Non-invasive detection of coronary artery disease using wearable vest with integrated phonocardiogram sensors

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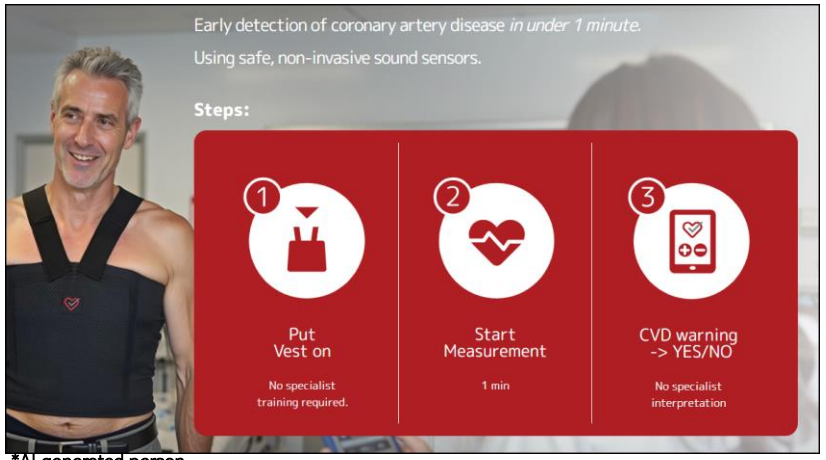
The Vision



*AI generated person

Background

- Traditional Heart auscultation – subjective person listening
- Coronary artery disease (CAD) – plaque accumulation in coronary arteries – decreases blood flow to heart[1]
- Occluded vessels cause turbulence – difficult to appreciate with traditional auscultation[1]
- Can digital phonocardiogram (PCG) signals, singly or in combination, with Machine Learning be useful in detecting CAD?

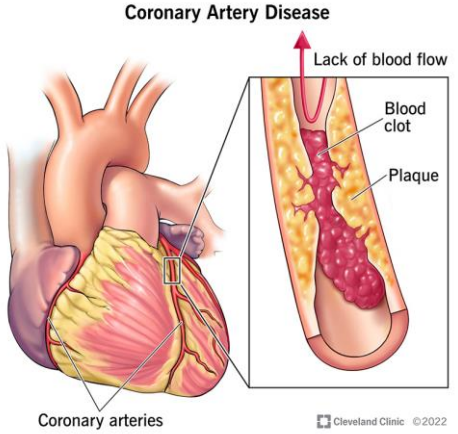


Fig 1: CAD depiction[2].

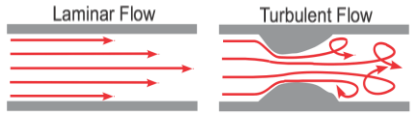


Fig 2: Laminar and Turbulent Flow[3].

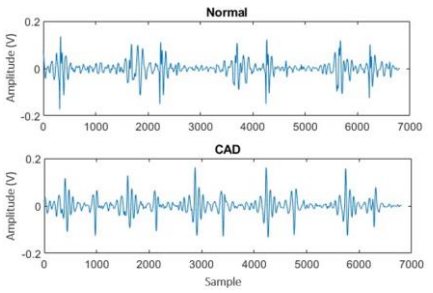


Fig 3: Normal and CAD PCG signal.

Methods

- A wearable vest embedded with 7 PCG sensors, - 6 front and 1 back- collects heart sounds.
- Subjects were fitted with vest and seated– measurements made in typical "noisy" clinical ward
- 10-second breath-held signals acquired.
- Signal Processing and Machine Learning applied post data collection

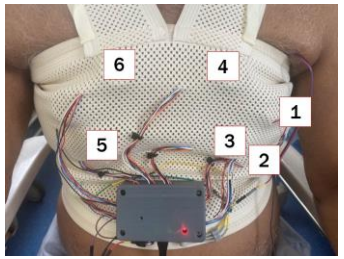


Fig 4: Left – Vest fitted on subject. Right – Signal Acquisition

Database

40 CAD	40 Normal
Age: 59.73 (8.02)	Age: 49 (18.8)
BMI: 24.62 (4.10)	BMI: 23.92 (3.03)

Demographics - Mean (std)

Machine Learning Model

- Linear frequency cepstral coefficients (LFCC) features – Support Vector Machine (SVM) classifier
- 5-fold cross validation - training and testings sets were mutually exclusive
- Metadata – BMI, blood pressure, left ventricular ejection fraction, hypertension, type II diabetes – inputs to SVM, and predictive probabilities fused with LFCC feature predictions

Results

- A four-channel combination – 2,3,6 (front) + 7 (back) gave highest performance

	Vest (PCG Only)	Vest + Metadata
Accuracy	80.44%	**82.00%**
Sensitivity	85.25%	85.13%
Specificity	75.62%	78.50%

Conclusion

- Digital PCG signals, with Machine Learning, can be useful in detecting CAD with Acc: 80.44% Sens: 85.25% Spec: 75.62%. Inclusion of metadata improves classification performance
- Utility of vest requires **no health/medical training** – Output is Binary – no **specialist interpretation** – potential for **community screening**
- Potential use for **pre-operative assessment** to identity CVD – can reduce cardiac complications

References

[1] Thomas JL, Winther S, Wilson RF, Bøttcher M. A novel approach to diagnosing coronary artery disease: acoustic detection of coronary turbulence. The international journal of cardiovascular imaging. 2017;33:129-36.
[2] Retrieved from https://my.clevelandclinic.org/health/diseases/16898-coronary-artery-disease
[3] Retrieved from https://cvphysiology.com/hemodynamics/h007

Fortis

Curtin University