Making sense of the ECG
Aims

• Clinical role/Purpose
• Anatomic Correlation
  - normal
  - abnormal
• Systematic approach to an ECG
• In Context
Purpose of ECG

• Screen
• Diagnose
• Monitor

- An instantaneous screenshot of the heart: hence need for serial ECGs or long strip ECGs
- An examination of the wiring of the heart
Different modalities of heart imaging

• CXR – visualise heart size, aortic knuckle, heart position, lung pathology
• 2DECHO – valve patency, function and heart function/volumes
• Angiography – heart vasculature, vessel occlusion
• CT/MRI – Visualise heart, vessels, pericardium, collections like pericardial effusion
• PET scan – muscle metabolic function, very rare
What about the ECG?

• Only modality that can give you a picture of the wiring and precise rhythm of the heart
• Arrhythmias are an important category of heart disease
• Implicated in multiple pathologies
Impulse

• Describe the electrical anatomy of the impulse.
Impulse

- SA node – Innervation?
- AV node – function?
- Bundle of His
- Left (ant. & pos.) and right bundle
- (Myocardium) – impulse spreads via gap junctions
- most efficient pathway - like a highway
Placing the 12-lead ECG

- If I am now a medical student, and I’m learning how to place an ECG, walk me through the process.
Placing the 12-lead ECG

- 3(4) Limbs, 6 pre-cordial - 4th and 5th IC space
- I, II, III are calculated from aVL, aVR and aVF
- Diff groups of lead look at diff parts of the heart
The ECG paper

- usually calibrated @ 25mm/s
- therefore 1 small square is 0.04s or 40 ms
- 1 big square is 0.2s or 200ms
- duration of squares change with calibration change
- you “slow down” the ecg as your paper speed increases
First Principles

• Wave of depolarisation registers positive when it moves toward a lead; registers negative when it moves away from a lead

• true of repol waves too, but in reverse
The Cardiac Cycle
Parts of the ECG
P wave

• Atrial contraction
• SA node > R atrium (via Bachmann Bundle) L atrium
• you do not see the SA node depolarisation
• P wave the result of **synchronised** atrial contraction with origin from SA node
right atrial component  left atrial component
What can go wrong?

- No P
- Weird P
- Many weird Ps
- “Taller” P
- P with 2 peaks

- Sinus rhythm - what does this mean?
QRS complex

- what is q, r & s?
- corresponds to ventricular depol
- usually less than 0.12s (how many ms is that? how many small squares is that?)
What can go wrong?

• Length
• Morphology - shape & voltage
• Both
• what goes on behind this?
R wave progression
ST-segment

- still corresponds to ventricular depolarisation
- normally isoelectric or slightly raised
- J-point to end of T-wave
What can go wrong?

- elevated - regional or global
- w/ reciprocal changes
- depression - may or may not be due to ischemic changes
- length - prolonged in hypocal, shortened in hypercal
- morphology
T-waves

• corresponds to ventricular repolarisation
• typically negative in aVR & V1
• usually broader and asymmetrical
What can go wrong?

• too tall
• peaked
• too short
• inverted
• biphasic
• camel hump
Intervals & durations

- PR - 0.12-0.2 - what can go wrong?
- QRS - <0.12
- RR - how is it related to heart rate?
- QT - QT vs QTc
lead aVR

• an important marker to check before reading any ECG
• what is aVR normally?
• VT
• Pacemaker
• extreme RAD
• wrong leads
• dextrocardia
Therefore, an approach

• aVR
• Sinus or non-sinus - look for P waves
• regular or irregular
• tachy or brady
• Axis
• QRS T wave > P wave
• ST segment
• Intervals
• R-wave progression
• any other observations
Now it's your turn to try (:
Some tips

• Go big to small
• do not skip steps
• even if you manage to eyeball pathologies, still be thorough
• break ECGs down into sections if complicated
• come up with possible differentials based on scenarios/context
• some things you won’t see unless you look for it
• don’t overread (:}
Context

• syncope
• chest pain
• breathlessness
• palpitations
• LoC
• weakness
• shock
Chest Pain

- 65/Chi/Male
- Sudden onset chest pain. Central. Radiates to both arms. Associated with vomiting.
- what is your approach?
- what if he had 2 weeks history of fever and productive cough?
- what if he is a known chronic smoker?
- what if you find absent breath sounds on one side?
- what if he were very tall and had long finger and limbs?
- what if this patient just underwent an OGD?
- what if this patient is a known Colon CA patient?
- what if the pain was pinpoint and reproducible with movement and pressure?
Chest Pain

Life-threatening
- AMI
- Uns Angina
- PE
- Aortic dsxn
- Oesoph Rupture

Non-life threatening
- Cardiac
  - Lung
  - MSK
  - Superficial
- Pleuritic
- Parenchymal
- Psychogenic
- GI
Breathlessness

• 70/Indian/Female
• acute onset breathlessness of 1 day. Sore throat, mild fever, cough. No travel Hx. Chronic smoker.
• what is your approach? causes?
• what if she has a family hx of AMI?
• what if she has some leg swelling?
• what if she just returned from US?
• what if she was a known HCC patient?
• what if she had severe diarrhoea 2 weeks ago?
• what if she was a known T1DM pt?
• in which of these would an ECG be helpful?
Syncope

• 30/Malay/Male
• sudden onset of syncope, brought to Emergency department. mention he could feel his heart beating very fast before he fainted. No significant PMHx or Rxhx

• define syncope
• causes?
• what if he had a PMHx of a previous AMI?
• what if he had recurrent attacks
• what if he has a long standing hx of uncontrolled T2DM
• what if he has a pacemaker implanted?
• what if he has long standing HTN and recently changed medication?
• in which of these scenarios is the ECG helpful?
Syncope

Reflex
- Vasovagal
- Situational
- Carotid Sinus

Orthostatic
- Primary
- Secondary
- Drugs
- Volume

Cardiac
- Rhythms
- Structure
For M3

- Normal ECG
- Sinus Tachy/Brady
- Heart Blocks
- STEMI/NSTEMI
- VT
- VF
- AF
- AFLut
Resources

• ECG made easy, Hampton
• The only EKG Book You’ll Ever Need, Malcolm S. Thaler
• learntheheart.com
• lifeinthefastlane.com
• various ECG quizzes e.g. 6-second ECG quiz