

Smart Wearable Devices

in telemedicine and healthcare

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How technology
could impact
public health and
nation's welfare?

The Heart



Some facts



HR - heart rate

HF - heart failure

HRV - HR variability

AF - atrial fibrillation

ECG - electrocardiography

- **HR** measurements predict diseases
 - Are indicators of high risk and predictor of HF
 - HRV is linked with adverse cardiovascular effects
 - Single lead ECG diagnose AF
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Wearables in cardiovascular care

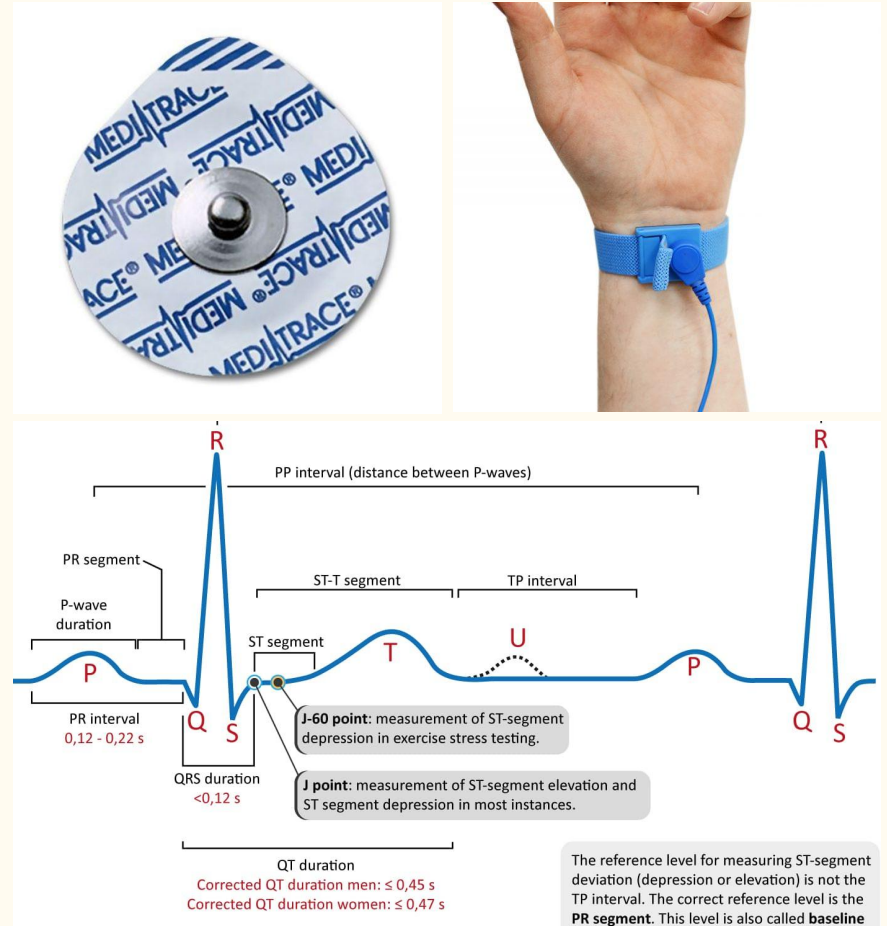
*MVPA - moderate to vigorous
physical activity*

*BCT - behaviour change
techniques*

- Help risk assessment
 - Empower lifestyle intervention
 - MVPA equals lower mortality
 - BCT changes outcome in hypertension, diabetes and coronary heart disease
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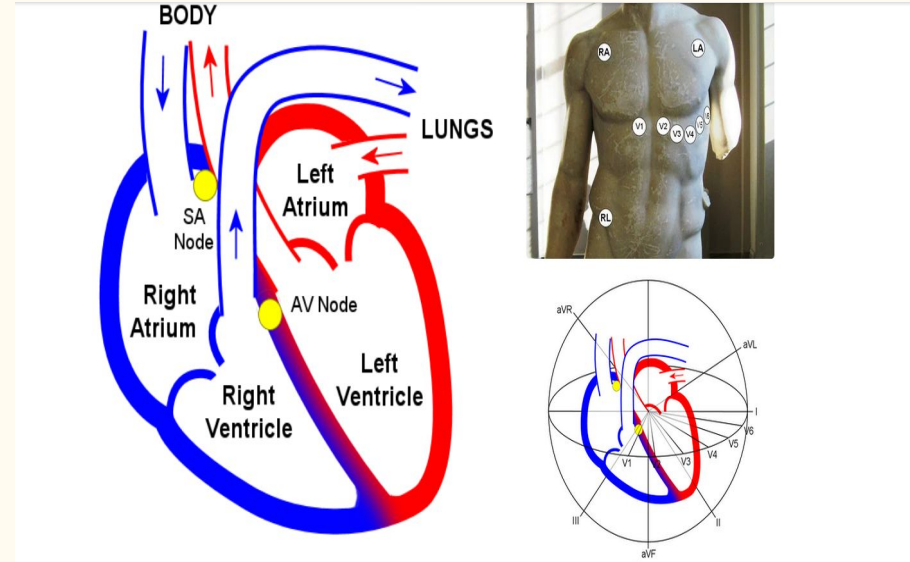
Procedure

1. Two ECG stickers are placed on the chest or arms
2. Oximeter wristband is placed on the left hand
3. ECG Device is paired either via bluetooth with phone or via wireless home network
4. Monitoring accounts for MVPA via 3-axis accelerometer



Sensors and impulses

1. Sinoatrial node (SA node) acts as an oscillator generating a pulse every second
2. AV node delays the pulse (by 120-200mS) then sends it to the muscles of the ventricles.
3. Different electrodes are like looking towards the centre of the heart from different directions
4. ECG records the action potentials of the different muscles.



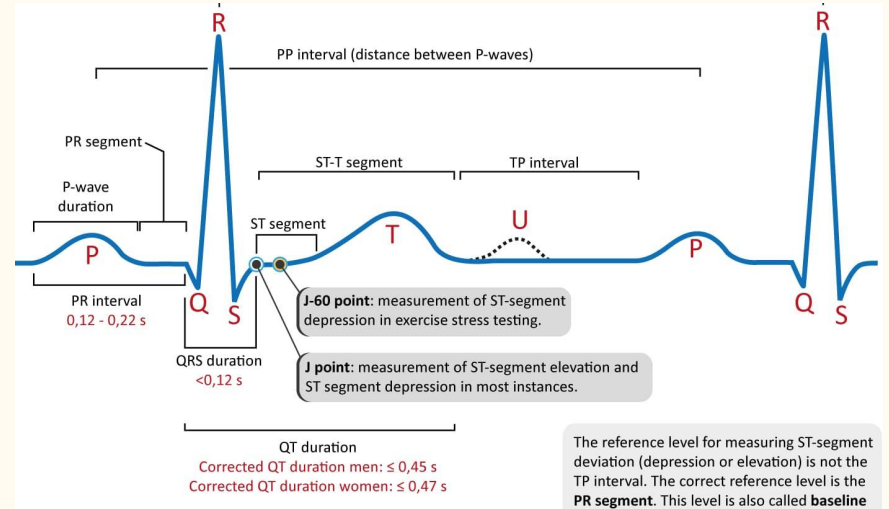
Muscle cell conduction is 0.3–0.4 m/s.

Purkinje fiber conduction is 2–3 m/s.

Normal neuron conduction is 70-120 m/s.

ECG info

1. P wave - atrial depolarisation. Atrial muscles starting to contract. PR interval - blood flows.
2. QRS - ventricular depolarisation. Ventricle muscles starting to contract.
3. T wave - ventricular repolarization. Ventricles relax.
4. Elevated ST - heart attack. Depressed ST - angina.



Bradycardia - pulse below average
Tachycardia - pulse above average
Higher HRV means better
Ectopic beats - 20% to 30%
different from preceding.

POINCARÉ Display

1. Plots the length of one interval (R to R) on the x-axis against the length of the next interval on the y-axis.
2. Normal Poincaré plot shows a diagonal band of points tapering to the bottom left. HRV decreases as heart rate increases.
3. Pauses in beats show as clouds in the top-middle and right middle.



Tachycardia - small group of dots near the lower left
Bradycardia - scattered group towards the top right
Arrhythmia - groups of dots away from main diagonal
Fibrillation - large cloud at the bottom left

Studies show

Wearable-measured physical activity to have an inverse dose-dependent relationship with all-cause mortality.

Wearable data also facilitate the application of real-time behavioural change techniques (BCTs) such as just-in-time adaptive interventions, designed to dynamically assess user needs.

Moderate-to-vigorous physical activity (MVPA), measured with the use of triaxial accelerometers, was associated with a lower mortality than light physical activity or sedentary behaviour.

Frequent wearable-generated HR measurements, such as resting average HR, HR recovery and HRV, can potentially be incorporated in cardiovascular risk scores given their correlation with cardiovascular disease.

Studies show

Hypertension screening in young adulthood is widely recommended to prevent cardiovascular disease.

ECG monitoring led to a higher rate of new AF diagnosis at 4 months and 1 year and was associated with the increased initiation of anticoagulation therapy and outpatient cardiology and primary care visits in patients without previously known AF.

Single-lead ECG can be similarly used to diagnose arrhythmias in patients with palpitations or presyncope.

HRV in patients with mildly symptomatic HF can help to identify individuals with limited benefit from cardiac resynchronization therapy.

Home-based form of cardiac rehabilitation was as effective as centre-based rehabilitation.

HR monitoring during sleep, rest and exercise:

Leads to better diagnosis

- Providing continuous HR, oximeter and activity data
- Does not disturb lifestyle or present inconvenience while wearing
- Easy to setup and use
- Could provide early cues of critical conditions

Facilitates recovery

- Compares HRV over similar periods of exercise or stress
- Correlated HR/oximeter data as indicator for lung recovery
- Prompts users for activity and lifestyle changes via different media and incentives
- BCT techniques empower small gradual changes

What if the
device does one
other thing as
well?

The sleep

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Some facts

REM - rapid eye movement

EEG - electroencephalogram

- Sleep affects physical and mental health
 - Sleep stages include REM and NON-REM sleep
 - REM is critical for brain development and detox
 - And also is the stage of dreams
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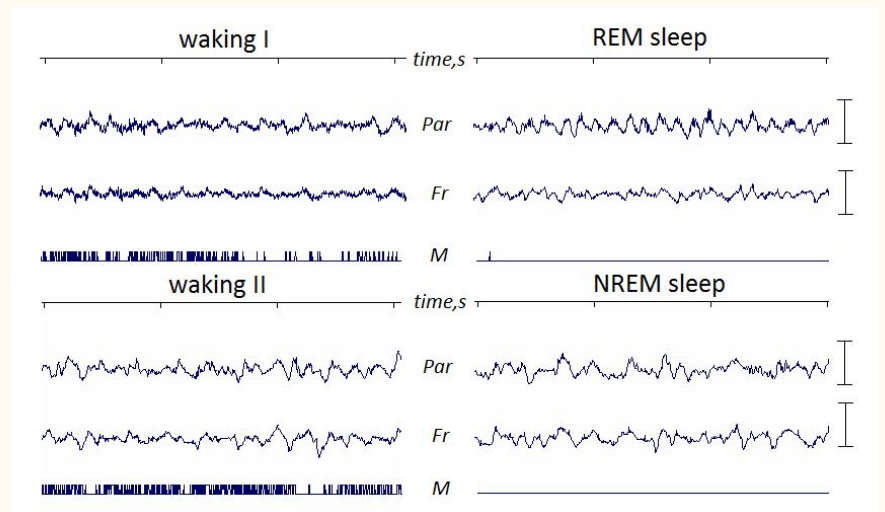
Some facts

apnea - temporary cessation of breathing during sleep

- Increases risk of heart failure
 - Causes higher cholesterol
 - Fatigue and mood swings
 - Could last up to a minute
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Procedure

1. Two EEG stickers are placed on both temples
2. Oximeter wristband is placed on the left hand
3. EEG Device is paired via bluetooth with phone
4. Phone monitors oxygen levels and REM via eye muscle contractions
5. If critical conditions occur, phone alarms via vibration or sound



Monitoring sleep

Improves life quality

- Providing continuous sleep stages data
- Everyday stress monitor
- Gives better guidance for relaxation
- Could help in understanding swinging moods and improve self-reflexion

Avoids oxygen deprivation

- Gentle sounds or vibrations do not necessarily interrupt sleep, but incite you to change position
- It is better to be underslept than oxygen-deprived
- Allows for monitoring the outcome of other measures and techniques

Thank you.

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