UNIWERSYTET MEDYCZNY W ŁODZI

Cardiovascular Disease Prevention – definition and rationale, cardiovascular risk, selected markers and factors

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CVD prevention - definition

Cardiovascular disease (CVD) prevention is defined as a coordinated set of actions, at the population level or targeted at an individual, that are aimed at eliminating or minimizing the impact of CVDs and their related disabilities.

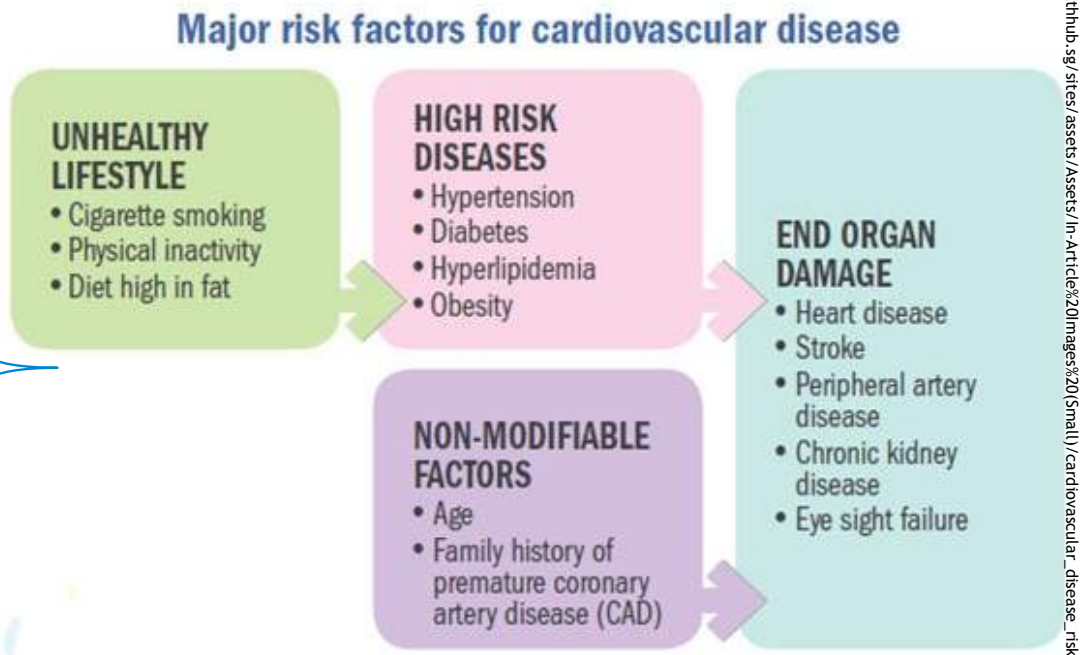
2016 European Guidelines on Cardiovascular Disease Prevention in Clinical Practice

Prevention phases:

- **Primordial prevention**
  - consolidation of correct healthy lifestyle patterns and elimination of unfavorable behavioral patterns in relation to healthy people
  - e.g. physical activity
- **Primary prevention**
  - prevention of disease by controlling risk factors in people exposed to them
  - e.g. blood pressure measurements
- **Secondary prevention**
  - prevention of the disease's consequences through its early detection and treatment,
  - e.g. screening tests to detect the sick
- **Tertiary prevention**
  - suppression of disease progression and reduction of complications
  - e.g. rehabilitation

Cardiovascular disease – risk factors

Modifiable CV risk factors	CV risk factors not subject to modification
❑ Unhealthy diet ❑ Smoking cigarettes ❑ Decrease physical activity ❑ Hypertension ❑ Dyslipidemia ❑ Glucose intolerance ❑ Overweight and obesity	❑ Age: • Men ≥ 45 years old • Women ≥ 55 years old ❑ Early occurrence of heart disease among relatives • Men <55 years old • Women < 65 years old ❑ Already developed CHD or other atherosclerotic CV disease



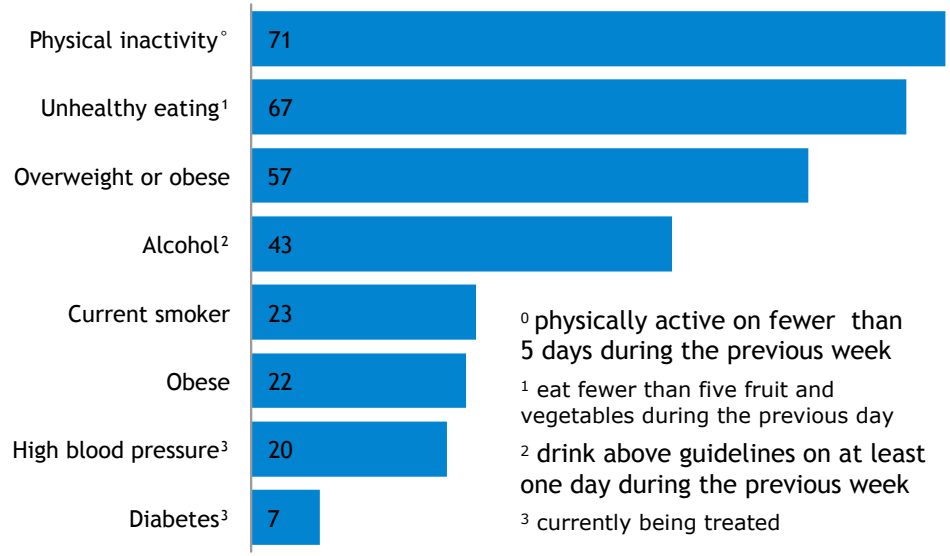
https://www.healthhub.sg/sites/assets/Assets/In-Article%20Images%20(Small)/cardiovascular_disease_risk.jpg

Cardiovascular disease – risk factors

The World Health Organisation (WHO) estimates that over 75% of premature CVD is preventable and risk factor amelioration can help reduce the growing CVD burden on both individuals and healthcare providers.

Reported risk factors for cardiovascular disease, age-standardised percentage, persons, age 16 and over, Wales, 2011

Produced by Public Health Wales Observatory, using Welsh Health Survey (WG)



[0] physically active on fewer than 5 days during the previous week

[1] eat fewer than five fruit and vegetables during the previous day

[2] drink above guidelines on at least one day during the previous week

[3] currently being treated

http://www.publichealthwalesobservatory.wales.nhs.uk/risk-factors

GIG CYMRU NHS WALES
Arsyllfa Iechyd Cyhoeddus Cymru
Public Health Wales Observatory

Estimation of total cardiovascular risk

- Screening involves identifying undiagnosed disease or unknown, elevated CVD risk in healthy people without symptoms
- Risk assessment can be performed:
  - Opportunically (without strategy, but by occasion)
  - Systematically (screening programme)

Example :

Results of a meta-analysis confirmed the effectiveness of GP-based health checks (e.g. cholesterol and BP measurements, control of BMI and smoking habit).
The improving outcomes were observed especially in high-risk patients

Current CVD risk estimation systems for use in apparently healthy person

The estimation for healthy person should be proceed by multiple, interacting risk factors.

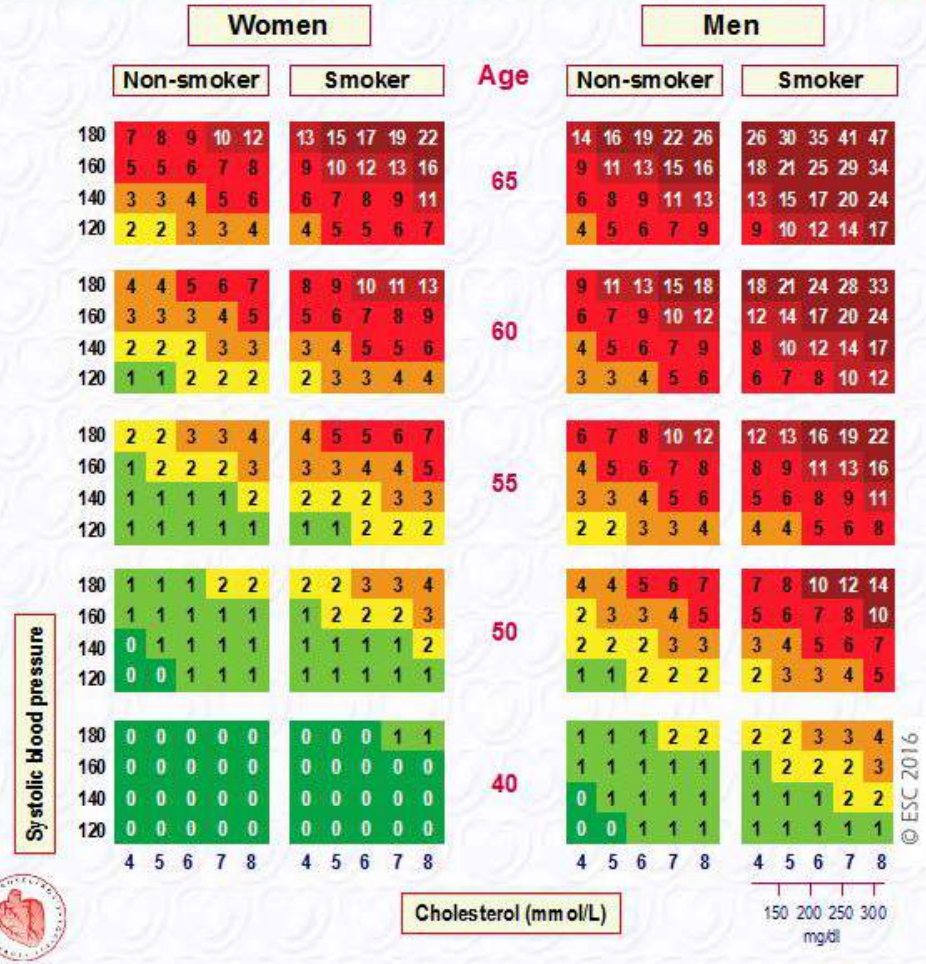
- Mostly recommended for 10 year risk of fatal atherosclerotic event assess - **SCORE scale** - based on large, representative European cohort datasets

SCORE scale:

- **Data**: 12 pooled prospective studies
- **Population**: 11 European countries: 117098 men and 88080 women (of age: 40-65)
- **Calculates**: 10-year risk of CVD mortality

by sex, age, total cholesterol or total cholesterol/ HDL-C ratio, SBP, smoking status. Versions for use in high and low-risk countries

SCORE chart: 10-year risk fatal cardiovascular disease (CVD) in population at high CVD risk



SCORE

- 15% and over
- 10%-14%
- 5%-9%
- 3%-4%
- 2%
- 1%
- <1%

10-year risk of fatal CVD in populations at **High CVD risk**

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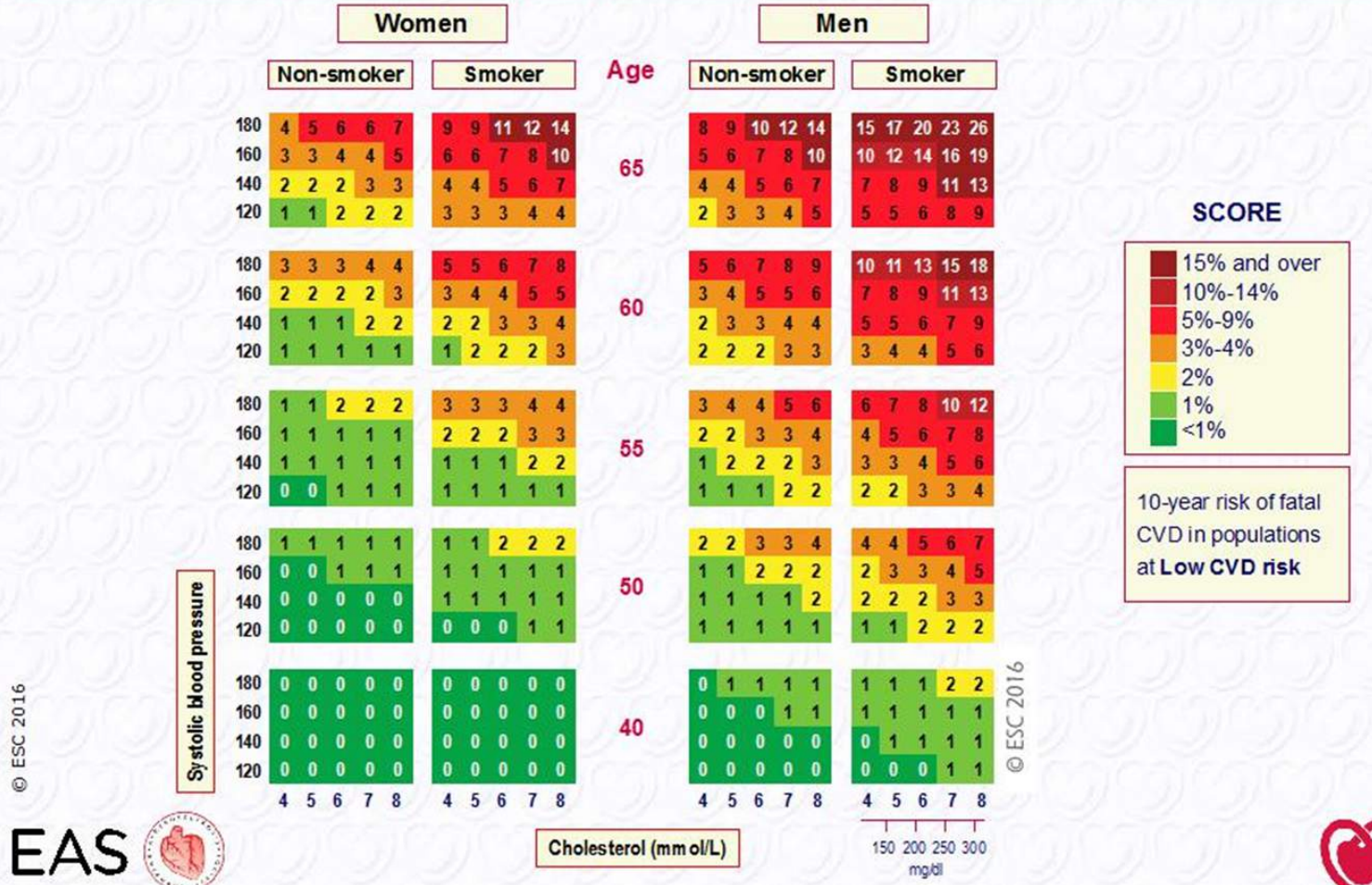
EAS

www.escardio.org/guidelines

European Heart Journal 2016; 37:2999–3058 - doi:10.1093/eurheartj/ehv272
Atherosclerosis 253 (2016) 281-344-d oi:10.1016/j.atherosclerosis.2016.08.018

EUROPEAN SOCIETY OF CARDIOLOGY®

SCORE chart: 10-year risk of fatal cardiovascular disease (CVD) in population at low CVD risk



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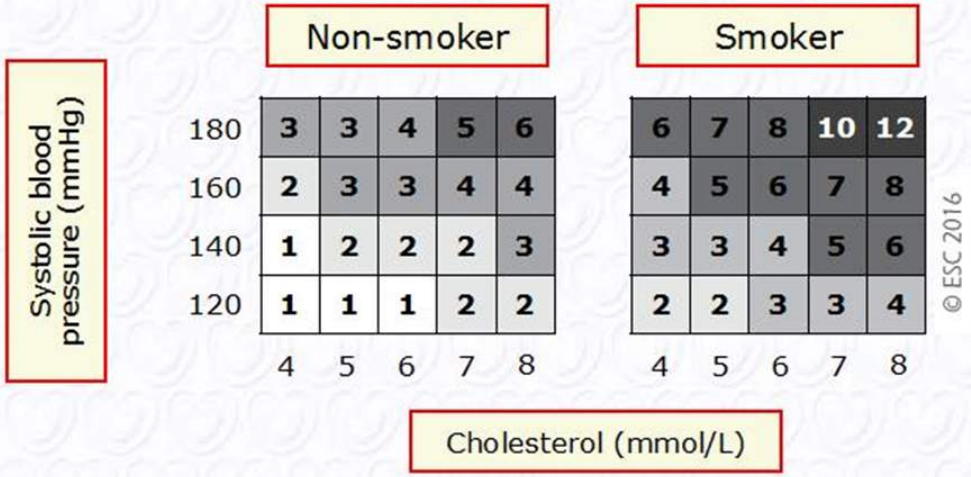
SCORE chart


Excellent
800-850
Very Good
750-799
Good
700-749
Fair
650-699
Poor
600-649
Very Bad
300-599
Expect the lowest possible interest rates and best terms.
You will be eligible for most loans with good rates.
Only secured loans are given for people in this range.

Relative risk chart for 10-year cardiovascular mortality



Please note that this chart shows RELATIVE not absolute risk. The risks are RELATIVE to 1 in the bottom left. Thus, a person in the top right hand box has a risk that is 12 times higher than a person in the bottom left.

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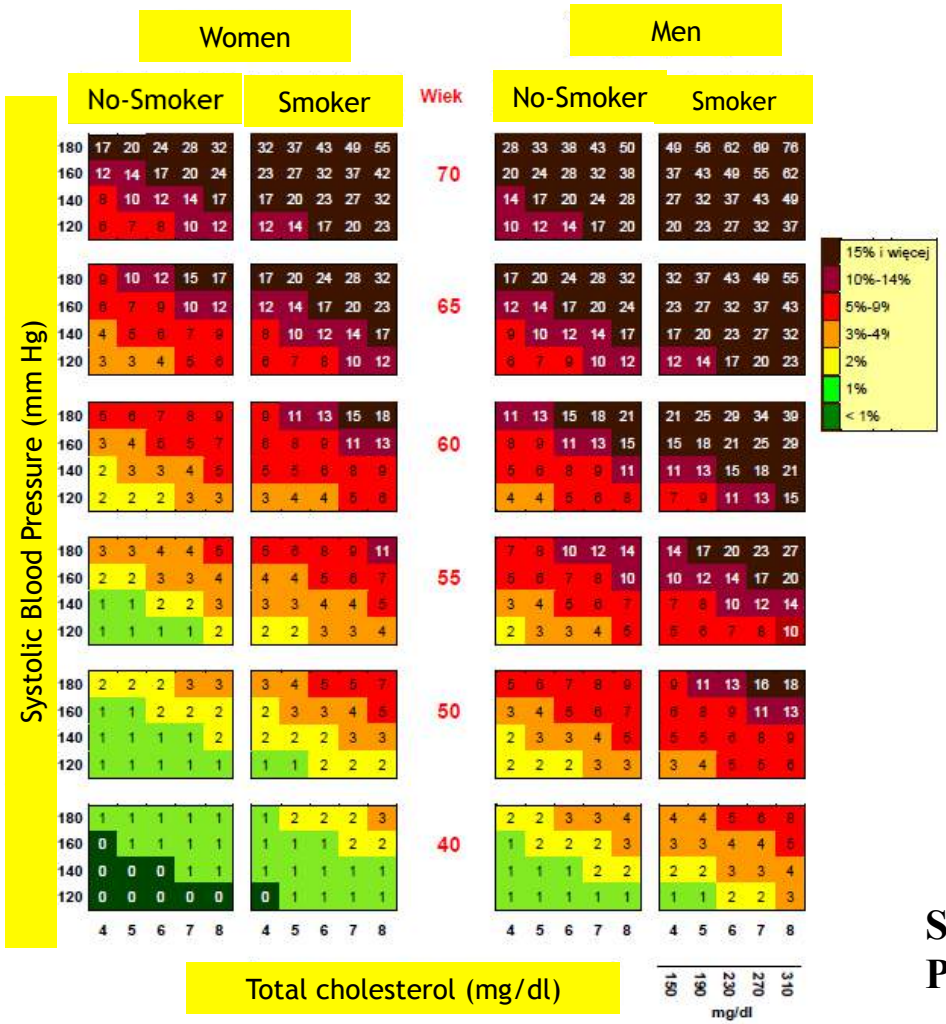
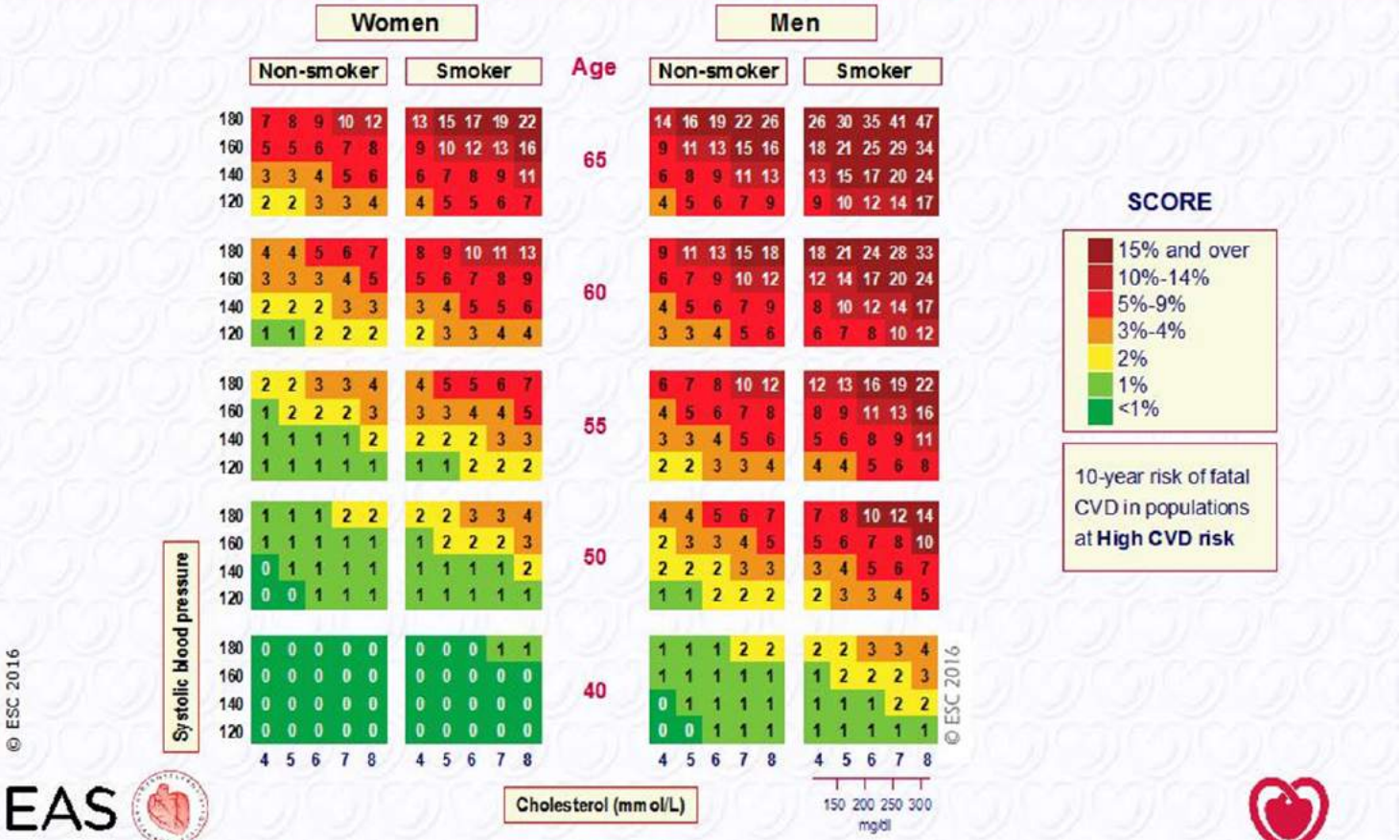
Pol-SCORE 2015

The 10-year risk of death for cardiovascular reasons



SCORE Scale for Polish population

SCORE chart: 10-year risk fatal cardiovascular disease (CVD) in population at high CVD risk



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SCORE SCALE - EXAMPLE

1. Smoker 72 yo male with total cholesterol 290 mg/dl and elevated BP around 180/100 mm Hg
2. Non-smoker 65yo female with high cholesterol level <200 mg/dl and BP 150/90 mm Hg
3. Compare the risk of 40 year old male smoker and 60 year old man with ideal risk factor.

HONG KONG MEDICAL JOURNAL 香港醫學雜誌
The official publication of the HONG KONG ACADEMY OF MEDICINE and the HONG KONG MEDICAL ASSOCIATION

Hong Kong Med J 2017 Apr;23(2):191-201

TABLE 3. Summary of lipid management goals[6,9,34]

	Recommended lipid levels (mmol/L or % reduction)			
	2016 European Guidelines on Cardiovascular Disease Prevention in Clinical Practice	2013 ACC/AHA Guideline on the Treatment of Blood Cholesterol to Reduce Atherosclerotic Cardiovascular Risk in Adults	2014 NICE Clinical Guideline on Lipid Modification	2016 Hong Kong Cardiovascular Task Force Recommendations
Primary prevention	LDL-C <1.8 to <3.0 mmol/L according to SCORE risk	↓LDL-C ≥30% if 10-year risk ≥7.50%	↓Non HDL-C ≥40%	LDL-C <1.8 mmol/L to <3.0 mmol/L according to individual CV risk level
Secondary prevention	LDL-C <1.8 mmol/L or ↓LDL-C ≥50%	↓LDL-C ≥50%	↓Non HDL-C ≥40%	LDL-C <1.8 mmol/L
Familial hyper-cholesterolaemia	No recommendation	↓LDL-C ≥50%	↓Non HDL-C ≥40%	LDL-C <2.5 mmol/L
Diabetes	LDL-C <1.8 mmol/L or ↓LDL-C ≥50%	↓LDL-C ≥50% if 10-year ASCVD risk ≥7.50% or ↓LDL-C ≥30-50%	↓Non HDL-C ≥40%	LDL-C <1.8 mmol/L to 2.5 mmol/L According to individual CV risk level
CKD	Severe: LDL-C <1.8 mmol/L or ↓LDL-C ≥50% Moderate: LDL-C <2.6 mmol/L or ↓LDL-C ≥50%	No target specified	↓Non HDL-C ≥40%	LDL-C <1.8 mmol/L to 2.5 mmol/L According to individual CV risk level

Abbreviations: ACC/AHA = American College of Cardiology/American Heart Association; ASCVD = atherosclerotic cardiovascular disease; CKD = chronic kidney disease; CV = cardiovascular; HDL-C = high-density lipoprotein cholesterol; LDL-C = low-density lipoprotein cholesterol; NICE = National Institute for Health and Care Excellence; SCORE = Systematic Coronary Risk Evaluation

http://www.hkmj.org/system/files/hkmj165045-table3.jpg

Risk factors and goals of Cardiovascular Diseases

Table 6 **Risk factor goals and target levels for important cardiovascular risk factors**

Smoking	No exposure to tobacco in any form.
Diet	Low in saturated fat with a focus on wholegrain products, vegetables, fruit and fish.
Physical activity	At least 150 minutes a week of moderate aerobic PA (30 minutes for 5 days/week) or 75 minutes a week of vigorous aerobic PA (15 minutes for 5 days/week) or a combination thereof.
Body weight	BMI 20–25 kg/m^2. Waist circumference <94 cm (men) or <80 cm (women).
Blood pressure	<140/90 mmHg[a]
Lipids[b] LDL[c] is the primary target	**Very high-risk: <1.8 mmol/L (<70 mg/dL),** or a reduction of at least 50% if the baseline is between 1.8 and 3.5 mmol/L (70 and 135 mg/dL)[d] **High-risk: <2.6mmol/L (<100 mg/dL),** or a reduction of at least 50% if the baseline is between 2.6 and 5.1 mmol/L (100 and 200 mg/dL) **Low to moderate risk: <3.0 mmol/L (<115 mg/dL).**
HDL-C	No target but >1.0 mmol/L (>40mg/dL) in men and >1.2 mmol/L (>45 mg/dL) in women indicate lower risk.
Triglycerides	No target but <1.7 mmol/L (<150 mg/dL) indicates lower risk and higher levels indicate a need to look for other risk factors.
Diabetes	HbA1c <7%. (<53 mmol/mol)

2016 European Guidelines on cardiovascular disease prevention in clinical practice

European Heart Journal (2016) 37, 2315–2381
doi:10.1093/eurheartj/ehw106

Risk Markers

1. Family history:

- The occurance of premature CVD in first-degree relatives increases the risk of CVD

(relatives before 55 years of age in men and before 65 year of age in women with premature CVD)

2. Genetic markers:

- There are some genetics markers associated with CVD; but the use of this method to assess CVD risk is not recommended
- NRI – defined as possiblities of genetic scores to predict CV events
- Genetic screening – e.g. familial hypercholesterolemia

Table 7 **Core questions for the assessment of psychosocial risk factors in clinical practice**

Low socio-economic status	• What is your highest educational degree? • Are you a manual worker?
Work and family stress	• Do you lack control over how to meet the demands at work? • Is your reward inappropriate for your effort? • Do you have serious problems with your spouse?
Social isolation	• Are you living alone? • Do you lack a close confidant? • Have you lost an important relative or friend over the last year?
Depression	• Do you feel down, depressed and hopeless? • Have you lost interest and pleasure in life?
Anxiety	• Do you suddenly feel fear or panic? • Are you frequently unable to stop or control worrying?
Hostility	• Do you frequently feel angry over little things? • Do you often feel annoyed about other people's habits?
Type D personality	• In general, do you often feel anxious, irritable, or depressed? • Do you avoid sharing your thoughts and feelings with other people?
Post-traumatic stress disorder	• Have you been exposed to a traumatic event? • Do you suffer from nightmares or intrusive thoughts?
Other mental disorders	• Do you suffer from any other mental disorder?

Risk Markers

3. Psychosocial risk factors

- Low socio-economic status (low educational level, low income, low status at work, living in poor area)
- Lack of social suport, being isolated
- Stress at work (long working hours, high psychological demands, unfairness) and in family life,
- acute mental stressors,
- Depression, vital exhaustion
- Anxiety, panic attacks

contribute to increase risk of CVD occurence or worsening prognosis ofr already diagnosed CVD

2016 European Guidelines on cardiovascular disease prevention in clinical practice

European Heart Journal (2016) 37, 2315-2381
doi:10.1093/eurheartj/ehw106

Clinical Conditions affecting CVD risk

- Chronic kidney disease;
- Influenza;
- Periodontisis;
- Cancer treatment;
- Autoimmune disease;
- Obstructive sleep opnea syndrome;

CVD risk factor intervention

Behaviour Change

- ‘Lifestyle’ as long-standing behavioural patterns that are maintained by social environment.
- Friendly and positive interaction enhances an individual’s ability to cope with illness and adhere to recommended lifestyle change – **EMPOWERMENT METHOD**
- extensive/longer interventions lead to better long-term results with respect to behaviour change and prognosis.

Table 8 Principles of effective communication to facilitate behavioural change

• Spend enough time with the individual to create a therapeutic relationship – even a few more minutes can make a difference.
• Acknowledge the individual’s personal view of his/her disease and contributing factors.
• Encourage expression of worries and anxieties, concerns and self-evaluation of motivation for behaviour change and chances of success.
• Speak to the individual in his/her own language and be supportive of every improvement in lifestyle.
• Ask questions to check that the individual has understood the advice and has any support he or she requires to follow it.
• Acknowledge that changing life-long habits can be difficult and that sustained gradual change is often more permanent than a rapid change.
• Accept that individuals may need support for a long time and that repeated efforts to encourage and maintain lifestyle change may be necessary in many individuals.
• Make sure that all health professionals involved provide consistent information.

2016 European Guidelines on cardiovascular disease prevention in clinical practice

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Physical activity

- Any increase in physical activity reduces risk of CVD, including hypertension, LDL cholesterol level, body weight and diabetes mellitus t2.
- Through regular physical activity it is possible to **lower blood pressure by 4 - 9 mm Hg** and lead to normalization of heart rate.
- Physical effort also has a beneficial effect on reducing sympathetic nervous system activity, decreased cardiac output and peripheral resistance

Recommendations

For healthy adults:

- At least 150 min a week of moderate intensity or
- 75 min a week of vigorous intensity aerobic PA
- Or equivalent combination

For additional benefits in healthy adults:

- Increase to 300 min a week of moderate intensity or
- 150 min a week of vigorous intensity aerobic PA
- Or equivalent combination

PA recommended in low-risk patient without further assessment.

Smoking intervention

- Stopping smoking is the most effective strategy for CVD prevention.
- European data indicate that smoking doubles the 10 year CVD mortality rate[3] whilst 30% of US CVD mortality is attributable to smoking.
- Smoking a single cigarette significantly increases blood pressure by stimulating the sympathetic nervous system. It also causes increased cardiac output and heart rate.
- Nicotine causes hemodynamic changes in the body, damaging the endothelium. This leads to a reduction in the production of vasodilators: nitric oxide and prostacyclin. The disadvantageous effect of tobacco smoking is also lipid metabolism disorders

It is recommended to identify smokers and provide repeated advice on stopping with offers to help, by the use of follow up support, nicotine replacement therapies, varenicline, and bupropion individually or in combination.

Lipid control

Possible intervention strategies as afunction of total cardiovascular risk and low-density lipoprotein cholesterol level

Total CV risk (SCORE) %	LDL-C levels				
	<70 mg/dL <1.8 mmol/L	70 to <100 mg/dL 1.8 to <2.6 mmol/L	100 to <155 mg/dL 2.6 to <4.0 mmol/L	155 to <190 mg/dL 4.0 to <4.9 mmol/L	≥190 mg/dL ≥4.9 mmol/L
<1	Lifestyle advice	Lifestyle advice	Lifestyle advice	Lifestyle advice	Lifestyle advice, consider drug if uncontrolled
Class[a]/Level[b]	I/C	I/C	I/C	I/C	IIa/A
≥1 to <5	Lifestyle advice	Lifestyle advice	Lifestyle advice, consider drug if uncontrolled	Lifestyle advice, consider drug if uncontrolled	Lifestyle advice, consider drug if uncontrolled
Class[a]/Level[b]	I/C	I/C	IIa/A	IIa/A	I/A
≥5 to <10, or high-risk	Lifestyle advice	Lifestyle advice, consider drug if uncontrolled	Lifestyle advice and drug treatment for most	Lifestyle advice and drug treatment	Lifestyle advice and drug treatment
Class[a]/Level[b]	IIa/A	IIa/A	IIa/A	I/A	I/A
≥10 or very high-risk	Lifestyle advice, consider drug	Lifestyle advice and concomitant drug treatment	Lifestyle advice and concomitant drug treatment	Lifestyle advice and concomitant drug treatment	Lifestyle advice and concomitant drug treatment
Class[a]/Level[b]	IIa/A	IIa/A	I/A	I/A	I/A

CV = cardiovascular;; LDL-C = low-density lipoprotein cholesterol; SCORE = Systematic Coronary Risk Estimation.
[a]Class of recommendation.
[b]Level of evidence.
Guidance on the use of drug treatment must be interpreted in the light of the physician's judgement and knowledge with regards to his or her individual patient. Note that risk stratification is not applicable in familial hypercholesterolaemia, where drug treatment is recommended, and that, in this table, drug treatment may be considered at risks lower than the generic treatment thresholds indicated in paragraph 2.3.5. Thus treatment may occasionally be considered in moderate risk (1–5%) individuals, provided that patients are well-informed of the limited absolute risk reduction, and high numbers needed to treat. In higher risk (5–10%), drug therapy is associated with somewhat larger absolute benefits, and should at least be considered. Drug therapy is strongly advised in those at very high risk (≥10%). If baseline LDL-C in this category is already below the target level of 1.8 mmol/L, benefit of statin therapy initiation is less certain, but may still be present.

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Nutrition

- Dietary habits, as much as, body composition and nutritional status, influence the risk of CVD and toher chronić diseases development.

Nutritional recommendation based on CVD guidelines
1. Increased intake of polyunsaturated fatty acids, by reducing total Energy intake form saturated fatty acids <10%; main source of PUFAs : nuts, oily fish, plants oil – in daily menu
2. The intake of trans unsaturated fatty acids contraindicated.
3. Vegetables and/or fruit contained in every meal (per 5 servings) > 400 g
4. The intake of 30-45g fibre per day, main source: vegetables and wholegrain products,
5. Highly limited salt intake for <5g per day
5. Elimintation of highly processed food, sugar-sweetened food products
6. Consumption of alcoholic beverages should be limited to 2 glasses per day (20 g/d of alcohol) for men and 1 glass per day (10 g/d of alcohol) for women
7. By following daily healthy diet there is no necessary for addidional supplementation intake

Body weight - maintenance of a healthy weight for reduction of CVD risk

Any body weight abnormalities – overweight, obesity and malnutrition – associate with increased risk CVD.

increase in body weight by 10 kg above the normal → **increase in SBP by 3 mm Hg and DBP by 2.3 mm Hg**

Having a body mass index (BMI) > 25 is a risk factor for CVD with **lowest all-cause mortality seen at BMI 20–25** but, due to increased all-cause mortality with BMI < 20,28 reductions below this level are not routinely recommended.

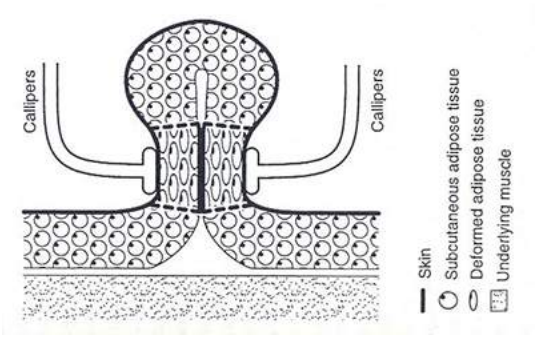
The influence of overweight and obesity on the cardiovascular system depends primarily on the distribution of adipose tissue

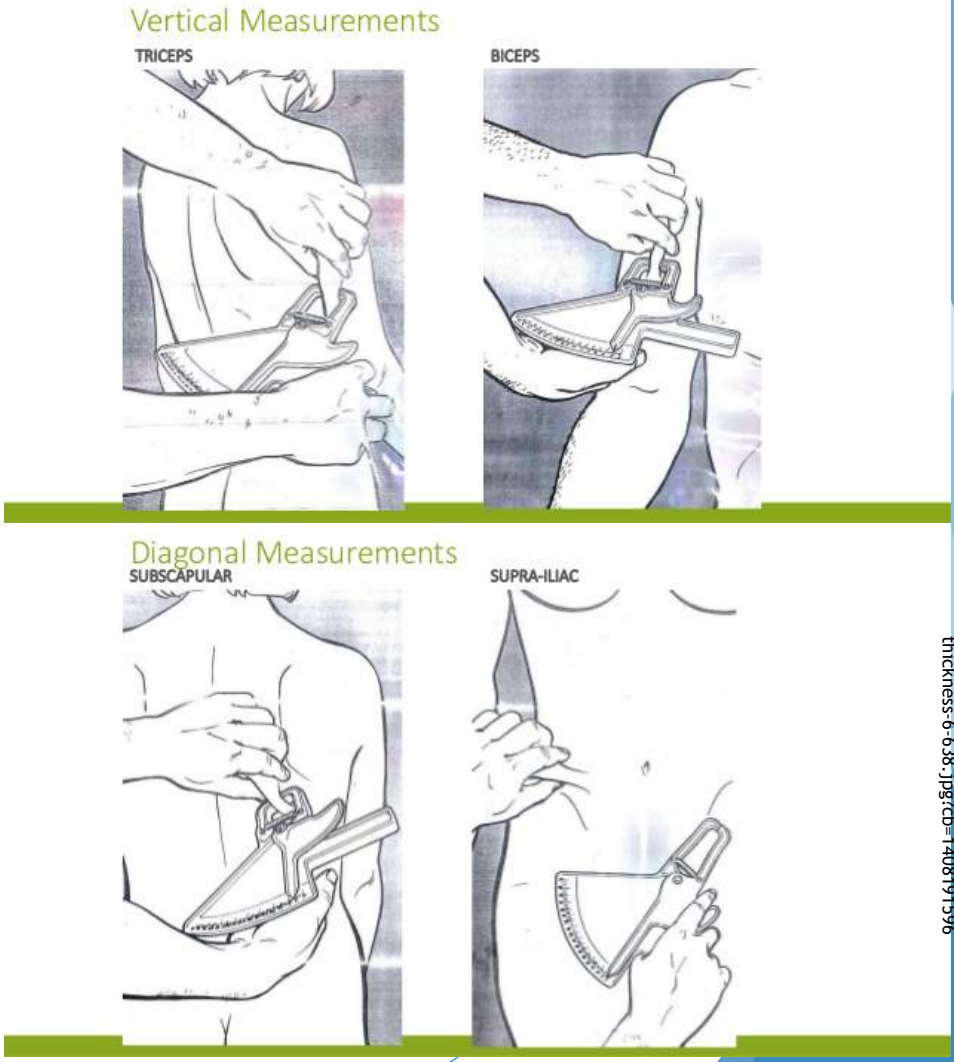
Distribution of fatty tissue	Cardiovascular consequences
abdominal adipose tissue	• increased insulin resistance, • atherogenic dyslipidaemia with elevated triglycerides in blood and LDL cholesterol, • with reduced HDL cholesterol • increased tendency to chronic inflammation, • increased tendency to intravascular coagulation or endothelial dysfunction
visceral fatty tissue	• The adipokines produced by it can regulate the tension of vascular walls or intensify inflammatory processes • he size under the epicardial fat tissue correlates with the increase in diastolic blood pressure, affects the mass of the left ventricle and the severity of coronary heart disease

The clinical consequences of obesity are general cardiovascular dysfunction (increased circulating blood volume and cardiac output increase, cardiac arrhythmias, left ventricular dysfunction or reduced peripheral resistance

Assessment of the nutritional status and body composition

- **Antropometric assessment:**
  - **Weight**
  - **Height**
  - **hip circumference**
  - **Waist circumference**
  - **Calf and mid-arm circumference**
  - **skinfold measurements**





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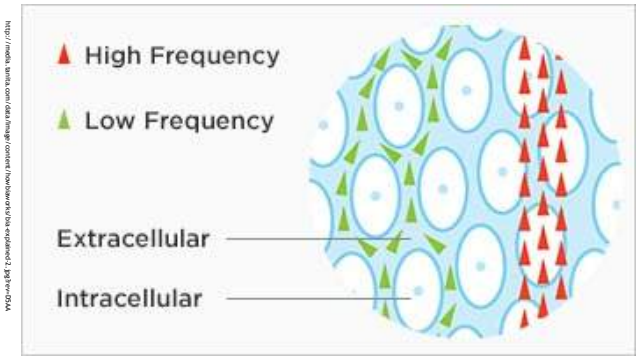
Assessment of the nutritional status: BODY COMPOSITION ANALYSIS

- The electrical conductivity of the body reflects FFM (fat-free mass), because it contains TBW (total body water) and conductive electrolytes.

- Bioelectrical impedance analysis (BIA) →

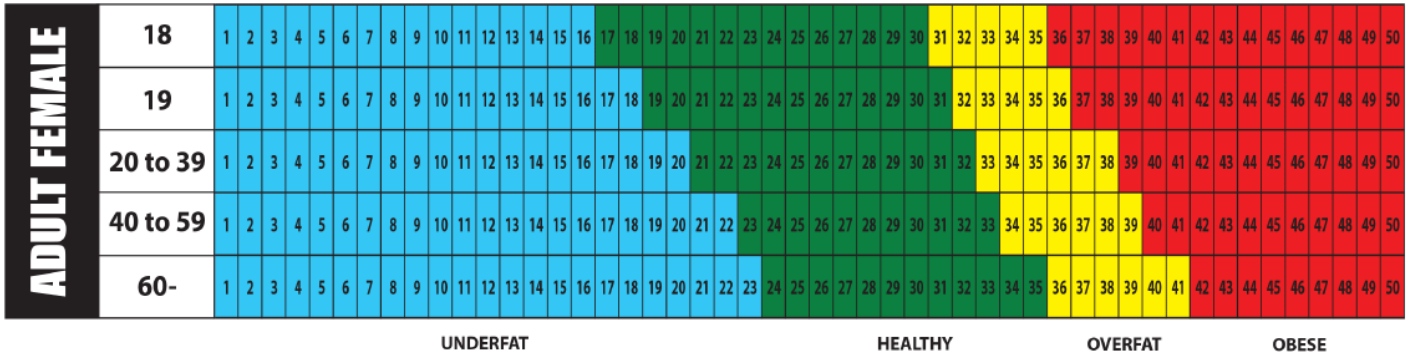


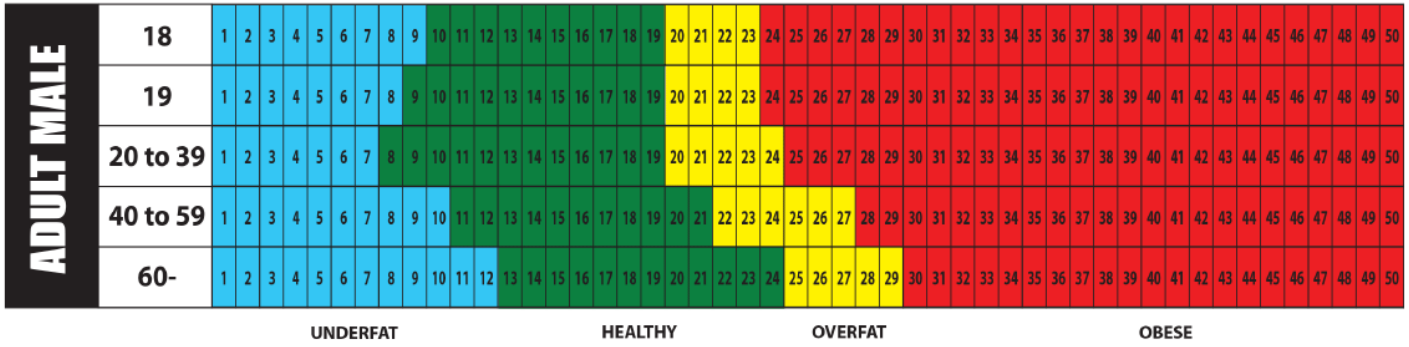
The electrical signal passes quickly through water that is present in hydrated muscle tissue but meets resistance when it hits fat tissue. This resistance, known as impedance.

- WARNING! Patient with an electronic medical implant, should **not** use a body composition monitor; neither pregnant women;

Assessment of the nutritional status: BODY COMPOSITION ANALYSIS

- Body fat %
- (http://www.tanita.com/en/understanding-your-measurements/)





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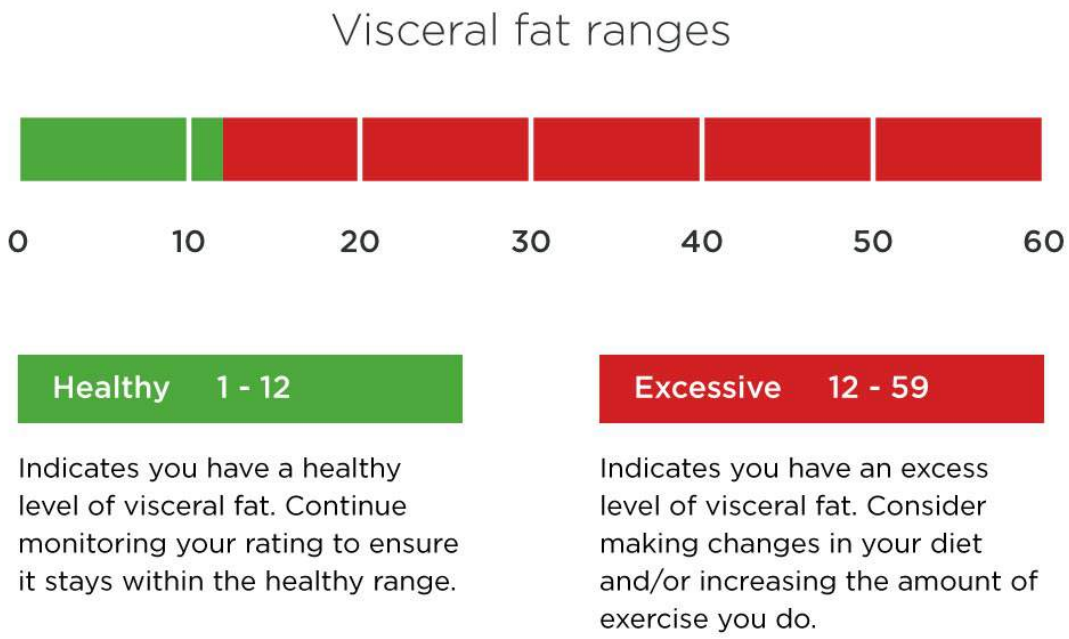
Assessment of the nutritional status: BODY COMPOSITION ANALYSIS

- **Visceral fat is located deep in the core abdominal area, surrounding and protecting the vital organs.**



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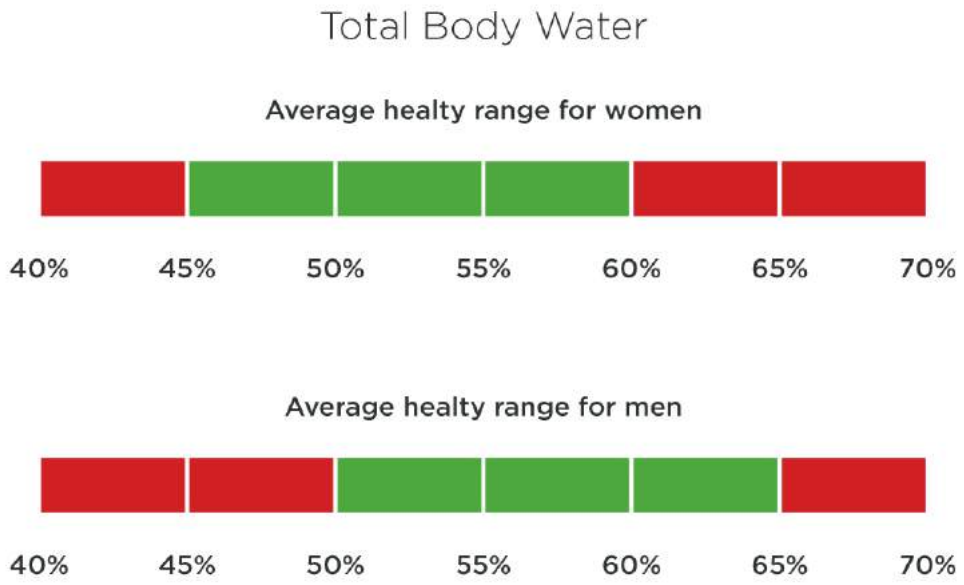
Assessment of the nutritional status: BODY COMPOSITION ANALYSIS

- **Total Body Water is the total amount of fluid in the body expressed as a percentage of total weight.**



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Assessment of the nutritional status: BODY COMPOSITION ANALYSIS

- **Bone Mass**

Bone Mass

Average of estimated bone mass (lb) Women

Less Than 110 lb	110 lb -165 lb	165 lb and up
4.3 lb	5.3 lb	6.5 lb

Average of estimated bone mass (lb) Men

Less Than 143 lb	143 lb - 209 lb	209 lb and up
5.9 lb	7.3 lb	8.1 lb

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Assessment of the nutritional status: BODY COMPOSITION ANALYSIS

- **Body Mass Index**

$$BMI = \frac{weight\,(kg)}{height^2\,(m^2)}$$

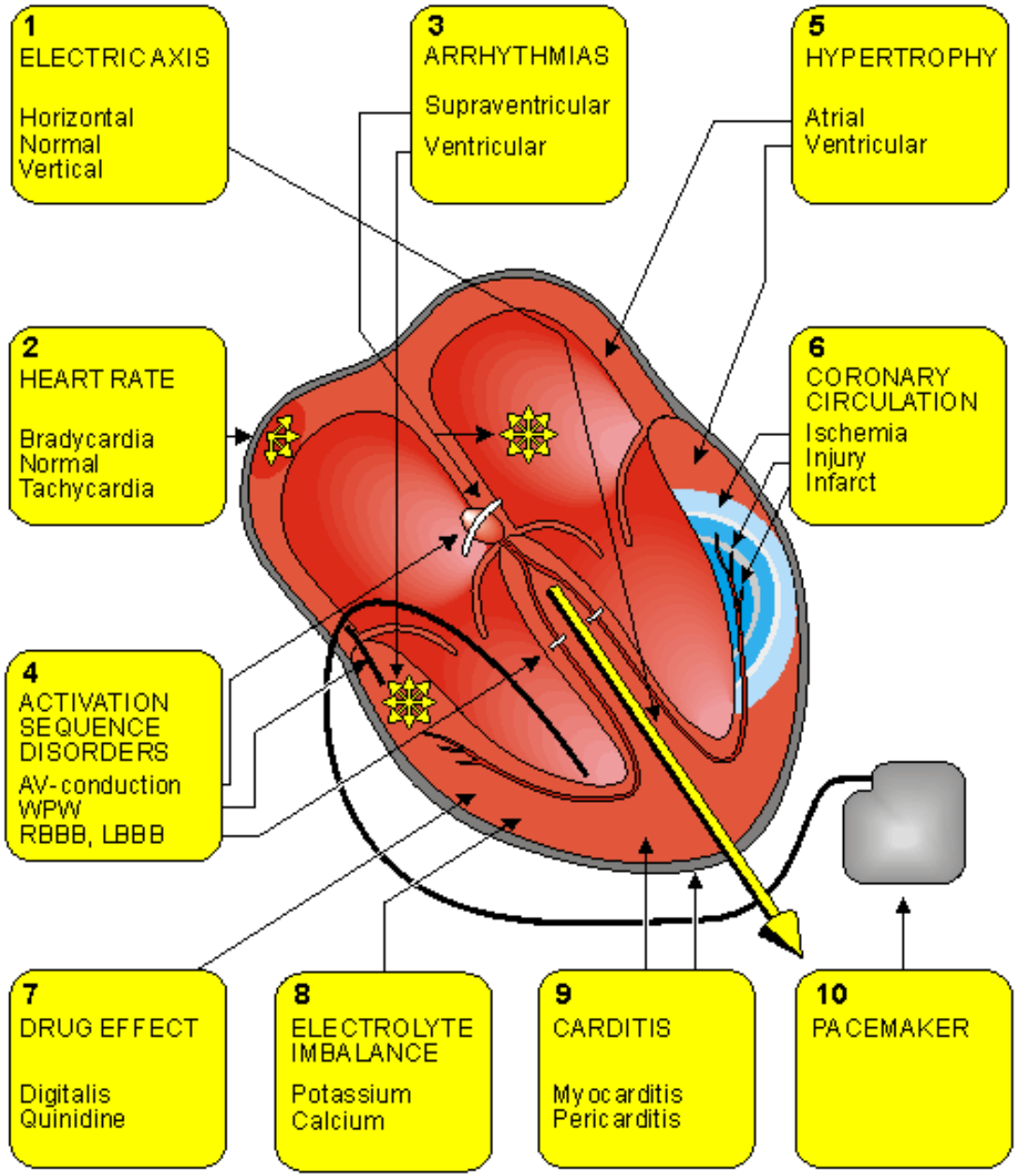
HEIGHT	WEIGHT (LBS)																														
	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195	200	205	210	215	220	225	230	235	240	245	250
4' 11"	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	44	44	45	46	48	48	49	50
5' 0"	19	21	21	22	23	25	25	26	28	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
5' 1"	19	20	21	22	22	24	25	25	27	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	42	43	45	45	46	47
5' 2"	18	19	20	21	22	23	24	25	26	27	27	28	29	30	31	32	33	34	35	35	37	37	38	40	40	41	42	43	44	45	46
5' 3"	18	19	20	20	21	22	23	24	25	26	27	27	29	29	30	31	32	33	34	34	36	36	37	38	39	40	41	42	43	43	44
5' 4"	17	18	19	20	20	22	22	23	24	25	26	27	28	28	29	30	31	32	33	33	34	35	36	37	38	39	39	41	41	42	43
5' 5"	17	18	18	19	20	21	22	22	24	24	25	26	27	28	28	29	30	31	32	32	33	34	35	36	37	37	38	39	40	41	42
5' 6"	16	17	18	19	19	20	21	22	23	24	24	25	26	27	27	28	29	30	31	31	32	33	34	35	36	36	37	38	39	40	40
5' 7"	16	17	17	18	19	20	20	21	22	23	24	24	25	26	27	27	28	29	30	30	31	32	33	34	35	35	36	37	38	38	39
5' 8"	15	16	17	17	18	19	20	20	22	22	23	24	25	25	26	27	28	28	29	30	31	31	32	33	34	34	35	36	37	37	38
5' 9"	15	16	16	17	18	19	19	20	21	22	22	23	24	24	25	26	27	27	28	29	30	30	31	32	33	33	34	35	36	36	37
5' 10"	14	15	16	17	17	18	19	19	20	21	22	22	23	24	24	25	26	27	27	28	29	30	30	31	32	32	33	34	35	35	36
5' 11"	14	15	15	16	17	18	18	19	20	20	21	22	23	23	24	24	25	26	27	27	28	29	29	30	31	31	32	33	34	34	35
6' 0"	14	14	15	16	16	17	18	18	19	20	20	21	22	23	23	24	25	25	26	26	27	28	29	29	30	31	31	32	33	33	34
6' 1"	13	14	15	15	16	17	17	18	19	19	20	20	21	22	22	23	24	25	25	26	27	27	28	29	29	30	30	31	32	32	33
6' 2"	13	14	14	15	15	16	17	17	18	19	19	20	21	21	22	22	23	24	24	25	26	26	27	28	28	29	30	30	31	32	32
6' 3"	12	13	14	14	15	16	16	17	18	18	19	19	20	21	21	22	23	23	24	24	25	26	26	27	28	28	29	30	30	31	31
6' 4"	12	13	13	14	15	15	16	16	17	18	18	19	20	20	21	21	22	23	23	24	25	25	26	26	27	28	28	29	29	30	30
6' 5"	12	13	13	14	14	15	16	16	17	17	18	18	19	20	20	21	22	22	23	23	24	24	25	26	26	27	27	28	29	29	30

UNDERWEIGHT NORMAL OVERWEIGHT OBESE

http://media.tanita.com/data/Image/measurements/bmi-ranges.png?rev=D630

UNIWERSYTET MEDYCZNY W ŁODZI

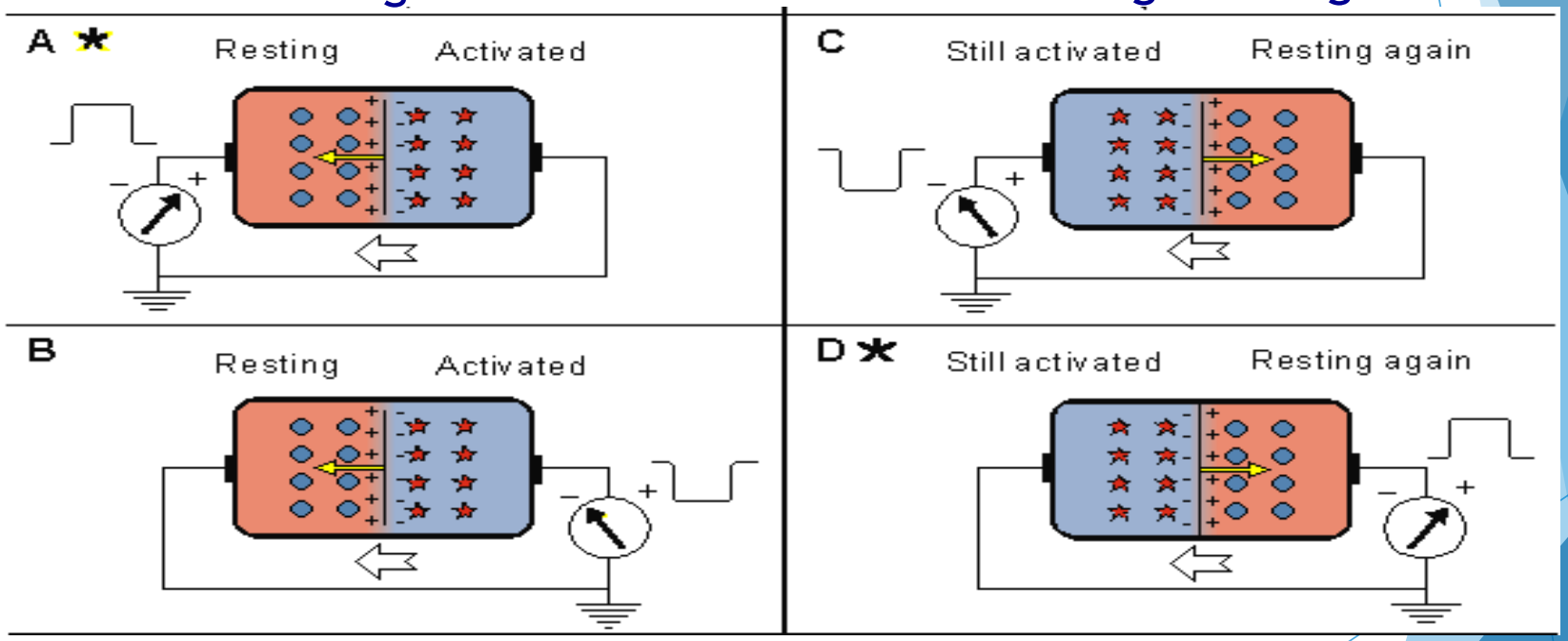
12 leads ECG


1
ELECTRIC AXIS
Horizontal
Normal
Vertical
3
ARRHYTHMIAS
Supraventricular
Ventricular
5
HYPERTROPHY
Atrial
Ventricular
2
HEART RATE
Bradycardia
Normal
Tachycardia
6
CORONARY CIRCULATION
Ischemia
Injury
Infarct
4
ACTIVATION SEQUENCE DISORDERS
AV-conduction
WPW
RBBB, LBBB
7
DRUG EFFECT
Digitalis
Quinidine
8
ELECTROLYTE IMBALANCE
Potassium
Calcium
9
CARDITIS
Myocarditis
Pericarditis
10
PACEMAKER

Propagating Activation Wavefront

Depol. toward positive electrode
Positive Signal

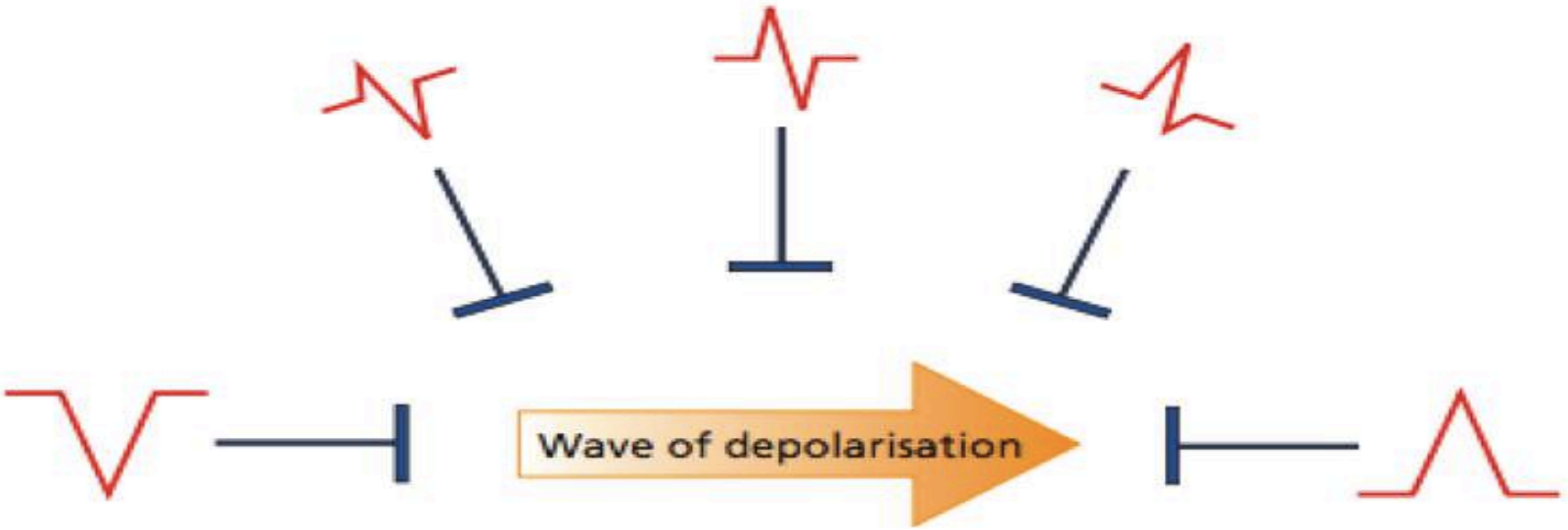
Repol. toward positive electrode
Negative Signal



Depol. away from positive electrode
Negative Signal

Repol. Away from positive electrode
Positive Signal

Wave of depolarisation

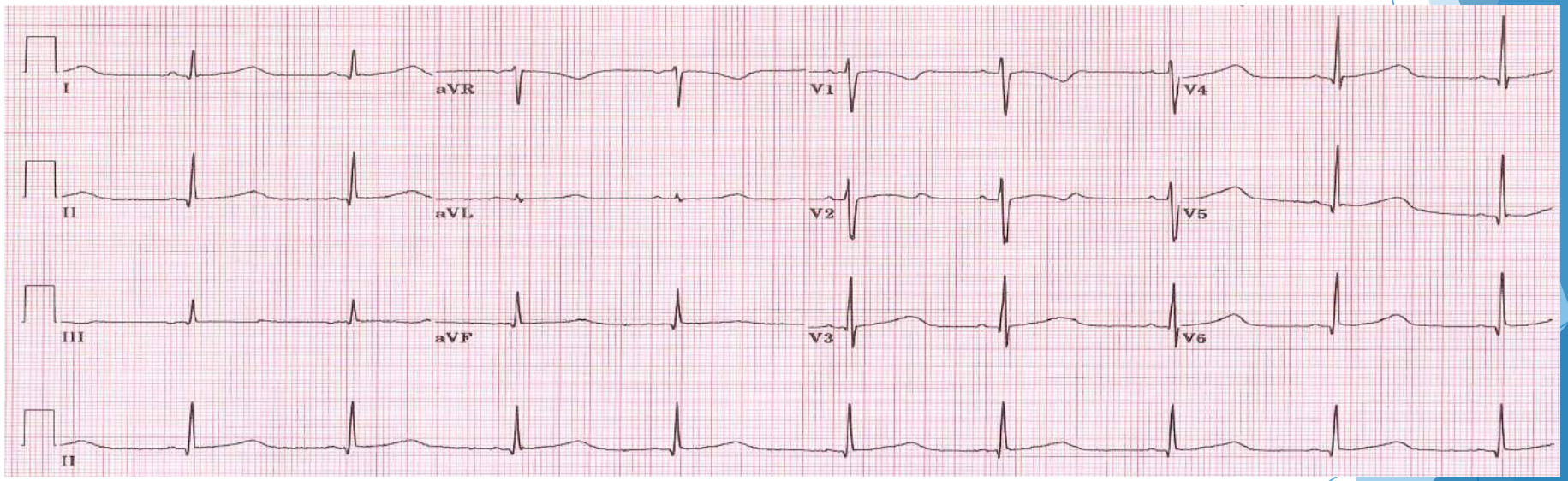


Shape of QRS complex depends on orientation of the lead to vector of depolarisation

The standard 12 Lead ECG

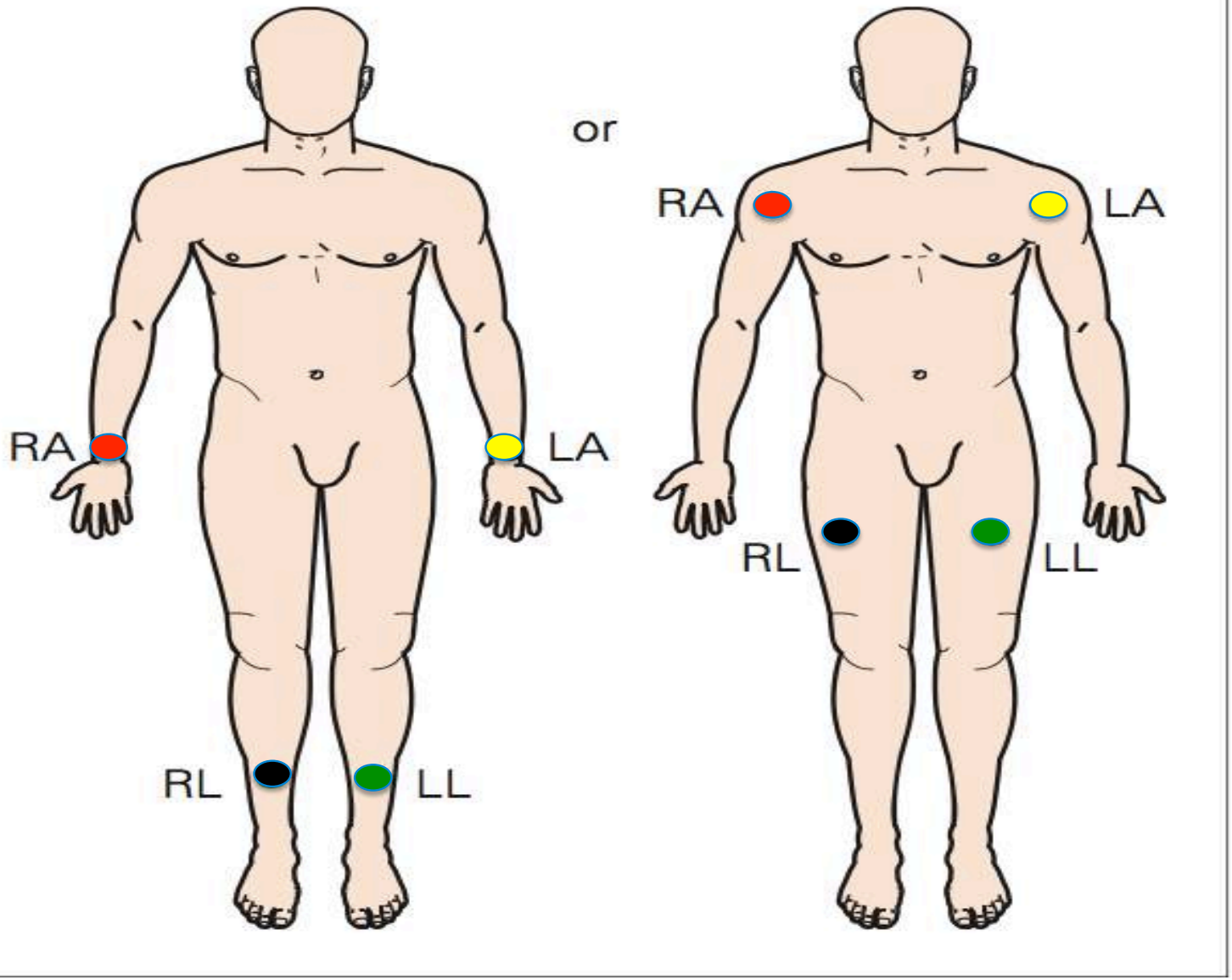
6 Limb Leads
I, II, III aVR, aVL, aVF,

6 Chest Leads (Precordial leads)
V1, V2, V3, V4, V5 and V6



Rhythm Strip

Standard Limb Lead Electrode Placement



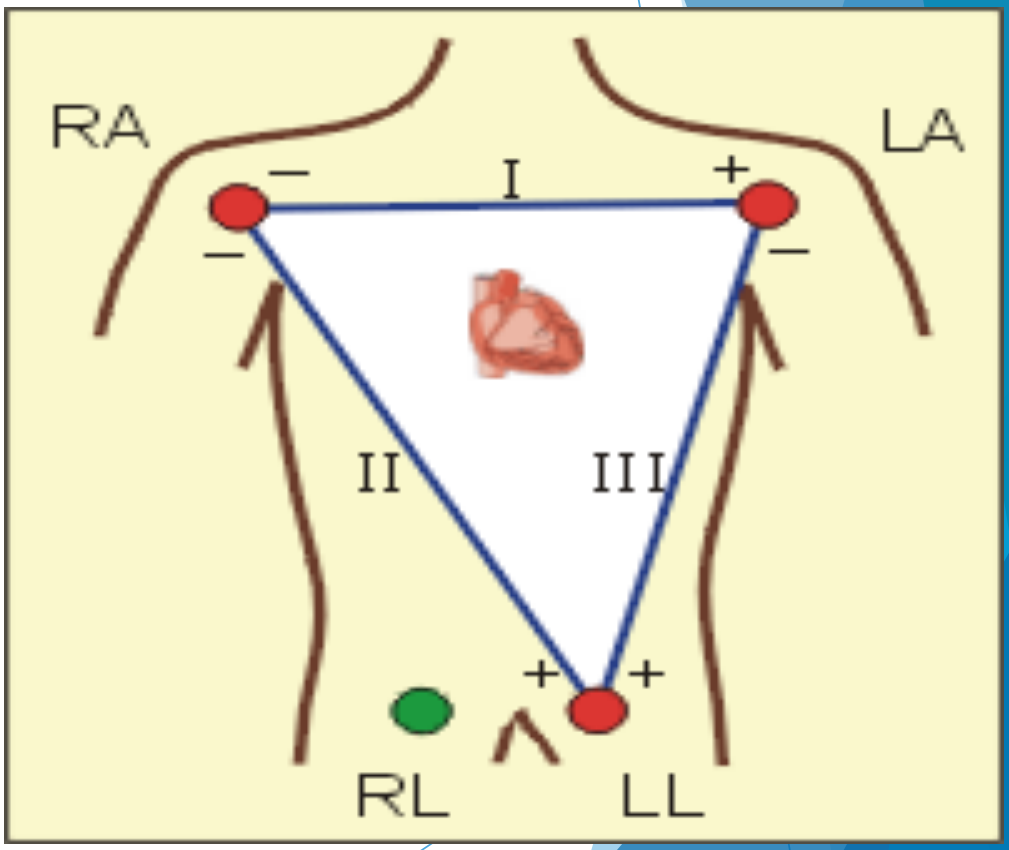
Bipolar Limb Leads

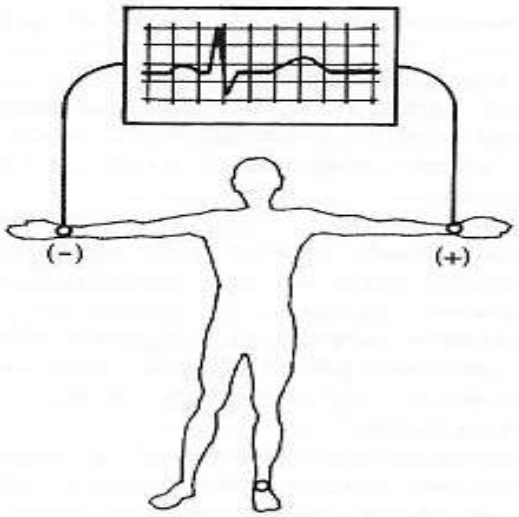
3 Bipolar Leads
form (Einthovens Triangle)

Lead I - measures electrical potential between right arm (-) and left arm (+)

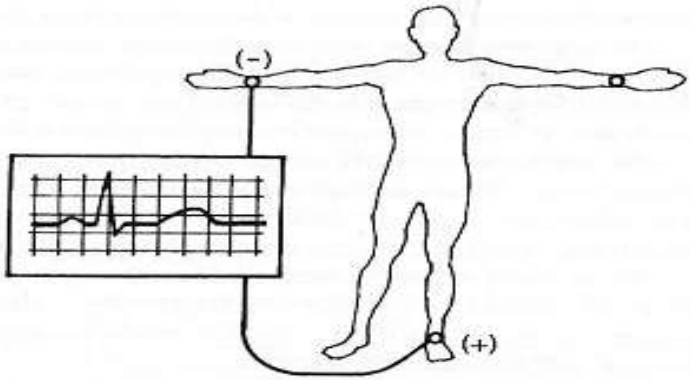
Lead II - measures electrical potential between right arm (-) and left leg (+)

Lead III - measures electrical potential between left arm (-) and left leg (+)

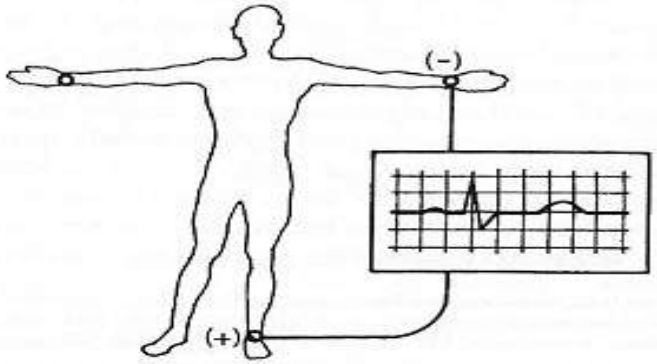




LEAD I



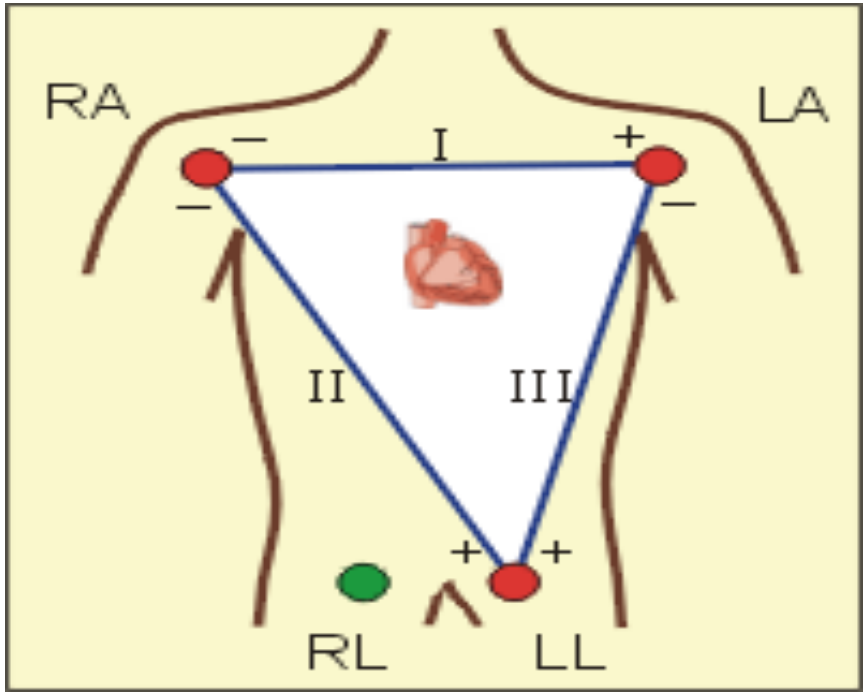
LEAD II



LEAD III

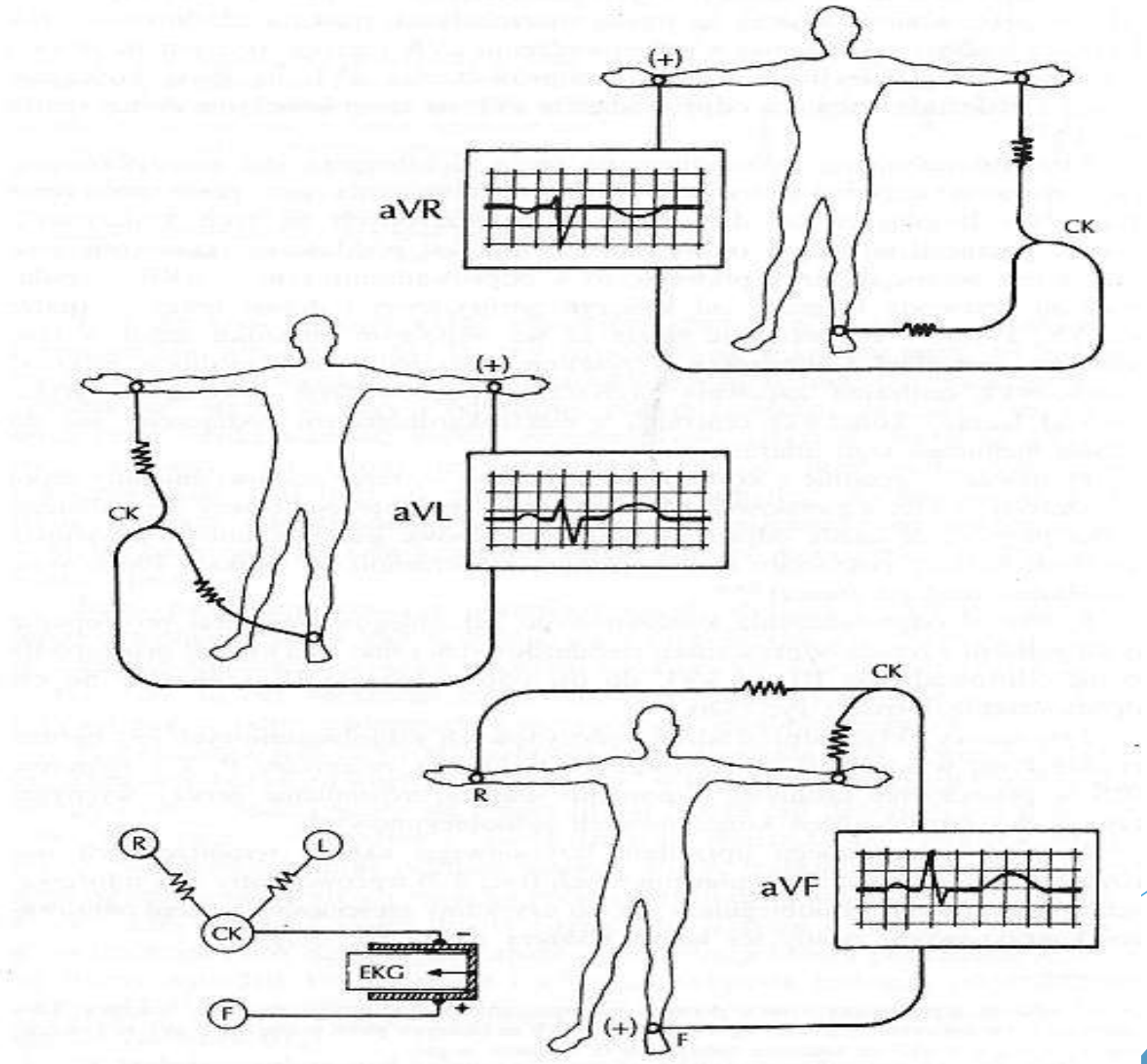
Unipolar Limb Leads

- avR - right arm (+)
- avL - left arm (+)
- avF - left foot (+)

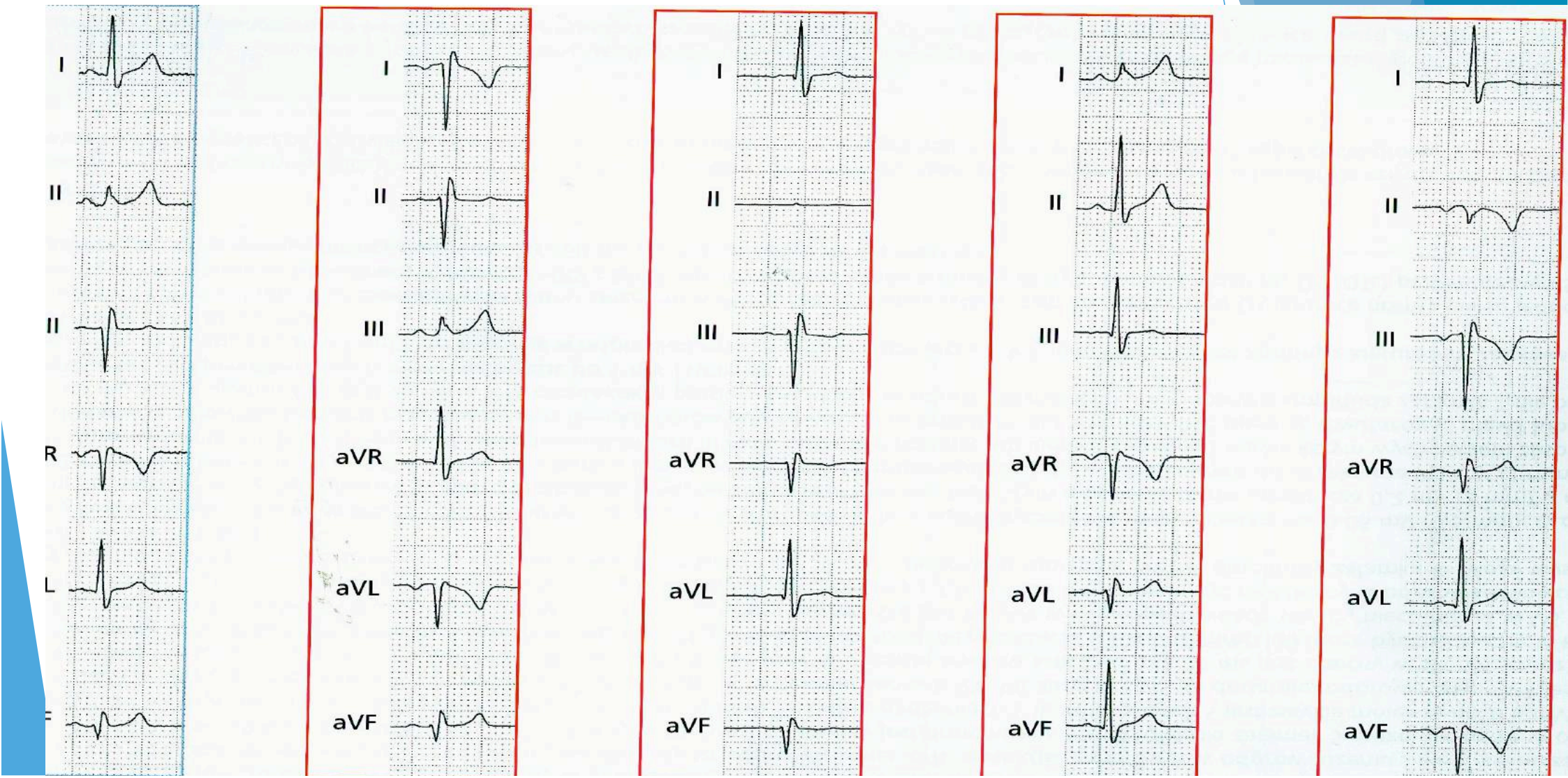


right foot is a **ground lead**

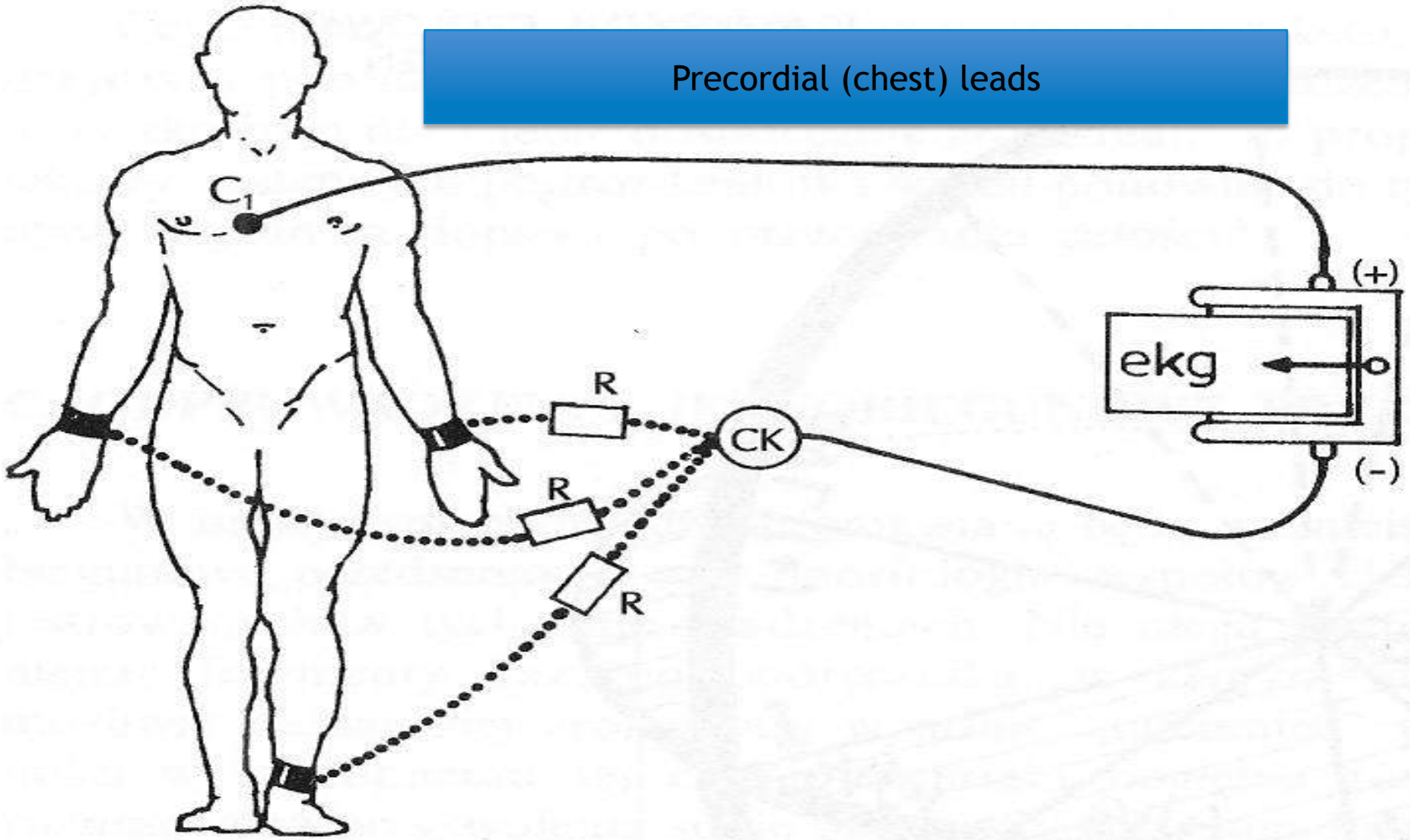
UNIPOLAR LEADS



Errors in limb leads locations



Precordial (chest) leads

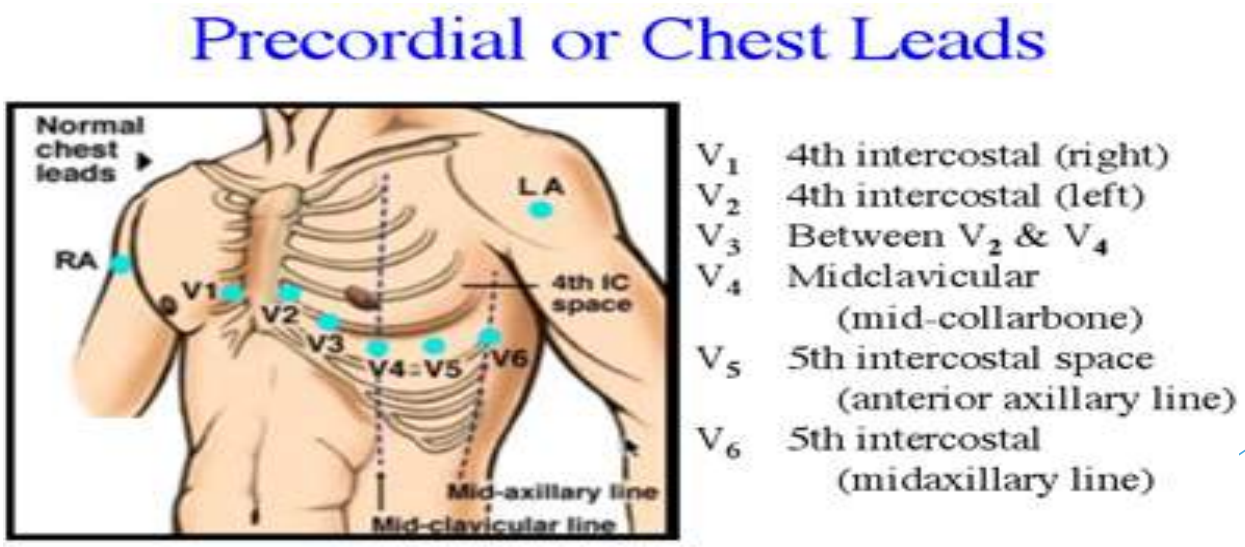


Chest Leads

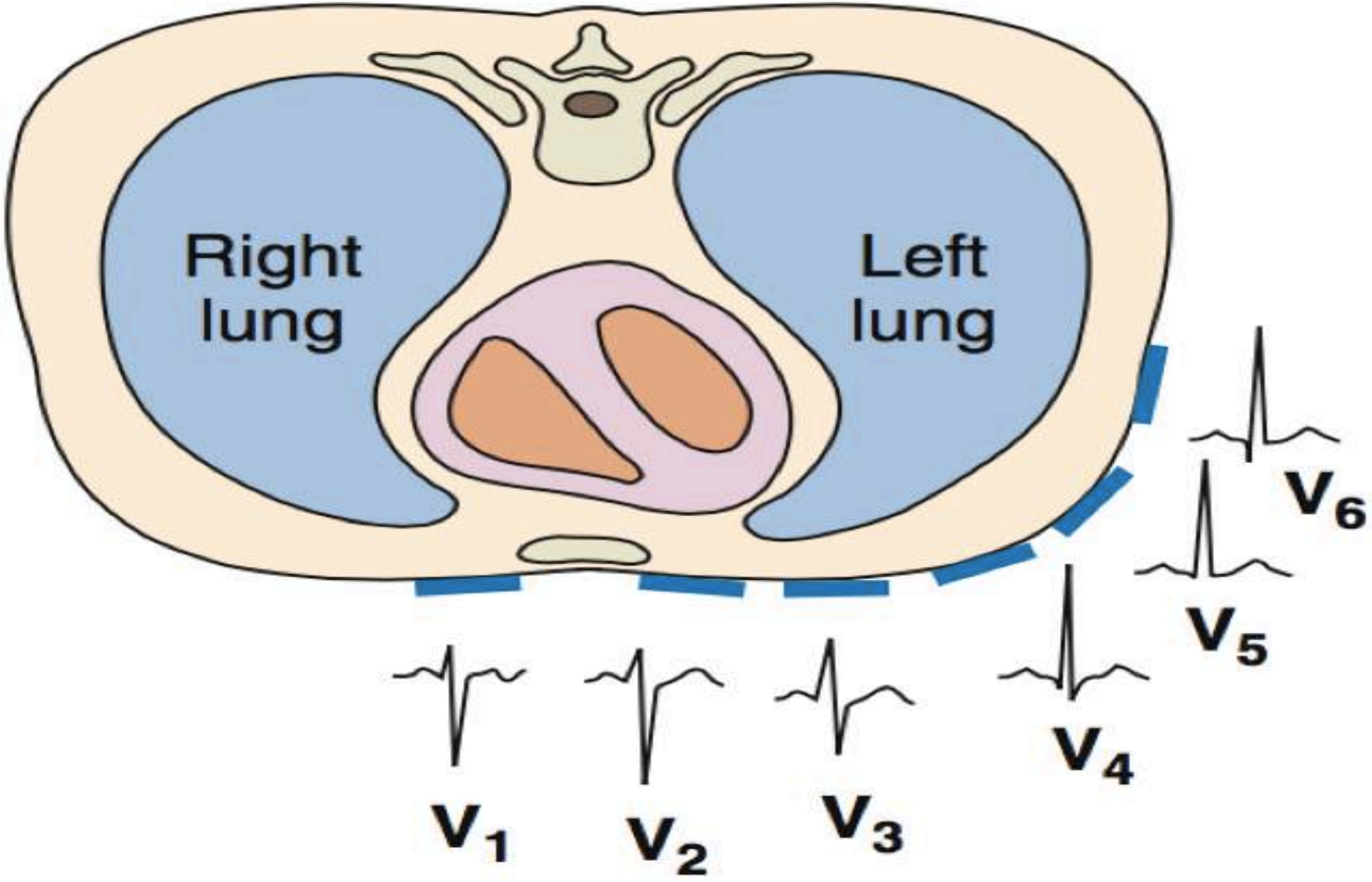
6 Unipolar leads

Also known as precordial leads

V1, V2, V3, V4, V5 and V6 - all positive



R-wave progression



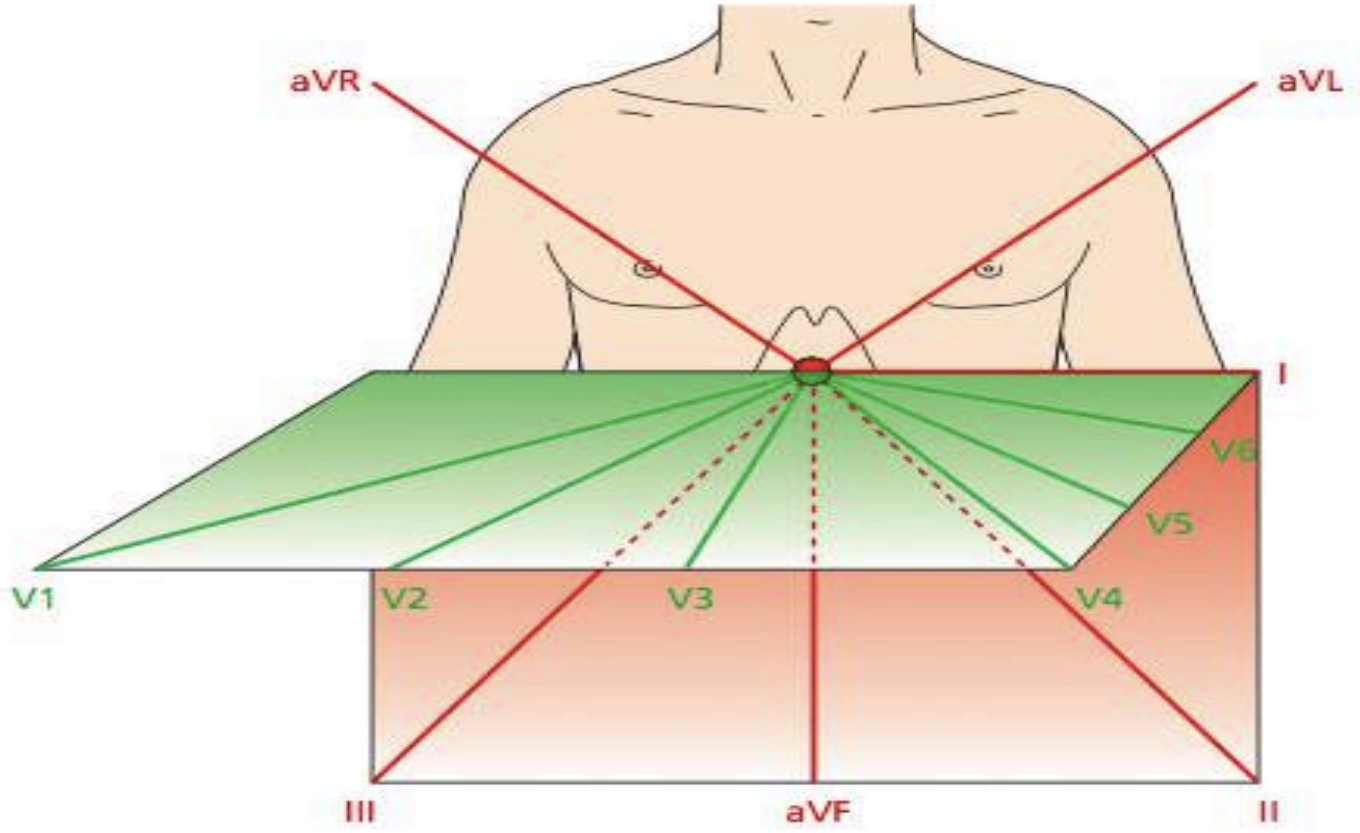
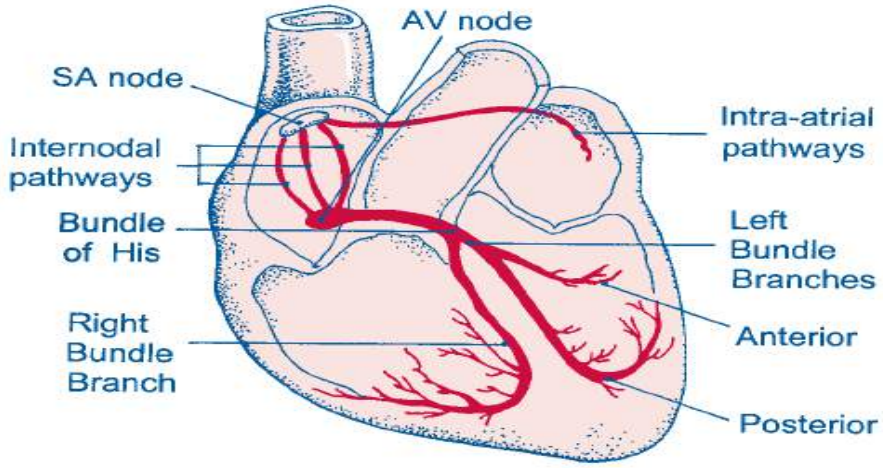


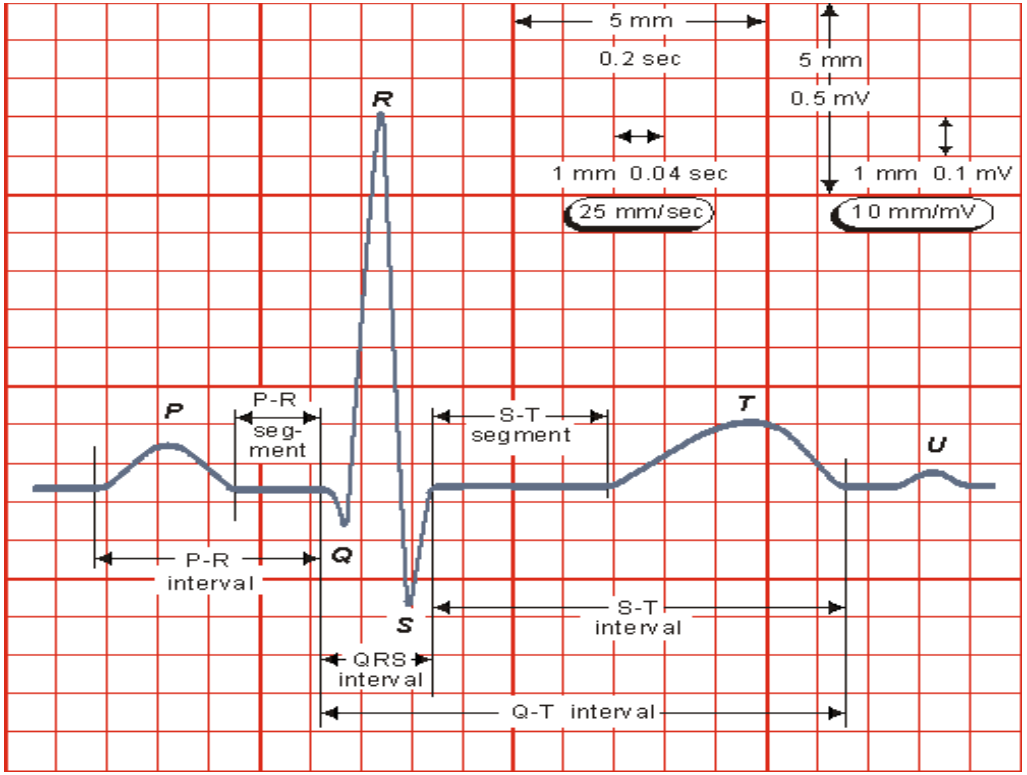
Figure 1.6 Vertical and horizontal perspective of the leads. The limb leads "view" the heart in the vertical plane and the chest leads in the horizontal plane.

- II, III, and aVF: inferior surface of the heart
- V1 to V4: anterior surface
- I, aVL, V5, and V6: lateral surface
- V1 and aVR: right atrium and cavity of left ventricle

The conduction system

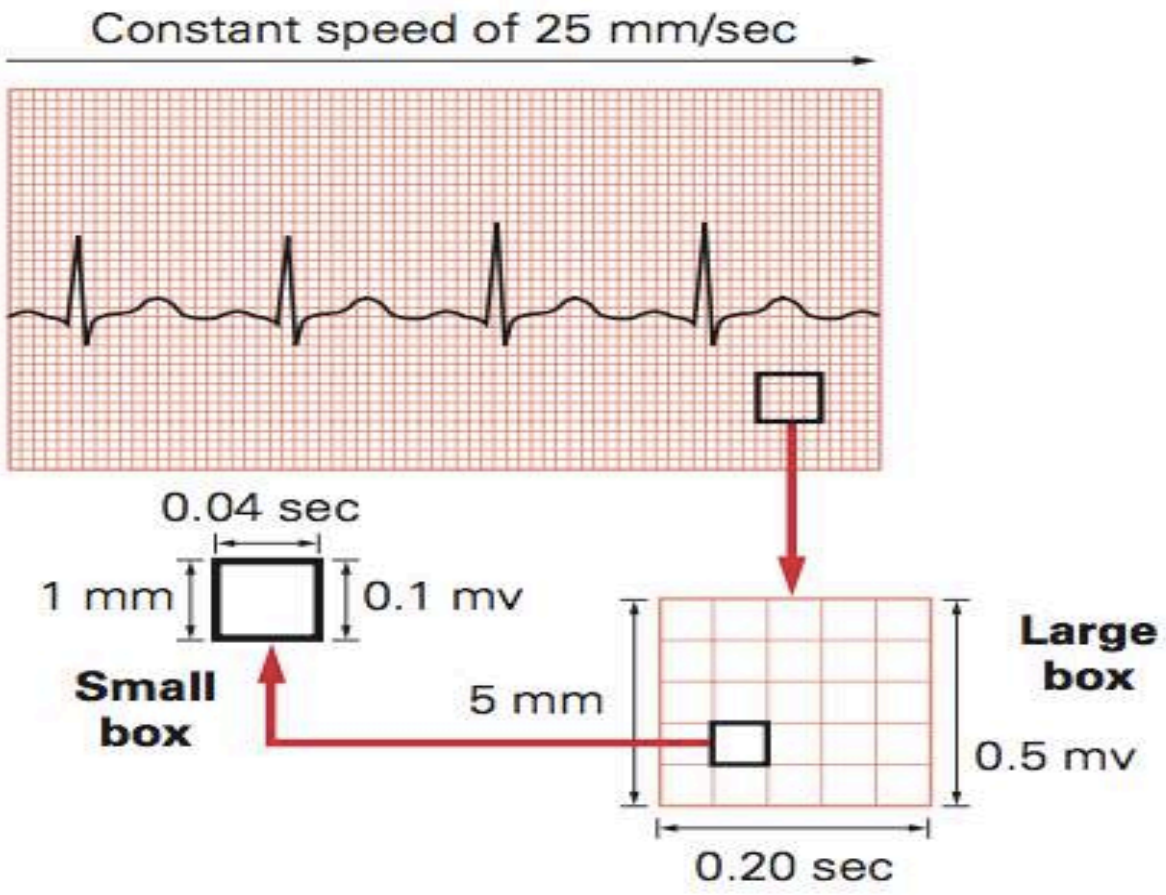


- Heart beat originates in the SA node
- Impulse spreads to all parts of the atria via internodal pathways
- ATRIAL contraction occurs
- Impulse reaches the AV node where it is delayed by 0.1second
- Impulse is conducted rapidly down the Bundle of His and Purkinje Fibres
- VENTRICULAR contraction occurs

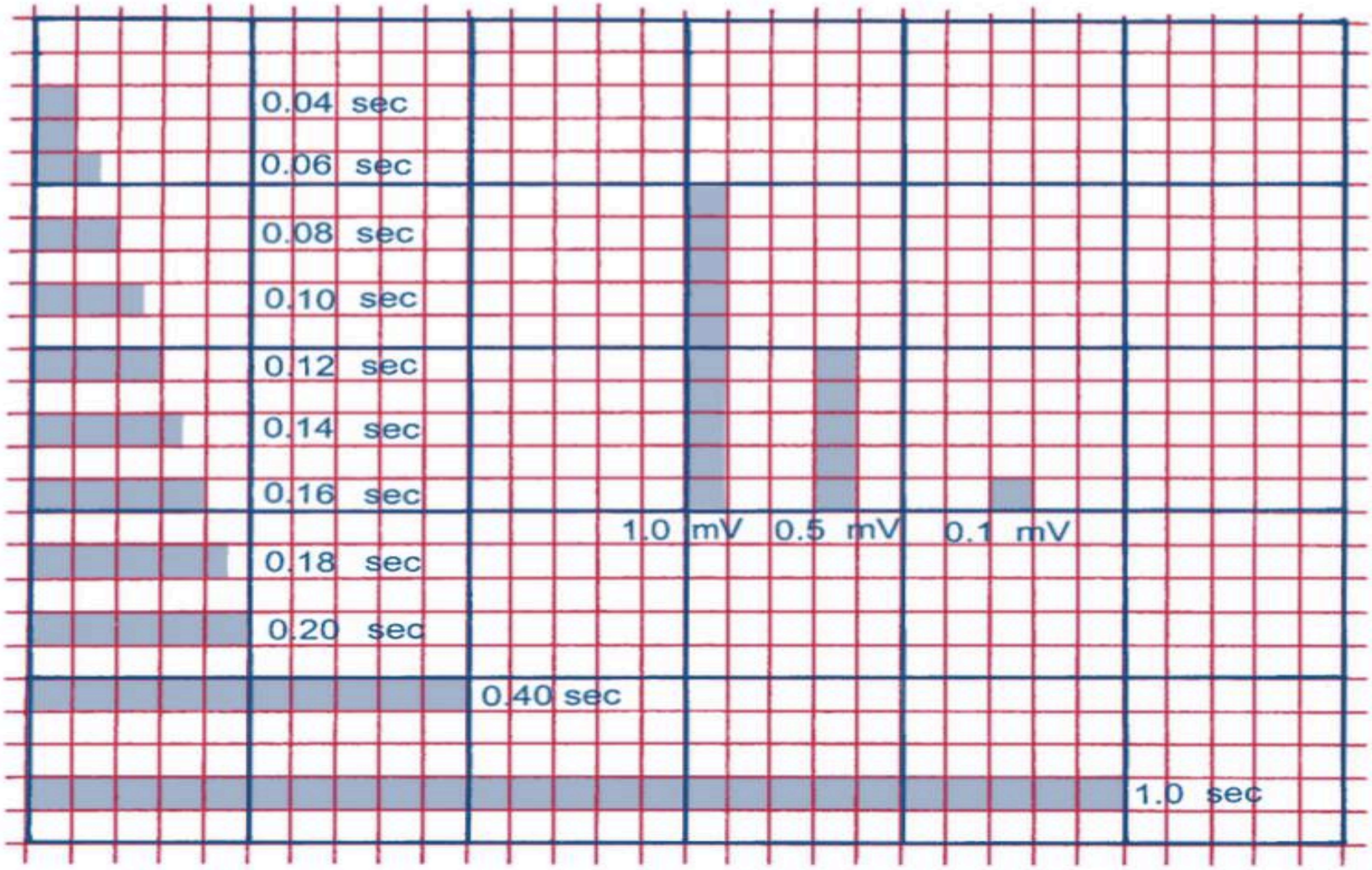


- The P wave represents atrial depolarization
- the PR interval is the time from onset of atrial activation to onset of ventricular activation
- The QRS complex represents ventricular depolarization
- The S-T segment should be iso-electric, representing the ventricles before repolarisation
- The T-wave represents ventricular repolarisation
- The QT interval is the duration of ventricular activation and recovery.

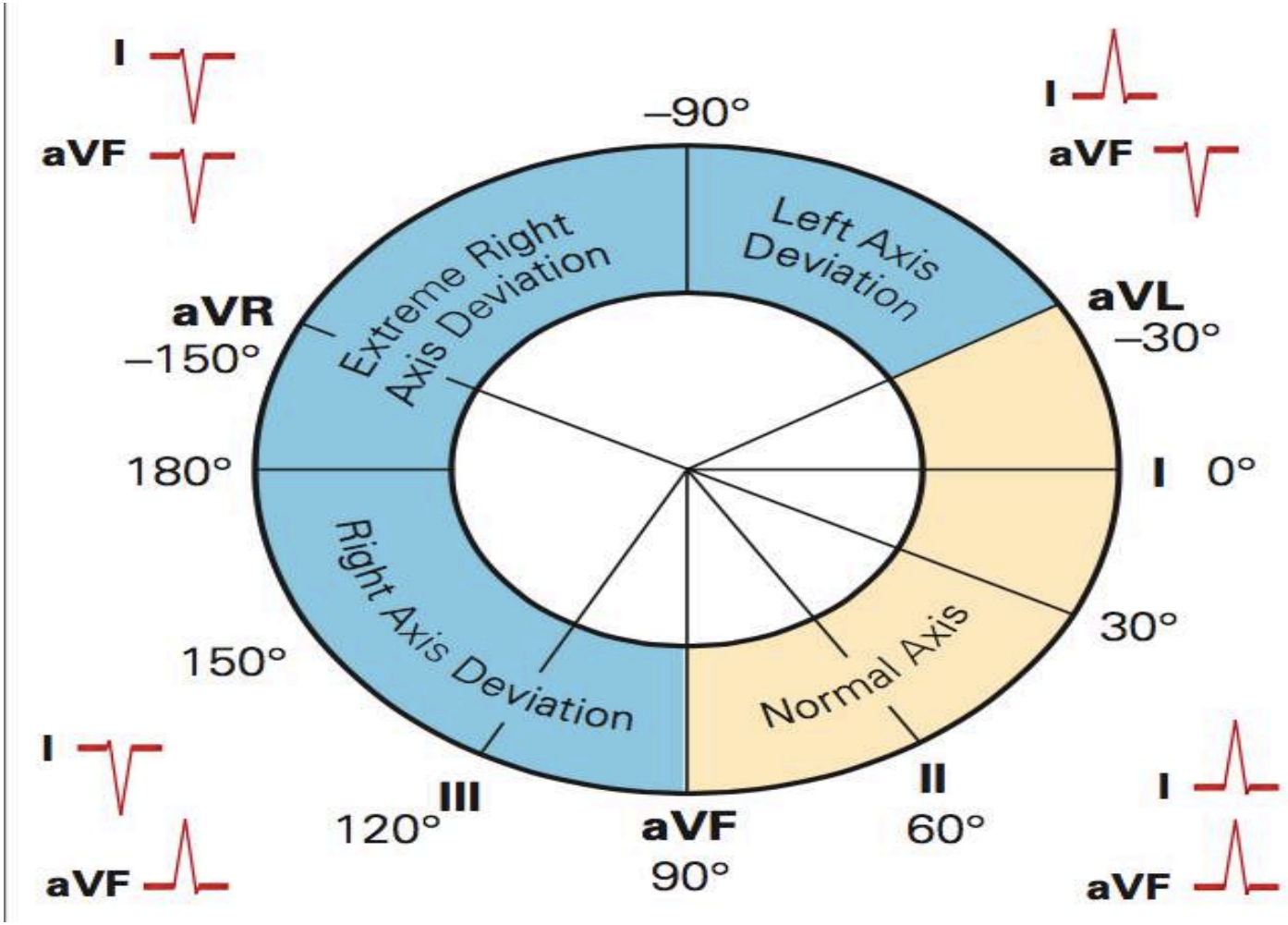
Intervals on ECG



Boxes and their standard values



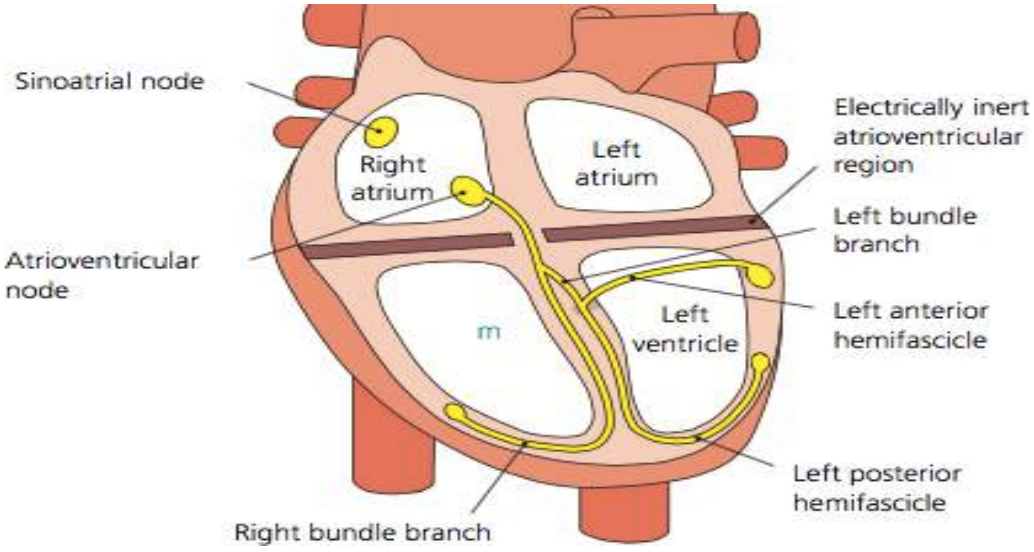
Electrical axis of the heart

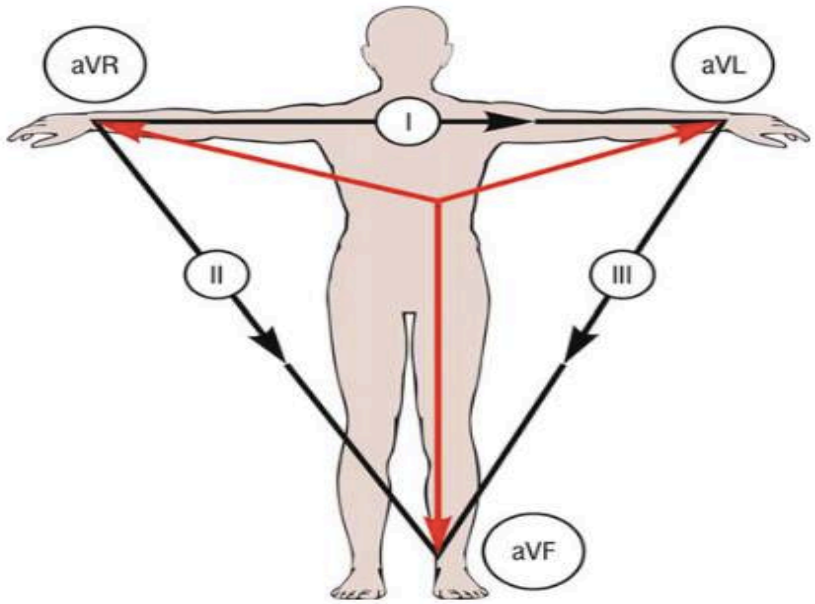


Sinus rhythm

- P waves positive in leads I, II, aVF
- P waves negative in lead aVR

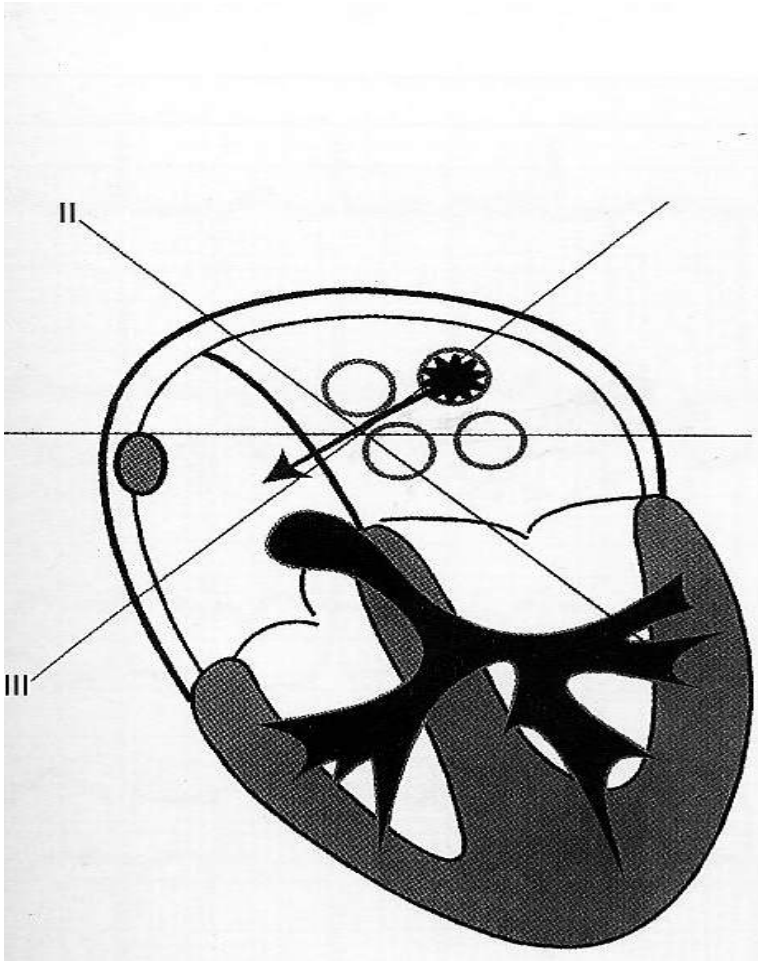
- Normal sinus HR 60-100 bpm

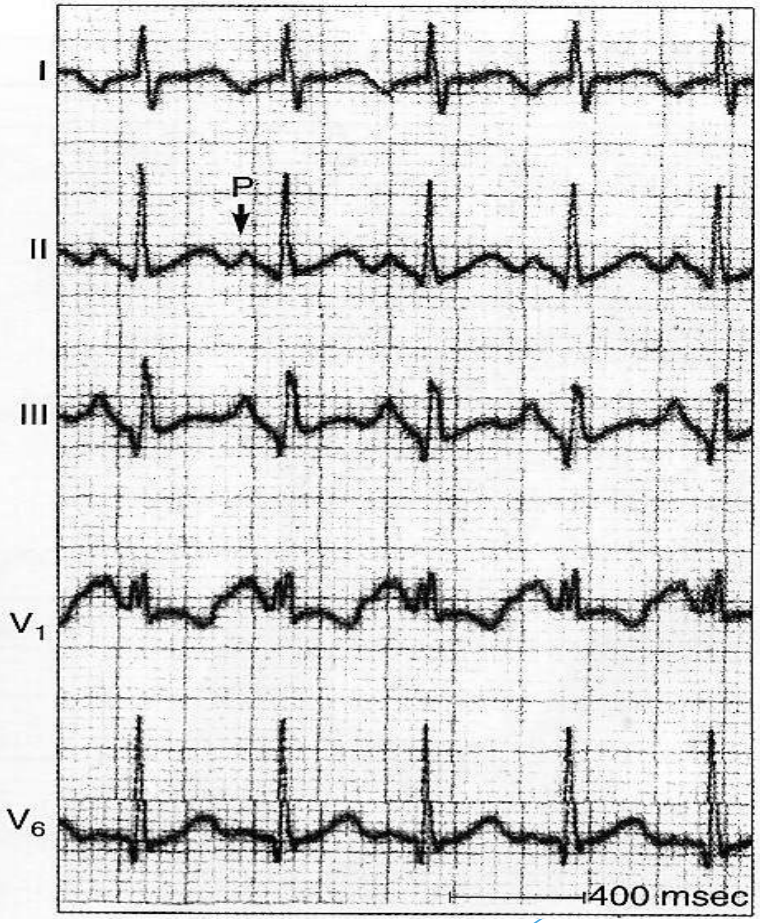




Examples of non-sinus atrial rhythms and their location

Left atrial tachycardia

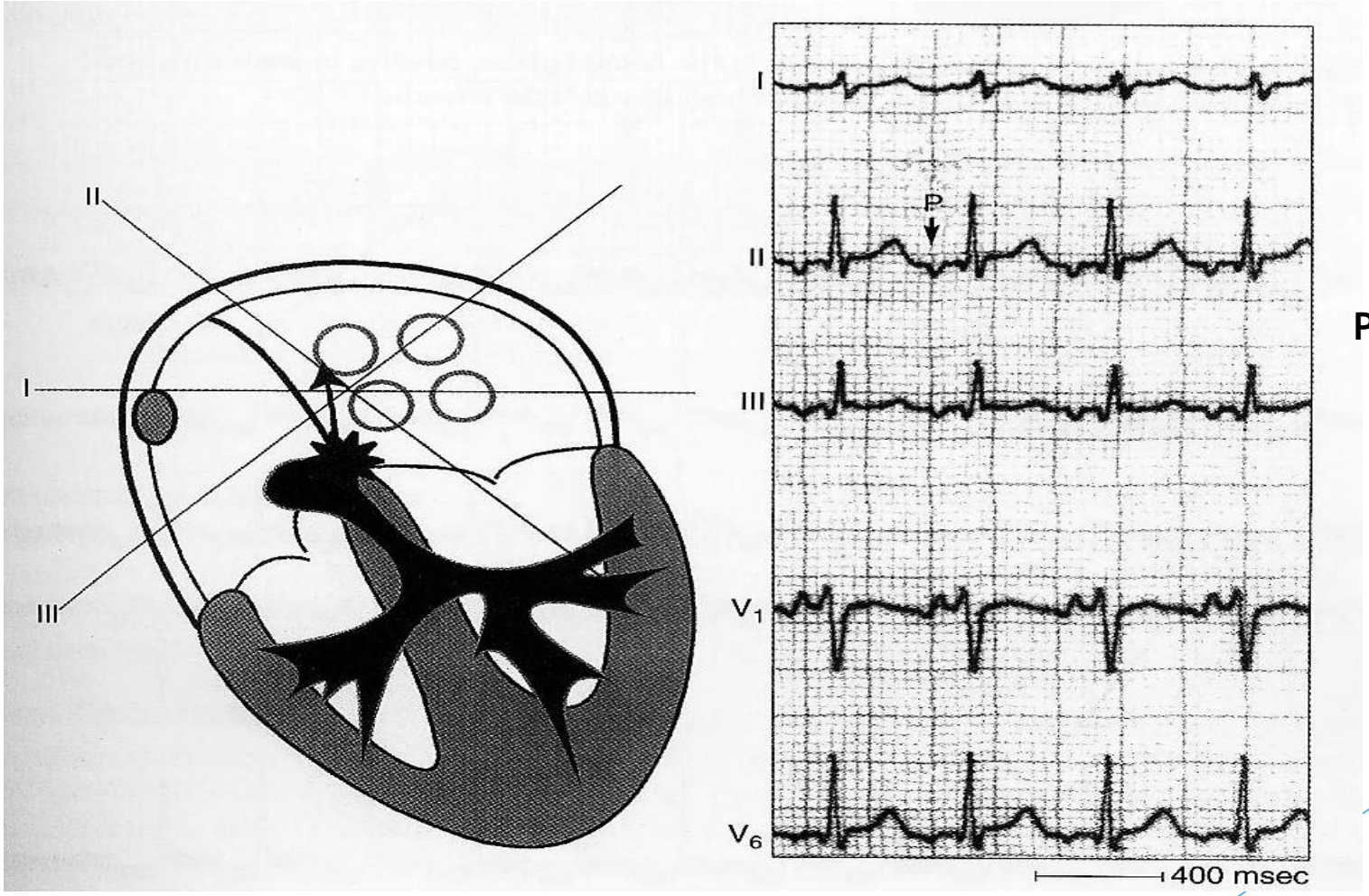




P negative in I

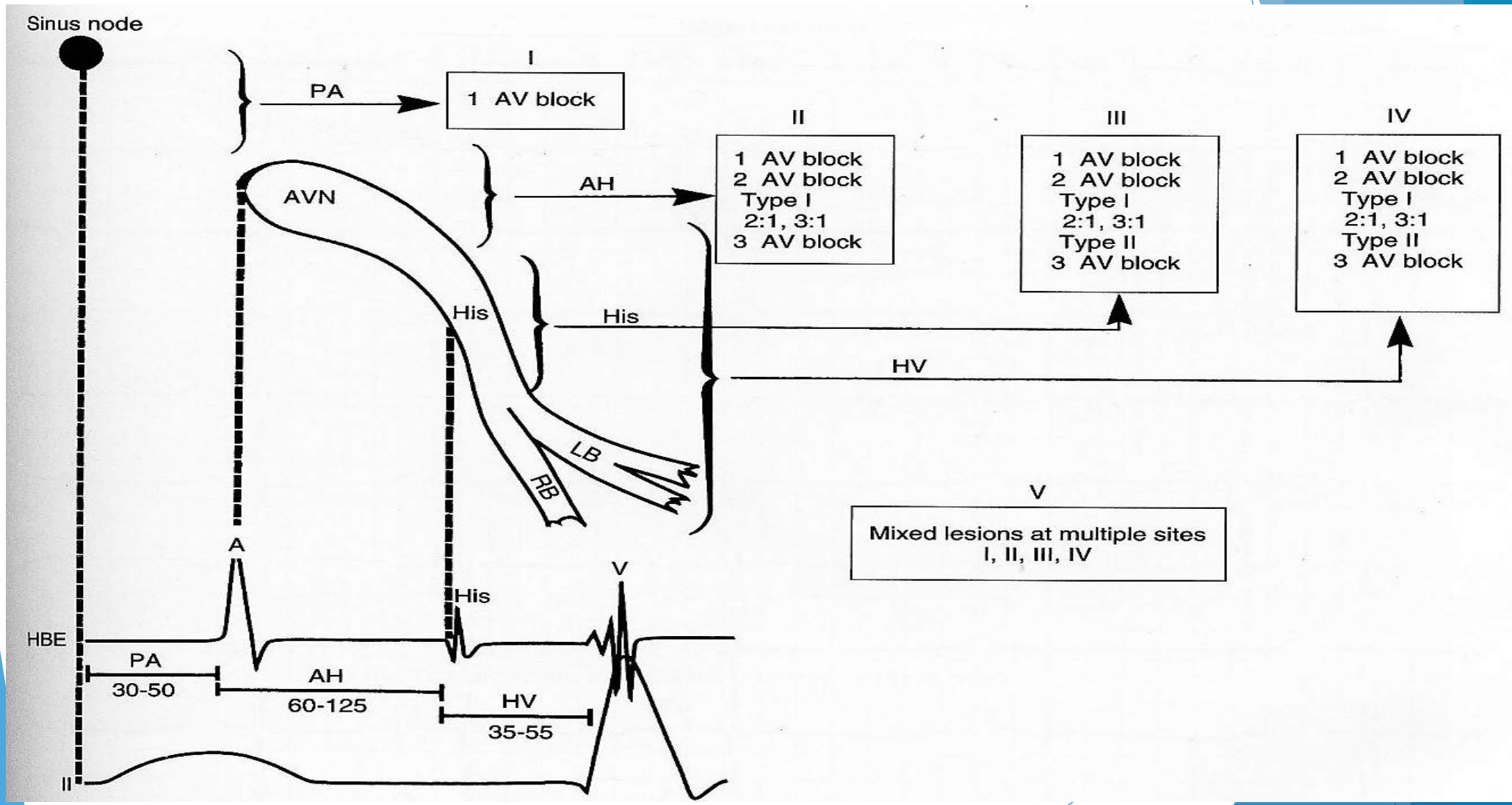
P positive in II, III

Inferior atrial tachycardia



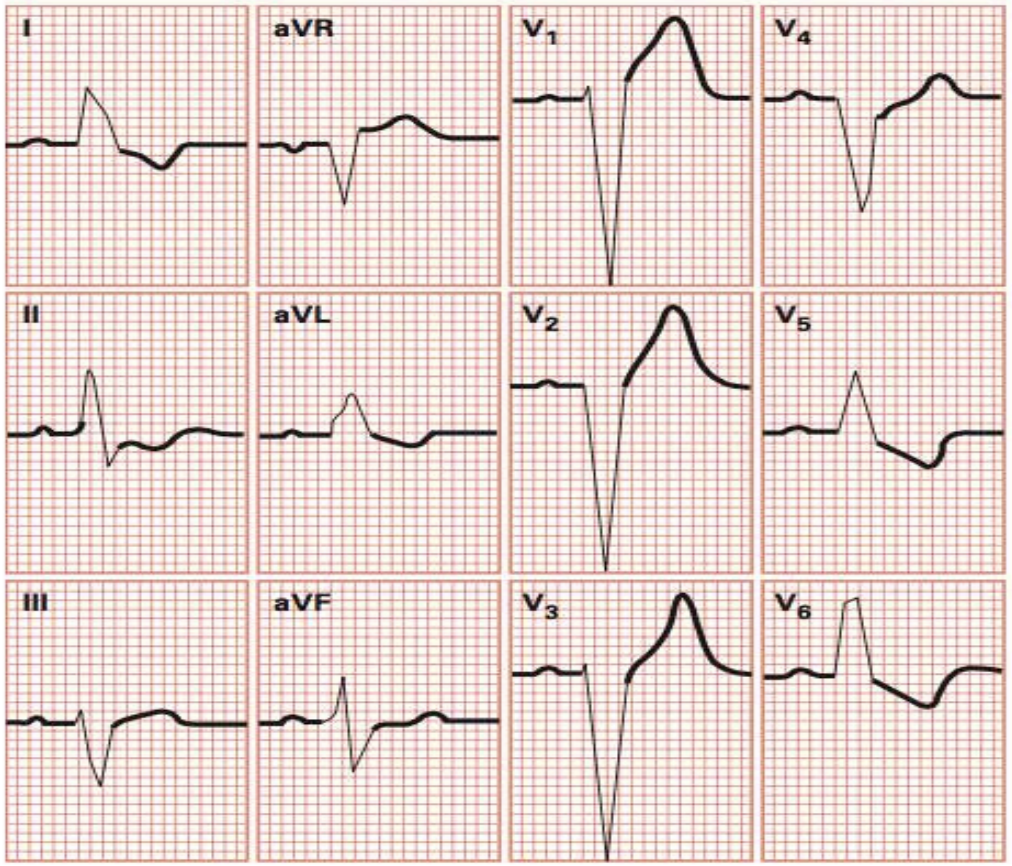
P negative in II, III

Conduction disturbances


Sinus node
PA
I
1 AV block
AVN
AH
II
1 AV block
2 AV block
Type I
2:1, 3:1
3 AV block
III
1 AV block
2 AV block
Type I
2:1, 3:1
Type II
3 AV block
IV
1 AV block
2 AV block
Type I
2:1, 3:1
Type II
3 AV block
His
His
HV
LB
RB
V
Mixed lesions at multiple sites
I, II, III, IV
A
His
V
HBE
PA
30-50
AH
60-125
HV
35-55
II

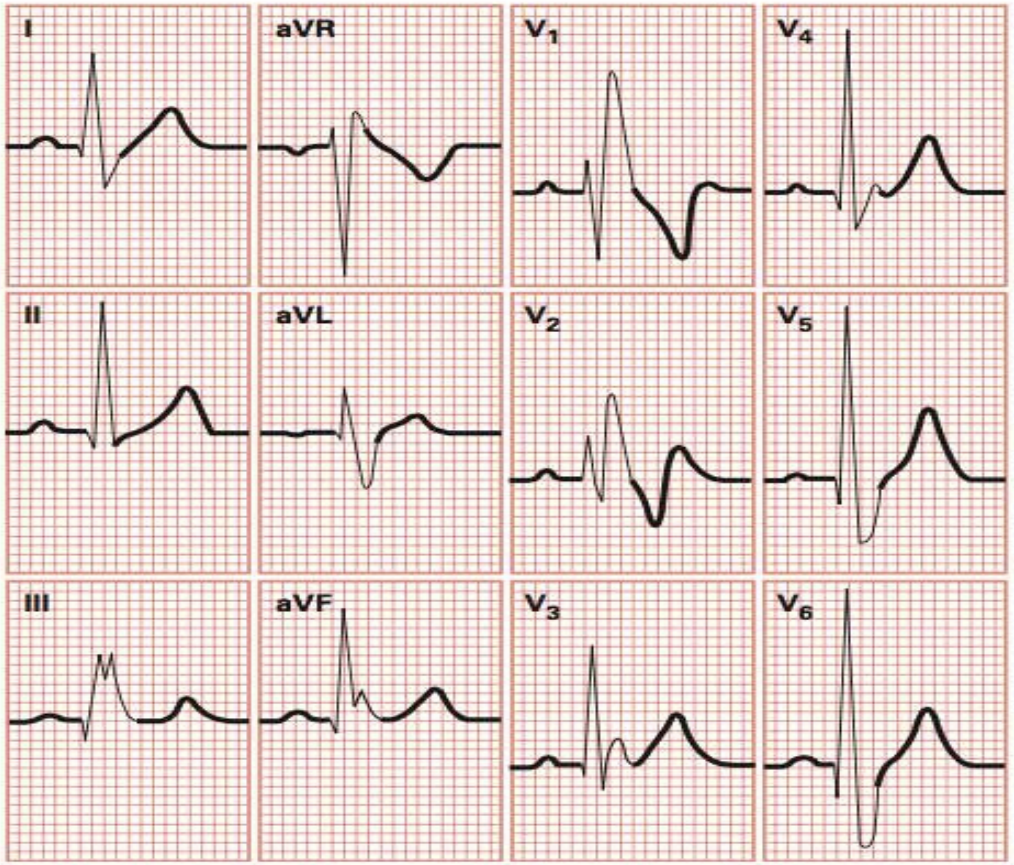
Left Bundle Branch Block

- QRS >0.10 sec
- QRS predominantly negative in leads V_1 and V_2
- QRS predominantly positive in V_5 and V_6 and often notched
- Absence of small, normal Q waves in I, aVL, V_5, and V_6
- Wide monophasic R waves in I, aVL, V_1, V_5, and V_6



Right Bundle Branch Block

- QRS >0.10 sec
- QRS normal or deviated to the right
- Slurred S wave in leads I and V_6
- RSR′ pattern in lead V_1 with R′ taller than R



Step by step ECG analysis

1. Rhythm and heart rate
2. Electrical axis of the heart
3. P-waves: morphology, sino-atrial conduction disturbances
4. PQ intervals: atrio-ventricular conduction disturbances
5. QRS: intraventricular conduction disturbances, ventricular hypertrophy, pathological Q waves
6. ST/T: ST elevation, depression, negative T waves
7. QT interval
8. Supraventricular or ventricular arrhythmias
9. Cardiac artificial pacemaker activity