HH Echo: How Far Can it Go?

Robert R Moss

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rmoss@providencehealth.bc.ca

$200/month per probe + $75/month warranty	>$10,000	Starts at $2,995	Starts at $6,900	$1,999 + $420/year for cloud user license

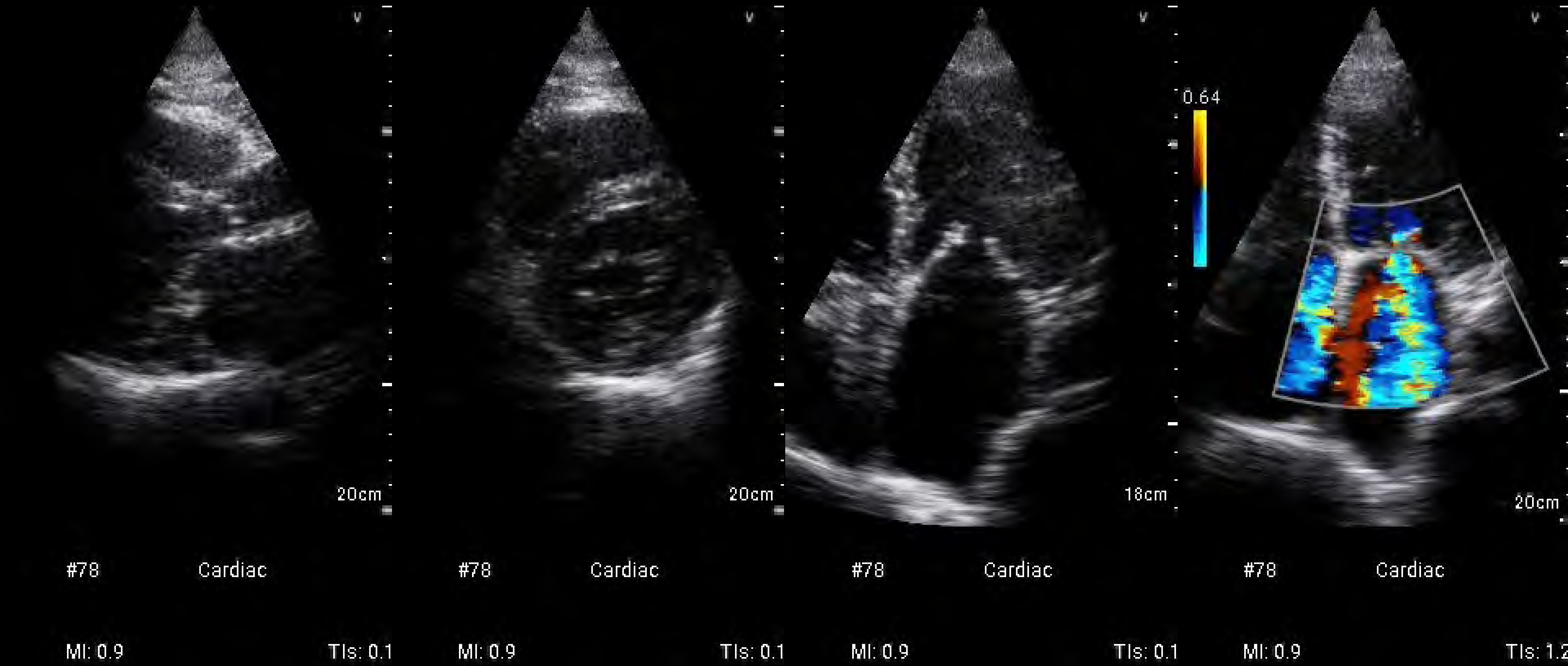
https://www.acepnow.com/article/whats-the-deal-with-pocket-ultrasound/

POCUS NOW
Case #1

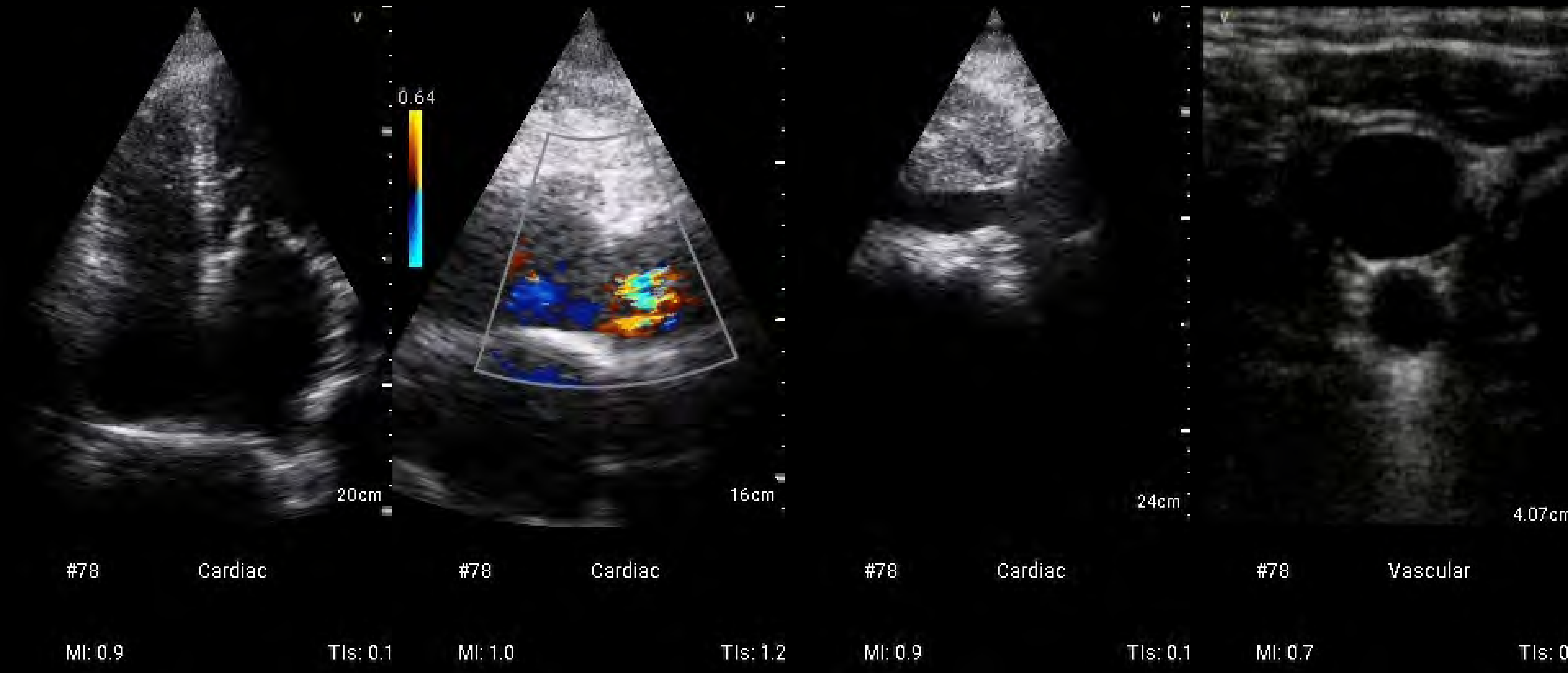
77 yo. F

Pre-POCUS diagnoses:

- hypotension NYD
- multiple comorbidities
- ‘failure to thrive’
- nurse is concerned about color, perfusion, oliguria



St. Paul's Hospital, Vancouver



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POCUS NOW
Case #1

Post POCUS diagnosis:

- Cardiogenic shock, biventricular CHF

Outcome:

- Emergent transfer to the Cardiac ICU

Rhythm: Atrial fibrillation.

Ordering MD:	Robert Moss
Clinical Indication(s):	Heart failure
Study Info:	Technically good study. Limited views.

Summary and Conclusions:

1. **Severely decreased LV systolic function. EF% cannot be quantitated.**
2. **Abnormal ventricular septal motion consistent with left bundle branch block.**
3. **Global LV hypokinesis.**
4. **Moderately decreased RV systolic function.**
5. **Tethering of the mitral anterior and posterior leaflets.**
6. **Severe mitral regurgitation.**
7. **Severe tricuspid regurgitation.**
8. **Severe biatrial enlargement.**
9. **Dilated inferior vena cava.**
10. **R Lung B lines noted.**

Findings:

Left Ventricle: Severely decreased systolic function. EF% cannot be quantitated. Global hypokinesis. Abnormal septal motion consistent with left bundle branch block.

Right Ventricle: Visually RV appears normal size. Moderately decreased systolic function.

Right Atrium: Dilated hepatic veins and dilated inferior vena cava.

Mitral Valve: Mild annular calcification. The opening of the leaflets is consistent with low output state. Tethering of the leaflets, posterior greater than anterior. Severe regurgitation.

Tricuspid Valve: Severe regurgitation.

Aortic Valve: Sclerosis.

Venous: Dilated superior vena cava. Inferior vena cava is dilated (>21 mm) with less than 50% respiratory variation.

Pericardium/Other: R Lung B lines noted.

Sonographer: Robert R Moss MBBS

Electronically signed by Robert R Moss MBBS

Signature Date/Time: 20-Oct-2020 at 1:03:18 PM; Facility SPH

Exam completed by Robert R Moss MBBS on 20-Oct-2020 at 1:03:18 PM

UBC

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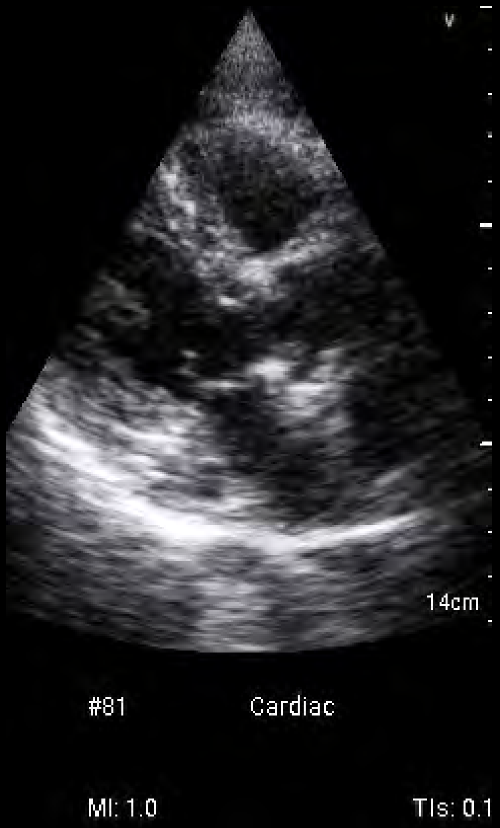
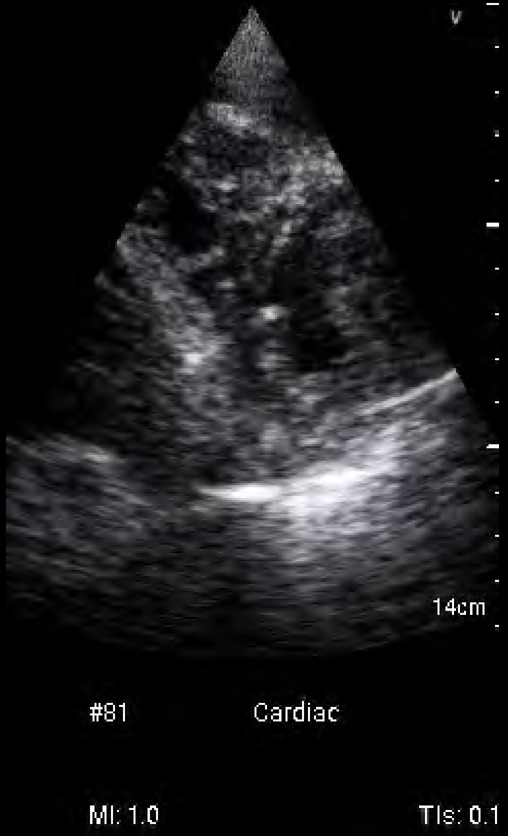
POCUS NOW
Case #2

93 yo female

Pre POCUS diagnosis:

- Peripheral edema
- CHF
- Volume overload
- Diuretic resistance (high dose diuretic infusion)





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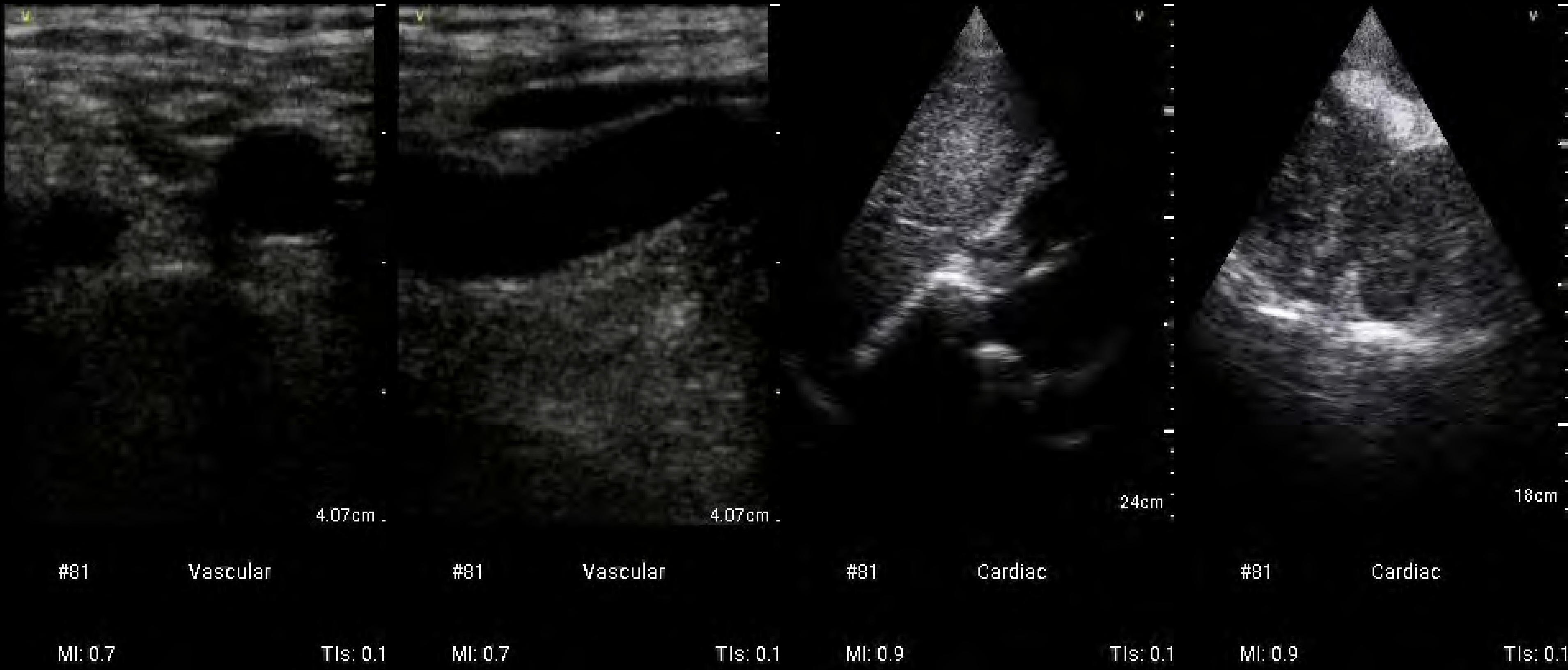
4.07cm
4.07cm
24cm
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#81
Vascular
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MI: 0.7
TIs: 0.1
MI: 0.7
TIs: 0.1
MI: 0.9
TIs: 0.1
MI: 0.9
TIs: 0.1

POCUS Now Case #2

Post POCUS diagnosis

- Hyper-dynamic LV, RV function
- Low venous pressure
- RA mass
- No B lines, small pleural effusion

Outcome:

- Diuretics discontinued
- Liberalized volume
- Improved renal function, status
- RA thrombus treated with OAC

Summary and Conclusions:

1. **Hyperdynamic LV systolic function. EF% cannot be quantitated.**
2. **Hyperdynamic RV systolic function.**
3. **Normal RA pressure.**

Study Comments: Patient being treated with diuretic infusion for volume overload, edema. Patient obtunded, could not be positioned for study.

Findings:

Left Ventricle: Hyperdynamic systolic function. EF% cannot be quantitated.
Right Ventricle: Visually RV appears normal size. Hyperdynamic systolic function.
Left Atrium: The LA is enlarged.
Right Atrium: Normal RA pressure. Large RA mass as previously described, consider thrombus.
Mitral Valve: No regurgitation.
Aortic Valve: Trileaflet valve. No restriction of cusp motion. Mild valvular regurgitation.
Venous: Inferior vena cava is normal size with greater than 50% respiratory variation. Internal jugular is collapsed. RAP <3 mmHg.
Pericardium/Other: No pericardial effusion. No B lines were seen, very small right pleural effusion.

Measurements and Calculations:

Left Ventricle:		Normal
LVIDd:	37 mm	(38-52)

Sonographer: Robert R Moss MBBS

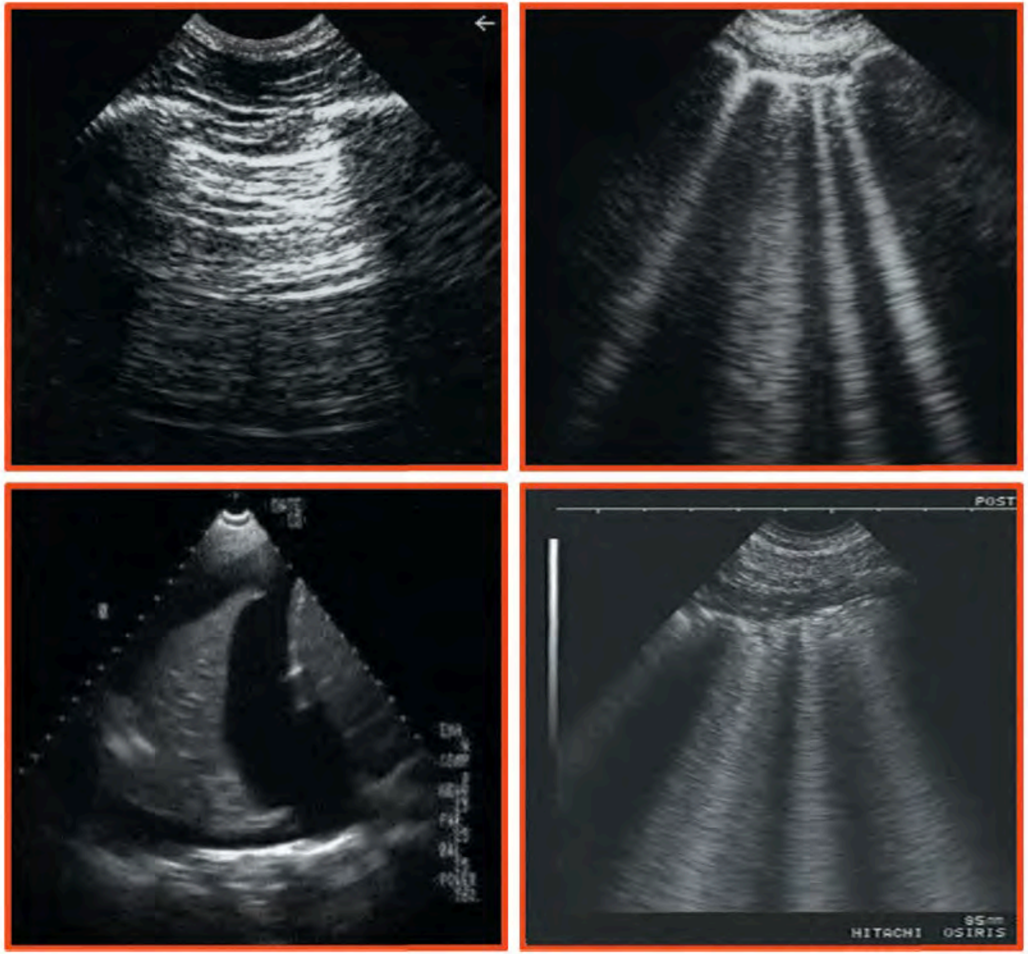
Diagnostic accuracy of POCUS for common conditions

Diaz-Gomez NEJM 2021; 385 1593-

American Society of Echocardiography
Sound Saves Lives

A-lines

Regular pleural line, B-lines



Large pleural effusion, lung consolidation

Irregular pleural line, B-lines

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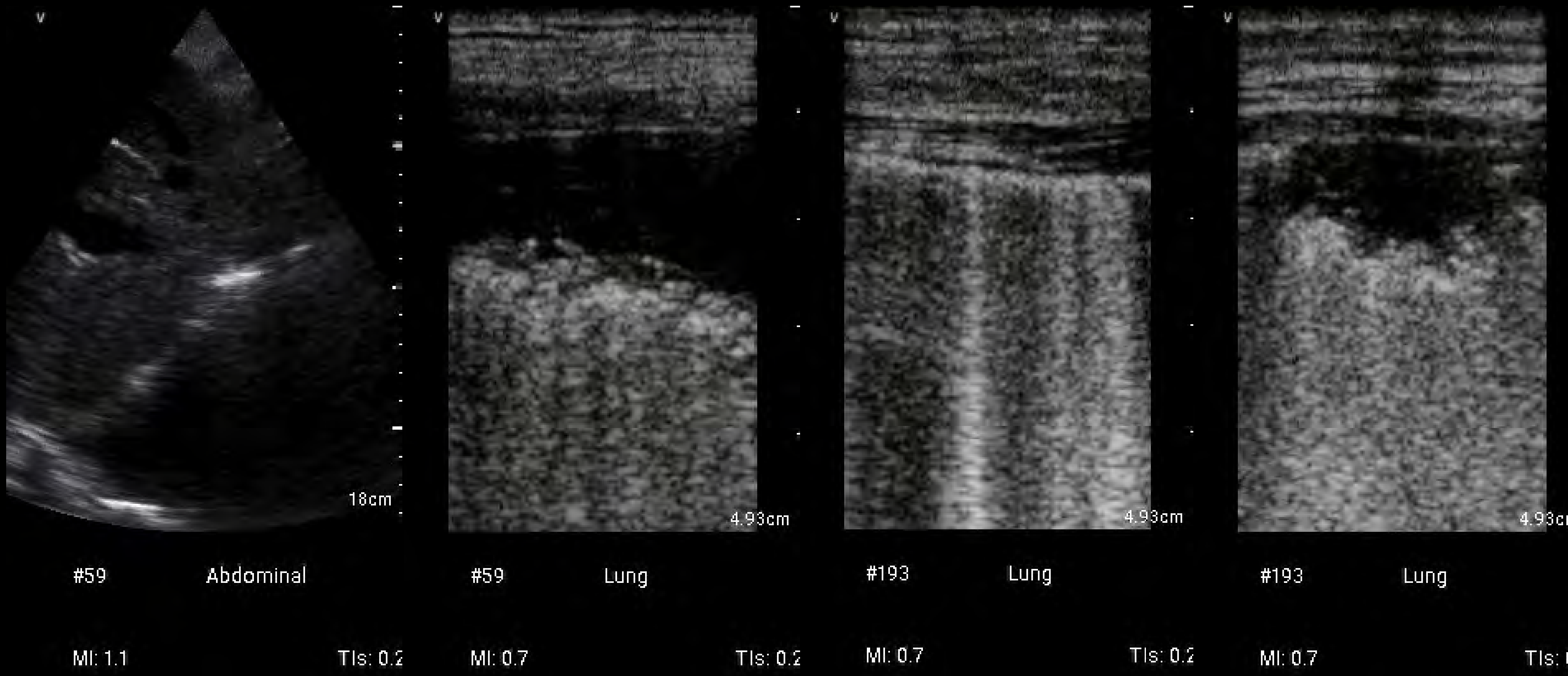
Picano E, et al. JACC Cardiovasc Imaging. 2018;11(11):1692-1705.

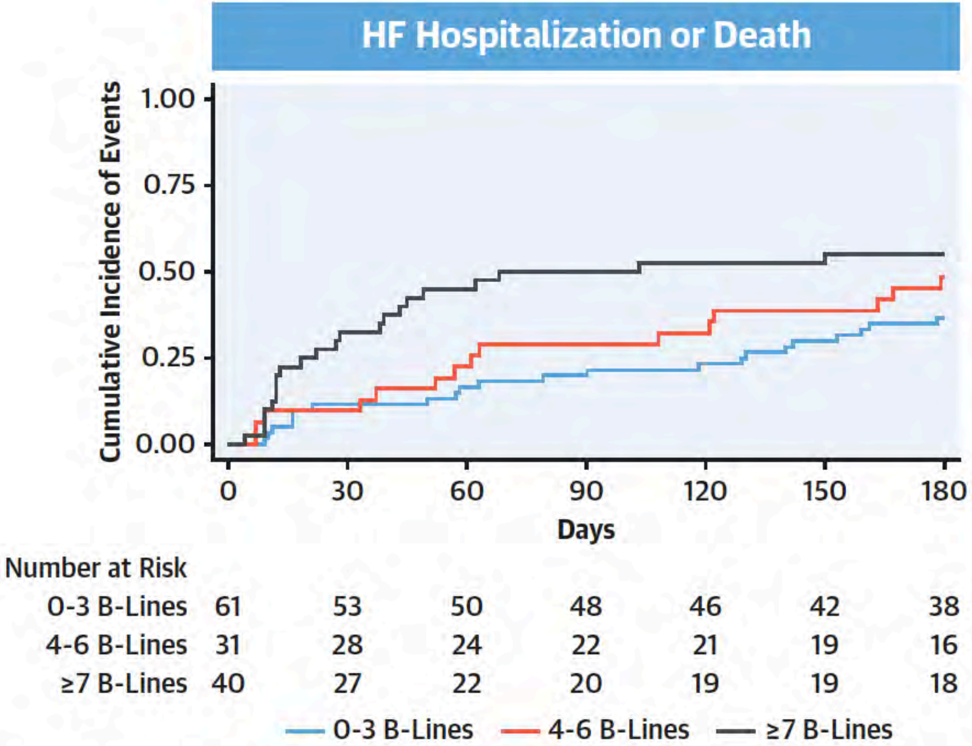
Pocus Now # 3: Lung POCUS



Lung Ultrasound in Acute Heart Failure

Prevalence of Pulmonary Congestion and Short- and Long-Term Outcomes

Diagnosis:
Favorable comparisons with chest X-ray in pandemic context
HF Management, diuretic titration
Prognostic implications



Platz, E. et al. J Am Coll Cardiol HF. 2019;7(10):849-58.

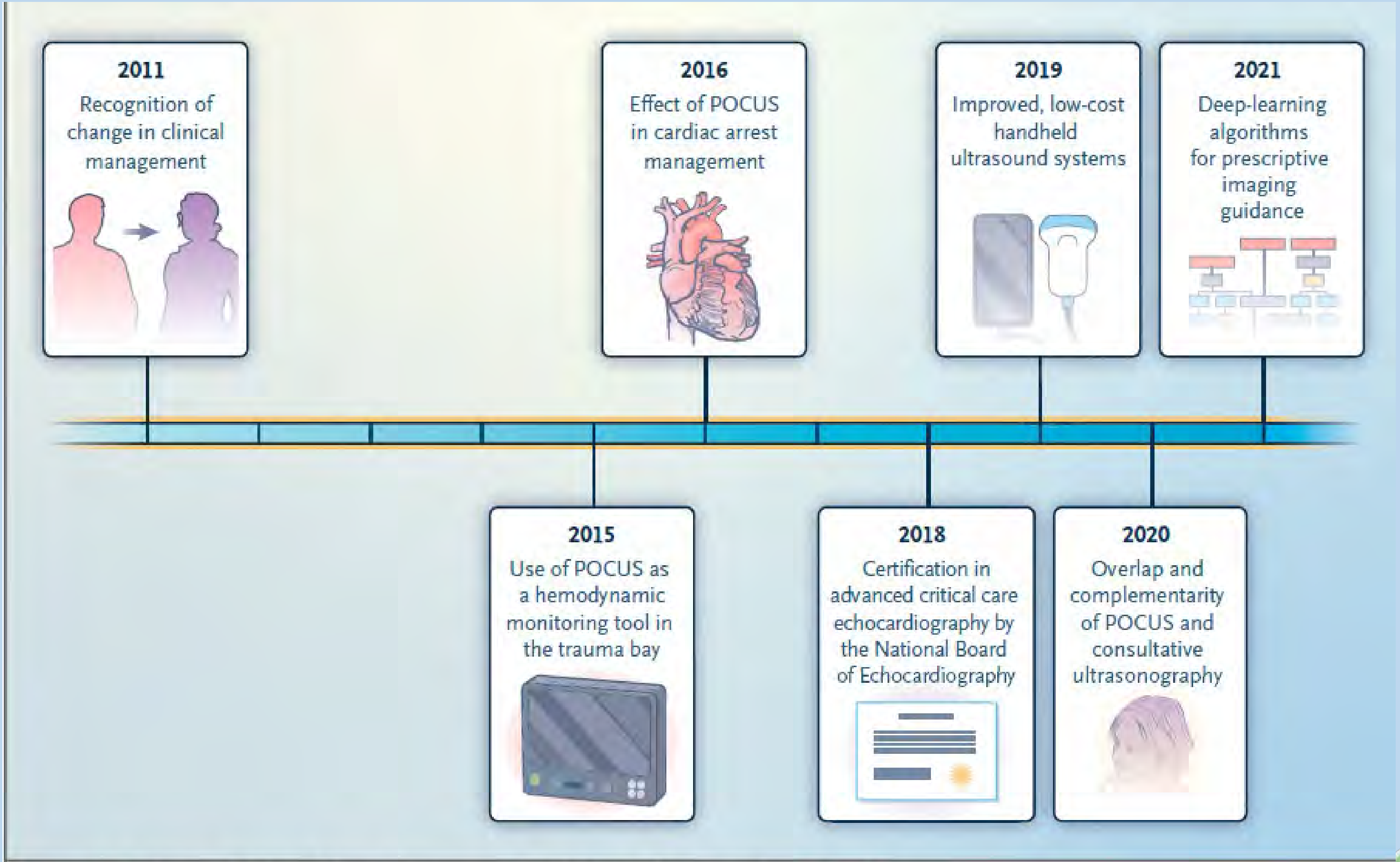


Figure 1. Evolution of Point-of-Care Ultrasonography (POCUS) during the Past Decade.

The leading areas of research on POCUS have been cardiothoracic ultrasonography and ultrasound-guided procedures. Most of the studies have been published in critical care medicine and emergency medicine journals.

Diaz-Gomez NEJM 2021; 385 1593-

POCUS: the future

The democratization of echo/US

The multiplier effect of AI deep learning algorithms on democratization

- Enhanced acquisition
- Enhanced imaged quality
- Enhanced image interpretation

Bringing diagnostic US to rural and remote communities

Leveraging POCUS to look to better understand extra-cardiac structures and organ function

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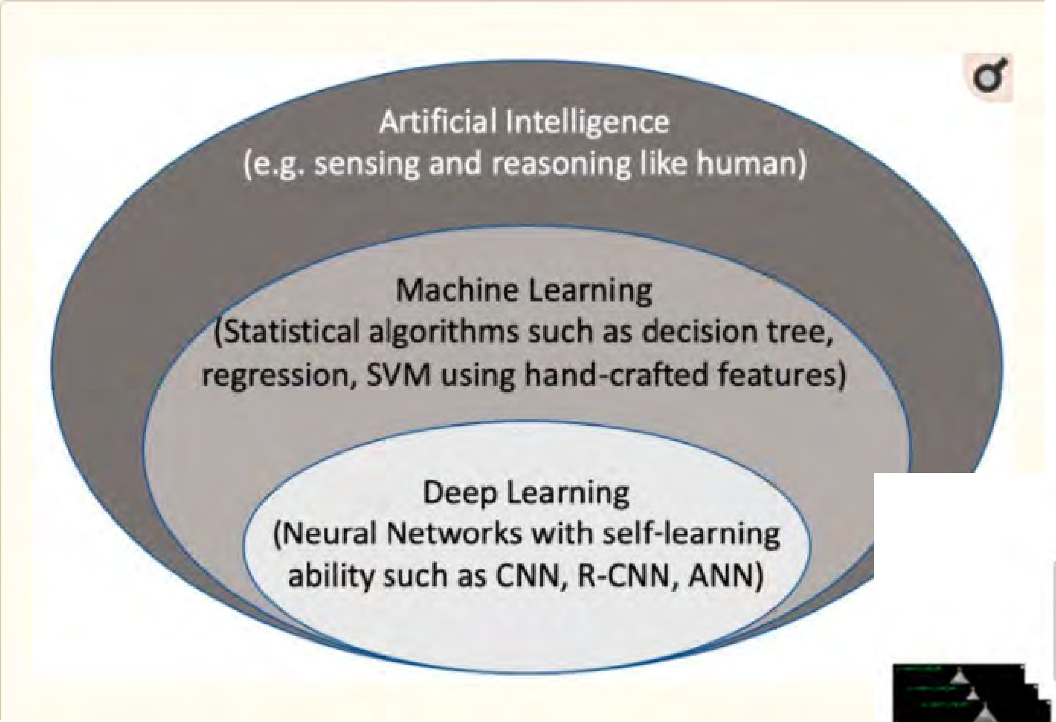


Akkus J Clin Med 2021

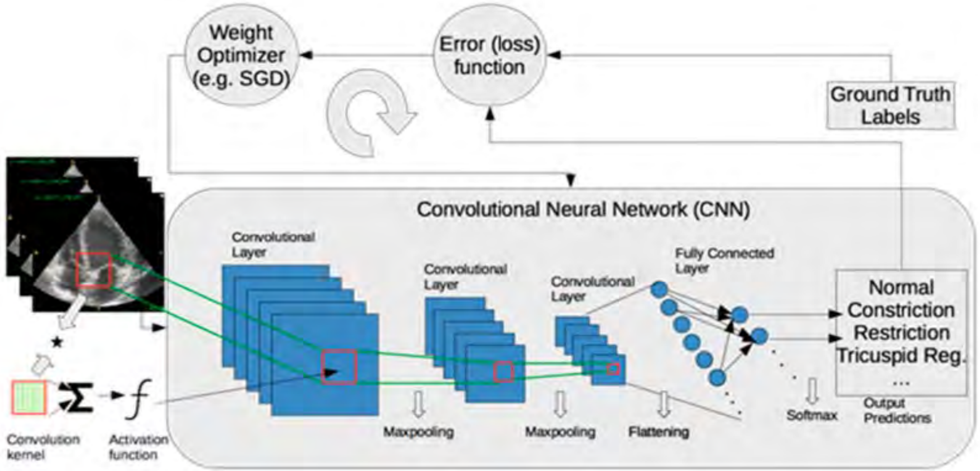


Figure 3. A framework of training a deep-learning model for classification of myocardial diseases. Operations between layers are shown with arrows. SGD: Stochastic Gradient Descent.

Training of Novice US Operators

DL algorithm allows novices to acquire acceptable images to assess ventricular size and function, PE

Narang JAMA Cardiol 2021;6(6):624

Research

JAMA Cardiology | Original Investigation

Utility of a Deep-Learning Algorithm to Guide Novices to Acquire Echocardiograms for Limited Diagnostic Use

Akhil Narang, MD; Richard Bae, MD; Ha Hong, PhD; Yngvil Thomas, MS; Samuel Surette, BS; Charles Cadieu, PhD; Ali Chaudhry, MBA; Randolph P. Martin, MD; Patrick M. McCarthy, MD; David S. Rubenson, MD; Steven Goldstein, MD; Stephen H. Little, MD; Roberto M. Lang, MD; Neil J. Weissman, MD; James D. Thomas, MD

Multimedia

Supplemental content

IMPORTANCE Artificial intelligence (AI) has been applied to analysis of medical imaging in recent years, but AI to guide the acquisition of ultrasonography images is a novel area of investigation. A novel deep-learning (DL) algorithm, trained on more than 5 million examples of the outcome of ultrasonographic probe movement on image quality, can provide real-time prescriptive guidance for novice operators to obtain limited diagnostic transthoracic echocardiographic images.

OBJECTIVE To test whether novice users could obtain 10-view transthoracic echocardiographic studies of diagnostic quality using this DL-based software.

DESIGN, SETTING, AND PARTICIPANTS This prospective, multicenter diagnostic study was conducted in 2 academic hospitals. A cohort of 8 nurses who had not previously conducted echocardiograms was recruited and trained with AI. Each nurse scanned 30 patients aged at least 18 years who were scheduled to undergo a clinically indicated echocardiogram at Northwestern Memorial Hospital or Minneapolis Heart Institute between March and May 2019. These scans were compared with those of sonographers using the same echocardiographic hardware but without AI guidance.

INTERVENTIONS Each patient underwent paired limited echocardiograms: one from a nurse without prior echocardiography experience using the DL algorithm and the other from a sonographer without the DL algorithm. Five level 3–trained echocardiographers independently and blindly evaluated each acquisition.

MAIN OUTCOMES AND MEASURES Four primary end points were sequentially assessed: qualitative judgement about left ventricular size and function, right ventricular size, and the presence of a pericardial effusion. Secondary end points included 6 other clinical parameters and comparison of scans by nurses vs sonographers.

RESULTS A total of 240 patients (mean [SD] age, 61 [16] years old; 139 men [57.9%]; 79 [32.9%] with body mass indexes >30) completed the study. Eight nurses each scanned 30 patients using the DL algorithm, producing studies judged to be of diagnostic quality for left ventricular size, function, and pericardial effusion in 237 of 240 cases (98.8%) and right ventricular size in 222 of 240 cases (92.5%). For the secondary end points, nurse and sonographer scans were not significantly different for most parameters.

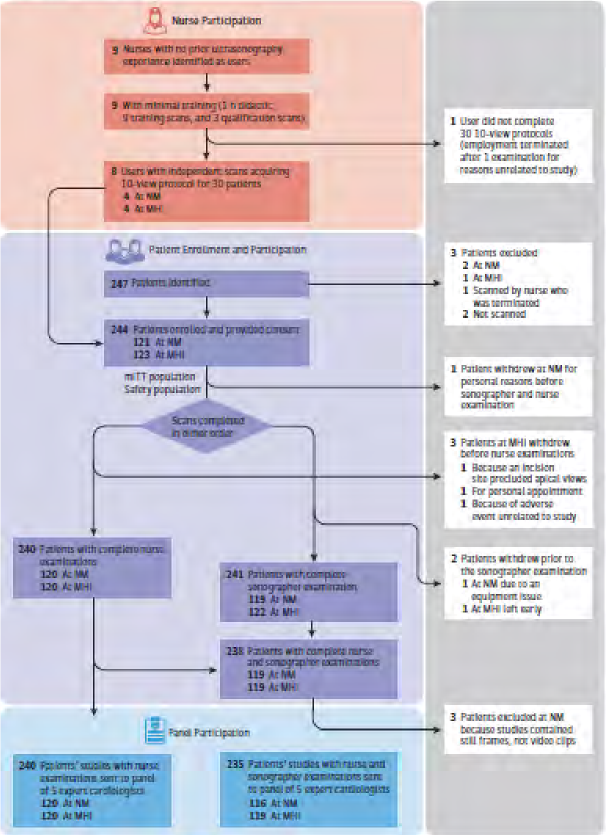
CONCLUSIONS AND RELEVANCE This DL algorithm allows novices without experience in ultrasonography to obtain diagnostic transthoracic echocardiographic studies for evaluation of left ventricular size and function, right ventricular size, and presence of a nontrivial pericardial effusion, expanding the reach of echocardiography to clinical settings in which immediate interrogation of anatomy and cardiac function is needed and settings with limited resources.

Author Affiliations: Bluhm Cardiovascular Institute, Northwestern University, Chicago, Illinois (Narang, McCarthy, J. D. Thomas); Division of Cardiology, Minneapolis Heart Institute, Minneapolis, Minnesota (Bae); Caption Health, Brisbane, California (Hong, Y. Thomas, Surette, Cadieu, Chaudhry, Martin); Division of Cardiology, Scripps Health, San Diego, California (Rubenson); Division of Cardiology, MedStar Washington Hospital Center, Washington, DC (Goldstein); Houston Methodist, Houston, Texas (Little); Section of Cardiology, The University of Chicago, Chicago, Illinois (Lang); MedStar Health Research Institute, Washington, DC (Weissman).

Corresponding Author: James D. Thomas, MD, Northwestern Medicine, 676 N St Clair St, Ste 700, Chicago, IL 60611 (jthomas8@nm.org).

JAMA Cardiol. 2021;6(6):624-632. doi:10.1001/jamacardio.2021.0165
Published online February 18, 2021.

Figure 1. Study Design

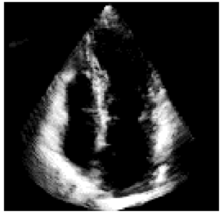


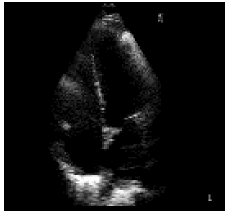
Ouyang D, et al. Nature. 2020;580(7802):252-256.

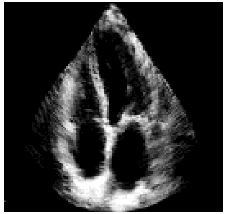
POCUS to Cart-based Image Conversion

POCUS

Translated to High Quality platform







Translating Echo video quality to enhance performance: POCUS LV Segmentation

POCUS

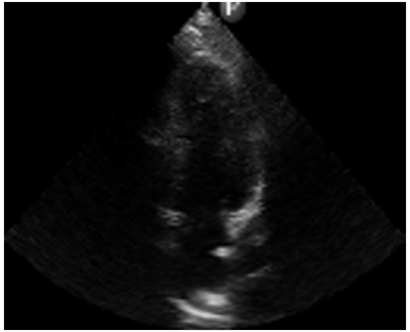
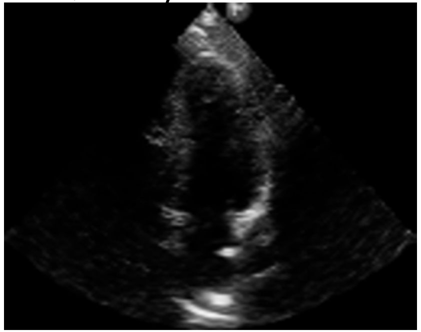
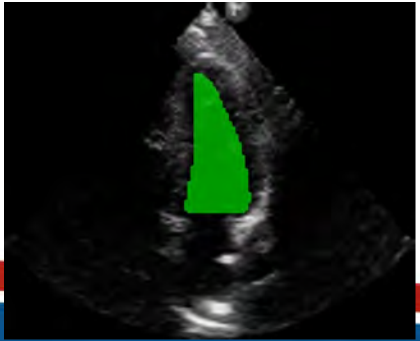


Image Quality Translation by Constrained CycleGAN

Quality translated





Segmentation by Level III Echo

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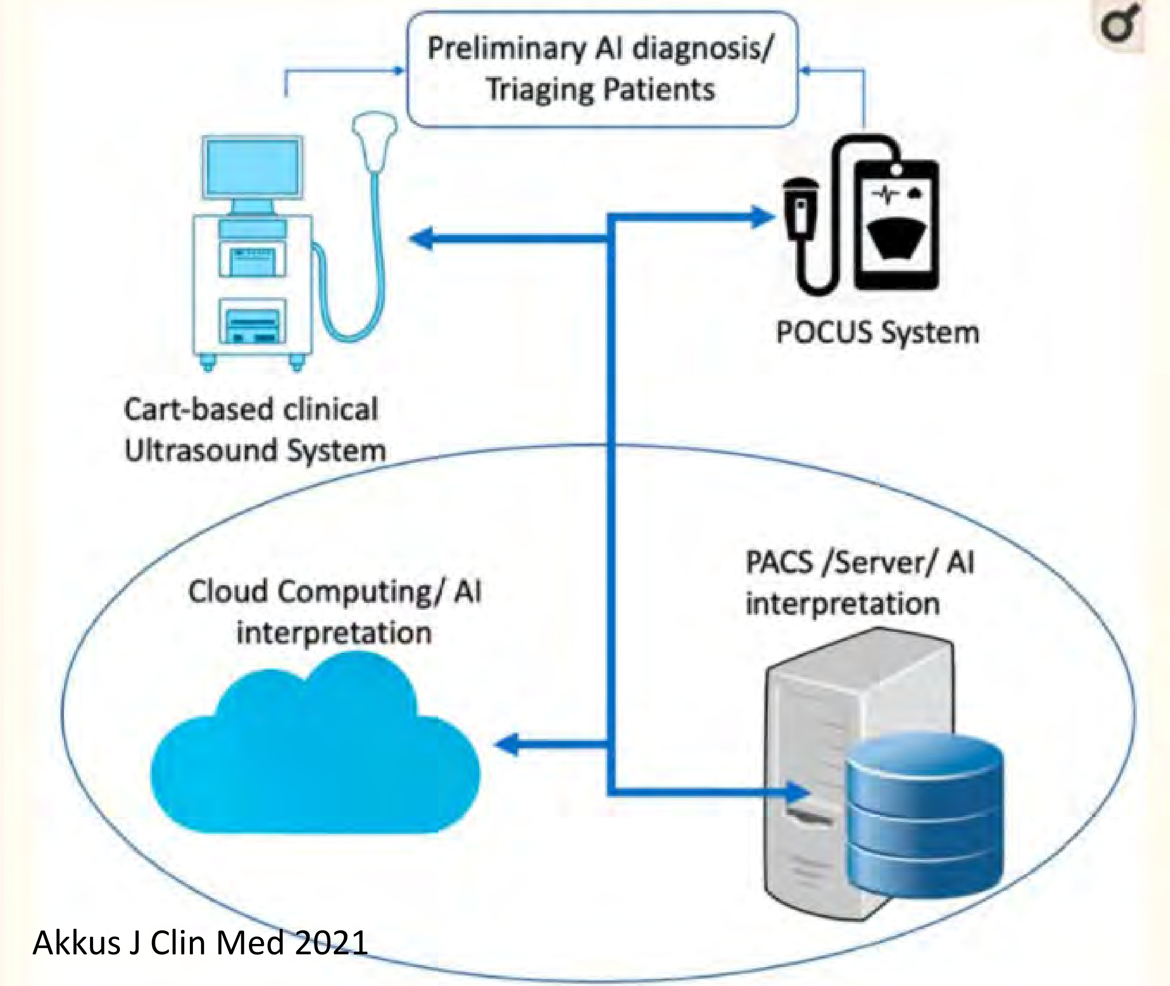
St. Paul's Hospital, Vancouver

Jafari M, et al. International Journal of Computer Assisted Radiology and Surgery. 2020



Akkus J Clin Med 2021

Limited access to diagnostic US services in BC

Train rural and remote practitioners in the use of cardiac POCUS

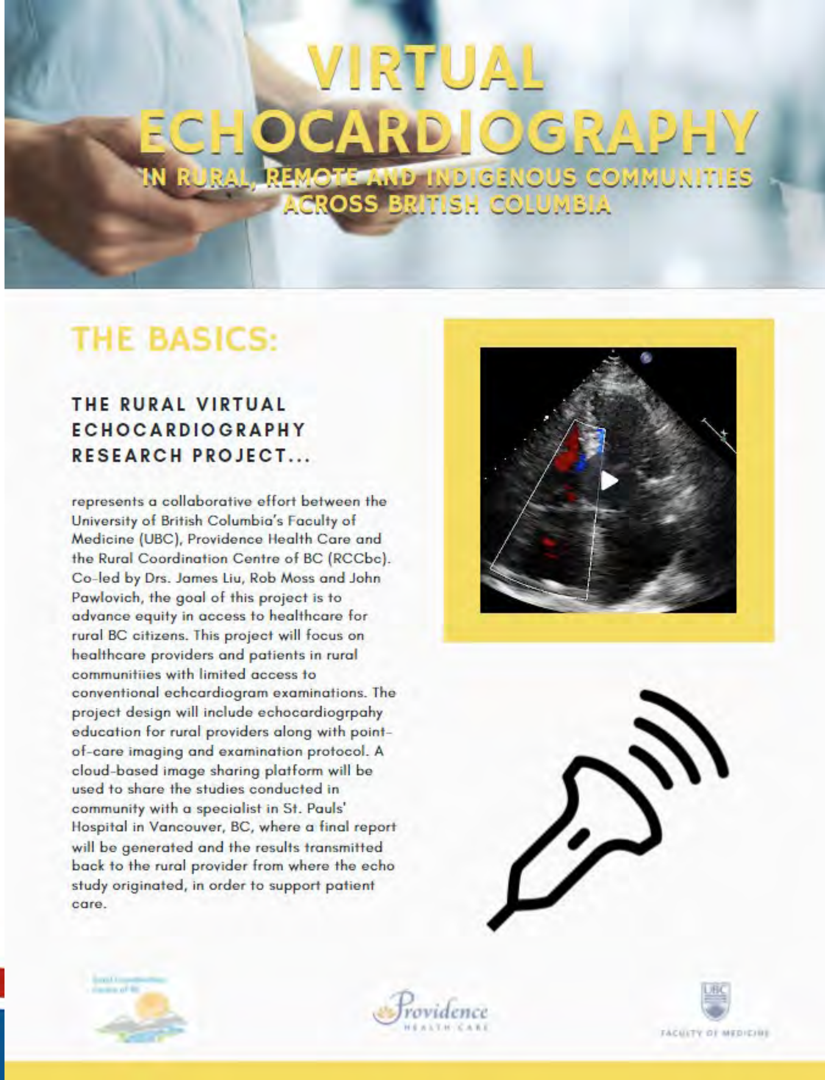
Equip a training cohort with POCUS units

Upload to cloud

Real time review by echocardiographer

Virtual clinical support

Metrics: accuracy, quality, triaging for transfer urgent investigation


VIRTUAL ECHOCARDIOGRAPHY

IN RURAL, REMOTE AND INDIGENOUS COMMUNITIES ACROSS BRITISH COLUMBIA

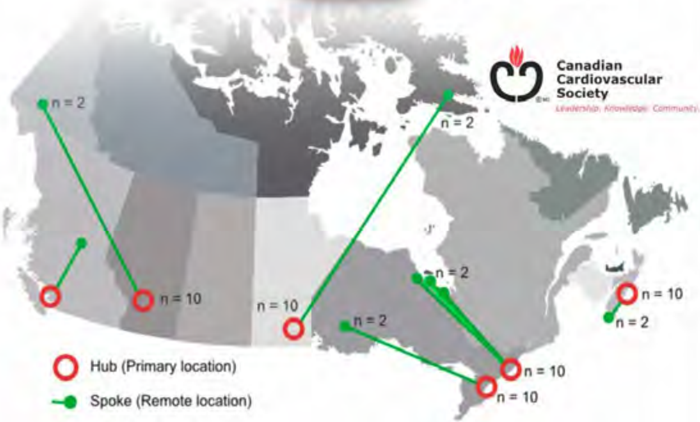
THE BASICS:

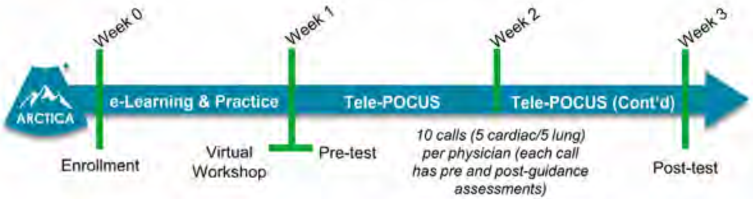
THE RURAL VIRTUAL ECHOCARDIOGRAPHY RESEARCH PROJECT...

represents a collaborative effort between the University of British Columbia's Faculty of Medicine (UBC), Providence Health Care and the Rural Coordination Centre of BC (RCCbc). Co-led by Drs. James Liu, Rob Moss and John Pawlovich, the goal of this project is to advance equity in access to healthcare for rural BC citizens. This project will focus on healthcare providers and patients in rural communitiies with limited access to conventional echcardiogram examinations. The project design will include echocardiogrpahy education for rural providers along with point-of-care imaging and examination protocol. A cloud-based image sharing platform will be used to share the studies conducted in community with a specialist in St. Pauls' Hospital in Vancouver, BC, where a final report will be generated and the results transmitted back to the rural provider from where the echo study originated, in order to support patient care.

IN PoCUS project to facilitate closer-to-home ultrasound-based assessment and diagnosis in rural BC

Posted on April 30, 2020 by

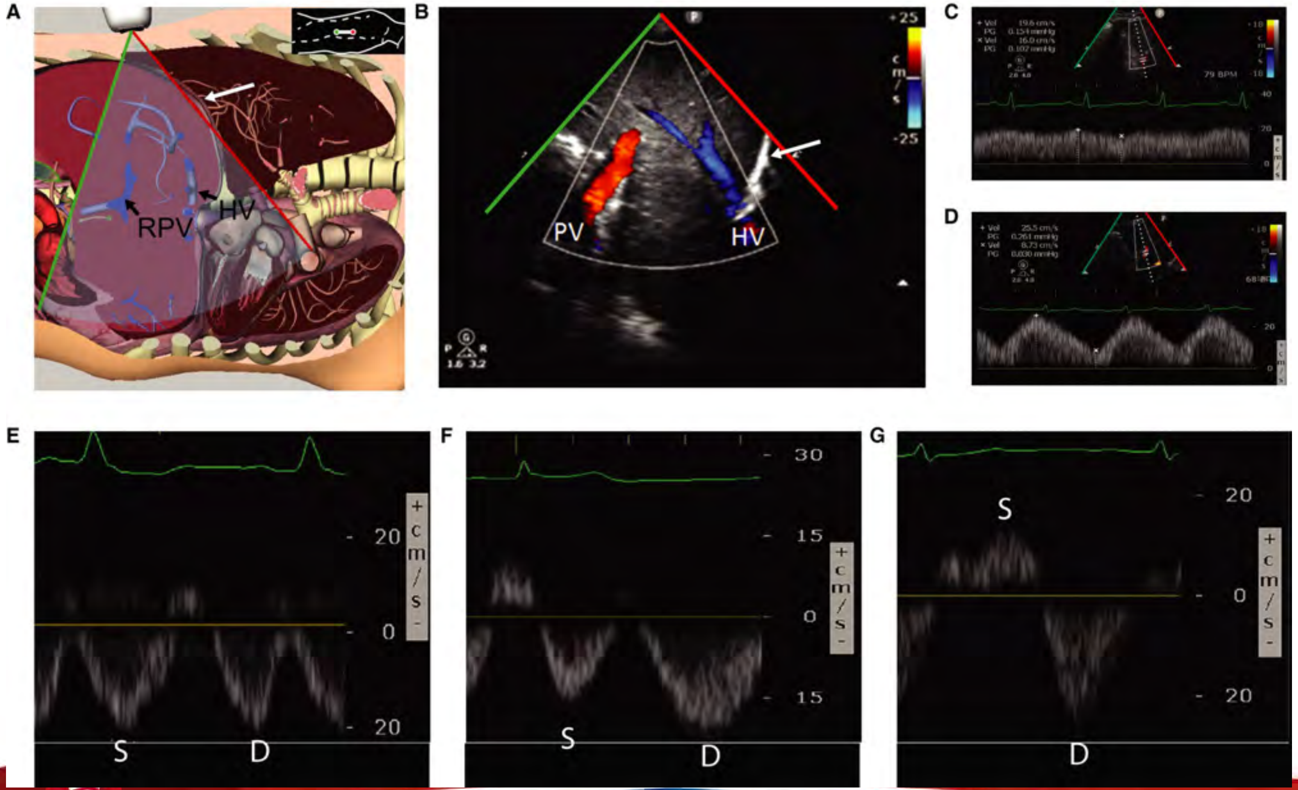




Lumify with REACTS

Reacts is integrated with the Philips' Lumify to share the live ultrasound stream from a Lumify device with a remote colleague This allows both parties to simultaneously view the live ultrasound image, as well as the webcam video stream, and provide real time feedback.

Alterations in portal vein flow and intrarenal venous flow are associated with AKI after Cardiac Surgery:



Normal portal flow showing minimal variations of flow velocities during the cardiac cycle (pulsatility fraction: 18.4%).

Abnormal variations of portal flow velocities during the cardiac cycle (pulsatility fraction 66%)

.

Denault. J Am Heart. Alterations in Portal Vein Flow and Intrarenal Venous Flow Are Associated With Acute Kidney Injury After Cardiac Surgery 2018

Take-homes

We are echocardiographers but we don’t ‘own’ cardiac POCUS

Cardiologists have been ‘late to the party’

POCUS evidence for diagnostic accuracy but no clear effect outcomes (yet, but I think it’s coming)

Need to move outside the heart

And understand lung, vascular imaging (at a minimum)

Insufficient attention to extra-cardiac imaging in echo training

Take-homes

Challenges in archival and reporting

Quality control

Training

- How much?
- How to maintain skills?
- Certification and recertification? By whom and how often?

Avoiding Mission Creep

Remuneration remains an issue. (HC funders are terrified of this)

Mission creep

THE FUTURE'S SO **BRIGHT,**
I GOTTA WEAR **SHADES.**


Showing all 3 studies
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2011
R1: MRI ORB/FACE/NECK
2006
Not intended for diagnostic use in a Citrix environment
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The NEW ENGLAND JOURNAL of MEDICINE

VIDEOS IN CLINICAL MEDICINE
SUMMARY POINTS

Julie R. Ingelfinger, M.D., *Editor*

Focused Cardiac Ultrasonography for Left Ventricular Systolic Function

Table 2. Echocardiographic Measures of Left Ventricular Ejection Fraction.*

Estimated LVSF or LVEF	Longitudinal Shortening	Anterior Mitral-Leaflet Motion	Thickening of Wall Segments	Change in Area of Cavity
Normal (>55%)	≥1 cm	Beyond midline	Increased by ≥1/3 from minimal thickness	Decreased by ≥1/3 from maximum area
Severely reduced (<30%)	<1 cm	Not beyond midline	Increased by <1/3 from minimal thickness	Decreased by <1/3 from maximum area