Cardiac Function Tests and Measurement of arterial blood gases.

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Objective of the lecture.

- To describe the investigations requested when assessing functioning status of the heart and methods of measuring arterial blood gases and interpretation of results.

Format of the lecture.

1. **Cardiac function tests**.

- Non-invasive.
- Invasive.

2. **Measurement of Arterial blood gases**.

- Techniques of measuring.
- Interpretation of results.

Cardiac Function tests.

Indications:

- To assess **electric** and
- **Structural** function of the heart.

These tests can be grouped as follows:

i. **Non-invasive procedures.**
ii. **Invasive procedures.**

Non-invasive procedures.

- **No pain inflicted.** Though patient may experience some discomfort.

Include:

1. Electrocardiography
2. Ambulatory Electrocardiography
3. Chest X-Ray
4. Echocardiography
5. Stress testing
6. Computer Imaging.

Electrocardiogram*

(EKG, ECG)

- A **series of electrodes** placed on the patient's chest and recording the **electrical activity** of the heart.
- Measures the **timing** and **duration** of each **electrical phase** of the heartbeat.
- **Information given by ECG***:

ELECTROCARDIOGRAPHY

Information given by ECG:

- If patient has had previous myocardial infarction/heart attack.
- If myocardial infarction is developing
- If there is any physical defect or damage to the heart or the valves
- Snapshot/picture of patients heart activities at the time of test

Ambulatory Electrocardiography*

(Holter Monitoring, Ambulatory ECG, Ambulatory EKG)

- Records **changes** in the **electrical activity** of the heart throughout the day.
- **Better** picture of heart.
- Generally gives better information than ECG which can be used for diagnosis and prognosis

Chest X-ray*

- **Different X-ray views** of the chest requested when a patient suspected to have heart disease.
- X-rays used to capture **images** of the **heart**, **lungs** and **bones** of the chest.

Chest X-ray

- It reviews the shape, size of the heart and any abnormalities of the lungs due to heart problem

Can detect the following;

- Large heart
- Large muscle
- Fluid around the heart

Echocardiography*

(**Echo**)

- Uses **Ultra sound** technique.
- Gives information on the **size** and **shape** of the heart and the various structures within it.
- Measures the **blood flow** in and out of the heart.
- It shows the fluid or swollen muscles making the heart grow big.

Stress testing*.

- Done to **exercise** the heart - more **blood** and **oxygen**.
- Determine how **efficiently** the heart working.

Two tests:

1. The patient runs on a treadmill (**physical**)*
   or
2. Administered more **invasively** through a **Thallium stress test***.

STRESS TESTING

- Done to assess whether heart is functioning as in a normal person
- **Thallium stress test:** inject a radioactive dye in veins and observe functioning of the heart. Dye penetrates heart muscle and you're able to tell whether there is any defect in the heart. Its an invasive procedure

Computer Imaging*.

- Computer imaging includes:

i. Computer Tomography (CT),

ii. Magnetic Resonance Imaging (MRI)

iii. Positron Emission Tomography (PET).

Information provided*:

Computer Imaging.

Information provided*:

- Pathology in the blood vessels
- Pathology in the heart muscles
- Abnormalities or defects in the pericardium

Invasive procedures.

- **Pain Inflicted**

Include:

i. **Blood investigations.**
ii. **Cardiac catheterisation.**
iii. **Transesophageal echocardiogram.**

Blood investigations.

Measurement of Cardiac markers (cardiac enzymes and protein levels)*.

- Measure the levels of **enzymes** and **proteins** that are linked with **injury** of the heart **muscle**:

1. **Creatine phosphokinase** (**CPK**)
   (Creatine kinase (CK)
2. **Creatine Kinase Muscle Brain** (MB) **isoenzyme** (mass and activity).
3. **Creatine Kinase Muscle Brain** (MB) **Isoform**

4. Myoglobin
5. Heart-type Fatty Acid Binding Protein (H-FABP)
6. Troponin T (Tn T)
7. Troponin I (Tn I)

1-3 are enzymes, 4-7 are proteins

- Interpretation of Cardiac markers results*.
- Use of Cardiac markers*

Cardiac markers

- The enzymes and proteins are usually low in the blood but they tend to rise when here is damage i.e myocardia infarction.
- These things are also found in the brain and muscles.
- Be careful to endure that the rise in heart is actually from the heart and no any other organ

Cardiac markers

Uses of cardiac markers

- Assists in making early diagnosis of MI within 6 weeks of symptoms.
- Detects myocardial damage during ischemia episodes.
- Its results guide the doctor as to which further interventions should be administered.
- Monitors how patient is responding to the treatment

Normal values*.

- Ck
- CK MB Isoenzyme
- CK MB Isoform
- **Myoglobin ⇨ (best test as it detects acute MI within 3 hours of development)**
- H-FABP
- Tn I
- Tn T

NORMAL VALUES

		MEN	WOMEN
Creatine Kinase		80-200 iu/L	96-140 iu/L
These down don't have ati men or women, I assume it's the same for both men and women			
CK MB	Activity	8 – 16 iu/L	
	Mass	5 -10 ng/mL	
Isoform		10 – 14 iu/L	
Myoglobin		0 – 85 ng/mL	
H – FABP		<5micrograms/L	
Troponin I		<10micrograms/L	
Troponin T		0-0.1 micrograms/L	

Cardiac Catheterization*.

Aka coronary angiogram

- One of the **most useful** procedures in diagnosing heart disease.
- Procedure takes place inside the vessels of the heart, and normally takes **2 to 3** hours to complete.
- **Information given**:

CARDIAC CATHETERIZATION

- Tube of catheter passed into one of the vessel (coronary artery).
- Dye is injected and movement of dye observed

INFORMATION GIVEN

- Site where blood vessels are blocked is revealed.
- Blood pressure measured using this procedure.
- Oxygen content of blood can be measured.
- Functioning status of the heart muscle can be established.

Transesophageal echocardiogram.

- An **invasive** form of echocardiography.
- A small ultrasound device placed in the **esophagus**, and then taking a **sound image** of the heart.

Measurement of Arterial Blood Gases (ABG).

Why* :

To determine :

1. The **functioning status** of the lungs well enough in patient with r**espiratory** abnormalities.(Determine exchange of O2 and CO2.)
2. There is an **imbalance** in the amount of **oxygen** and **carbon dioxide** in blood or **acid-base imbalance (**indicating respiratory, metabolic, or kidney disorders).

Indications.

(When):

1. Patient with **abnormal breathing**:

- **Dyspnoea** (difficulty breathing),
- **Apnoea** (shortness of breath),
- **Tachypnoea** (rapid breathing).

2. Patients with **symptoms** of an **oxygen/carbon dioxide** or an **acid-base** imbalance.

3. **Periodically** when condition of acute or chronic **oxygen shortage** and patient on **oxygen therapy**.
4. During certain **surgeries** to monitor the patient’s blood's oxygen and carbon dioxide levels.

Role of respiration, metabolism, and kidneys in maintaning Blood pH, CO_2/O_2 , and electrolyte balance*.

- Blood pH: **7.35-7.45**

Acute & chronic conditions (diseases) affecting*:

1. Kidney function
2. Acid production
3. Lung function

Blood pH changes*.

1. Decreased (more **acidic**)
2. Increased (more **alkaline**)

BLOOD pH changes

- A measure of the balance of acid and bases in blood.
- When blood pH decreases, blood gets more acidic meaning an increase in CO_2 levels in blood.
- When blood pH increases, means blood is more alkaline meaning a decrease in CO_2 levels and increase in amount of bases(HCO_3)

Methods for measuring arterial blood gases:

Use of:

1. **Arterial blood gas analyser (ABG)**
2. **Pulse oximeter**

Arterial Blood gas analyser (ABG)

- Gives the **state** of the blood's **pH** and **oxygen** and **carbon dioxide** content.
- **Directly** measure:

i. **pH** - a measure of the balance of **acid** and **bases** in the blood.
ii. **Partial pressure of O_2** (PO_2) - the amount of oxygen gas in blood.
iii. **Partial pressure of CO_2** (PCO_2) - the amount of carbon dioxide gas in the blood.

Indirect measurements*.

- **Calculations** or measurements done to give **other parameters**, such as:

a) **Oxygen saturation***.

b) **Bicarbonate (HCO_3^-) levels***.

c) **Base excess/base deficit.**

INDIRECT MEASUREMENTS

OXYGEN SATURATION

- % of Hb combined O2.

BICARBONATE LEVELS

- Main form of CO2 in the body.
- Calculated from readings of the **pH** and **partial pressure of CO2.**

BASE EXCESS/BASE DEFICIT

- Calculations are the sum total of the **metabolic buffering agents**, anions in blood and these are: **Haemoglobin**, **Proteins**, **Phosphates** and **Bicarbonates**.

Procedure for blood sample collection.

- **Arterial blood (radial artery),** almost always used.
- Some cases, **heelsticks** used (babies).
- **Umbilical cord blood for** newborn.

Artery of choice

- An arterial blood sample usually from the **radial** artery.
- A circulation test , **Allen test*,** done before the collection - **adequate circulation** in the patient's wrist.
- If one hand not flush, other wrist tested.
- Other arteries: **Brachial** or **Femoral** arteries.

Allen test*,

- Occlude/block flow of blood through the hand by squeezing the wrist for a moment then observe the redness that occurs after release

Technique.

- **ABG analyser** used.
- Test blood taken from an **artery**, by **puncturing** the artery with needle and syringe.

ABG analyser*

- **Plastic** and **glass** syringes used for blood gas samples.
- Most syringes come pre-packaged and contain a small amount of **heparin**.
- **Anticoagulated** blood.
- **Eliminate** any visible gas bubbles.

- Sealed syringe taken to an **ABG gas analyzer.**
- If a **plastic syringe** used, sample transported and kept at **room** temperature and analyzed **within 30 min**.
- If prolonged time delays expected (i.e., **greater** than 30 min) prior to analysis, the sample drawn in a **glass syringe** and immediately **placed on ice**.

Interpretation of results of ABG analyser.

- Reading:

1. **pH**,
2. **PO_2**,
3. **PCO_2**.

- **Abnormal** results of any of the blood gas components might mean:

i. Patient **not getting** enough **oxygen**.

ii. Patient **not getting rid** of enough **carbon dioxide.**

iii. Impaired kidney function.

Normal and abnormal ABG analysis values*.

1. pH
2. PCO_2
3. PO_2
4. HCO_3-

NORMAL AND ABNORMAL ABG ANALYSIS VALUES

	VALUES	
pH	>7.45 7.35-7.45 <7.35	Alkalemia Normal Acidemia
pCO2	>45mmHg 35-45mmHg <35mmHg	Acidosis Normal Alkalosis
pO2	>100mmHg 80-100mmHg <80mmHg	 Normal Hypoxemia
pHCO3	>26mmol/L 22-26mmol/L <24mmol/L	High Normal Low

Explanation*.

1. **Hypoxia**
2. **Respiratory acidosis**
3. **Respiratory alkalosis**
4. **Metabolic alkalosis**
5. **Metabolic acidosis**

- Combination of results that may be seen in certain conditions are summarized below:

pH result	Bicarbonate result	PCO_2 result	Condition	Common causes
<7.35	Low	Low	**Metabolic acidosis**	Kidney failure, shock, diabetic ketoacidosis
>7.45	High	High	**Metabolic alkalosis**	Chronic vomiting, Hypokalemia, sodium bicarbonate overdose
<7.35	High	High	**Respiratory acidosis**	Lung diseases such as pneumonia, COPD, narcotic overdose
>7.45	Low	Low	**Respiratory alkalosis**	Hyperventilation, pain, anxiety

- If left untreated, conditions may be **life-threatening .**
- Necessary **medical intervention** required:

1. Correct the **underlying** cause of imbalance
2. Restore body's **normal balance**.

Pulse oximeter*

- Pulse oximetry, a **non-invasive** method.
- Monitor the **oxygen saturation** of a patient's **hemoglobin**.
- **Indirectly** monitors the **oxygen saturation** of a patient's blood and **changes** in **blood volume** in the **skin**.


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- **The procedure*.**
- **Readings***
- **Advantages*.**
- **Limitations*.**

PROCEDURE

- A thin part of the body (fingertip or earlobe even the toe).
- Light of different wavelength passes through the skin (arterial blood).

READINGS

- Normal O2 saturation is 94-99%
- In (peripheral) mild respiratory disease, O2 saturation is >90% but <94%
- Severe respiratory disease and patient on oxygen therapy O2 saturation is <90%

ADVANTAGES

- Can measure level of oxygenation in unstable conditions including intensive care, operating, recovery, emergency and hospital ward settings.
- Pilots in unpressurized aircrafts.
- For other assessment of any patient's oxygenation and determining the effectiveness of or need for supplemental oxygen.

LIMITATIONS

- Measures % of oxygenation and provides no information on ventilation, giving and incomplete picture of the level of lung function.
- Dose not give info on;
  - ✓blood pH reading.
  - ✓CO_2 levels
  - ✓bicarbonate conc.
  - ✓Base acid deficit information

FIN