

All you need to know about Tilt Testing

**Richard Sutton DSc
Emeritus Professor of Clinical Cardiology
National Heart & Lung Institute
Imperial College
London, UK**

Tilt Testing

What is it?

An electrically-controlled flat bed with footplate and safety belts on which the patient lies. It can be raised to 60 or 70 degrees head-up with a fast tilt down time of <12s.

During the test, various aspects (parameters) of body function are monitored, namely heart rate by sticky electrodes on the chest, beat-to-beat blood pressure by Finapres (or similar) by cuff around a finger and, possibly, electroencephalogram and parameter of brain bloodflow by electrodes on the head

Tilt Testing

What does it do?

It is a method of delivering postural stress to the body.

In an upright position approximately 1 litre of blood is pulled by gravity into the abdominal cavity and legs. Since we have an approximate 5 litres of blood circulating, this is 20% which has the effect of reducing the volume of blood returning to the heart from the veins and reducing the amount of blood pumped by each heart beat (stroke volume). This is compensated by a rise in heart rate.

Blood pressure falls immediately and recovers as the response to the stress is constriction of the small arteries (arterioles) throughout the body.

Tilt Testing

What does it do?

As the upright position is maintained the effect of the reduction in circulating blood may trigger a faint or vasovagal attack.

Other abnormalities may also be exposed such as a progressive fall in blood pressure uncompensated because the compensatory mechanisms are lacking due to disease of the control systems. This typically happens from the beginning of tilt-up but may also be delayed taking 10+ min. to show. These are forms of orthostatic hypotension.

Tilt Testing

What does it do?

The patient may experience a fast heart rate, felt as palpitation, without blood pressure fall but with other unpleasant symptoms. This is postural orthostatic tachycardia syndrome (POTS)

Rarely, the patient may appear to lose consciousness without change in blood pressure, heart rate or electroencephalogram. This is currently termed psychogenic pseudosyncope.

Tilt Testing

Makes the following diagnoses



Vasovagal syncope if usual symptoms are reproduced but a vasodepressive tendency if usual symptoms are not reproduced or there have been no previous symptoms

Orthostatic hypotension – Immediate or Delayed

Postural orthostatic tachycardia syndrome

Psychogenic Pseudosyncope

VVS: Clinical Pathophysiology

- **Neurally-mediated pathophysiological reflex mechanism has two components:**
 - Cardioinhibitory ( HR) primarily vagal origin
 - Vasodepressor ( BP) primarily sympathetic origin
- **Both components are usually present:**
 - Vasodepressor may be masked by severe bradycardia.
 - Pace or pre-treat with atropine to observe Vasodepressor component

Head-Up Tilt Test (HUT)

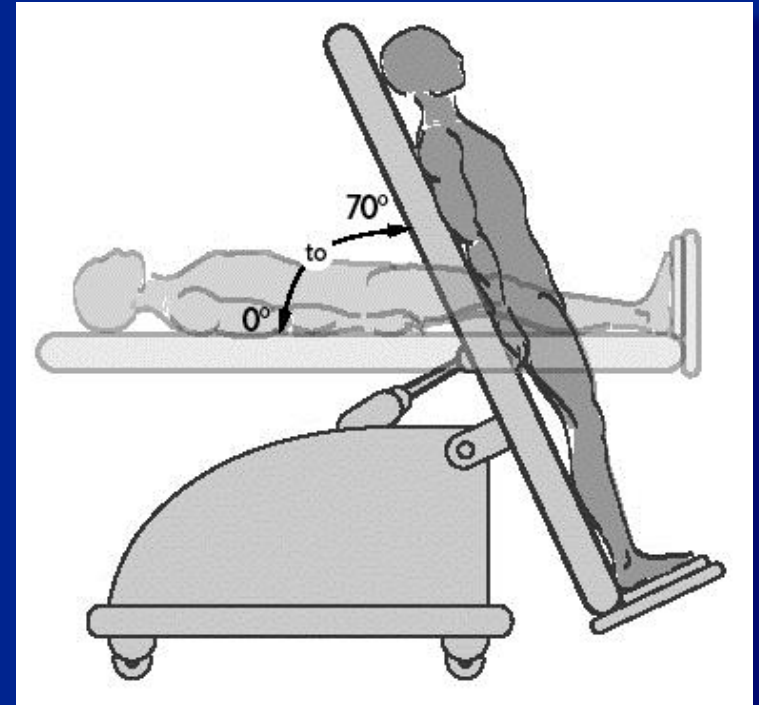
- **Protocols vary**

- some use provocative drugs

- **Goals:**

- Unmask VVS susceptibility
 - Reproduce symptoms
 - Patient learns VVS warning symptoms
 - Patient more confident of diagnosis

- **Not recommended for predicting treatment benefit**



VVS: Typical HUT Protocols

• Basic Preparation

- 2-4 hour fast
- Continuous ECG monitor
- Continuous BP monitor
 - Finometer® (Finapres) or equivalent preferred
 - Intra-arterial line-disruptive to autonomic nervous system (>1 hour before test) - rarely required/used
 - Sphygmomanometer BP discouraged – too much data lost

Noninvasive Beat-to beat BP

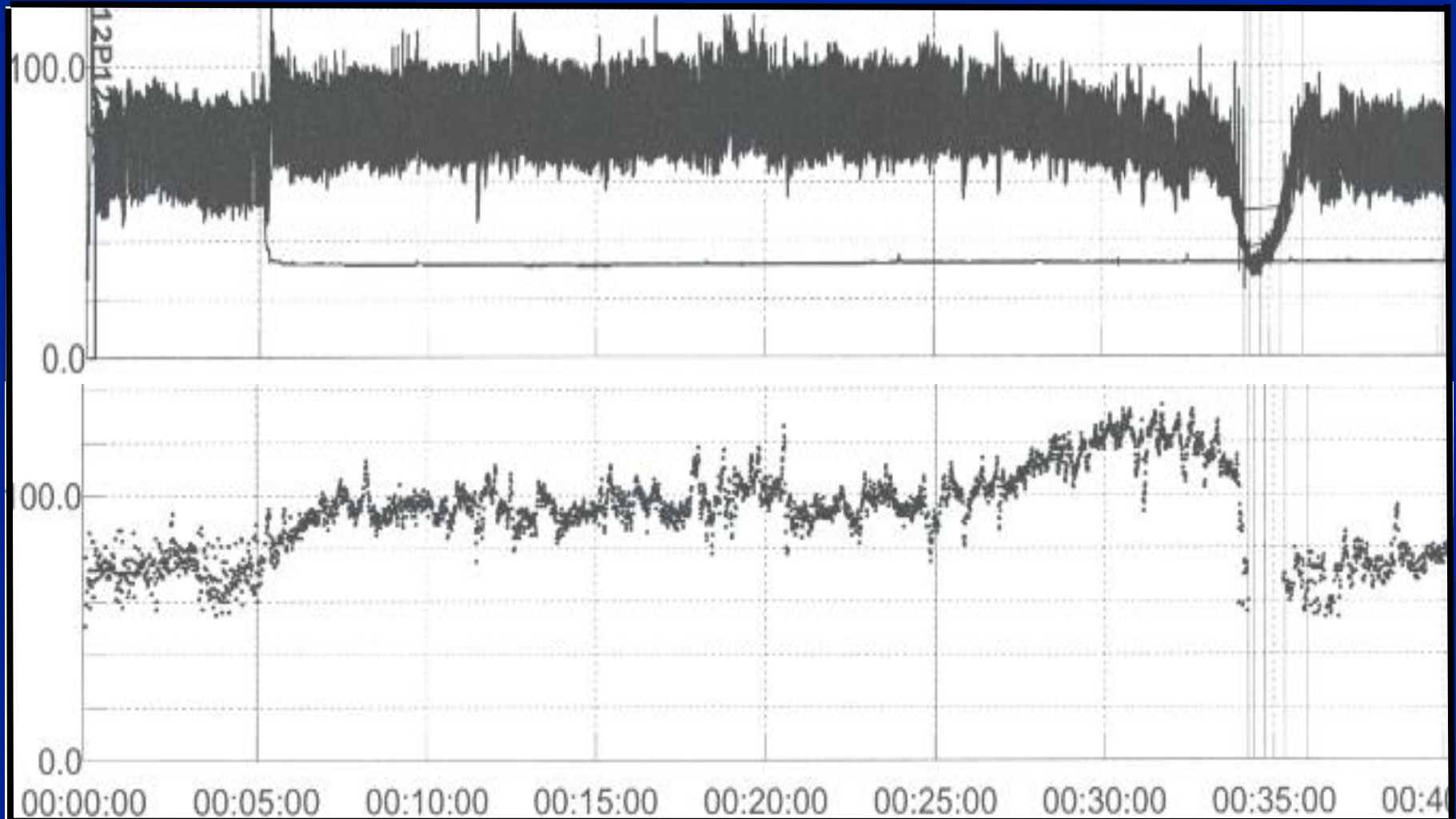


VVS: Typical HUT Protocols - 2

- **Supine rest period 5-15 min**
- **Tilt head-up to 60-70° for 20 min**
- **Positive end-point: Syncope with reproduction of symptoms**
- **If negative, then add drug provocation while still upright**
 - Nitroglycerine 0.4mg SL, or
 - Isoproterenol 1-5 mcg/min, to increase HR to 125% baseline
- **Extend tilt period after drug for 10-15 min.**

Vasovagal Syncope

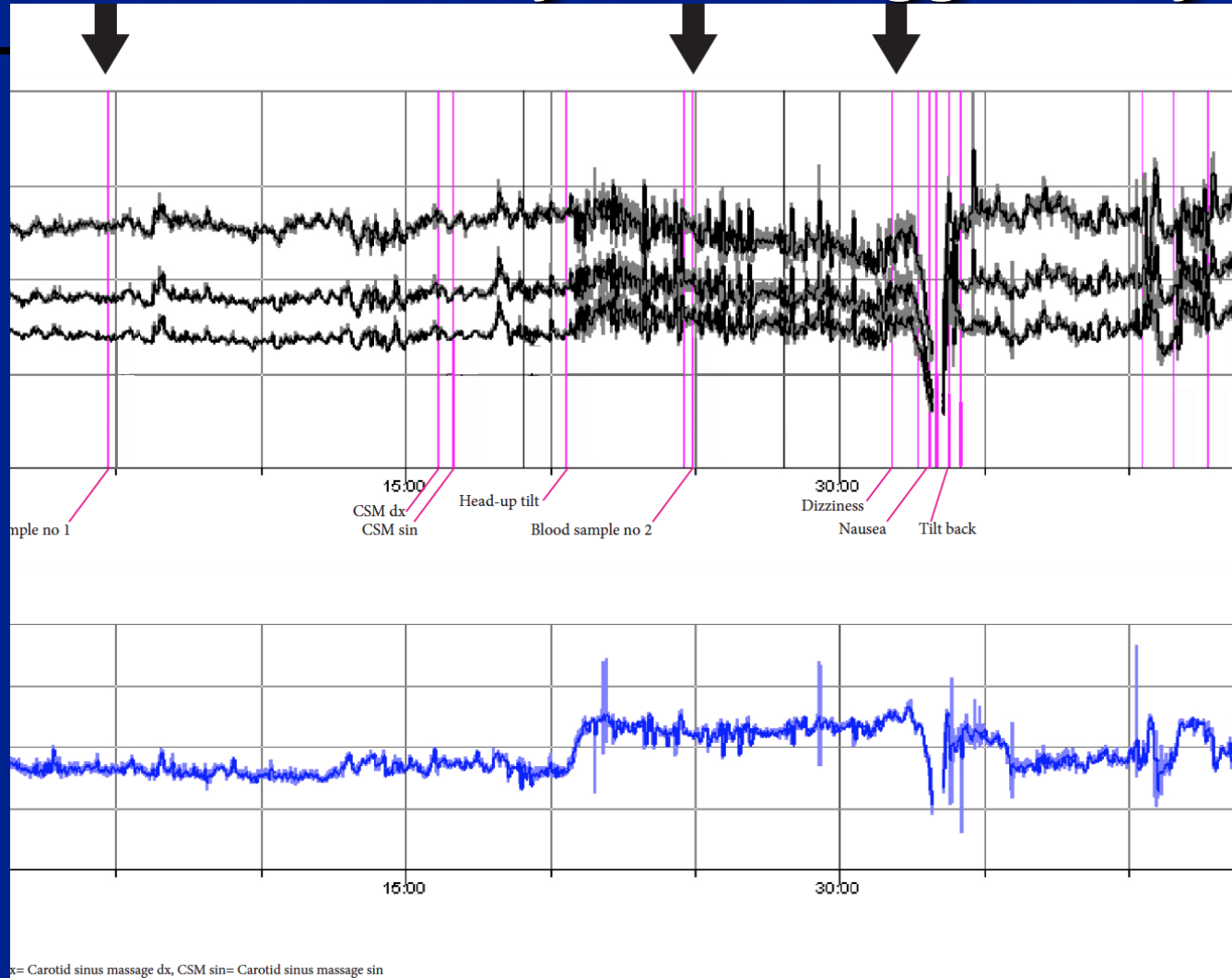
Hypotension and Bradycardia Triggered by HUT



Courtesy R Sutton DSc

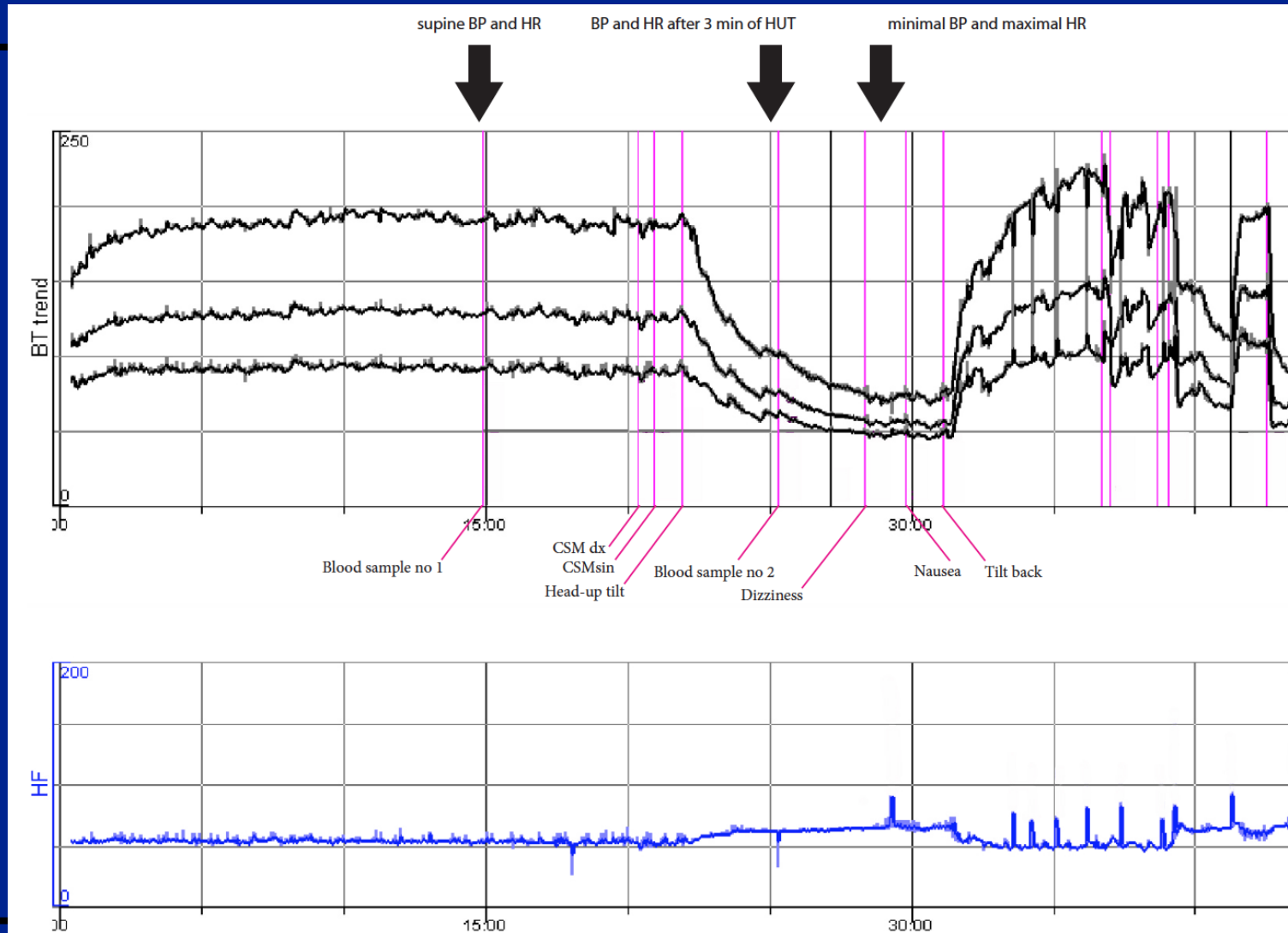
Vasovagal Syncope

Hypotension and Bradycardia Triggered by HUT



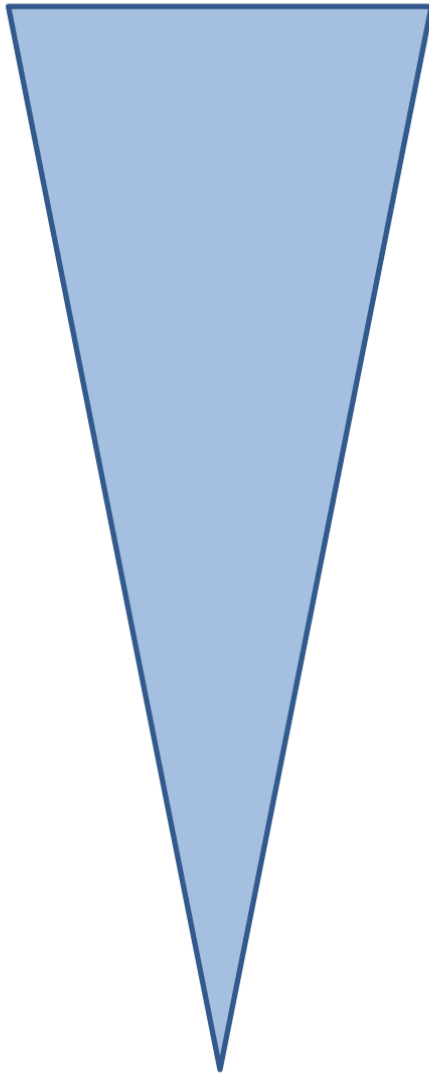
Tilt

Orthostatic Hypotension Triggered by HUT



Courtesy R Sutton/A Fedorowski

Tilt testing: positivity rate



92%	Typical VVS, emotional trigger (Clom) ³
78%	Typical VVS, situational trigger (TNT) ³
73%-65%	Typical VVS, miscellaneous (Clom) ⁴ (TNT) ^{3,9}
56%-51%	Likely reflex, atypical (TNT) ^{7.8}
47%	Cardiac syncope (TNT) ⁸
45%	Likely tachyarrhythmic syncope (Passive) ¹⁰
36%-30%	Unexplained syncope (TNT) ^{3,9} (Clom) ³
13%-8%	Subjects without syncope (Passive) ⁵ (Clom) ⁴ (TNT) ⁶

Sutton R, Brignole M. 28yrs. Eur Heart J 2014; 35, 2211–2212.

ISSUE-3 Study design

ILR screening phase

ILR eligibility criteria:

- *Asystolic syncope* ≥ 3 s, or
- *Non-syncopal asystole* ≥ 6 s

ISSUE 3 study phase

Endpoint

Neurally-mediated syncope

ILR implantation (Reveal DX/XT)

ILR follow-up (max 2 yrs)

Randomization

PM ON

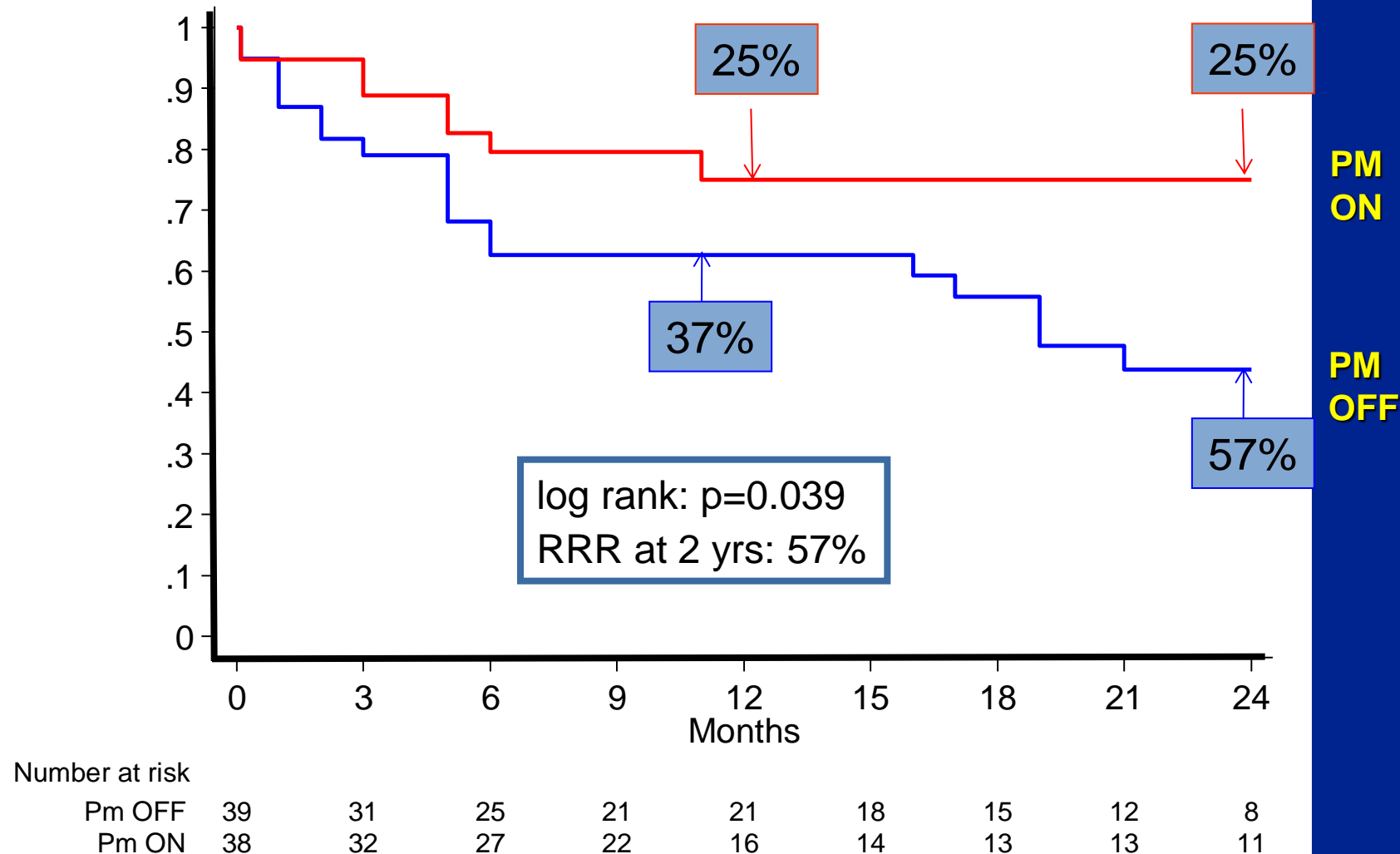
PM OFF

Time to first syncope recurrence

ISSUE-3 Population

- **Diagnosis: Reflex (neurally-mediated) VVS**
- **Mean age at presentation: >60 years**
- **Recurrent syncope beginning in middle or older age**
- **Clinical presentation sufficiently severe to require treatment (high risk and/or high frequency)**
- **Atypical presentation without warning**
- **Injuries related to presentation without warning**
- **ILR documentation of marked bradycardia (mean pause duration, 11 seconds)**

ISSUE -3: Intention-to-Treat

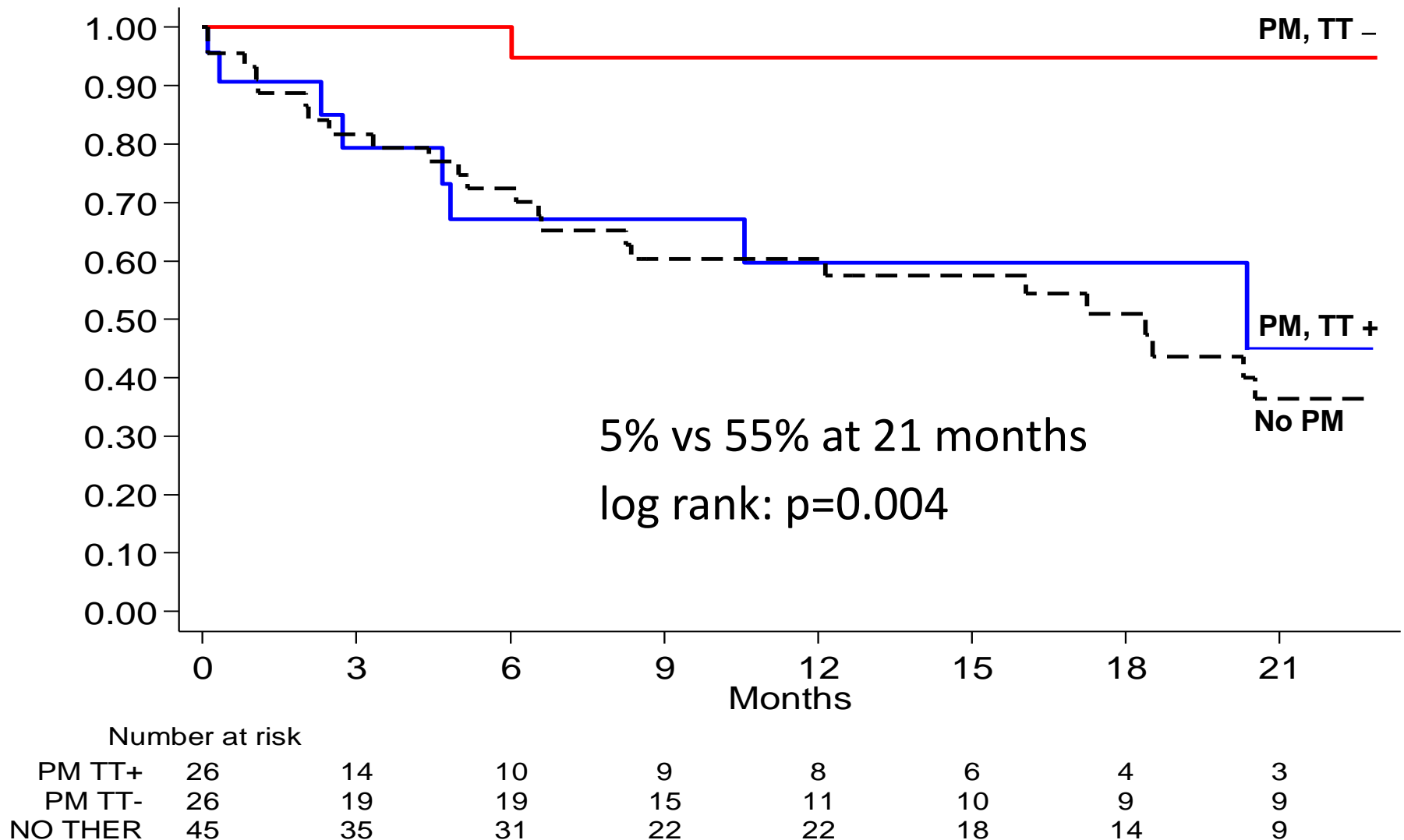


ISSUE-3

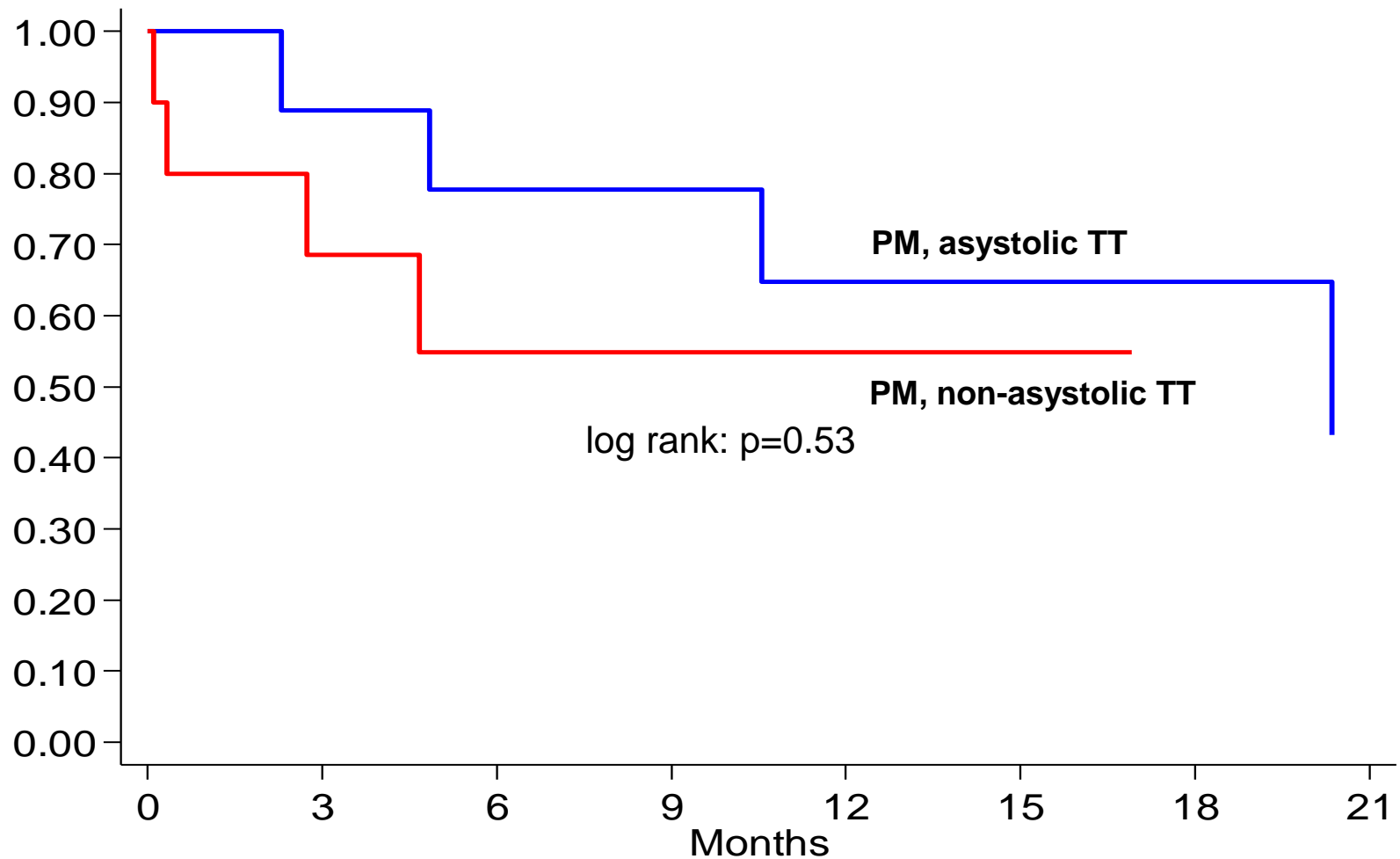
Conclusion

- **In patients ≥ 40 years with severe asystolic VVS/reflex syncope:**
 - Dual-chamber pacing reduces recurrence of syncope
 - The 32% absolute and 57% relative syncope reduction rate support use pacing.
- **The strategy of using ILR to determine indication for pacing likely explains the positive outcome and difference from prior negative results in pacemaker studies.**

Syncope recurrence after PM therapy according to tilt test results. RCT + Registry



Syncope recurrence after PM therapy according to tilt test response. RCT + Registry



	Number at risk							
	0	3	6	9	12	15	18	21
PM TT+ Asyst	14	8	6	6	5	4	3	2
PM TT+ No Asyst	12	6	4	3	3	2	1	1

Conclusions from ISSUE 3

RCT + Registry

Brignole M et al *Circ Arr Electrophysiol* DOI: 10.1161/CIRCEP.113.001103

- 1. Cardiac pacing is very effective in asystolic NMS patients for whom tilt is negative. Conversely, there is no evidence of efficacy in patients with a positive tilt.
- 2. Although an asystolic response during tilt predicts asystolic spontaneous NMS, the pacing benefit is similar to that seen in patients with non-asystolic response (all tilts positive).

The implication of a positive tilt test in reflex syncope

The observation in patients with vasovagal syncope that a positive tilt test implies important vasodepression is supported by evidence from

Carotid sinus syndrome, a similar reflex syncope.

In cardioinhibitory CSS, recurrence of syncope after pacing is 2.7 times more frequent amongst those with a positive tilt compared those with a negative tilt

Gaggioli et al Am J Cardiol 1995; 76: 720.

Pacing in VVS : Summary

- Initial studies were not double-blind and not based on documented spontaneous bradycardia
- PM implantation may create psychological responses that modify autonomic responses
- Patient selection is crucial prompting ISSUE 2 Registry and ISSUE 3 RCT (+Registry)
- ISSUE-3 suggests that pacing therapy is effective if spontaneous bradycardia is documented on ILR
- **ISSUE 3 RCT + Registry suggests that tilt-testing can be used as risk stratification for syncope recurrence. Similar findings in CSS**

Pacing for Vasovagal Syncope: Is it effective?

Therapy for all is reassurance, fluids, salt & PCM

Pacing is only good for a minority which needs very careful selection (< 5% of those presenting to syncope specialist).

In older pts. pacing is chosen for symptoms resistant to standard approaches (inc. meds). Tilt induced asystole predicts spontaneous asystole (PPV 87%) but tilt positivity also suggests an important vasodepressor component & likely syncope recurrence.

We have no guidance in the young.

We have achieved something but much more remains to be done