Imperial College London

HRV Project

Background Research

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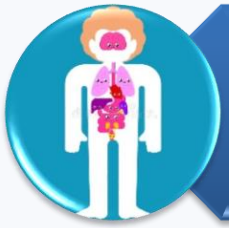


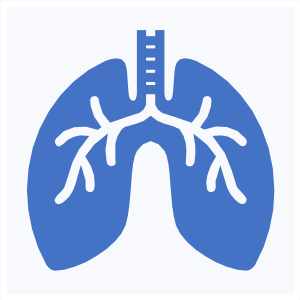
1.Physiological systems

2. Heart rate variability (HRV)

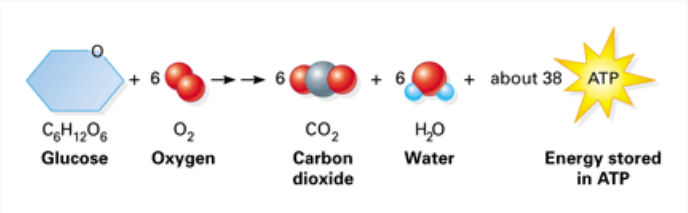
3. Cardiorespiratory monitoring

4. Electrocardiogram (ECG)

Physiological systems



Respiratory



Measured: RR / breaths per minute

Cardiovascular

Transport of substances (nutrients in, waste out)

Physiological systems

Blood pressure control

- Force driving blood flow

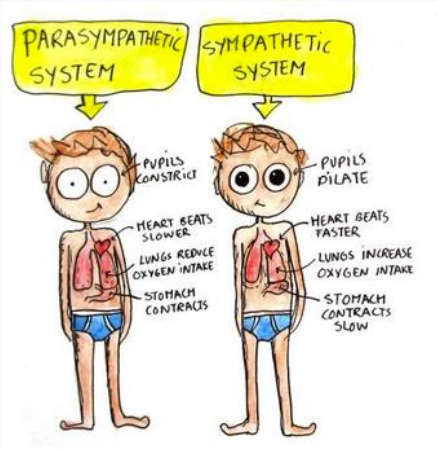
Thermoregulation

- Body operates at specific temperature range
- Conduction, convection, radiation, evaporation
- Vasoconstriction vs vasodilatation

Maintenance at specific values

Heart Rate Variability (HRV)

Underlying Physiology



Hypothalamus

- Receives information and processes it.
- Includes info from hormones, senses, nerves etc.

Autonomous Nervous System

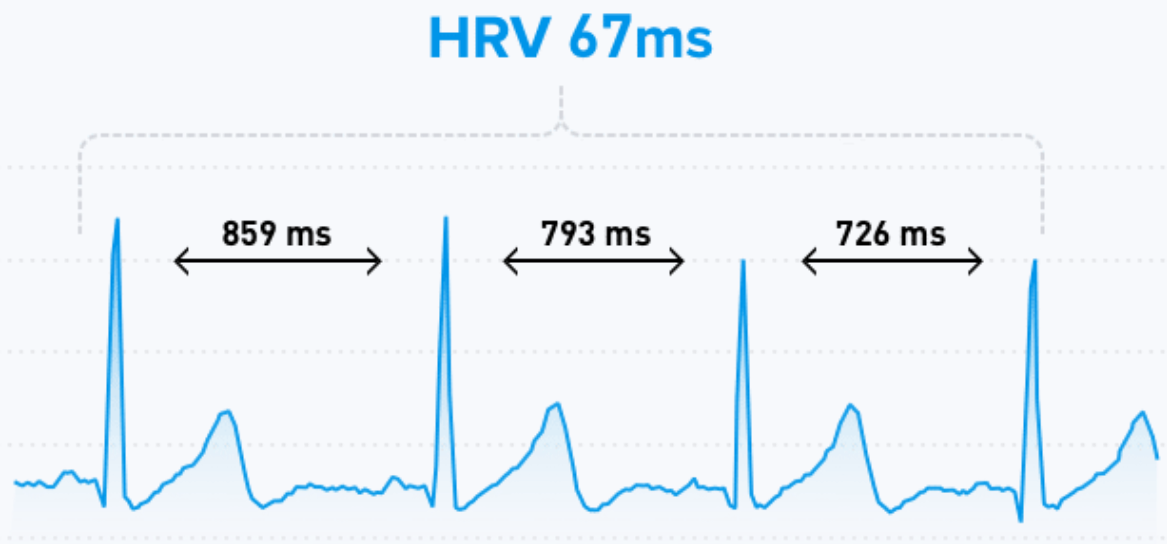
- Sympathetic and Parasympathetic Nervous Systems

Response

- Heart rate either goes up or down.
- BP changes accordingly.
- Temperature matches response.

Heart Rate Variability (HRV)

Measurements and Reference Range



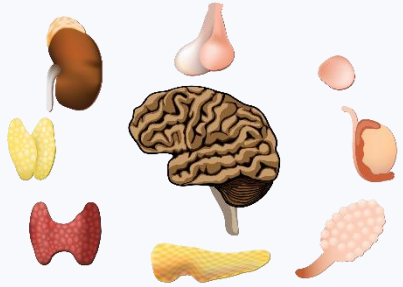
Age Range	Gender	ln(RMSSD)	HRV Score
18-25	**Male** (337)	4.46 ± 0.55	68.68 ± 8.52
	Female (89)	4.23 ± 0.65	65.09 ± 9.99
25-35	**Male** (1936)	4.19 ± 0.63	64.48 ± 9.69
	Female (327)	4.02 ± 0.69	61.83 ± 10.59
35-45	**Male** (3099)	3.92 ± 0.64	60.26 ± 9.92
	Female (449)	3.82 ± 0.68	58.72 ± 10.45
45-55	**Male** (2238)	3.68 ± 0.65	56.65 ± 9.94
	Female (372)	3.73 ± 0.69	57.35 ± 10.57
55-65	**Male** (948)	3.46 ± 0.72	53.27 ± 11.07
	Female (170)	3.48 ± 0.68	53.50 ± 10.44
65-75	**Male** (282)	3.42 ± 0.83	52.66 ± 12.70
	Female (26)	3.21 ± 0.72	49.35 ± 11.10
75+	**Male** (35)	3.50 ± 0.98	53.88 ± 15.09
	Female (2)	3.24 ± 1.09	49.85 ± 16.79

1. RR intervals
2. Difference between consecutive RR intervals.
3. Mean

Heart Rate Variability (HRV)

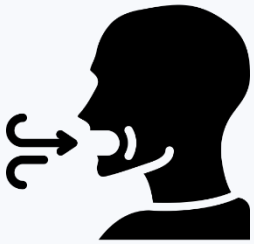
Significance

Stress



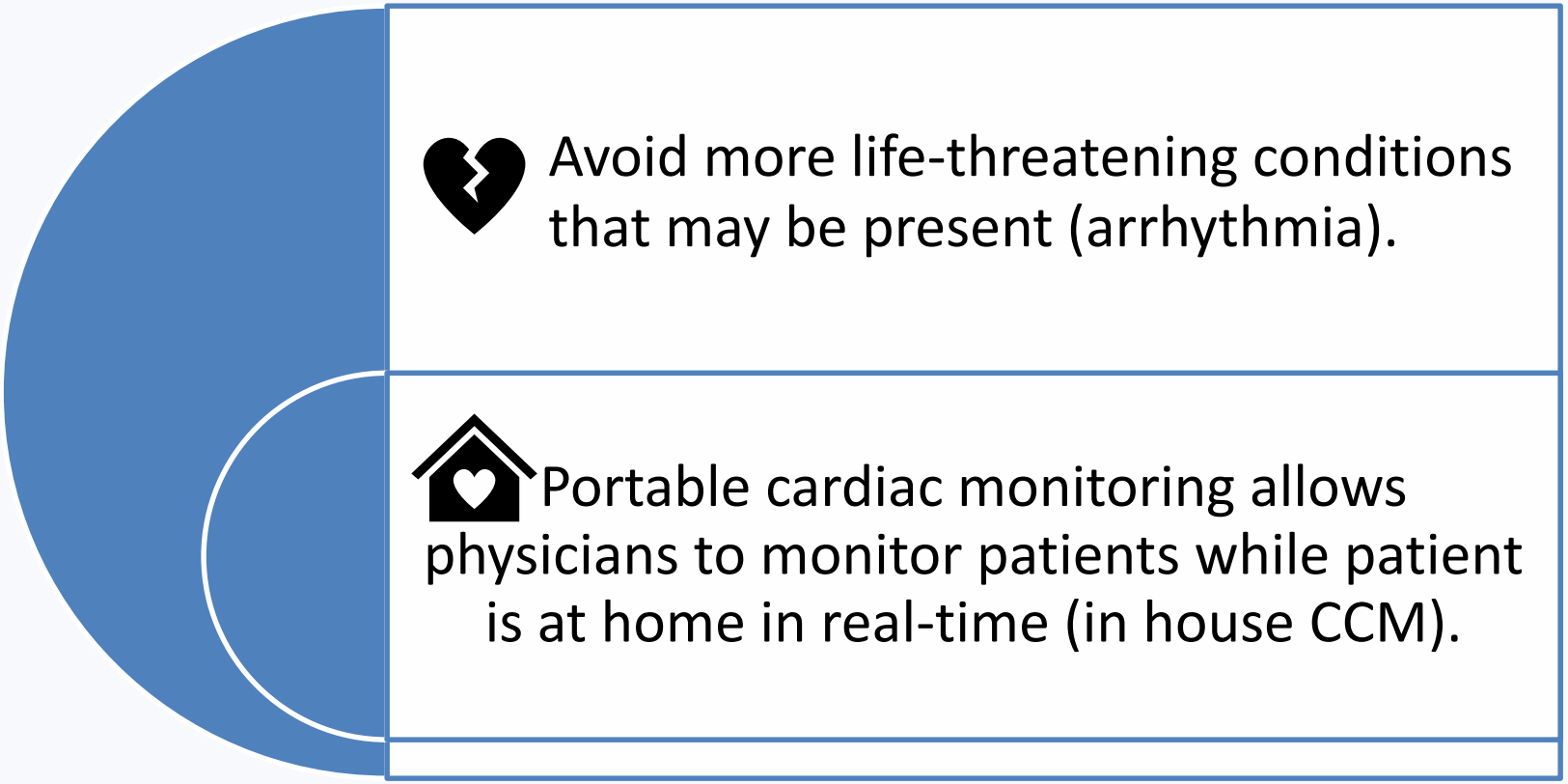
Hormones

Physical Activity
& Fitness



Breathing

Why is Cardiorespiratory (CR) Monitoring important?



Multiple Start-Ups

OCTAGOSHealth

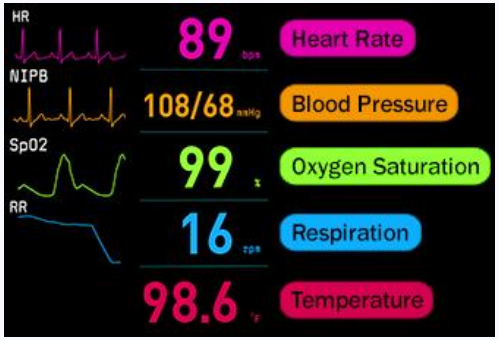
AliveCor®

iRhythm™

These start-ups emerged as a consequence of the current pandemic as patients with heart conditions are particularly vulnerable to COVID-19.

Importance of CR Monitoring in the ICU

Most basic monitors show:



In critical care, daily monitoring is essential.

Interest: Temperature monitoring

Different body sites, different temperature

Recommended in ICU: Urinary, esophageal or nasopharyngeal

Function and relationship with respiratory and CV system

Used in ambulances, emergency departments, ITU, neonatal ICU, etc. [1]

Monitoring of patient state or condition [1]

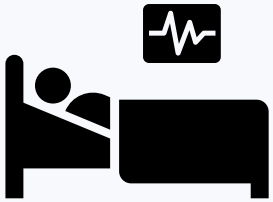
Identification/Diagnosis of underlying diseases such as arrhythmia, apnea and hypoxemia

Direct the decision of appropriate treatment [2]

Monitoring foetal heart and respiratory conditions during gestation and labour using Doppler ultrasound technology [1]

Monitoring the condition or assessing the cardiorespiratory ability of athletes during training

Warning medical staff of abnormalities in patient condition (e.g. parameters outside normal set values) through an alarm [2]



Current Methods and Devices

Companies making cardiorespiratory monitors [1,2]:

- Abbott
- GE Healthcare
- Hill-Rom
- Medtronic
- Philips Healthcare
- St. Jude Medical
- Boston Scientific
- Edwards Lifesciences
- Johnson & Johnson
- Getinge
- Terumo
- W.L.Gore & Associates
- Lepu Medical Technology

Types of Cardiorespiratory Monitors:

1. Bedside Monitors
2. Insertable Cardiac Monitor (ICM)
3. Wearable Cardiac Monitors (e.g. for sports): Apple Watch, Garmin, Fitbit, Samsung, etc.
4. Diagnostic ECG
5. Ambulatory Monitors

Features and Examples of Cardiorespiratory Monitors

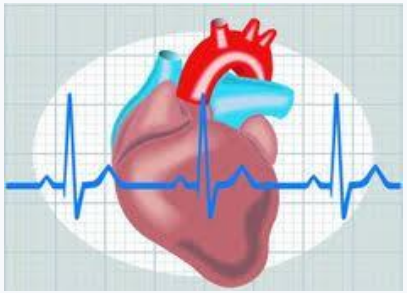
Parts: monitor or screen, cables, electrode patches, pressure transducers, pulmonary artery catheter, arterial blood saturation probe, blood pressure cuff, printer, alarms [1] and sometimes defibrillators [2]

Displays and records the electrical and pressure waveforms and parameters of the cardiorespiratory system of the patient such as heart rate, ECG, cardiovascular pressures, cardiac output, blood temperature and oxygen saturation levels [1]

Confirm Rx ICM (Abbott) [2]

CARESCAPE ONE Monitor (GE Healthcare) [3]

ECG: Clinical Importance



- Identify arrhythmias (irregular heartbeats)
- Determine overall health of heart before procedures (e.g. surgery)
- Determine health of heart after treatment for conditions such as a heart attack (myocardial infarction), or endocarditis (inflammation or infection of one or more heart valves)
- Used to get a baseline tracing of heart function during a physical exam to compare in with future ECGs

ECG: Morphology

Health care professionals look for different features in an ECG which can indicate different issues.
Differences in amplitude, frequency and shape are looked at.

Examples include:

- Changes in shape of P wave - mitral or pulmonary stenosis
- Changes in the interval between P and R wave – first degree atrioventricular block or pre-excitation
- Wide QRS complexes (>0.12s) - bundle branch block, hyperkalaemia, aberrant ventricular conduction.
- Loss of R wave amplitude – myocardial infarction

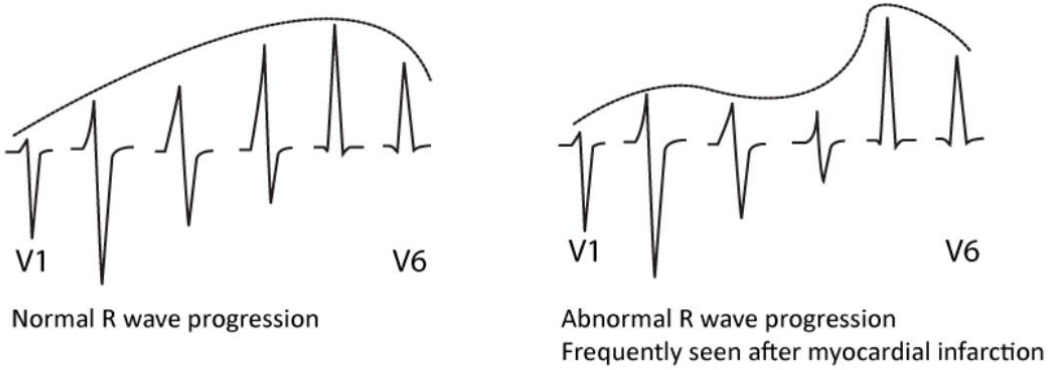
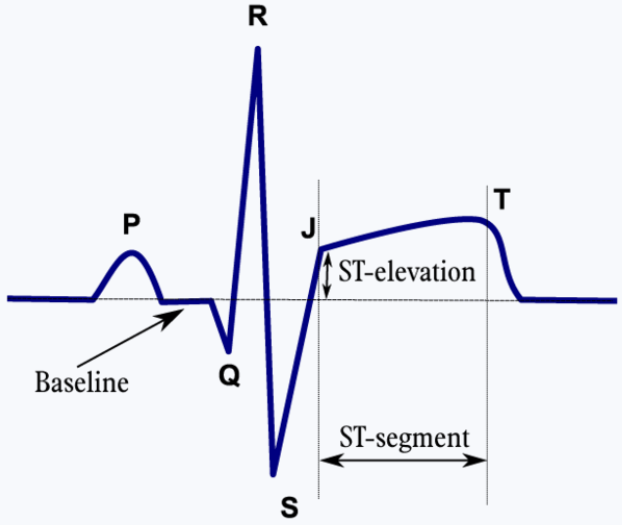


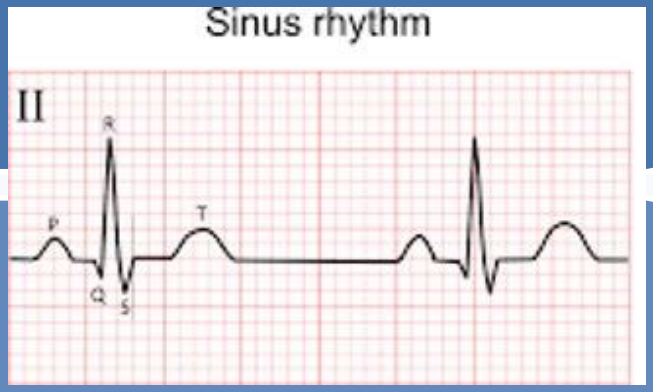
Figure 10. Normal and abnormal R-wave progression.

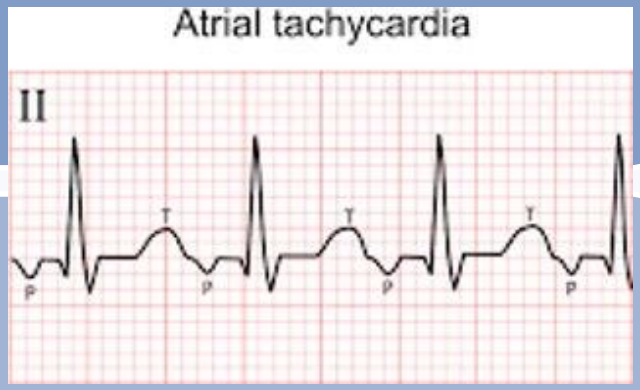


How to measure ST elevation?

ECG: Variations in Heart Rate

- Tachycardia
- Atrial Fibrillation
- Bradycardia
- And many more...





Thanks for listening!

Questions?