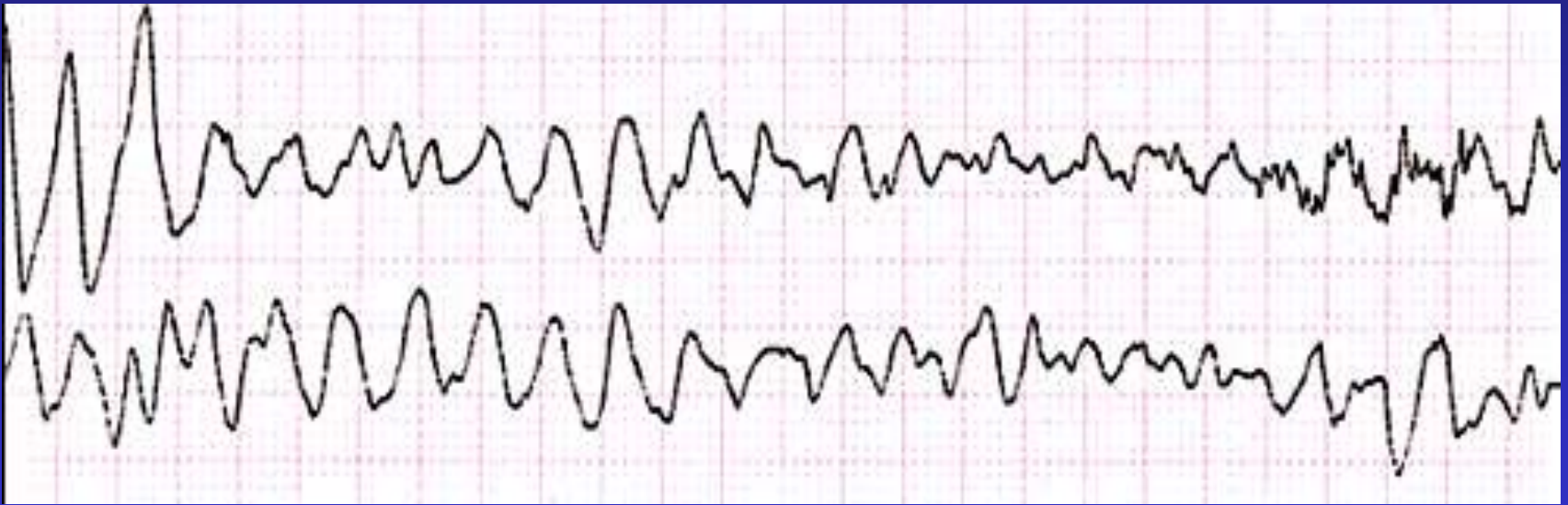
ICD

+/- AA drugs

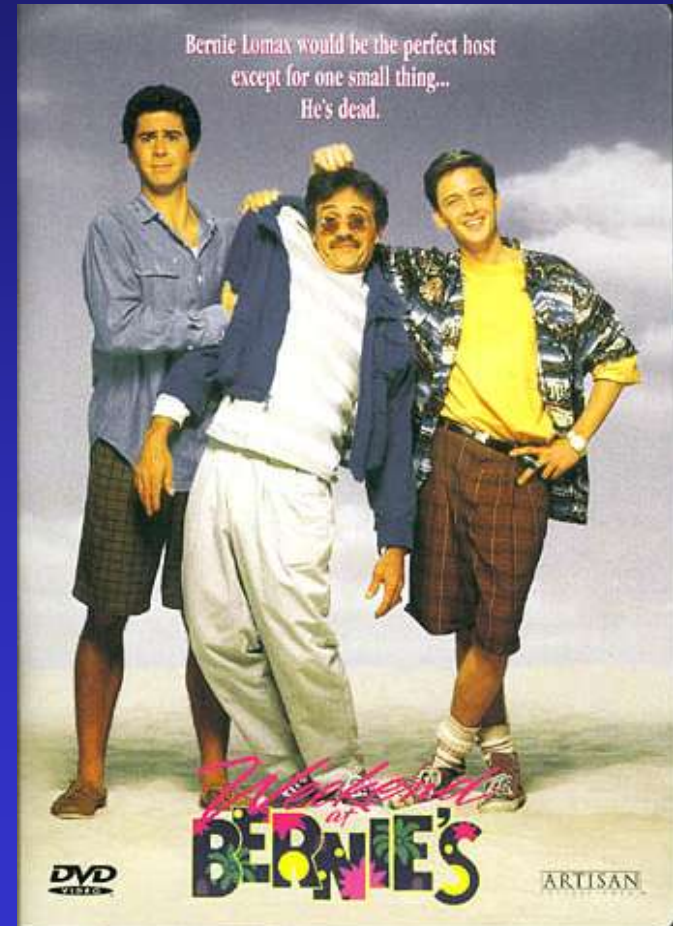
=/- ablation



Two possibilities . . .



# Depends on how the patient looks



# What to do with a patient with syncope when the work-up has been fruitless . . .



# AHA/ACCF Scientific Statement

## AHA/ACCF Scientific Statement on the Evaluation of Syncope

**From the American Heart Association Councils on Clinical Cardiology, Cardiovascular Nursing, Cardiovascular Disease in the Young, and Stroke, and the Quality of Care and Outcomes Research Interdisciplinary Working Group; and the American College of Cardiology Foundation  
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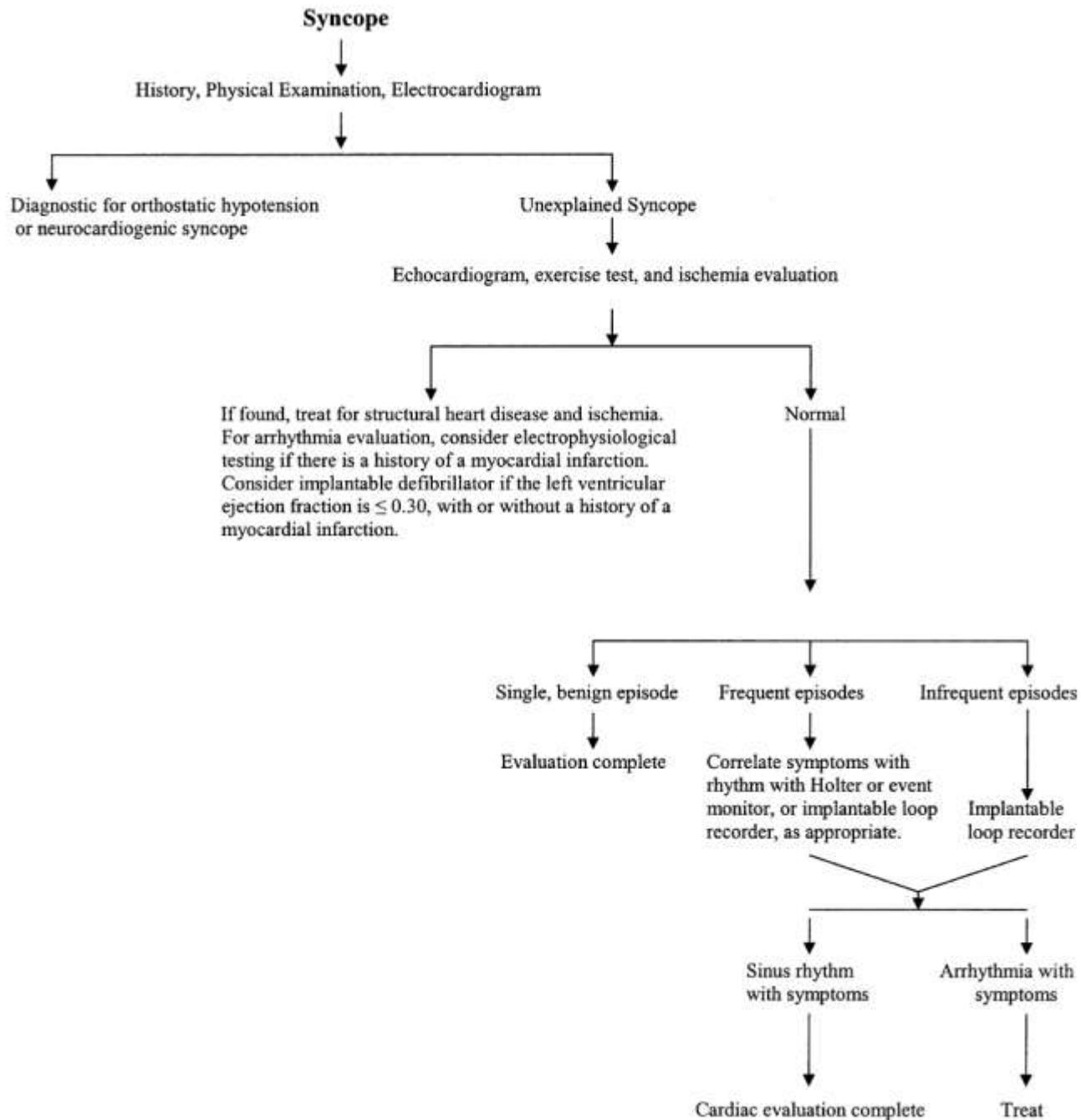
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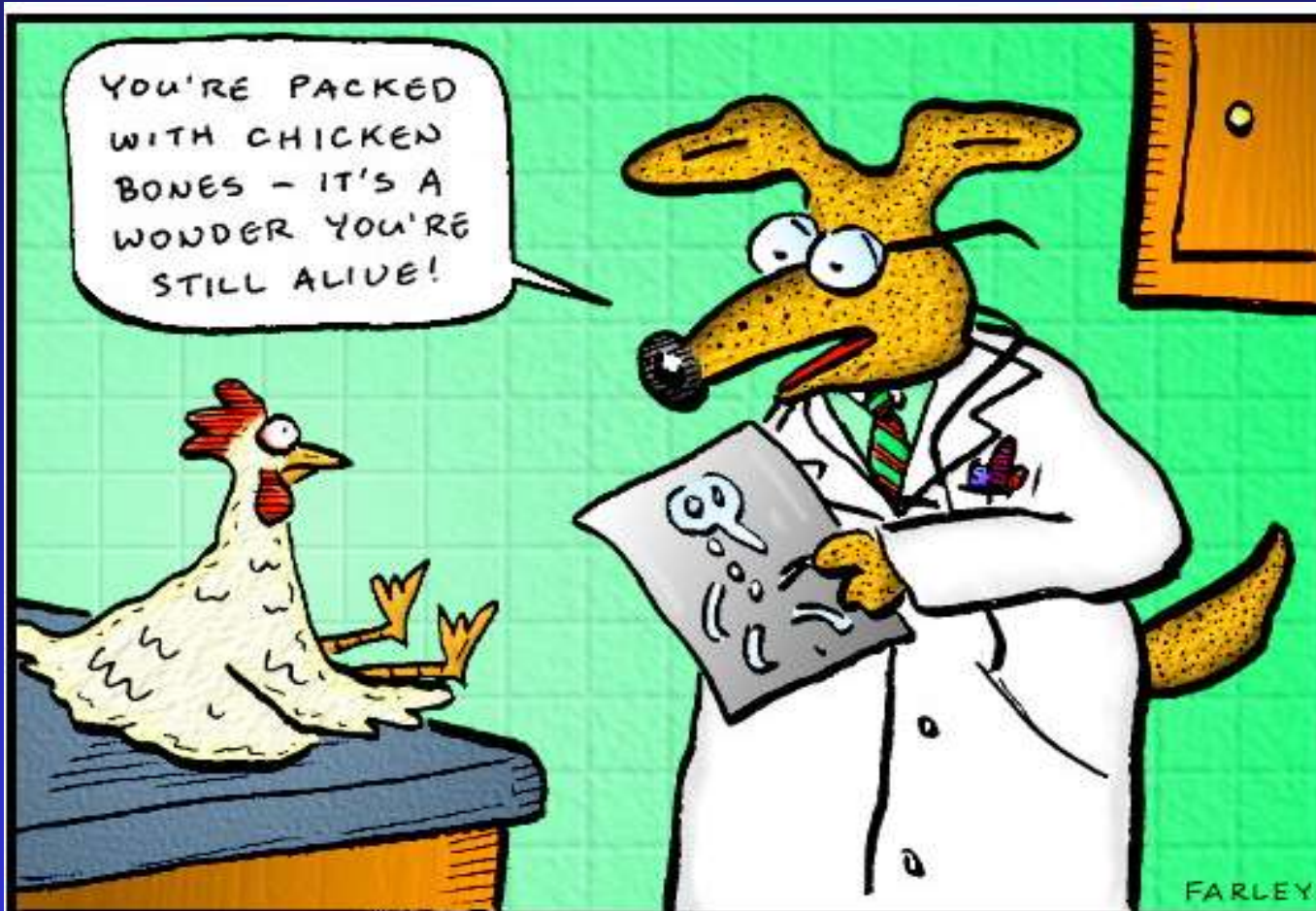
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**JACC 2006;47:473-84**



# Unnecessary Testing at the Dog Doctors



# Usefulness of Carotid Ultrasound in Patients with Syncope

- Mayo Clinic 1997 & 1998
- 140 patients
- Median Age = 74 years (interquartile range, 66-80 years)
- 49% male

– Schnipper JL, et al. Mayo Clinic Proc 2005;80(4):480-8

# Results

- 20 pts. (14%) - “severe extracranial or intracranial cerebrovascular disease”
- 19 of 20 pts (95%) - focal neurologic signs or symptoms or carotid bruits with positive test compared with 46 (38%) of 120 patients without severe disease ( $P < .001$ ).
- Ultrasonography identified cerebrovascular lesions that may have contributed to the syncopal process in only 2 (1.4%) of 140 patients but the lesions were unlikely to have been the primary cause of syncope in either patient.

– Schnipper JL, et al. Mayo Clinic Proc 2005;80(4):480-8

# Tilt Table Test

- Tilt of 60° - 80°
- 30 - 60 minutes at baseline
- with and without isoproterenol
- with and without SL nitroglycerine
- Sensitivity 67 - 83%
- Specificity 75 - 100%

» Kapoor WN Am J Med Sci 1999;317:110-6

# Specificity of Tilt Table Test

- 34 normal volunteers
  - 21 men, 13 women, mean age 32.9 yrs
  - 45 minute tilt at baseline at 80°
  - 20 minutes isoproterenol infusion
  - 2 positive at baseline, 1 with isoproterenol
  - 1 subject later had syncope

» Grubb et al. PACE 1997;20:2019-23

# Electrophysiologic Study



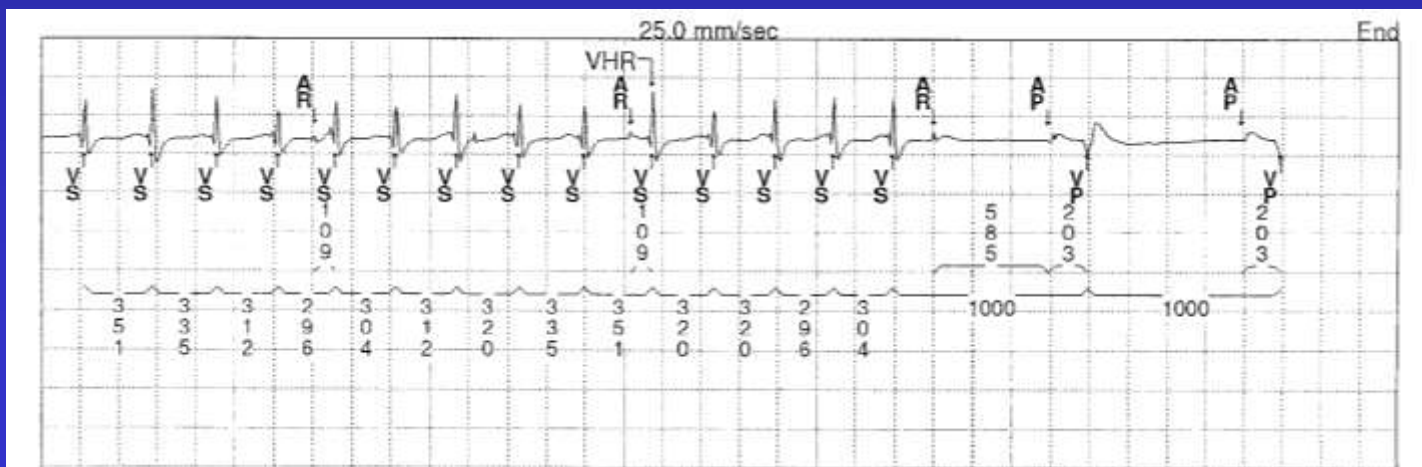
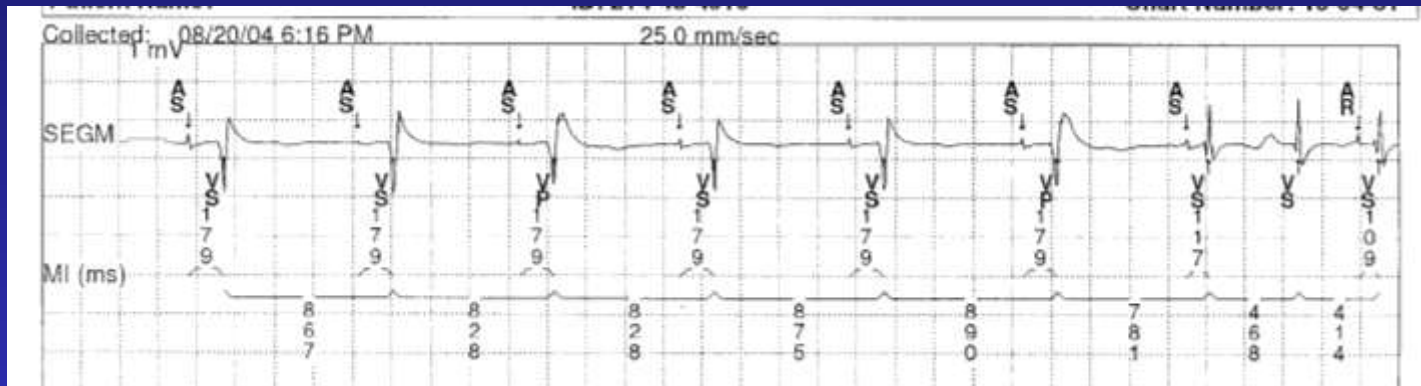
# Sensitivity of EPS in Pts with Transient Bradycardia

- 21 pts - ECG documented AV block (13) or sinus pauses (8) causing syncope
- 63 ± 13 yrs, 14 organic heart disease
- 3 of 8 pts w/ documented sinus pauses had SA nodal abn. (37.5% sensitivity)
- 3 of 8 had abn. unrelated to syncope
- 2 of 13 pts w/ documented AV block confirmed w/ EPS (15.4% sensitivity)

How about some free information  
from your pacemaker?



# Pacemaker Interrogation in a pt with syncope at dialysis



# More Data

Pacemaker Model: Medtronic EnPulse E1DR01  
Serial Number:

08/18/04 3:23:25 PM  
EnPulse Software 2.0  
Copyright (c) Medtronic, Inc. 2002

## High Rate Episodes

Page 1

Data Collection Period: 05/27/04 11:23 AM - 08/18/04 3:17 PM (Over Last 83 days)

### Atrial High Rate Episodes

Episode Trigger Mode Switch  
Collection Delay 30 sec  
Detection Rate 170 bpm  
Detection Duration No Delay

### Episode Data

VHR Episodes 4  
Mode Switches 0 (0.0 hrs/day - 0.0%)  
AHR Episodes 0  
PVC Singles 237,483  
PVC Runs 2,884  
PAC Runs 0

### Ventricular High Rate Episodes

Detection Rate 150 ppm  
Detection Beats 5 beats  
Termination Beats 5 beats

Type	Date/Time	Duration hh:mm:ss	Rates (bpm):			
			Max A	Max V	Avg V	Sensor
VHR	06/18/04 3:01 PM	:19	93	157	150	94
VHR	07/06/04 3:08 PM	:04	109	154	150	93
VHR	07/22/04 5:46 PM	:05	104	171	150	95
VHR	08/05/04 10:33 AM	:05	90	183	150	87

# Summary

- Syncope is a common condition stretching across many disciplines of medicine.
- Classical diagnostic modalities are costly and often prove fruitless.
- Careful history and determination of structural heart disease is important.
- Loop/event monitor - external or implantable - may be cost effective.