**Electrocardiography (ECG)**

Principles of ECG recording & description
Interpretation of the most common ECG pathologies

**Standard ECG recording**

- 12-lead ECG
  - 3 bipolar limb leads I, II and III
  - 3 unipolar “augmented” limb leads aVL, aVR, aVF
  - 6 unipolar precordial leads V1 – V6

**Placement of electrodes**

- limbs
  - right upper limb
  - left upper limb
  - left lower limb
  - right lower limb
- chest
  - 4th intercostal space right parasternally
  - …
  - 5th intercostal space in middle axillar line

**Electrocardiogram (ECG)**

- record of potential changes over the time course
- potential changes results from periodical depolarisation followed by repolarisation of the myocardium
  - this produces electrical field measurable by electrodes placed on the body surface
- morphology of the ECG curve is a sum of instantaneous el. vectors

**ECG curve**

**Description of ECG - algorithm**

1. rhythm
   - a. pacemaker
   - b. regular/irregular
2. frequency
3. el. cardiac axis
4. analysis of individual waves and intervals
Description of ECG

- **rhythm**
  - sinus: the only physiological, 60-90/min
  - other:
    - junctional: 40-60/min
    - idioventricular: 30-40/min
    - atrial fibrillation: atria up to 600/min
    - atrial flutter: ventricles 60-90/min
- **heart beat**
  - regular
  - irregular
- **frequency**
  - normal: 60 – 90/min
  - tachycardia: > 90/min
  - bradycardia: < 60/min

Electrical cardiac axis

- direction of el. activity during depolarisation of chambers
  - normal axis: -30 to +105
  - pathology:
    - ventricular hypertrophy
    - bundle branch block

How to determine el. axis?

- direction of el. axis is conventionally described in frontal level by an angle between al. axis and horizontal line of the 1st lead
- projection of R in limb leads into Eithoven’s triangle

Analysis of waves and intervals

- waves: P, T, (U)
- deflections: Q, R, S
- intervals:
  - PQ (PR): 0.12 – 0.20s
  - QRS complex: 0.06 – 0.10s
  - ST
  - QT
- amplitude:
  - R
  - deep Q

P wave (≤0.1s), PQ interval (0.12-0.20s)

- **P wave = atrial depolarisation**
  - P absent in:
    - atrial (ventricular) fibrillation and flutter
    - SA block, ventricular and supraventricular tachycardia, junctional rhythm
    - P mitrale
    - P pulmonale
- **PQ interval = AV conduction**
  - normally isoelectric
  - prolonged PQ
  - sign of fitness, digitalis, beta-blockers, myocarditis
  - shortened PQ
  - preexitation, tachycardia
QRS complex (0.06 – 0.1s)
- depolarisation of chambers
  - wider QRS
  - bundle branch block, ventricular extrasystoles, ventricular tachycardia, idioventricular rhythm
  - pathologic ("deep") Q
    - over the electrically "silent" area of myocardium
      - duration > 0.04s, depth > 3mm, > 1/4 of the following R
    - typically after transmural myocardial infarction
  - pathologic R
    - higher amplitude in ventricular hypertrophy
    - smaller amplitude in obesity, oedema (pericardial, pleural, generalised), emphysema etc.

Ventricular hypertrophy – voltage criteria
- "golden standard" method = echocardiography
  - ECG criteria are auxiliary
- Hypertrophy
  - concentric
  - eccentric
    - tLV > 12mm
    - tRV > 5mm
- ECG criteria
  - amplitude of R
  - el. axis points towards hypertrophic chamber
  - wider QRS (longer depolarisation of hpt. chamber)
  - event. ST-T changes as a sign of overload

ST segment
- ST + T wave = repolarisation of ventricles
- normally isoelectrical
- ST elevation
  - epicardial damage
    - transmural IM
    - pericarditis
    - aneurysm
    - Prinzmetal angina
- ST depression
  - subendocardial damage
    - ischemia (angina pectoris, non-transmural IM)
    - volume/pressure overload
    - tachycardia

T wave, QT interval (0.32 - 0.42s)
- repolarisation of ventricles
- except of aVR lead usually positive
- pathological T
  - coronary
  - flat
  - spiked
- pathological QT
  - prolonged
    - hypercalcemia, hypocalcemia, ischemia, LQTS
  - shortened
    - hypocalcemia, hypercalcemia

ECG presentation of AIM

Sequence of ECG changes during transmural AIM
- A. initial physiological curve
- B. super-acute stadium
  - spiked positive T waves (minutes)
- C. acute stadium
  - ST elevation = Pardee wave (minutes to hours)
- D. sub-acute stadium
  - normalisation of ST segment
- E. development of "deep" Q (event: persistent ST-T changes)
- F. chronic stadium
  - persistence of deep Q