



AFCC ***DIGITAL HEALTH***
2025 IN **HEART DISEASE CARE**
PRE-CONGRESS

Hosted by:

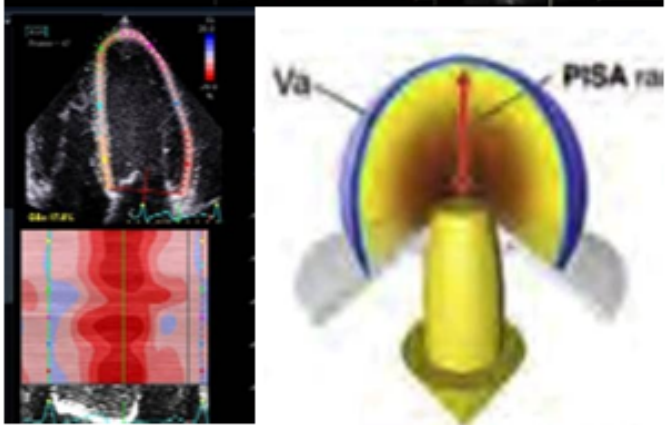
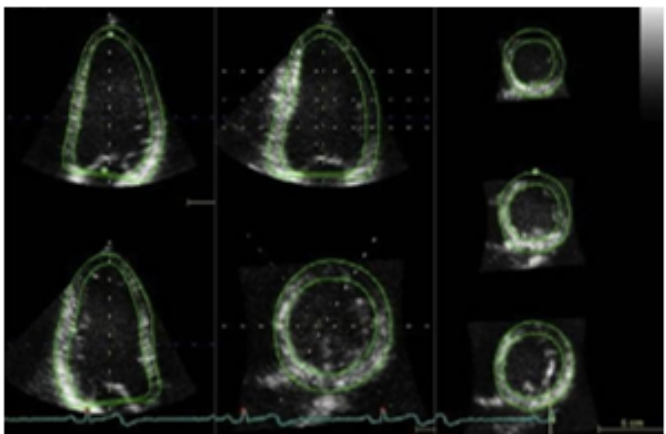
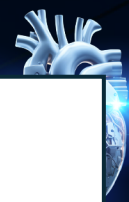


Under the auspices of:



AI in clinical echocardiography

Andy Ko Tze Yang
Sarawak Heart Center



Scheduling



Guided Image
acquisition

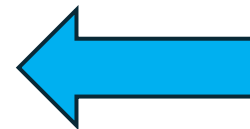


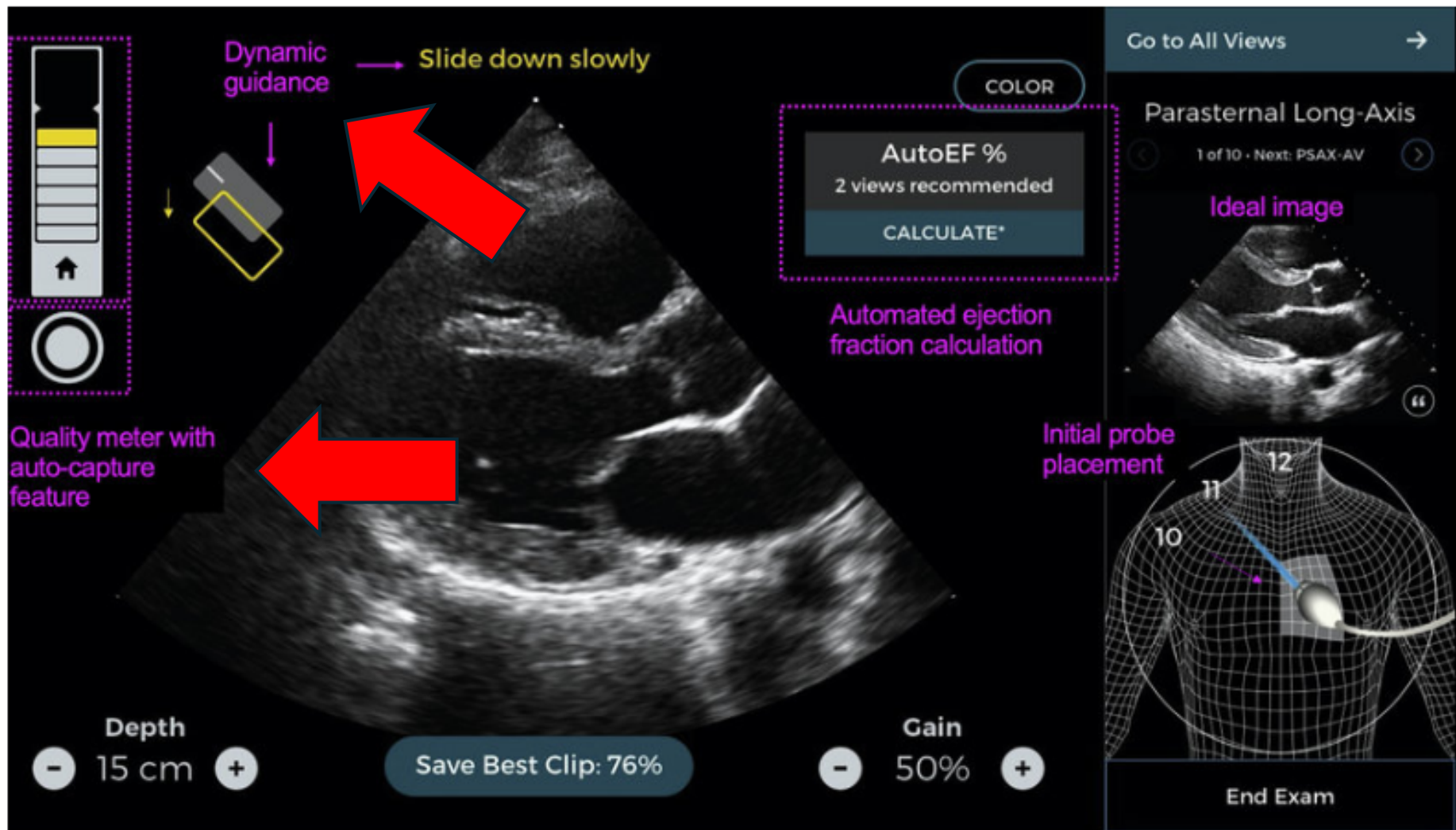
Automated
quantification



Disease detection

Reporting and data
management





Guided image acquisition

Narang, A., Bae, R., Hong, H., Thomas, Y., Surette, S., Cadieu, C., ... & Thomas, J. D. (2021). Utility of a deep-learning algorithm to guide novices to acquire echocardiograms for limited diagnostic use. *JAMA cardiology*, 6(6), 624-632.

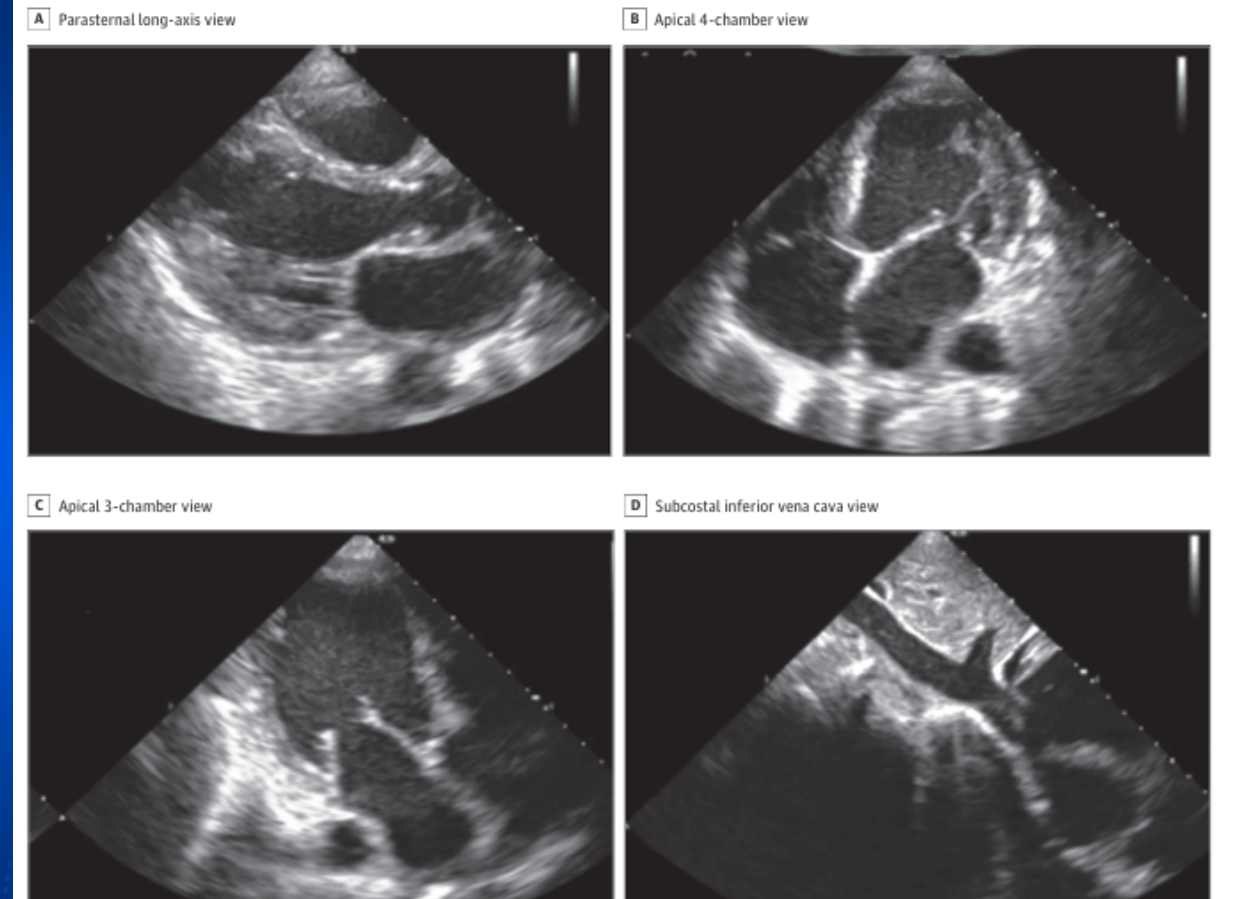
Utility of a deep-learning algorithm to guide novices to acquire echocardiograms for limited diagnostic use

Table 1. Proportion of Nurse-Acquired Artificial Intelligence–Guided Echocardiography of Sufficient Quality to Assess Core Cardiac Clinical Parameters in Population Scanned by Nurses^a

End point	Clinical parameter examined by qualitative visual assessment	Performance goal, %	Total scans performed, No.	Scans of sufficient quality, No.	Scans of sufficient quality (95% CI)
1	Left ventricular size	80	240	237	98.8 (96.7–100)
2	Global left ventricular function	80	240	237	98.8 (96.7–100)
3	Right ventricular size	80	240	222	92.5 (88.1–96.9)
4	Nontrivial pericardial effusion	80	240	237	98.8 (96.7–100)

Table 2. Comparison of Nurse-Acquired and Sonographer-Acquired Studies for Primary and Secondary Clinical Parameters^a

Image No.	Clinical parameter examined by qualitative visual assessment	No. (%) [95% CI]		Nurse-sonographer difference, percentage points
		Nurse examination	Sonographer examination	
1	Left ventricular size	232 (98.7) [96.3–99.7]	235 (100) [98.4–100.0]	–1.3
2	Global left ventricular function	232 (98.7) [96.3–99.7]	235 (100) [98.4–100.0]	–1.3
3	Right ventricular size	217 (92.3) [88.2–95.4]	226 (96.2) [92.9–98.2]	–3.9
4	Nontrivial pericardial effusion	232 (98.7) [96.3–99.7]	234 (99.6) [97.7–100.0]	–0.9
5	Right ventricular function	214 (91.1) [86.7–94.4]	226 (96.2) [92.9–98.2]	–5.1
6	Left atrial size	222 (94.5) [90.7–97.0]	234 (99.6) [97.7–100.0]	–5.1
7	Aortic valve	215 (91.5) [87.2–94.7]	228 (97.0) [94.0–98.8]	–5.5
8	Mitral valve	226 (96.2) [92.9–98.2]	233 (99.1) [97.0–99.9]	–2.9
9	Tricuspid valve	195 (83.0) [77.6–87.6]	217 (92.3) [88.2–95.4]	–9.3
10	Inferior vena cava size	135 (57.4) [50.9–63.9]	215 (91.5) [87.2–94.7]	–34.1



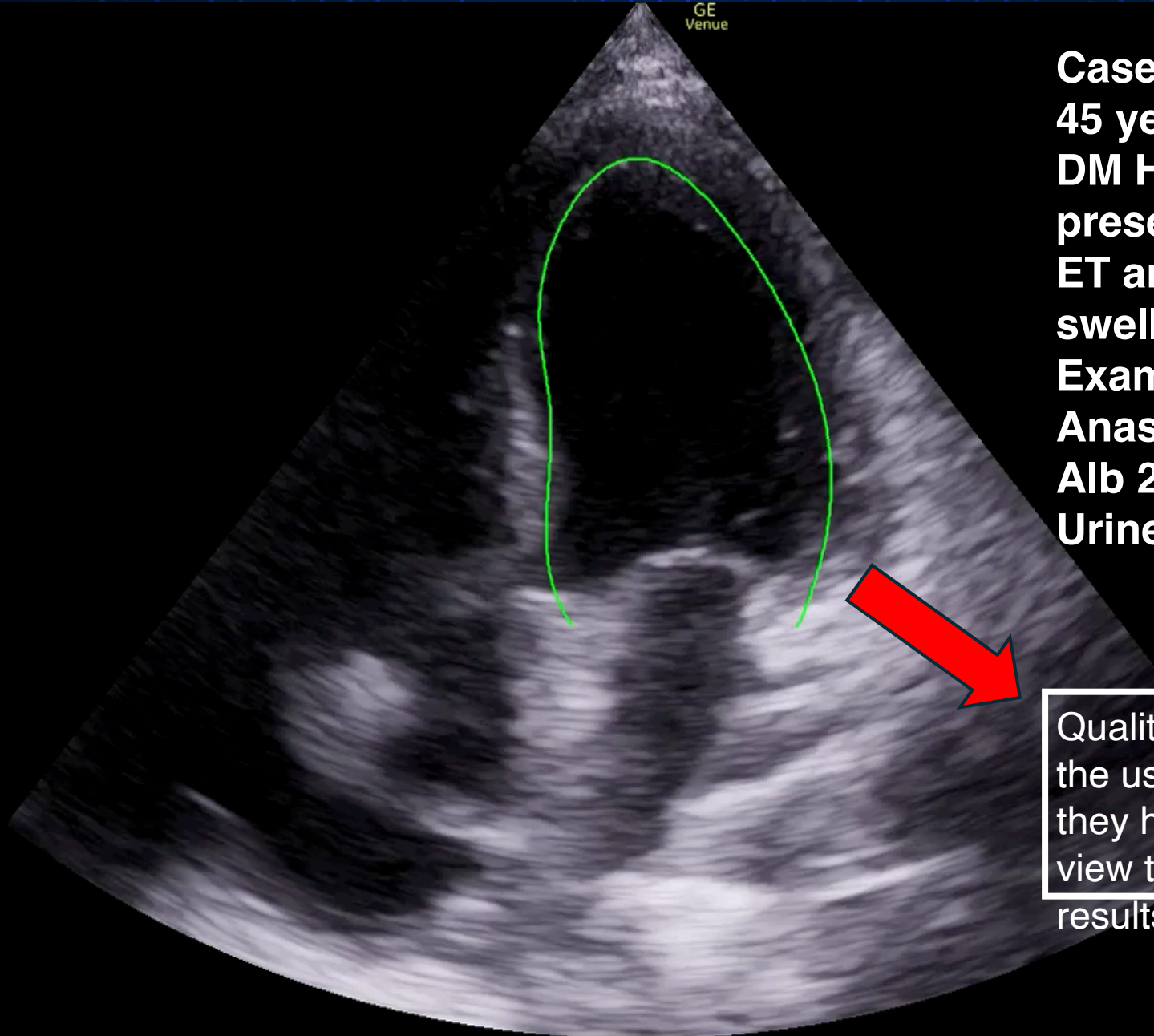
Real-Time EF



Realtime A4C EF 53 %
HR 97 bpm



Continuously
calculates real
time EF

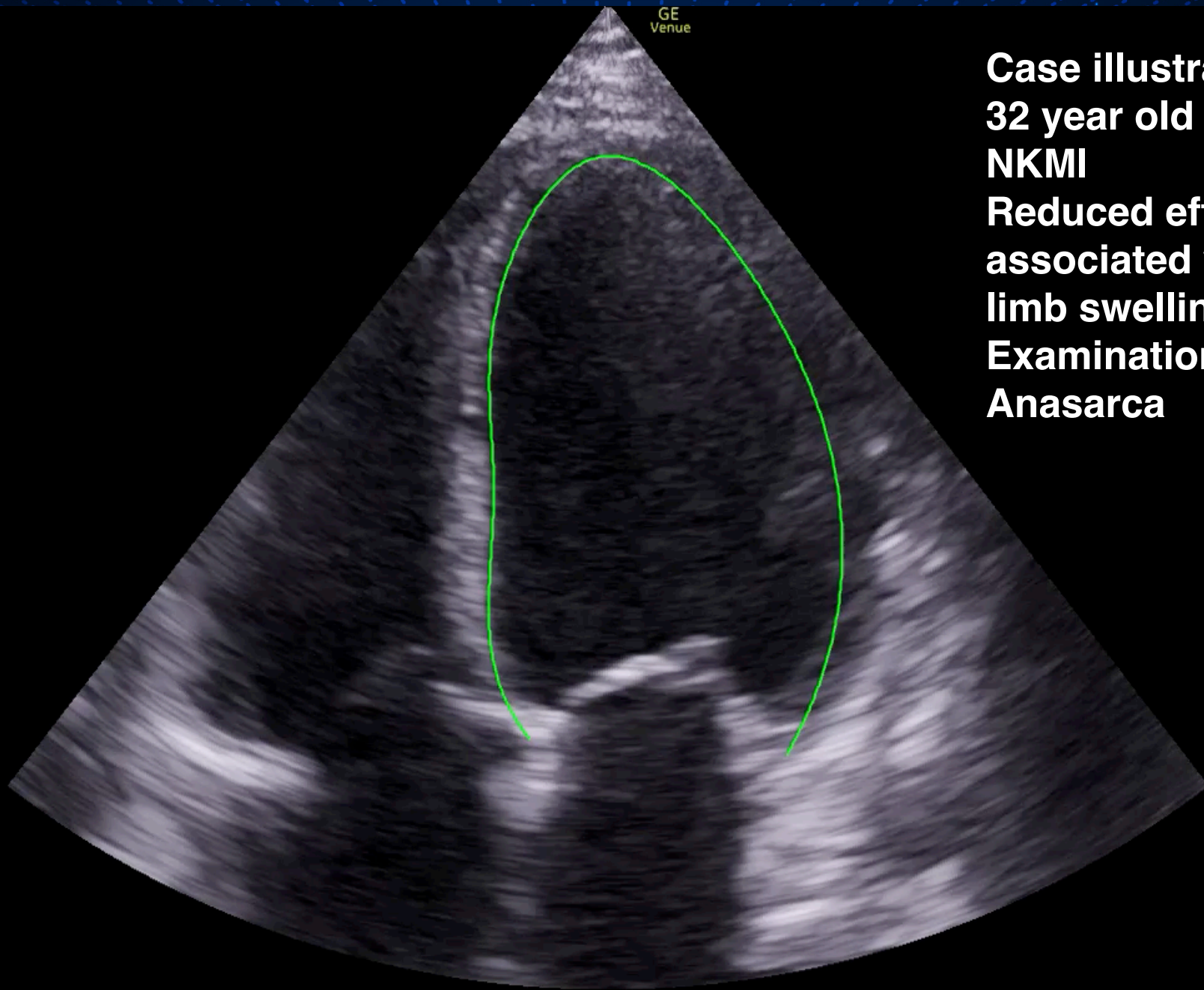


Case illustration 1
45 year old lady
DM HPT DLP
presented with reduced
ET and lower limb
swelling
Examination
Anasarca
Alb 28
Urine Protein 2+

Quality indicator helps
the user know when
they have an adequate
view to generate
results

0
5
10
15

Realtime A4C EF 18 %
HR 59 bpm



Case illustration 2
32 year old male
NKMI
Reduced effort tolerance
associated with lower
limb swelling
Examination
Anasarca

5

10

15



Pusat Jantung Sarawak
06/06/2025 15:14:09

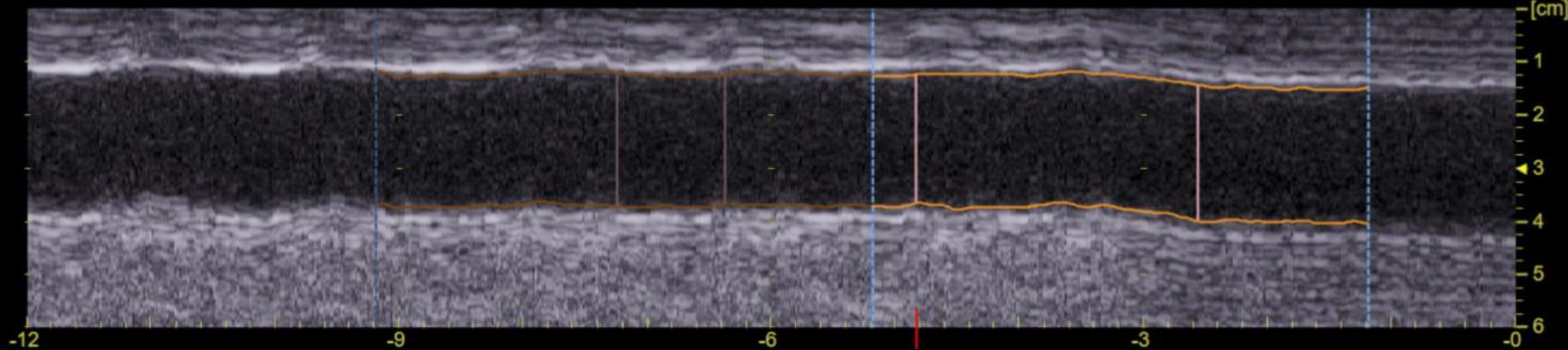
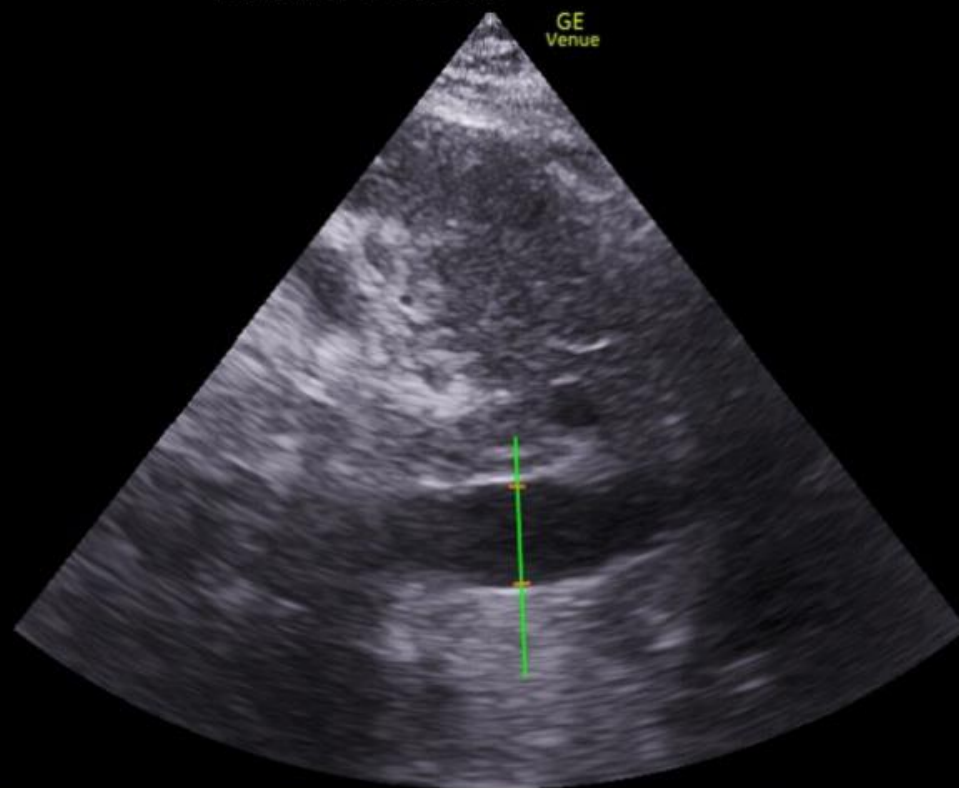
3Sc
*** Cardiac

MI 1.4
TIs 0.7



+ Dmin 24.11 mm
+ Dmax 25.52 mm
+ CI 6 %

GE
Venue





AI Support



Segmentation



View Classification



AI Support



Segmentation



View Classification



Auto Measurements



AI Report



AI Diagnosis

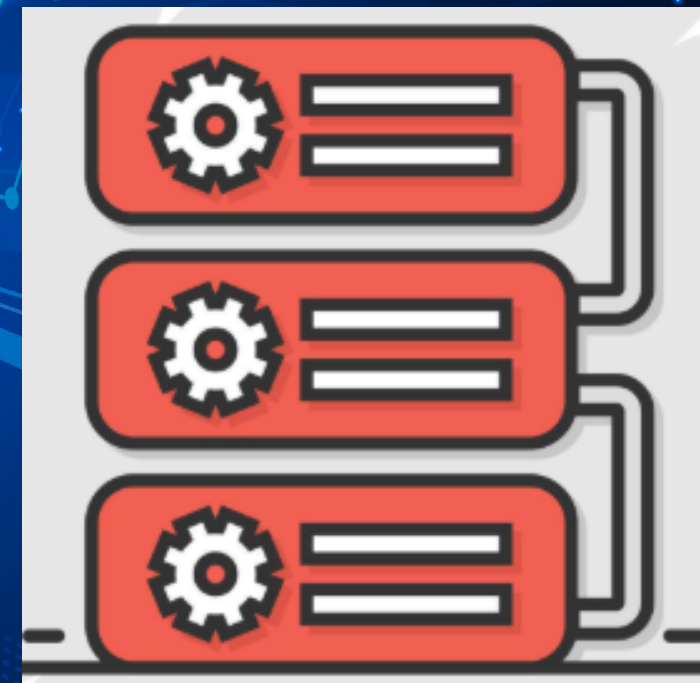
Automated quantification



Accuracy



Consistency



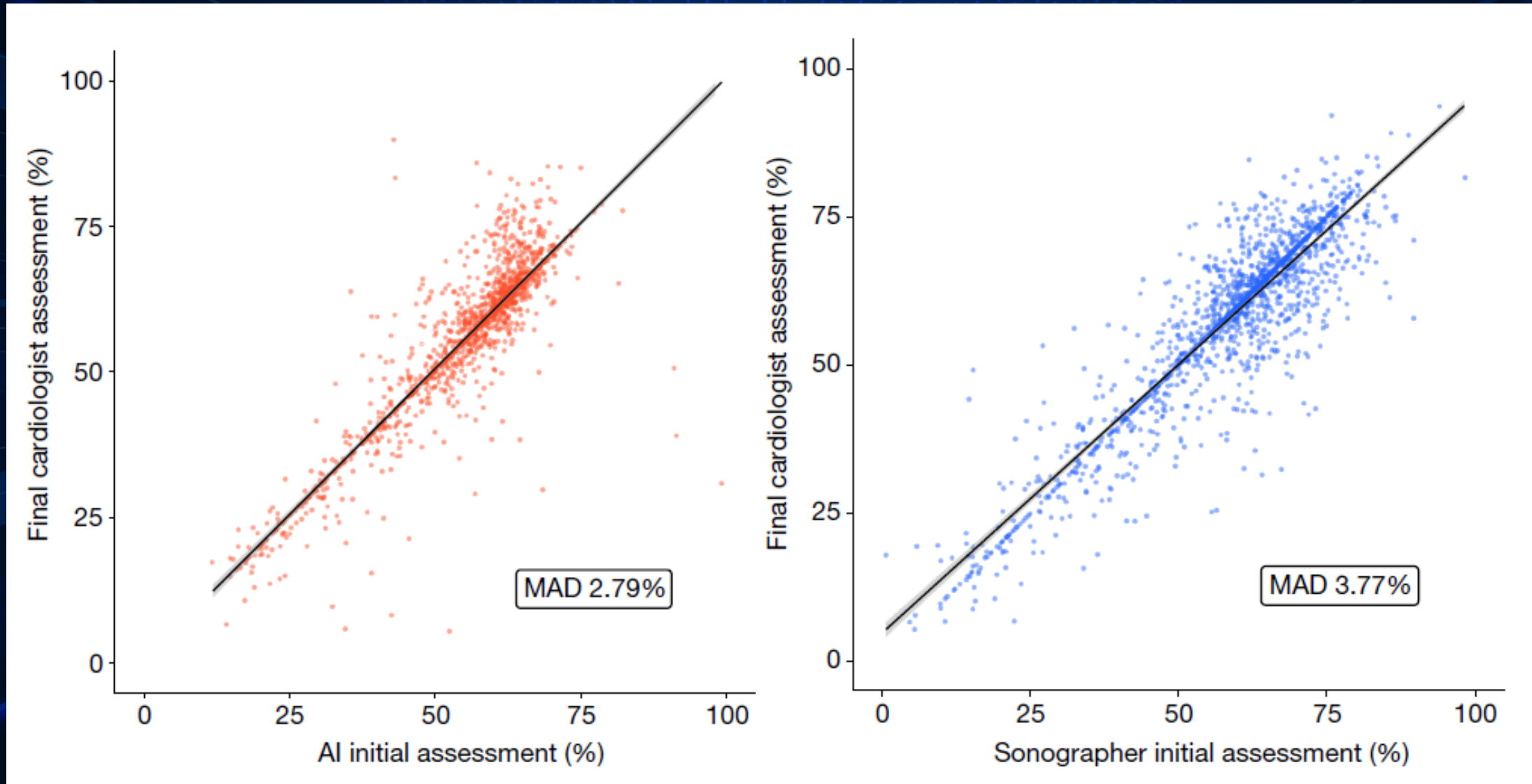
Efficiency

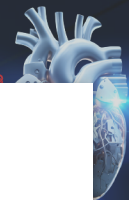
Automated quantification - Accuracy



Accuracy

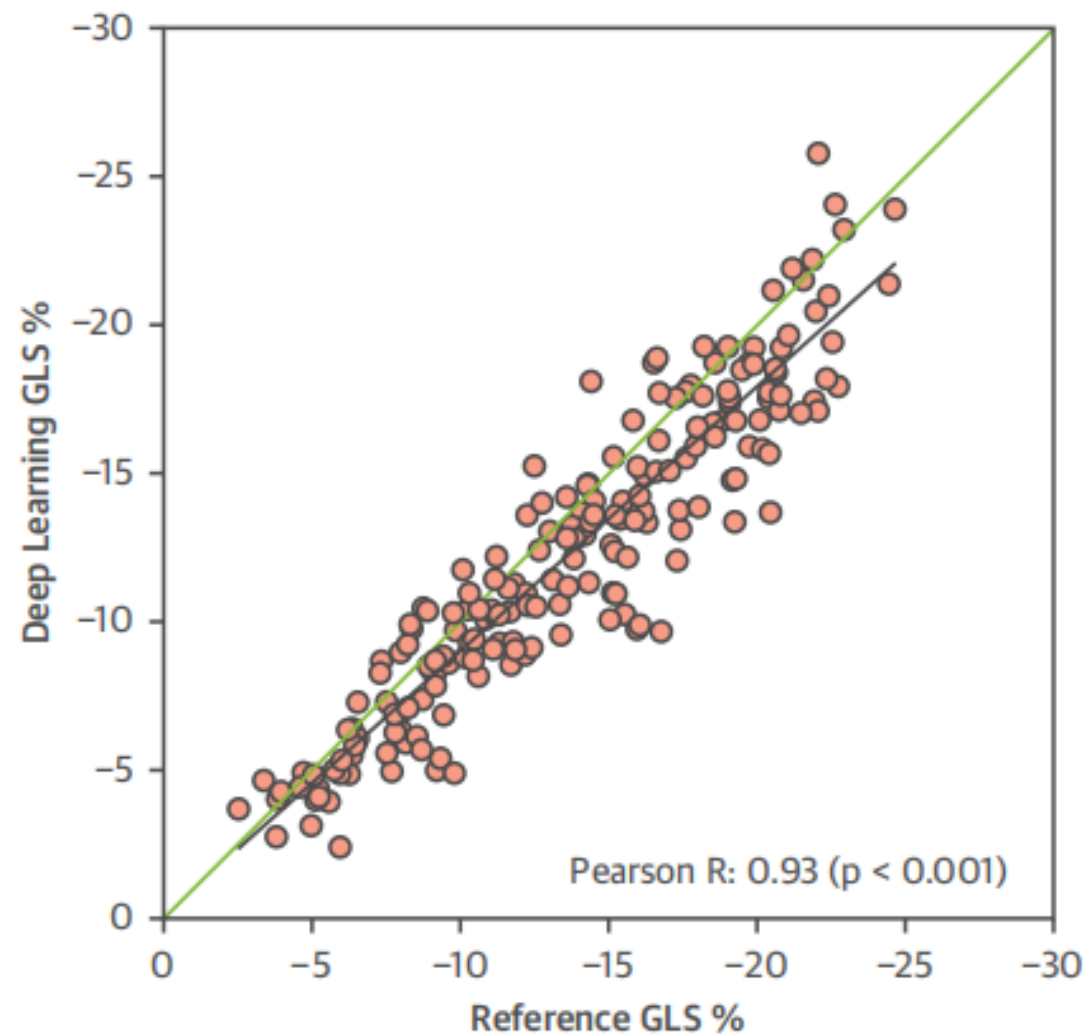
Blinded, randomized trial of sonographer versus AI cardiac function assessment





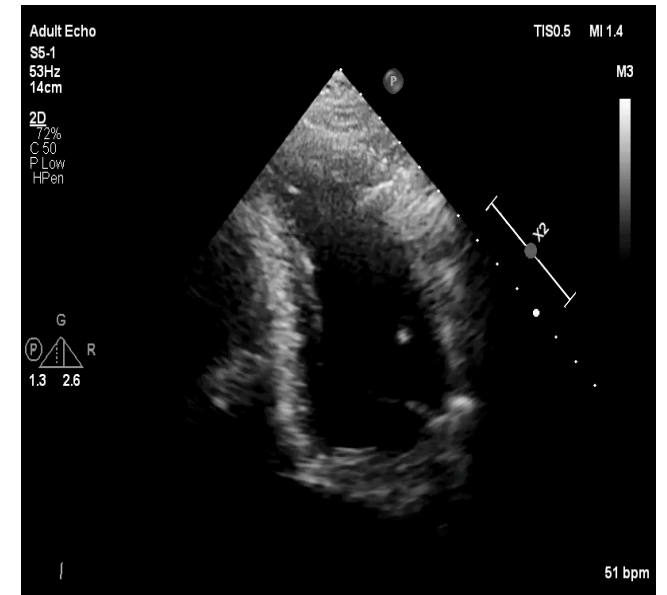
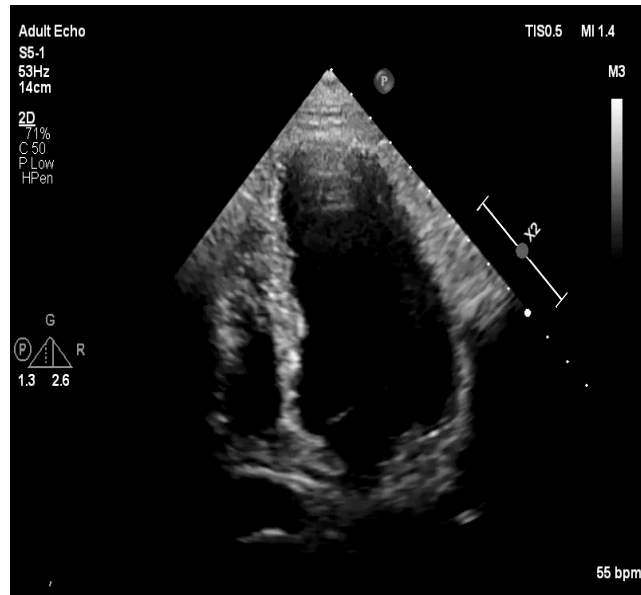
Artificial Intelligence for Automatic Measurement of Left Ventricular Strain in Echocardiography

Ivar M. Salte, MD,^{a,b} Andreas Østvik, MSc,^c Erik Smistad, MSc, PhD,^c Daniela Melichova, MD,^{b,d}
Thuy Mi Nguyen, MD,^{a,b} Sigve Karlsen, MD,^d Harald Brunvand, MD, PhD,^d Kristina H. Haugaa, MD, PhD,^{b,e}
Thor Edvardsen, MD, PhD,^{b,e} Lasse Lovstakken, MSc, PhD,^c Bjørnar Grenne, MD, PhD^{c,f}



ESC 2022 recommendations for cardiac imaging modalities in patients with cancer

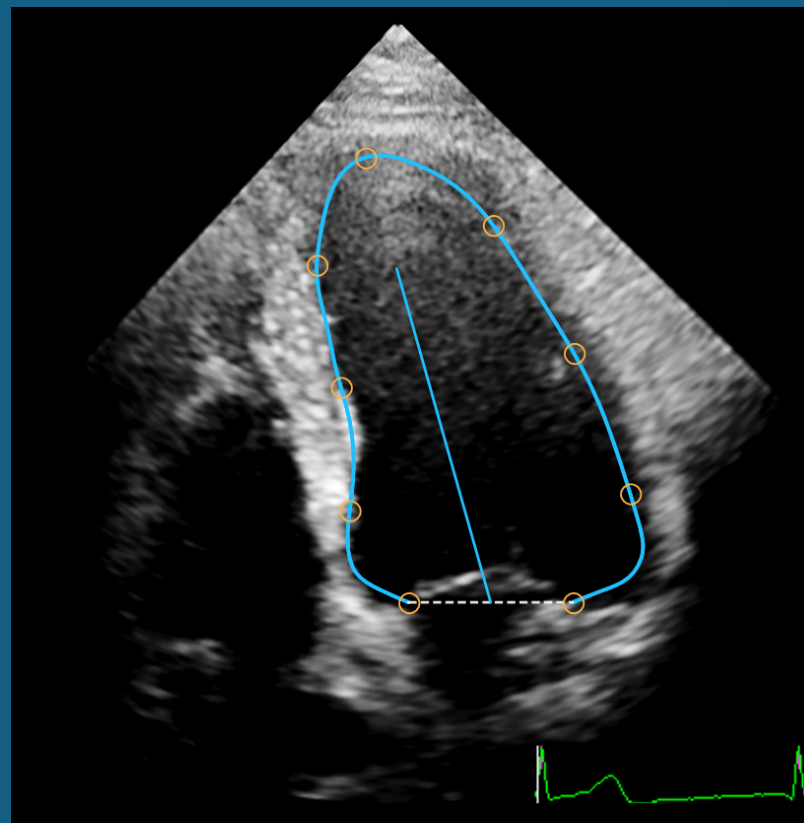
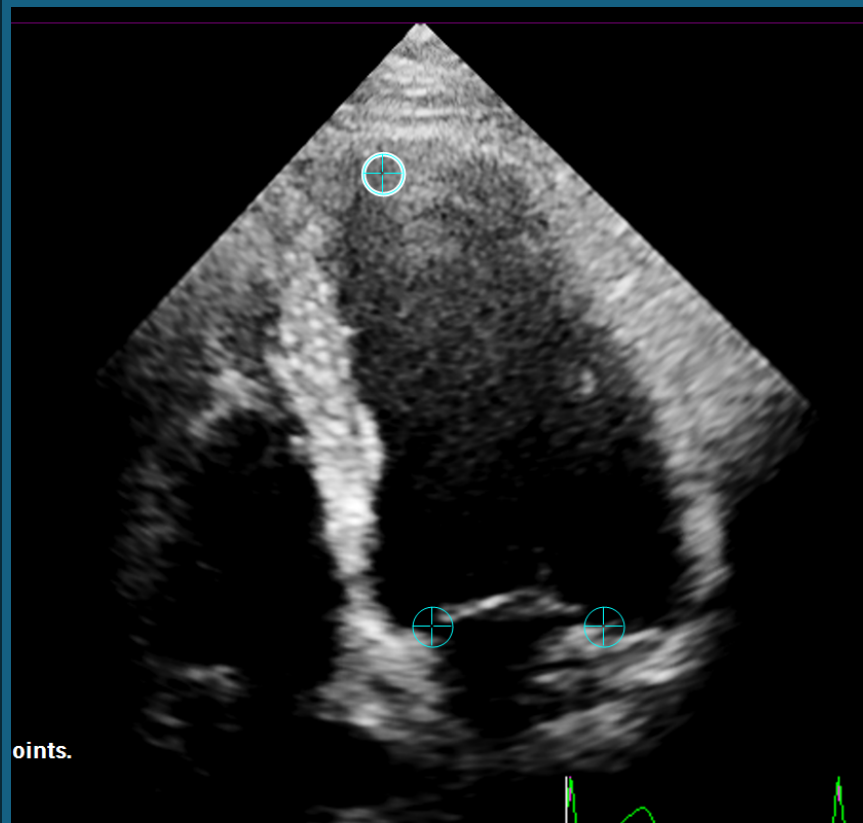
General	Class ^a	Level ^b
Echocardiography is recommended as the first-line modality for the assessment of cardiac function in patients with cancer. ^{4,12,54,94}	I	C
3D echocardiography is recommended as the preferred echocardiographic modality to measure LVEF. ^{77–79,89}	I	B
GLS is recommended in all patients with cancer having echocardiography, if available. ^{75,80,81,89,90,92,93,102,103}	I	C



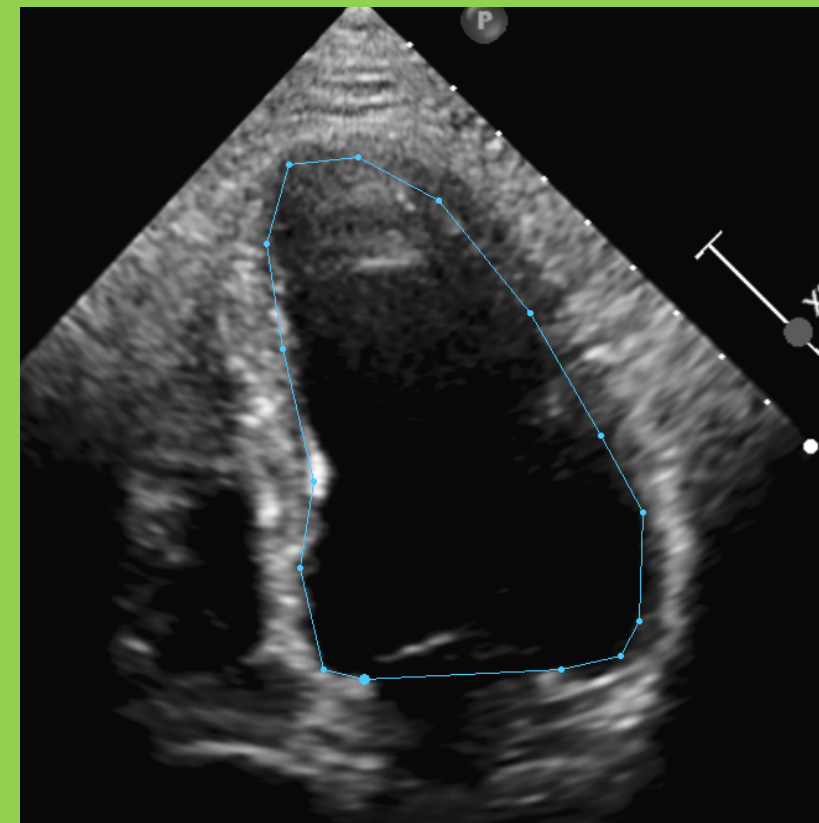
Case illustration

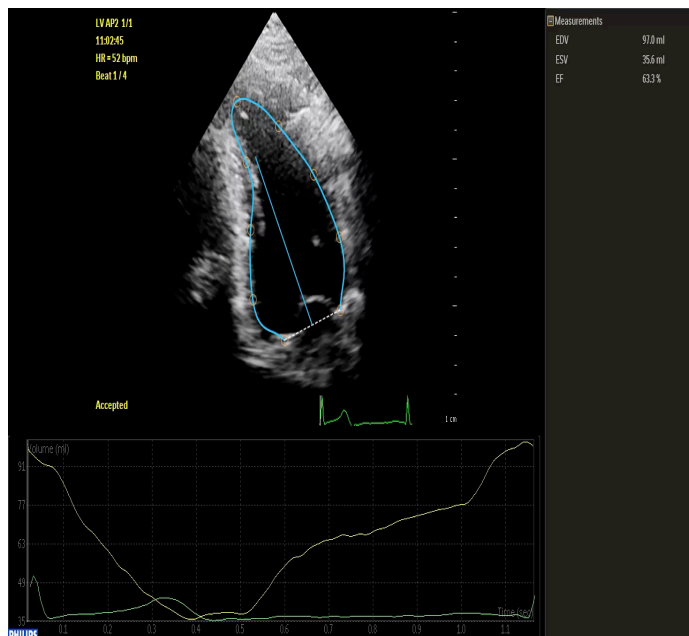
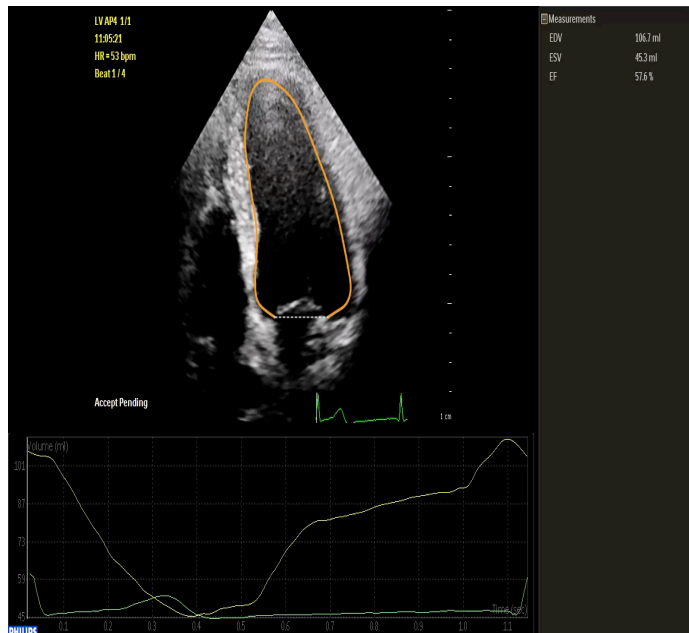
- 56 year old gentleman
- 20 pack years of smoking history
- Newly diagnosed DLBCL planned for anthracycline based chemotherapy
- NYHA I, CCS 0

Semiautomated method

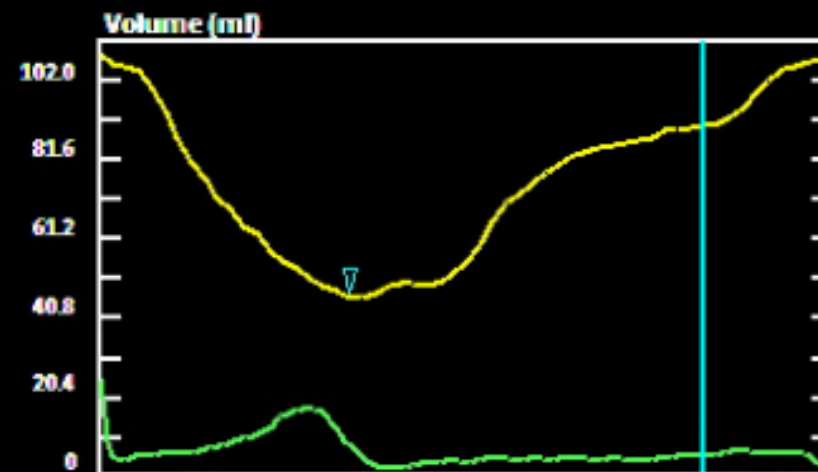


Manual tracking





LV AP4 Cardiac Function Report



HR **57 bpm**

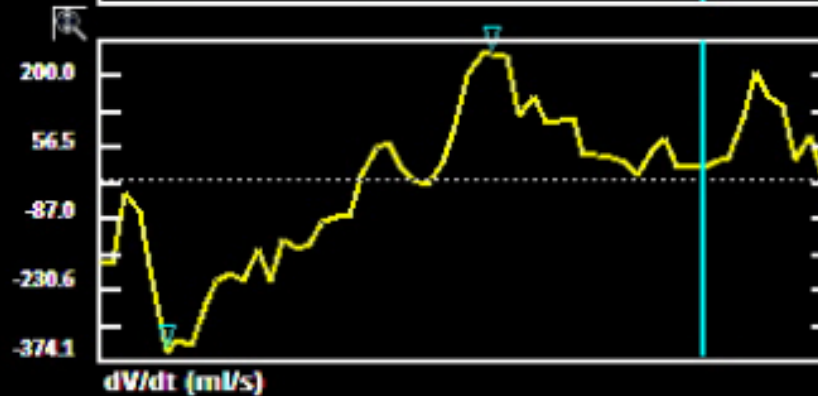
LV Systolic Function

EDV **112.2 ml**

ESV **46.2 ml**

EF **58.8 %**

PER **3.3 EDV/s**



LV Diastolic Function

PRFR **2.5 EDV/s**

AFF **27.5 %**

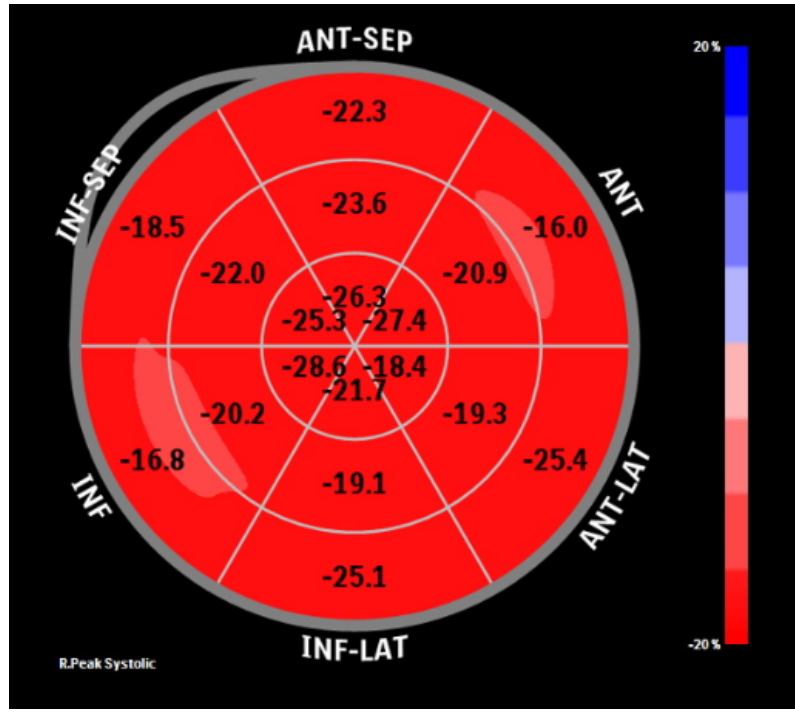
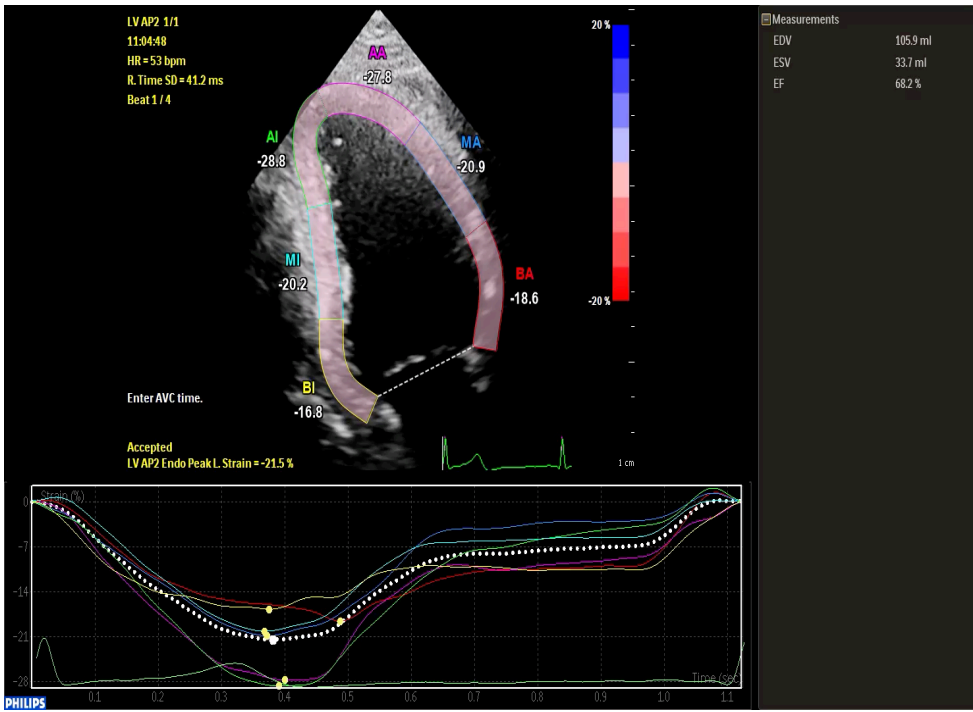
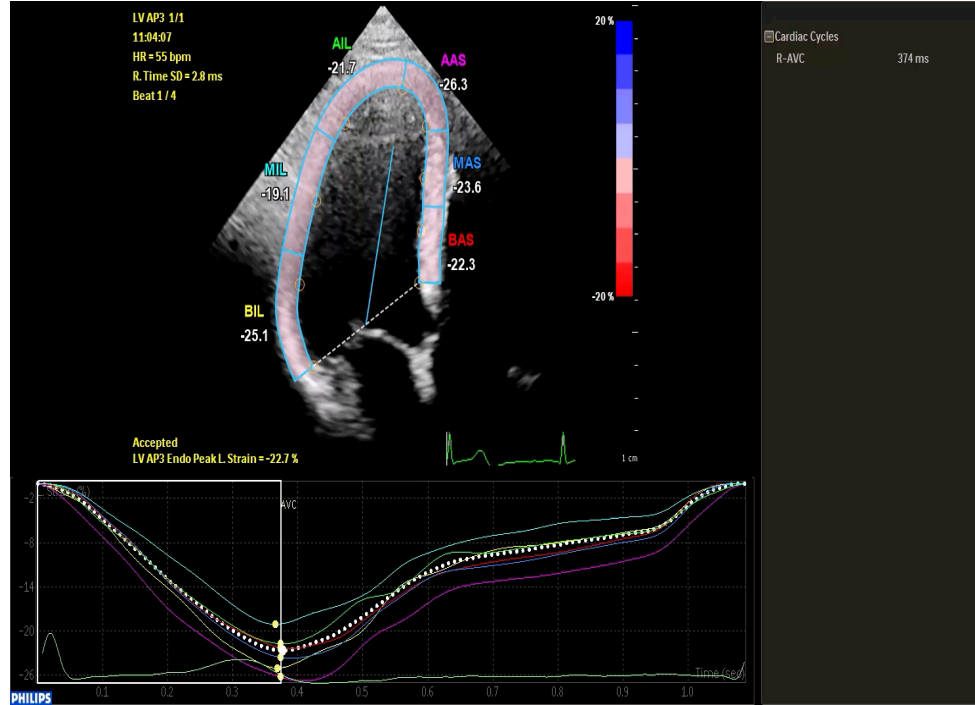
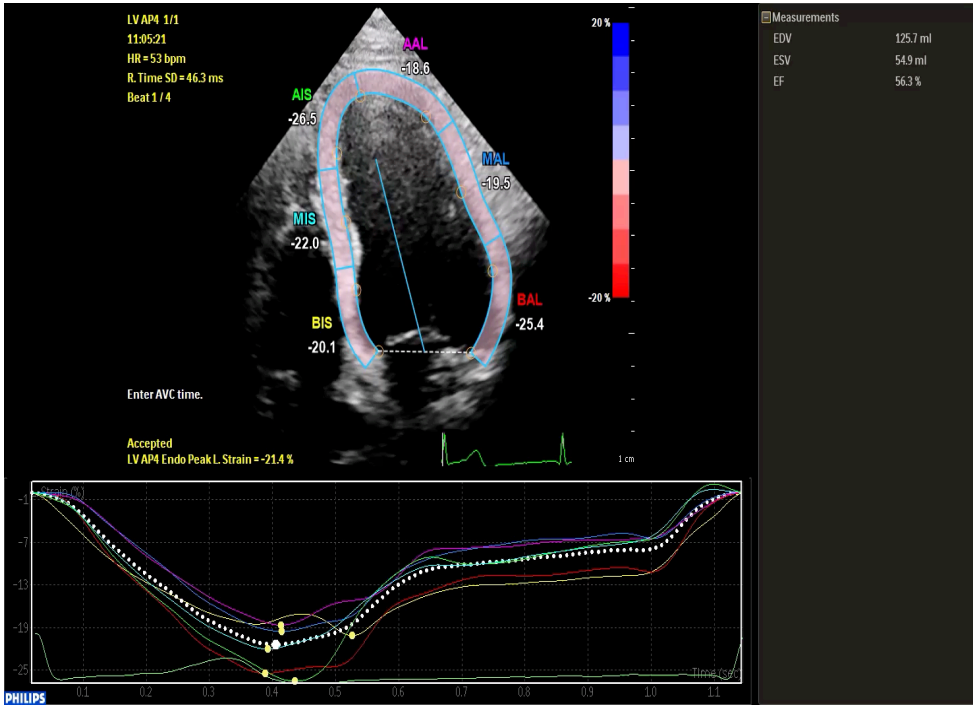
Yellow: Accepted

Red: Accept Pending

EDV (LV Bi-Plane) **101.5 ml**

ESV (LV Bi-Plane) **45.0 ml**

EF (LV Bi-Plane) **55.7 %**



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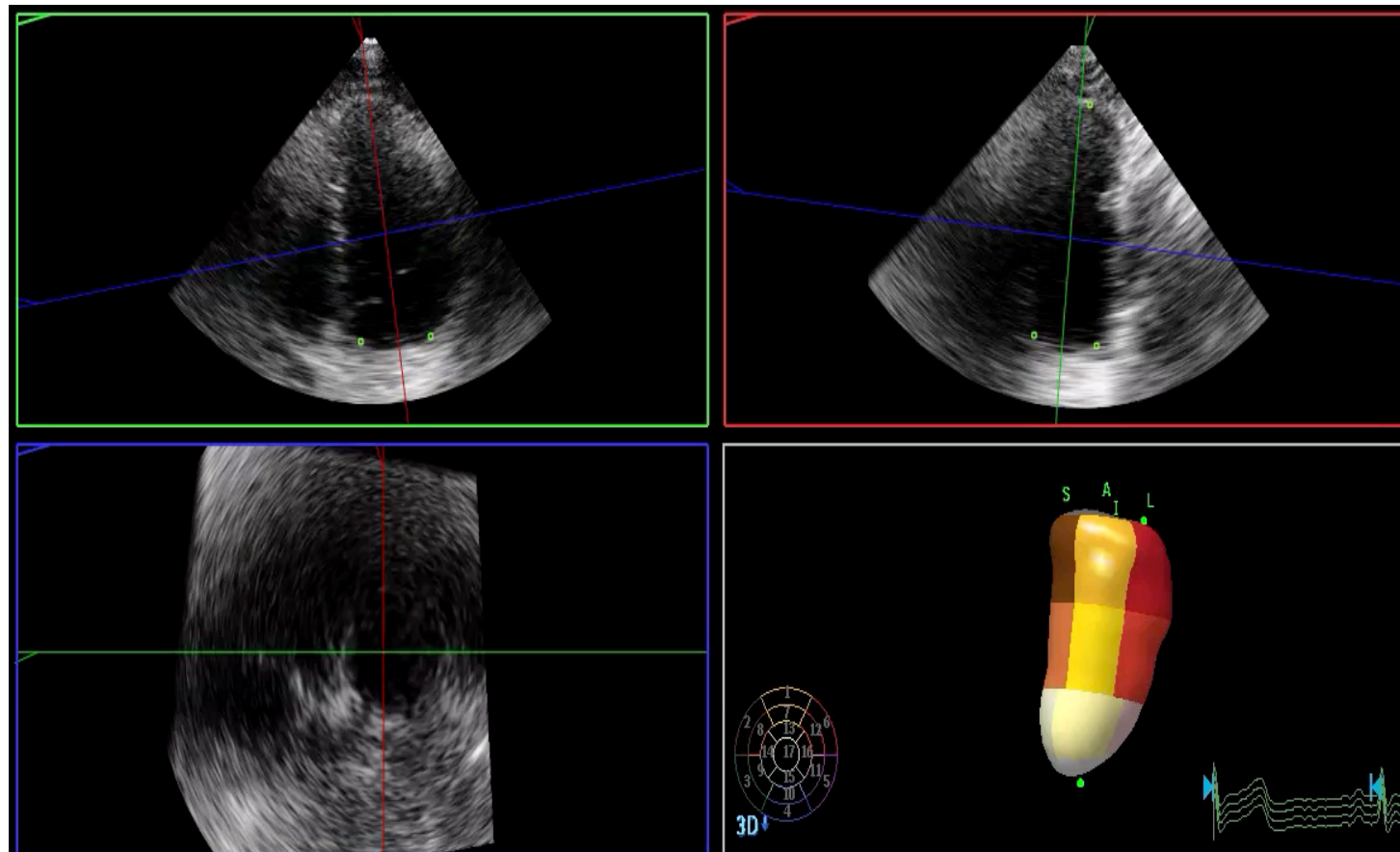
aCMQ
Assess left ventricle global function
and regional wall motion, deformation
and timing.

Semiautomated 3D LVEF

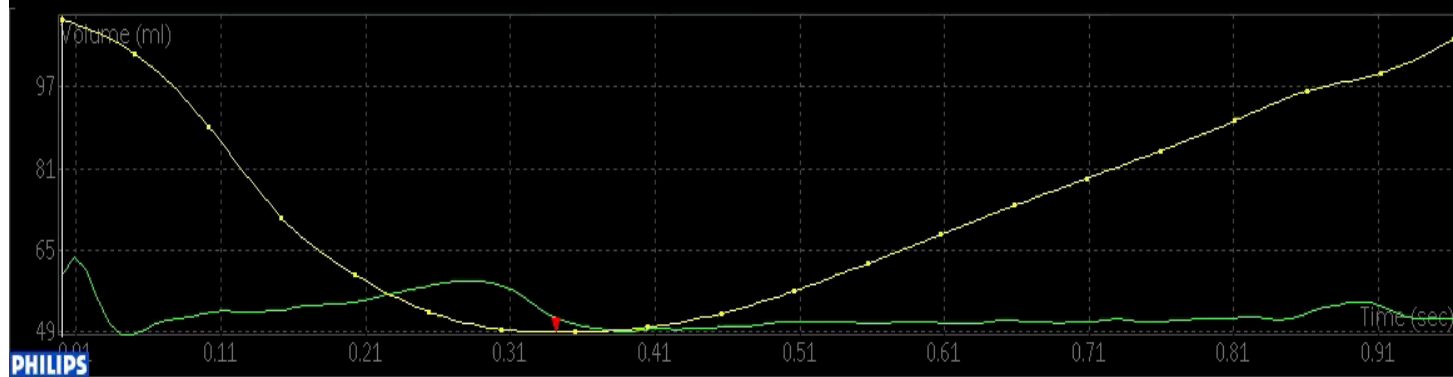


3DQ Adv

Measure the global and regional function of the LV from a 3D full volume data set.

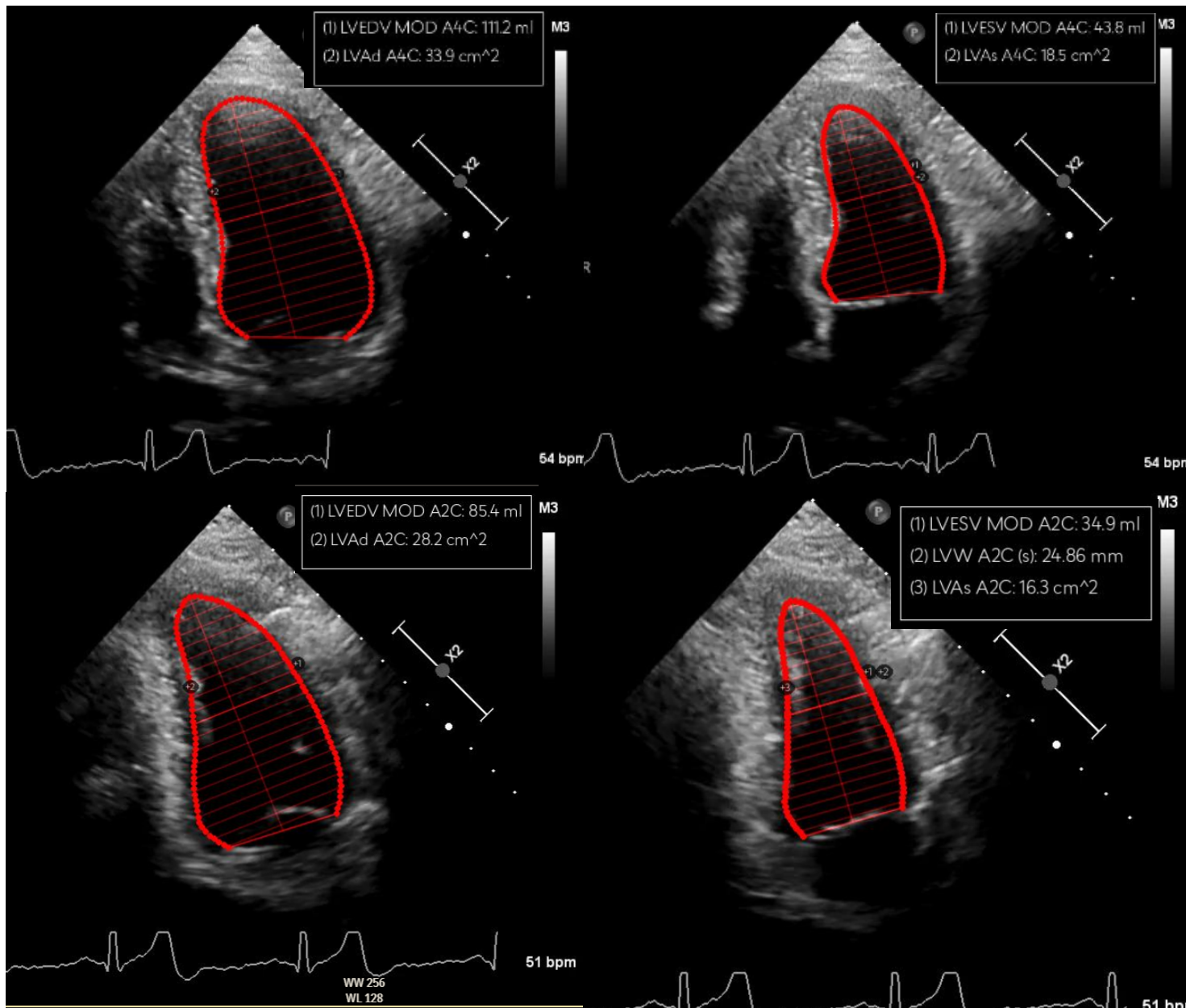


Volume(s)	
EDV	110.3 ml
ESV	48.9 ml
Calculation(s)	
EF	55.6 %
SV	61.4 ml
Regional	
Tmsv Sel-SD	**** ms
Tmsv Sel-Dif	**** ms
Tmsv Sel-SD	**** %



Fully automated - 3rd party AI software (EF, volume & reporting)

IN-HEART DISEASE CARE



PUSAT JANTUNG
SARAWAK
WE CARE FOR YOUR HEART

Preliminary Report
Sarawak Heart Centre

Patient Name
Patient ID
Gender
Processed Date



Date of Birth
Age (on exam date)
Body Surface Area
Visit Date



Main Findings

LV Systolic Function

The left ventricular (LV) systolic function is classified as normal, with a calculated left ventricle ejection fraction (LVEF) of 59.7 % by modified biplane Simpson's method.

Regional Wall Motion

Regional wall motion abnormalities cannot be assessed.

LV Diastolic Function

The left ventricle (LV) diastolic function is normal. The E/A ratio is 0.9 . The mitral valve E velocity (MV-E) measures at 59.86 cm/s. The septal E' velocity is 8.5 cm/s. The lateral E' velocity is 11.1 cm/s. The average E/e' ratio, which represents the ratio of mitral inflow velocity (E) to average mitral annular early diastolic velocity (e'), at both septal and lateral regions is 6.1 .

LV Size

The left ventricular (LV) size is normal. When indexed to body surface area, the LV end-diastolic volume index (LVEDVi) is 54.6 ml/m², and the LV end-systolic volume index (LVESVi) is 22.0 ml/m², both of which are within normal limits.

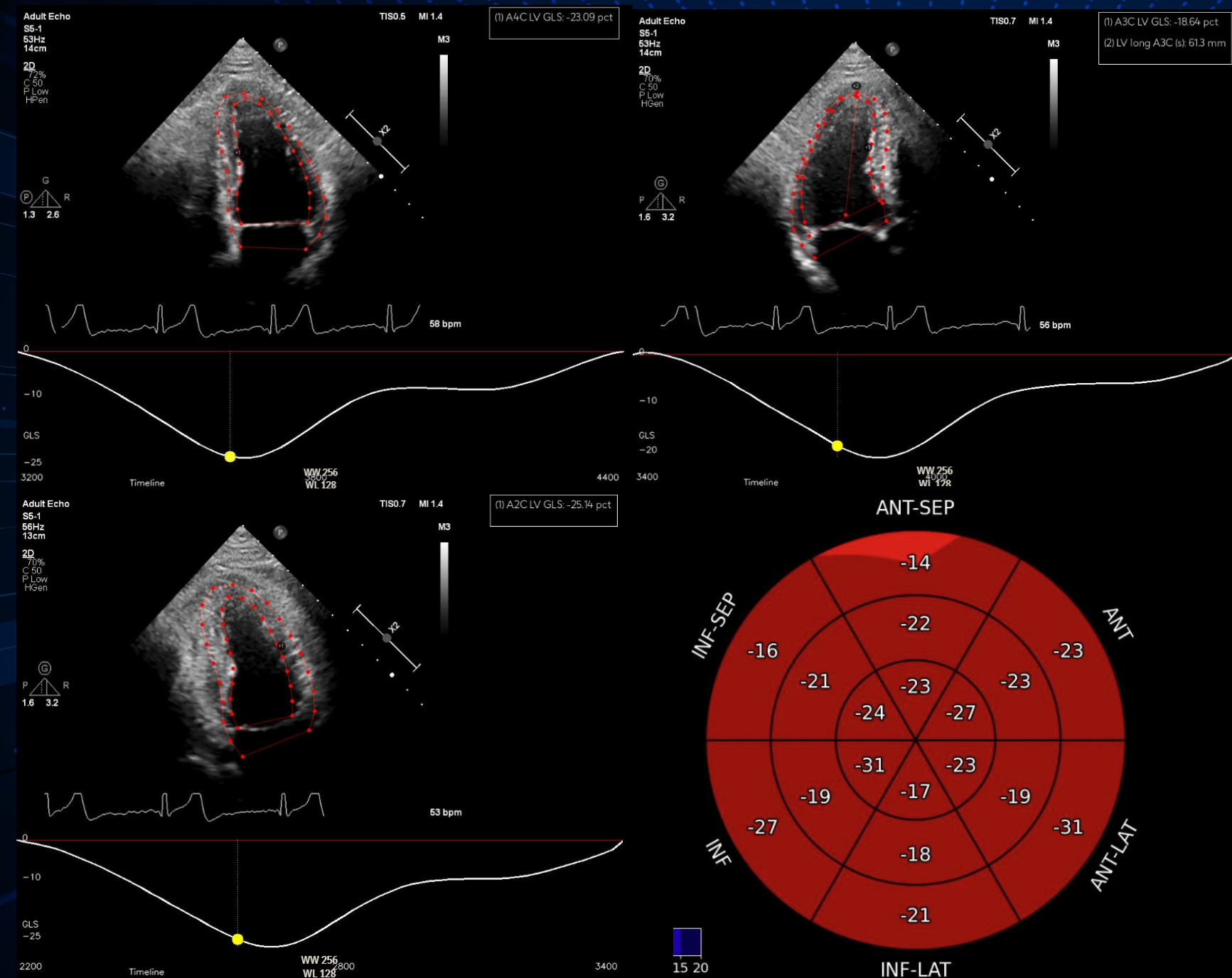
Measurements

Left Ventricle

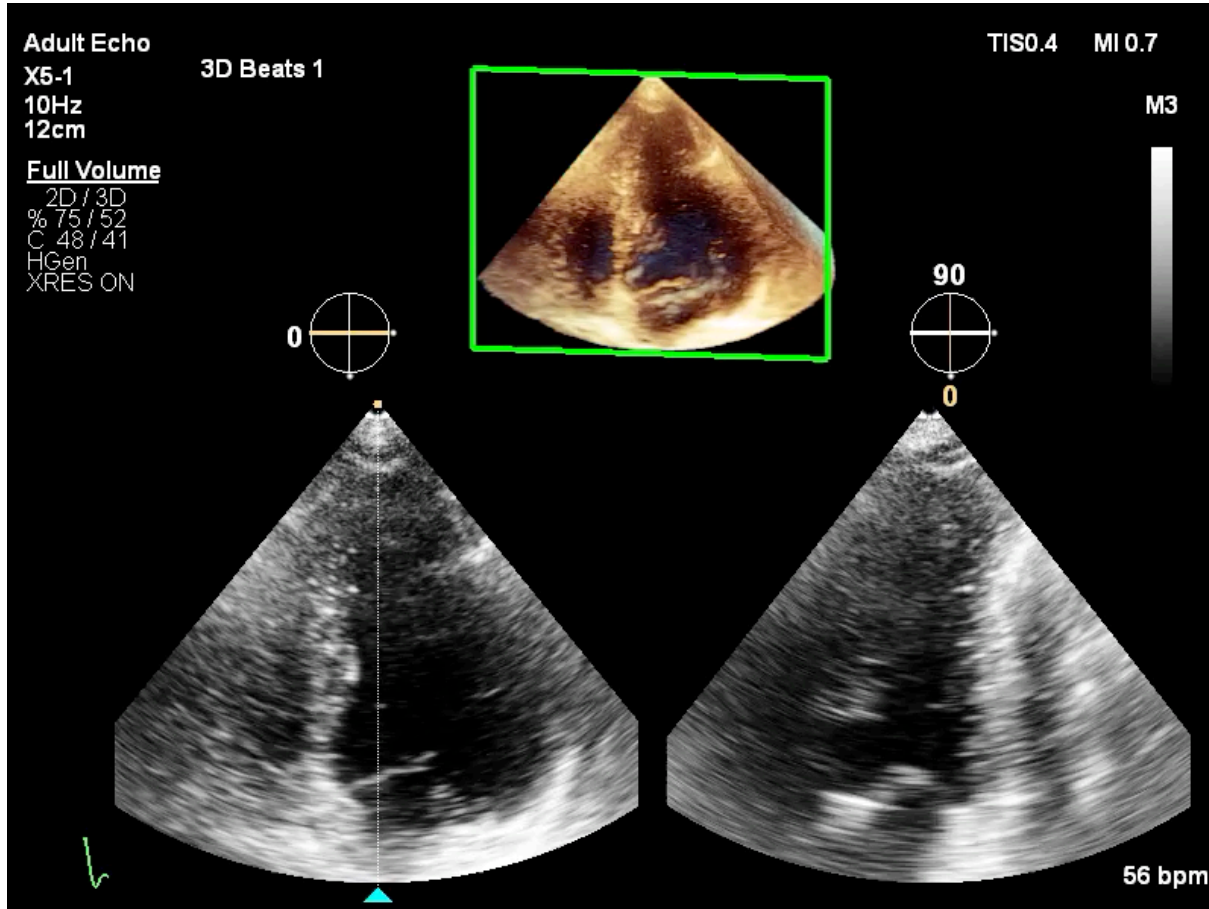
Name	Value	Normal Ref. Range
LVEF MOD biplane	59.7 %	52.0 - 72.0
LVEDV MOD biplane	96.9 ml	62.0 - 150.0
LVEDVi MOD biplane	54.6 ml/m ²	34.0 - 74.0
LVESV MOD biplane	39.0 ml	21.0 - 61.0
LVESVi MOD biplane	22.0 ml/m ²	11.0 - 31.0
LVSVMOD biplane	58.9 ml	
LVSVMOD biplane	33.2 ml/m ²	

Fully automated 3rd party AI software GLS & reporting

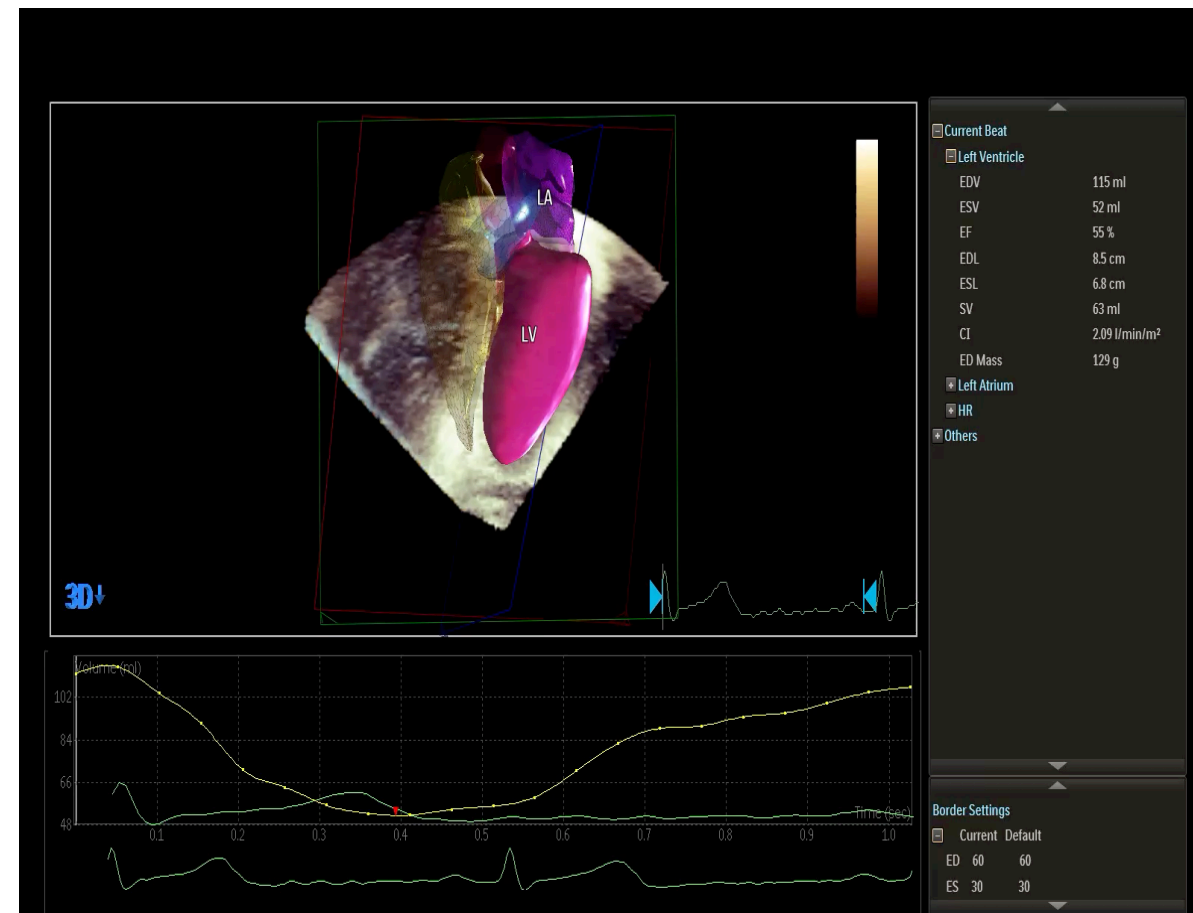
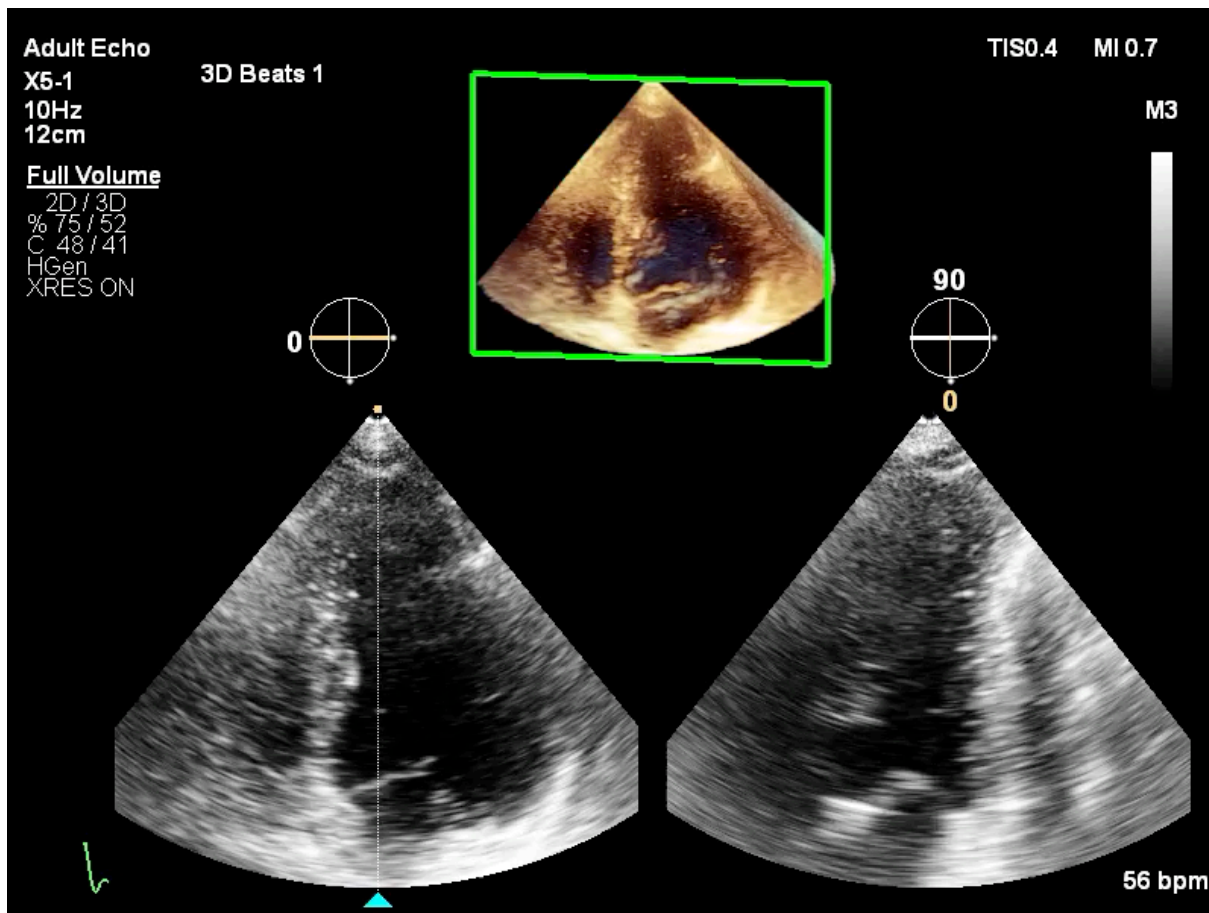
LV GLS	-22.22 %
A4C LV GLS	-22.48 %
A2C LV GLS	-25.2 %
A3C LV GLS	-18.98 %



Fully automated 3D LVEF



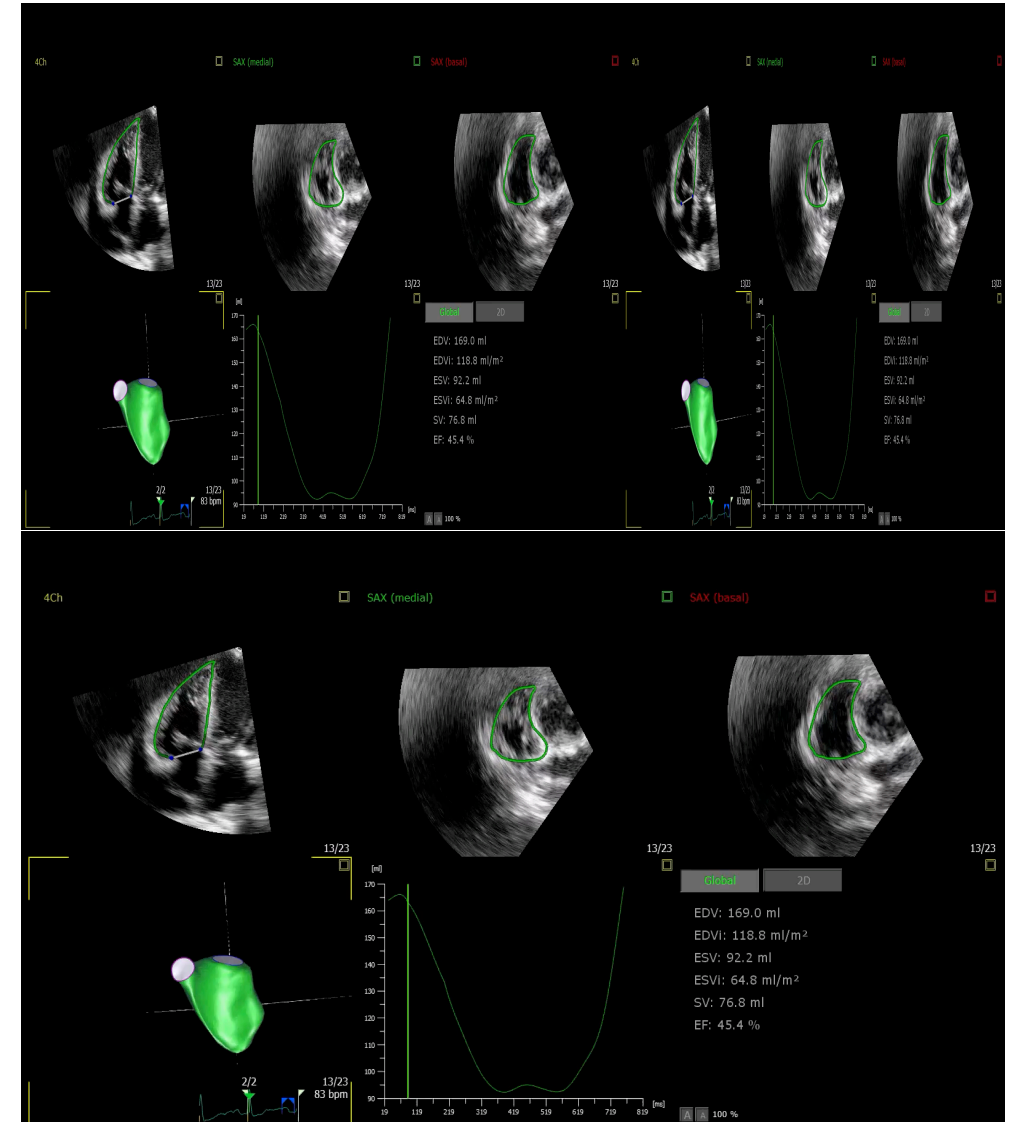
Fully automated 3D LVEF



Comparison of LV volumes and EF between different AI platform

	2D a2DQ - Semi	2D Us2AI - Full	3D LVEF - Semi	3D HQM - Full
LVEDV	101.5	96.9	110.3	115
LVESV	45	39	46.9	52
LVEF	55	59.7%	55.6%	55%

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Automated quantification – Intraobserver variability



Consistency

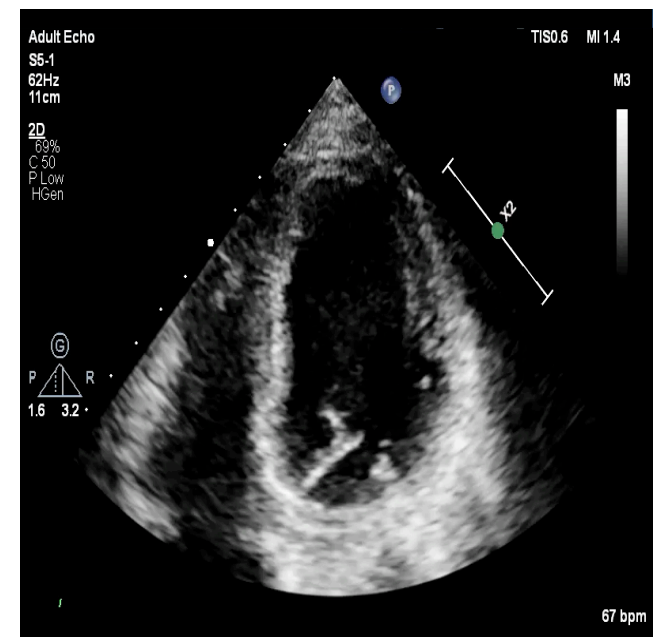
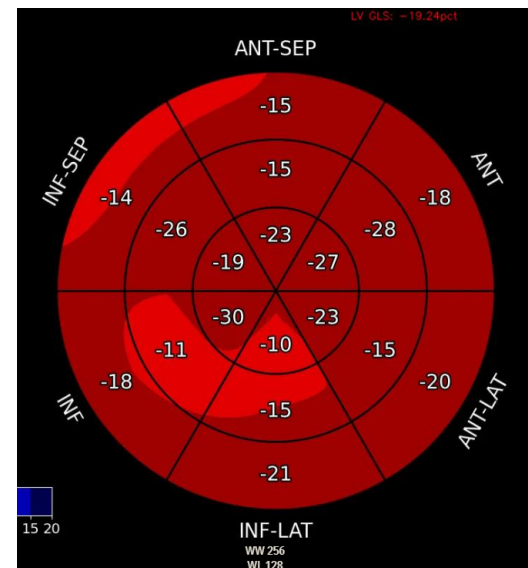
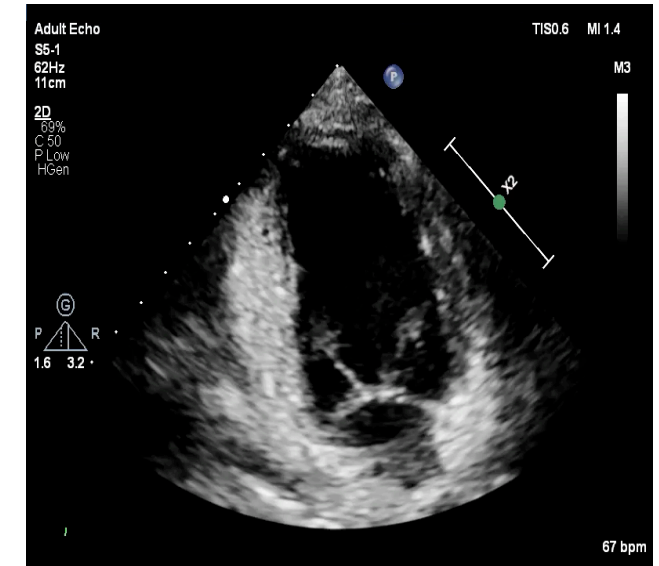
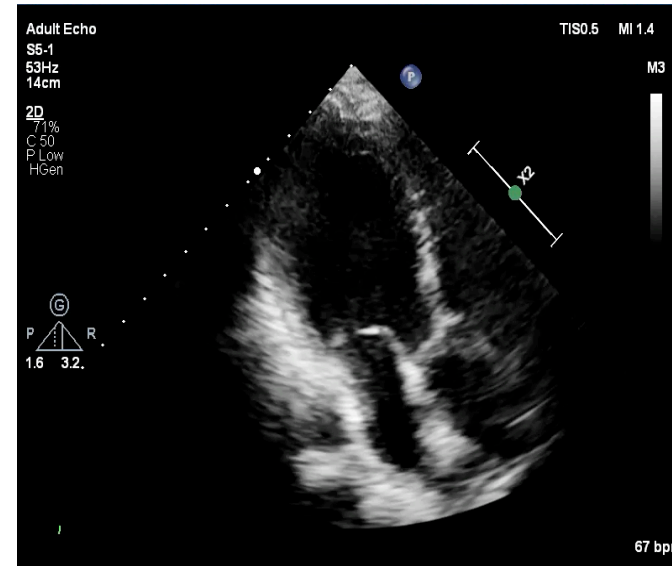
Intra & Interobserver variability of echocardiography

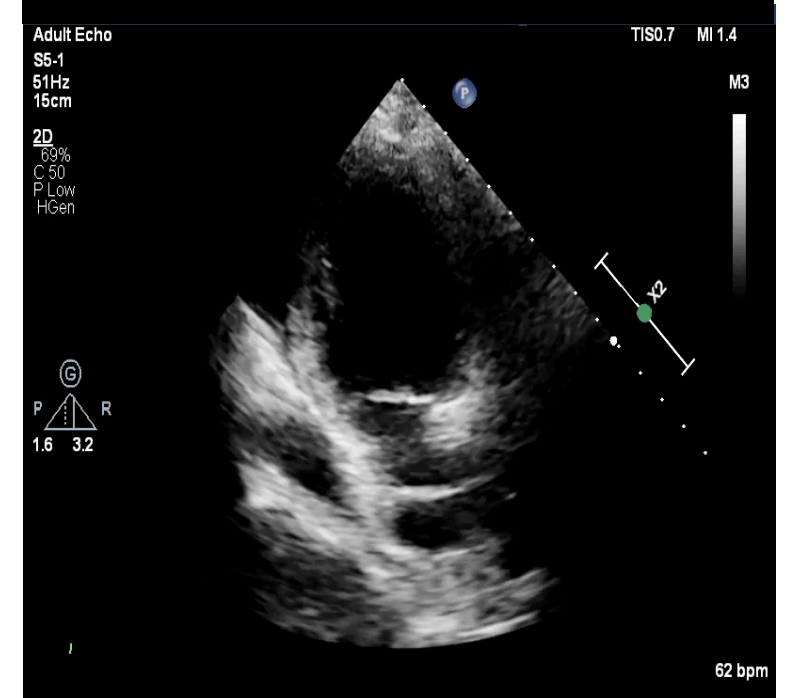
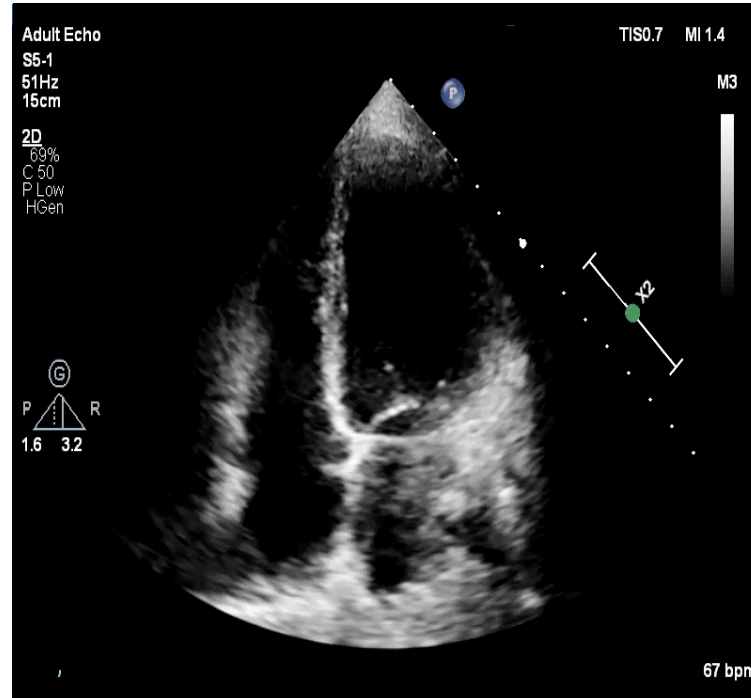
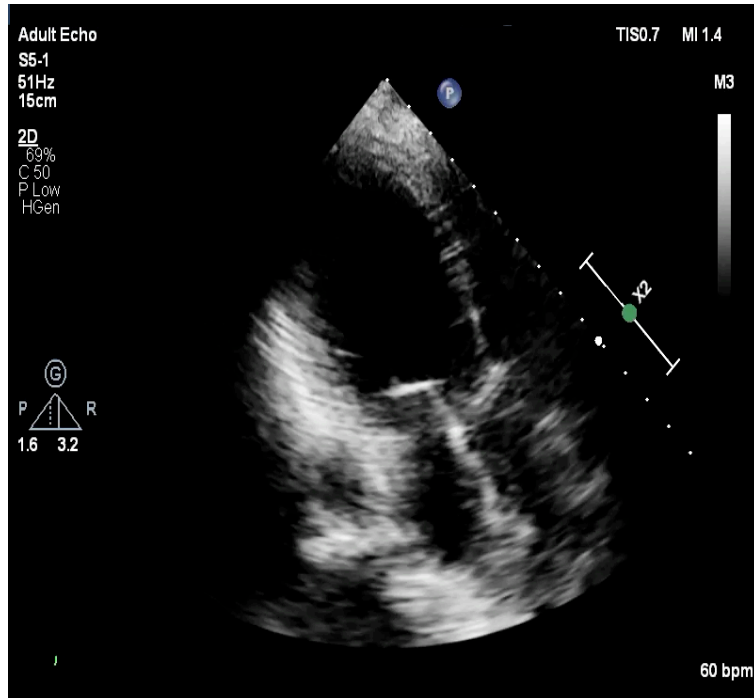
Author	Method	Interobserver variability (1.96SD of differences)	Intraobserver variability
Senior (55)	Simpson's rule	9%	6%
Jensen-Urstad (62)	Simpson's rule	16%	NR
Tsujita-Koroda (67)	Simpson's rule	21% (AQ)	13% (AQ)
		11% (H + AQ)	6% (H + AQ)
Yu (68)	Simpson's rule	8% (echogenic)	11% (echogenic)
		12% (H)	6% (H)
		4% (C)	2% (C)
Berning (40)	WMI	14%	NR
McGowan (37)	WMI	20%	NR
van Royen (36)	Subjective visual	17%	13%
Jensen-Urstad (62)	Subjective visual	8%	NR
van't Hof (64)	Subjective visual	15%	11%

NR, Not reported; echogenic, conventional 2-D imaging in selected echogenic subjects; AQ, acoustic quantification; H, secondary harmonic imaging; C, contrast imaging.

Case illustration

- 59 year old lady
- Stage I Breast cancer (Her 2 positive)
- Completed
 - Epirubicin/Cyclophosphamide
 - Docletaxel/Transtuzumab
 - Maintainence Transtuzumab
- Pre chemotherapy
 - **LVEF 53.3%**
 - **GLS -19.2%**



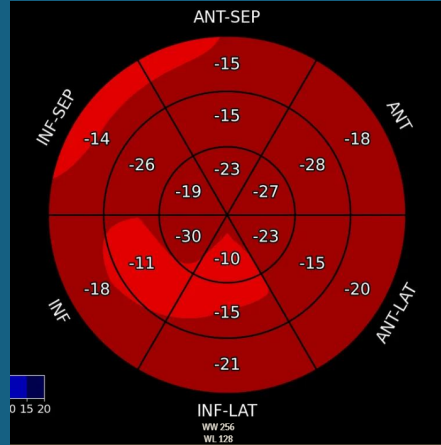


**Surveillance
echocardiogram at 6
months
LVEF 39.3%, GLS 13%**

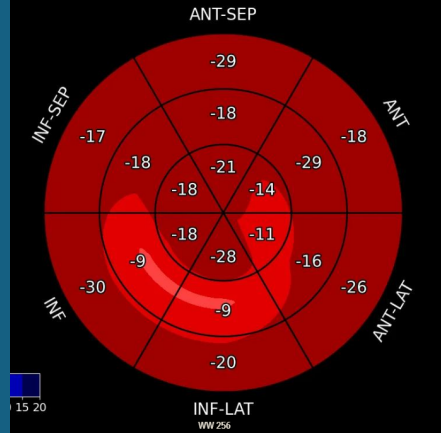
Asymptomatic severe cancer therapy related cardiac dysfunction

- Transtuzumab was withheld
- Started on 4 pillars of heart failure therapy

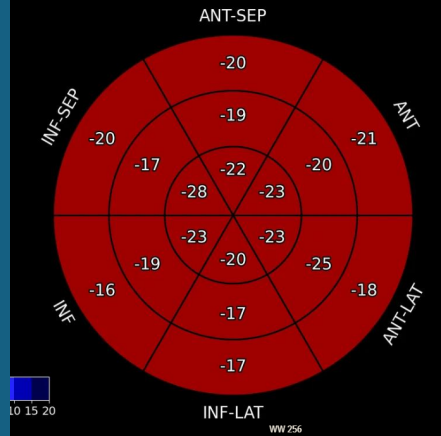
AI Analysis performed December 2024



Prechemotherapy
LVEF 53.3%, GLS
-19.2%

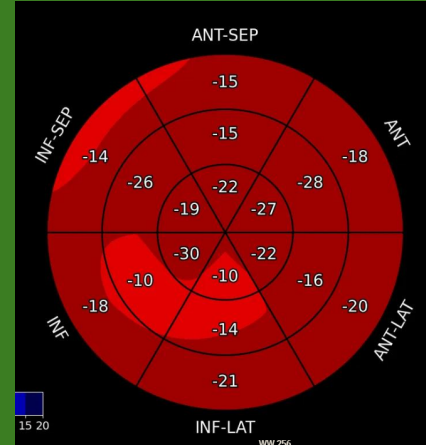


1 month post
discontinuation of
Transtuzumab
LVEF 54.1%, GLS
-19.3%

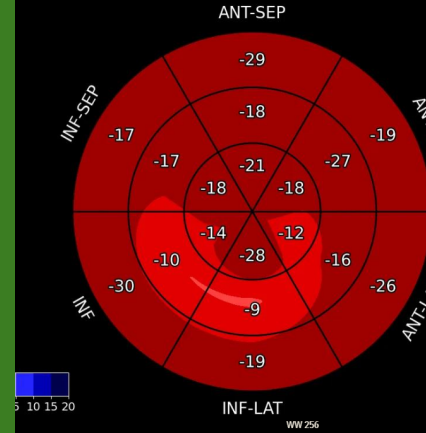


3 months post
discontinuation of
Transtuzumab
LVEF 54.1%, GLS
-19.3%

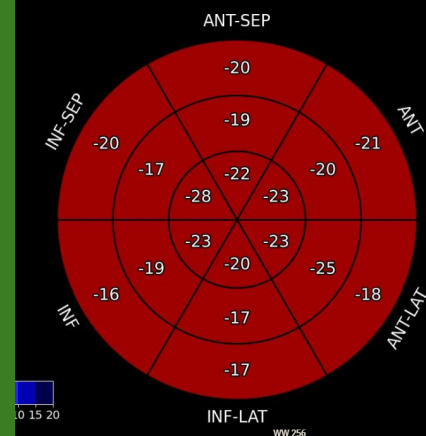
AI Analysis performed May 2025



Prechemotherapy
LVEF 53.3%, GLS
-19.2%



1 month post
discontinuation of
Transtuzumab
LVEF 54.1%, GLS
-19.3%



3 months post
discontinuation of
Transtuzumab
LVEF 54.1%, GLS
-19.3%



AI vs Visual vs Manual EF & Strain

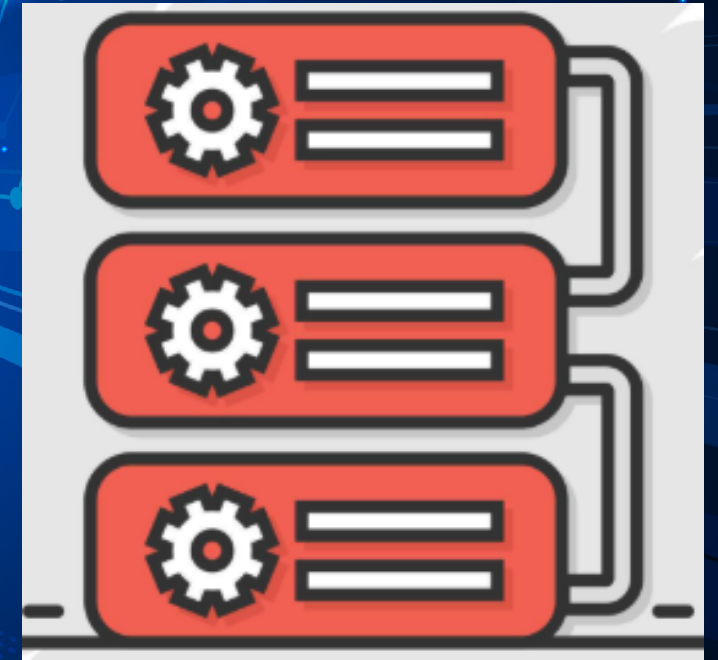
TABLE 4 Interrater and Intrarater Reliability of EF and LS Measurements in MAA and PAD

	Intraobserver Variability					Interobserver Variability				
	Reading 1	Reading 2	p Value	ICC	Bland-Altman Bias (LOA)	MAA	PAD	p Value	ICC	Bland-Altman Bias (LOA)
Visual EF, %						43.8 ± 14.8	51.4 ± 17.4	0.001	0.87	−7.6 (−25.6 to 10.4)
MAA	43.8 ± 14.8	50.5 ± 13.6	<0.001	0.96	−6.8 (−9.4 to −4.1)					
PAD	51.4 ± 17.4	49.5 ± 15.9	0.18	0.97	1.9 (−1.0 to 4.7)					
Manual EF, %						49.6 ± 14.8	62.0 ± 16.1	<0.001	0.78	−12.4 (−29.8 to 5.0)
MAA	49.6 ± 14.8	52.2 ± 14.3	0.19	0.90	−2.6 (−6.7 to 1.4)					
PAD	62.0 ± 16.1	62.1 ± 17.2	0.93	0.96	−0.1 (−3.0 to 2.8)					
Manual LS, %						19.7 ± 6.0	20.3 ± 6.0	0.539	0.88	−0.6 (−9.2 to 8.0)
MAA	18.3 ± 7.0	19.7 ± 6.0	0.14	0.90	−1.4 (−3.3 to 0.5)					
PAD	21.8 ± 7.0	20.3 ± 6.0	0.03	0.95	1.6 (0.1 to 3.0)					
Automated LS, %	19.1 ± 6.0	19.1 ± 6.0	—	1.00	0	19.1 ± 6.0	19.1 ± 6.0	NS	1.00	0

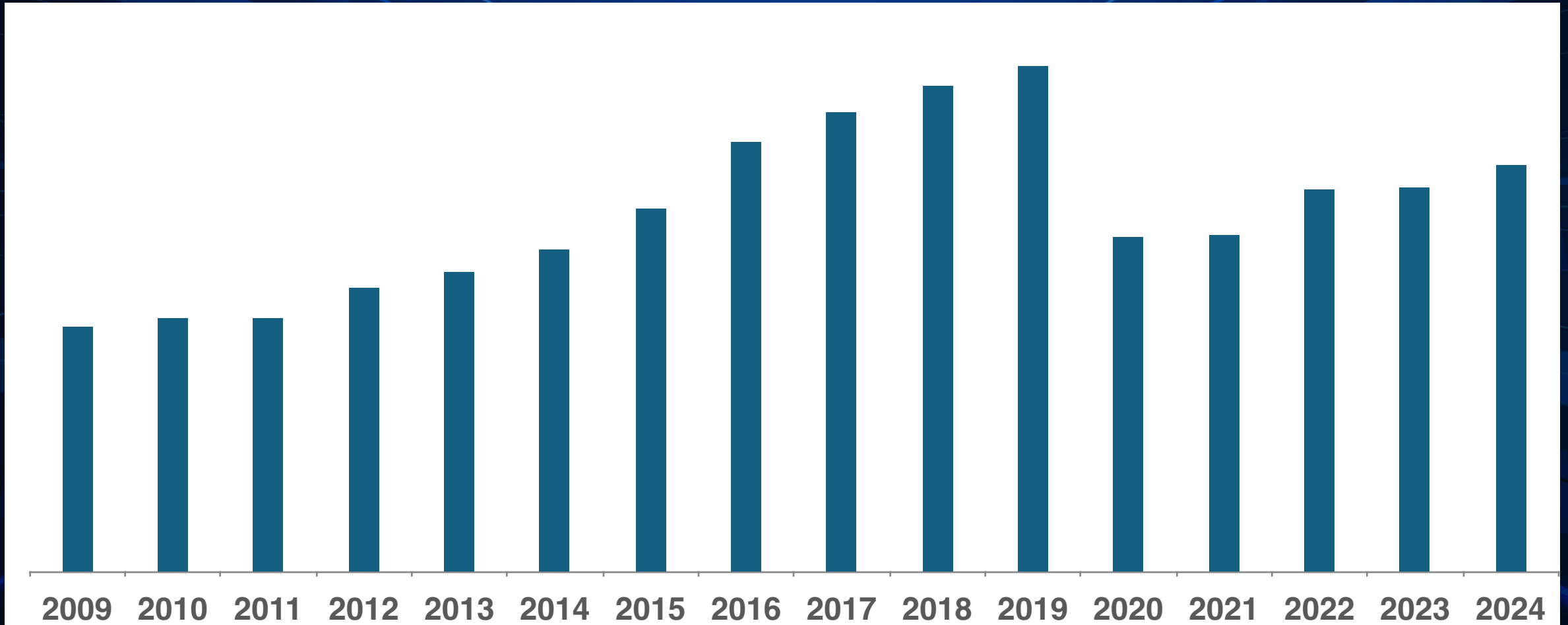
Values are mean ± SD.

LOA = levels of agreement; PAD = Padua; other abbreviations as in Tables 2 and 3.

Automated quantification - Efficiency

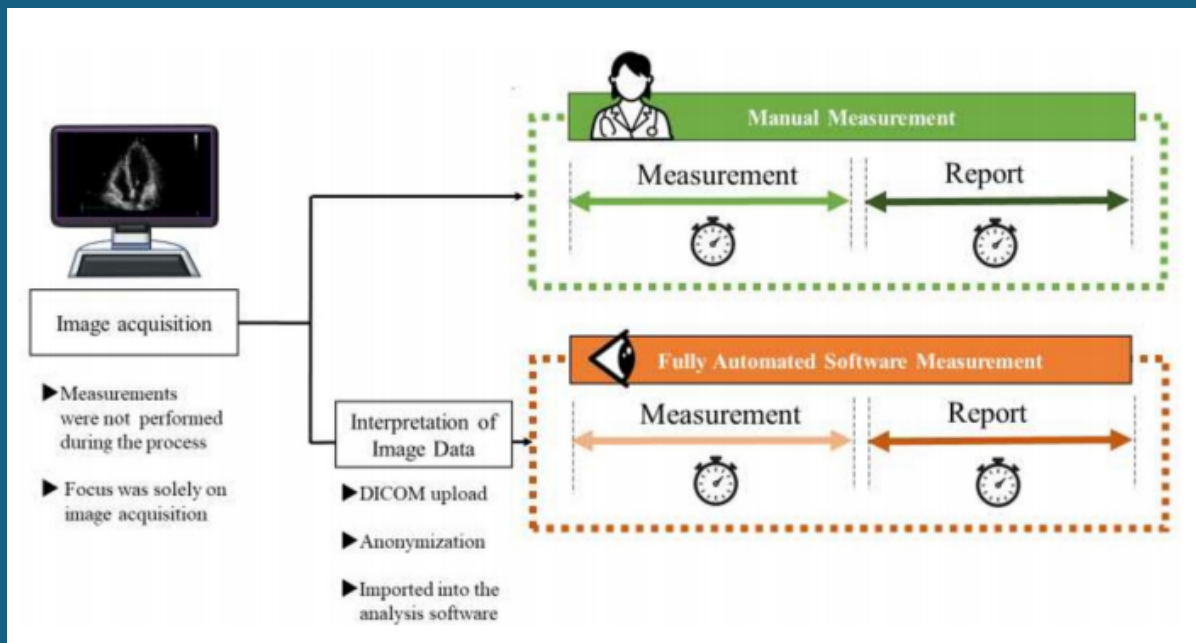


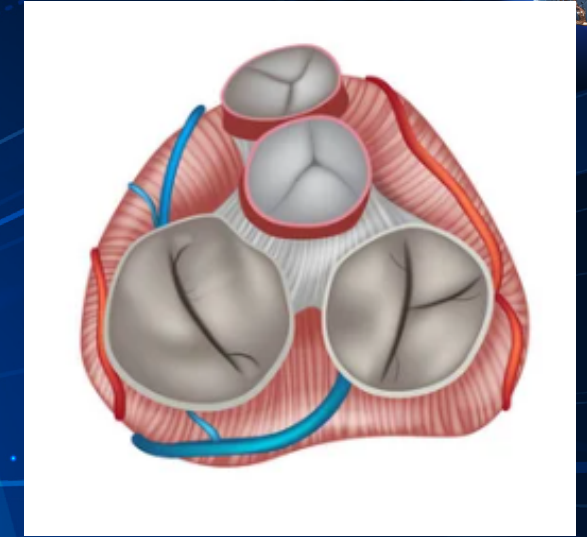
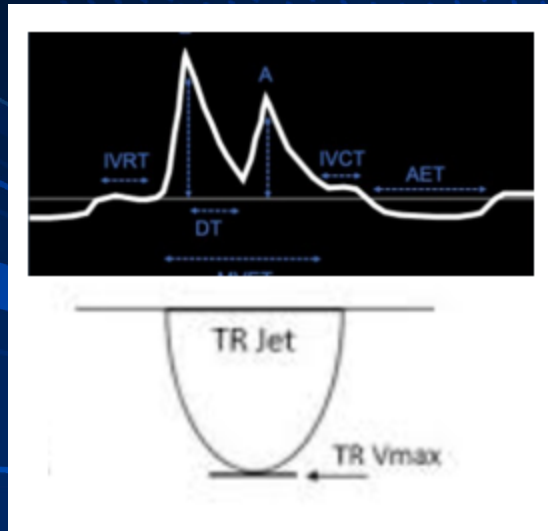
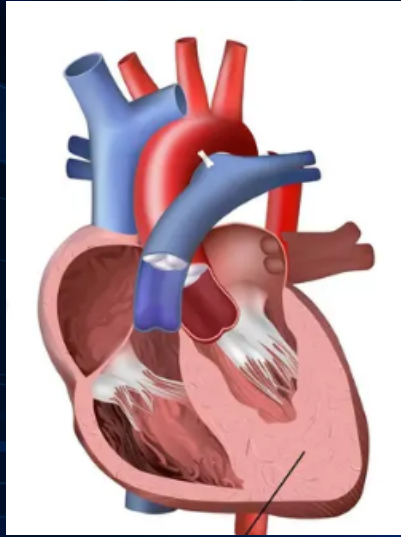
Number of echocardiogram performed from 2009-2024 at PJS, Sarawak



Reducing echocardiographic examination time through routine use of fully automated software: a comparative study of measurement and report creation time

Yukina Hirata¹ · Yuka Nomura¹ · Yoshihito Saijo² · Masataka Sata² · Kenya Kusunose^{2,3} 

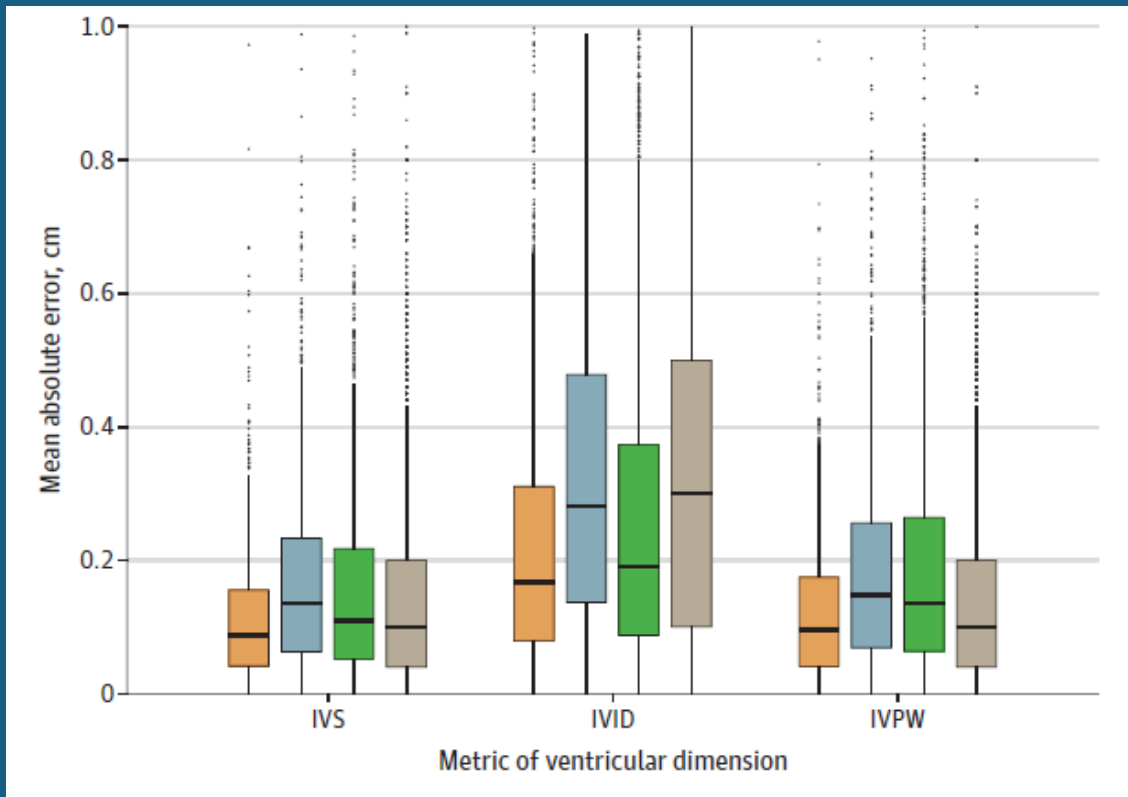




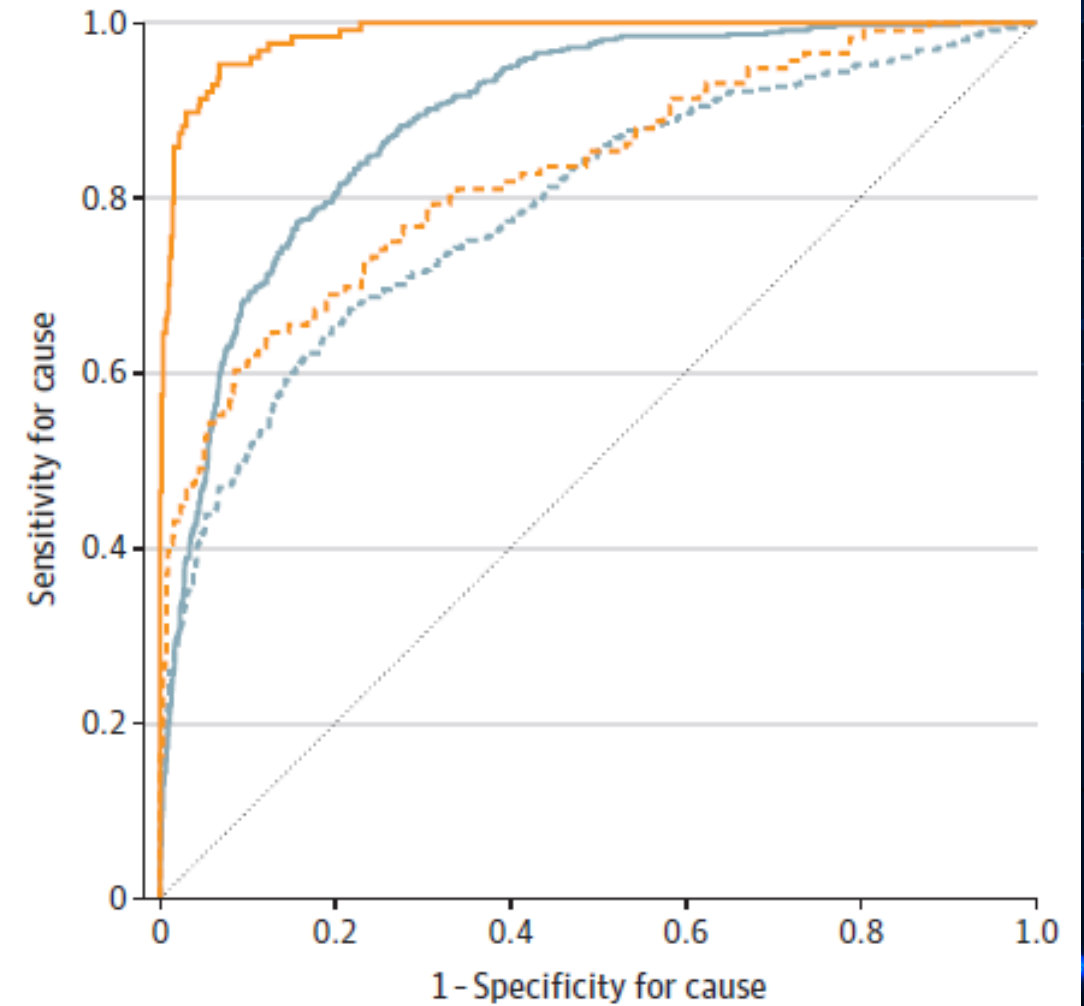
Disease detection

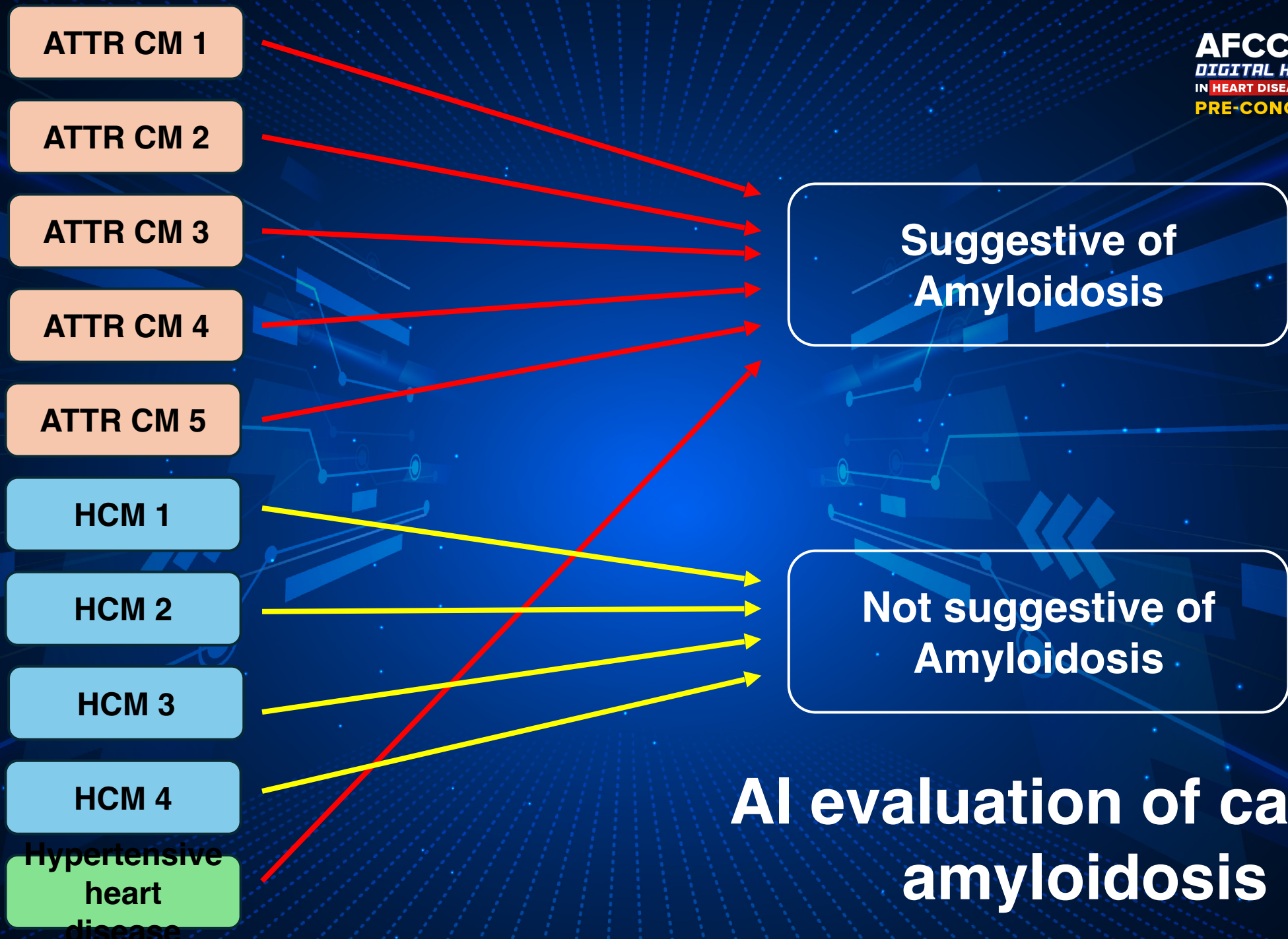
High-Throughput Precision Phenotyping of Left Ventricular Hypertrophy With Cardiovascular Deep Learning

Grant Duffy, BS; Paul P. Cheng, MD, PhD; Neal Yuan, MD; Bryan He, BS; Alan C. Kwan, MD; Matthew J. Shun-Shin, PhD; Kevin M. Alexander, MD; Joseph Ebinger, MD; Matthew P. Lungren, MD; Florian Rader, MD, MSc; David H. Liang, MD, PhD; Ingela Schnittger, MD; Euan A. Ashley, MBChB, DPhil; James Y. Zou, PhD; Jignesh Patel, MD, PhD; Ronald Witteles, MD; Susan Cheng, MD, MPH; David Ouyang, MD



D Receiver operating characteristic curves for diagnosis of amyloidosis

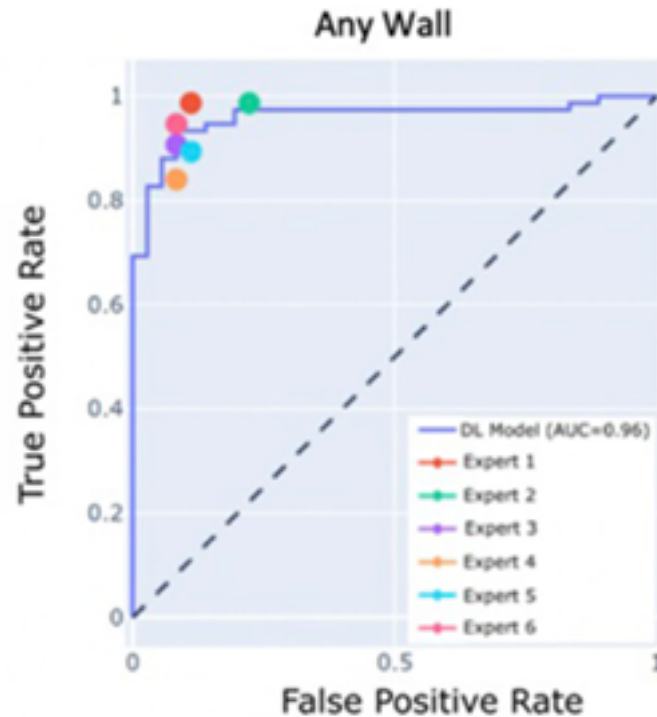




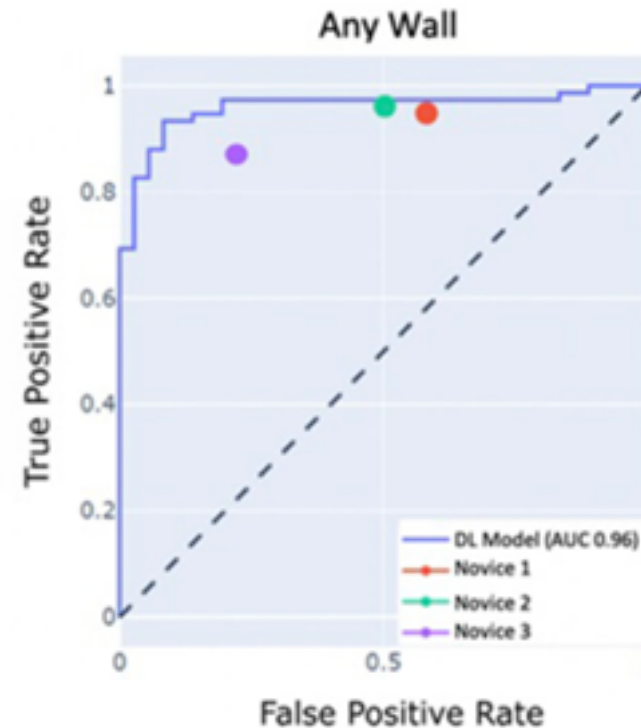
AI evaluation of cardiac amyloidosis

Ischemic heart disease

B. AI Provides Comparable Accuracy to Expert Readers



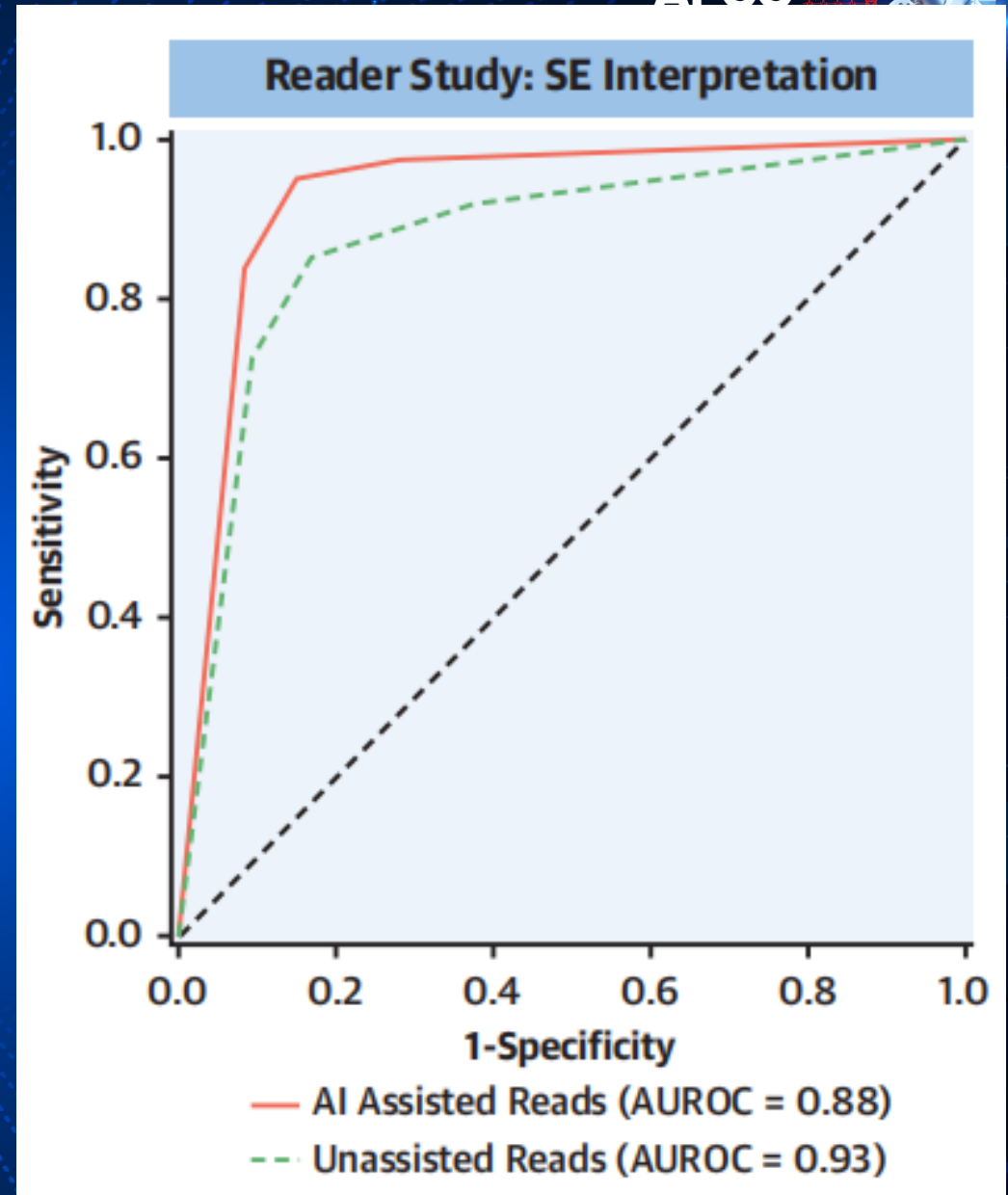
C. AI Outperforms A Majority of Novice Readers



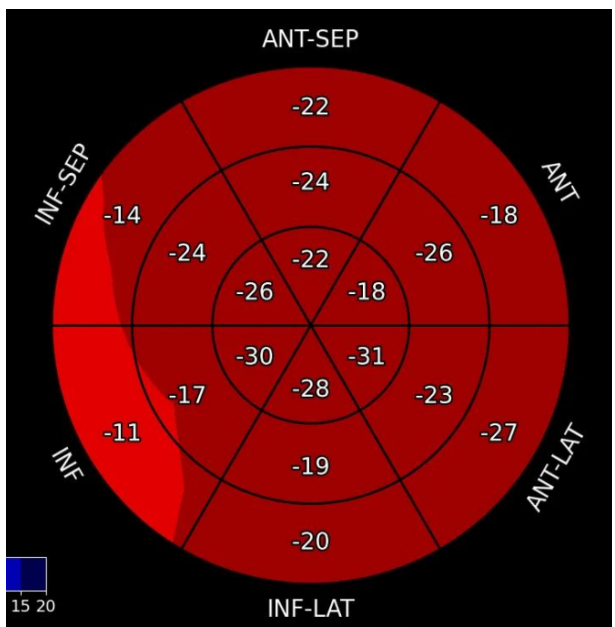
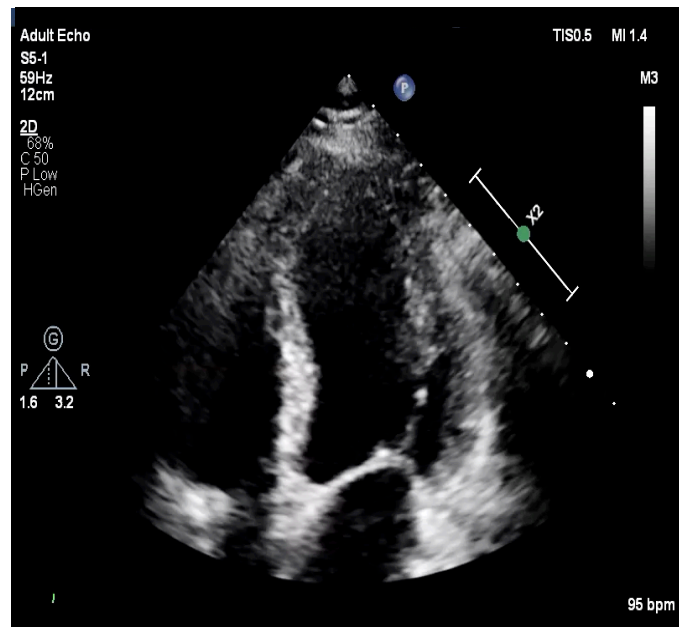
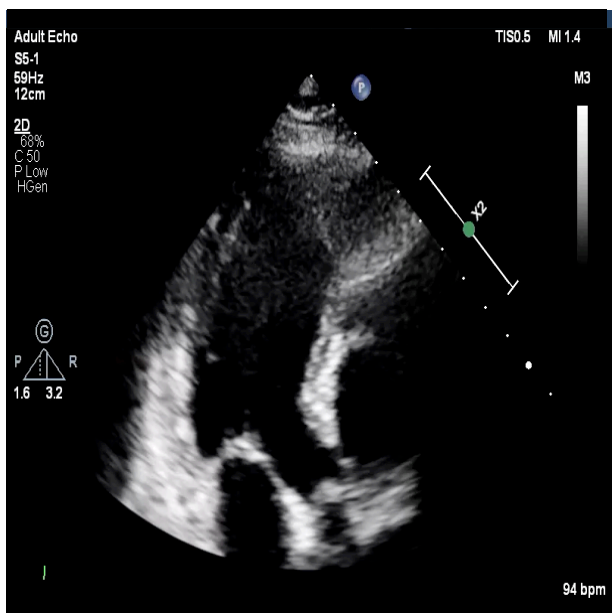
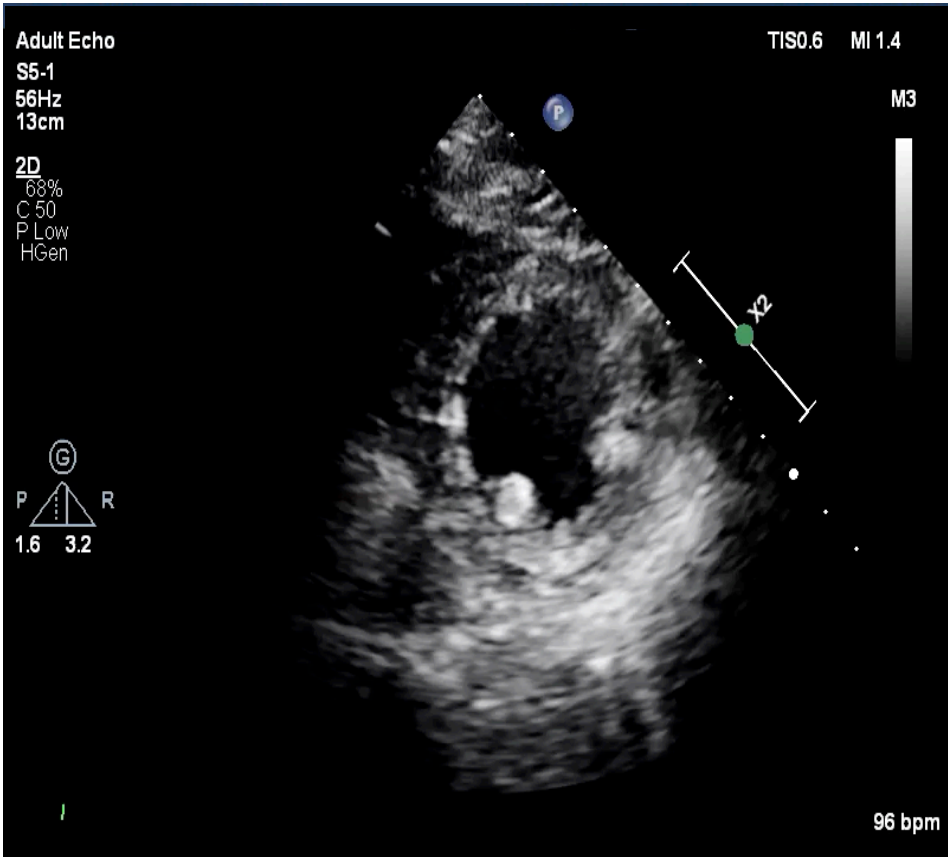
Automated Echocardiographic Detection of Severe Coronary Artery Disease Using Artificial Intelligence

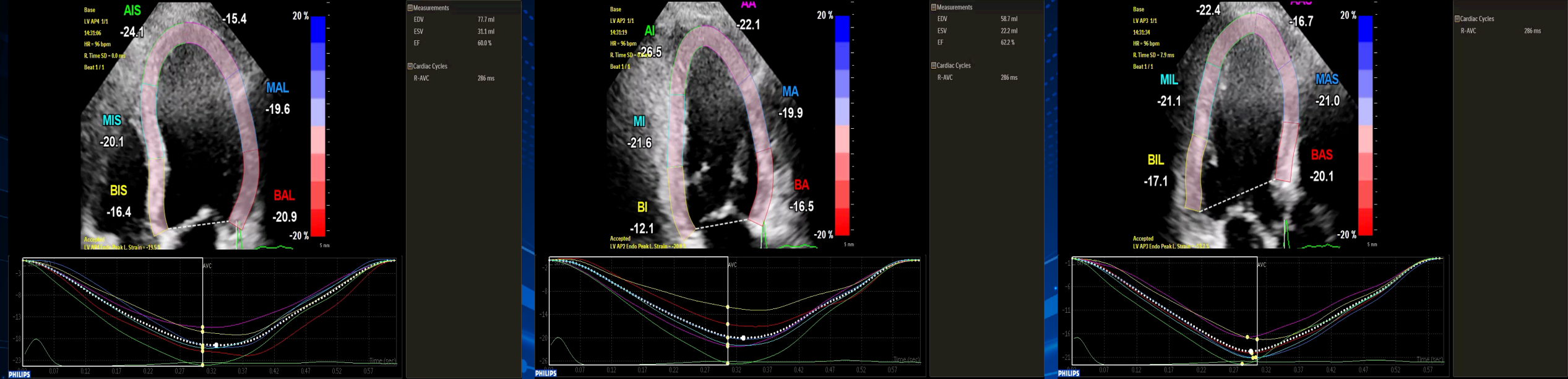


Ross Upton, PhD,^{a,b} Angela Mumith, PhD,^{a,*} Arian Beqiri, PhD,^{a,*} Andrew Parker, PhD,^{a,*} William Hawkes, PhD,^{a,*} Shan Gao, PhD,^a Mihaela Porumb, PhD,^a Rizwan Sarwar, MD,^b Patricia Marques, BSc,^a Deborah Markham, PhD,^a Jake Kenworthy, BSc,^a Jamie M. O'Driscoll, PhD,^{a,c} Neelam Hassanali, PhD,^a Kate Groves, PhD,^a Cameron Dockerill, BSc,^b William Woodward, BSc,^b Maryam Alsharqi, MSc,^b Annabelle McCourt, MSc,^b Edmund H. Wilkes, PhD,^a Stephen B. Heitner, MD,^d Mrinal Yadava, MD,^d David Stojanovski, MEng,^e Pablo Lamata, PhD,^e Gary Woodward, PhD,^a Paul Leeson, MB, BCHIR, PhD^{a,b}

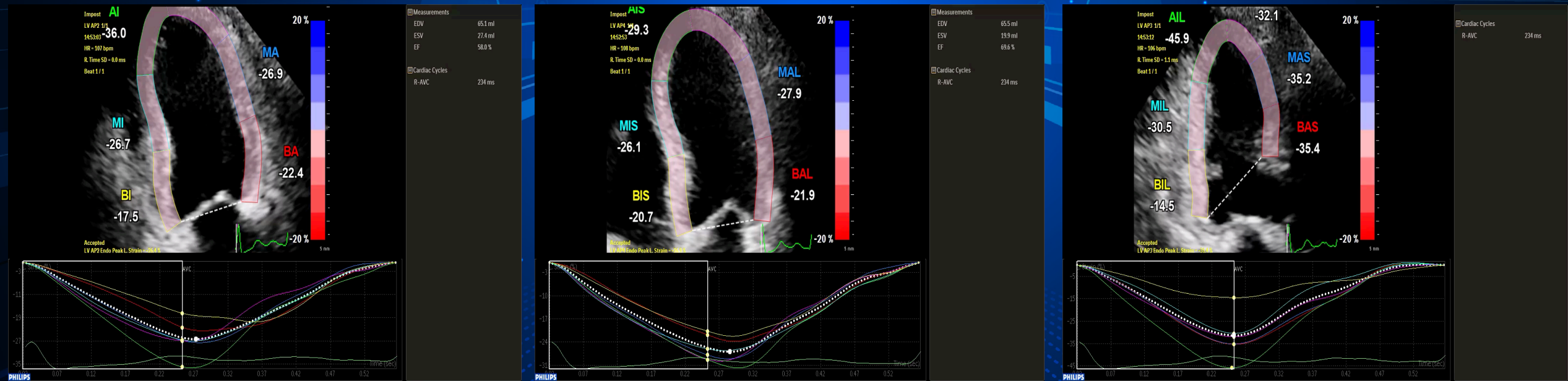


Case illustration
76 year old gentlemen with shortness of breath





GLS and LVEF at rest



GLS and LVEF at peak stress

* :HR Variation > 10%; Yellow: Accepted; Red: Accept Pending
Base

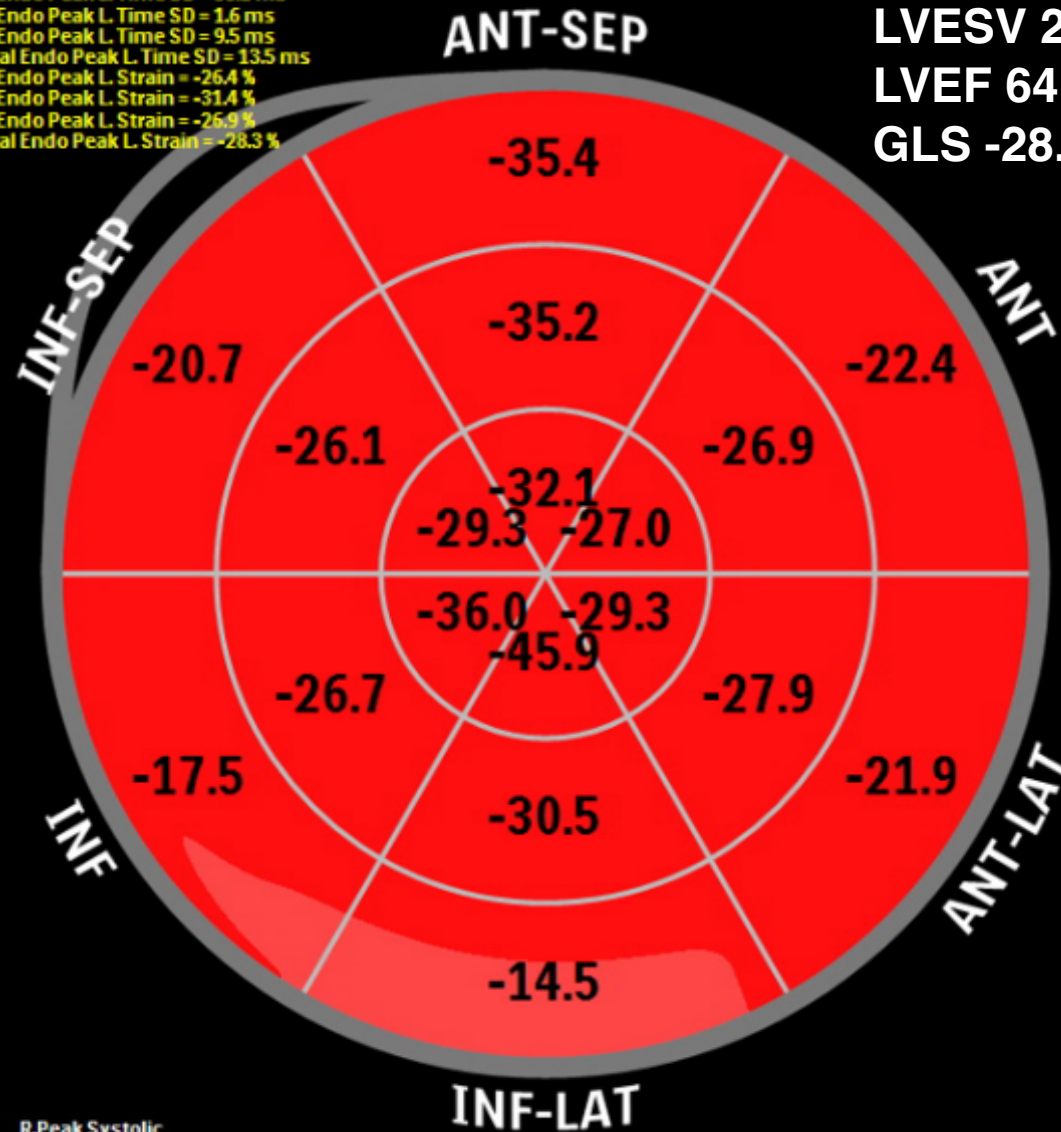
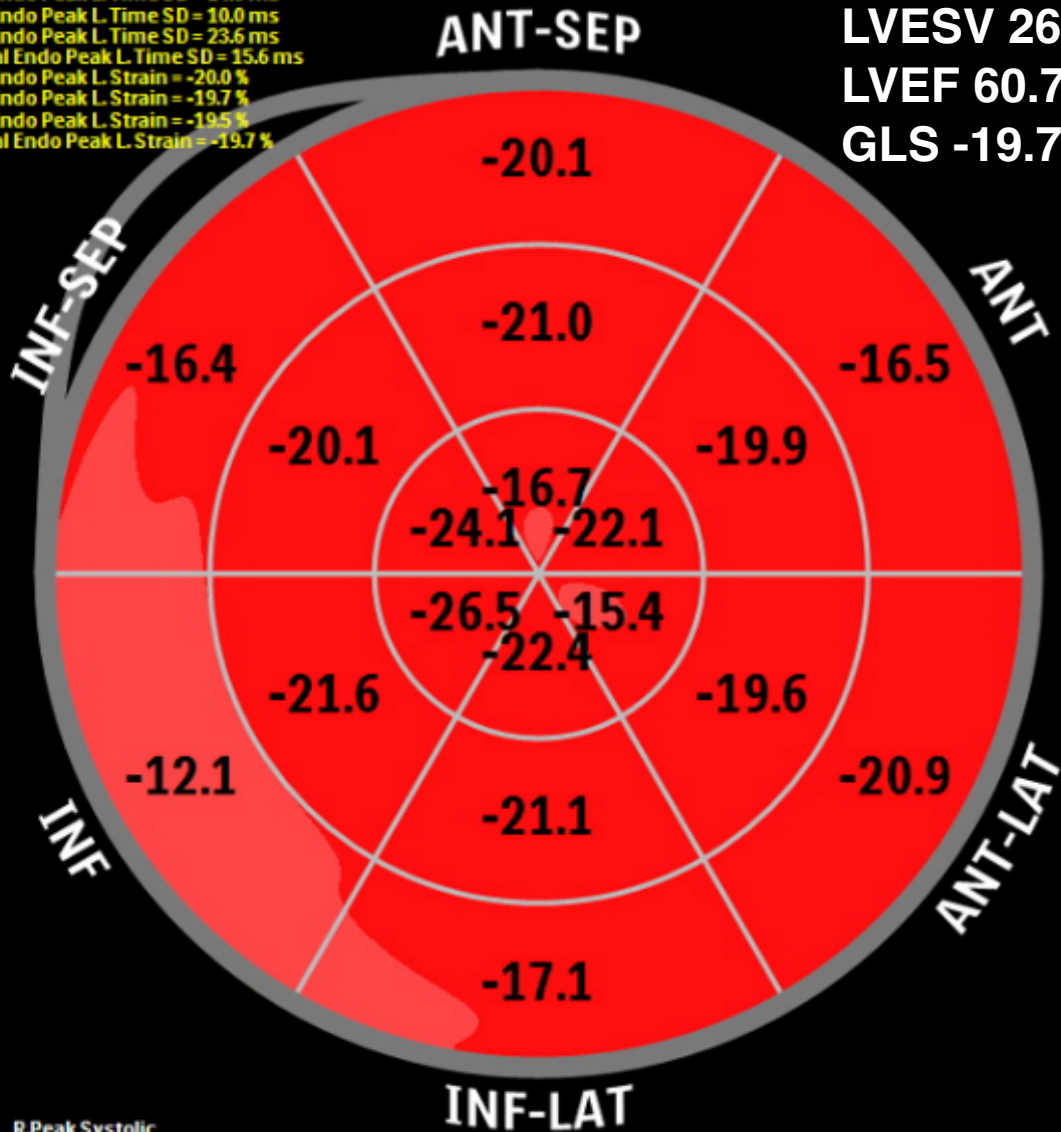
HR (Avg.) = 96 bpm
EDV (LV Bi-Plane) = 68.2 ml
ESV (LV Bi-Plane) = 26.8 ml
EF (LV Bi-Plane) = 60.7 %
LVAP2 Endo Peak L. Time SD = 14.0 ms
LVAP3 Endo Peak L. Time SD = 10.0 ms
LVAP4 Endo Peak L. Time SD = 23.6 ms
LV Global Endo Peak L. Time SD = 15.6 ms
LVAP2 Endo Peak L. Strain = -20.0 %
LVAP3 Endo Peak L. Strain = -19.7 %
LVAP4 Endo Peak L. Strain = -19.5 %
LV Global Endo Peak L. Strain = -19.7 %

Base
LVEDV 68.2ml
LVESV 26.8ml
LVEF 60.7%
GLS -19.7%

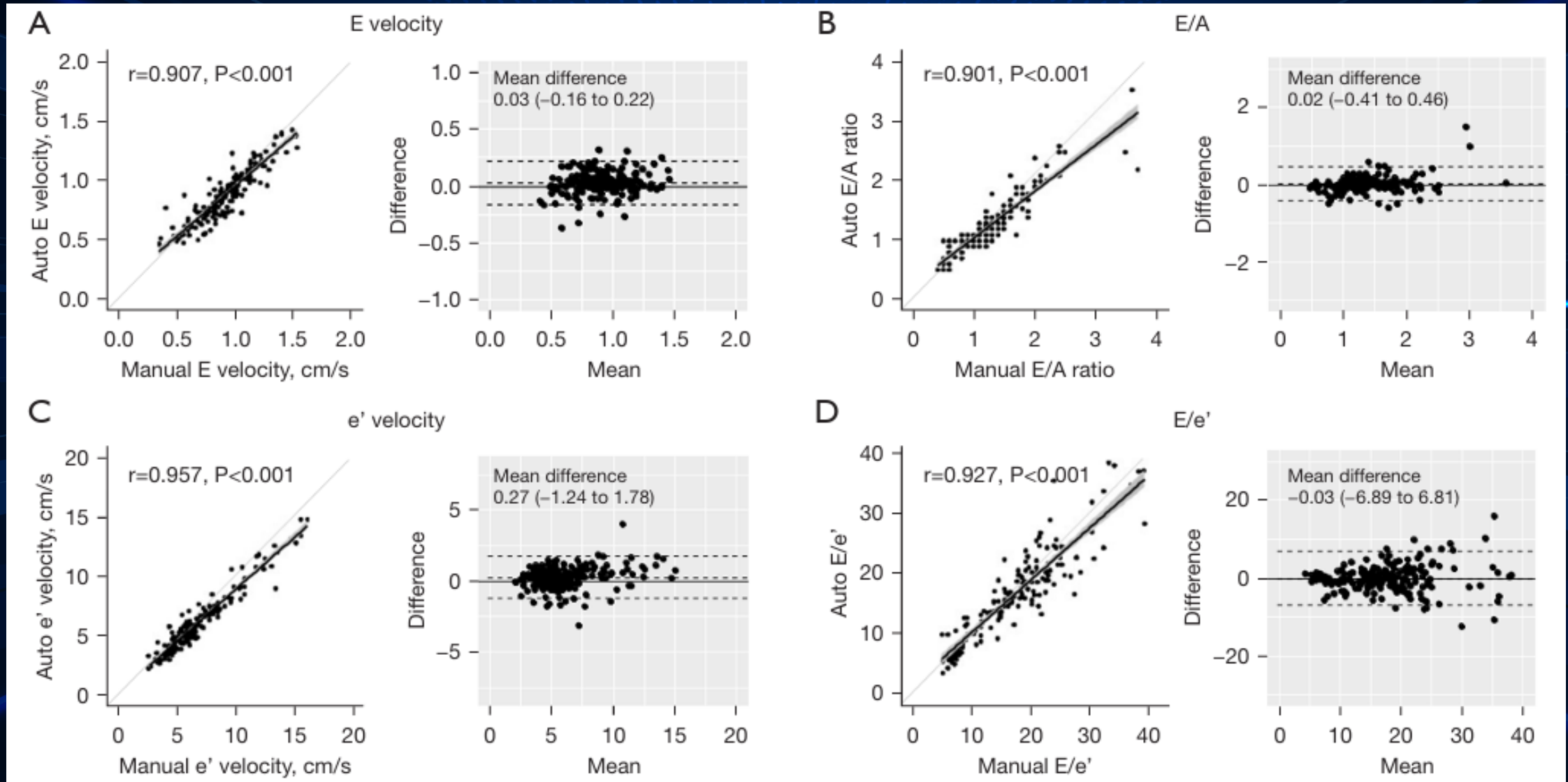
Impost

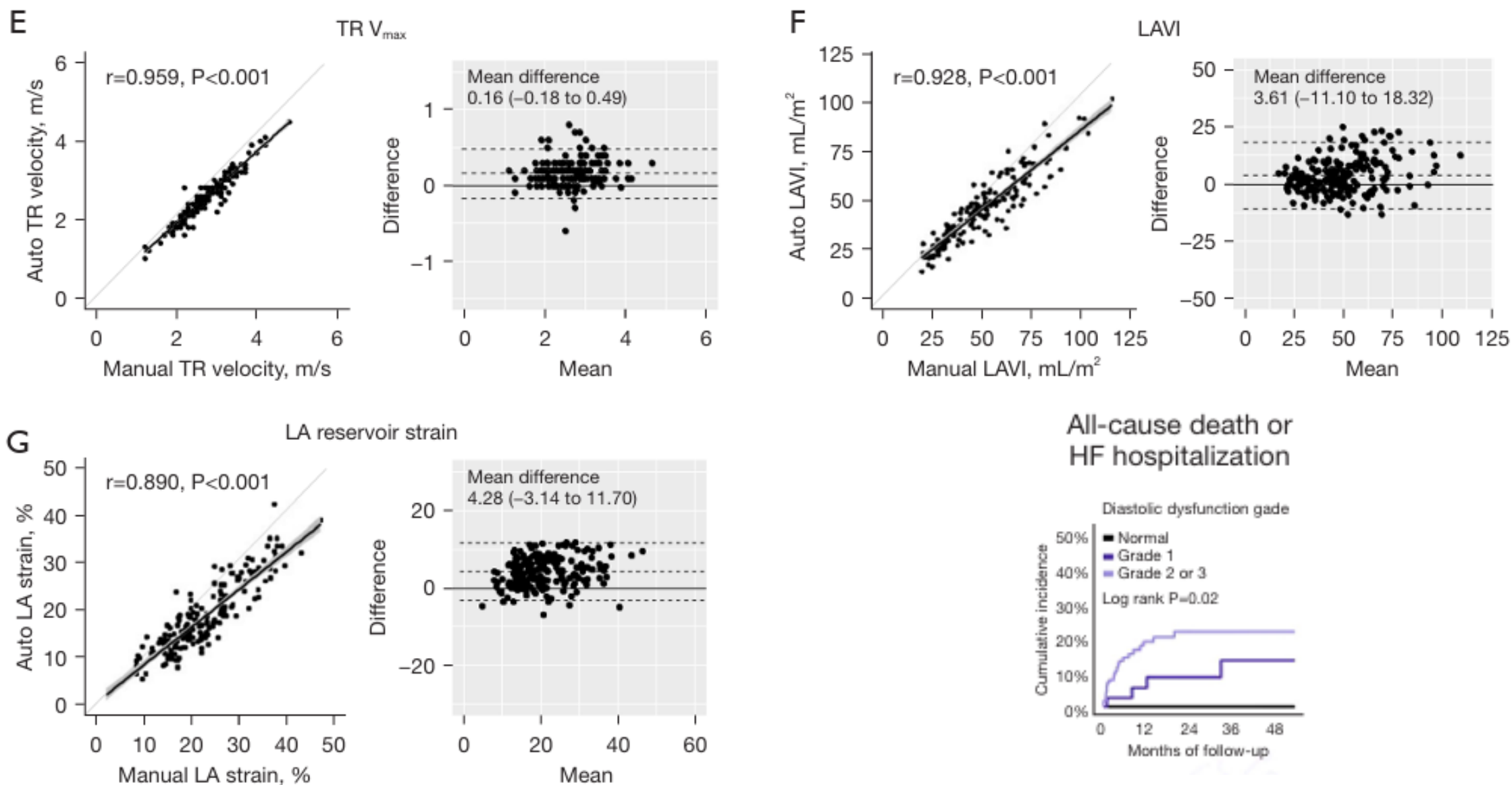
HR (Avg.) = 107 bpm
EDV (LV Bi-Plane) = 65.9 ml
ESV (LV Bi-Plane) = 23.2 ml
EF (LV Bi-Plane) = 64.7 %
LVAP2 Endo Peak L. Time SD = 33.1 ms
LVAP3 Endo Peak L. Time SD = 1.6 ms
LVAP4 Endo Peak L. Time SD = 9.5 ms
LV Global Endo Peak L. Time SD = 13.5 ms
LVAP2 Endo Peak L. Strain = -26.4 %
LVAP3 Endo Peak L. Strain = -31.4 %
LVAP4 Endo Peak L. Strain = -26.9 %
LV Global Endo Peak L. Strain = -28.3 %

Peak stress
LVEDV 65.9ml
LVESV 23.2ml
LVEF 64.7%
GLS -28.3%



Diastolic dysfunction



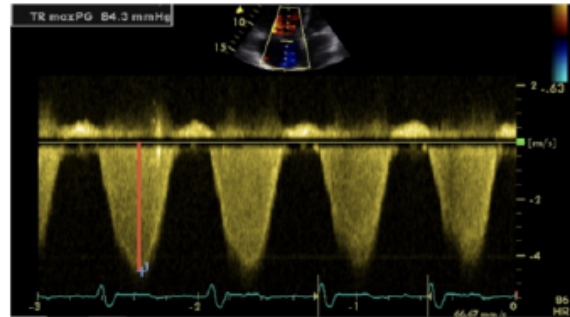


Pulmonary hypertension

Suspected PH
(n=1031)



Echocardiography:
recommended first-line screening tool



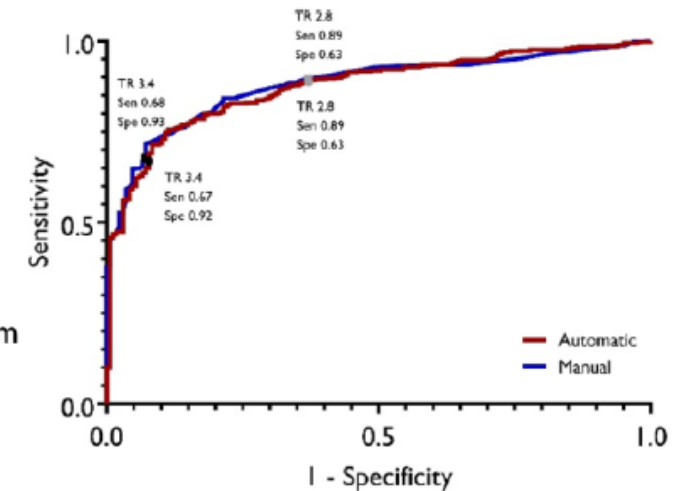
AI



Automated TRJV
measurement from
echocardiogram

AI-based tool for evaluating echocardiograms can accurately and reliably measure TRJV in patients with PH. The study supports a role for AI-based evaluation of echocardiograms in PH patients.

Prediction of PH
mPAP >20 mmHg: Automatic vs Manual



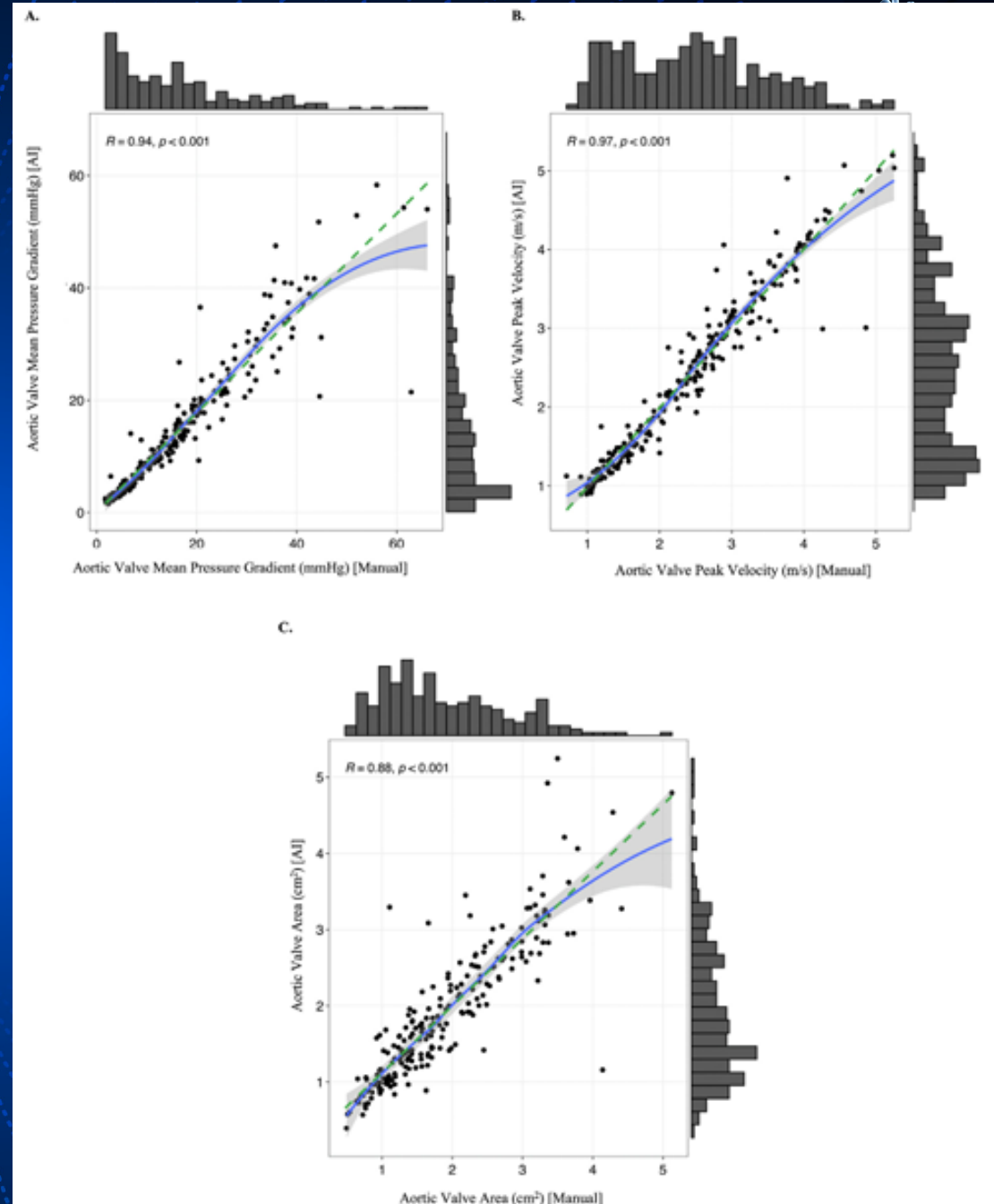
Automated TRJV measurement showed equally high diagnostic accuracy for PH vs manual measurements (AUC 0.88 vs 0.88)

AI in Valvular heart disease – severe AS

Fully Automated Artificial Intelligence Assessment of Aortic Stenosis by Echocardiography



Hema Krishna, MD, Kevin Desai, MD, Brody Slostad, MD, Siddharth Bhayani, MD, Joshua H. Arnold, MD, Wouter Ouwerkerk, PhD, Yoran Hummel, PhD, Carolyn S. P. Lam, MBBS, PhD, Justin Ezekowitz, MBBCh, MSc, Matthew Frost, BE, Zhubo Jiang, MSc, Cyril Equilbec, MEng, Aamir Twing, MD, Patricia A. Pellikka, MD, Leon Frazin, MD, and Mayank Kansal, MD, *Chicago, Illinois; Singapore; Amsterdam, Netherlands; Edmonton, Alberta, Canada; and Rochester, Minnesota*

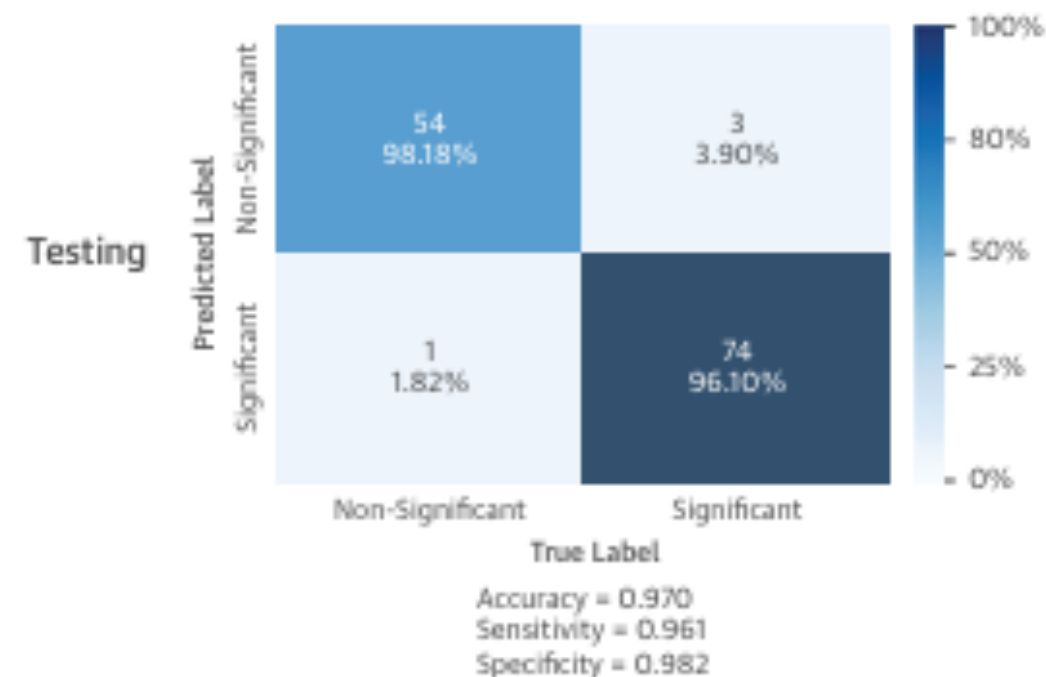
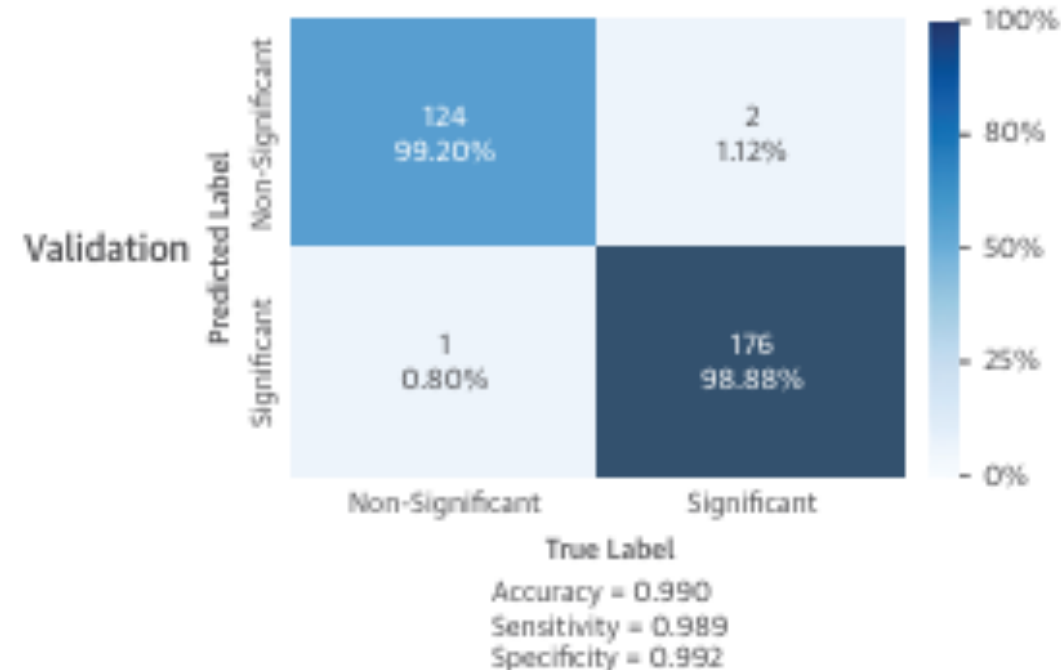


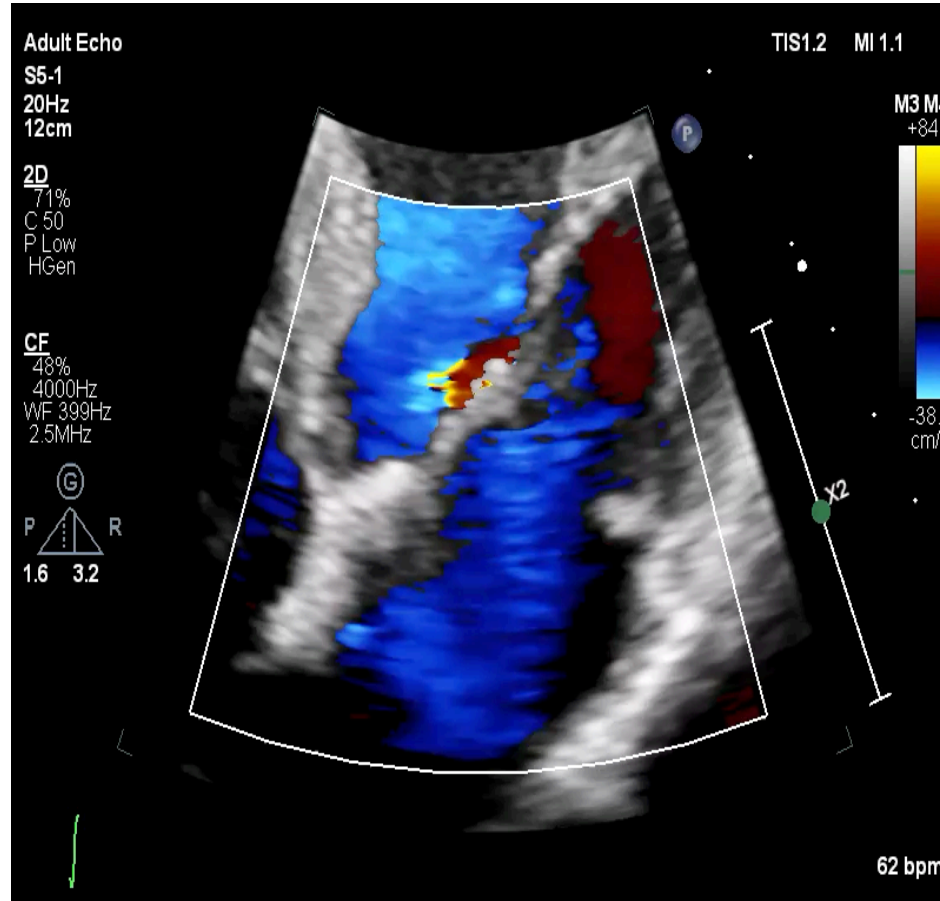
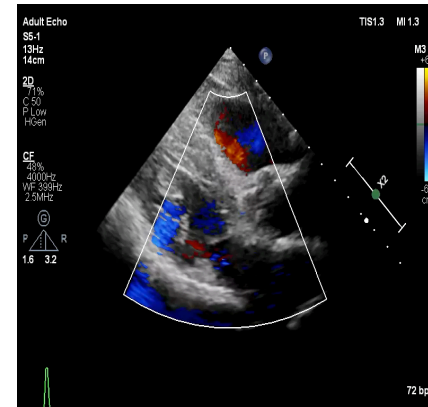
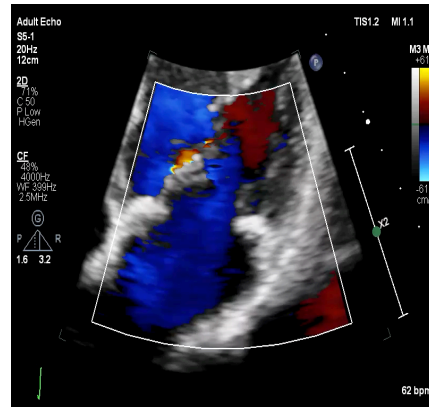
AI in Valvular heart disease – MR

An Automated Machine Learning-Based Quantitative Multiparametric Approach for Mitral Regurgitation Severity Grading



Anita Sadeghpour, MD,^a Zubo Jiang,^b Yoran M. Hummel, PhD,^b Matthew Frost, BE,^b Carolyn S.P. Lam, MD,^c Sanjiv J. Shah, MD,^d Lars H. Lund, MD,^e Gregg W. Stone, MD,^f Madhav Swaminathan, MD,^g Neil J. Weissman, MD,^a Federico M. Asch, MD^a

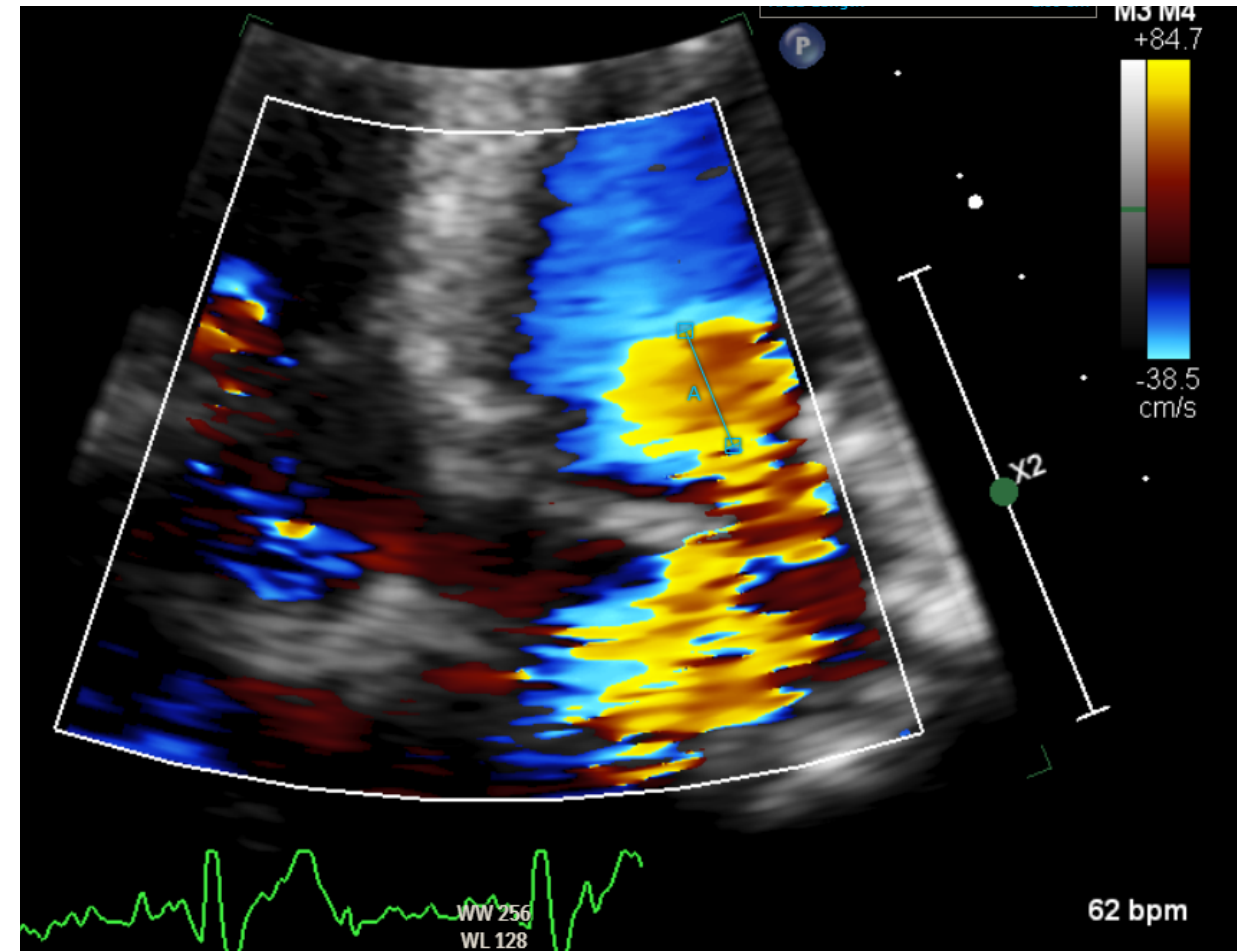
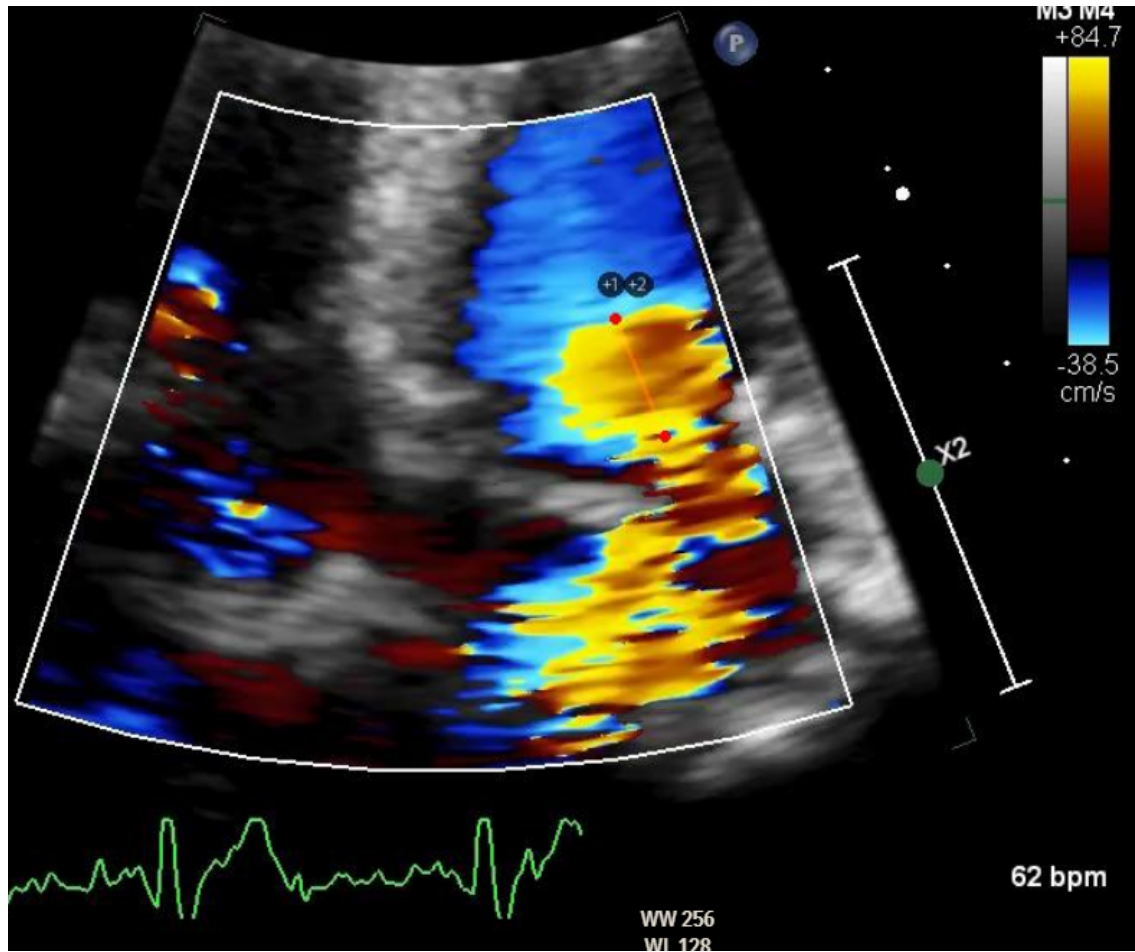




Case illustration

79 year old
 Gentlemen
 Atypical chest
 discomfort

Mitral regurgitation PISA head at 38.4cm/s



AI's impression

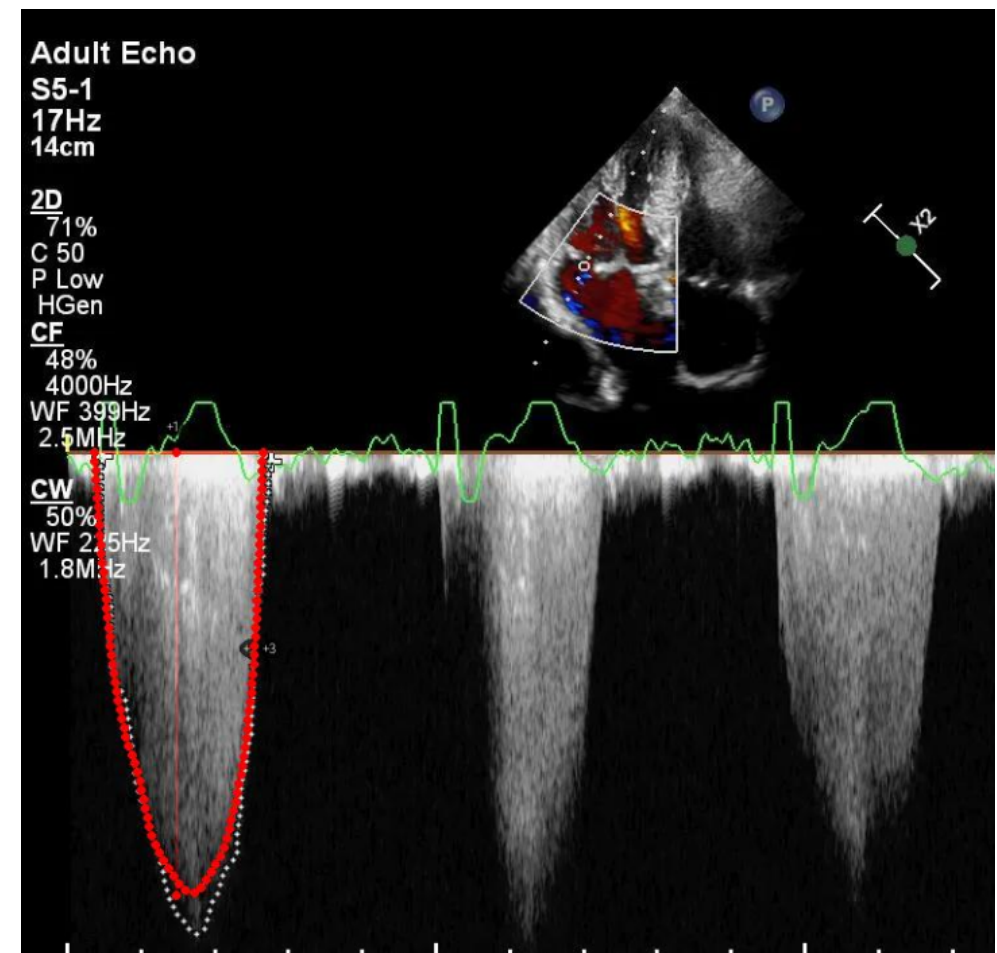
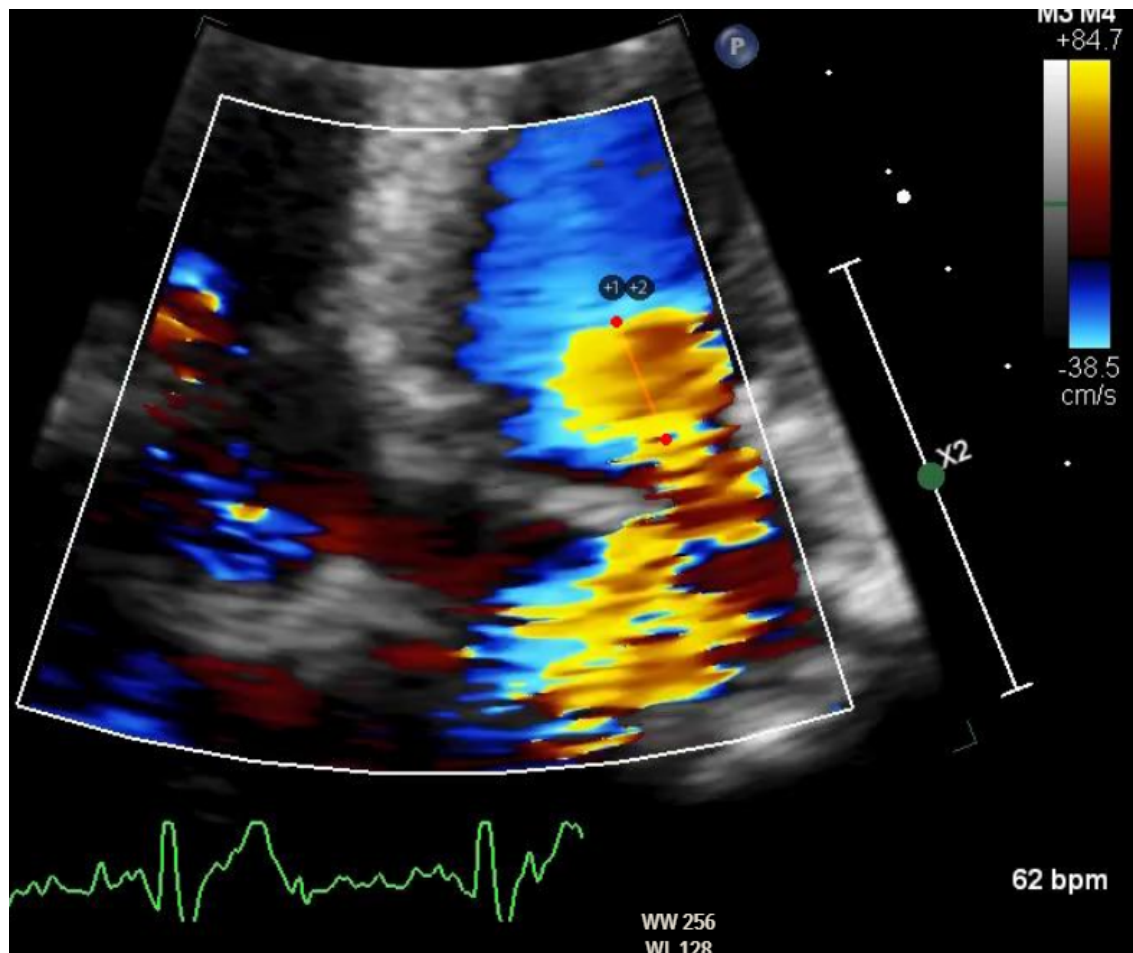
Severe Mitral regurgitation

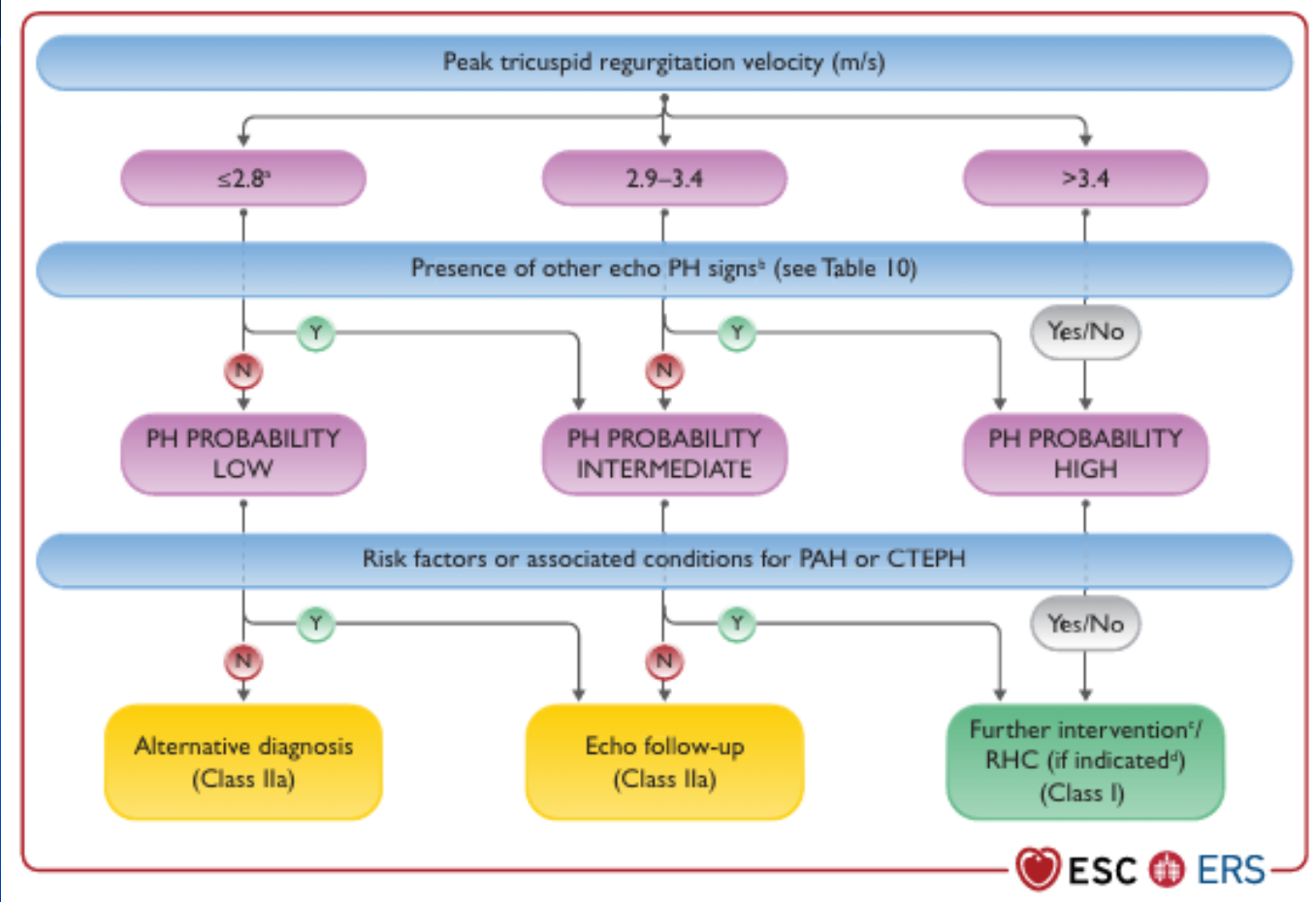
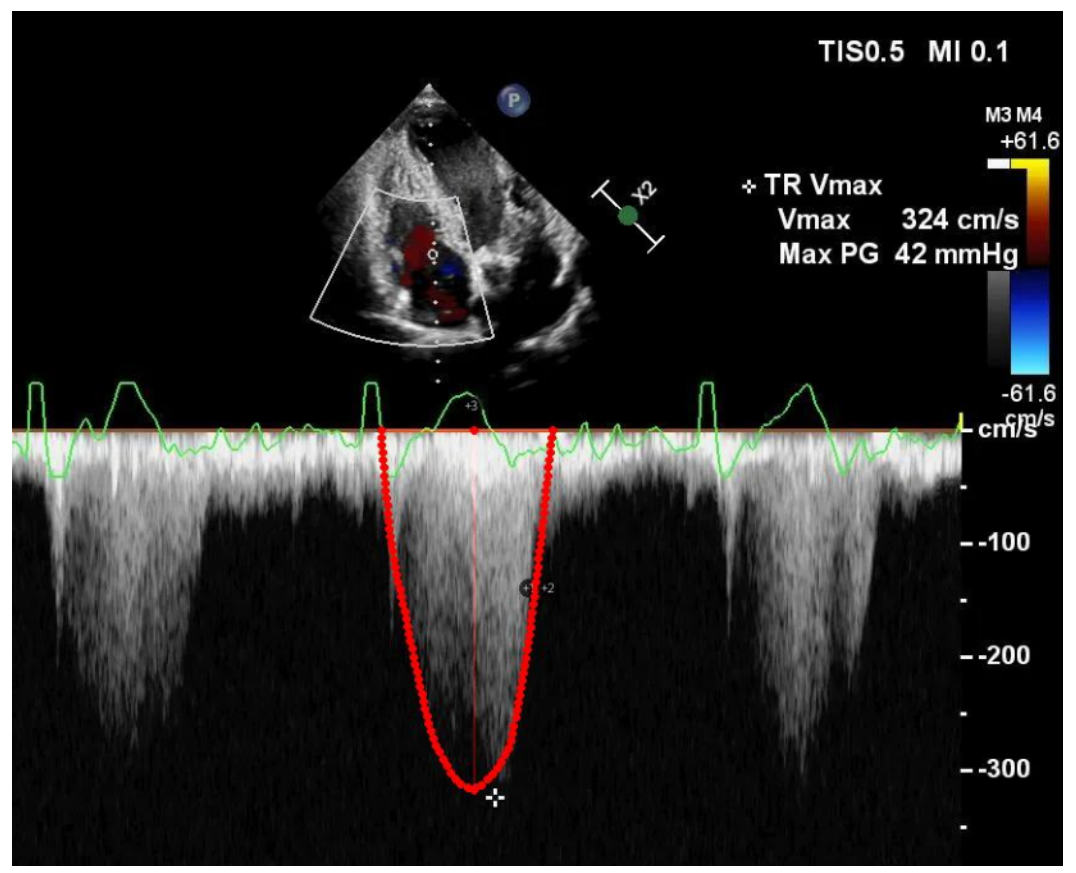
- PISA radius 1.1
- EROA 0.4



US2.AI

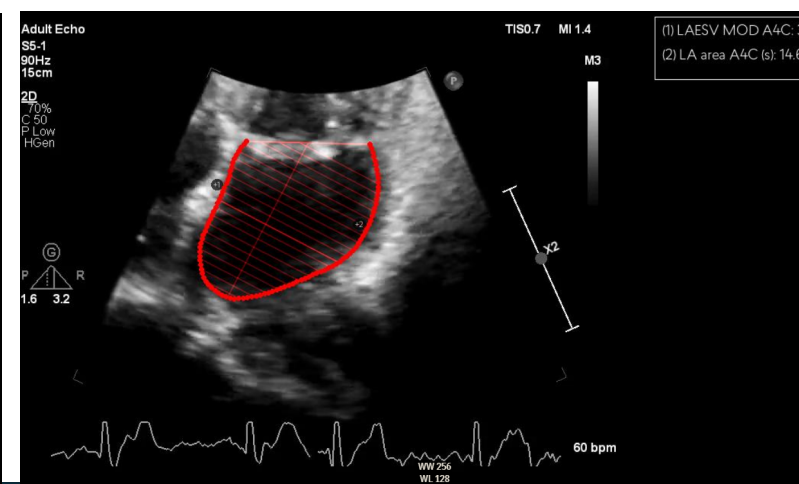
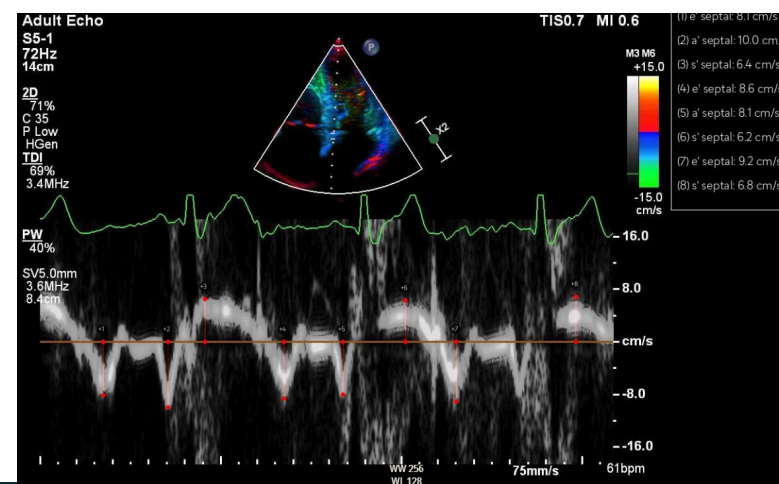
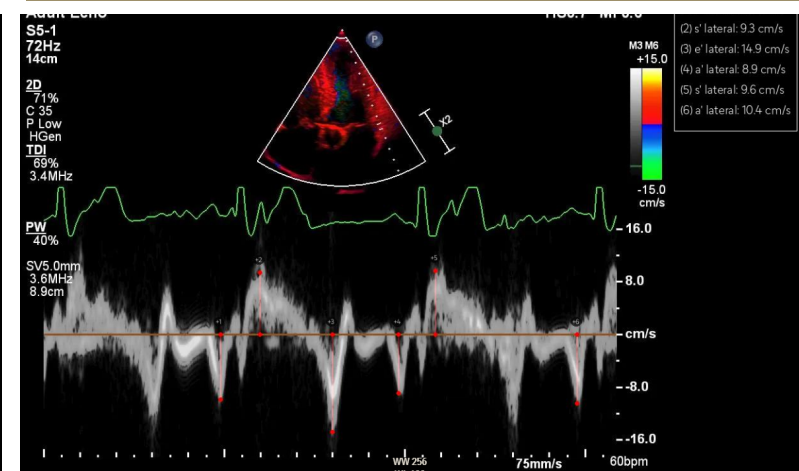
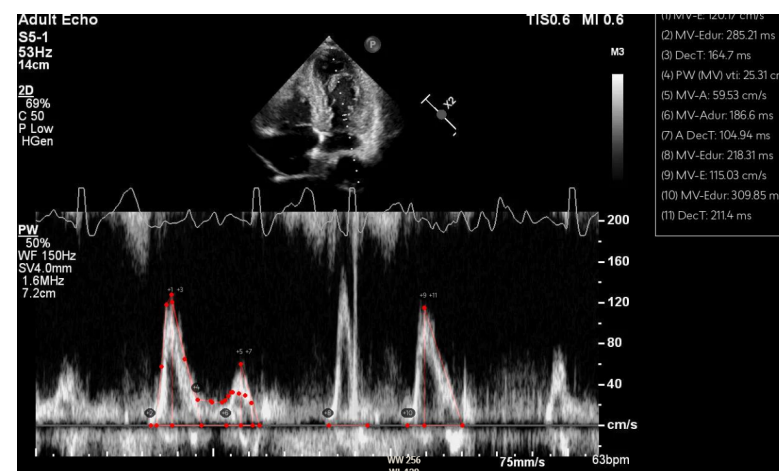
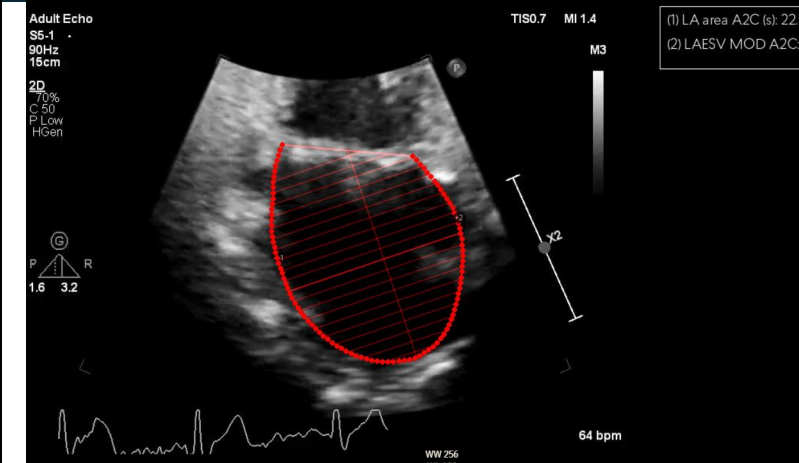
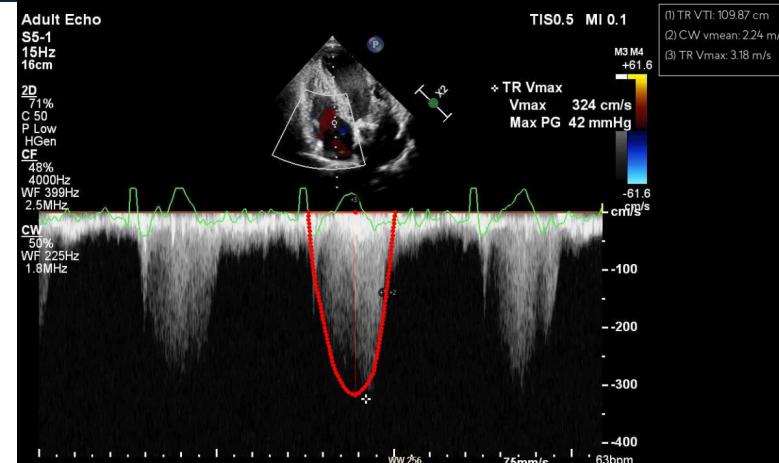
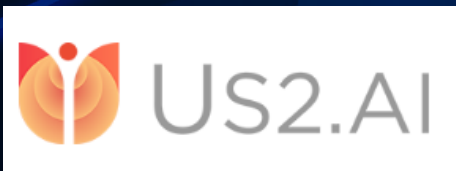
AFCC 2025
DIGITAL HEALTH
IN HEART DISEASE CARE
PRE-CONGRESS





AI's impression
Intermediate probability of pulmonary hypertension
- TRVmax 3.1

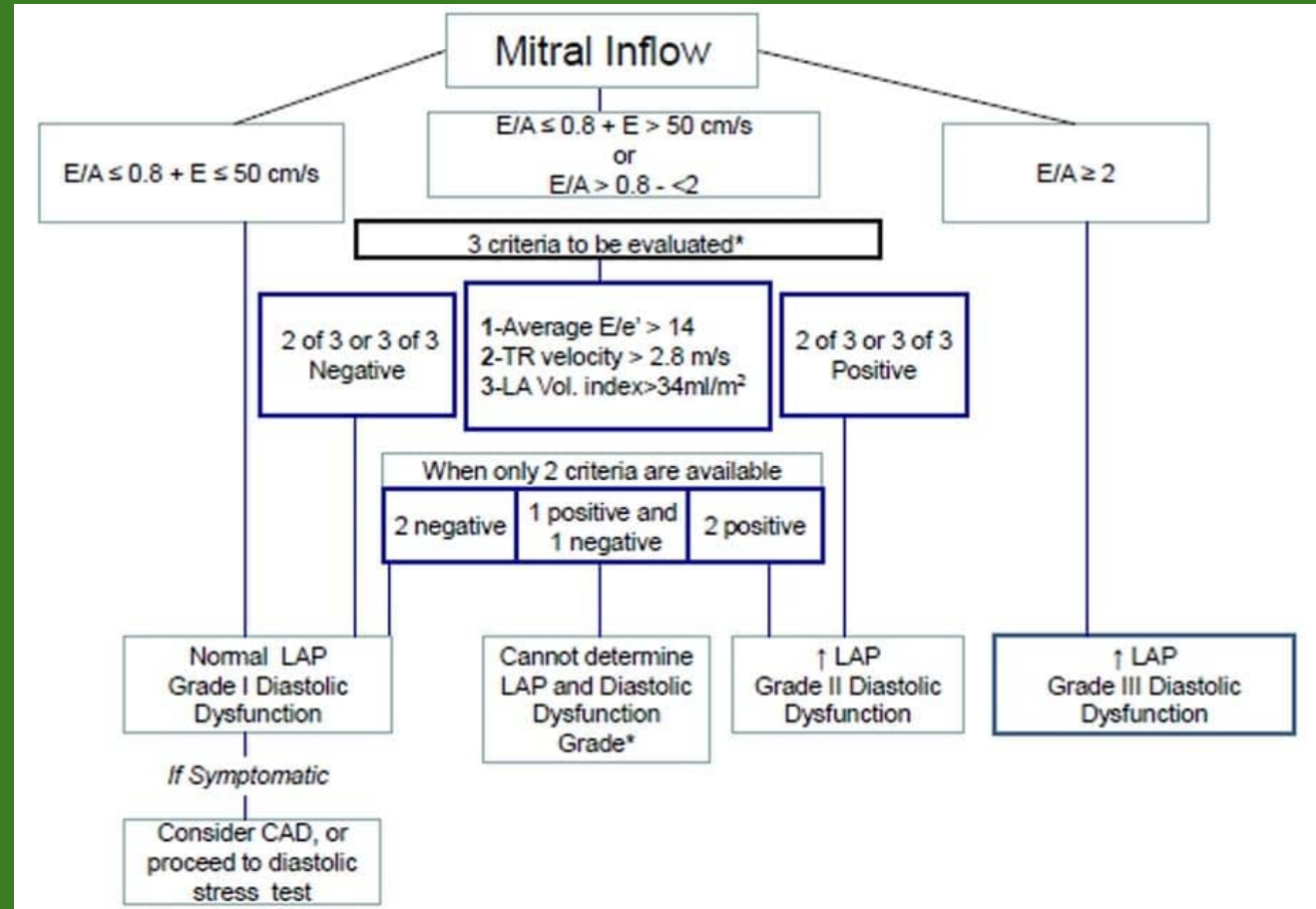
Automated quantification of diastolic function



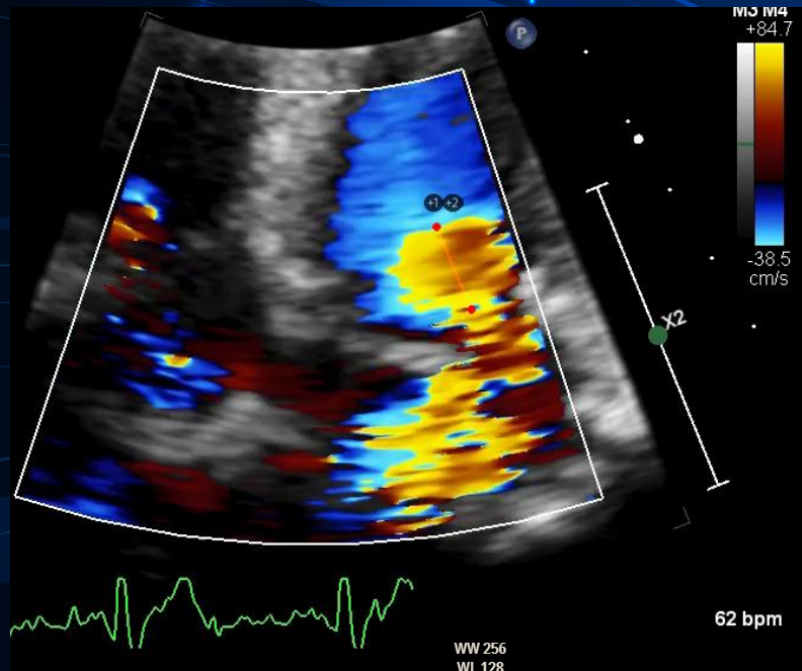
AI's impression

•Grade II DD

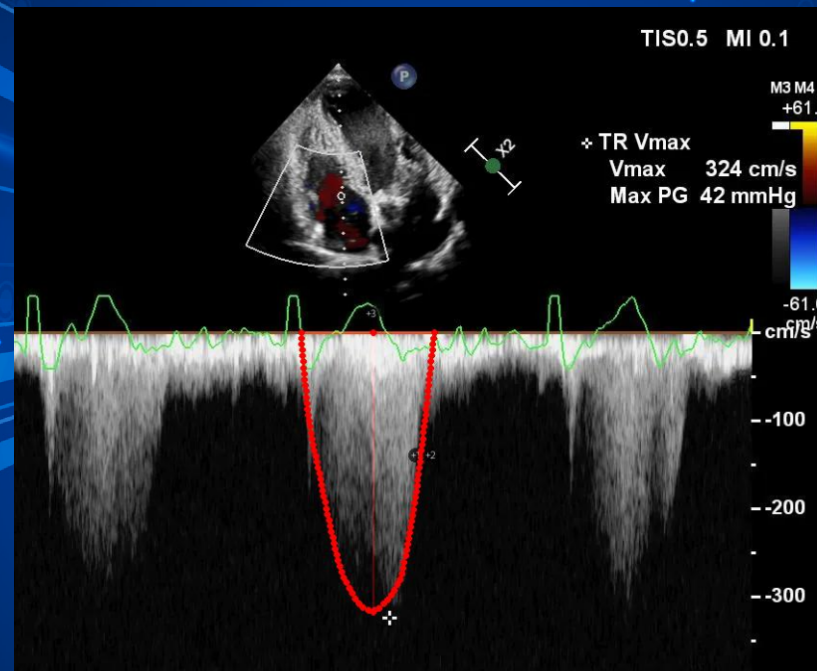
- E/A 2.0
- Med e' 8
- Lateral e' 14
- E/Avg e' 10
- TRVmax 3.1
- LAVi 35ml/m2



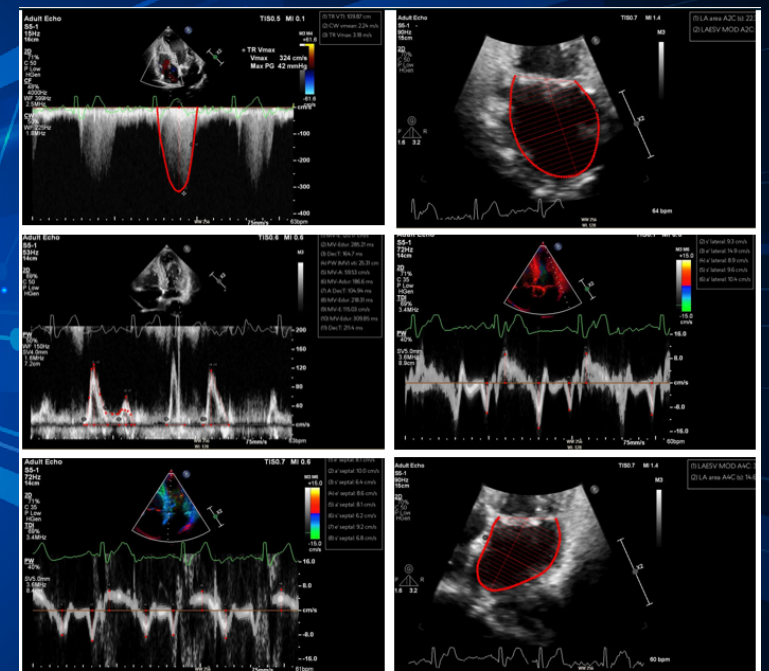
van de Bovenkamp, A. A., Enait, V., de Man, F. S., Oosterveer, F. T., Bogaard, H. J., Vonk Noordegraaf, A., ... & Handoko, M. L. (2021). Validation of the 2016 ASE/EACVI guideline for diastolic dysfunction in patients with unexplained dyspnea and a preserved left ventricular ejection fraction. *Journal of the American Heart Association*, 10(18), e021165.



Severe MR



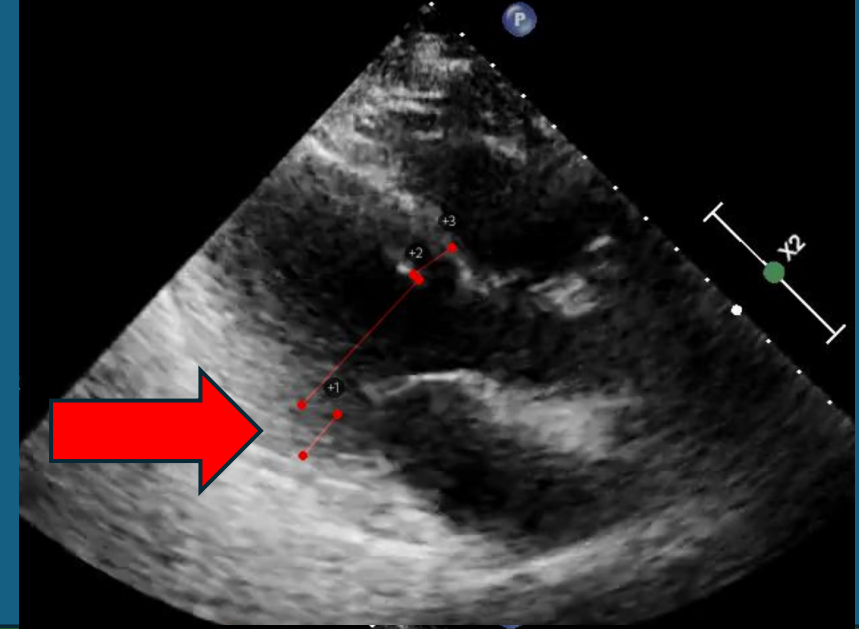
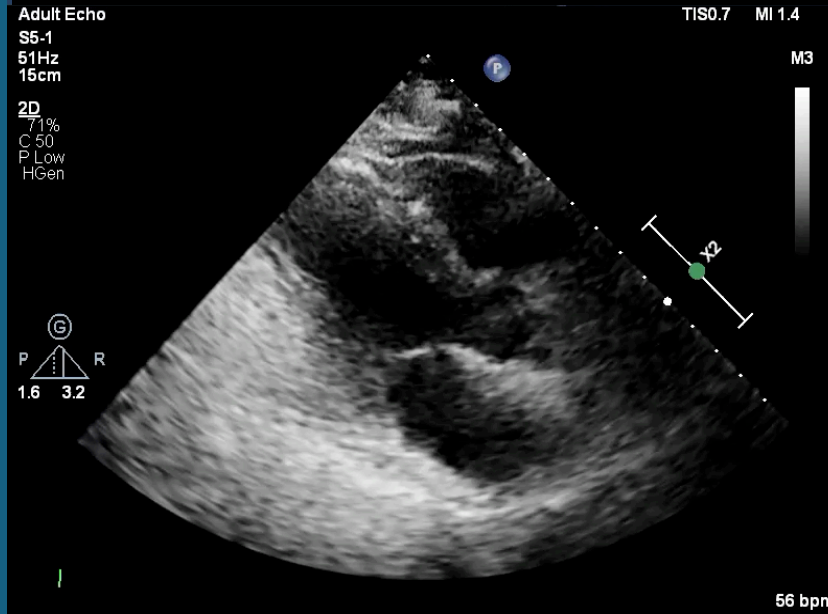
Intermed probability pulm HPT



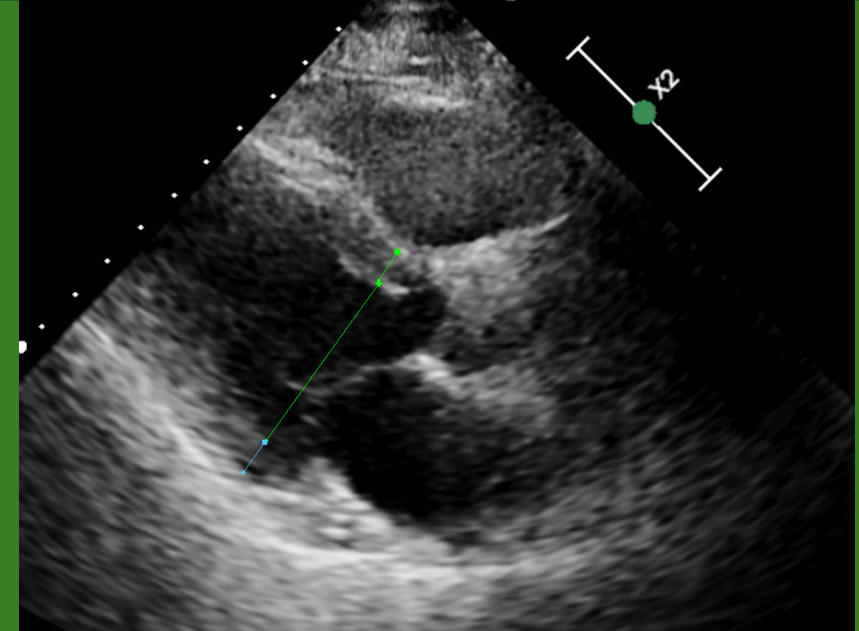
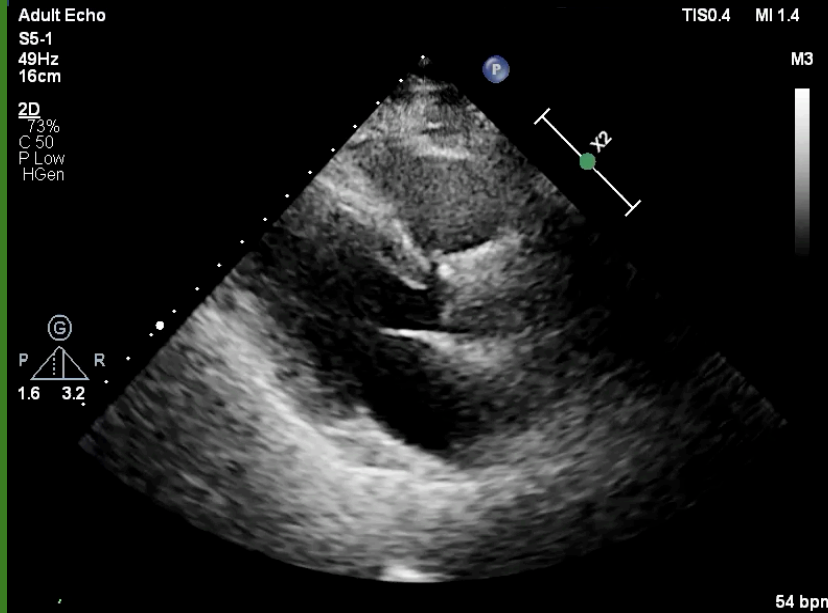
Grade II DD

Limitation – Poor Image Quality

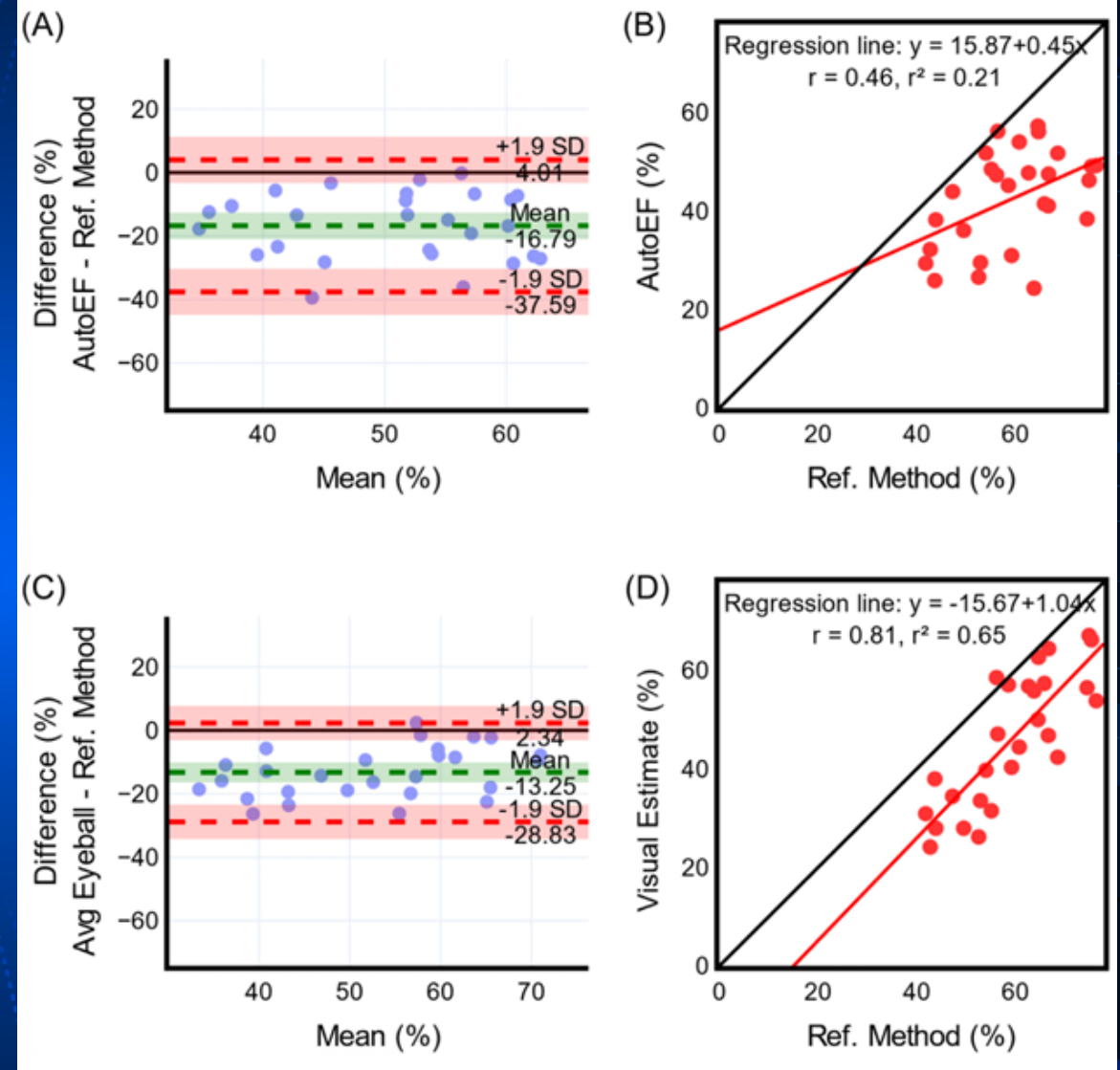
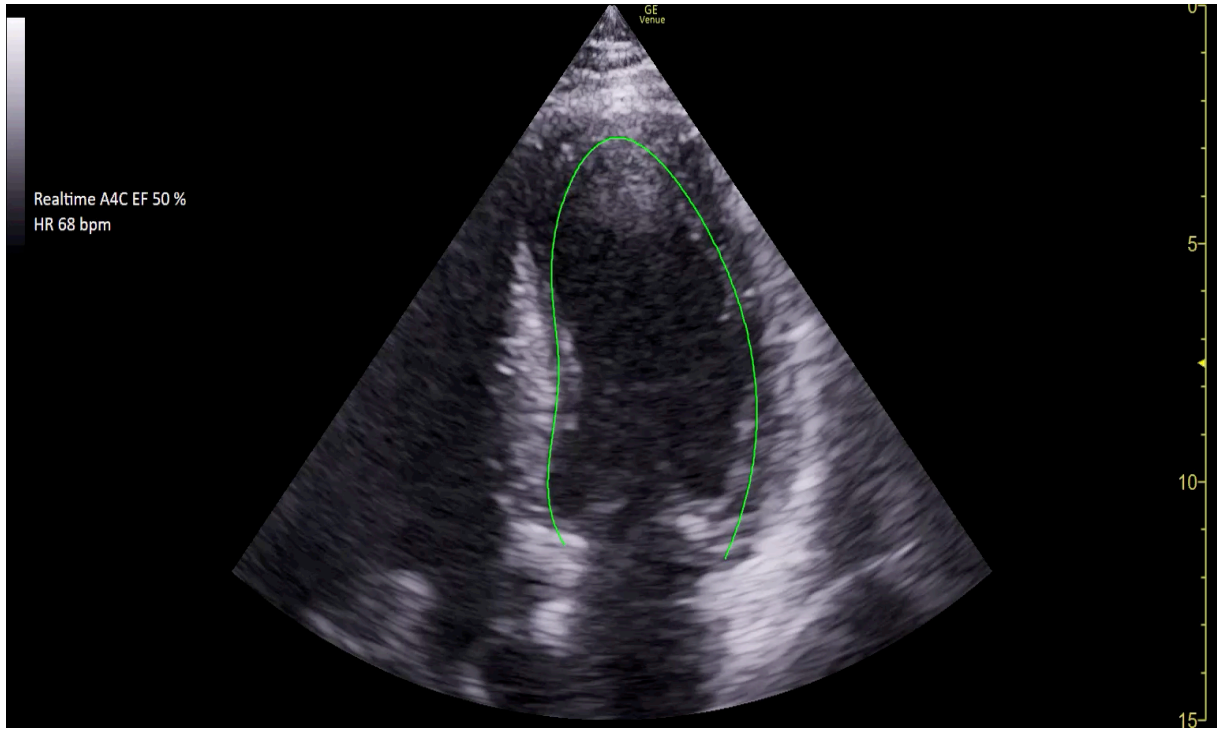
Suboptimal image quality with automated measurement



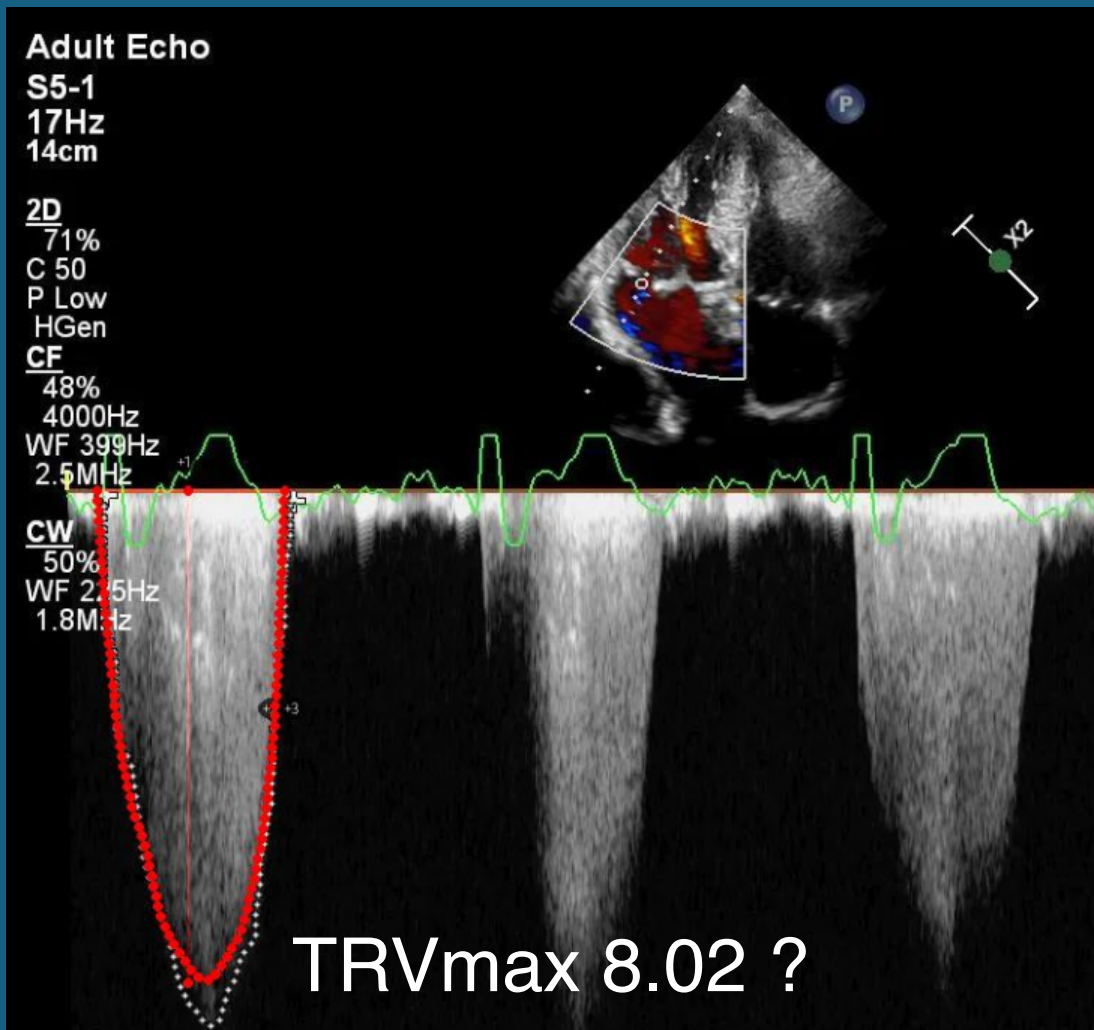
Improved image quality with manual quantification



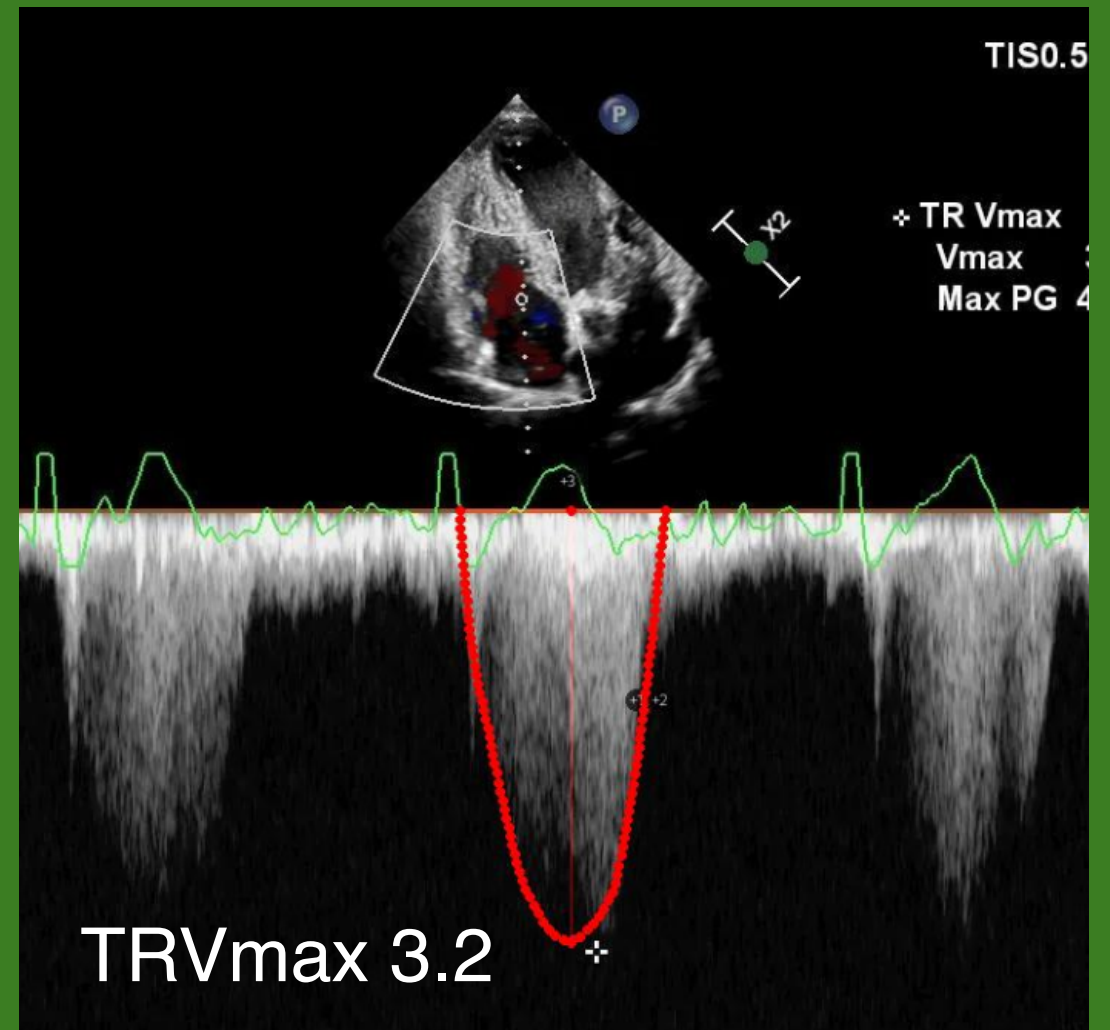
Limitations – Non controlled setting



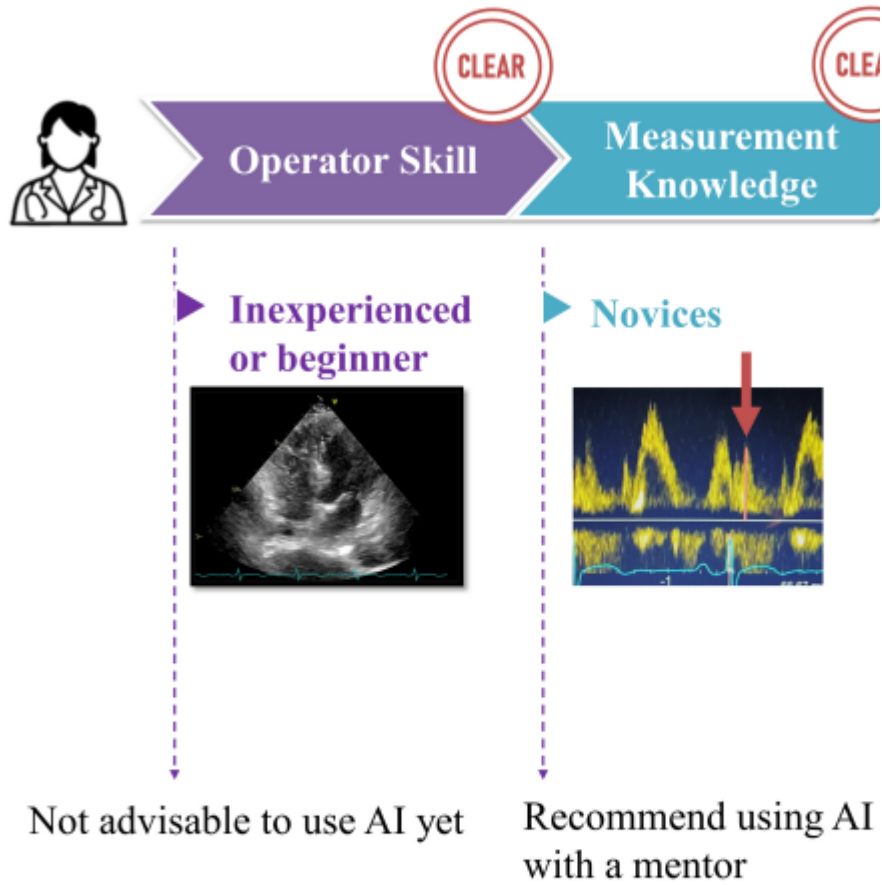
Misdiagnosis

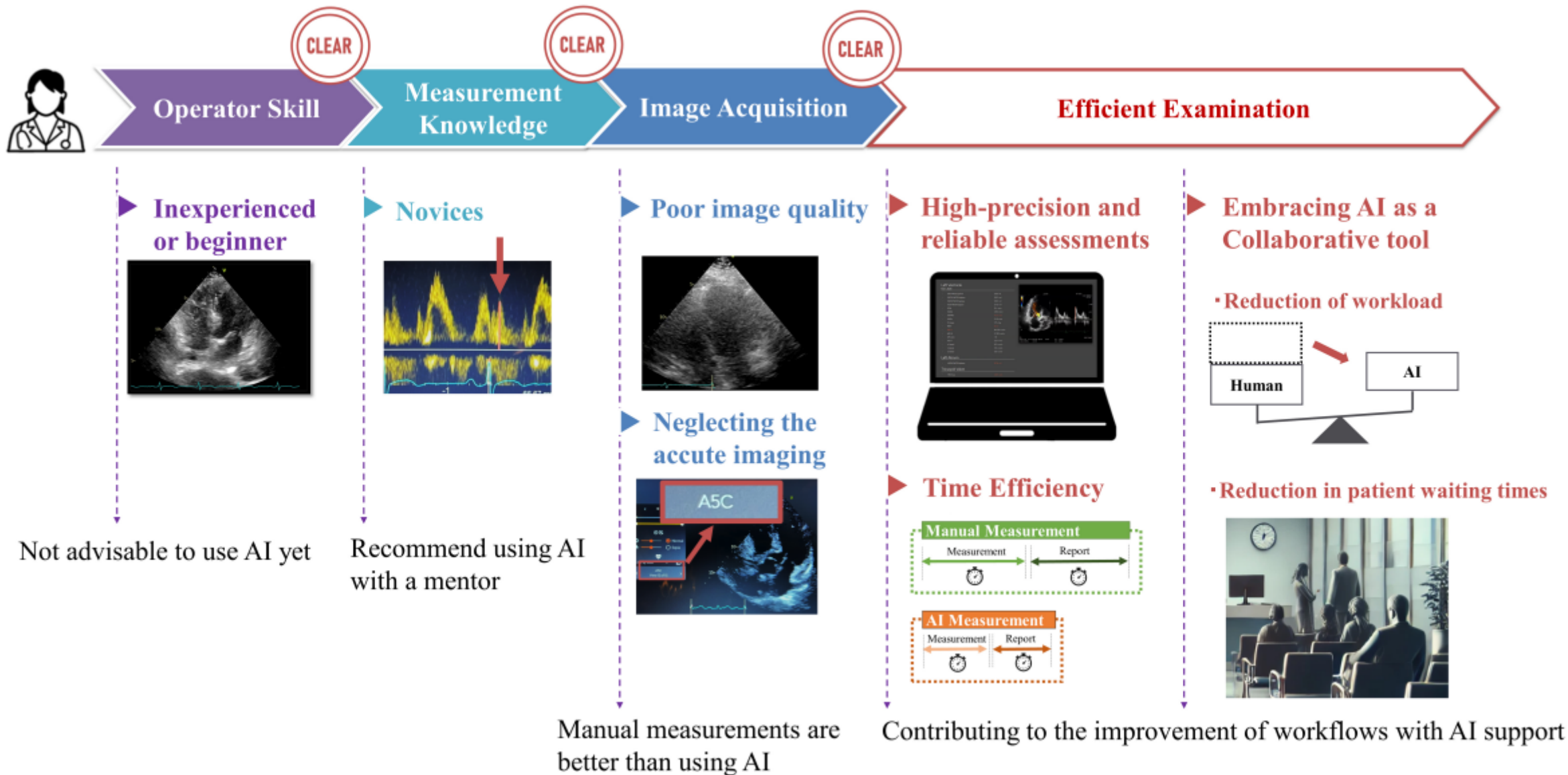


Apical 3 chamber (modified)



Focused RV view







Thank you



***“Artificial intelligence is a tool,
not a threat”***
- Rodney Brooks

***“AI wont replace humans – But
humans with AI will replace
humans without AI ”***
- Harvard business review

Thank you



85B0A7
MI 1.3
TIS 1.2

Rotate counter-clockwise slowly



COLOR

Real-time prescriptive guidance

Depth

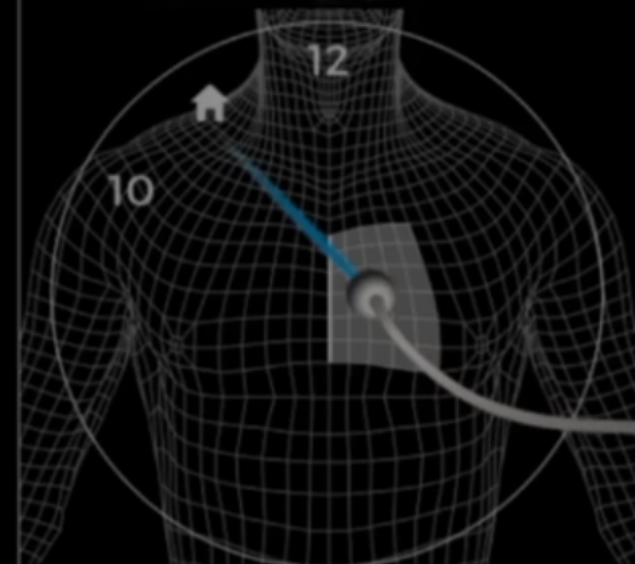
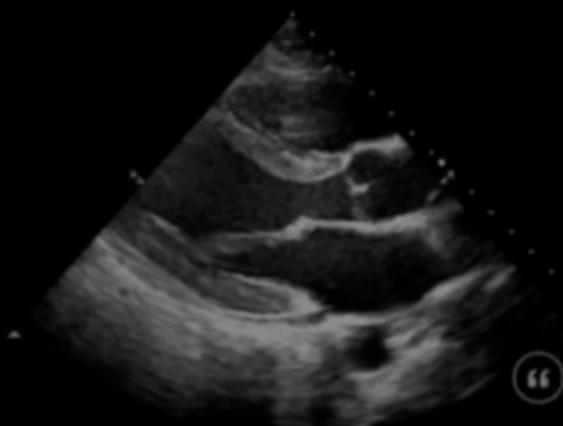
Gain

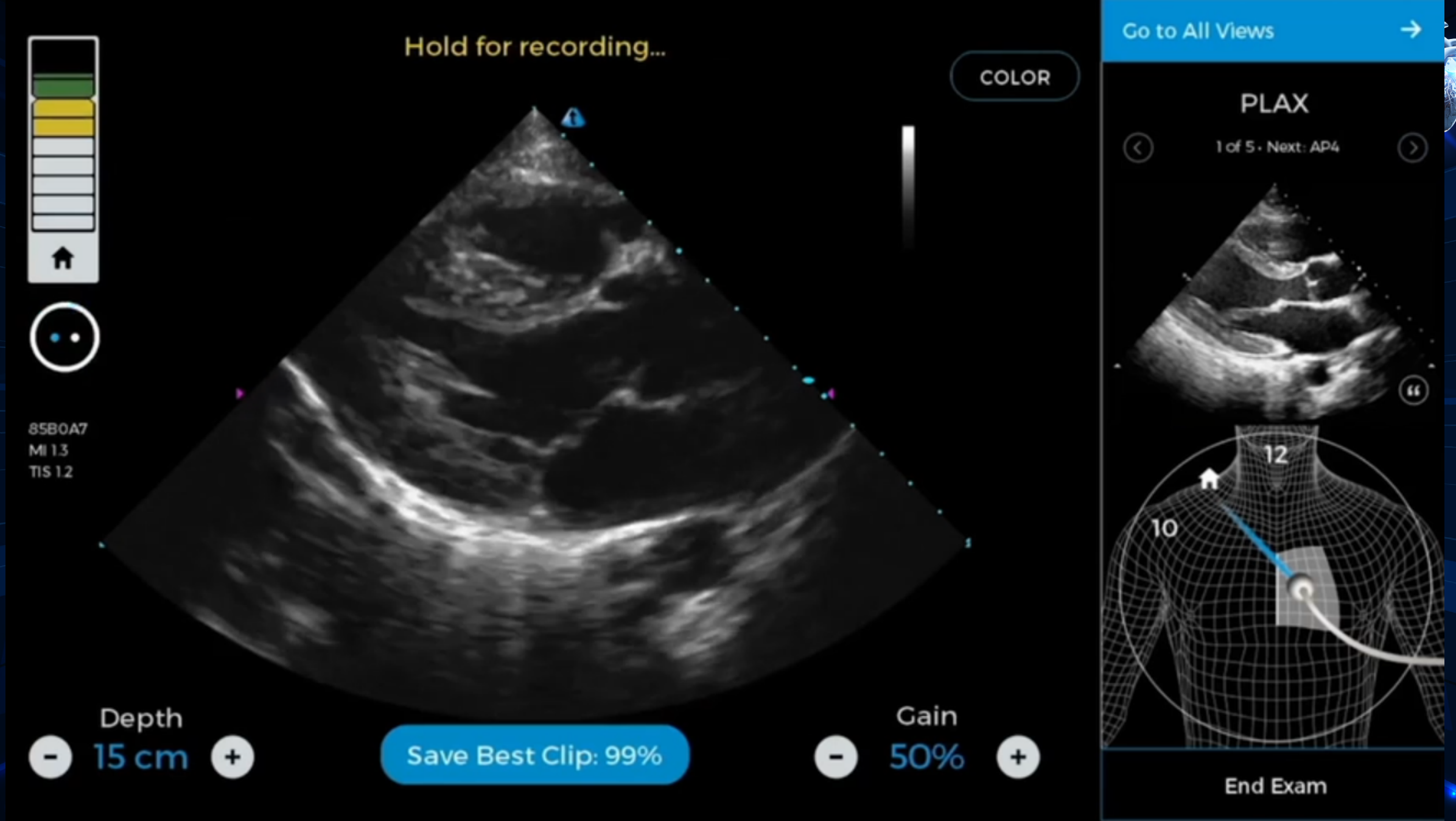
Go to All Views



PLAX

1 of 5 - Next: AP4





Semiautomated 3D LVEF

