•Handheld Echocardiography – It Depends Whose Hands are Holding it: Educational? Diagnostic? Overshadowing the Physical Examination?

Martin E. Goldman MD

Arthur Master MD Professor of Medicine

Mount Sinai Heart

Icahn School of Medicine , Mount Sinai NYC

Point of Care US: performed in real time at pt bedside to correlate with signs and symptoms for immediate Dx and Rx For Procedure Guidance /Diagnosis/ Screening

~~Point of Care – Focused~~

•~~Handheld~~ Echocardiography – It Depends Whose Hands are Holding it: Educational? Diagnostic? Overshadowing the Physical Examination?

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Point –of Care Ultrasound

- Define problem
- Define terms
- Equipment
- Who does the imaging?
- Education
- Adoption & Application

Case:

- 49 yr old woman
- h/o breast cancer
- Rx'd : Adriamycin
- Presents with dyspnea
- tachycardia and mildly hypotensive

- *Normal vs Abnormal:*
- *Outside – In : any fluid?*
- *Chambers Normal Size:*
- *LV Wall Motion*
- *Valves Moving normally?*
- *Abnormal Mass*:

Focused Exam

FCU is a focused examination of the cardiovascular system performed by a *physician* by using ultrasound as an *adjunct to the physical examination* to recognize specific ultrasonic signs that represent a narrow list of potential diagnoses in specific clinical settings.

Synonyms

- *Hand-held cardiac ultrasound*
- *Point-of-care cardiac ultrasound*
- *Ultrasound stethoscope*
- *Hand-carried cardiac ultrasound*
- *Bedside cardiac ultrasound*
- *Quick look cardiac ultrasound*

J Am Soc Echo 2013; 26: 567 – Spencer K

~~Point of Care – Focused~~

- ~~Handheld~~ Echocardiography – It Depends Whose Hands are Holding it: Educational? Diagnostic? Overshadowing the Physical Examination?

- Educational? **YES**
- Diagnostic? **YES**
- Overshadow the Physical Exam? ***NO***

- *ADJUNCT*
- *STRENGTHEN*
- *MODERNIZE*

Physical Exam Is A Lost Art!

TUESDAY, JANUARY 29, 2002

CASES

Restoring The Physical To the Exam

By SANDEEP JAUHAR, M.D.

A man comes into the hospital with fever and a cough producing green sputum. He is elderly and frail. What does he have? "Pneumonia," proclaims the resident presenting the case to her team. "Take a look at this chest X-ray." She pulls up an image on a computer screen showing a distinct pneumonic streak. The senior physician waves it off. "First let's talk about your lung exam," he says.

It is a common scene at teaching hospitals today: young doctors ignoring physical examination to the chagrin of their supervisors. At one time, keen observation and the judicious laying on of hands were virtually the only diagnostic tools a doctor had. Now, they seem almost obsolete. Technology like ultrafast CAT scans and nuclear imaging studies rules the day, permitting diagnosis at a distance. Some doctors don't even carry a stethoscope anymore.

The New York Times

"Some doctors don't even carry a stethoscope anymore"

The NEW ENGLAND JOURNAL of MEDICINE

Hearing Without Listening

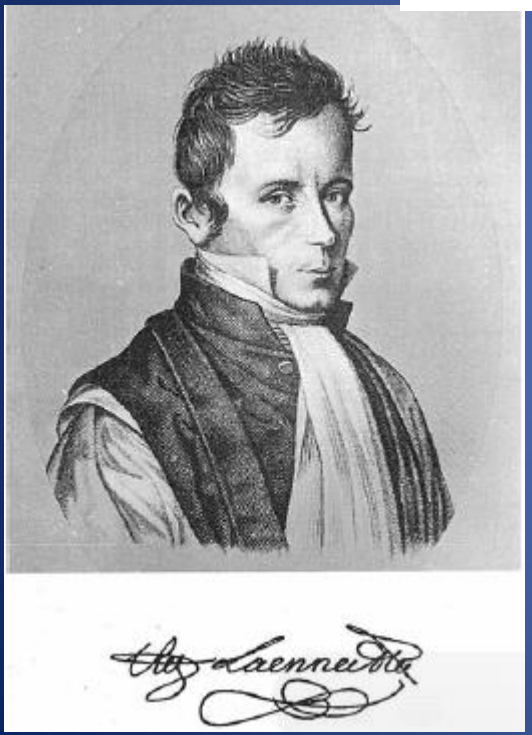
- As the “teaching attending,” I discover very few people are paying real attention
- Most are staring at their screens, ticking boxes and checking data.
- Occasionally, the presenter will slip up and say something outrageous — “The potassium was 29,” instead of 2.9 — and no one will react.
- ***To me it feels empty.***

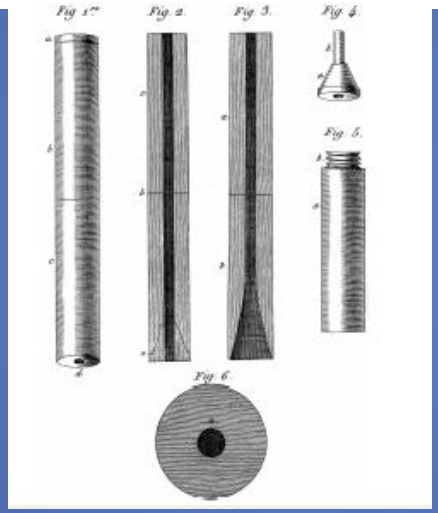
Drazen j NEJM 2016 375: 412-3

The 200th anniversary of the stethoscope: Can this low-tech device survive in the high-tech 21st century?

Ivan Bank[1,2], Hubert W. Vliegen[3], and Albert V.G. Bruschke[3]*

Feb 2016





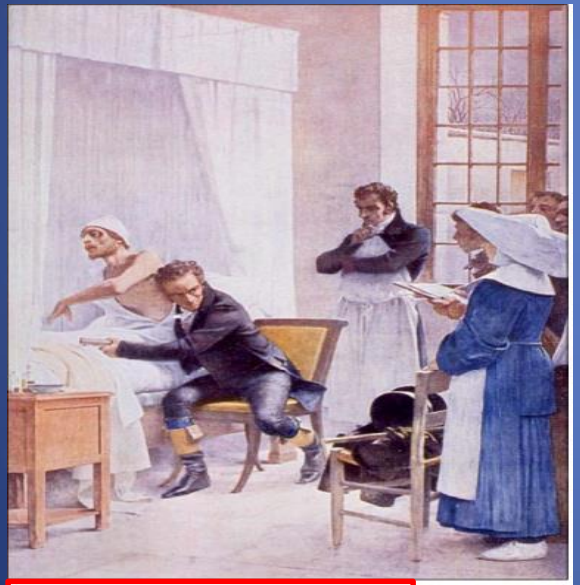
without new initiatives to improve proficiency in auscultation the stethoscope may soon be degraded from a valuable diagnostic instrument to a chain of honor worn around the neck by a next generation of doctors and allied health professionals.

The NEW ENGLAND JOURNAL of MEDICINE

Tenuous Tether

Elazer R. Edelman, M.D., Ph.D., and Brittany N. Weber, M.D., Ph.D.

The stethoscope can help us dx and teach but above all ties us to our pts.
A hand-held echo device may one day displace the stethoscope



Laennec at a Patient's Bedside, by Théobald Chartran, 1816.

The Authors Demonstrating Modern Electronic Auscultation, 2015.

NEJM 2015:373; 23; 2199-2201

The Stethoscope's Prognosis

Very Much Alive and Very Necessary

Valentin Fuster, MD, PhD

- In my view, practically and economically, echo systems are not—and will never be—poised to totally eradicate the stethoscope, as it is not possible for every clinician to possess a handheld echo. Thus, *we cannot discontinue the important training that takes place during physical examination.*

JACC 2016 67 :(9) 1118-9

Focus cardiac ultrasound: the European Association of Cardiovascular Imaging viewpoint

FoCUS : the point-of-care cardiac US exam, ***adds to the physical examination***, by an operator not necessarily fully trained in echo but appropriately trained in FoCUS, usually responsible for *immediate decision-making and/or treatment*

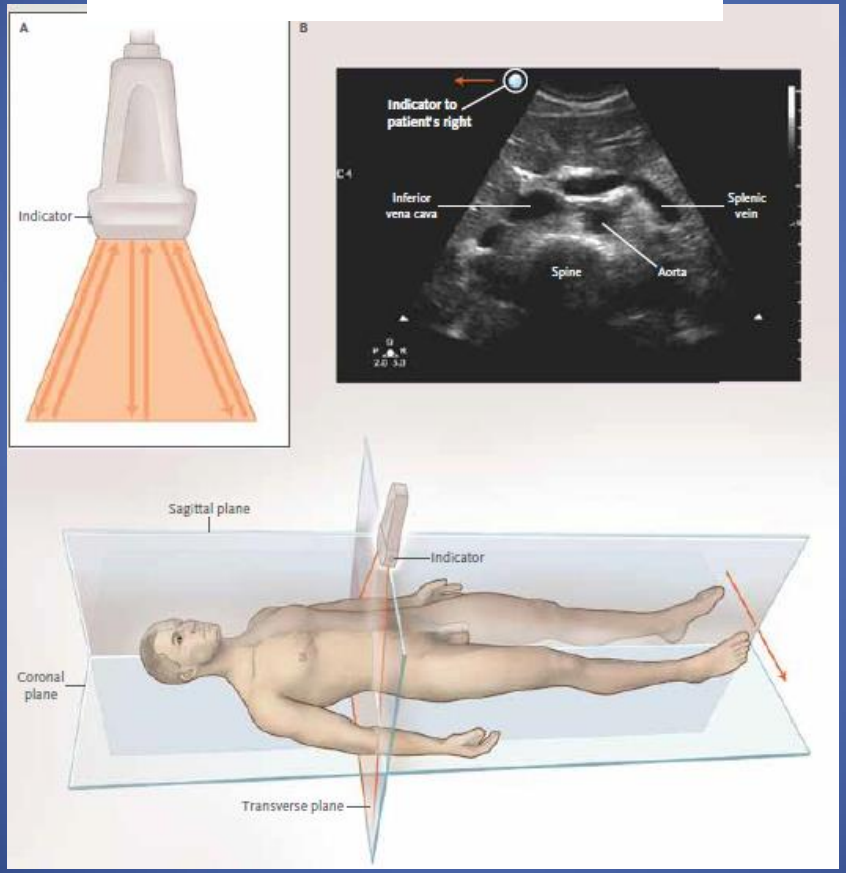
FoCUS examination provides sufficient information for mostly *qualitative gross assessment of cardiac morphology and function*, reported as 'absent/present', or 'yes/no'

Neskovic European Heart Journal – Cardiovascular Imaging (2014) 15, 956–960

CURRENT CONCEPTS

Point-of-Care Ultrasonography

Christopher L. Moore, M.D., and Joshua A. Copel, M.D.



NEJM 2011 364; 749-57

CURRENT CONCEPTS

Point-of-Care Ultrasonography

Christopher L. Moore, M.D., and Joshua A. Copel, M.D.

Table 1. Selected Applications of Point-of-Care Ultrasonography, According to Medical Specialty.*

Specialty	Ultrasound Applications
Anesthesia	Guidance for vascular access, regional anesthesia, intraoperative monitoring of fluid status and cardiac function
Cardiology	Echocardiography, intracardiac assessment
Critical care medicine	Procedural guidance, pulmonary assessment, focused echocardiography
Dermatology	Assessment of skin lesions and tumors
Emergency medicine	FAST, focused emergency assessment, procedural guidance
Endocrinology and endocrine surgery	Assessment of thyroid and parathyroid, procedural guidance
General surgery	Ultrasonography of the breast, procedural guidance, intraoperative assessment
Gynecology	Assessment of cervix, uterus, and adnexa; procedural guidance
Obstetrics and maternal–fetal medicine	Assessment of pregnancy, detection of fetal abnormalities, procedural guidance
Neonatology	Cranial and pulmonary assessments
Nephrology	Vascular access for dialysis
Neurology	Transcranial Doppler, peripheral-nerve evaluation
Ophthalmology	Corneal and retinal assessment
Orthopedic surgery	Musculoskeletal applications
Otolaryngology	Assessment of thyroid, parathyroid, and neck masses; procedural guidance
Pediatrics	Assessment of bladder, procedural guidance
Pulmonary medicine	Transthoracic pulmonary assessment, endobronchial assessment, procedural guidance
Radiology and interventional radiology	Ultrasonography taken to the patient with interpretation at the bedside, procedural guidance
Rheumatology	Monitoring of synovitis, procedural guidance
Trauma surgery	FAST, procedural guidance
Urology	Renal, bladder, and prostate assessment; procedural guidance
Vascular surgery	Carotid, arterial, and venous assessment; procedural assessment

* FAST denotes focused assessment with sonography for trauma.

NEJM 2011 364; 749-57

Point of Care – Focused Echo Exam

Definition

- Bedside
- Goal-directed
- Problem oriented
- Qualitative
- Rapid
- Store for review *or*
- Transmit for review

Examine

- LV size and function
- RV size and function
- Valve Motion
- Pericardial Effusion/ Tamponade
- Cardiac Masses
- IVC : Volume status

Point of Care US – Quick Scan

Box 1. Clinical benefits of the quick-scan.

- Risk stratification
- Timely diagnosis
- Improving clinical diagnosis
- Cardiac arrest
- Extension of physical examination
- Differentiating between competing diagnoses
- Patient expectations
- Increasing access to echo
- Guidance of invasive procedures

Indication	Specific areas to assess with a quick-scan
Acute dyspnoea	Left ventricle
	Right ventricle
	Valve disease
	Pericardium
Acute chest pain	Left ventricular function
	Right ventricle
	Pericardium
Hypotension	Left ventricular size and/or systolic function
	Right ventricle
	Inferior vena cava
Syncope	Critical aortic stenosis
	Severe mitral stenosis
	Hypertrophic cardiomyopathy
Ventricular arrhythmia	Left ventricle size and systolic function: possible evidence of ischaemia and/or infarct, or of impaired function?
	Right ventricle
Cardiac arrest	Pericardium
	Hypovolaemia
	Pulmonary embolus
	Distinguishing PEA (cardiac standstill) from pseudo-PEA (left ventricle contraction visible)
Procedural guidance	Guidance of pericardial aspiration and/or drainage

Hothi SS Clin Med 2014 14 608-11

Point of Care Echo/US

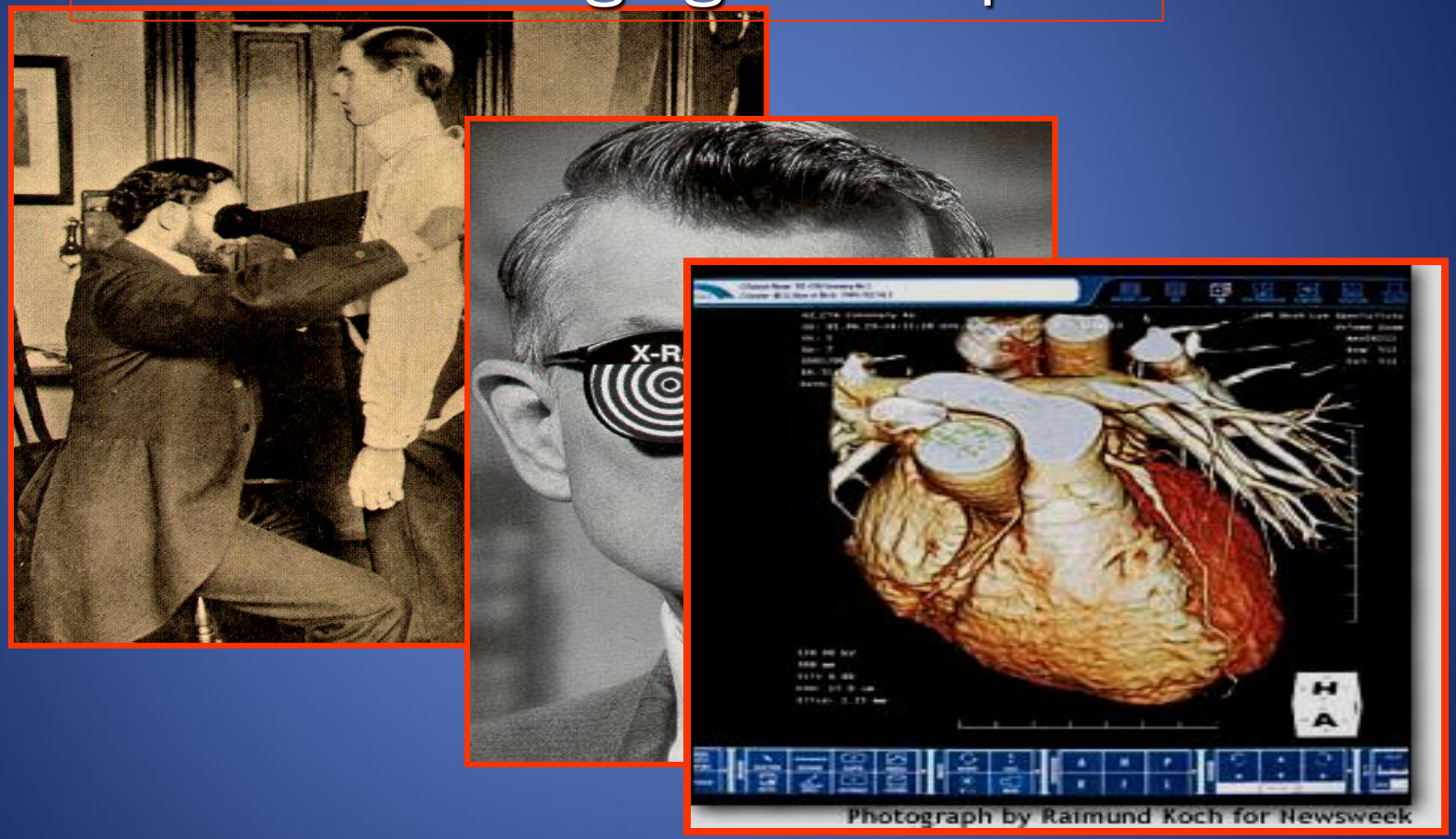
- Advantages
  - Adds to Bedside Physical Exam
  - Fast
  - provides immediate information
  - low cost
  - Modernizes the “tenuous Tether”
  - Demonstration / Teaching / Murmur
  - Rapid Dx and Rx

- Disadvantages
  - Operator dependent
  - Errors in acquisition
  - Errors in interpretation
  - Equipment cost
  - Training
  - Supervision

Point –of Care Ultrasound

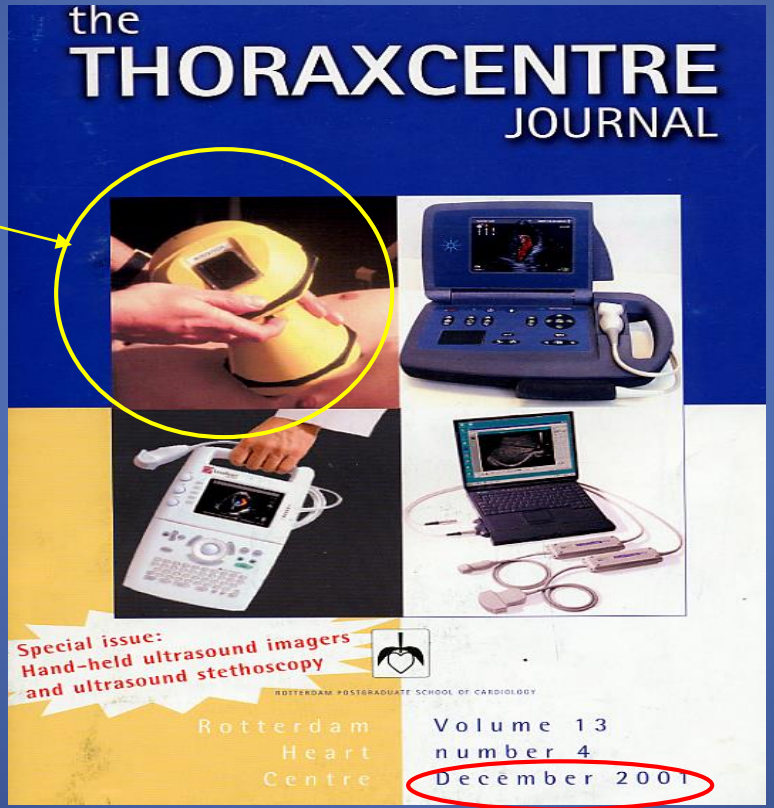
- Define problem
- Define terms
- ***Equipment***
- Who does the imaging?
- Education
- Adoption & Application

Alternative Imaging Techniques



HCU is not new: Ligtvoet constructed in 1978, Roelandt as part of physical in ’78-80

Minivisor



European Journal of Echocardiography (2011) **12**, 85–87
doi:10.1093/ejechocard/jeq184

The use of pocket-size imaging devices: a position statement of the European Association of Echocardiography

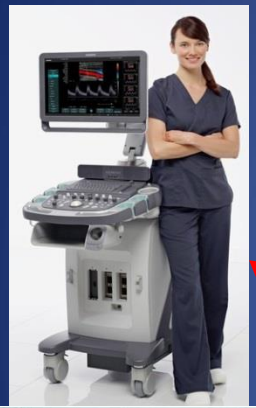
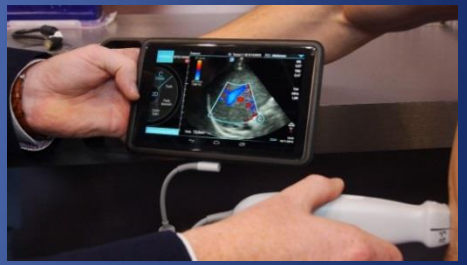


Table 1 Classification of currently available echo machines according to their size and functions

Echo machines	Capabilities
Stationary high-end systems	Full range of standard echo modalities and measurements (MM, 2D, PW, CW, Colour, TVI, TEE), and advances modalities (3D, contrast)
Mobile (smaller machines on wheels, middle range technology)	Full range of standard echo modalities and measurements (MM, 2D, PW, CW, Colour, TVI, TEE)
Portable (small machines that can be carried by a person)	Basic, standard echo modalities and measurements (MM, 2D, PW, CW, Colour)
Hand-held or pocket-size imaging devices	Limited functions (2D, Colour) and measurement package



REVIEW

Pocket-sized focused cardiac ultrasound: Strengths and limitations

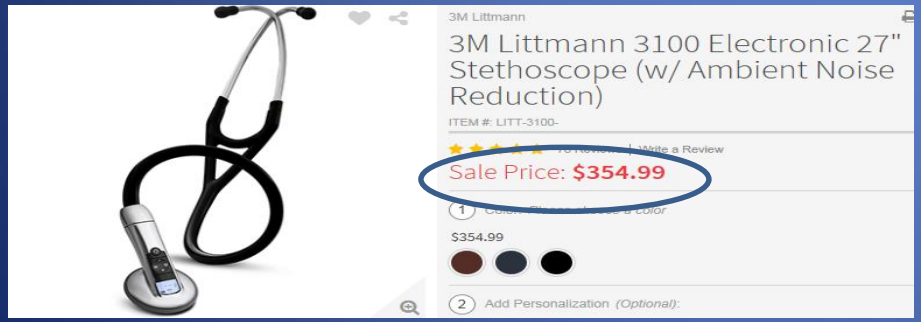
Table 2 Summary of the technical characteristics of the four commercially available pocket-echo devices for FCU.

	Acuson P10™	Vscan V1.2	MobiUS™ SP1	
				
Company	Siemens	GE Healthcare	MobiSante	Signostics
Size[a] (cm)	5.4 × 9.7 × 14.2	13.5 × 7.3 × 2.8	13 × 7 × 0.99	11.5 × 15 × 6
Total weight (g)	725	390	329	304
Transducer (MHz)	2–4	1.7–3.8	3.5–5.0	3.0–5.0
Screen dimension (cm)	9.4	8.9	8.0	11.5
Image resolution (pixels)	640 × 480	240 × 320	480 × 480	250 (M-Mode)
Grey scale	Yes	Yes	Yes	Yes
Colour Doppler	No	Yes	No	No
Measurements	Distance, area	Distance	—	Distance, area, circumference, volume
Digital storage	Still frames	Still frames, loop, voice recording	Loop	Still frames, patient ID
Means to download to a PC	Specific software	4 GB microSD card	USB sync	4 GB microSD card
M-Mode	No	No	No	Yes
Continuous/pulsed Doppler	No/No	No/No	No/No	No/Yes
Battery scanning time (min)	60	90	60–330	48
Price[b] (USD/€)	8100/6508	8410/6760	—	7995/—

FCU: focused cardiac ultrasound; ID: identification; PC: personal computer; SD: secure digital; USB: universal serial bus; USD: United States dollars.
[a] Includes the largest size of each component, as ultrasound probe, display unit or touch screen if available.
[b] The commercial prices of MobiUS™ SP1 and SignosRT devices are not available in the European zone. The SignosRT price is available in the US.

Mirabel M . Arch CVD 2015:108; 197-205

Relative Costs



$8,000

Point –of Care Ultrasound

- Define problem
- Define terms
- Equipment
- ***Who does the imaging?***
- Education
- Adoption & Application

REVIEW J Cardiovasc Ultrasound 2016;24(1):1-6

Pocket-Sized Echocardiography Devices: One Stop Shop Service?

Table 1. Summary of hand-held portable echo studies assessing the length of training and the added diagnostic benefit for cardiovascular pathology as an addition to clinical examination

Study	No.	Operators	Clinical setting	Type of training	Type of assessment	Results
Galderisi et al.[10]*	304	Expert operators (102 studies), trainees (202 studies)	Outpatient cardiology clinic	15 hr of teaching and 3 months experience in handling and visual interpretation	LV dilatation, hypertrophy and function, RV dilatation, valve calcification, pericardial/ pleural effusions	Additional diagnostic power 31.5% compared to physical examination. Concordance with sTTE was good
Panoulas et al.[11]*	122	5 final year medical students, 3 junior doctors	Emergency department, cardiology ward	2 hr bedside tutorial	LV function, RV function, valvular abnormalities	Improvement in diagnostic accuracy, for LV dysfunction and valvular disease
Cavdim et al.[12]*	189	6 cardiologists	Outpatient cardiology clinic	Experienced operators	Pocket-size echo added to clinical examination	Increase in number of diagnosis, reduction in referrals for sTTE, facilitating discharges from cardiology clinic
Brennan et al.[14]	40	4 internal medicine residents	Inpatients, < 1 hr after right sided catheterization	4 hr didactic teaching and 20 studies	Assessment of right atrial pressure	Diagnostic accuracy for RA pressure > 10 mm Hg was higher compared to physical examination
Kobal et al.[15]	61	2 medical students	Inpatients	18 hr of training in cardiac US	Assessment of valvular heart disease, LV function/ hypertrophy	Student's assessment with HCU resulted in higher diagnostic accuracy than that of cardiologists performing a physical examination
Spencer et al.[9]	36	4 cardiologists	Outpatient	Experienced cardiologists who had performed 10–15 studies using the hand-held device	LV dysfunction, valvular heart disease, HCM, VSD	Improvement in diagnostic accuracy. Cardiac examination failed to identify 59% of findings, and this was reduced to 29% when portable echo was used
Martin et al.[16]	354	10 hospitalists	Inpatients	5 training studies	LV function, cardiomegaly, valvular disease, pericardial effusion	Improvement in diagnostic accuracy for LV function, cardiomegaly and pericardial effusion. No improvement in assessment of AR, AS, MR

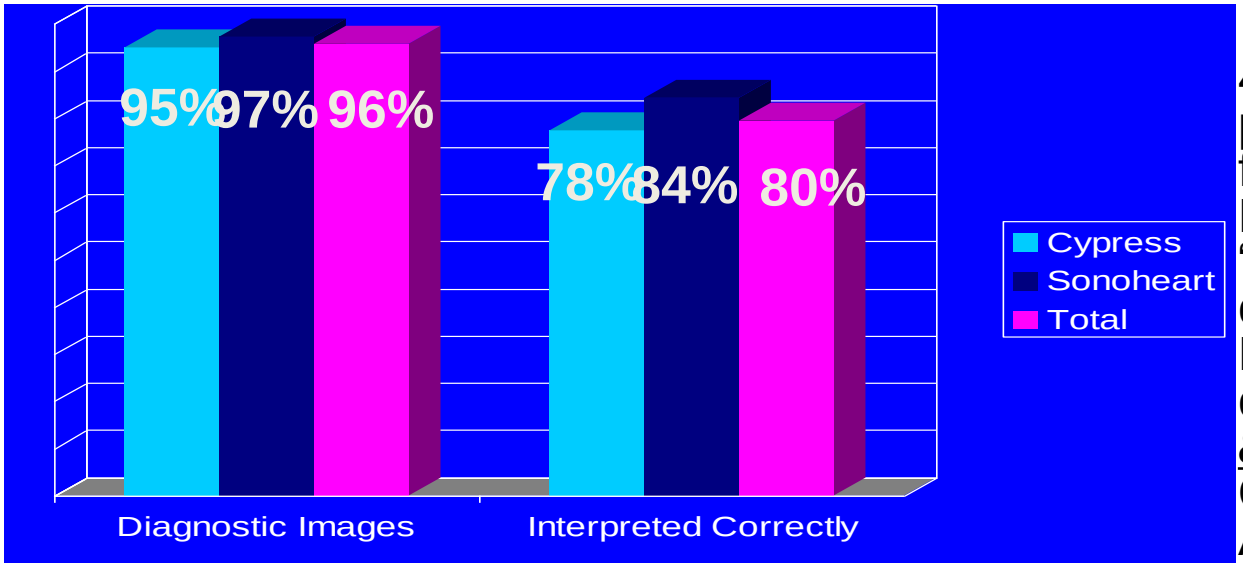
REVIEW J Cardiovasc Ultrasound 2016;24(1):1-6

Pocket-Sized Echocardiography Devices: One Stop Shop Service?

Table 2. Studies comparing the diagnostic accuracy of pocket-sized echo devices with sTTE, showing operators, clinical setting and operator training

Study	No.	Operators (no. of studies)	Clinical setting	Training	Type of assessment	Main findings
Prinz and Voigt[20]	349	Experienced cardiologist	Echo department	Operators experienced in echocardiography	LV size and function, RWMA, pericardial effusion, valve stenosis and valve regurgitation	Good correlation with sTTE. Good concordance for valve regurgitation with slight overestimation of severity
Kono et al.[70]	186	Experienced ultrasonographers (121), less experienced ultrasonographers (65)	Echo department	Less experienced ultrasonographer had 6 months experienced in echocardiography	Assessment of MR and AR	Good correlation with sTTE, with slightly reduced correlations for the less experienced operator
Filipiak-Strzecka et al.[72]	90	2 medical students	ITU/outpatients	5 day course (5 hours a day)	LV function, pericardial effusion, RWMA, LV/RV/LA/ascending aorta	Moderate to very good agreement with sTTE, with notable learning curve effect
Culp et al.[21]	40	1 cardiology fellow	Echo department	2 months experience in echocardiography	Visual estimation of EF	Good correlation for EF estimation
Andersen et al.[19]	108	3 cardiologists	Cardiac and non-cardiac units	Operators experienced in echocardiography	LV function, LA size, IVC, AA, pericardial effusion	Almost perfect correlation for LV function, AA, pericardial effusion. Strong correlation between RV and valvular function
Fukuda et al.[22]	125	Expert sonographer (90 patients) Physician (35)	Echo department (90) Bedside (35)	Operators experienced in echocardiography	Cardiac chamber size and function	Excellent correlation and agreement with sTTE
Kitada et al.[30]	200	Expert physician	Echo department	Operators experienced in echocardiography	LV size and function, RWMA, LA size, pericardial effusion, valvular heart disease	Strong correlation with sTTE. Overestimation of abnormalities in 14 patients, missed findings in 7 patients
Liebo et al.[180]	97	Ultrasonographers	Inpatients, outpatients	Echo performed by ultrasonographers. Images interpreted by 2 cardiology fellows (2-month echo experience) and 2 cardiologists	EF, RWMA, LV end-diastolic dimension, pericardial effusion, valvular heart disease, IVC	Good correlation for LV function, RWMA, cardiac structures with sTTE. Suboptimal visualization of IVC

Students' Performance by HCU Echo System



4 Med Students trained to perform brief, "focused" exam following a week of training
Med students performed "limited" echo's on consecutive subjects in the ER and the ICU who consented to an IRB protocol
8.1 minutes ± 3.5 minutes
Over-read and repeated
A total of the *235* "limited" independent echo's

Dx changes: 29%

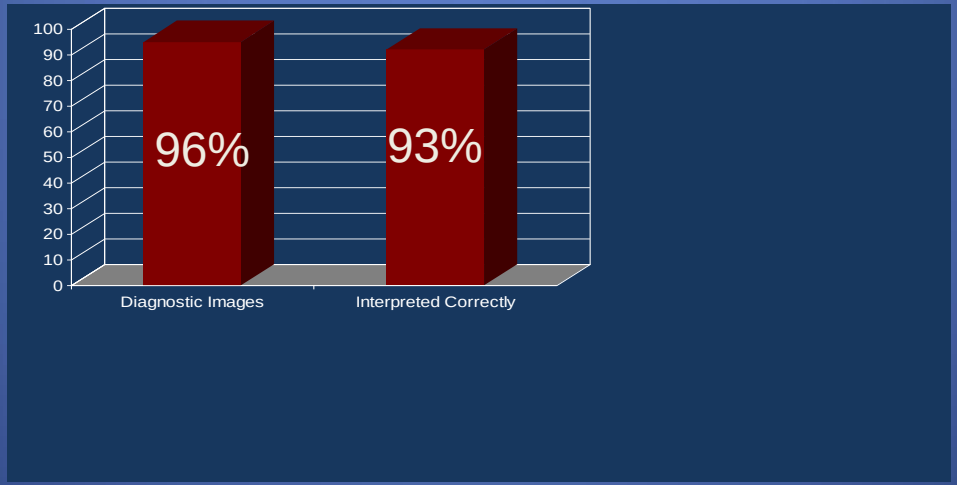
Rx changes: 27%

• HCU: Mt. Sinai Medical Residents Outpt Medical Clinic

♥4 medical residents imaged 73 pts with HCU (Optigo™) as part of their routine clinic visit

♥Their study reviewed by expert immediately post

♥Mean echo time: 4.3 min(3-7)



Croft, Goldman. ACC 2003

ORIGINAL INVESTIGATION

A Pilot Study of the Clinical Impact of Hand-Carried Cardiac Ultrasound in the Medical Clinic

Lori B. Croft, M.D., W. Lane Duvall, M.D., and Martin E. Goldman, M.D.

The Zena and Michael A. Wiener Cardiovascular Institute and The Marie-Josée and Henry R. Kravis Center for Cardiovascular Health, Mount Sinai Medical Center, New York, NY

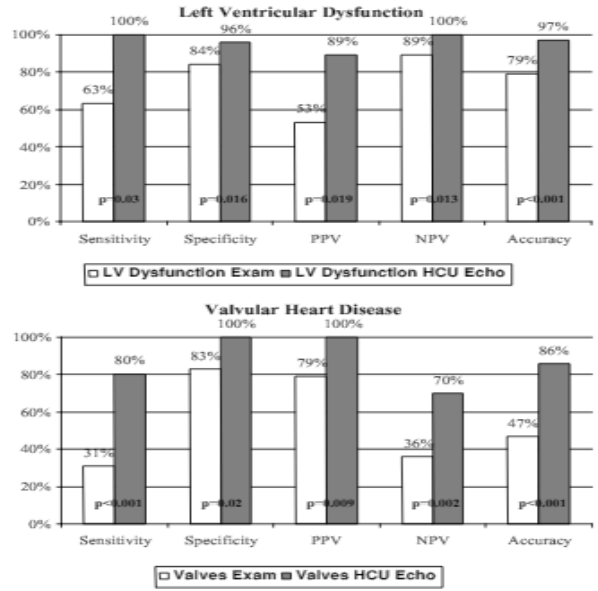


Figure 1. *Diagnostic characteristics for LV function and valvular disease by history and physical examination compared to the addition of HCU limited echo.*

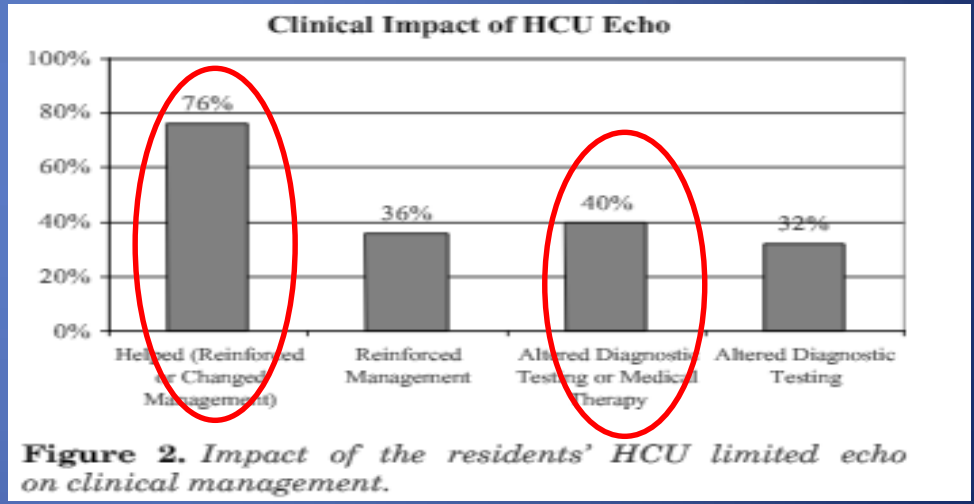


Figure 2. *Impact of the residents' HCU limited echo on clinical management.*

ECHOCARDIOGRAPHY, Volume 23, July 2006

Annals of Internal Medicine®

ORIGINAL RESEARCH | 5 JULY 2011

Is Pocket Mobile Echocardiography the Next-Generation Stethoscope? A Cross-sectional Comparison of Rapidly Acquired Images With Standard Transthoracic Echocardiography

Table 2. Visualizability, Accuracy, and Variability of Readings of Images Obtained by Using Pocket Mobile Echocardiography

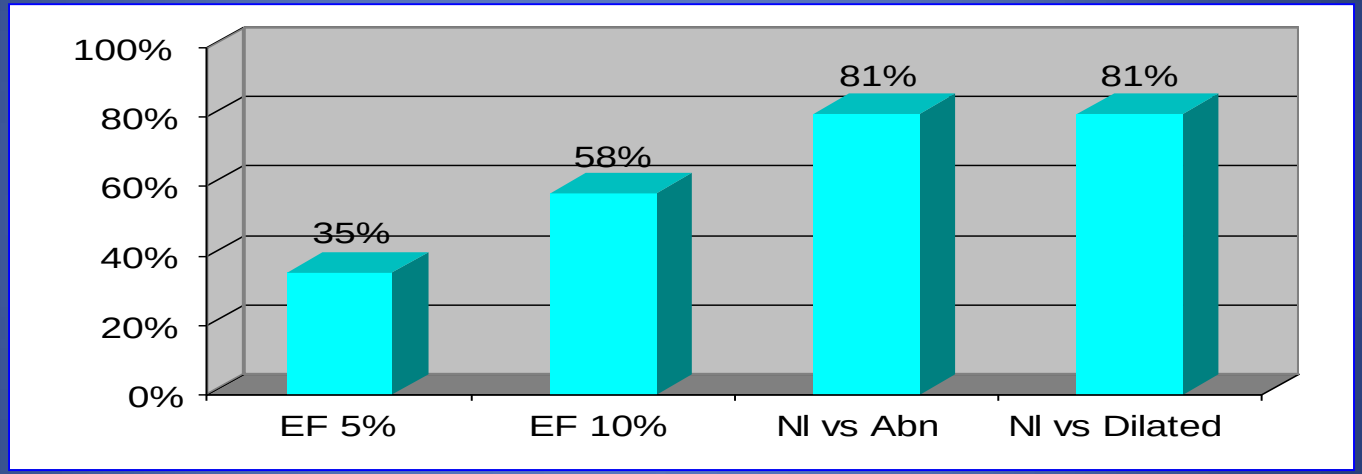
TTE Variable	Abnormal, %	Visualized, %			True-Positive Plus True-Negative Readings (Visualized/Total), %/%*			Variability (λ)		
		Overall	Attendings	Fellows	Overall	Attendings	Fellows	Overall (4 Raters)	Attendings (2 Raters)	Fellows (2 Raters)
Ejection fraction	14 (low)	95	93	97	95/91	97/91	93/91	0.71	0.95	0.68
WMA†	13	83	85	81	89/74	90/77	87/71	0.72	0.90	0.47
LVEDD	15 (enlarged)	95	95	94	92/87	94/90	91/85	0.67	0.82	0.55
Pericardial effusion	0 (significant)	94	94	94	NA	NA	NA	NA	NA	NA
Aortic valve	6	82	86	80	96/79	97/83	95/76	0.76	0.84	0.75
Mitral valve	7	90	90	90	85/77	88/79	82/74	0.35	0.59	0.29
IVC size‡	12 (dilated)	75	73	77	78/58	81/59	74/57	0.42	0.84	0.39

IVC = inferior vena cava; LVEDD = left ventricular end-diastolic dimension; NA = not available; TTE = transthoracic echocardiography; WMA = wall-motion abnormality.

Pocket echo produced images that were accurate for LVEF and but not all cardiac structures compared with standard echo. MD's with less experience disagreed more often about what the mobile images showed than did MD's with more experience

Liebo, Israel, Topol ann Int Med 2011:155; 33-8

Nurse Practitioners : HCU Echo to Screen 50 Pts Having Nuclear Stress



Croft, Duvall, Goldman. 2004

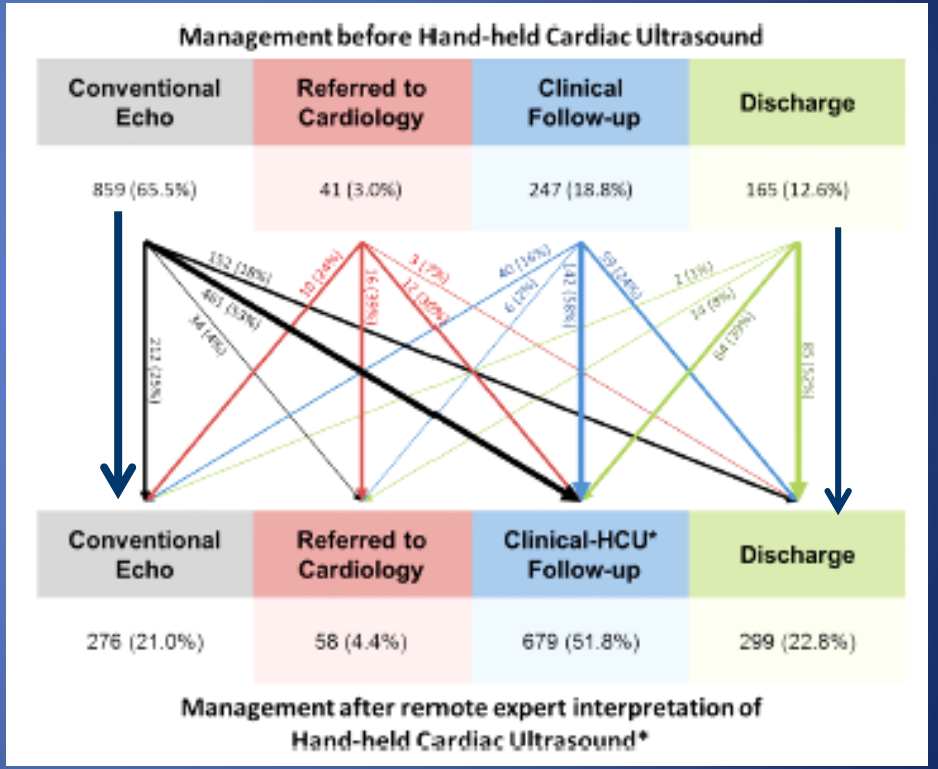
Handheld echocardiographic screening for rheumatic heart disease by non-experts

- Non-expert, Ugandan nurses with handheld echo Vscan screened for RHD in Africa
- Sensitivity 74.4% and a spec of 78.8% for (borderline or definite) RHD
- Sens 90.9% for definite RHD.
- Ploutz Heart 2016 102 35

Hand-held cardiac echo screening by family doctors with remote support interpretation

- Prospective, ***1312*** consecutive pts seen in primary care by Family MDs.
- Training : 7hr/day x 4 days
- Vscan (GE) via Studycast

HCU expert diagnosis	n (%)	κ (95% CI)
AS*	72 (5.5)	0.53 (0.39–0.63)
AR*	51 (3.9)	0.61 (0.50 to 0.74)
MR*	79 (5.6)	0.65 (0.56 to 0.74)
MS*	8 (0.6)	0.29 (0.9 to 0.47)
TR*	54 (4.1)	0.42 (0.25 to 0.59)
HCM	9 (0.6)	0.53 (0.23 to 0.83)
LV dysf	51 (3.9)	0.51 (0.37 to 0.62)
LVH*	164 (12.5)	0.70 (0.60 to 0.78)
LA dil*	41 (3.1)	0.38 (0.24 to 0.50)
AA dilat	122 (9.3)	0.54 (0.43 to 0.71)



Evangelista A ; Heart 2016;102: 376-382

REVIEW

Pocket-sized focused cardiac ultrasound: Strengths and limitations

Table 1 Accuracy of parameters assessed by pocket-echo.

Parameters	Accuracy[a]
Left ventricular size	Good [11,15–19]
Left ventricular systolic function	Good [4,6,10–18]
Regional wall motion abnormalities	Good [10,19]
Ultrasound lung comet	Good [21,22]
Pleural effusion	Good [23]
Inferior vena cava	Variable [4,11,13,15,27]
Left atrial size	Fair [28]
Pericardial effusion	Excellent [4,5,10,11,15–19]
Aortic valve disease presence/severity	Fair [10,13,16,30]
Mitral valve disease presence/severity	Fair [10,13,16,30]
Abdominal aortic aneurysm	Good [10,32,33]
Right ventricle	Variable [4–6,10,16]

[a] Accuracy is defined as a compromise between sensitivity and specificity. Excellent: sensitivity $\geq$ 90%, specificity $\geq$ 95%, including by non-experts. Good: sensitivity > 90%, specificity > 90% by experts. Fair: sensitivity $\approx$ 80%, specificity $\approx$ 80%. Variable: figures vary across studies.

Mirabel M . Arch CVD 2015:108; 197-205

THE NATION'S NEWSPAPER

Special Reprint Edition

USA TODAY

NO. 1 IN THE USA

As seen in USA TODAY Life

May 24, 2001

Screening athletes for sudden death

Procedure is costly, but it can identify cardiomyopathy, a rare heart disorder

By Robert Davis
USA TODAY

Chad Butrum dropped dead during a league football game without even taking a hit.

The 26-year-old was the picture of health when he died in 1994 on the California field. His body was fit, but his heart was not.

Like many victims of cardiomyopathy — a silent disease that can strike fatally during exercise — Butrum died without any warning. After a huddle, he walked to the line of scrimmage, where he fell.

"Nobody hit him or anything," says Butrum's mother, a New York actress who goes by the name Arista.

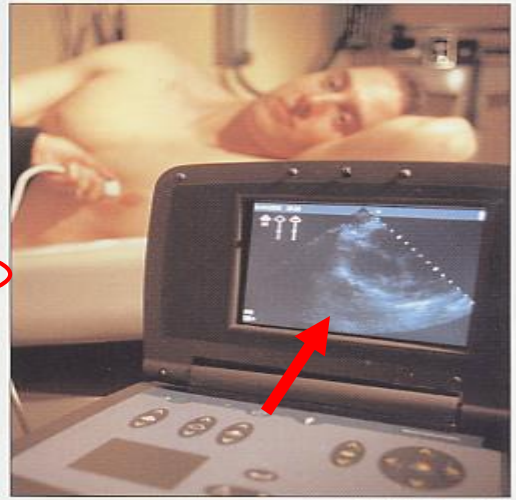
Chad became one of an estimated 200 young victims of cardiomyopathy who die suddenly on athletic fields each year. Like the others, his heart — which had become enlarged by the disease — could not handle the stress of physical activity.

The silent disease is one known cause of sudden cardiac death in young athletes.

Since his death, Chad's mother has been on a crusade to screen others for the disease.

"We want to raise enough awareness to let every parent know that their kids need this," she says.

But because the medical test that detects the rare disorder is so costly — an echocardiogram, which is typically done in a hospital's cardiac center, costs more than $1,000 — the medical community has been slow to support the idea of screening every young athlete for the condition.



By Todd Plitt for USA TODAY

Checking for the silent disease: Dominick Lingelet's

Typical ER Resident At Work (Performing Echo!!)

The New York Times

NEW YORK, FRIDAY, JUNE 14, 2002

Limits on Residents' Hours Worry Teaching Hospitals

By REED ABELSON

Many of the nation's teaching hospitals, already under financial pressure, are raising concerns about the effect of new rules that will limit the number of hours worked by medical residents.

"For academic medical centers, the impact is going to be profound," said Dr. Peter Herbert, the chief of staff for Yale-New Haven Hospital, a teaching affiliate of the Yale School of Medicine, who estimates that the cost for some hospitals could run into the millions of dollars.

The rules, which are being imposed by the group that accredits teaching hospitals, will limit the average workweek to 80 hours and restrict a resident's duty to no more than 24 hours at a time.

Some hospitals consider residents an inexpensive source of labor. Some residents say they work 100 hours or

with a loss of accreditation because of the long hours residents worked, is hiring 12 physician associates to reduce the residents' workload, Dr. Herbert said.

"There is a huge financial hit," said Dr. Jon Cohen, the chief medical officer for the North Shore-Long Island Jewish Health System, which, like other New York hospitals, has had to adopt to a law that already limits residents' hours.

The cost of two to three physician assistants can run as high as $200,000 a year, compared with $50,000 to pay a medical resident, Dr. Cohen said. "No one knows where that money is going to come from," he said.

Many hospitals acknowledge that the new rules will require significant changes in how they do things and how they view residents.

"The big cultural change is the institutions have to recognize and

Peter Thompson for The New

Rene Adrian, a first-year resident in emergency medicine University of Chicago hospital, used ultrasound on a patient.

Losing a cheap source of labor when budgets are tight

Mr. Bentley said.

But hiring nurses or physi sistants may not add signifi costs, others say. "The finar pact won't be catastrophi

Echo by Resident in ER

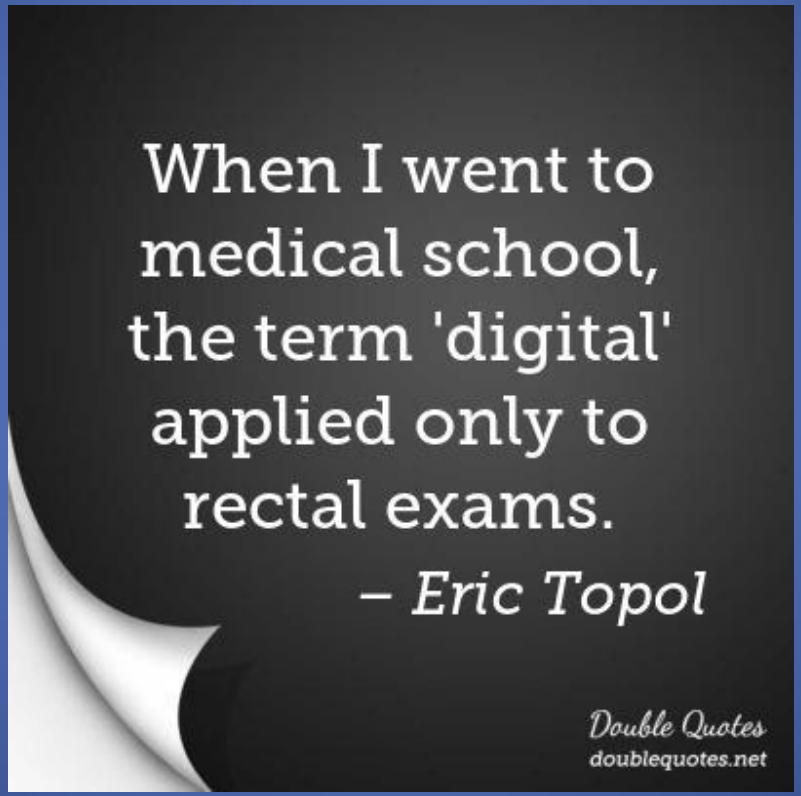
Point –of Care Ultrasound

- Define problem
- Define terms
- Equipment
- Who does the imaging?
- ***Education***
- ***Adoption & Application***

High Quality Echo *IS NOT* Automatic

Variables: 1. Body habitus
2. Image Acquisition skills
3. Equipment
4. Physician interpretation
5. Appropriate Application

ALL 5 REQUIRED FOR A GOOD ECHO STUDY!


When I went to medical school, the term 'digital' applied only to rectal exams.
– Eric Topol
Double Quotes
doublequotes.net

The use of pocket-size imaging devices: a position statement of the European Association of Echocardiography

- pocket-size imaging devices *do not provide a complete diagnostic echocardiographic examination*.
- should be *reported as part of the physical examination* of the patient.
- *Image data should be stored* according to the applicable national rules for technical examinations.

- *does not replace a complete echocardiogram*.

Sicari European Journal of Echocardiography (2011) 12, 85–87

JACC
Journal of the American College of Cardiology

TRAINING STATEMENT

COCATS 4 Task Force 5: Training in Echocardiography

As part of the hands-on aspect of the echo training program, *experience with HCU devices is desirable*.

These devices extend the clinical utility of echo by allowing the operator to offer a "visual physical examination" in a manner that can be applied practically in the clinical setting .

HCU devices offer capabilities similar to but less robust than their standard echo counterparts.

Ryan T JACC 65: 17; 2015-1786-99

European Journal of Echocardiography (2011) **12**, 85–87
doi:10.1093/ejechocard/jeq184

The use of pocket-size imaging devices: a position statement of the European Association of Echocardiography

Table 2 Summary of indications for pocket-size devices

1. Complement to a physical examination in the coronary and intensive care unit
2. Tool for a fast initial screening in an emergency setting
3. Cardiologic counselling in- or outside health-care facilities and hospitals
4. First cardiac evaluation in ambulances
5. Screening programmes in schools, industry, and community activities
6. Triaging candidates for a complete echocardiographic examination
7. Teaching tool
8. Semi-quantification of extravascular lung water

European Journal of Echocardiography (2011) **12**, 85–87
doi:10.1093/ejechocard/jeq184

The use of pocket-size imaging devices: a position statement of the European Association of Echocardiography

EAE recommendations on the use of pocket-size echo devices

Recommendation 1. Pocket-size imaging devices (category 4 of the present classification) do not provide a complete diagnostic echocardiographic examination. The range of indications for their use is therefore limited as specified in Table 2.

Recommendation 2. Imaging assessment with pocket-size imaging devices should be reported as part of the physical examination of the patient. Image data should be stored according to the applicable national rules for technical examinations.

Recommendation 3. With the exception of cardiologists who are certified for transthoracic echocardiography according to national legislation, specific training and certification is recommended for all users. The certification should be limited to the clinical questions that can potentially be answered by pocket-size devices.

Recommendation 4. The patient has to be informed that an examination with the current generation of pocket-size imaging devices does not replace a complete echocardiogram.

The Evolving Future of Cardiovascular Practice

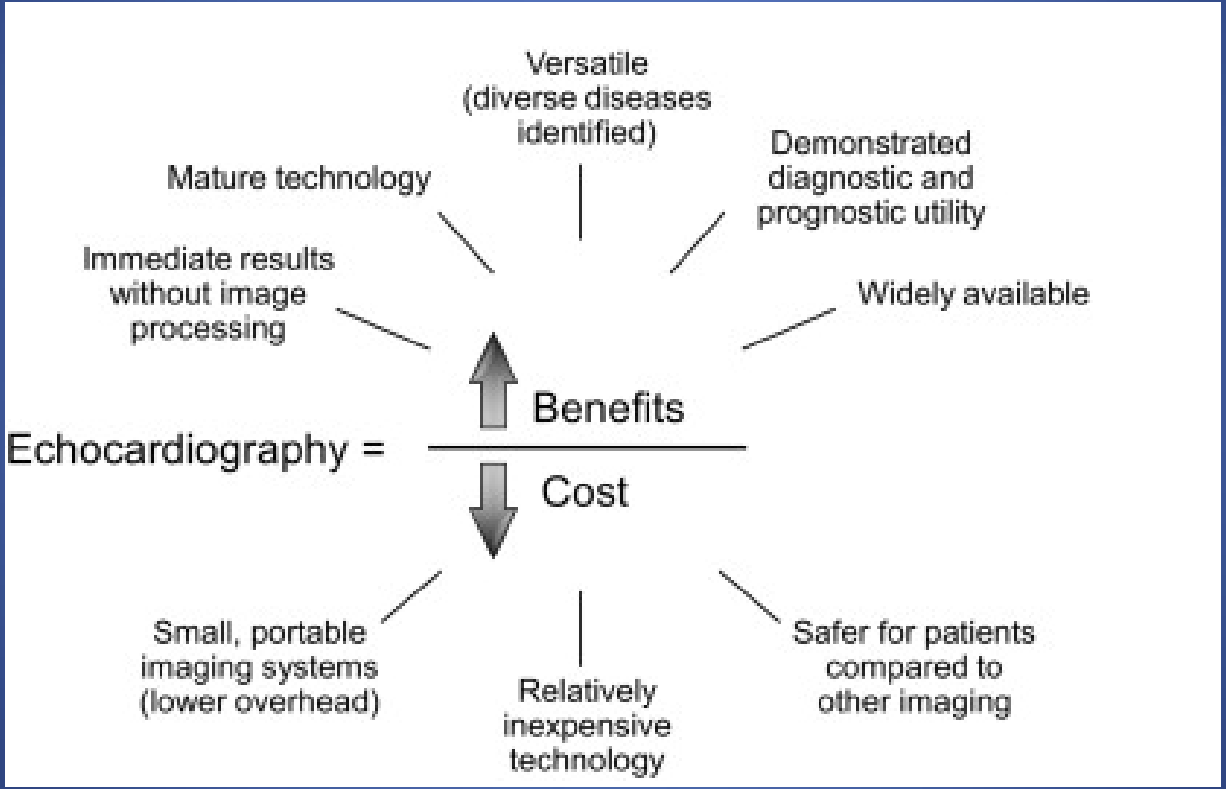
Technology + Clinicians: A Means to a Better End

Valentin Fuster, MD, PhD

- the triple aim of health care—
- 1. to improve the delivery and experience of care
- 2. to improve the health of populations
- 3. to reduce the per capita costs
- ***we cannot resist the changes, or means, that are needed to achieve that end.***

JACC July 2015

Value of Echo in Era Healthcare Reform



Pellikka, P. Progress CV Dis 57; 1-3 , 2014

Cardiac Exam : stethoscope or pocket echo: why not both ?

THE AMERICAN JOURNAL of MEDICINE®

- Introduced 1978; cost < $10k; no reimbursement
- *Studies have shown neither modality perfect*
- *Can reduce unnecessary standard costly echo's*
- ***If I were a young physician beginning a career as a cardiologist, I would obtain a pocket echo and become an expert in its use!***

James Dalen MD, MPH. AJM. 2016; 129: 650

HCU - Echo-Stethoscope Can Significantly Improve the Patient –Doctor Interaction and Improve Dx and Rx

TUESDAY, JANUARY 29, 2002

CASES

Restoring The Physical To the Exam

By SANDEEP JAUHAR, M.D.

A man comes into the hospital with fever and a cough producing green sputum. He is elderly and frail. What does he have? "Pneumonia," proclaims the resident presenting the case to her team. "Take a look at this chest X-ray." She pulls up an image on a computer screen showing a distinct pneumonic streak. The senior physician waves it off. "First let's talk about your lung exam," he says.

It is a common scene at teaching hospitals today: young doctors ignoring physical examination to the chagrin of their supervisors. At one time, keen observation and the judicious laying on of hands were virtually the only diagnostic tools a doctor had. Now, they seem almost obsolete. Technology like ultrafast CAT scans and nuclear imaging studies rules the day, permitting diagnosis at a distance. Some doctors don't even carry a stethoscope anymore.

"Some doctors don't even carry a stethoscope anymore"…BUT THEY ARE ENTHUSUASTIC to CARRY A STETHOSCOPE and USE ULTRASOUND

Point-of-Care Ultrasound in Medical Education — Stop Listening and Look

The NEW ENGLAND JOURNAL of MEDICINE

A generation of physicians will need to be trained to view this technology as an extension of their senses, just as many generations have viewed the stethoscope. That development will require the medical education community to embrace and incorporate the technology throughout the curriculum.

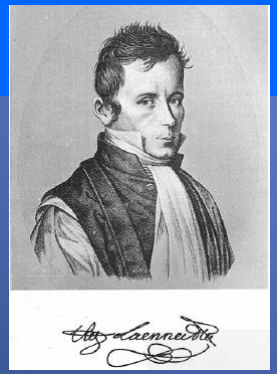
Scott D. Solomon, M.D., and Fidencio Saldana, M.D.

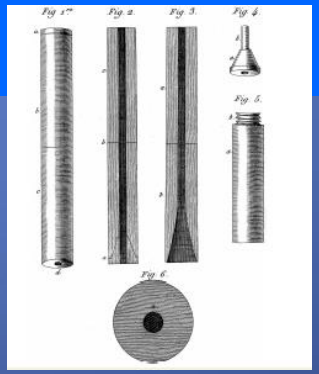
N ENGL J MED 370;12 NEJM.ORG MARCH 20, 2014

THE TIMES

"That it will ever come into general use, notwithstanding its value, is extremely doubtful; because its beneficial application requires much time and gives a good bit of trouble both to the patient and the practitioner; because its hue and character are foreign and opposed to all our habits and associations."

- London Times, 1834





~~Point of Care – Focused~~

- ~~Handheld~~ Echocardiography – It Depends Whose Hands are Holding it: Educational? Diagnostic? Overshadowing the Physical Examination?

- Educational? **YES**
- Diagnostic? **YES**
- Overshadow the Physical Exam? ***NO***

- *ADJUNCT*
- *STRENGTHEN*
- *MODERNIZE*

Handheld echocardiographic screening for rheumatic heart disease by non-experts

- Non-experts Ugandan nurses with handheld echo Vscan : sens 74.4% and a spec of 78.8% for (borderline or definite) RHD; Sens 90.9% for definite RHD. Ploutz Heart 2016 102 35

Point of Care US – Quick Scan

- H-USS in trained hands adds value to the physical exam
- Ideal for acute care
- rapid at the point of care improves diagnosis, decision-making.
- another potential revolution in clinical exam

Box 1. Clinical benefits of the quick-scan.

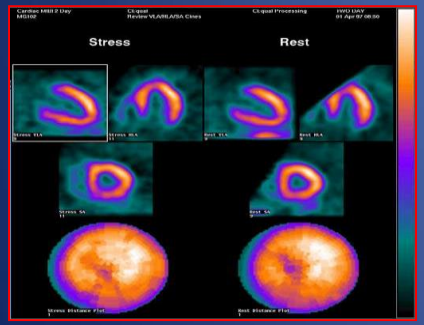
- Risk stratification
- Timely diagnosis
- Improving clinical diagnosis
- Cardiac arrest
- Extension of physical examination
- Differentiating between competing diagnoses
- Patient expectations
- Increasing access to echo
- Guidance of invasive procedures

Indication	Specific areas to assess with a quick-scan
Acute dyspnoea	Left ventricle
	Right ventricle
	Valve disease
	Pericardium
Acute chest pain	Left ventricular function
	Right ventricle
	Pericardium
Hypotension	Left ventricular size and/or systolic function
	Right ventricle
	Inferior vena cava
Syncope	Critical aortic stenosis
	Severe mitral stenosis
	Hypertrophic cardiomyopathy
Ventricular arrhythmia	Left ventricle size and systolic function: possible evidence of ischaemia and/or infarct, or of impaired function?
	Right ventricle
Cardiac arrest	Pericardium
	Hypovolaemia
	Pulmonary embolus
	Distinguishing PEA (cardiac standstill) from pseudo-PEA (left ventricle contraction visible)
Procedural guidance	Guidance of pericardial aspiration and/or drainage

Hothi SS Clin Med 2014 14 608-11

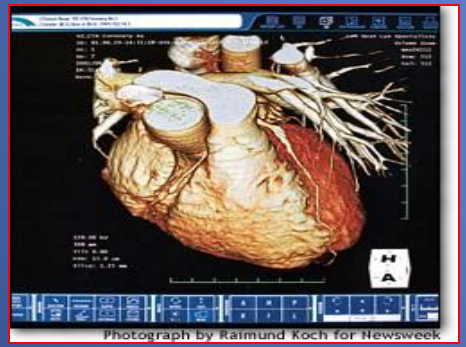
Cardiology Imaging

Nuclear



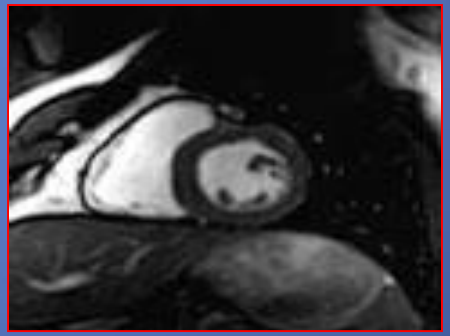
$250-500k

CT



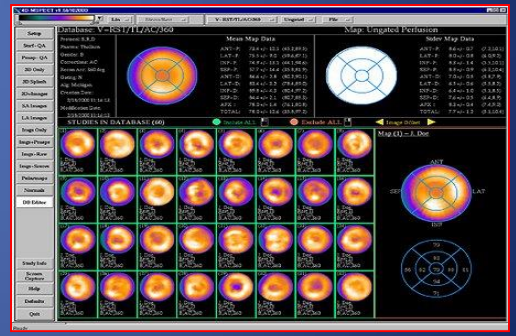
$1.4 million

MRI



$2million

PET

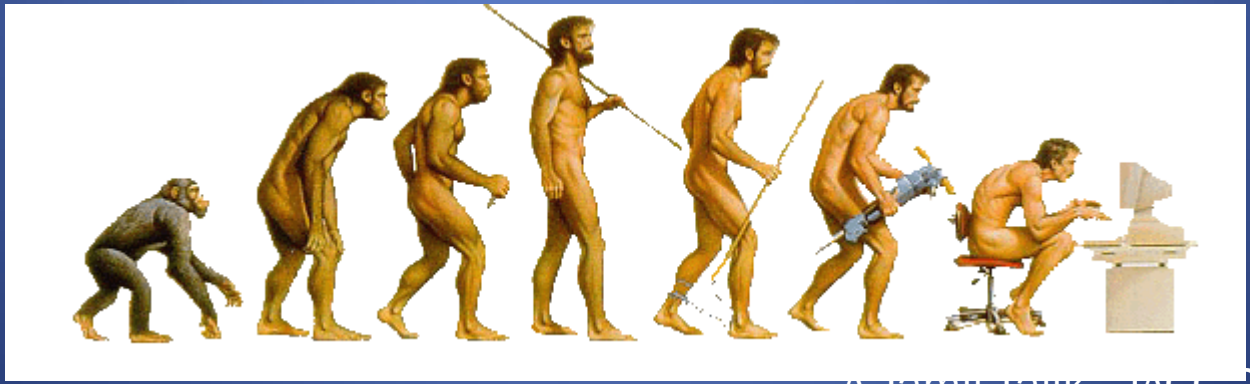


$2.8million

Cardiac Related Applications

- Cardiac
  - LV Size & Function
  - RV Size & Function
  - Peric Effusion
  - Volume Status
  - Source of Murmur
  - Wall Thickness – Hi BP
  - Hypotension Etiology
  - Correlate Abn ECG (ER)
- Volume Status : IVC fill
- Pulm : effusion , PTX
- Abd Aortic Aneurysm
- Bladder volume?

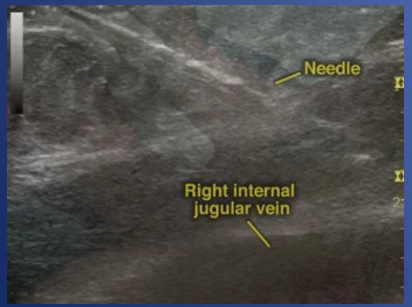
Computers are incredibly fast, accurate, and stupid. Human beings are incredibly slow, inaccurate, and brilliant. Together they are powerful beyond imagination.
—Albert Einstein (1)

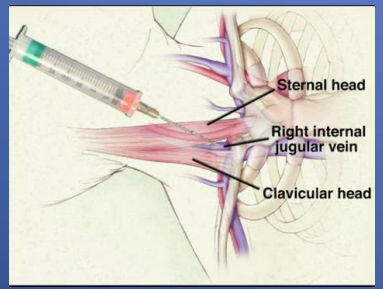


VIDEOS IN CLINICAL MEDICINE

Ultrasound-Guided Internal Jugular Vein Cannulation

Rafael Ortega, M.D., Michael Song, M.D., Christopher J. Hansen, M.A., and Paul Barash, M.D.

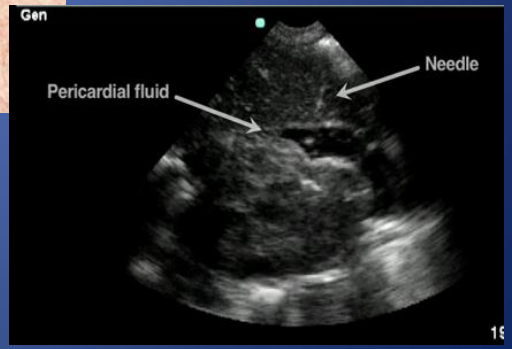




VIDEOS IN CLINICAL MEDICINE

Emergency Pericardiocentesis

Michael T. Fitch, M.D., Ph.D., Bret A. Nicks, M.D., Manoj Pariyadath, M.D., Henderson D. McGinnis, M.D., and David E. Manthey, M.D.



REVIEW

Pocket-sized focused cardiac ultrasound: Strengths and limitations

Table 1 Accuracy of parameters assessed by pocket-echo.

Parameters	Accuracy[a]
Left ventricular size	Good [11,15–19]
Left ventricular systolic function	Good [4,6,10–18]
Regional wall motion abnormalities	Good [10,19]
Ultrasound lung comet	Good [21,22]
Pleural effusion	Good [23]
Inferior vena cava	Variable [4,11,13,15,27]
Left atrial size	Fair [28]
Pericardial effusion	Excellent [4,5,10,11,15–19]
Aortic valve disease presence/severity	Fair [10,13,16,30]
Mitral valve disease presence/severity	Fair [10,13,16,30]
Abdominal aortic aneurysm	Good [10,32,33]
Right ventricle	Variable [4–6,10,16]

[a] Accuracy is defined as a compromise between sensitivity and specificity. Excellent: sensitivity $\geq$ 90%, specificity $\geq$ 95%, including by non-experts. Good: sensitivity > 90%, specificity > 90% by experts. Fair: sensitivity $\approx$ 80%, specificity $\approx$ 80%. Variable: figures vary across studies.

Mirabel M . Arch CVD 2015:108; 197-205

Development and Evaluation of Methodologies for Teaching Focused Cardiac Ultrasound Skills to Medical Students

- 12 1st yr med students :

Annals of Internal Medicine®

ORIGINAL RESEARCH | 5 JULY 2011

Is Pocket Mobile Echocardiography the Next-Generation Stethoscope? A Cross-sectional Comparison of Rapidly Acquired Images With Standard Transthoracic Echocardiography

Max J. Liebo, MD; Rachel L. Israel, MD; Elizabeth O. Lillie, PhD; Michael R. Smith, MD; David S. Rubenson, MD; Eric J. Topol,

Table 2. **Visualizability, Accuracy, and Variability of Readings of Images Obtained by Using Pocket Mobile Echocardiography**

TTE Variable	Abnormal, %	Visualized, %			True-Positive Plus True-Negative Readings (Visualized/Total), %/%*			Variability (λ)		
		Overall	Attendings	Fellows	Overall	Attendings	Fellows	Overall (4 Raters)	Attendings (2 Raters)	Fellows (2 Raters)
Ejection fraction	14 (low)	95	93	97	95/91	97/91	93/91	0.71	0.95	0.68
WMA†	13	83	85	81	89/74	90/77	87/71	0.72	0.90	0.47
LVEDD	15 (enlarged)	95	95	94	92/87	94/90	91/85	0.67	0.82	0.55
Pericardial effusion	0 (significant)	94	94	94	NA	NA	NA	NA	NA	NA
Aortic valve	6	82	86	80	96/79	97/83	95/76	0.76	0.84	0.75
Mitral valve	7	90	90	90	85/77	88/79	82/74	0.35	0.59	0.29
IVC size‡	12 (dilated)	75	73	77	78/58	81/59	74/57	0.42	0.84	0.39

EXPERT CONSENSUS STATEMENT

Focused Cardiac Ultrasound: Recommendations from the American Society of Echocardiography

Table 3 Differences between limited echocardiography and FCU

	Limited echocardiogram	FCU
Patients	Any adult patient	Defined scope of practice
Location of imaging	Any location	Defined scope of practice
Image protocol	Skill to perform any view, but only selected views may be required	Limited number of views
Equipment	Full function (M-mode, 2D, color Doppler, spectral Doppler, TDI, contrast), EKG gated	2D minimum
Transducers	Multiple	Single
Measurements	Advanced quantification	None or linear measurement
Acquisition	Sonographer or level II/III echocardiographer	Physician with FCU training
Interpretation	Echocardiographer; all pathology and normal structures within imaging view	Physician with FCU training defined, limited scope
Image storage	DICOM format, archived for easy retrieval and review	Only for select indications (see text)
Documentation	Formal report meeting ICAEL standards	Documentation as brief report or as part of PE depending on indication
Billing	93308	None

TDI, Tissue Doppler imaging; *ICAEL*, Intersocietal Commission for the Accreditation of Echocardiography Laboratories; *PE*, physical examination.

J Am Soc Echo 2013; 26: 567 – Spencer K

Focused Exam

FCU is a focused examination of the cardiovascular system performed by a *physician* by using ultrasound as an *adjunct to the physical examination* to recognize specific ultrasonic signs that represent a narrow list of potential diagnoses in specific clinical settings.

Terms

- Hand-held cardiac ultrasound
- Point-of-care cardiac ultrasound
- Ultrasound stethoscope
- Hand-carried cardiac ultrasound
- Bedside cardiac ultrasound
- Quick look cardiac ultrasound

J Am Soc Echo 2013; 26: 567 – Spencer K

A Summary of the American Society of Echocardiography Foundation Value-Based Healthcare: Summit 2014

Comparison of imaging modalities

Characteristic	Echocardiography	CMR	CT	Nuclear scintigraphy
Availability	++++	++	++	+++
Portability	++++	—	—	—
Cost (relative value units)∗	9.11†	22.51‡	14.39§	13.59‖
Radiation risk	—	—	++++	++++

CMR, Cardiovascular magnetic resonance; *CPT*, Current Procedural Terminology; *CT*, computed tomography.

Byrd B J AM Soc Echo 2015;28: 755

EDITORIAL

VIEWS FROM THE MASTERS

Pocket ultrasound devices: time to discard the stethoscope?

Sanjiv Kaul MD

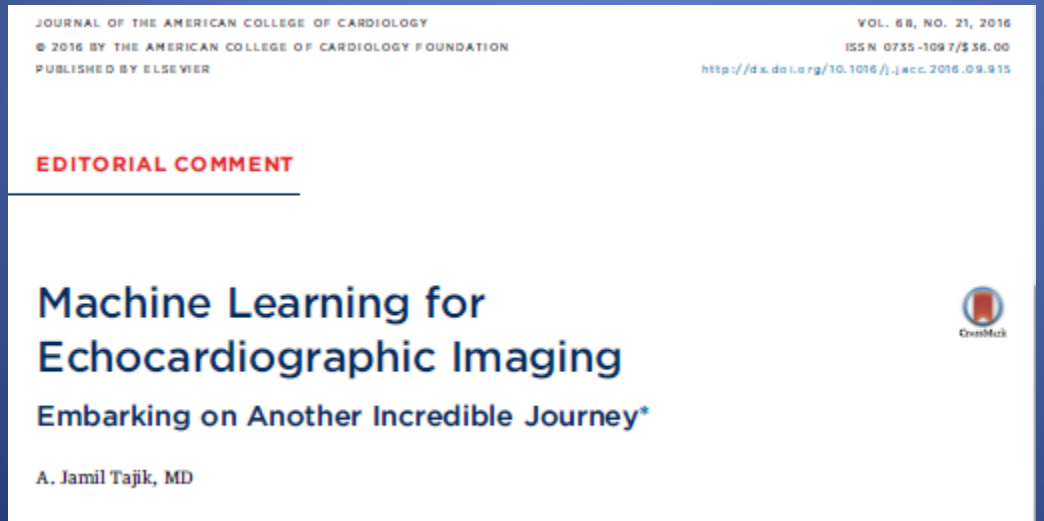
Knight Cardiovascular Institute, UHN-62, Oregon Health and Science University, 3181 SW Sam Jackson Park Road, Portland, Oregon 97239, USA

Corresponding author should be addressed to S Kaul
Email
kauls@ohsu.edu

- In summary, pocket ultrasound devices provide high quality diagnostic images of the heart in real time. These devices are relatively *easy to use* and *far more accurate than the stethoscope*. Their use can potentially decrease additional expensive tests. These devices bring us into the present and propel us into the future. *It is time to discard the inaccurate albeit iconic stethoscope and join the rest of mankind in the technology revolution!*

Kaul S. Echo Research & Practice . Dec 2014

Computers are incredibly fast, accurate, and stupid. Human beings are incredibly slow, inaccurate, and brilliant. Together they are powerful beyond imagination.
—Albert Einstein (1)



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EDITORIAL COMMENT

Machine Learning for Echocardiographic Imaging

Embarking on Another Incredible Journey*

A. Jamil Tajik, MD

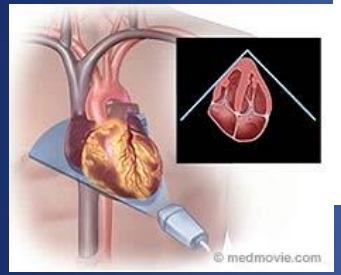
European Journal of Echocardiography (2011) 12, 85–87
doi:10.1093/ejechocard/jeq184

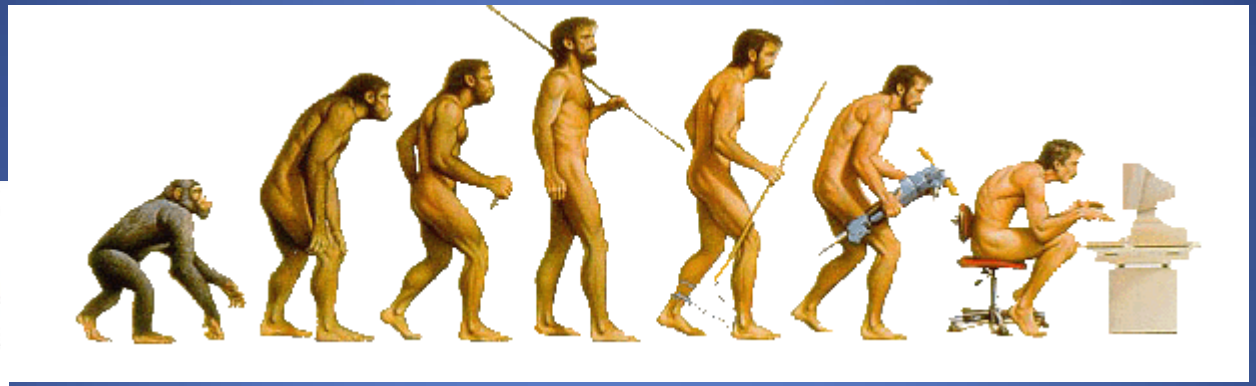
The use of pocket-size imaging devices: a position statement of the European Association of Echocardiography

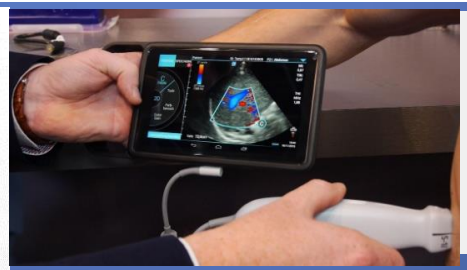
Table 1 Classification of currently available echo machines according to their size and functions

Echo machines	Capabilities
Stationary high-end systems	Full range of standard echo modalities and measurements (MM, 2D, PW, CW, Colour, TVI, TEE), and advances modalities (3D, contrast)
Mobile (smaller machines on wheels, middle range technology)	Full range of standard echo modalities and measurements (MM, 2D, PW, CW, Colour, TVI, TEE)
Portable (small machines that can be carried by a person)	Basic, standard echo modalities and measurements (MM, 2D, PW, CW, Colour)
Hand-held or pocket-size imaging devices	Limited functions (2D, Colour) and measurement package

Evolution of Echo Technology





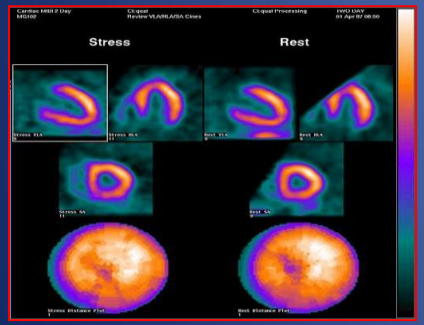


ipad sized

iphone sized

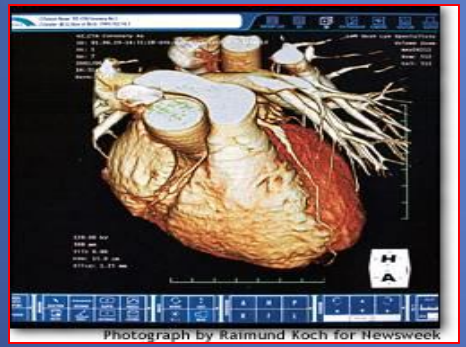
Cardiology Imaging

Nuclear



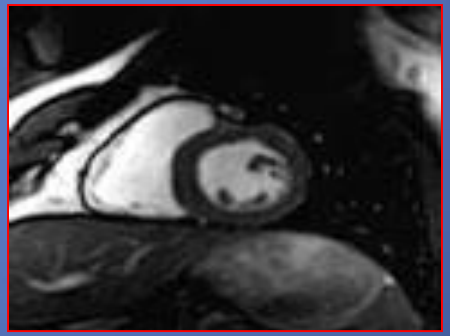
$250-500k

CT



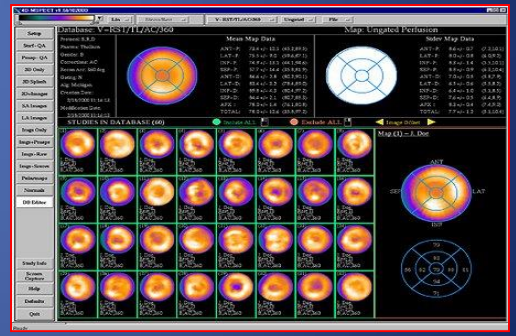
$1.4 million

MRI



$2million

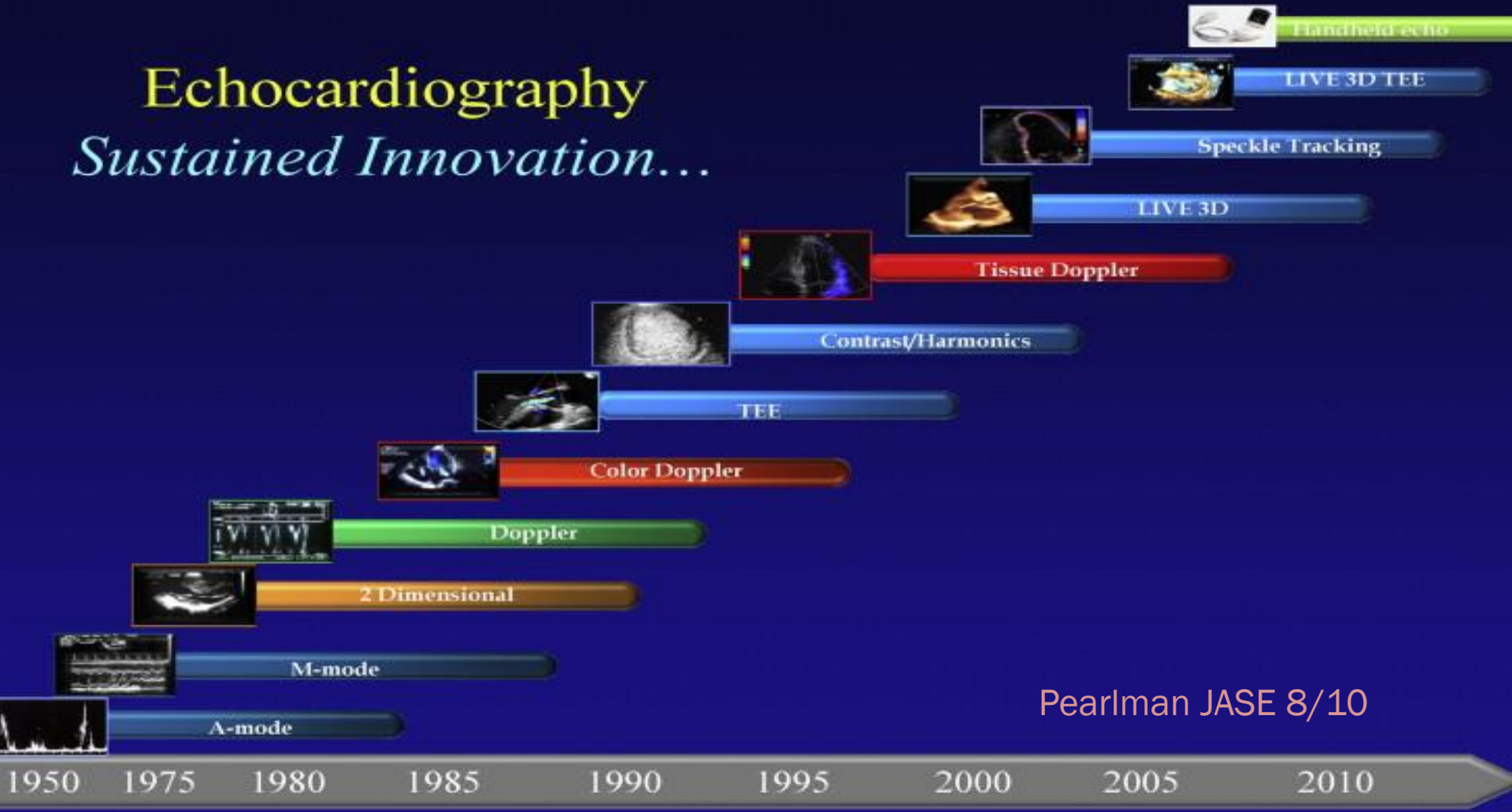
PET



$2.8million

Echocardiography

Sustained Innovation…



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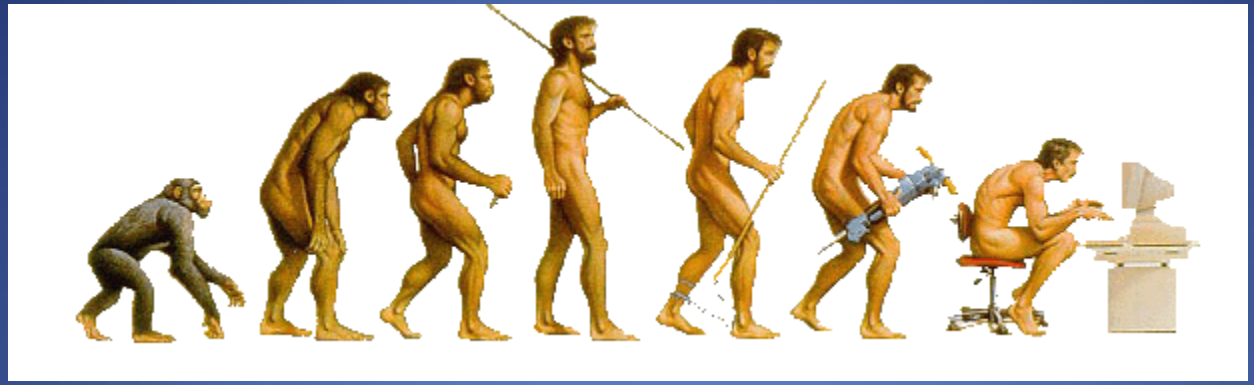


AIUM : Compact US Conference 2004

Point of care vs. referral based

1. Adjunct to Physical Exam
2. Guidance for Procedures :
   - vessel finder
   - pericardiocentesis
3. Diagnostic : Focused Exams
   - ER
   - Screening
4. Diagnostic : comprehensive Exam

- Greenbaum LD, Benson CB J Ultrasound Med 2004; 23:1249-1254

ORIGINAL INVESTIGATION

A Pilot Study of the Clinical Impact of Hand-Carried Cardiac Ultrasound in the Medical Clinic

Lori B. Croft, M.D., W. Lane Duvall, M.D., and Martin E. Goldman, M.D.

The Zena and Michael A. Wiener Cardiovascular Institute and The Marie-Josée and Henry R. Kravis Center for Cardiovascular Health, Mount Sinai Medical Center, New York, NY

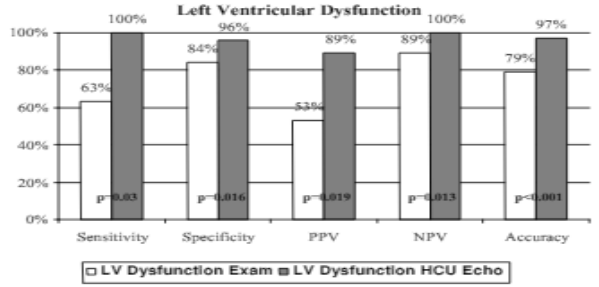


Figure 1. *Diagnostic characteristics for LV function and valvular disease by history and physical examination compared to the addition of HCU limited echo.*

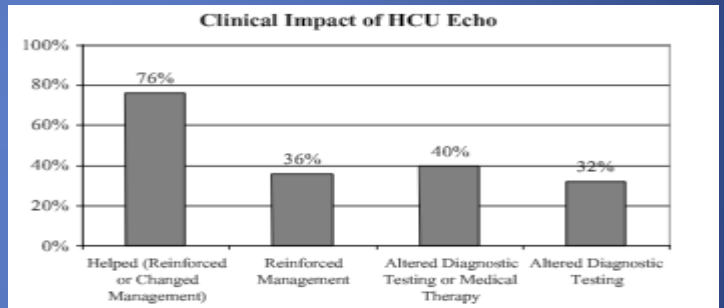


Figure 2. *Impact of the residents' HCU limited echo on clinical management.*

AIUM : Compact US Conference 2004

- Miniaturization of Ultrasound equipment is inevitable , as with smaller phones and computers
- All US units vary in capability, resolution and functionality

- Greenbaum LD, Benson CB J Ultrasound Med 2004; 23:1249-1254

Point-of-Care Ultrasound in Medical Education — Stop Listening and Look

The NEW ENGLAND JOURNAL of MEDICINE

A generation of physicians will need to be trained to view this technology as an extension of their senses, just as many generations have viewed the stethoscope. That development will require the medical education community to embrace and incorporate the technology throughout the curriculum.

Scott D. Solomon, M.D., and Fidencio Saldana, M.D.

N ENGL J MED 370;12 NEJM.ORG MARCH 20, 2014

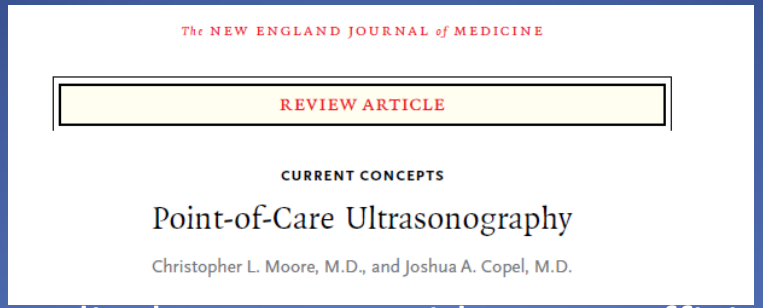
Point-of-Care Ultrasound in Medical Education — Stop Listening and Look

The NEW ENGLAND JOURNAL of MEDICINE

- The risk of misdiagnosis is high when diagnostic US is used by inexperienced practitioners.
- The amount of training required to perform a competent US examination is not trivial…Although medical students trained in US may be able to make relatively crude diagnoses—determining whether ventricular function is normal or reduced, assessing vena cava size, or detecting gallstones—more sophisticated anatomical assessment will require substantially more training
- In addition, false positive findings may lead to additional and often unnecessary testing, and false negatives may provide unwarranted reassurance and result in underdx leading to unnecessary costs to the health care system.
- these “devices can distract students from the core principles of physical diagnosis, especially if introduced early in training, and will interpose another layer of technology between doctor and patient”

Scott D. Solomon, M.D.

N ENGL J MED 370;12 NEJM.ORG MARCH 20, 2014



- POC US can decrease medical errors, provide more efficient real time diagnosis, may be cost effective , replace more expensive imaging
- However, ultrasonography is a user-dependent technology, and as usage spreads, there is a need to ensure competence, define the
- benefits of appropriate use, and limit unnecessary imaging and its consequences.

NEJM 2011 364;8; 749-756

CURRENT CONCEPTS

Point-of-Care Ultrasonography

Christopher L. Moore, M.D., and Joshua A. Copel, M.D.

Table 1. Selected Applications of Point-of-Care Ultrasonography, According to Medical Specialty.*

Specialty	Ultrasound Applications
Anesthesia	Guidance for vascular access, regional anesthesia, intraoperative monitoring of fluid status and cardiac function
Cardiology	Echocardiography, intracardiac assessment
Critical care medicine	Procedural guidance, pulmonary assessment, focused echocardiography
Dermatology	Assessment of skin lesions and tumors
Emergency medicine	FAST, focused emergency assessment, procedural guidance
Endocrinology and endocrine surgery	Assessment of thyroid and parathyroid, procedural guidance
General surgery	Ultrasonography of the breast, procedural guidance, intraoperative assessment
Gynecology	Assessment of cervix, uterus, and adnexa; procedural guidance
Obstetrics and maternal–fetal medicine	Assessment of pregnancy, detection of fetal abnormalities, procedural guidance
Neonatology	Cranial and pulmonary assessments
Nephrology	Vascular access for dialysis
Neurology	Transcranial Doppler, peripheral-nerve evaluation
Ophthalmology	Corneal and retinal assessment
Orthopedic surgery	Musculoskeletal applications
Otolaryngology	Assessment of thyroid, parathyroid, and neck masses; procedural guidance
Pediatrics	Assessment of bladder, procedural guidance
Pulmonary medicine	Transthoracic pulmonary assessment, endobronchial assessment, procedural guidance
Radiology and interventional radiology	Ultrasonography taken to the patient with interpretation at the bedside, procedural guidance
Rheumatology	Monitoring of synovitis, procedural guidance
Trauma surgery	FAST, procedural guidance
Urology	Renal, bladder, and prostate assessment; procedural guidance
Vascular surgery	Carotid, arterial, and venous assessment; procedural assessment

* FAST denotes focused assessment with sonography for trauma.

NEJM 2011 364; 749-57

The Stethoscope's Prognosis

Very Much Alive and Very Necessary

Valentin Fuster, MD, PhD

- In my view, practically and economically, echo systems are not—and will never be—poised to totally eradicate the stethoscope, as it is not possible for every clinician to possess a handheld echo. Thus, we cannot discontinue the important training that takes place during physical examination.

JACC 2016 67 :(9) 1118-9

Definitions

- Point of Care US: performed in real time at pt bedside to correlate with signs and symptoms for immediate Dx and Rx
- Procedural /Diagnostic / Screening
- Agency Healthcare Research & Quality: use of real time US guidance during central line insertion to prevent complications is 1/12 most highly rated pt safety practices

Point of Care Echo/US

- Advantages
  - Adds to Physical Exam
  - Fast, low cost
  - Modernizes the “tenuous Tether”
  - Demonstrate
  - Immediate
  - Eliminates delay for formal exam
- Disadvantages
  - Operator dependent
  - Initial cost

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