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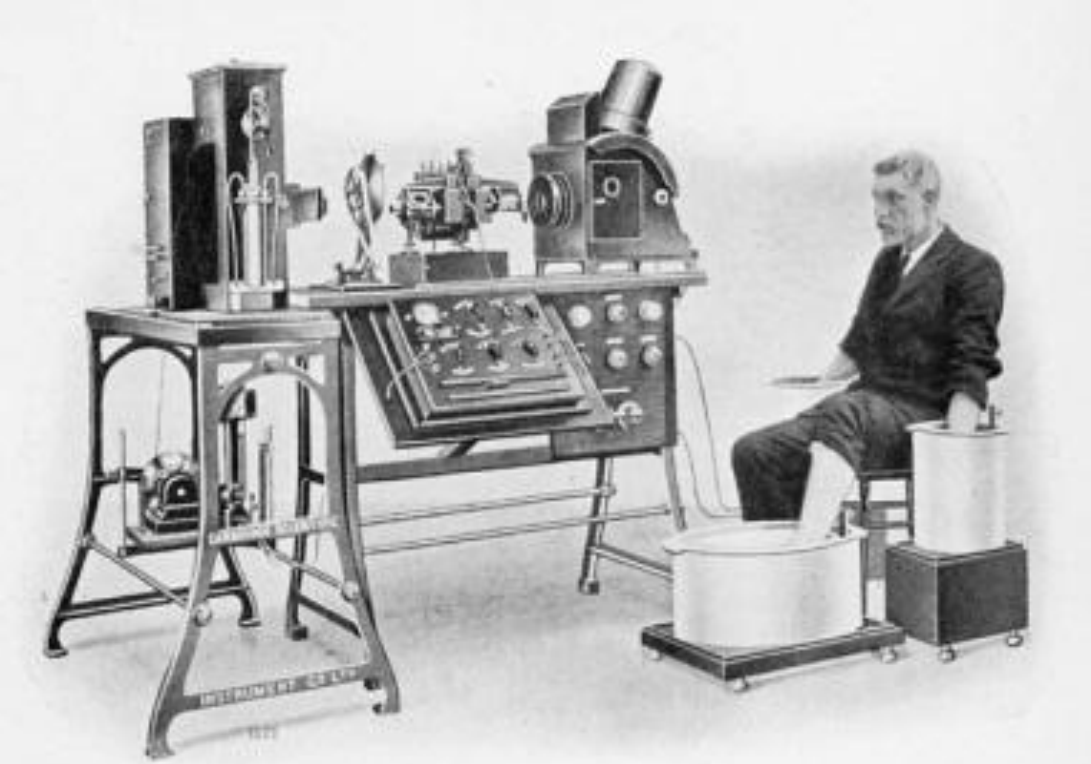
Electrocardiograph testing: current measures and future challenges

NHS

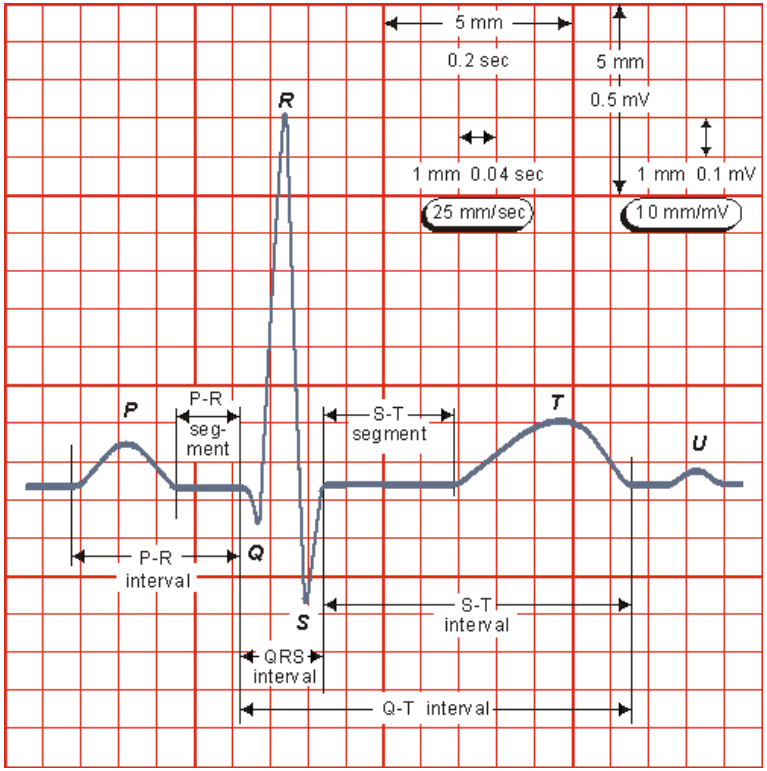
The Cambridge Electrocardiograph



PHOTOGRAPH OF A COMPLETE ELECTROCARDIOGRAPH, SHOWING THE MANNER IN WHICH THE ELECTRODES ARE ATTACHED TO THE PATIENT, IN THIS CASE THE HANDS AND ONE FOOT BEING IMMERSED IN JARS OF SALT SOLUTION

Is this ECG 'normal'?

- P-QRS-T
- P-R interval (>200mS) ?A-V block
- QRS duration (>120mS) BBB
- R wave amp. (>26mm;V4 – V6) LVH
- ?U wave Hypokalaemia



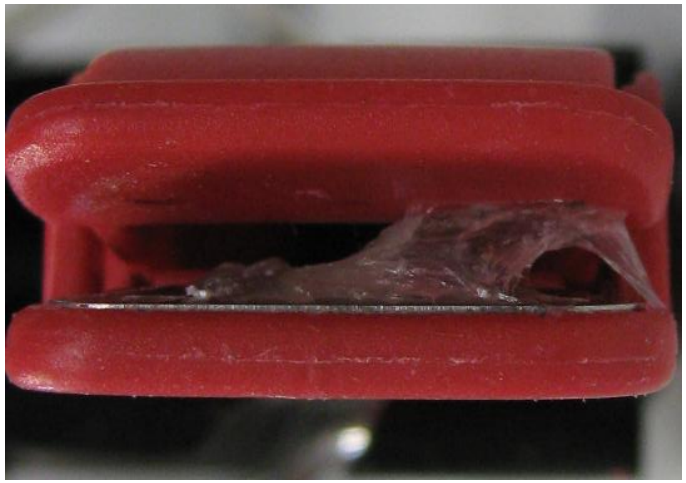
It's all about the morphology

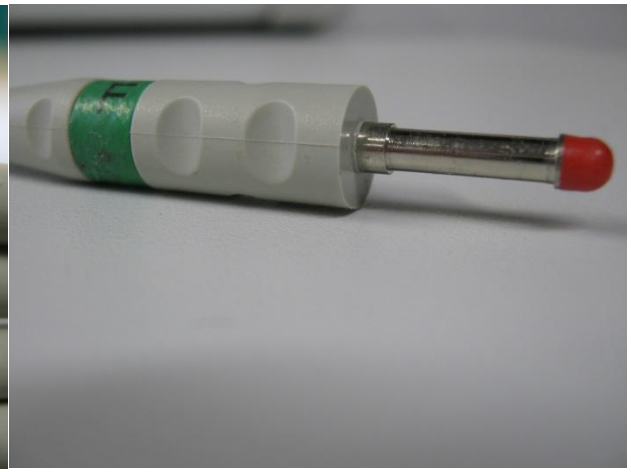
Common faults

Visual inspection

70% of faults can be identified by a visual inspection – 3 examples

1. Electrode gel on SkinTact® Easytab contact
2. Exposed/frayed screen on the patient cable
3. Missing ‘Lantern spring’



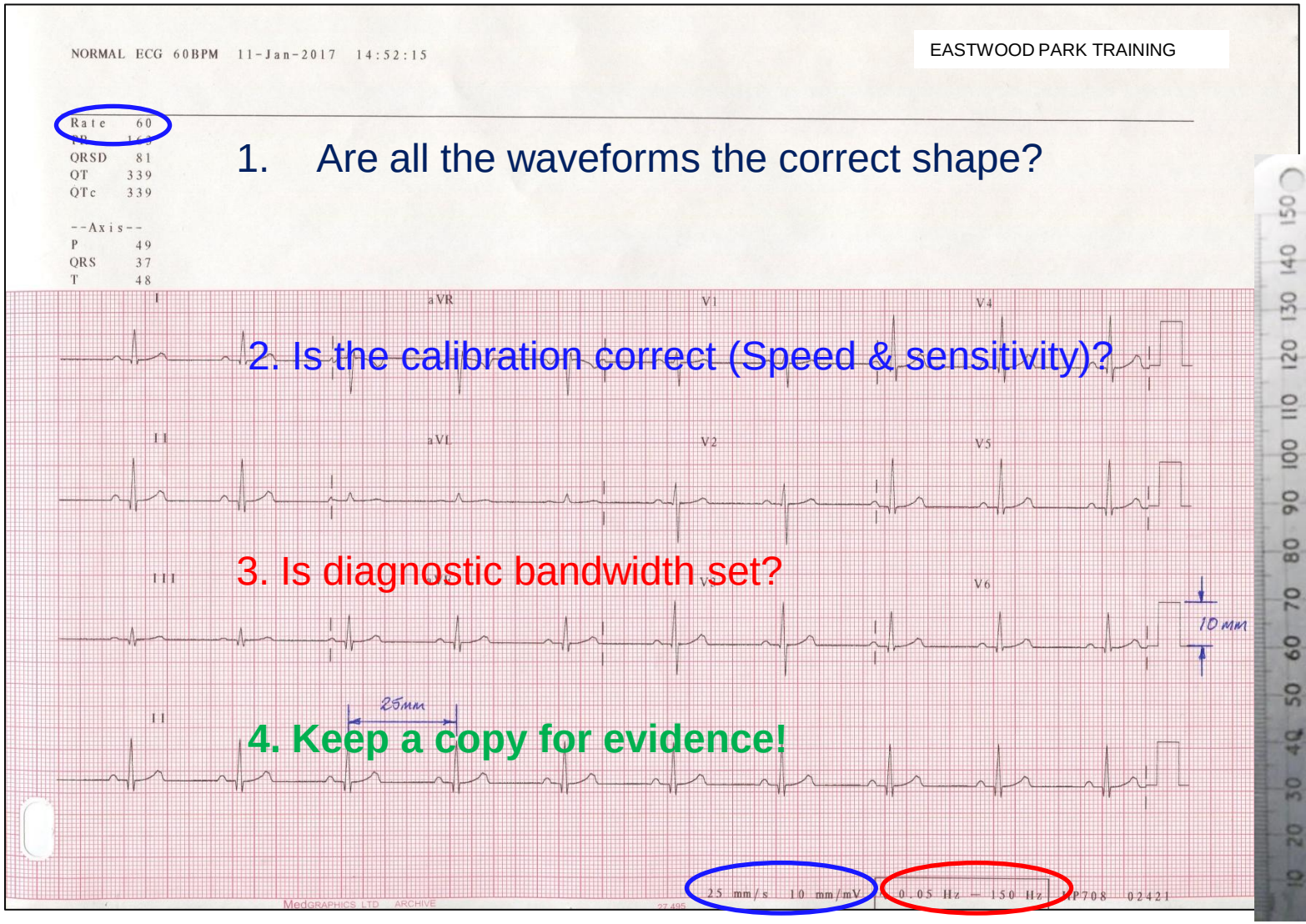


Performance verification

Real-time preview checks

Checking the display

- Confirm the simulator is within its calibration date
- Connect ECG leads to the simulator and select NSR 60BPM
- Observe all waveforms are displayed on the screen
- Check the lead off/electrode impedance indicator.



1. Are all the waveforms the correct shape?

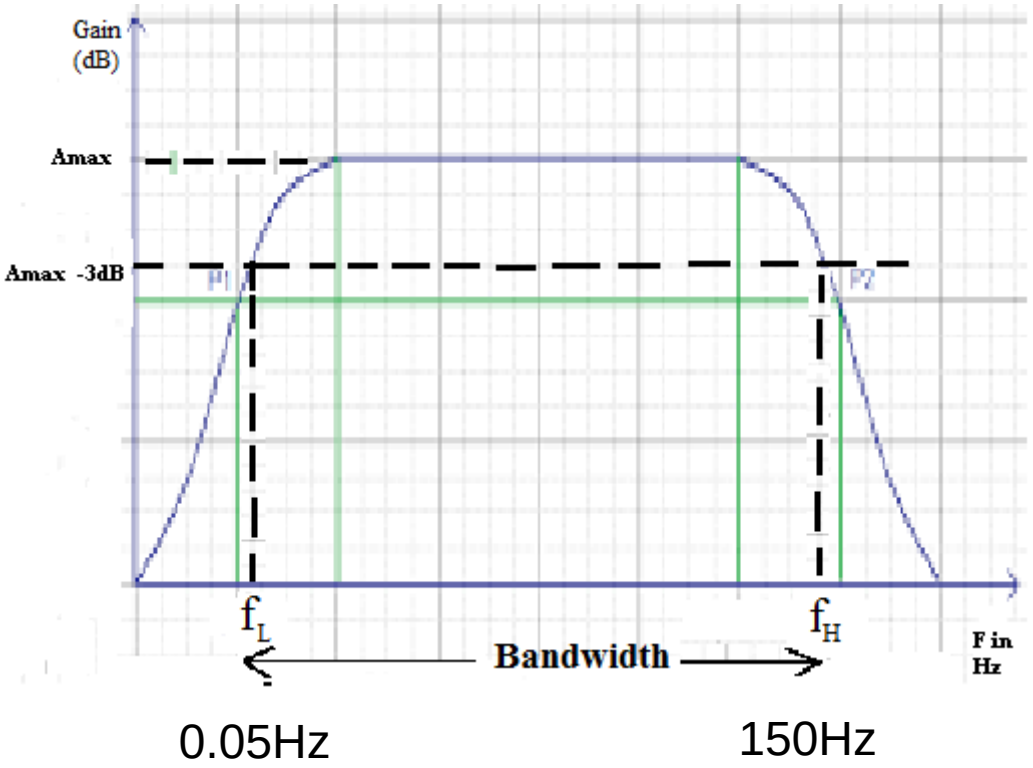
2. Is the calibration correct (Speed & sensitivity)?

3. Is diagnostic bandwidth set?

4. Keep a copy for evidence!

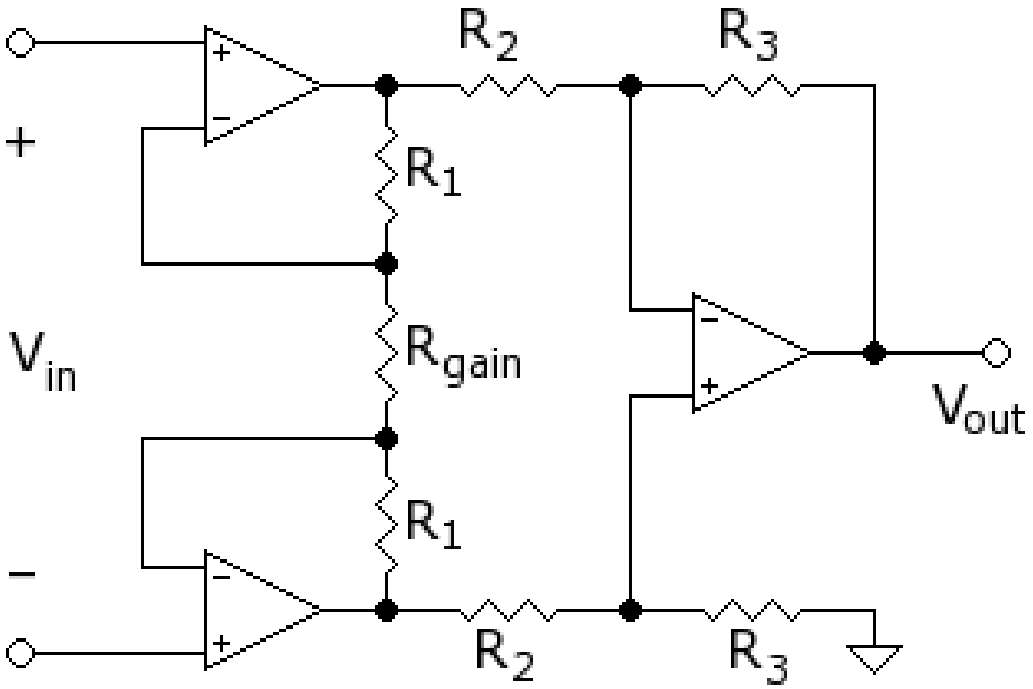
It's a matter of frequencies

- Diagnostic or monitoring bandwidth
  - 0.05 – 150 Hz Diagnostic
  - 0.5 – 40Hz Monitoring
- Effect of Monitoring bandwidth
  - Masks large QRS amplitude
  - Erroneously displays ST segment changes

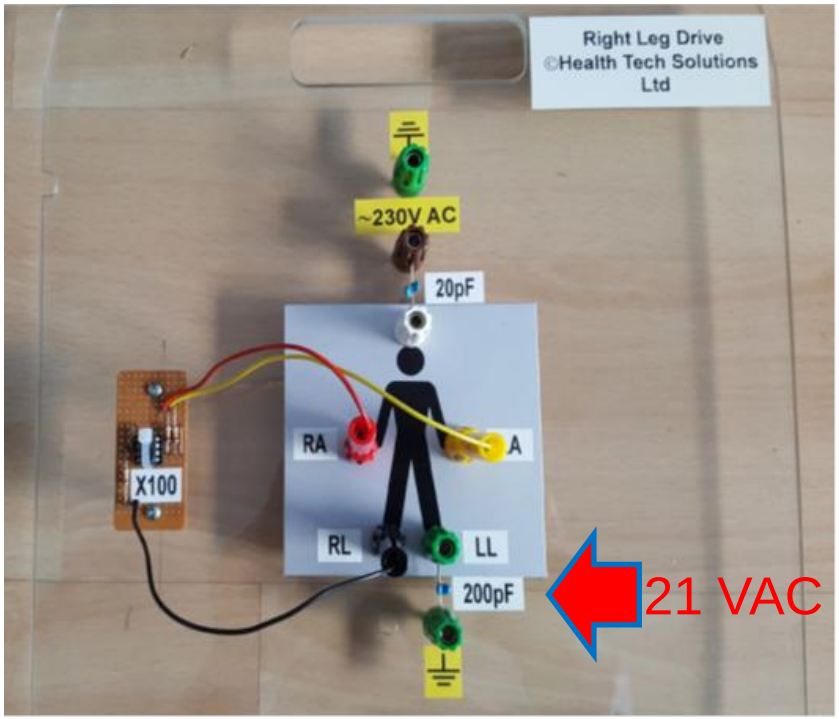


Should we be measuring the bandwidth?

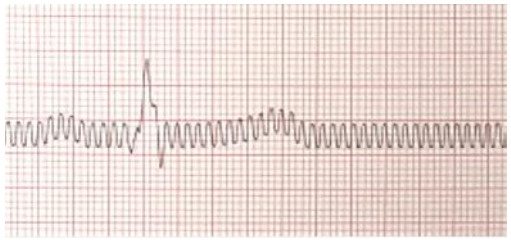
The Instrumentation Amplifier



$$G_d = \frac{2\,R_1 + R_{gain}}{R_{gain}} * \frac{R_3}{R_2}$$



Dr John G Webster



Should we be performing more tests?

- Frequency response
- CMRR
- Pacemaker rejection…

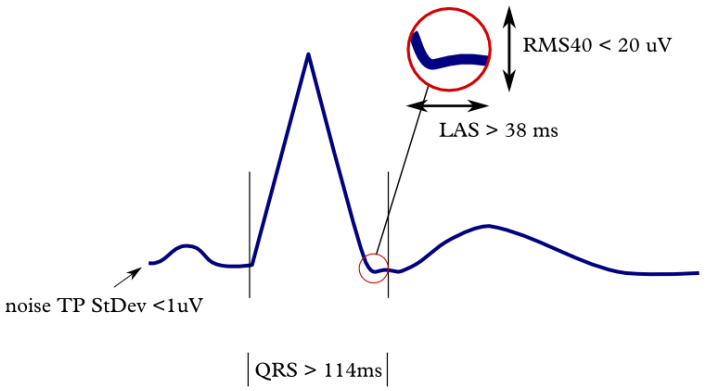
What about PPM?

- ECRI – Medium Risk Category
- MHRA – *Managing Medical Devices*
- Rigel recommends regular testing
- Manufacturers – 6 or 12 monthly PPM

It is all about the perceived risk

Challenges – software diagnostics

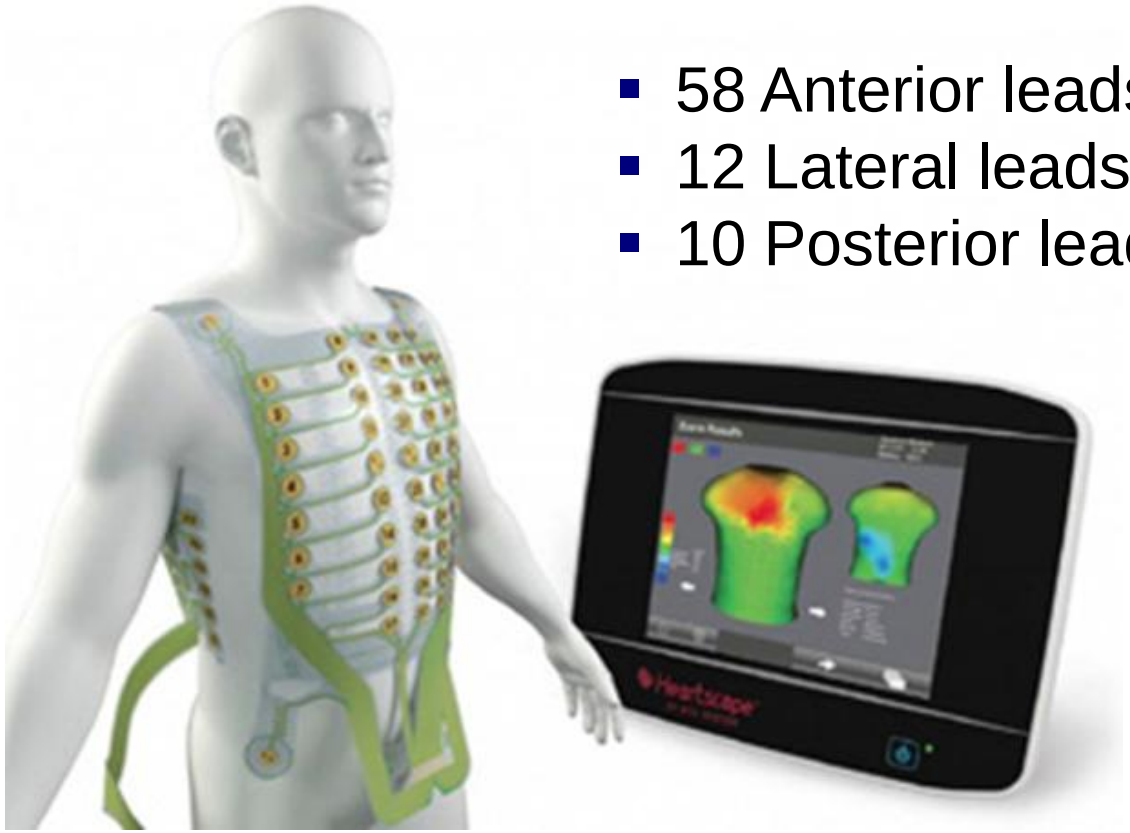
- ACI-TIPI (Pozen *et al*, 1984)
- SAECG – “late potentials”(1990’s)
- Synthesised 18 – Lead ECG (2015)
- ECG on your iPhone



The 80 lead ECG

Just imagine the size of the simulator!

- 58 Anterior leads
- 12 Lateral leads
- 10 Posterior leads



References

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Pozen, M.W., D'Agostino, R.B., Selker, H.P., Sytkowski, P.A. and Hood, W.B. Jr. (1984) A predictive instrument to improve coronary-care-unit admission practices in acute ischemic heart disease. A prospective multicenter clinical trial. *N Engl J Med*. 310(20)1273-8

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