Artificial Intelligence

Bedside applications

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ECHO AUSTRALIA

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Talk outline

1. Introduction
2. Acquisition – AGILE echo preliminary analysis
3. Recognition/Interpretation
4. Clinical Reporting
5. Conclusions

Introduction

Artificial Intelligence (AI) is now well and truly embedded into our clinical processes for echocardiography.

- Repeatable tasks dependent on having high concordance

From a workflow perspective, the TTE AI process can be broken down into the:

- Acquisition
- Recognition/interpretation Measurement of images and diseases
- Clinical reporting/Decision making

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AI and POCUS

Currently, a bottleneck to TTE access exist. Handheld echocardiography now incorporates AI feedback into image acquisition.

How can AI assist in wait times?; Increased wait times for TTE (rural especially) means people may have events, missed time for intervention. How to prioritise likely abnormal studies?

Use of artificial intelligence-guided echocardiography to detect cardiac dysfunction and heart valve disease in rural and remote areas: Rationale and design of the AGILE-echo trial

Check for updates

Cheng Hwee Soh, PhD[a,b], Leah Wright, PhD[a], Angus Baumann, MBBS[c], Bastian Seidel, PhD[d], Christopher Yu, MBBS[e,f], Mark Nolan, PhD[a], Tony Mylius, MBBS[g], and Thomas H. Marwick, PhD, MPH, MBBS[a,b,h], on behalf of the AGILE-Echo investigators in Tasmania, Western New South Wales, Northern Victoria, Western Australia, Western Queensland and Northern Territory, Australia

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Image acquisition

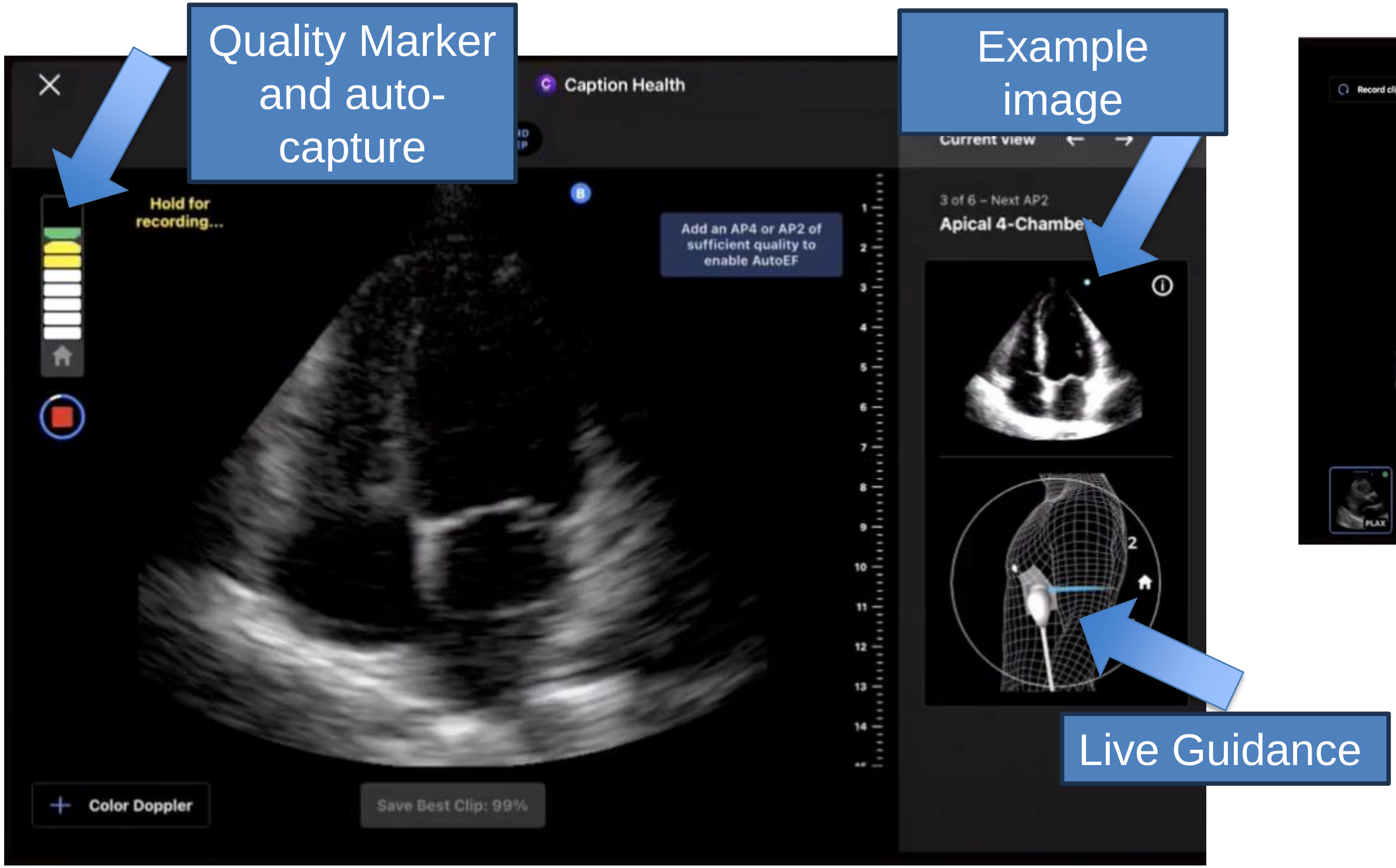
AI assistance can help users (with minimal sonography training) obtain diagnostic-quality images. These systems typically offer:

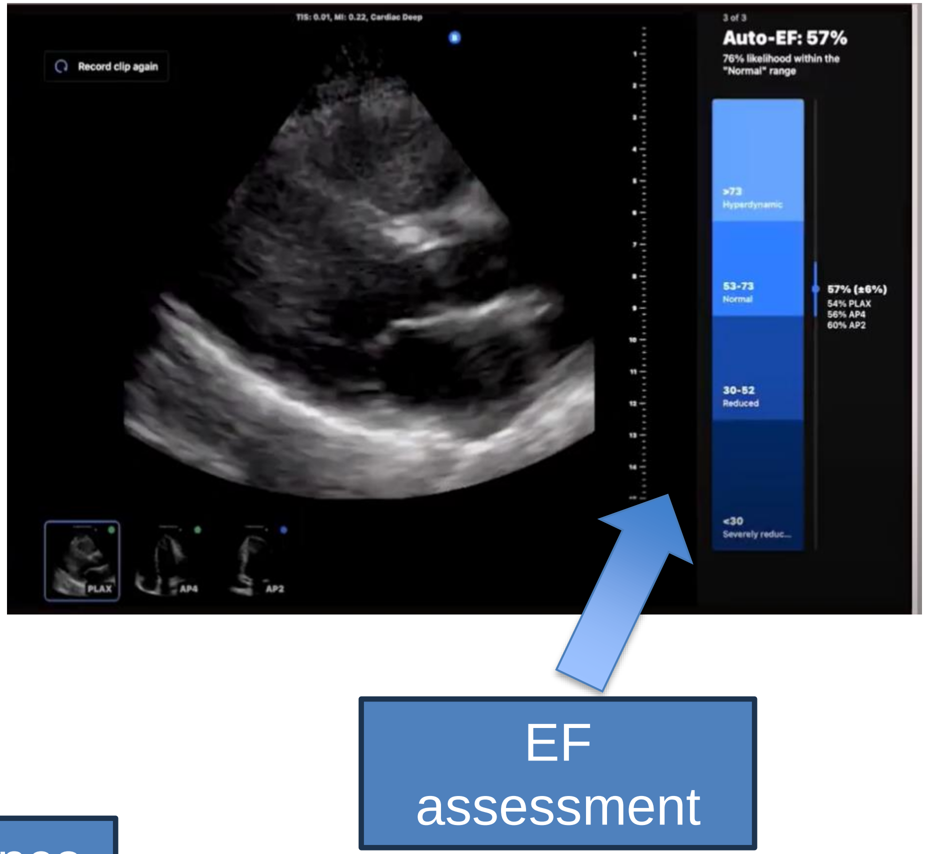
Real-time guidance and feedback- This includes probe positioning (sweeping, fanning, rotation) to optimise images

View recognition- Through training on neural networks, recognition of standard views. A quality feedback marker with automated capture

Image and Disease quantification- Automated analysis of measurements of systolic function (potential for valvular disease discrimination coming

Image acquisition





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Training and image quality?

Although marketed as a tool for novices, most studies have incorporated a training program before use:

- Some papers comment on a two-week training period(6), although short periods of 1 day are most common (7)

AGILE training program:

•Basic principles of ultrasound. Doppler Vs 2D imaging. Probe position and movement and 2D image guidance

•Cardiac anatomy and examples of basic valve disease examples

•Option for a day to shadow a echocardiographer (dependent on location)

1) Huang W Sci Rep. 2024;14(1) 2) Peck D. J Am Soc Echocardiogr. 2023;36(7):724-32.

Image quality; Previous work

Mor-Avi assessed 240 studies (10 standard views) performed by inexperienced users guided by AI software (UltraSight, Ltd) as compared to sonographer scans:

- 99% of AI-guided novice exams had sufficient quality to assess LV size and function with a high concordance (83-96%) in diagnostic interpretation between images
- Quantitative analysis (100 selected studies) was feasible in 83% of novice-images, with high correlations ($r \geq 0.74$) to expert measurements

Conclusions:

After minimal training with the novel artificial intelligence guidance software, novice users can acquire images of diagnostic quality approaching that of expert sonographers

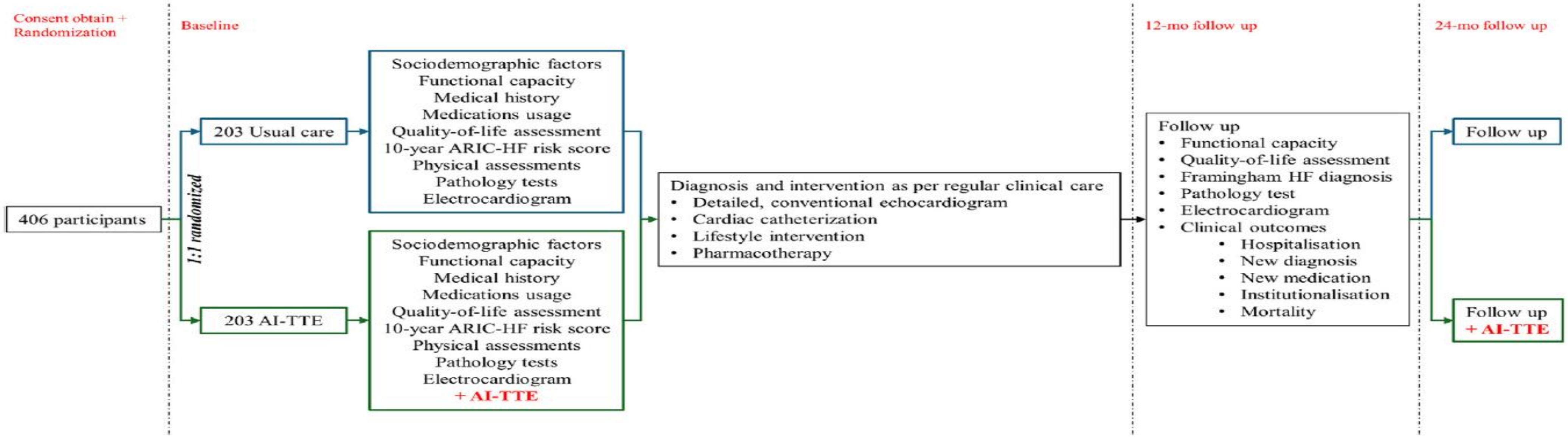
Victor Mor-Avi et al. Circulation; Cardiovascular imaging 2023 16(11)

AGILE echo; RCT of AI community healthcare

AGILE echo:

- Adults presenting to GPs/community health centres
- Inclusion; Positive for CV risk factors + concerns about exercise intolerance, or Heart valve disease are randomized into AI-TTE or usual care

Figure 1. Trial flowchart. (AI-TTE, artificial intelligence guided transthoracic echocardiography; ARIC-HF, heart failure risk score derived from the atherosclerosis risk in communities; HF, heart failure).



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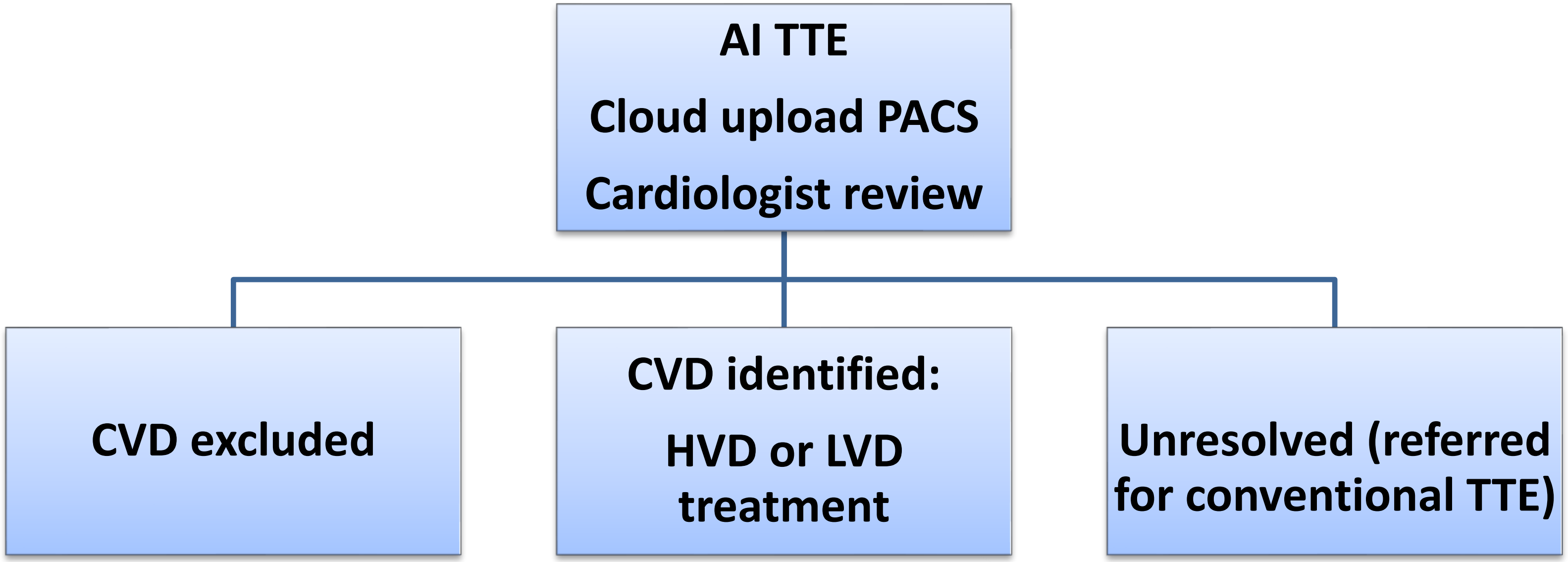
AGILE; Study randomisation

Intervention

- UC participants undergo usual management at the discretion of the treating clinicians as per their usual care (may or not include referral for standard TTE).
- Patients in the AI-TTE group with abnormal findings are treated as they would be in regular clinical care for HVD or HF (with standard TTE if required)



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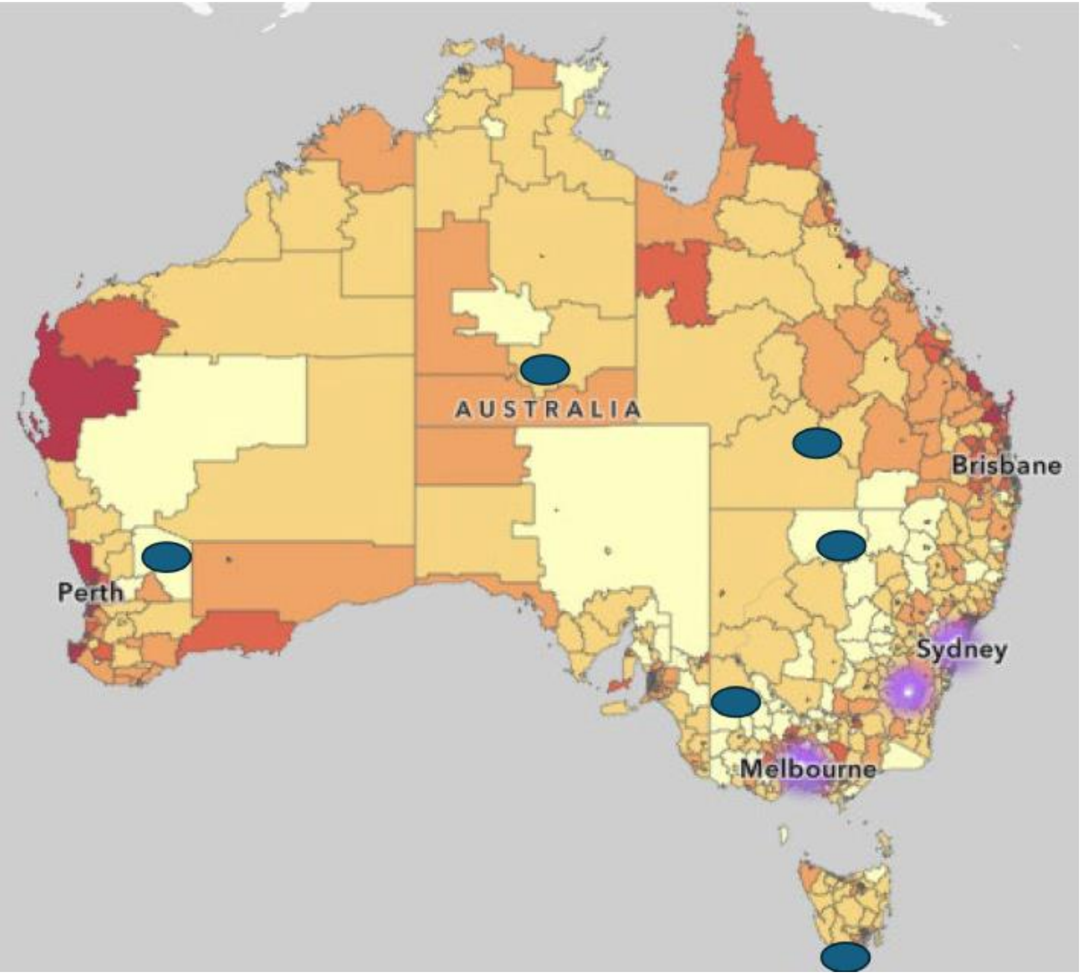
AGILE Echo Substudy; Quality Control and learning curves



Distribution of 6 rural and remote research sites

What is the current image quality of AI-TTEs in the AGILE cohort:

- Aim 1) What is our current diagnostic quality, and do demographic factors influence this?
- Aim 2) Does a learning curve exist for training?

Quality scale for studies

	Emergency Physicians score (1)
1	No recognizable structures
2	Minimally recognizable structures but insufficient for diagnosis
3	Minimal criteria met for diagnosis, recognizable structures but with some technical or other flaws
4	Minimal criteria met for diagnosis, all structures imaged well
5	Minimal criteria met for diagnosis, all structures imaged with excellent image quality
	Score entire study for Diagnostic vs Non-Diagnostic

1)ACEM 2022 Aug 11;29(10):1261–1263.

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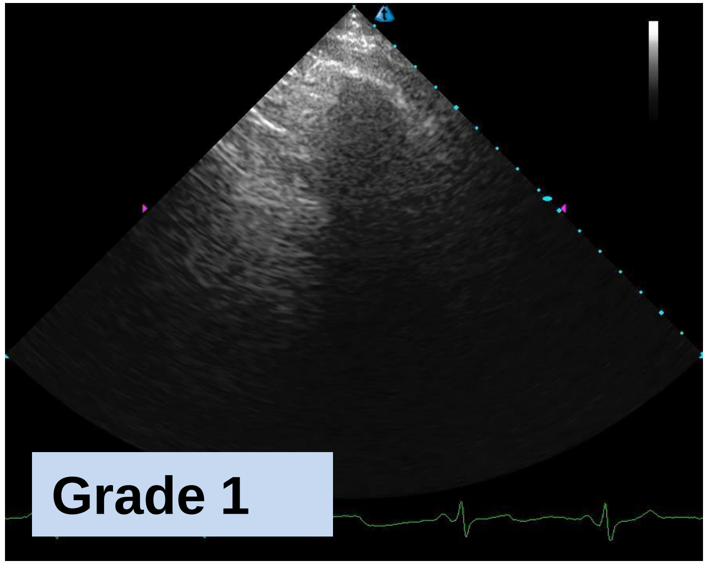
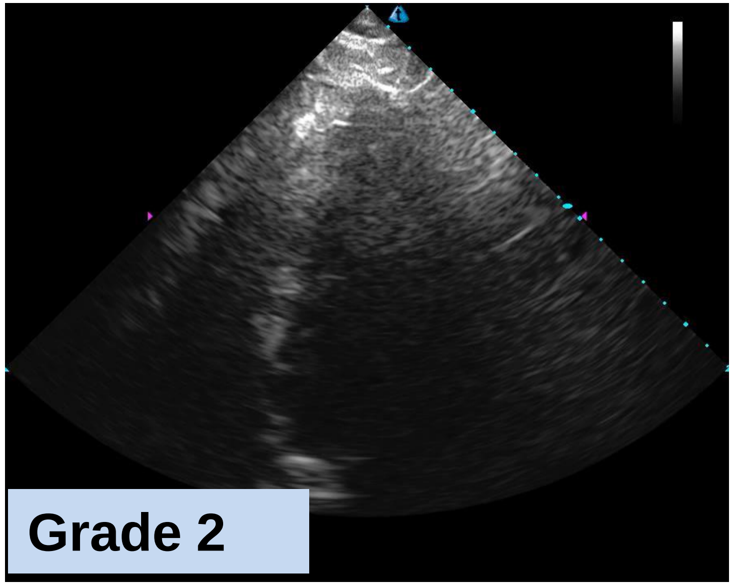
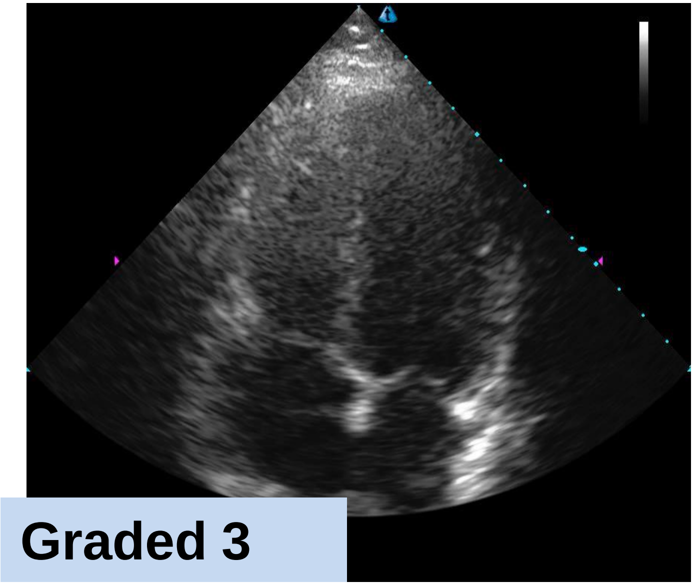
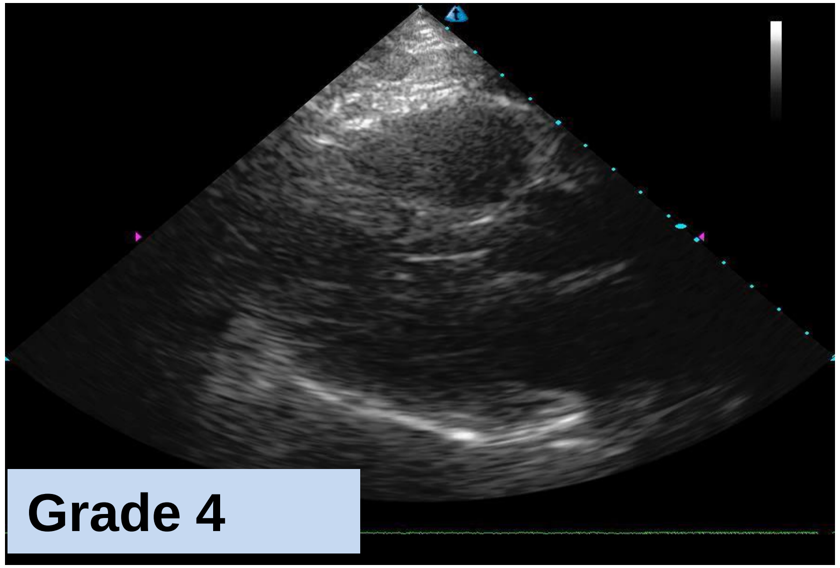
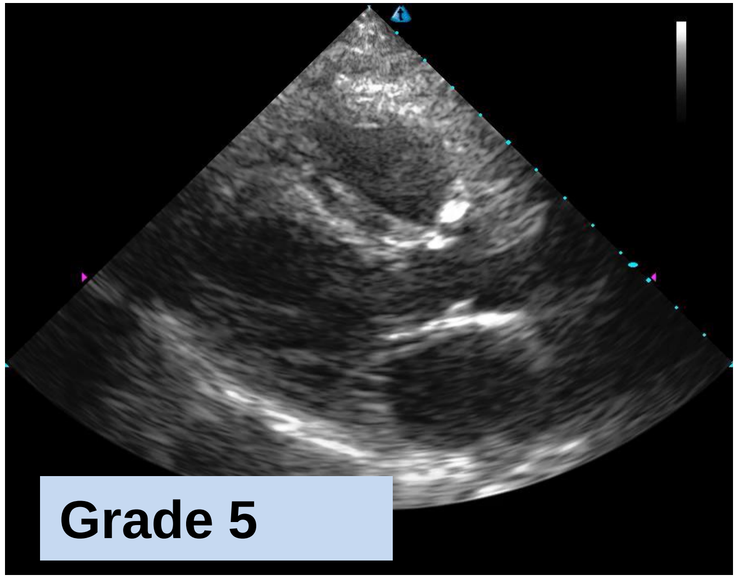
Quality scale: Examples











AI and Disease recognition: Valvular Heart Disease

AI can be used in multiple steps in the valvular heart disease process:

- Pattern recognition of images (automated image detection of disease and severity)
- Measurement of images (spectral Doppler and 2D) . Measurement of the spectral Doppler signal is already available on cart.
- Reporting process (? Improve concordance between readers)

Previous research:

- AI (ML) could detect severe AS(1) with a high level of discrimination (area under the receiver operating curve of 0.94-0.98). Using images, no Doppler. Interestingly, LFLG AS excluded (1)
- AI has shown a strong ability to interpret colour Doppler (83% quality rate) (3).

1) Holste. Eur Heart J. 2023;44(43):4592-604 2) Khera. EHJ (2023) **44**, 4592–4604
3) Mor-Avi Circ Cardiovasc Imaging. 2023;16(11).

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AI and Disease recognition: Valvular Heart Disease

Interpreting correct alignment for accuracy is necessary for clinical judgment.

Human interpretation is critical for this.

- In aortic stenosis, the R values between the user and AI often shows tight correlation(1). It does not describe the accuracy of the degree of variation between AI and traditional measures.
- 2D measures of the left ventricular outflow tract produce increased variability with AI (1).

<u>Image quality is key for AI image interpretation</u>

1) Krishna H. J Am Soc Echocardiogr. 2023;36(7):769-77.

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AI guided POCUS and Interpretation RHD

Remoteness of RHD screening and turnover of clinical staff means it is a prime candidate for AI POCUS. Novice users underwent a 1-day training curriculum to complete a 7-view screening protocol using AI guidance (Uganda).

- Novice images enabled diagnostic interpretation in >90% for presence/absence of RHD, abnormal MV morphology, and mitral regurgitation (vs 99% by experts, $P \leq .001$)
- Nonexpert images were highest in the **PLAX (81% ≥ 3)** compared with lower scores for **apical 4 (74% ≥ 3)** and apical 5-chamber images (38% ≥ 3).

JASE. 2023. The Use of Artificial Intelligence Guidance for Rheumatic Heart Disease Screening by Novices

AI in the reporting process

Several developers and companies are incorporating AI in clinical reporting software for disease identification (and quantification), stratification and risk prediction.

- Automated online EF and GLS (automation of routine tasks). Image segmentation and structure identification
- Disease specific flags (Amyloid) through ML image processing(2), or integration of patient risk factors (ethnicity, HF risk scores) into reporting process

Potential to improve concordance of echo reporting. We know it's something we don't do particularly well…

AI Generated patient reports; Health literacy

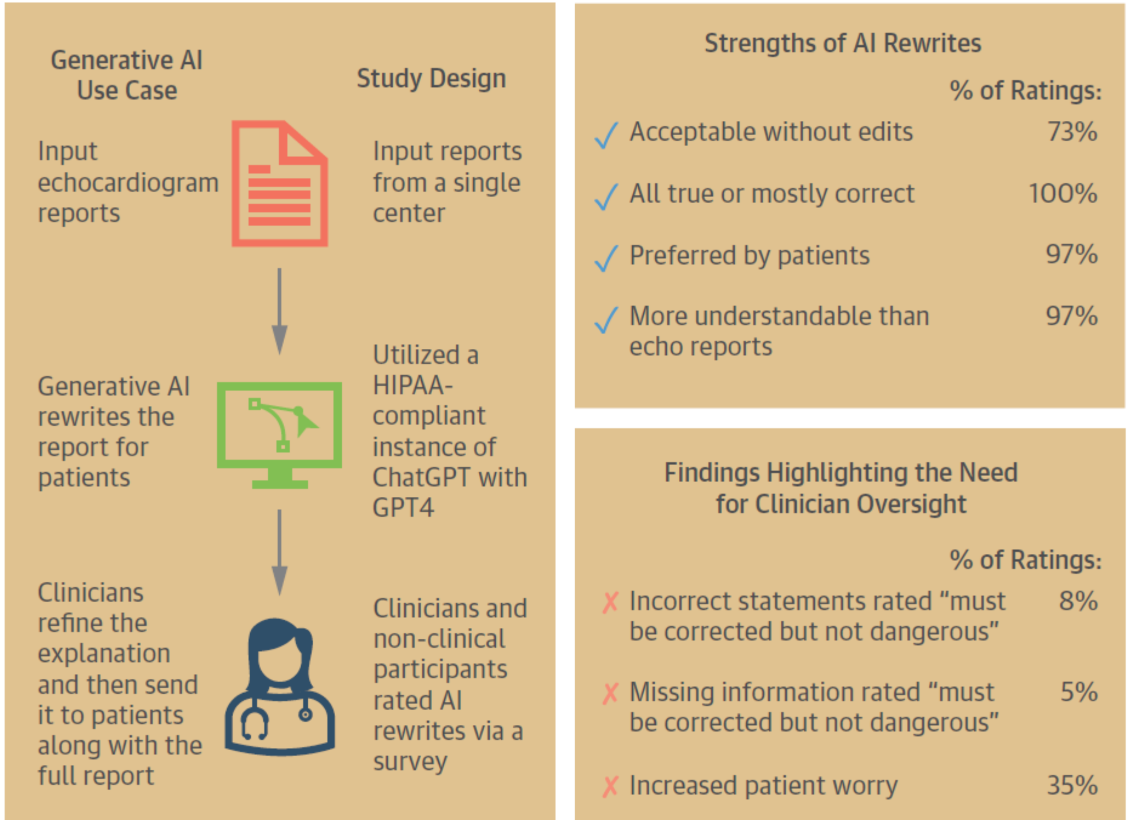
21st Century cures act (2021): Immediate release of TTE results to patients (USA)

- Immediate Access: Patients need immediate electronic access to their health information, including echo results, as soon as they are available
- No Delay: The traditional practice of delaying the release of radiology reports (including echocardiograms) to allow physicians to review results first is no longer permitted under the Act.

Leads to…..

Some institutions are exploring the use of AI, such as ChatGPT, to generate patient-friendly versions of echo reports to help explain findings and alleviate confusion

AI Generated patient reports



- Enhanced understanding from rewrites reduced worry for 50% of participants, slightly increased it for 30%, and strongly increased it for 5%.
- Notably, the 2 instances where rewrites strongly heightened worry both involved critical findings.
- Nearly all participants (97%) also preferred receiving the rewrites alongside the original reports.

AI hallucination, or presenting false or misleading information, was detected in 1 instance, in which the rewrite stated that a pleural effusion was small when size was not originally specified.

Conclusions

AGILE echo:

- Quality is a factor, how you judge quality and what you expect from the studies is critical to understand (it's not a full clinical TTE). How to interpret the findings from research studies?
- Is there a ceiling effect for quality if no further education given?
- We didn't rely on AI interpretation, an experienced cardiologist reported all images

Incorporation AI in the workflow

- POCUS AI in improving access to those on wait lists and exclude "normals"
- RHD and reducing reliance on a highly trained workforce
- Improving reporting workflow, concordance and alerting of risk

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