Noninvasive Detection of Coronary Artery Disease Using Resting Phase Signals and Advanced Machine Learning

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Disclosure Statement of Financial Interest

Within the past 12 months, I or my spouse/partner have had a financial interest/arrangement or affiliation with the organization(s) listed below.

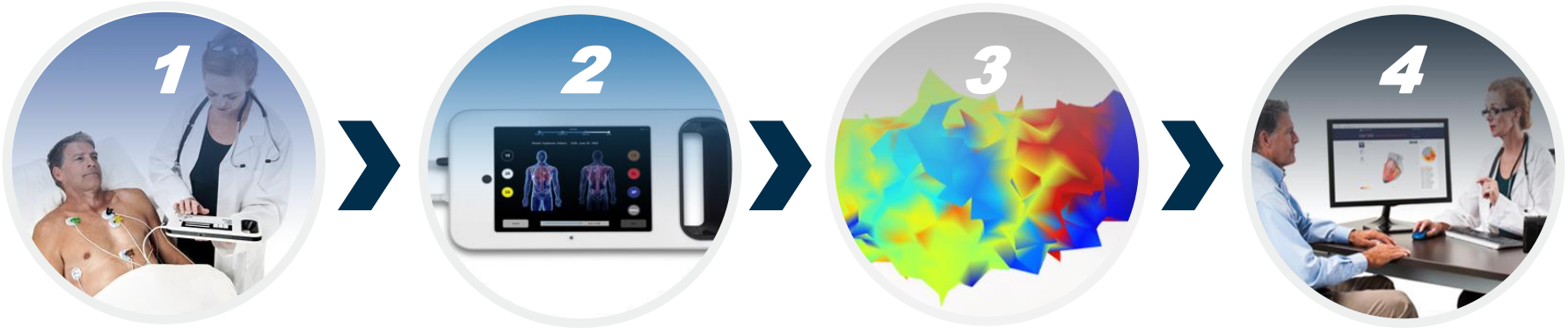
Affiliation/Financial Relationship
- None

Company
- None

Background

- *Artificial intelligence (AI)* **techniques are increasingly being applied to cardiovascular (CV) medicine, yielding diagnostic tools that may significantly enhance the care of cardiac patients**
- *cardiac Phase Space Tomography Analysis (cPSTA)* **is a novel technology that employs machine learning to assess the presence of significant coronary artery disease (CAD)**

Utilization of the *cardiac* Phase Space Tomography Analysis (*c*PSTA) System



*c*PSTA System Scan

The phase signals emitted by the heart are scanned while the patient is lying down

Data Transfer

The patient's data is automatically transferred to the cloud using Wi-Fi or cellular data connection

Cloud Computing

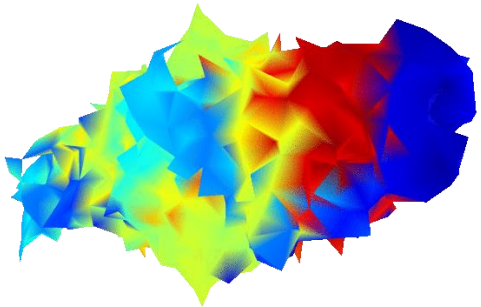
Advanced mathematics and machine-learned algorithms transform and analyze the data

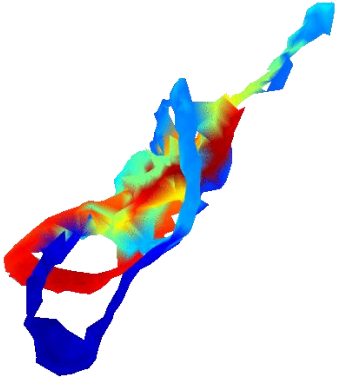
Physician Portal

Imaging results from the scan are available in a secured web portal for interpretation

Phase Space Tomography

Solid Appearing
Uniform in Nature





Contains Arcs
Angulation in Space

CAD-

CAD+

Stage I of the Coronary Artery Disease Learning and Algorithm Development (CADLAD) Trial

CADLAD is an ongoing prospective, multicenter, non-significant risk study sponsored by Analytics 4 Life designed to:

1

Develop machine-learned algorithms to assess the presence of CAD (defined as one or more ≥ 70% stenosis, or fractional flow reserve < 0.80)

2

Test the accuracy of these algorithms prospectively in a verification cohort

CADLAD Study Locations

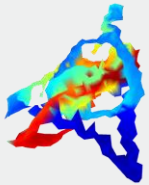
Methods
Stage I of the CADLAD Trial

Learn

Gold Standard
Coronary Angiogram

+

Paired Data
(Clinical & Phase Signal)



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Mathematical feature extraction

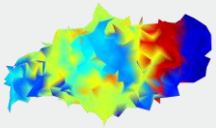
Machine Learning
(genetic algorithms, neural networks)

=

Algorithms
Formulae embedded into ***cPSTA System***

Verify

Naïve Phase Signal Data



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Algorithms
Formulae embedded into ***cPSTA System***

=

cPSTA Result

VS.

Coronary Angiogram Result

The Stage I Cohort

606 phase signals were obtained from subjects at rest, just prior to angiography

Angiographic results were paired with phase signal data

A training set of 512 subjects were used for machine learning

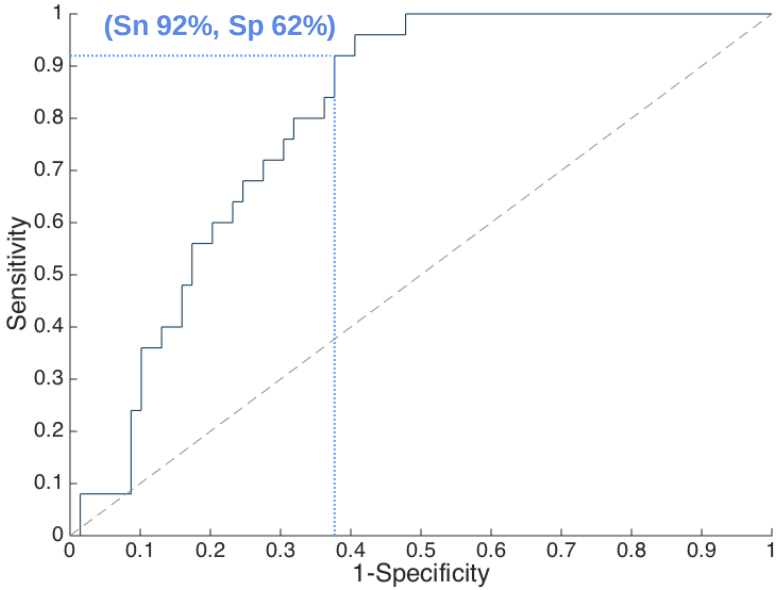
A verification set of 94 subjects was reserved for blind testing

Demographics of Population

Characteristics	Development (n=512)	Test (n=94)	p-value
Mean Age - Years (Range)	61.5 ± 10.7	59.0 ± 9.8	0.04
Male (%)	60.2%	69.1%	NS
Female (%)	39.8%	30.9%	NS
Mean BMI (Range)	31.3 ± 7.0	32.5 ± 7.6	NS
Diabetes Mellitus (%)	31.4%	35.1%	NS
Hypertension (%)	72.9%	75.5%	NS
Hypercholesterolemia/Hyperlipidemia (%)	71.3%	70.2%	NS
CAD Negative (%)	69.1%	73.4%	NS
CAD Positive (%)	30.9%	26.6%	NS

All comparisons of p-values were greater than 0.05 except AGE which was p=0.04

AUC-ROC Curve for *c*PSTA Assessment of CAD



CADLAD Stage I	
Number of subjects (total signals)	606
Number of subjects for ML Training Cohort	512
Number of subjects in Validation Cohort	94
AUC-ROC Curve	0.80

Results
CADLAD Stage I

Test	Sensitivity Range	Specificity Range
CADLAD (n=94)	**92% (CI=74% to 100%)**	**62% (CI=51% to 74%)**
Exercise SPECT[1]	73 to 92%	63 to 87%
Exercise ECG[1]	45 to 50%	85 to 90%

**** Negative Predictive Value for CADLAD was 96% (CI=85% to 100%)***

[1] *Eur Heart J, 2013. 34(38): p. 2949-3003*

Conclusions

The findings of Stage I of the CADLAD trial demonstrate:

- Features extracted from phase signals can be employed in machine learning to develop final mathematical predictors that assess the presence of significant CAD
- Performance of the *c*PSTA is comparable to the most commonly employed functional test of MPI
- Acquisition of phase signals:
  - Requires no ionizing radiation or contrast
  - Requires no physiologic or pharmacologic stress
  - Requires minimal patient time
  - No safety issues were observed (no AEs in 606 procedures)
- The *c*PSTA System holds promise for value-based healthcare

Thank You