Marc Bisnaire, founder

Cardio-Phoenix™

Cardio-HART ™

"CHART"

A non-invasive, AI-powered, cardiac-diagnostic service
for early detection of CVD onset,
heart failure and heart valve diseases,
for use in Primary care & telehealth settings.

"CHART provides clinical indications of cardiac status that are not only of diagnostic interest but also guides the practitioner in deciding whether to refer the patient to the cardiologist,

and

provides the cardiologist with relevant information to guide clinical decisions about testing and treatment."

1. Primary Care is the main point of contact with patients, where heart disease is 1st suspected, but all too often goes unnoticed, sometimes for years.

2. ECG is the only device currently allowed for use in Primary Care, but

3. ECG has serious limitations, it is able to detect only **44%** of all common cardiac conditions, and worse... ECG cannot detect any life-threatening diseases such as heart failure & valve diseases that are typically only diagnosable by Echocardiology.

4. 98.9% of all ECG's done in Primary Care detect nothing; results = high # FN.

5. As such, any opportunity for *early detection of CVD onset*, is missed.

6. Also, ECG does not provide GPs with sufficient diagnostic data to help guide them in whether to send a patient to cardiology, or not; results = high # FP.

7. Consequently, Cardiologists must deal with a large number of healthy patients (TP) in their waiting room, bloating waiting lists, incurring unnecessary costly testing.

In Primary Care, the most critical UMNs are:

1. Early Detection of CVD onset (NHS 1st priority in LTP)

2. Detection of the 14 most prevalent ECHO diseases not detected by ECG, the two most critical being:

   a. Heart failure, both preserved and decreased (EF)

   b. Heart Valve diseases (AS, MS, AR, MR, TR)

Compounding the severity of the UMN, the lack of a suitable diagnostic device specifically for use in Primary Care settings. (W.H.O., 2019)

Cardio-Phoenix™

Breakthrough Technology to detect, in Primary Care:

- **Heart Failure** (HF): HFpEF, HFmdEF, and HFdEF:
  - consumes 2% of NHS healthcare budget

- **Heart Valve Diseases:** AS, MS, AR, MR, TR...
  - consumes 1.5% of NHS healthcare budget

- **Early onset of CVD**
  - Main goal of NHS Long Term Plan

Significantly, CHART meets the critical UMN's for Primary Care.

Cardio-Phoenix™

- Cardio-HART™, "CHART", combines in a single device the functionality of:

    1) a Standard 12-Lead ECG, plus

    2) an Echocardiograph, plus

    3) high definition Auscultation.

"ECG + ECHO + Auscultation"

- Combined, CHART can detect **95%** of all common heart diseases.

- Compare that to ECG, which is limited to only **44%**.

- Most significantly however is that CHART does this in Primary Care!

Cardio-**Phoenix**™

More specifically, this combined functionality means it can detect:

o 14 Significant Heart Diseases (<u>Echo Findings</u>): typically only diagnosable by Echocardiography, including:

> o **LVH, LVE, LVEF, RVE, RAE, LAE, AS, MS, RVS, DDIR, MR, AR, TR w/o Pulm. Hypertension, and TR w/ Pulm. Hypertension**

o All Common <u>ECG findings</u>, including:

> ▪ **MI, LVH, RVH, AE, ST-Deviations, AF, AFl, Rhythms, Long PR, QRS intervals, Bundle Branch Block (3), LAFB,** + 160 ECG diagnostic parameters and measurements.

o and Phonocardiography (<u>PCG) findings</u>, including:

> ▪ **Murmurs, Systolic** and **diastolic, S1, S2, S3, & S4** (heart sounds)**, EMAT, PEP, SPI, LVET, S1-Wide,** and many more...

Cardio-Phoenix™

Proven Performance...

- Clinically meaningful Sensitivity and Specificity make it reliable, accurate and Robust.

- Trustworthy PPV and NPV values.

- Credible confidence levels.

- Together they result in higher GP diagnostic effectiveness.

- HART-Findings are the same diseases as ECHO-findings, but done with bio-signals, not images.
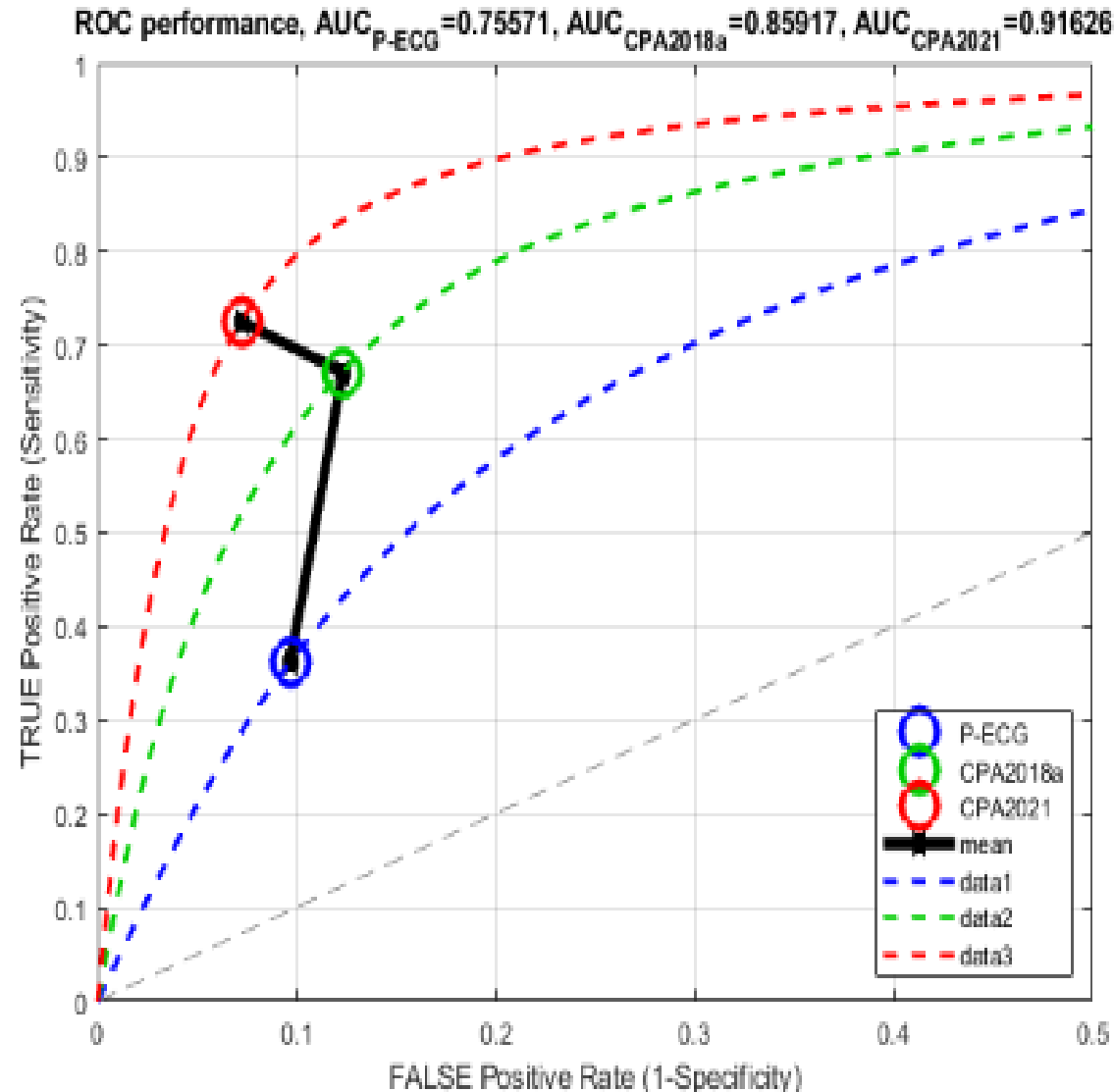
HART Finding	Performance with confidence interval (95% CI)	
LVH	SE = 71.5% (95% CI: 69.6-73.4) SP = 89.2% (95% CI: 88.5-89.9)	PPV = 67.1% (95% CI: 65.2-69) NPV = 91% (95% CI: 90.4-91.7)
DCM	SE = 75.9% (95% CI: 73.7-78) SP = 95.5% (95% CI: 95-95.9)	PPV = 76.2% (95% CI: 74-78.3) NPV = 95.4% (95% CI: 95-95.9)
RVE	SE = 60.6% (95% CI: 56.4-64.6) SP = 96.8% (95% CI: 96.4-97.1)	PPV = 53.8% (95% CI: 49.8-57.7) NPV = 97.5% (95% CI: 97.2-97.8)
LAE	SE = 88.9% (95% CI: 86.8-90.7) SP = 95.5% (95% CI: 95.1-96)	PPV = 70.8% (95% CI: 68.3-73.3) NPV = 98.6% (95% CI: 98.3-98.8)
RAE	SE = 73.2% (95% CI: 69.7-76.5) SP = 94.5% (95% CI: 94.1-95)	PPV = 50.7% (95% CI: 47.6-53.8) NPV = 97.9% (95% CI: 97.5-98.2)
WMA	SE = 76% (95% CI: 73.2-78.6) SP = 91% (95% CI: 90.4-91.6)	PPV = 48.5% (95% CI: 46-51) NPV = 97.2% (95% CI: 96.8-97.5)
LVSD	SE = 81.6% (95% CI: 79.6-83.6) SP = 90.2% (95% CI: 89.5-90.8)	PPV = 60.1% (95% CI: 57.9-62.2) NPV = 96.4% (95% CI: 96-96.9)
LVDD	SE = 70.3% (95% CI: 68.7-71.9) SP = 84.5% (95% CI: 83.6-85.3)	PPV = 69.1% (95% CI: 67.5-70.7) NPV = 85.2% (95% CI: 84.3-86.1)
AS	SE = 84% (95% CI: 80.6-87) SP = 98.2% (95% CI: 97.9-98.4)	PPV = 72.8% (95% CI: 69.1-76.3) NPV = 99.1% (95% CI: 98.8-99.2)
MS	SE = 60.6% (95% CI: 53.3-67.7) SP = 98.5% (95% CI: 98.3-98.8)	PPV = 45.2% (95% CI: 39-51.6) NPV = 99.2% (95% CI: 99-99.4)
AR	SE = 70.6% (95% CI: 68.5-72.7) SP = 85.6% (95% CI: 84.8-86.3)	PPV = 52.5% (95% CI: 50.5-54.5) NPV = 92.8% (95% CI: 92.2-93.4)
MR	SE = 65.7% (95% CI: 63.5-67.8) SP = 91.3% (95% CI: 90.6-91.9)	PPV = 65.3% (95% CI: 63.2-67.4) NPV = 91.4% (95% CI: 90.7-92)
TR	SE = 64.3% (95% CI: 61.8-66.8) SP = 93.3% (95% CI: 92.7-93.8)	PPV = 62.4% (95% CI: 59.9-64.9) NPV = 93.8% (95% CI: 93.3-94.3)
PH	SE = 70% (95% CI: 65.9-74) SP = 97.5% (95% CI: 97.2-97.8)	PPV = 61.4% (95% CI: 57.4-65.4) NPV = 98.3% (95% CI: 98-98.6)

ROC performance, $AUC_{P-ECG}=0.75571$, $AUC_{CPA2018a}=0.85917$, $AUC_{CPA2021}=0.91626$

Cardio-Phoenix™   **ROC Performance...**

- P-ECG = State of the Art ECG algorithm used in many OEM devices. (blue dotted line)   **AUC = .757**
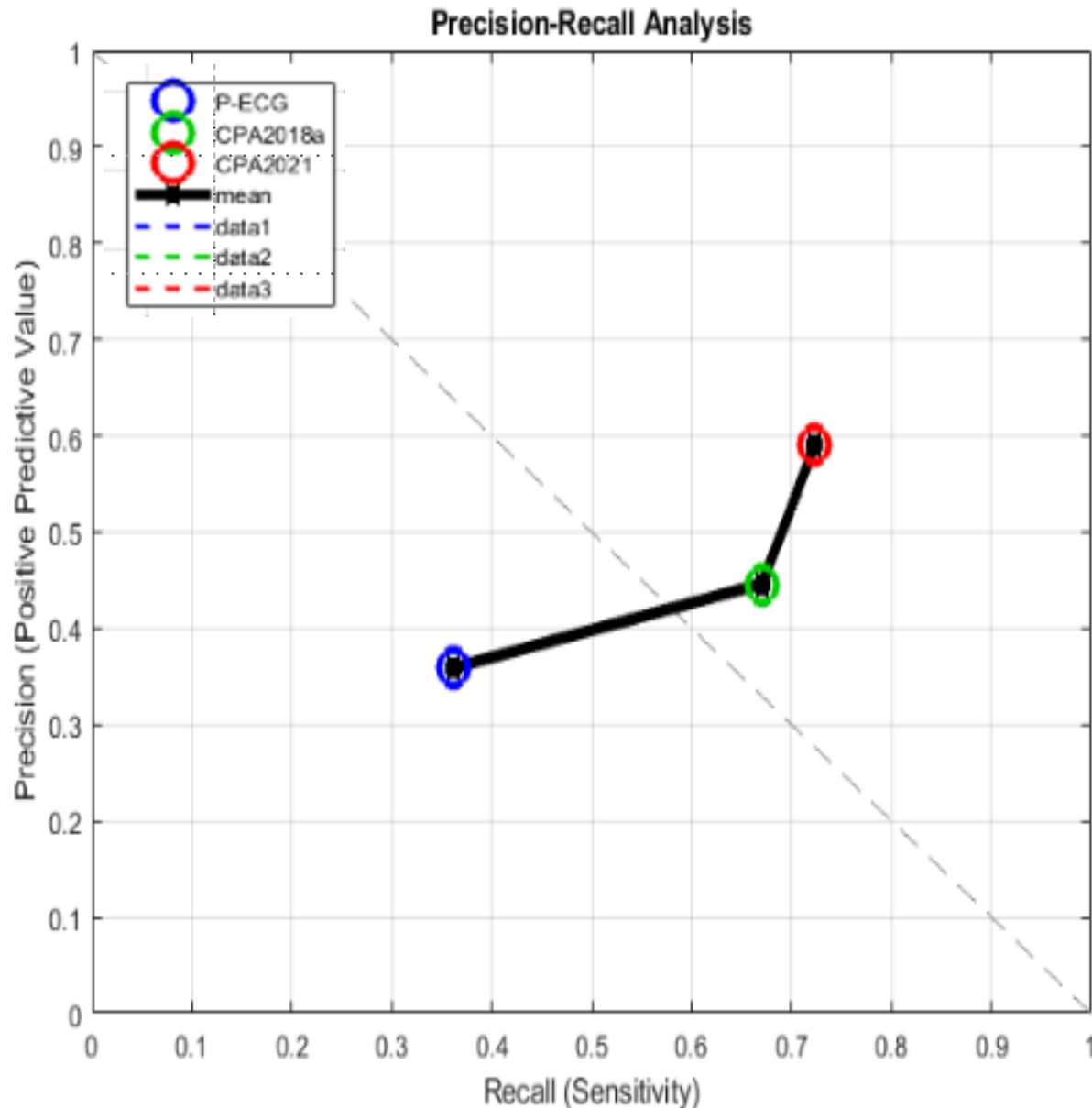- CPA2018 is 1st version.   **AUC = .859**
- CPA2021 is most recent vs.   **AUC = .916**

ROC performance figure clearly shows significant improvement in diagnostic capabilities over State of the Art ECG.

Both sensitivity and specificity are greatly improved.

Precision-Recall Analysis

o Precision-Recall analysis is used in imbalanced dataset settings, e.g. too many normals, as such ROC curve performance can be misleading, skewing the true measure of Specificity to Sensitivity.

o In imbalanced classification settings, Positive Predictive Value or PPV is a better measure of specificity to sensitivity.

o CHART's PPV to Sensitivity is greatly improved compared to ECG.

o Also, CHART 2021 shows a clinically significant PPV improvement over ECG.

Cardio-Phoenix™

Robust Predictive Powers, gives the Practitioner diagnostic certainty.

A patient predicted as <u>Negative or Normal</u> by HART Summary is:

- **NPV = 97.6%,** probability they really are "Normal", True Negative
- With a 20% probability it is Mild
- With only a 2.4% probability that they have an "Abnormality"
- Very important in Secondary care situations (reduces TN)

A patient predicted as <u>Positive or Abnormal</u> by HART Summary is:

- **PPV = 96.7%,** probability they really have an "Abnormality", True Positive
- With a 25% probability it is Mild
- With only a 3% probability that they are "Normal"
- Increases GP diagnostic effectiveness (reduces FP).

Prevalence of Moderate/Severe conditions at patients having LVIDd < threshold
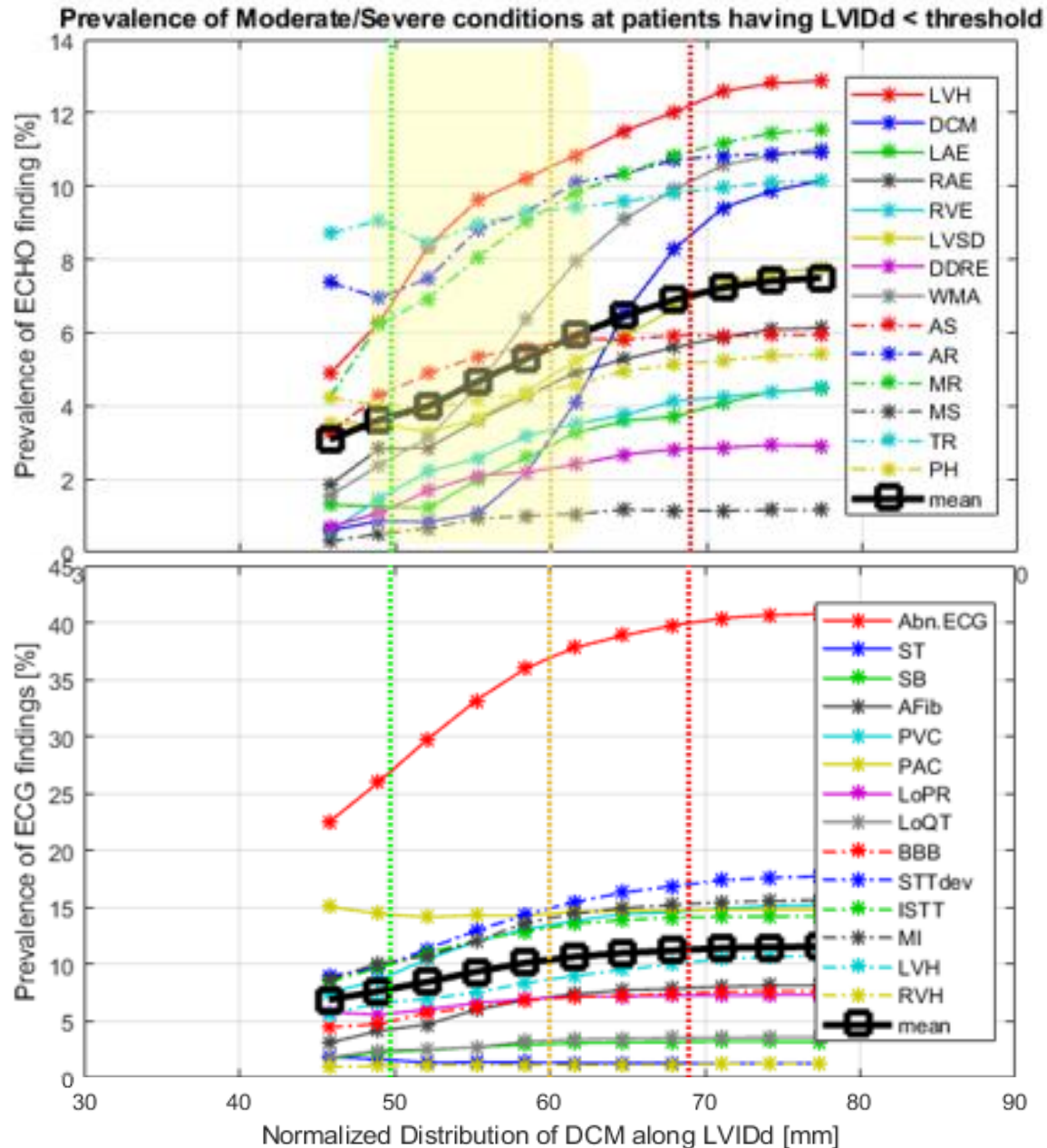
Comorbidities

o Ability to address Multiple diseases together, including comorbidities, in one examination, an advantage in clinical use.

o Detect early onset of comorbidities as they start to develop. Top figure shows that LVIDd progresses most during the Mild phase (yellow), but also other diseases start.

o Enhances ECG (bottom) sensitivity.

o Early detection (Mild) means preventing comorbidities from aggravating patient condition, stabilizing them for the longer term. Reduces costs. Better outcomes.

Cardio-Phoenix™

Patient General Data

Patient ID	"f15ede88-2084-4d59..."
DOB	1938-02-02
Age [year]	74
Gender	MALE
Race	Caucasian
BMI [kg/m^2]	22.99
BSA [m^2]	1.8
Height [cm]	172
Weight [kg]	68
CHART-BSI [m+1/5kg$^{0.27}$]	2.34
Hip Size [cm]	96.9387
Waist Size [cm]	111.221
Waist/hip ratio	1.01953
Sys. BP [mmHg]	131.276
Dia. BP [mmHg]	74.3655

HART Findings

LV Hypertrophy	ABNORMAL
Dilated Cardiomyopathy	Absent
RV Enlargement	Mild
LA Enlargement	Absent
RA Enlargement	Absent
LV Wall Motion	Absent
LV Systolic Function	Absent
Impaired Relaxation	Mild
AV Stenosis	ABNORMAL
MV Stenosis	Mild
AV Insufficiency	Absent
MV Insufficiency	Absent
TV Insufficiency	Absent
Pulm. Hypertension	Absent

Estimated LV EF %

Heart Failure	EF%	Systolic	Diastolic
Absent	EF>52%	Absent	Absent
HFpEF	EF>52%	Absent	Mild
HFmrEF	EF>40%	Mild	Mild/Abnormal
HFrEF	EF<40%	Abnormal	Abnormal

ECG Findings

Rhythm	Sinus
Prem. Vent. C. (PVC)	Prem. Vent. C. (PVC)
Prem. Atrial C. (PAC)	Absence
PR interval	Normal
QT interval	Normal
Axis Deviation	Rightward Axis
B. Branch Block	Absence
L. A. Fasc. Block	Absence
V. Hypertrophy Criteria	Absence
STT deviation	STT deviation
Ischemic ST-T	Consider Ischemia
Myocardial Infarction	Absence
ECG Signal Quality	Good
ECG Summary	ABNORMAL

PCG Findings

Systolic Murmur	Holo SM
Diastolic Murmur	Diastolic Murmur
Ejection Click	Absence
Opening Snap	Absence
3rd Sound	Absence
4th Sound	Absence
S1 Wide	Normal
S2 Wide	Normal
Wheeze	Absence
Artifact	Absence
PCG Signal Quality	Good
PCG Summary	ABNORMAL

MCG Findings

EMAT (Q-MitralClosure)	EMAT (Q-MitralClosure)
PEP - Pre Ejection	PEP - Pre Ejection
LVET - Vent. Ejection	Normal
SPI - Systolic Perf.	SPI - Systolic Perf.
MPI - Myocardial Perf.	Normal
MCG Signal Quality	Good
MCG Summary	ABNORMAL

Cardio-Phoenix™

Referral Recommendation

Refer Patient to Cardiologist?

DON'T
- No Action
- Watch
  - Watch 12m
  - Watch 6m
  - Watch 3m

SEND ☑
- Routine ☑
- Immediate
- Urgent

General Heart Health State

DON'T | SEND

Normal — ABNORMAL
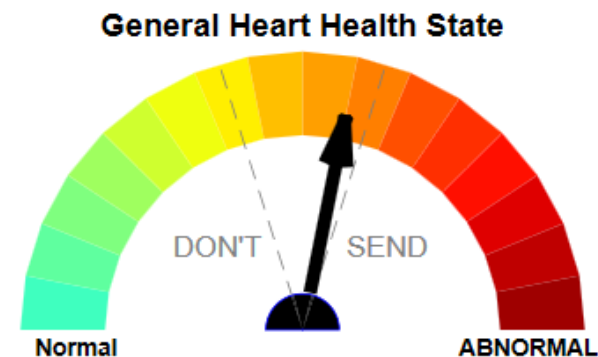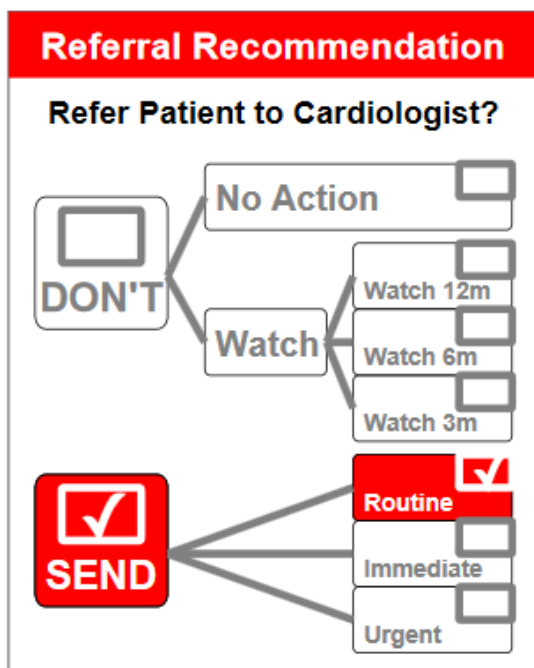
WARNING: CHART is for use by qualified clinicians in conjunction with the patient's clinical history, symptoms, physiology, and other diagnostic tests as might be available, as well as the clinician's professional judgment. They are offered on an advisory basis only and no treatment or other therapies should be initiated based solely on the indications produced by the CHART Program.
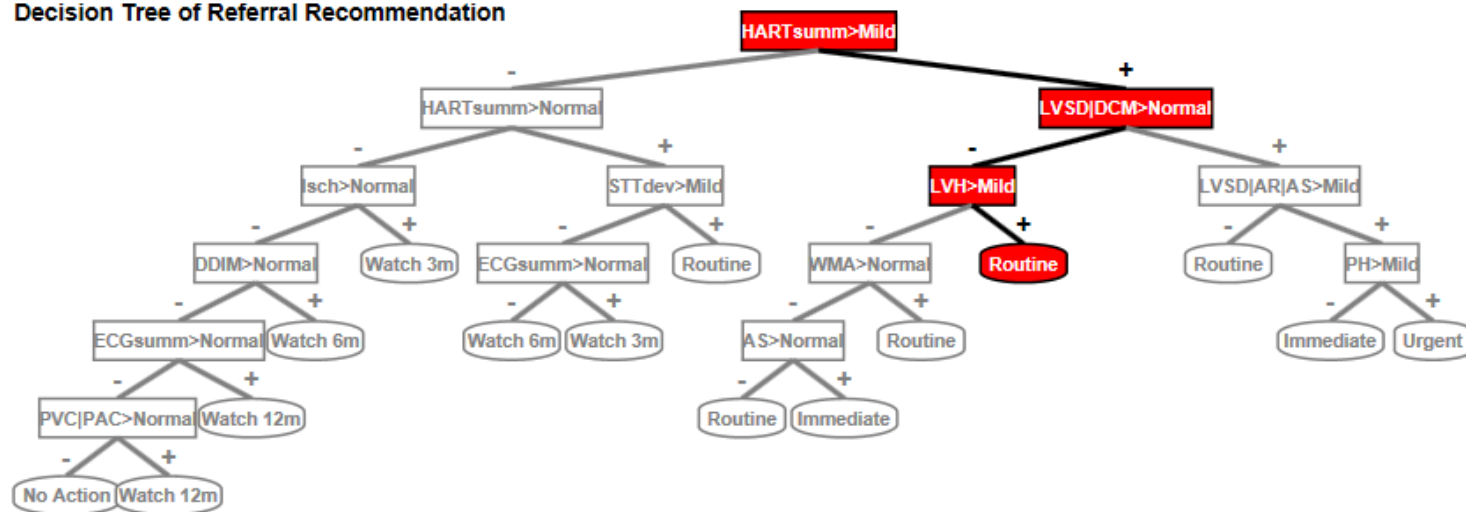
SUMMARY

Finding	Value
HART Summary	ABNORMAL
Heart Size	ABNORMAL
Heart Function	Normal
Heart Valves	ABNORMAL
Rhythm	Sinus
ECG Summary	ABNORMAL
PCG Summary	ABNORMAL
MCG Summary	ABNORMAL

WARNING: No breath-hold section in record!

WARNING: Patient data Blood Pressure Missing

WARNING:

Finding	Value	Condition
HARTsumm	: Abnormal	> Mild (+)
LVSD	: Normal	> Normal (-)
LVH	: Abnormal	> Mild (+)

Decision Tree of Referral Recommendation

Cardio-Phoenix™

Cardio-TriTest™ (CTT). An approved medical device for the non-invasive capture of 3 types of bio-signals, (Electrical, acoustic and physiological).

CHART Processing Software (CPS). A cloud-based (AWS), AI-powered, diagnostic assessment of bio-signals.

Clinical Management System (CMS), the clinic and patient management system that enables the operations of the system in the cloud. (not a medical device).

Back

Front

Cardio-Phoenix™

1. Cost-Efficient, and very affordable.

2. Non-invasive, with very low risk

3. Reduces unnecessary referrals to Cardiology, also confirms need for one.

4. Telehealth = better access for remote and isolated communities.

5. Improves "immediacy" of patient management decisions

6. Reduces wait-times for critical echocardiograph confirmation services,

7. Direct substitute for Standard 12 Lead ECG devices

8. Does not change the Standard of Care, slips into existing workflows.

9. Easy to use, a trained ECG Nurse can learn it less than 20 min.

10. Clinically proven to increase GP diagnostic effectiveness, ~250%.

Cardio-Phoenix™

How do the benefits of our innovation reach the patient?

We transform the medical device marketplace

to a diagnostic services marketplace.

Our innovative business model provides GP's with

breakthrough cardiac diagnostic services,

delivered as a lab-report, for a nominal lab-fee!

Cardio-Phoenix™

"This 1 device, does in 1 examination, what currently takes 2 different examinations, by 2 different devices, in 2 different levels of care."

"This level of simplicity is incredible!"

Tom Gordy,
CEO, medical device specialist
TAGG, Inc., Atlanta, GA

Visit https://cardiophoenix.com, register as a Clinic, then place your order.

Cardio-Phoenix™

Early detection of CVD onset

Ready Now

Marc Bisnaire,

CEO, Founder