Before you start
Check name, date, time, paper speed (25 mm/sec), scale (10 mm/min).
Contrast the 7±2 ± step-glass.
Step 1: Rhythm
Sinus rhythm (SR) (60-100/min): every P wave is followed by a QRS
Narrow QRS tachycardias (QRS<120ms, >100/min) are always supraventricular tachycardias (SVT)
Sinus tachycardia: sinus rhythm
> 100/min. Eg. Fever, Psych. stress / Cardiomyopathy
Atrial flutter: irregular
• Permanent – chronic.
• Paroxysmal – supernumerary
chemical / electrical cardioversion
• Paroxysmal = comes and goes spontaneously
• SR: V1-V5: bradycardia
Atrial flutter: flutter waves on baseline. Often regular 300 / min. A 2:1 or 3:1 block.
AVNR. AV nodal re-entry tachycardia.
Regular, 180-250 / min. P in QR complex (resulting in RSR in V1). Often young patients and paroxysmal. Valvulae / coroid massage / adenosine can terminate episode.
Wide complex tachycardias (QRS>120ms): possible risk of sudden death, always consult with cardiologist.
Ventricular tachycardia: Arguments for VT (Brugada criteria): fusion (sudden narrow beat), absence of RS preceeding, RS > 100ms, AV dissociation, atypical BBPP. Typically in older patient with previous MI.
• Unconscious – proceed to immediate defibrillation.
SVT with aberrancy: Typical in younger patient. How was the QRS duration / shape on a previous non-tachycardic ECG?
Ventricular fibrillation – no QRS complexes, chaotic ECG-patterns, like ‘noise’— mechanical cardiac arrest = resuscitate. If patient recovery limited to 80%.
Brady cardio (60/min): Consider stop / reduce beta-blocker / digoxin / Ca- antagonist. Asynymptomatic sinus bradycardia with a normal blood pressure in general doesn’t require treatment.
• 1° degree AV-block: prolonged PQ interval (> 200ms)
• 2° degree AV-block type I (Wenekbach): PQ interval increases until 1 QRS complex is blocked. Good prognosis.
• 2° degree AV-block type II (Mobitz): PQ interval is normal, but not every P wave is followed by QR. Requires pacemaker.
• 3° degree AV-block – complete block. AV dissociation: no relationship between P waves and QR. Requires pacemaker.
Ventricular escape rhythm: wide complex rhythm < 40/min; dangerous. Consult cardiologist. Ischemia? Severe electrolyte shift?
Step 2: Count rate
Number the count of large grids between two QRS complexes: 1 box in between = 300/min, >150/min = 100 - 75 - 60 - 50 - 40. Or use methods at the bottom of this page.
Heart rate = 10 times number of QRS complexes within these 15 cm (< ~6 seconds x 25 mm/sec)
Step 3: Conduction intervals (PQ, QRS, QT)
Normal: PQ < 200ms (5 small squares), QRS < 120ms (3 squares), QTc < 450ms, Q > 460 ms, preferably measured in lead II or lead V5.
PQ < 200ms = AV block (above)
PQ < 120ms + delta wave = Wolff-Parkinson-White syndrome (WPW), risk of a circus movement tachycardias (= AVRT: AV re-entry tachycardia)
QRS > 120ms = wide QR complex (check V1)
• Left Bundle Branch Block (LBBB)
Latest activity towards the left, away from V1, so QRS ends negative V1.
New LBBB? Consider ischemia.
• Right Bundle Branch Block (RBBB)
RS’ (rabbit ear) latest activity righthwards, (on average) positive in V1.
• Intraventricular conduction delay=
If it’s not LBBB nor RBBB
QTC > 450ms: consider: hypokalemia, post myocardial infarction, long QT syndrome, medication (full list on torsades.org). Risk of cardiac arrest in the QTc range: prolonged QTc (risk increases especially >500ms).
Step 4: Heart axis
Heart axis: vector of the average electrical activity. Normal range between ~30˚ and +90˚.
How to measure ST elevation?
• Normal axis: ST negative in all leads.
• Right axis: AVF and II negative. Eg. left anterior fascicular block (LAFB, LHV). Negative T wave: e.g. pulmonary embolism, COPD.
Step 5: P wave morphology
Normal P wave: positive in I and II, bisac in V1, similar shape in every beat. Otherwise coexisting ectopic atrial rhythm.
Left atrial enlargement: terminal negative part in V1 = 1mm. or m. atrial refutation. Left atrial enlargement: P=2.5mm high in II, III, AVF and I or P =1.5mm in V1. E.g. COPD
Step 6: QRS morphology
Pathologic Q waves? Old myocardial infarction (see schematic).
Left ventricular hypertrophy (LVH): Rn V5/V6 > 5 + S in V1 > 35 mm.
Maximal QT per given heart rate when QTc is normal: see Table 1.
Step 7: ST morphology
ST elevation: consider ischemia, pericarditis, LVH, benign ST elevation, ‘early repolarisation’
ST depressions can be reciprocal in ischemia, strain pattern in LVH, digoxin intoxication
Negative T wave: at least 5mm in the same direction as the QRS complex (consider (subendocardial) ischemia, LVH
Flat T wave (~0.5 mm): aspecific
Maximal QTc per given heart rate when QTc is normal: see Table 1.
Step +1: Compare with previous ECG
New LBBB? Change in axis? New pathologic Q waves? Reduced R wave height?
Step +2: Conclusion (1 sentence)
Example: Sinus tachycardia with ST elevation in the chest leads with a trifascicular block consistent with an acute anterior myocardial infarction.
Ischemia
Acute myocardial infarction (AMI): symptoms (chest pain, vagal response), ECG consistent with transmural ischemia (ST elevations = (reciprocals depressions), new LBBB, sometimes already pathologic Q waves), sometimes already elevated cardiac markers for AMI (Troponin, CK, CK-MB). "Time is muscle". If you suspect AMI, consult cardiologist immediately (< 5 min.)
ST-elevation points at the infarcted area:
• Anterior: V1-V4, symmetrical territory, I, AVL, sometimes tachycardia.
• Inferior: II, III, AVF: Coronary: 80% RCA (bradycardia, elevation III; depression II, AVF); LAD (Delta branch)
• Right ventricular: SI, S + V1 and V4: IV fluid of hypotensive
• Posterior: high R wave and ST depression in V1-V3
Lateral: deviation in V5, V6, AVF (LAD) (Branchal branch)
Left main: diffuse ST depression with ST elevation in AVF. Very high risk of cardiogenic shock.
Recurrent depression: depression in reciprocal territory (e.g. ST depression in II, III, AVF during MI).
IPL-infarction: inferior-posterior-lateral. They frequently come together
Pathologic Q wave (any Q in V1-V3 or Q width > 30ms in II, AVL, V4-V6, minimal in 2 contiguous leads, minimal depth 1 mm) previous MI. Leads III and AVF may have a Q wave, which is non-pathological.
Miscellaneous
VPB (ventricular premature beat, VES; ventricular extrasystole, PVC. Premature ventr. contr.), QRS > 120ms. Seen in 50% of healthy men. Increased risk of arrhythmias if: complex form, very frequent occurrence (> 30 / hour) or Von T.
Consider: Ischemia? Previous MI? Cardiomyopathy?
PAC (premature atrial contraction, AES): abnormal P wave, mostly narrow (normal) QRS complex.
Pericarditis: ST elevation in all leads. PTA depression in II (between the end of the P wave and the beginning of Q wave).
Hyperkalemia: tall waves QRS wide, flat P wave.
Hypokalemia: QT prolongs, U wave, tordades.
Hypocalcemia: ST prolongs, normal T.
Hypocalcemia: QT short, high T.
Digoxin-intoxication: sagging ST depressions.
Pulmonary embolism: sinus tachycardia, deep V4 in I, Q wave and negative T in III, negative T-V1, V3, right axis.
Chest lead positioning: V1= 4th intercostal space (right), V2=IC2, V3=between V2 and V4, V4=IC5 in midclavicular line, V5=between V4 and V6, V6= same height as V4 in axillary line. To register V4, use V3 in the right mid-clavicular line.
Heart rate: measure 2 cardiac cycles
1st R 2nd R 3rd R 4th R 5th R 6th R 7th R 8th R 9th R 10th R 11th R 12th R 13th R 14th R 15th R 16th R 17th R 18th R 19th R 20th R
Heart rate: 10 times number of QRS complexes within these 15 cm (~6 seconds x 25 mm/sec)
Normal sinus rhythm. Every P wave is followed by a QRS complex. Heart rate between 60-100 /min.

Ventricular Premature Beat (VPB)
- RBBB, Right Bundle Branch Block
- LBBB, Left Bundle Branch Block (Wolff-Parkinson-White)

Atrium/fibrillation met 6:1 blok.
- Atrium/fibrillen met hoge kamerfrequentie.

AV-nodale re-entry tachycardie

Ventricular tachycardia

Acute anterior MI. ST-elevation in V1-V5, I and AVL.
- Reciprocal ST-depression in II, III and AVF.

Acute infero-posterior MI. ST-elevation in II, III and AVF.
- Reciprocal ST-depression in I, AVL, V1-V5

Left Ventricular Hypertrophy (LVH, R in V5/V6 + S in V1 > 35 mm)

Supraventricular tachycardias (‘cherchez le P’)
- AV nodal re-entry tachycardia (AVNRT)
- AV re-entry tachycardia (re-entry through accessory bundle as in WPW)

Atrial tachycardia (single focus)

Atrial flutter (often around tricuspid valve annulus)

Pathologic Q wave, sign of a previous MI

Color scheme to facilitate MI localisation. The colors mark contiguous leads. Example: (see above): ST elevation in II, III, AVF acute inferior MI.