

# Can Machine Learning Tools Bring Diagnostic Imaging to the Home with Safety and Efficacy?

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# Time Matters

2/3 of Diagnostic Dilemma's  
Can be Solved with Simple Imaging



Ordering Studies Results  
In Delaying Treatment



# The Journey to the Left of the Care Continuum

From hospitals to primary care offices and home



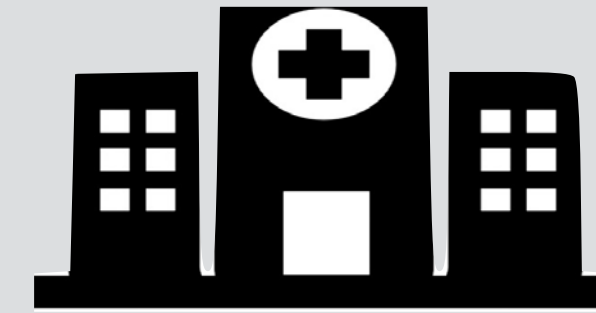
Home



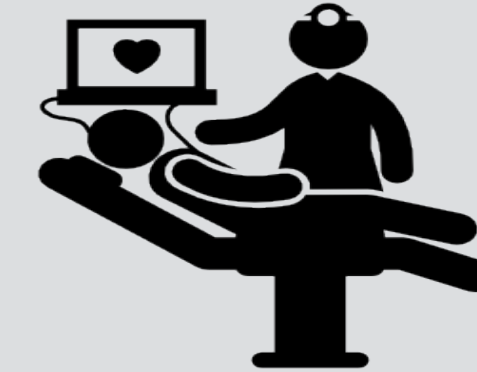
Doctor's Office



Pre Hospital



Hospital PoC



Ultrasound Lab



Upstream Diagnostics: Personalization of Imaging

Lower Costs

Improved Outcomes

Increased Patient Satisfaction

Critical Value Based Care Priorities



# Home Diagnostics Have Proven Value



Present



Future

# Safety & Efficacy Threshold For Imaging In The Home



Consumer Level Interface

Exam is Easy to Perform

Reproducible Results

Accuracy that Matches Professional

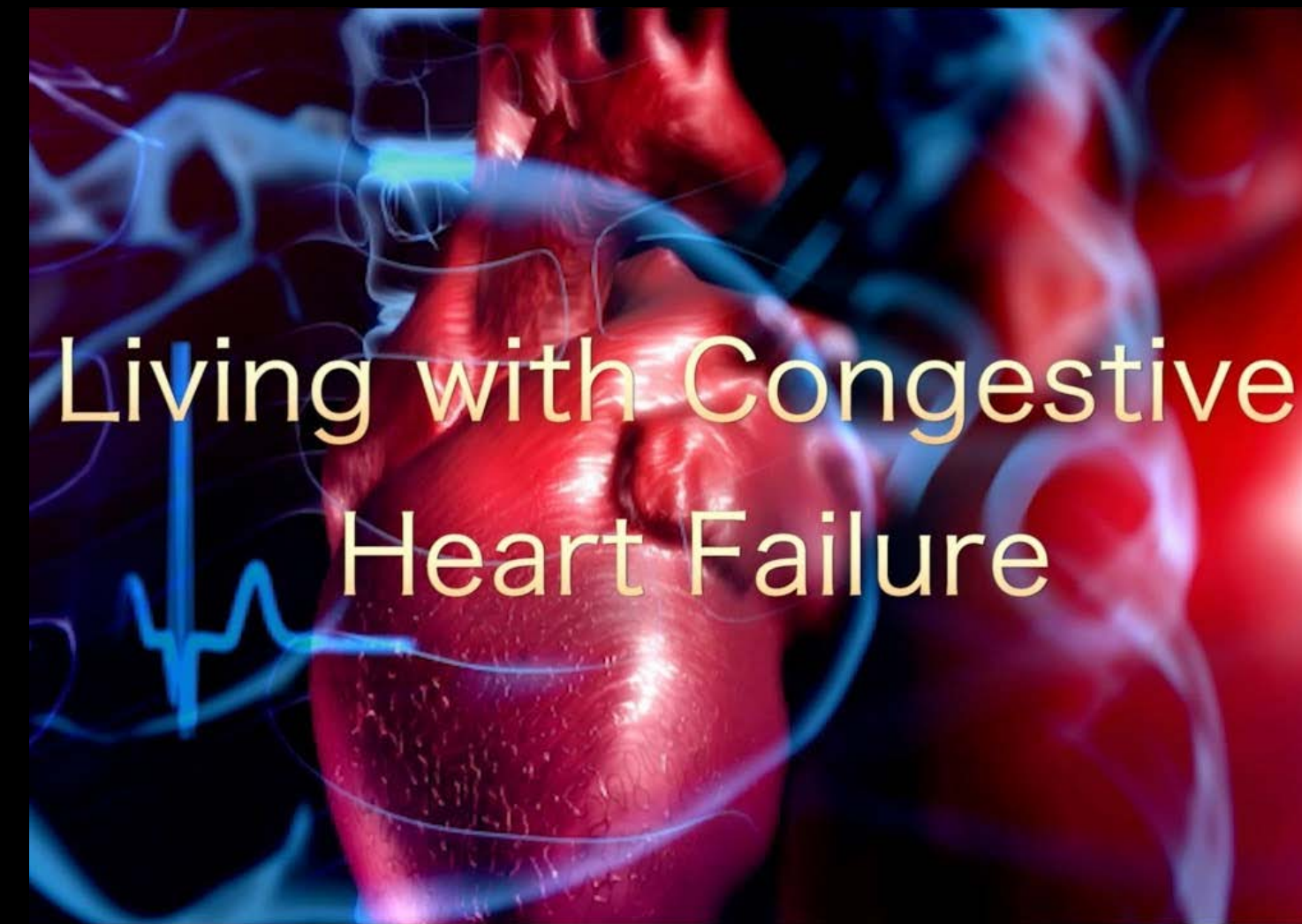
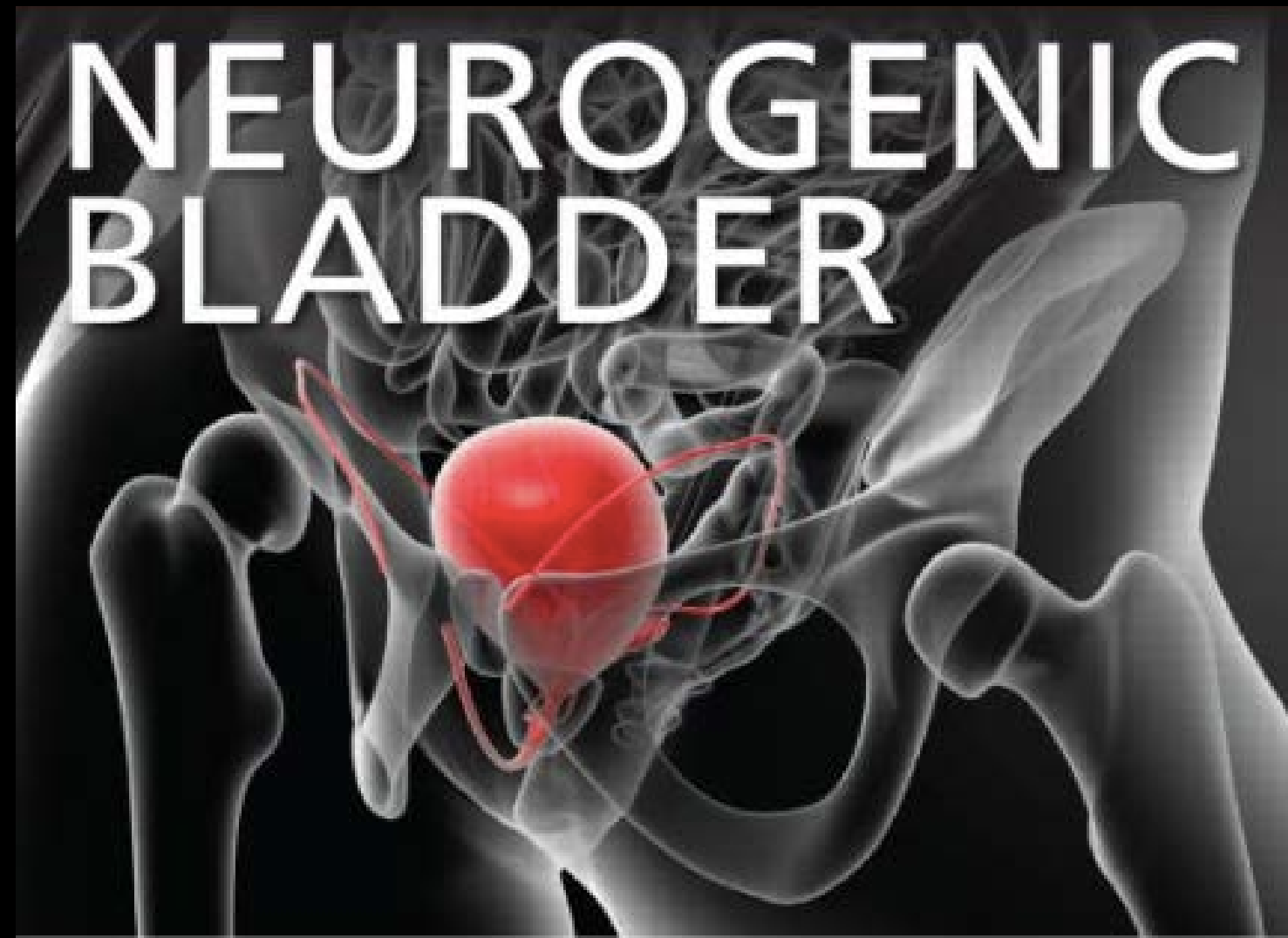
Guidelines For Physician Notification



# Key Questions to Resolve

- Are there clinical conditions in which scanning at home makes sense?
- Can a patient be taught to scan themselves reliably?
- Can AI make this easier and more reliable?
- Are there devices available that can practically achieve this?
- Are there reimbursement models in place to incentivize?

# High Impact Opportunities



Average 16 office visits per year  
ED visit every other year  
1/3 of these result in hospitalizations

5 Million ED Visits  
4 Million Hospitalizations  
Mean Cost/Adm. \$11,552

# Ultrasound is Clinically Useful



Bladder scan accurately  
determines bladder volume



B-lines arise from pleural line  
Number and intensity proportional to  
pulmonary edema



# How Hard Is it to Learn Ultrasound?





# How Long Does it Really Take to Learn POCUS?

TABLE 2

Point-of-care ultrasound: How accurate? How much training?

Protocol	Sensitivity	Specificity	Training requirement	Time required to perform protocol
Evaluation for left ventricular systolic function (compared with expert sonography) <sup>20,21,23</sup>	69%-94%	91%-94%	8 hours of training or 20 practice exams	*
Evaluation of IVC to determine volume status and predict readmission for CHF <sup>26,27</sup>	81%	72%	4 hours of training and 20 practice exams	*
Evaluation for pleural effusion (compared with CT or expert sonography) <sup>32,33</sup>	94%	98%	3 hours of training	*
Evaluation for pneumonia (compared with x-ray or CT) <sup>38,39,41</sup>	90%-96%	88%-93%	3 hours of training	*
Evaluation for pulmonary edema (compared with final diagnosis by blinded chart review) <sup>44,48</sup>	86%-100%	92%-98%	5 practice exams	*
Screening exam for AAA (compared with expert sonography) <sup>55-57</sup>	100%	100%	50 practice exams	<4 minutes
Evaluation for proximal leg DVT (compared with expert sonography) <sup>63-65</sup>	95%	96%	10 minutes to 5 hours of training	<4 minutes

AAA, abdominal aortic aneurysm; CHF, congestive heart failure; CT, computed tomography; DVT, deep vein thrombosis; IVC, inferior vena cava.

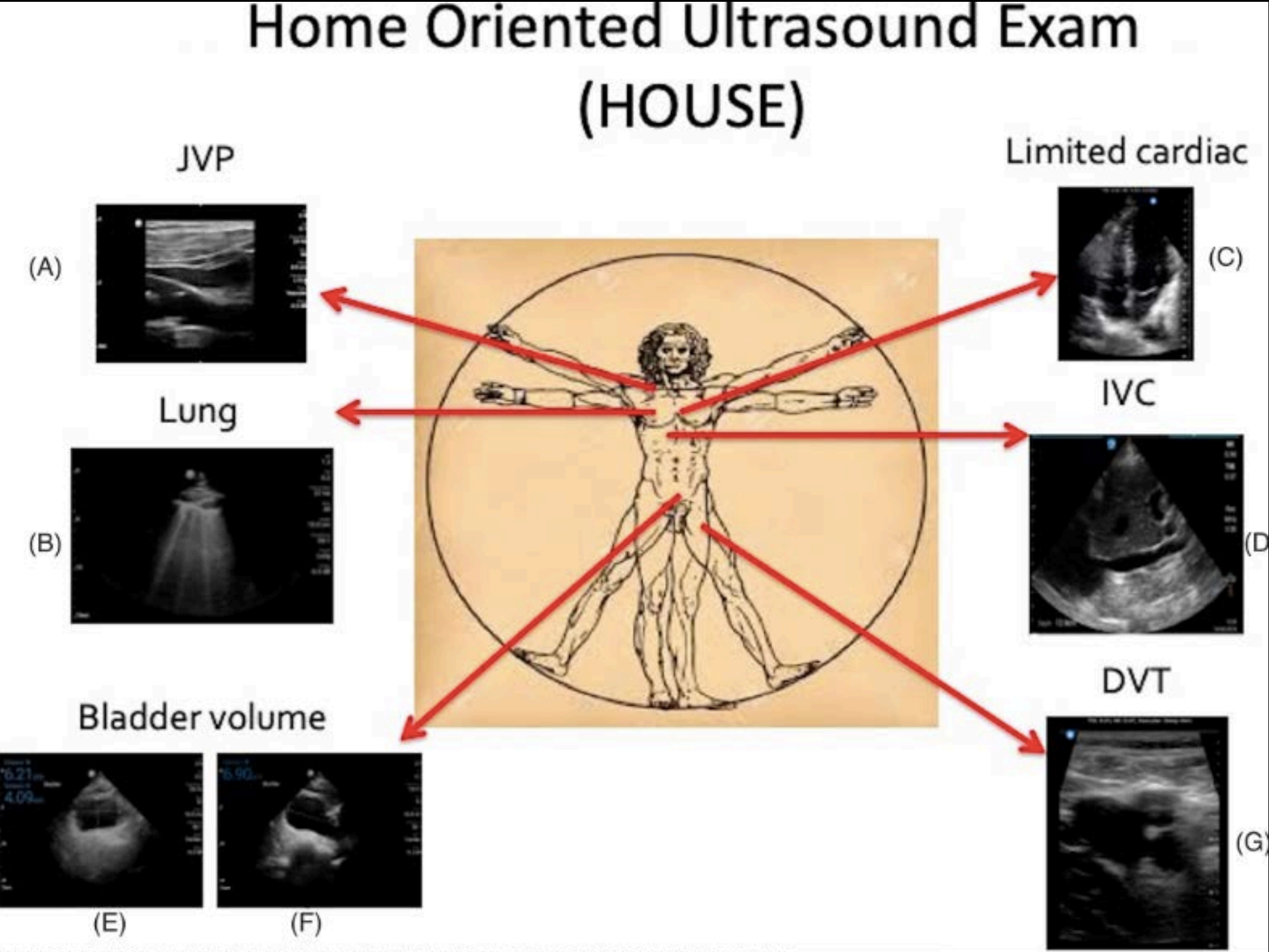
\*Time required to perform was not evaluated for these protocols in the literature that was reviewed.



# Studies Are Underway

Using Point-of-Care Ultrasound on Home Visits: The Home-Oriented Ultrasound Examination (HOUSE)

Alexander R. Bonnel MD, Cameron M. Baston MD, Paul Wallace MD, Nova Panebianco MD, Bruce Kinoshian MD



Patient Performed Lung Ultrasound (PLUS)

UCLA Dr. Alan Chiem

Teleguidance for Home Lung Ultrasound in Patients with CHF

NYU Dr. Harold Sauthoff



## Not This Easy



## Not This Hard



[Cureus](#). 2018 Sep 17;10(9):e3320. doi: 10.7759/cureus.3320.

### **Can You Teach Yourself Point-of-care Ultrasound to a Level of Clinical Competency? Evaluation of a Self-directed Simulation-based Training Program.**

[Mackay FD](#)<sup>1</sup>, [Zhou F](#)<sup>2</sup>, [Lewis D](#)<sup>3</sup>, [Fraser J](#)<sup>4</sup>, [Atkinson PR](#)<sup>4</sup>.

# Is A Home System Feasible?

## Emergence of POCUS





### 3. Devices Available?

## New Handhelds unlock the Full Potential of Ultrasound.

Reduced Cost

Increased Portability

Competitive Image Quality





# Value Proposition of Machine Learning

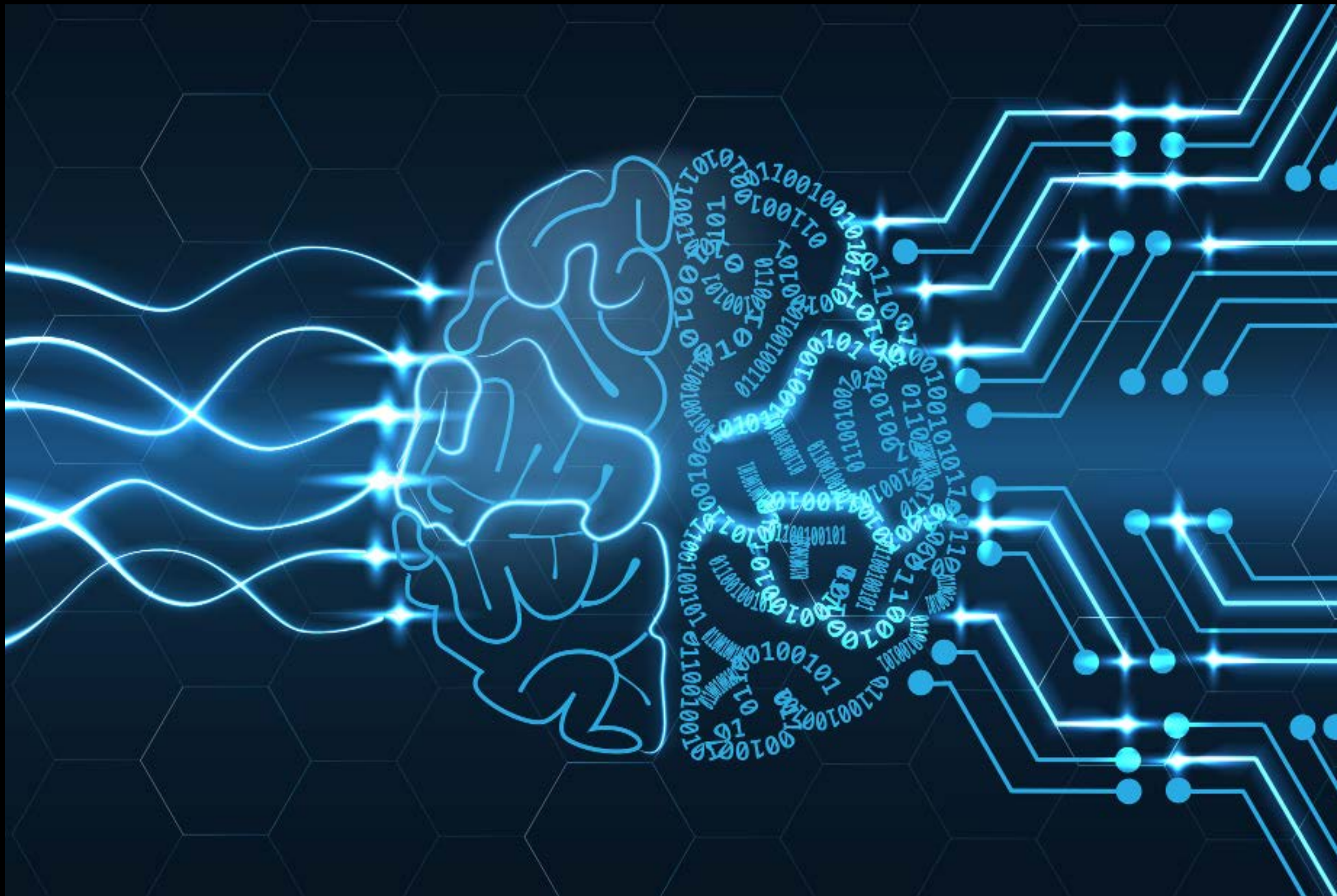
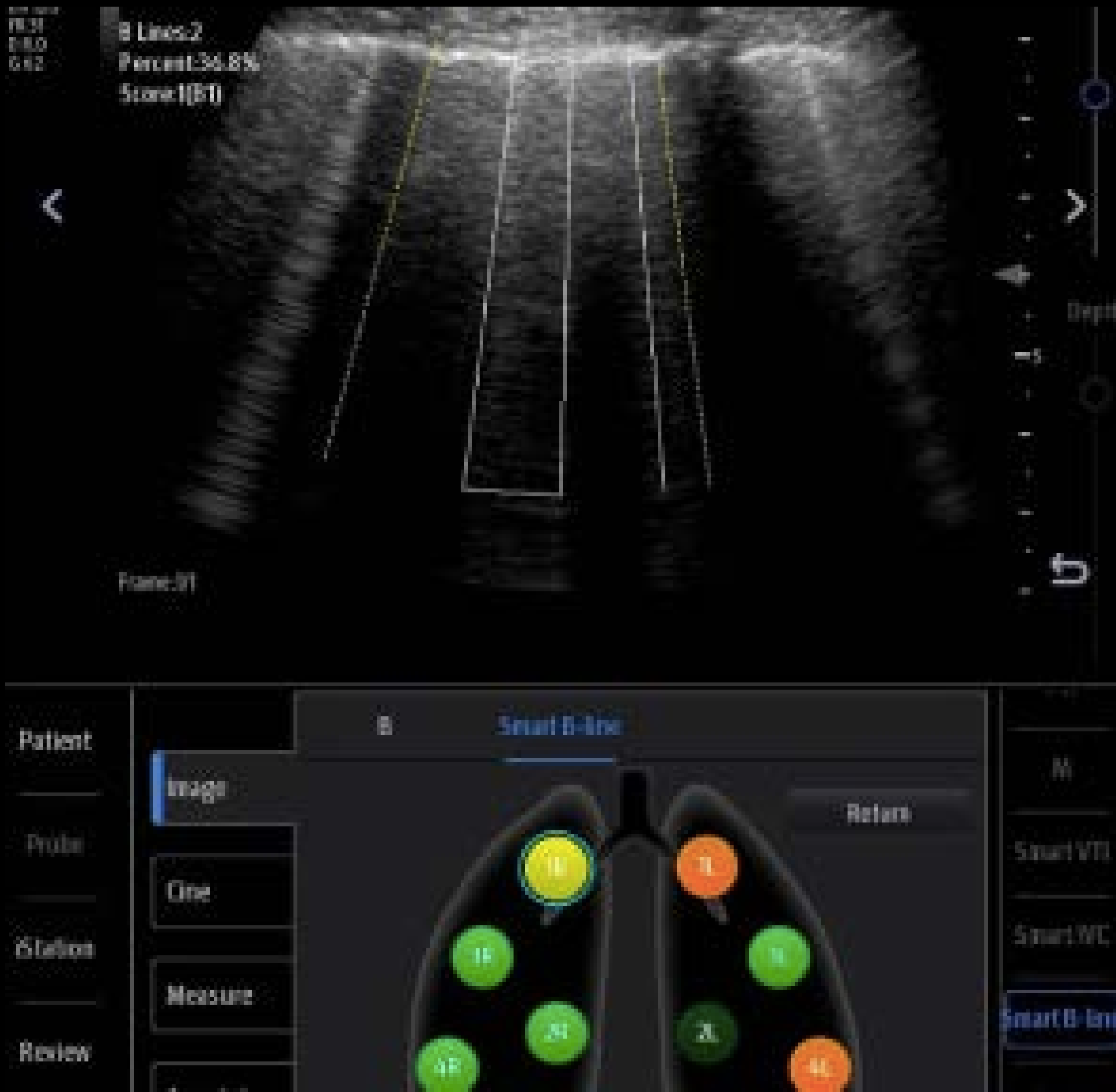


Image Interpretation

Image Guidance



# Image Interpretation Work is Exploding



Automated B- Line Counter

Open Access | Published: 04 June 2019

Computer aided detection in automated 3-D breast ultrasound images: a survey

Ehsan Kozegar, Mohsen Soryani, Hamid Behnam, Masoumeh Salamaty & Tao Tan

Artificial Intelligence Review (2019) | Cite this article

Machine Learning for Medical Ultrasound: Status, Methods, and Future Opportunities

Laura J. Brattain, PhD, Brian A. Telfer, PhD, Manish Dhyani, MD, Joseph R. Grajo, MD, and Anthony E. Samir, MD

Phys Med Biol. 2019 Sep 17;64(18):185010. doi: 10.1088/1361-6560/ab3ad1.

Automated 3D ultrasound image analysis for first trimester assessment of fetal health.

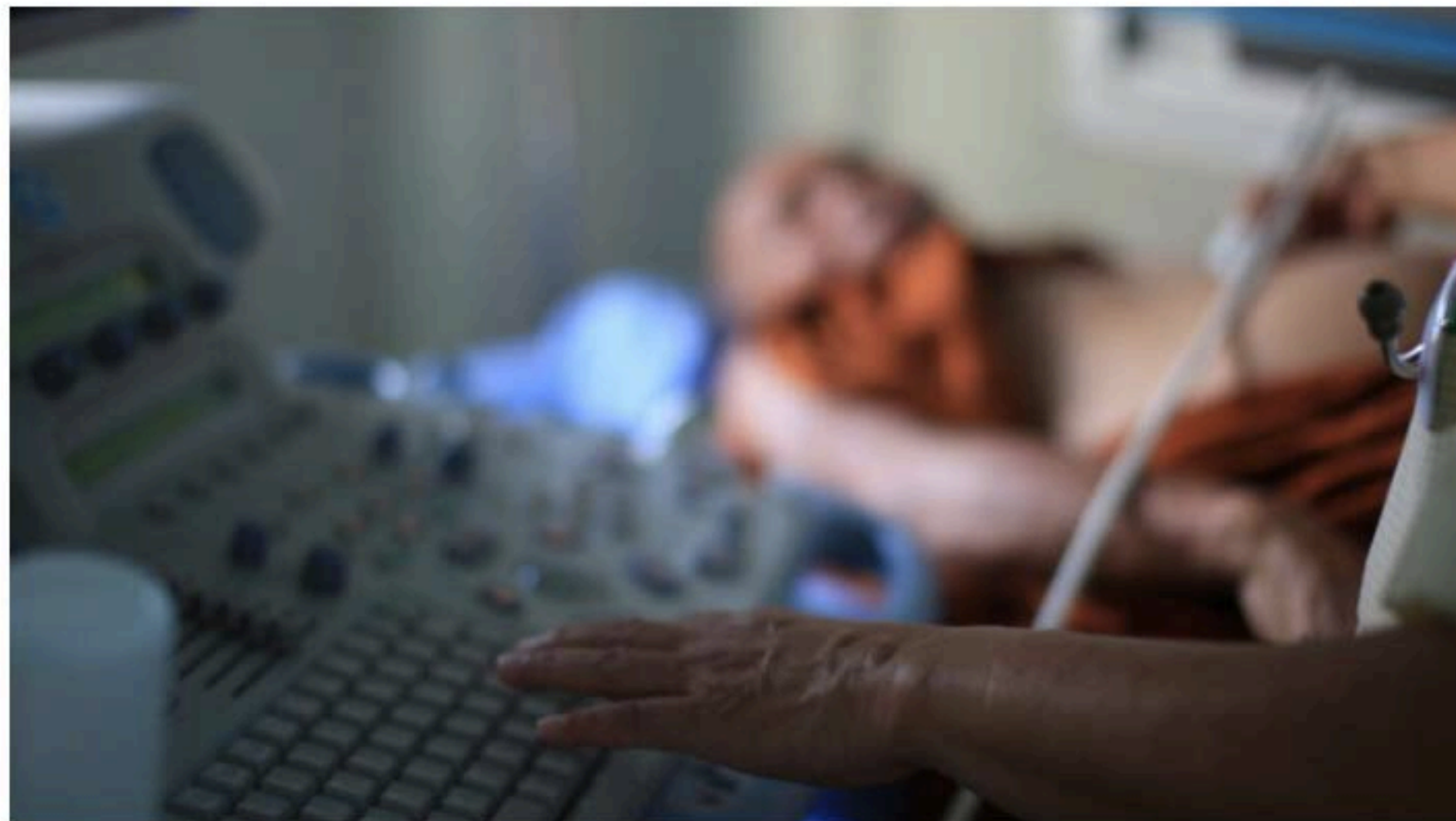
Ryou H<sup>1</sup>, Yaqub M, Cavallaro A, Papageorgiou AT, Alison Noble J.

Author information

# Image Guidance

## FDA approves AI-based software that helps doctors take ultrasound pictures of the heart

By MATTHEW HERPER @matthewherper / FEBRUARY 7, 2020



ADOBE

Accelerate Competence for Novices

Promote Consistent Image Quality

Reduce Scan Times

Expand Access by Including other Classes of

Health Care Professionals

Path to the Consumer?



# Why Is this So Important?



**1 in 4 Patients with CHF Readmitted within 30 Days!**

5. Reimbursement Models



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