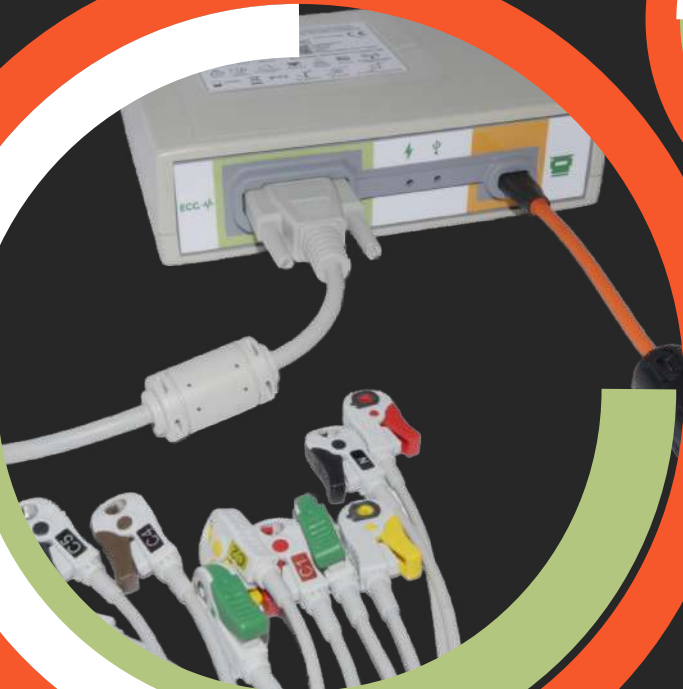# COMPARING REPORTS

Cardio-HART™
vs. ECG

Cardio-HART

CHART is a 21st century makeover of the 12 lead ECG that uses AI and novel bio-signals to augment and complement ECG and give it the diagnostic functionality and power of 3 different medical devices in one, including ECG, Phonocardiography, and Echocardiography.

Cardio-HART™ ("CHART™") is a breakthrough cardiac diagnostic for the early detection of Cardio-Vascular Disease [CVD], Heart Failure [HF], and all Heart Valves diseases [HVD].
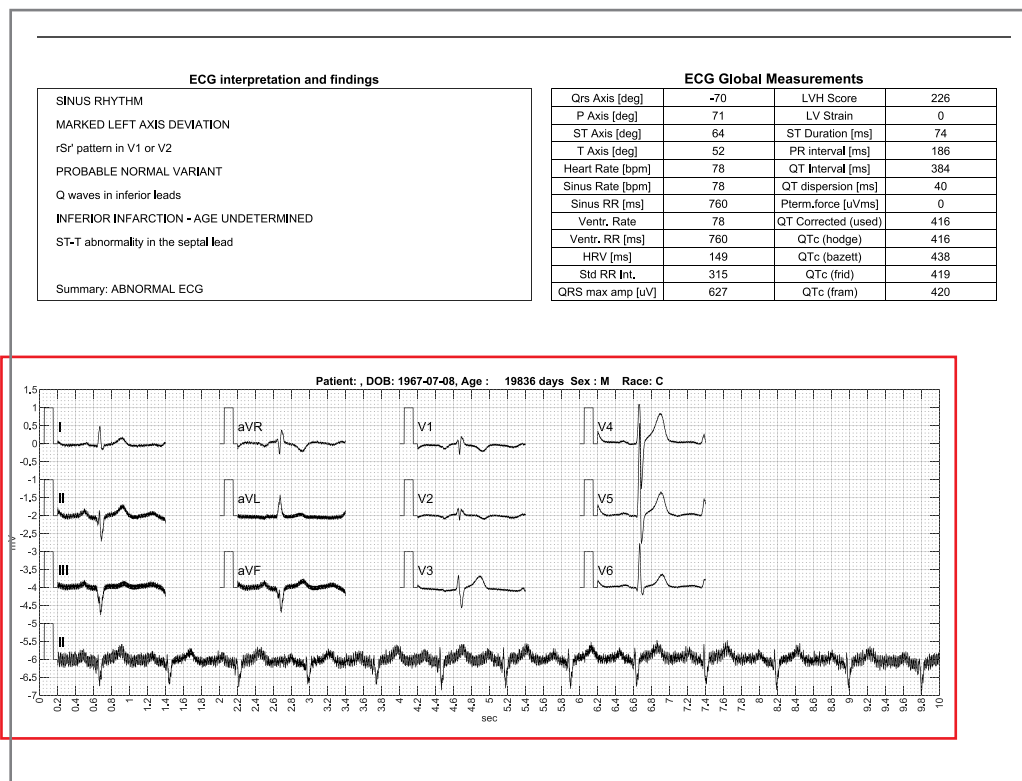
"This 1 device, does in 1 test, by 1 nurse, what now takes 2 devices, doing 2 tests, in 2 different levels of care, by 2 healthcare professionals!"
T. Gorden, CEO
Atlanta, Georgia

ECG vs. Cardio-HART™

Typical ECG report
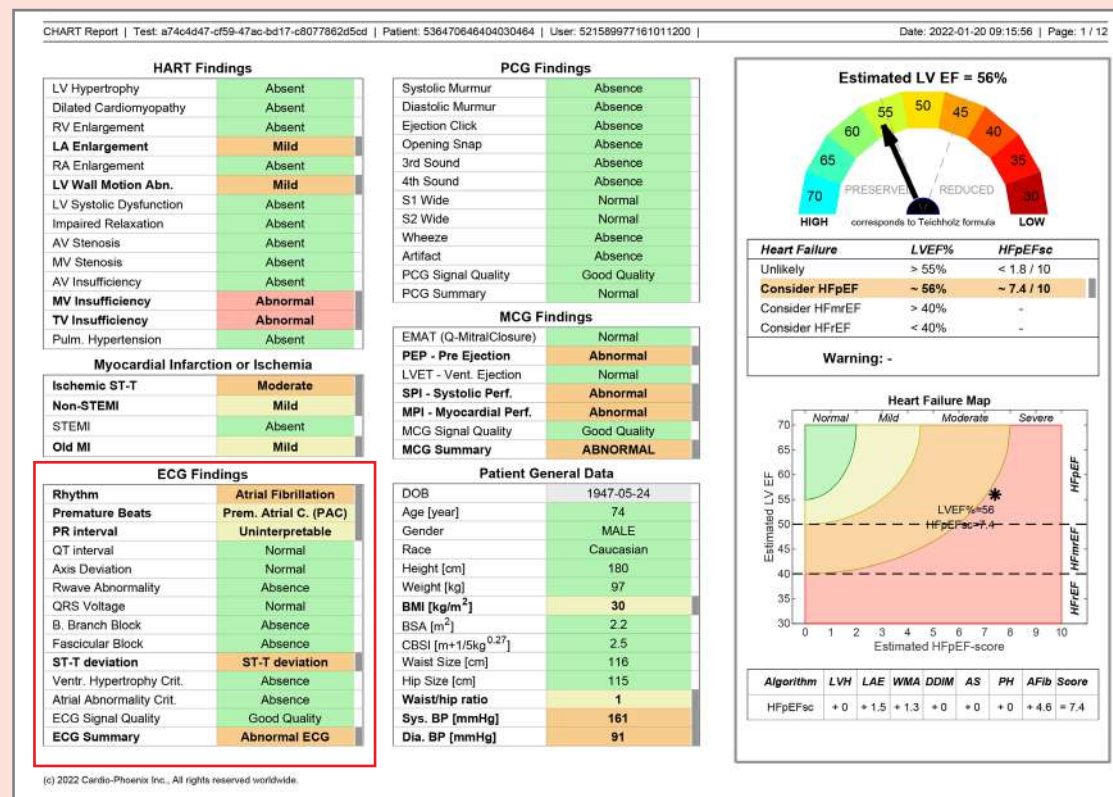
Typical CHART™ report page 1

ECG

Alphanumeric value
- Demographic information
  - Patient ID
  - Date
  - Ethnicity
- ECG parameter values
  - Ventricular rate
  - PR interval
  - QRS duration

- QT/QTc
- P-R-T axes
- Interpretation

Waveform data
- 12 lead waveform data
  - I,II, III
  - aVR, aVL, aVF
  - V1, V2, V3, V4, V5, V6

CHART™

CHART™ report consists of 9 pages.
Complete ECG report +

Myocardial Infarction or Ischemia - details
HART (Echo) Findings +
PCG Findings +
MCG Findings +
Heart Failure

and much more.

The difference between
Glasgow ECG and CPA ECG are:

- Colored interpretation of measurements
- Poincare plot
- HR plot
- severity information of MI
- more clear Non-STEMI
- better performance for some findings

44% ECG   Detect common heart diseases.   **CHART™ 95%**

ECG vs. Cardio-HART™

	CHART™	ECG
ELECTROCARDIOGRAPHY		
Rhythm	✓	✓
Premature Beats	✓	✓
PR interval	✓	✓
QT interval	✓	✓
Axis Deviation	✓	✓
Rwave Abnormality	✓	✓
QRS Voltage	✓	✓
Bundle branch block	✓	✓
Fascicular Block	✓	✓
ST-T deviation	✓	✓
Ventricular Hypertrophy Criteria	✓	✓
Atrial Abnormality Critical	✓	✓
ECG Signal Quality	✓	✓
Myocardial Infarction Critical	✓	✓
MYOCARDIAL INFARCTION		
Ischemic ST-T	✓	✗
Non-STEMI	✓	✗
STEMI	✓	✗
Old MI	✓	✗

Cardio-HART™- ECG report

The same as ECG
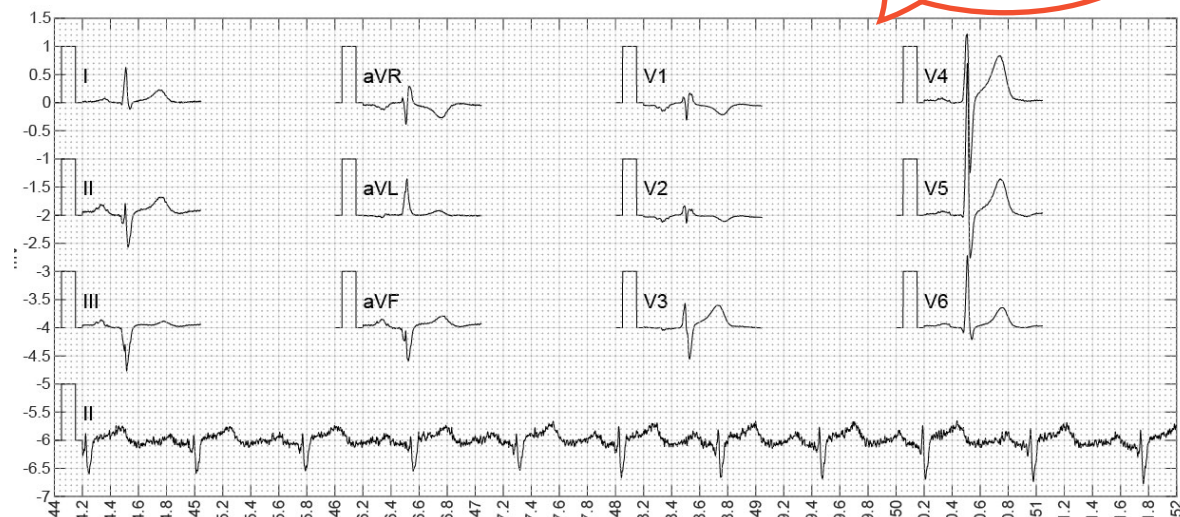
More details

The CHART™ ECG report plots a clear averaged ECG signals generated by an advanced signal processing.
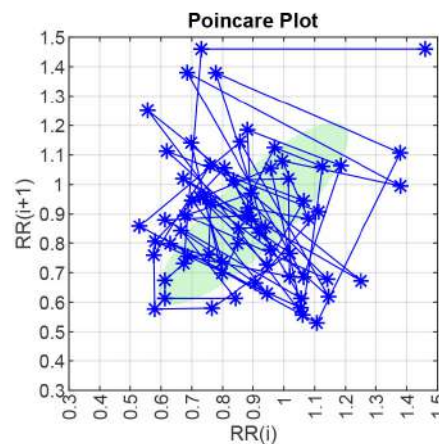
Pioncare Plot

The Poincare Plot illustrates the heart rhythms pattern in a compact way, where the various arrhythmia easily recognizable.

Heart Rate

The Heart Rate tachograph synchronously plots the instantaneous heart rate with breathing activity.

Cardio-HART™ - ECG report

ECG Findings

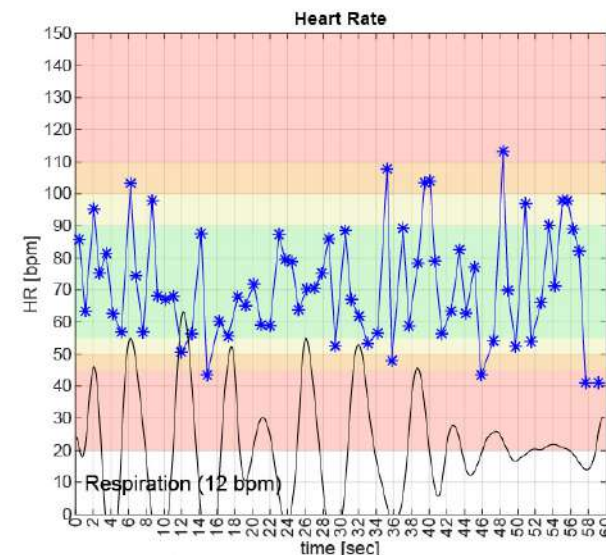| Rhythm	Atrial Fibrillation
Premature Beats	Prem. Atrial C. (PAC)
PR interval	Uninterpretable
QT interval	Normal
Axis Deviation	Normal
Rwave Abnormality	Absence
QRS Voltage	Normal
B. Branch Block	Absence
Fascicular Block	Absence
ST-T deviation	ST-T deviation
Ventr. Hypertrophy Crit.	Absence
Atrial Abnormality Crit.	Absence
ECG Signal Quality	Good Quality
ECG Summary	Abnormal ECG

Myocardial Infarction or Ischemia

Ischemic ST-T	Non-extensive
Non-STEMI	Borderline
STEMI	Absent
Old MI	Extensive

ECG Global Measurements

Measurement	Value
Heart Rate [bpm]	72
median RR [s]	0.86
RR std [ms]	223
RMSSD [ms]	305
PNN50 [%]	87
LF/HF (0.15Hz)	1.2
QRS axis [deg]	-29
PQ interval [ms]	304
PRc (Soliman) [ms]	304
P interval [ms]	116
P axis [deg]	-38
P term.force [mVms]	0.18
QT interval [ms]	370
QTc (fram)	392
QTc-CHART	372
JTc	298
QRS interval [ms]	94
VAT	42
ST interval [ms]	80
ST axis [deg]	-53
T axis [deg]	142
Rsum (V1:V6) [uV]	1366
Sok-Lyon [mV]	2.2
Cornell Volt [mV]	1.4
Lewis index [mV]	1.7
LVH Score	501
RVH Score	3.4

Virtual Scale

ECG Findings

The ECG finding table summarize the standard diagnostic findings in exhaustive mode (shows not only positive diagnoses).

Myocardial Infarction or Ischemia

The CHART™ provides a more detailed MI and ST-T interpretation providing estimation for type, severity and location.

The color in the location box represent the probability of abnormality, which suggest the severity of the infarction.
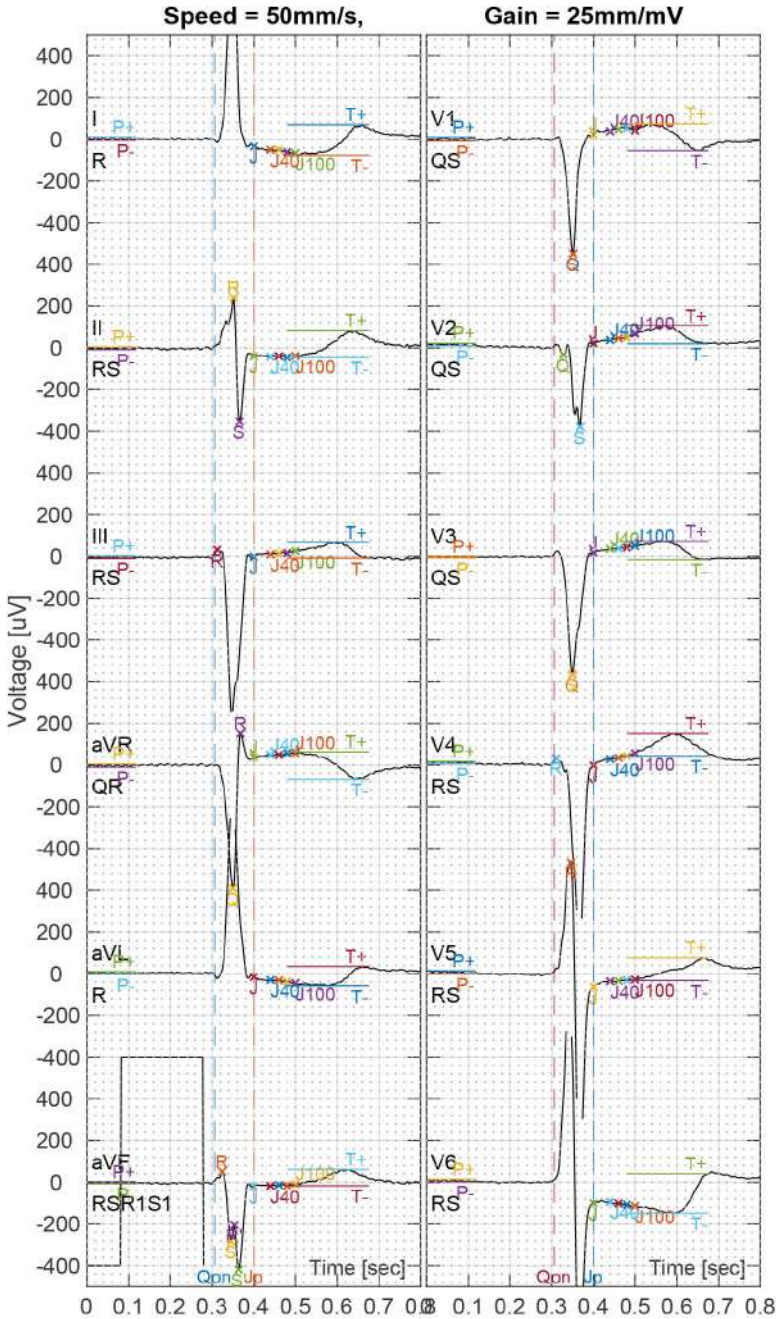
ECG Global Measurements

CHART™ publishes the most important global measurements for the ECG findings.

Virtual Scale

The virtual scale helps you see at a glance which values need your attention compared to normal range.

Cardio-HART™ - ECG report

Speed = 50mm/s, Gain = 25mm/mV

12-lead ECG Measurements

Meas	Unit	I	II	III	aVR	aVL	aVF	V1	V2	V3	V4	V5	V6
Qamp	uV	0	0	0	-591	0	0	-549	-33	-566	0	0	0
Ramp	uV	955	239	32	151	851	51	0	0	0	33	532	801
Samp	uV	0	-354	-769	0	0	-284	-549	-378	-566	-962	-1062	-854
R'amp	uV	0	0	0	0	0	-205	0	0	0	0	0	0
S'amp	uV	0	0	0	0	0	-418	0	0	0	0	0	0
Jamp	uV	-35	-40	-3	38	-16	-20	21	22	17	-2	-64	-101
J40amp	uV	-51	-43	9	49	-31	-18	38	37	36	29	-37	-95
J60amp	uV	-52	-40	14	49	-32	-13	48	45	39	35	-36	-101
J80amp	uV	-62	-46	16	57	-38	-17	54	50	43	43	-31	-108
J100amp	uV	-67	-39	25	57	-45	-8	42	68	50	57	-29	-114
STslo0-80	mV/s	-0.26	-0.09	0.14	0.21	-0.19	0.01	0.33	0.31	0.28	0.47	0.29	-0.18
STslo50-70	mV/s	-0.16	0.18	0.39	-0.09	-0.24	0.3	0.41	0.07	0.31	0.53	0.36	-0.1
Rarea	mVs	21.89	-0.81	-22.6	-10.47	22.26	-11.49	-12.76	-9.03	-16.47	-23.46	-7.28	3.04
QRSptp	uV	991	593	801	742	874	469	570	403	591	995	1601	1655
P+amp	uV	11	5	3	5	10	3	9	22	1	17	14	14
P-amp	uV	-5	-9	-9	-10	-3	-7	-9	9	-7	6	0	2
Parea	mVs	0.3	-0.1	-0.32	-0.28	0.27	-0.24	0.05	1.85	-0.41	1.57	0.74	0.84
P+area	mVs	0.35	0.09	0.03	0.07	0.3	0.03	0.23	1.85	0	1.57	0.74	0.84
P-area	mVms	0.05	0.19	0.35	0.35	0.04	0.27	0.18	0	0.41	0	0	0
T+amp	uV	69	83	67	63	35	61	73	106	73	150	76	41
T-amp	uV	-78	-46	-8	-68	-59	-17	-55	20	-15	43	-33	-147
Tarea	mVs	-4.94	2.83	7.12	1.46	-5.87	4.62	4.05	13.31	7.83	19.86	2.8	-19.79
T+area	mVs	2.84	5.57	7.2	5.1	1.09	4.97	6.6	13.31	8.26	19.86	4.27	0.62
T-area	mVs	7.78	2.74	0.08	3.63	6.96	0.35	2.55	0	0.42	0	1.47	20.41
Q/R	mV/mV	0	0	0	3.91	0	0	50	50	50	0	0	0
R/S	mV/mV	50	0.68	0.04	50	50	0.18	0	0	0	0.03	0.5	0.94
R/R'	mV/mV	50	50	50	50	50	0.25	50	50	50	50	50	50
T/R	mV/mV	0.07	0.35	2.09	0.42	0.04	1.2	50	50	50	4.55	0.14	0.05
Qint	ms	0	0	0	52	0	0	76	24	64	0	0	0
Rint	ms	70	52	20	30	74	26	0	0	0	20	50	50
R'int	ms	0	0	0	0	0	0	0	0	0	0	0	0
Sint	ms	0	28	64	0	0	22	76	68	64	74	44	44
S'int	ms	0	0	0	0	0	32	0	0	0	0	0	0
RWPT	ms	44	46	6	62	42	18	-	-	-	4	40	38

Virtual Scale

12-lead have 12 bars

12-lead ECG Measurements

The 12-lead local measurements also presented besides a zoomed ECG signal which supports detailed evaluation of the ECG.

Virtual Scale

The virtual scale helps to quickly overview how the measurements fall in the normal range.
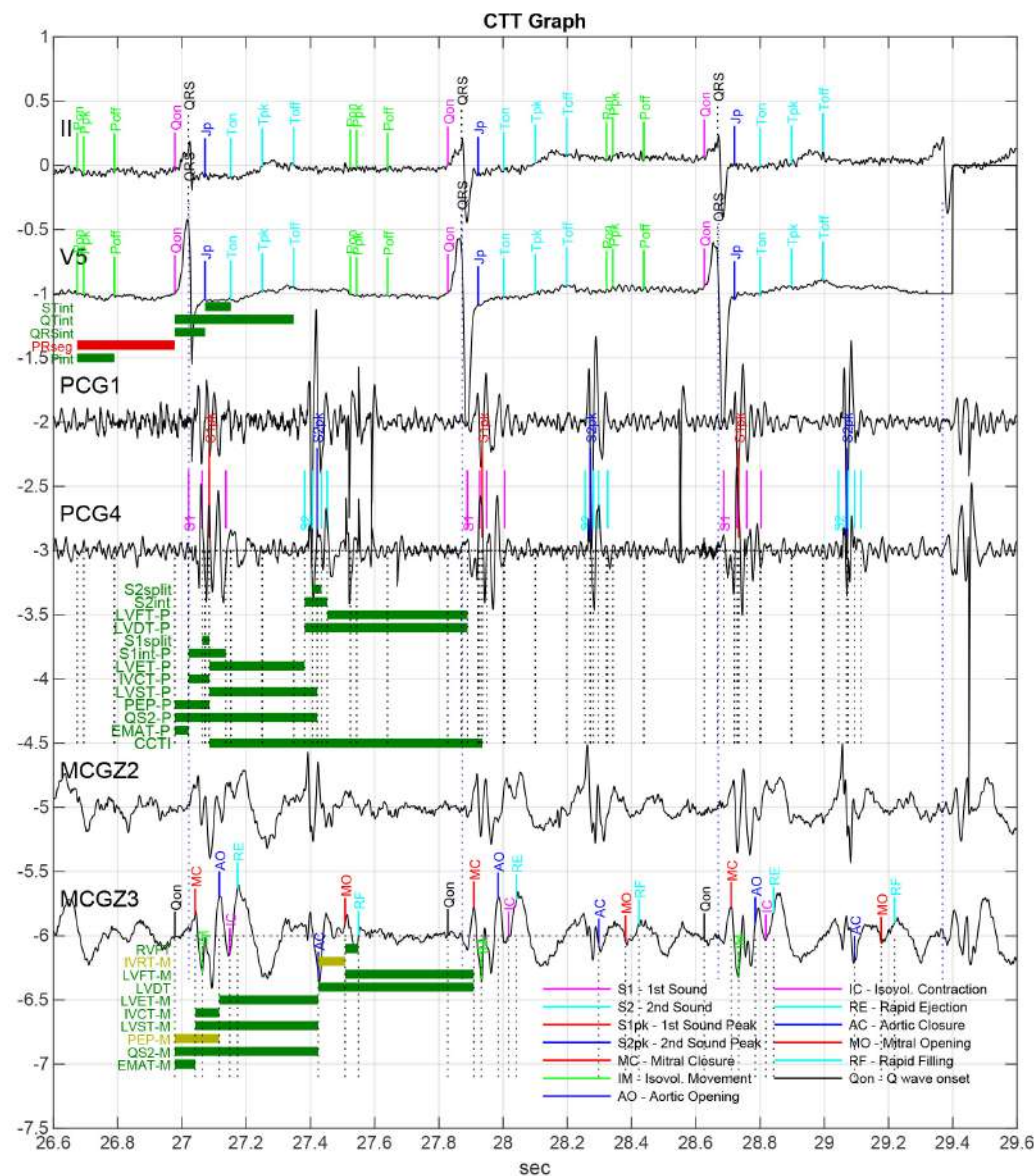
ECG vs. Cardio-HART™

PHONOCARDIOGRAPHY

	CHART™	ECG
Systolic Murmur	✓	✗
Diastolic Murmur	✓	✗
Ejection Click	✓	✗
Opening Snap	✓	✗
3rd Sound	✓	✗
4th Sound	✓	✗
S1 Wide	✓	✗
S2 Wide	✓	✗
Wheeze	✓	✗
Artifact	✓	✗
PCG Signal Quality	✓	✗

MECHANOCARDIOGRAPHY

	CHART™	ECG
EMAT (Q-MitralClosure)	✓	✗
PEP - Pre Ejection	✓	✗
LVET - Vent. Ejection	✓	✗
SPI - Systolic Perf.	✓	✗
MPI - Myocardial Perf.	✓	✗
MCG Signal Quality	✓	✗

Cardio-HART™ - PCG and MCG report

CTT Graph

The CTT graph, in a unique way, plots the synchronized ECG, PCG and MCG signals with the key heart cycle characteristic time events.

Cardio-HART™ - MCG report

MCG Findings

CHART™ provides systolic time interval findings.

Used for detecting alterations in LV systolic function.

The systolic time intervals (STI) offer a temporal description of the sequential phases of the cardiac cycle which are influenced physiologically by the same variables as affect other measures of left ventricular (LV) performance.

The MCG signal has physiological characteristics, represented by Systolic Time Interval (STI).

STI metrics represent the myocardial contractility of the heart, defined as the time intervals between Q wave, opening and closure of the aortic valve or first or second heart sounds.

MCG STI Measurement

MCG STI Measurement	Value
MCG EMAT [ms]	80
MCG QS2 [ms]	445
MCG PEP [ms]	155
MCG LVST [ms]	367
MCG IVCT [ms]	75
MCG LVET [ms]	292
MCG LVDT [ms]	495
MCG LVFT [ms]	413
MCG IVRT [ms]	83
MCG RVFT [ms]	42
MCG MPI (ivct+ivrt)/lvet	541
MCG SPI (pep/lvet)	526
MCG EMATc (emat/rr)	92
MCG QS2I	595
MCG PEPI	184
MCG LVETI	410
MCG LVFTc (lvft/rr)	491
MCG S1int [ms]	104

Virtual Scale

MCG Findings

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

STI's are simple echocardiographic parameters of left ventricular systolic performance: correlation with ejection fraction and longitudinal two-dimensional strain.

Patients with systolic time interval abnormalities have a poorer prognosis, a greater incidence of congestive heart failure and more abnormalities of directly measured indexes of left ventricular performance.

Cardio-HART™ - PCG report

PCG Findings

CHART™ provides sound measurement findings.

PCG is auscultation on steroids, and provides objective interpretation of heart sounds, S1, S2, S3 and S4 during systolic and diastolic periods of the heart cycle and their relation to malfunctioning heart structures.

Used to screen for structural abnormalities; amplitudes can reveal valuable information about myocardial contractility.
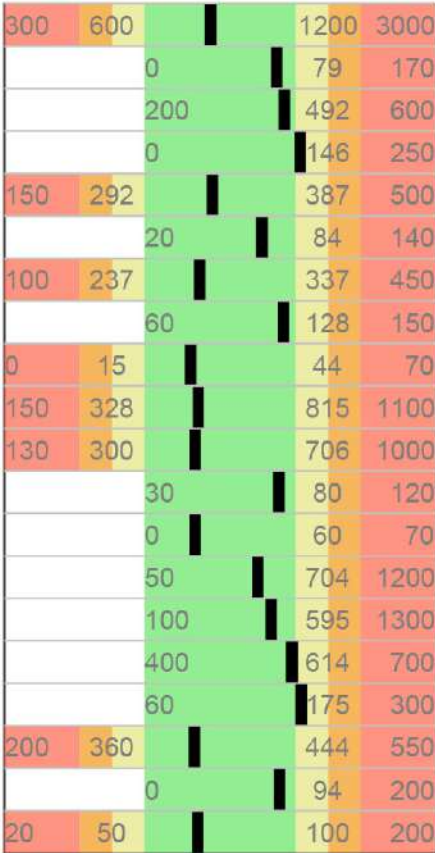
PCG Findings

Systolic Murmur	Absence
Diastolic Murmur	Absence
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 Quality
PCG Summary	Normal

PCG STI Measurement

| Measurement	Value			Virtual Scale			
PCG CCTI [ms]	869	300	600			1200	3000
PCG EMAT [ms]	62			0		79	170
PCG QS2 [ms]	443			200		492	600
PCG PEP [ms]	**133**			0		146	250
PCG LVST [ms]	336	150	292			387	500
PCG IVCT [ms]	65			20		84	140
PCG LVET [ms]	276	100	237			337	450
S1 interval [ms]	116			60		128	150
S1 split [ms]	25	0	15			44	70
PCG LVDT [ms]	515	150	328			815	1100
PCG LVFT [ms]	449	130	300			706	1000
S2 interval [ms]	70			30		80	120
S2 split [ms]	18			0		60	70
PCG MPI (ivct+ivrt)/lvet	490			50		704	1200
PCG SPI (pep/Lvet)	473			100		595	1300
PCG QS2I (qs2+2.1HR)	588			400		614	700
PCG PEPI	**165**			60		175	300
PCG LVETI	390	200	360			444	550
PCG EMATc (emat/rr)	75			0		94	200
Heart Rate [bpm]	69	20	50			100	200

Normal heart sounds are low-frequency transient signals generated by the heart valves, and PCG signals can deliver significant information relevant to the performance of heart valves.

Heart murmurs are high frequency pathological heart sounds, generated from turbulence in blood flow through the narrow cardiac valves or reflow through the atrioventricular valves. Most heart murmurs are pathological and many of these can be related to malfunctioning of cardiac valves.

Aortic regurgitation, aortic stenosis, mitral regurgitation, and mitral stenosis are among the most common pathological types of murmurs.

Cardio-HART™ - PCG and MCG report
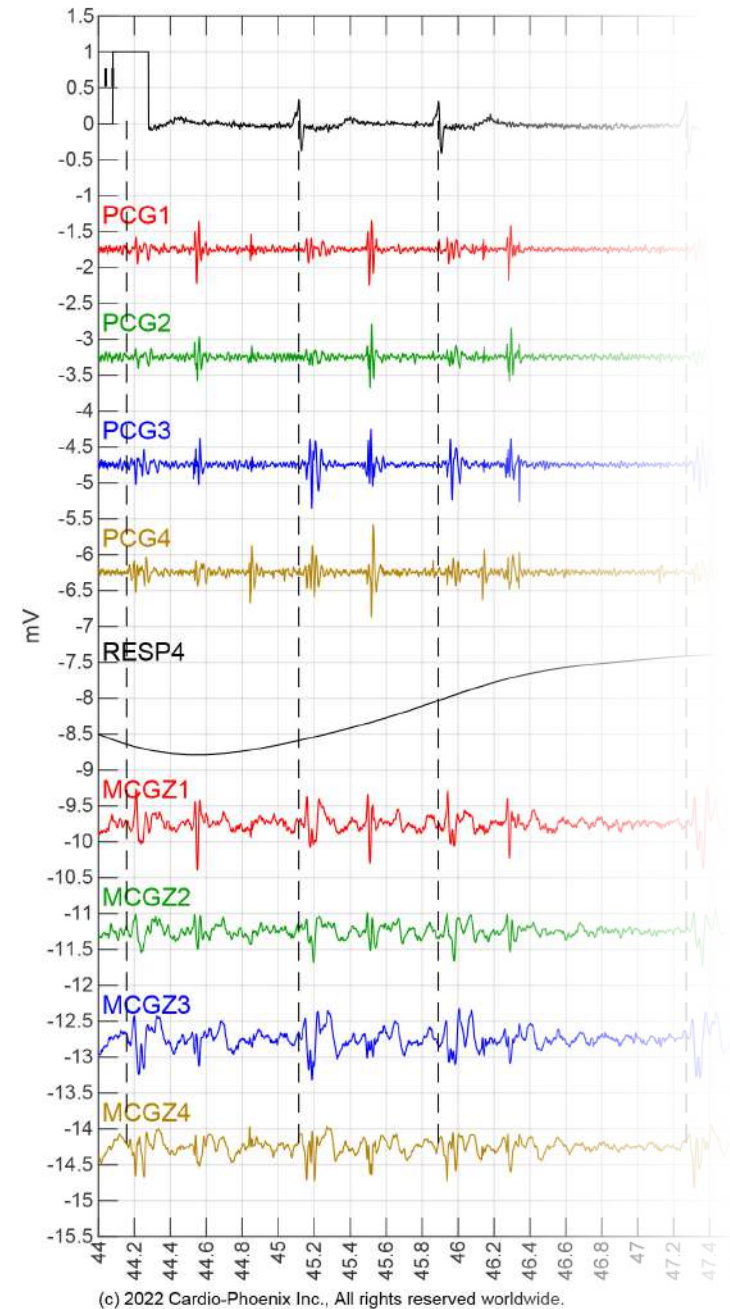
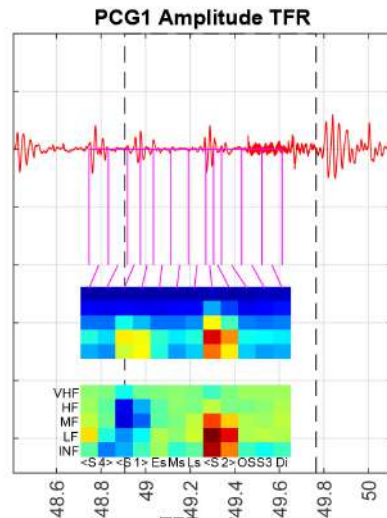## PCG/MCG/RESP Signals

CHART™ plots all the four PCG and MCG signals synchronously with one ECG lead able to overview more heart beats.
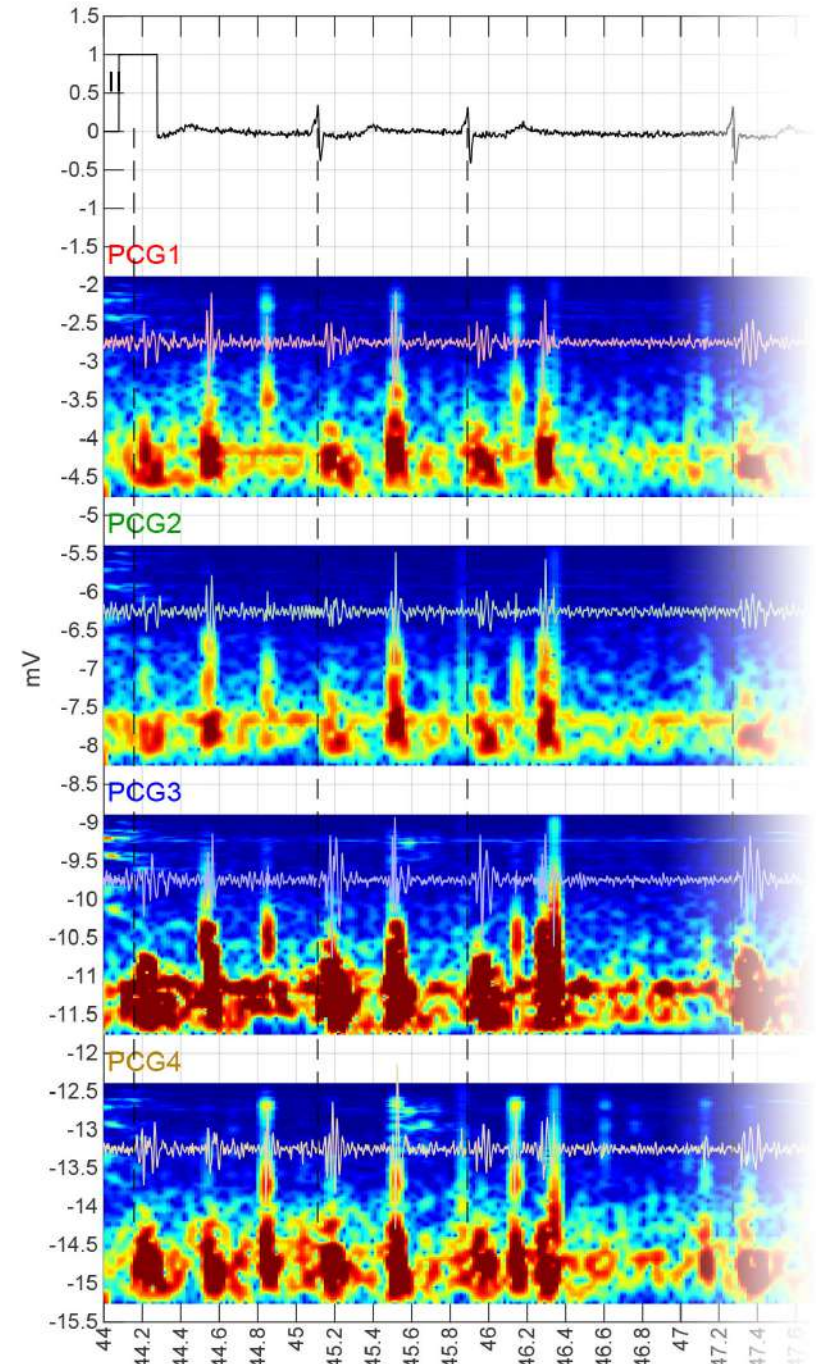
PCG spectrogram

The colorful spectrogram of PCG helps to identify heart sounds, murmurs, wheezing and artifacts.

PCG Amplitude measurement plot

CHART™ illustrates how the PCG sound amplitudes are measured using 12x5 time-frequency representation model.

ECG vs. Cardio-HART™

HART (vertical sidebar)

	CHART™	ECG
Left ventricular Hypertrophy	✓	✗
Dilated Cardiomyopathy	✓	✗
Right ventricular Enlargement	✓	✗
Left atrial Enlargement	✓	✗
Right atrial Enlargement	✓	✗
Left Ventricular Wall Motion Abnormal.	✓	✗
Left Ventricular Systolic Dysfunction	✓	✗
Impaired Relaxation	✓	✗
Aortic valve Stenosis	✓	✗
Mitral valve Stenosis	✓	✗
Aortic valve Insufficiency	✓	✗
Mitral valve Insufficiency	✓	✗
Tricuspid valve Insufficiency	✓	✗
Pulmonary hypertension	✓	✗

Cardio-HART™ - HART report

HART Findings

HART findings are disease equivalent to Echo-findings, but derived from bio-signals not images.

Colors represent the severity.

Mild is an indication of early onset of the disease.

HART Findings

LV Hypertrophy	Absent
Dilated Cardiomyopathy	Absent
RV Enlargement	Absent
LA Enlargement	**Mild**
RA Enlargement	Absent
LV Wall Motion Abn.	**Mild**
LV Systolic Dysfunction	Absent
Impaired Relaxation	Absent
AV Stenosis	Absent
MV Stenosis	Absent
AV Insufficiency	Absent
MV Insufficiency	**Abnormal**
TV Insufficiency	**Abnormal**
Pulm. Hypertension	Absent

Cardio-HART™ - Heart Failure

	CHART™	ECG
Heart Failure With Preserved Ejection Fraction	✓	✗
Heart Failure With Mildly Reduced Ejection Fraction	✓	✗
Heart Failure With Reduced Ejection Fraction	✓	✗

Heart Failure

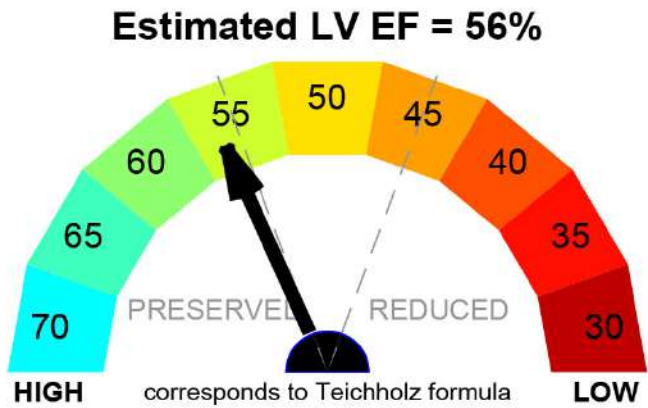Unlike ECG, CHART™ displays data from all three types of Heart Failure in its report.

In the CHART™ system the Heart Failure and its type prediction is based on the HART-findings and the estimated LVEF.

Cardio-HART™ - Heart Failure

Estimated LV EF

Estimated LV EF = 56%

PRESERVED / REDUCED

corresponds to Teichholz formula

HIGH — LOW

Heart Failure	LVEF%	HFpEFsc
Unlikely	> 55%	< 1.8 / 10
Consider HFpEF	**~ 56%**	**~ 7.4 / 10**
Consider HFmrEF	> 40%	-
Consider HFrEF	< 40%	-

Warning: "Consider BNP test"
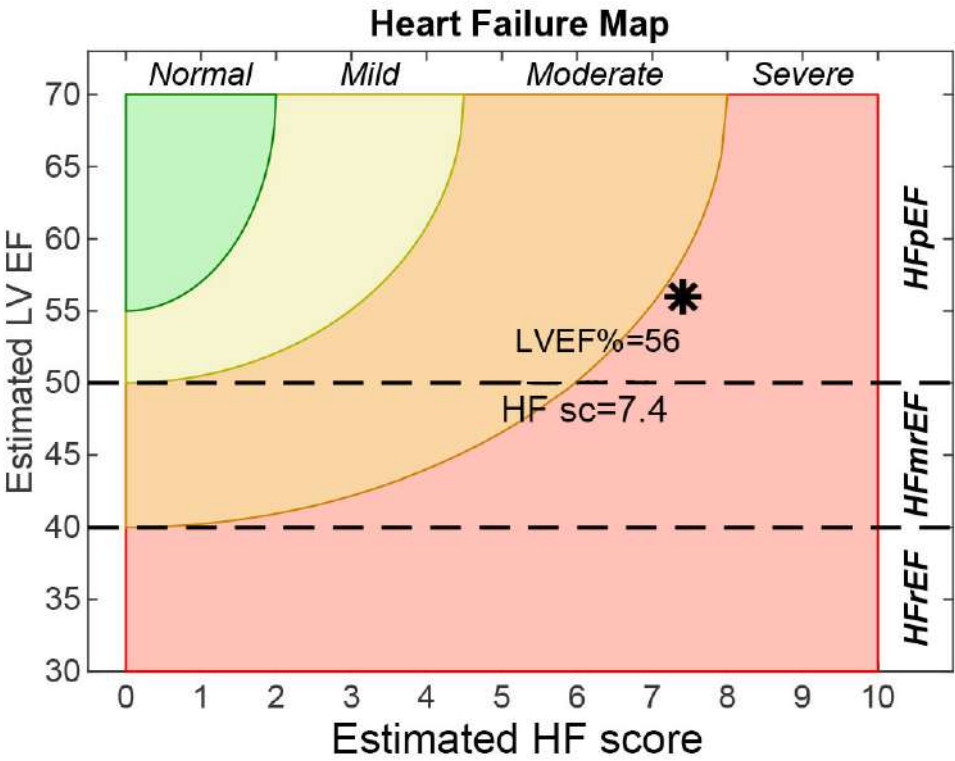
CHART™ provides an estimated LVEF based on the bio-signals, which helps to assess the systolic function and heart failure.

It is presented on a colored scale that helps to interpret quickly the patient systolic function and heart failure.

The heart failure type table shows the predicted category of the patient condition based on the LVEF.

In case of borderline HFpEF, consider HFpEF and consider HFmrEF the CHART™ report proposes to confirm HF with BNP test and as such displays a warning text: "Consider BNP test!"

Heart Failure Map

CHART™ calculate HF-score based on HART-findings, which represent the probability of heart failure in case of preserved LVEF.

Heart Failure Map shows patient state in function of estimated LVEF and estimated HF-score.

Heart Failure Map

Normal Mild Moderate Severe

LVEF%=56

HF sc=7.4

HFpEF | HFmrEF | HFrEF

Estimated LV EF

Estimated HF score

Algorithm	LVH	LAE	WMA	DDIM	AS	PH	AFib	Score
HF score	+ 0	+ 1.5	+ 1.3	+ 0	+ 0	+ 0	+ 4.6	= 7.4

HF score Table

This table shows how the HF score is calculated from the ECG and HART-findings.
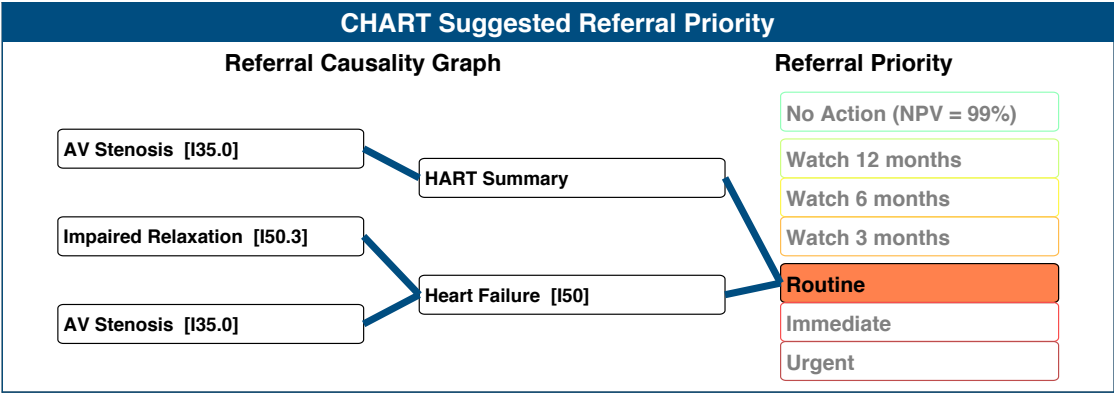
Cardio-HART™ Decision page
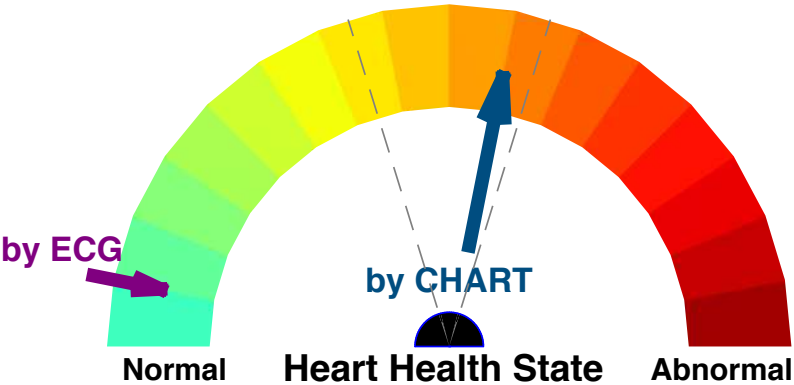
Summary table
Summary table provides all the important summary findings from all the CHART™ findings.

by ECG

by CHART

Normal — Heart Health State — **Abnormal**

General Heart Health State
General Heart Health State illustrates the general severity of the heart problems primarily based on HART-findings, but independently of heart failure.

CHART Summary

HART Summary	Mild
- Heart Structure	Normal
- Heart Function	Normal
- Heart Valves	Abnormal
Heart Failure	Consider HFpEF
Rhythm	Sinus
ECG Summary	Normal ECG
PCG Summary	Abnormal
MCG Summary	Abnormal

CHART Suggested Referral Priority

Referral Causality Graph

- AV Stenosis [I35.0]
- HART Summary
- Impaired Relaxation [I50.3]
- Heart Failure [I50]
- AV Stenosis [I35.0]

Referral Priority

- No Action (NPV = 99%)
- Watch 12 months
- Watch 6 months
- Watch 3 months
- **Routine**
- Immediate
- Urgent

CPA Warnings

Wrong sensor direction or patient not in supine position - retest recommended!: LAT

CPA Warnings
Warning table lists any detected problems in the recorded signals and patient data.

Decision Tree
CHART™ provides a decision support for a primary care situation based on only the detected findings.

It modeled with a decision tree.

Referral Priority Decision Tree

Hsum(AS) — Normal | **Mild** | Mod.

Hsum(AS) — Normal | **Mild** | Mod.

LVSD,DCM,ISTT — Normal | Mild | Mod.

AS — Normal | Mild | Mod.

HF(DDIM+AS) — Normal | Mild | **Mod.** → **Routine**

HF(DDIM+AS) — Normal | Mild | Mod.

HF(DDIM+AS),AS — Normal | Mild | Mod.

DD — Normal | Mild | Mod.

ISTT — Normal | Mild | Mod.

DD — Normal | Mild | Mod.

AS — Normal | Mild | Mod.

RVE — Normal | Mild | Mod.

Routine

LVSD,PH — Normal | Mild | Mod.

DD — Normal | Mild | Mod.

Watch 3m

Watch 3m

Routine

Watch 6m

Watch 3m

Routine

Immediate

Routine

Immediate

Immediate

Urgent

PCG(DM),MCG(SPI) — Normal | Mild | Mod.

Watch 6m

No Action

Watch 12m