Teaching Med-5 Students Point-of-Care Transthoracic Echocardiography

Anthony M.-H. **Ho**, Lester A. H. **Critchley**, Patricia **Kan**, Sylvia **Au**, Siu Keung **Ng**, Simon K. C. **Chan**, Philip **Lam**, Gordon **Choi**, Alex **Lee**, Hector S. O. **Chan**, Joseph **Leung**

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Medical Education

Supplementary Fund

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The NEW ENGLAND JOURNAL of MEDICINE

REVIEW ARTICLE

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

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ISSN 2218-5836 (online)

REVIEW

Ultrasound in the diagnosis of clinical orthopedics: The orthopedic stethoscope

Alexander Blankstein

Deep Impact of Ultrasound in the Intensive Care Unit

The "ICU-sound" Protocol

Emilpaolo Manno, M.D.,* Mauro Navarra, M.D.,† Luciana Faccio, M.D.,† Mohsen Motevallian, Luca Bertolaccini, M.D., Ph.D.,‡ Abdou Mfochivè, M.D.,† Marco Pesce, M.D.,† Andrea Evangelista, M.S.§

Anesthesiology, V 117 • No 4 801 October 2012

Table 4. Study Population Stratified According to Admitting Diagnosis, SAPS II Score at Admission, and Number of New Ultrasound Abnormalities

Diagnostic Group	No. of Patients	%	SAPS II Score* (95% CI)	No. of New Ultrasonographic Abnormalities
Cardiac arrest	14	11.2	52 (43–60)	19
COPD-Asthma	16	12.8	39 (32–46)	13
Trauma	9	7.2	29 (19–38)	3
Acute Cardiac Decompensation	27	21.6	40 (36–45)	34
ARDS/Pneumonia	11	8.8	42 (32–55)	13
Postoperative complications	14	11.2	40 (33–47)	14
Meningo-encephalitis	5	4	42 (35–49)	2
Neurologic disease	5	4	36 (18–55)	2
Septic shock	18	14.4	47 (39–55)	28
Other	6	4.8	42 (34–50)	8
Total/average	125	—	41 (39–44)	136

“… the University of South Carolina School of Medicine has developed an extensive ultrasound training program with the intent of providing a series of educational programs for its medical students, medical residents, and practicing physicians in primary care from around the state, the Southeast, and globally.”
http://ultrasoundinstitute.med.sc.edu/

Programmatic activities involving US currently underway at the Univ of South Calif School of Medicine are:

1. 4-year curriculum in clinical ultrasound for medical students
2. Ultrasound training integrated into medical residency curriculum in primary care
3. On-site ultrasound training for South Carolina rural primary care physicians”

First year (M1)

Orientation week: before classes begin

1. 50-min hands-on introductory ultrasound session: scan the neck

Fall semester: in conjunction with anatomy

1. Introductory lecture and demonstration: history of ultrasound, basic physics, definitions/terms, screen orientation, technique, “knobology”

2. Introduction to cardiac ultrasound (laboratory session)

Left parasternal long axis view (PLAX): B-mode only; identification of heart chambers, valves, review screen orientation, knobology, depth, focus, frequency, gain

1st year: Spring semester: in conjunction with physiology

1. Introduction to vascular US-vascular hemodynamics

2. Echocardiography: hemodynamics (laboratory)

Apical 4 and 5 chamber views (B-mode and color flow mode): wall motion, valve motion, cardiac cycle with color flow

3. Cardiogenic shock: PLAX, apical four-chamber, subcostal

Cardiomypoathy: assess wall motion and shape of the LV

Cardiac tamponade: assess for pericardial effusion, the right ventricle (RV) size and compression with cardiac cycle

Pulmonary embolism: assess for RV strain: assess for RV/RA for thrombosis

Assessment: Questions are added to the physiology written examination to test understanding of physiology/ultrasound concepts in the context of a clinical case

Second year (M2)

1. Ultrasound physics

2. TTE: standard cardiac views (laboratory session)

Parasternal long and short axis, apical 4 and 5 chamber, subcostal; chambers, valves, wall thickness and motion

3. General abdomen (laboratory session)

Liver, gall bladder, kidneys, spleen, urinary bladder, aorta, IVC; identify structures and measure organ size

4. Abdominal aorta assessment (laboratory session)

AAA screening; transverse and longitudinal, B-mode, color flow and pulse wave, three measurements, characteristics that differentiate aorta from IVC

University of California, Irvine and Ohio State University

- Echocardiography taught in Medical School Yr 1 and yr 2

http://www.ultrasound.uci.edu/curriculum.asp

A Pilot Study of Comprehensive Ultrasound Education at the Wayne State University School of Medicine

A Pioneer Year Review

Sishir Rao, BA, Lodewijk van Holsbeeck, BA, Joseph L. Musial, PhD, Alton Parker, MD, J. Antonio Bouffard, MD, Patrick Bridge, PhD, Matt Jackson, PhD, Scott A. Dulchavsky, MD, PhD

 • J Ultrasound Med 2008; 27:745–749

The Use of Echocardiography in the Simulation Center to Foster the Teaching of Cardiac Auscultation Skills

James Day, BA, RDCS
Thomas Jefferson University, Philadelphia, Pennsylvania, United States

Seeing Is Believing: Mount Sinai School of Medicine Aims to Revolutionize Medical School Program

PR Web

New York, NY (PRWEB) September 14, 2012

Seeing Is Believing: Mount Sinai School Of Medicine Aims To Revolutionize Medical School Program

Class of 2016 Medical Students to Participate in Research Study Involving GE Pocket-Sized Ultrasound

New York City, NY September 14, 2012 – First-year medical students at Mount Sinai School of Medicine will be the first in New York to be introduced to a digital-age ultrasound device that can visualize inside the body, and fit directly into the pockets of their brand new white coats.

The visualization tool, made by GE Healthcare, is a handheld ultrasound device called Vscan*, and is roughly the footprint of a smartphone. The Vscan houses innovative technology that can provide an immediate, non-invasive method to secure visual information from inside the body. A total of 72 pocket-sized devices will be provided for use in a research study and distributed to teams of first year medical school students that make up the 140-member Class of 2016. The objective of the study is to demonstrate that handheld imaging technology can contribute to medical education at all levels of instruction and learning.

At the beginning of each academic year, first-year medical students at Mount Sinai School of Medicine participate in a medical school tradition that kicks off their medical career—the White Coat Ceremony. After listening to inspirational speeches, students don their new white coats and receive a stethoscope at a special ceremony attended by family, friends and faculty members. During this momentous day, students, parents and faculty will also be introduced to the handheld ultrasound.

Feasibility of a focused ultrasound training programme for medical undergraduate students

Ivan Wong,
Thilina Jayatilleke,
Richard Kendall,
Paul Atkinson

The Clinical Teacher
Volume 8, Issue 1, pages 3–7, March 2011

A UK Study

EMERGENCY MEDICINE NEWS

VOL XXXII, No. 11

Viewpoint

Time to Integrate Ultrasound into Medical School Curricula

By James Hwang, MD

With all that ultrasound has to offer, there is no doubt that it is time to incorporate it not just into clinical practice but into medical school curricula. The American College of Emergency Physicians has been on board for a few years, releasing its Emergency Ultrasound Guidelines in 2008. The guidelines show its already wide reach, with classifications into clinical categories such as resuscitative, diagnostic, symptom- or sign-based, procedure guidance, and therapeutic and monitoring. (Ann Emerg Med *2009;53[4]:550; http://bit.ly/emUS.)*

Despite its increasing availability, the question remains: When can we expect to see ultrasound's routine use in clinical practice by all specialties? The answer is probably when all physicians are trained in ultrasound, and that training should start in medical school.

Advances in technology have made bedside ultrasound an outstanding, readily available teaching tool. Ultrasound has been shown to help students explore and to reinforce concepts covered in anatomy and physiology.

The value of incorporating ultrasound into medical school education goes beyond love of it. Except for those going into surgical specialties, most medical students will never experience anatomy in the same manner again, and are more likely to apply their understanding of anatomy through imaging modalities such as ultrasound. Earlier exposure gives future clinicians a better foundation for understanding pathophysiology, and increases the likelihood of integration of ultrasound into daily practice. Bedside ultrasound can augment the history and physical exam, and help clinicians narrow their differential diagnoses and arrive at a correct diagnosis earlier and with less ancillary testing. (*Crit Care Med* 2004;32[8]:1798.) As technology

Continued on page 18

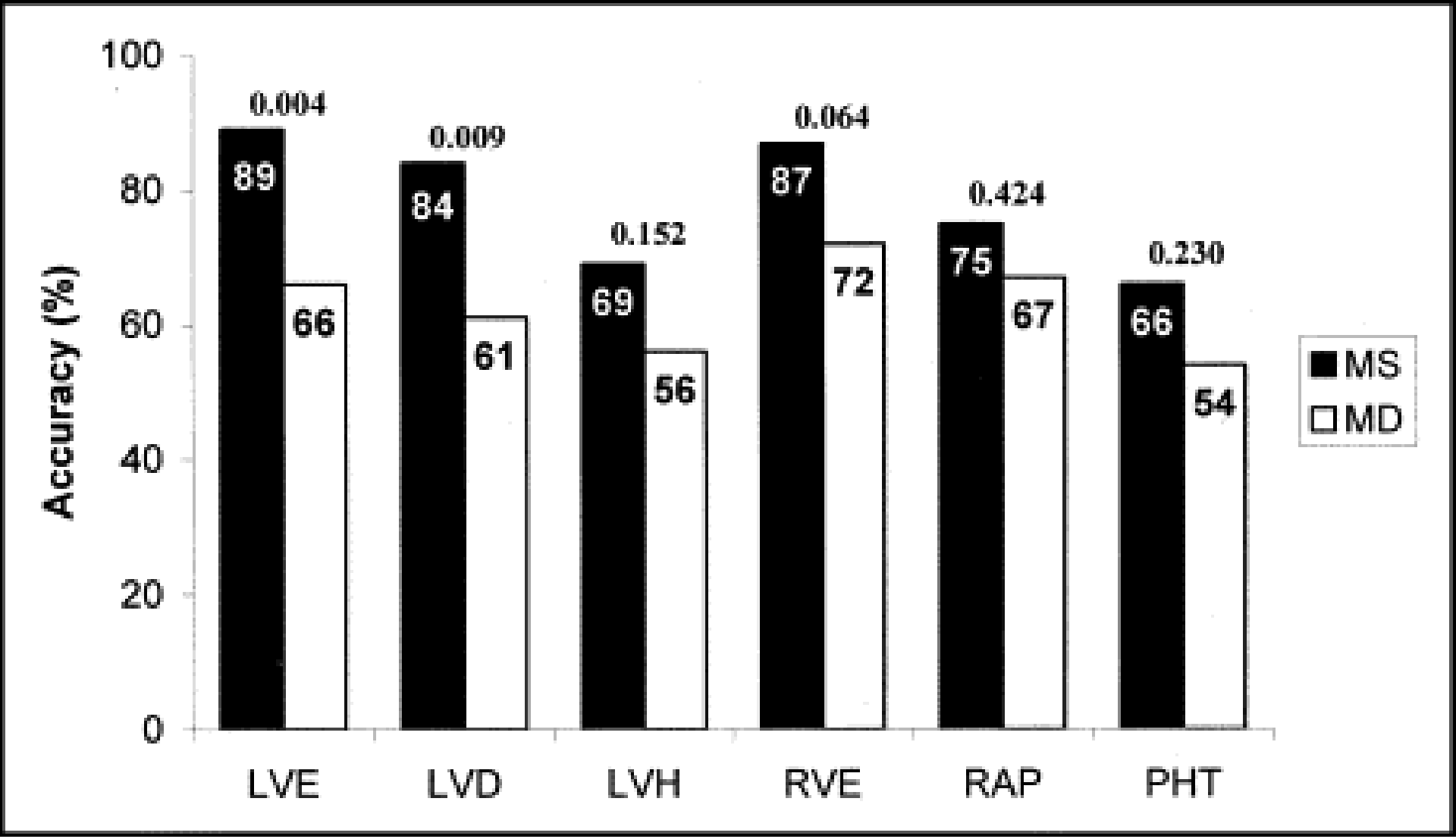
Focused Cardiac Ultrasound in the Emergent Setting: A Consensus Statement of the American Society of Echocardiography and American College of Emergency Physicians

Arthur J. Labovitz, MD, FASE, Chair,* Vicki E. Noble, MD, FACEP,** Michelle Bierig, MPH, RDCS, FASE,* Steven A. Goldstein, MD,* Robert Jones, DO, FACEP,** Smadar Kort, MD, FASE,* Thomas R. Porter, MD, FASE,* Kirk T. Spencer, MD, FASE,* Vivek S. Tayal, MD, FACEP,** and Kevin Wei, MD,* *St. Louis, Missouri; Boston, Massachusetts; Washington, District of Columbia; Cleveland, Ohio; Stony Brook, New York; Omaha, Nebraska; Chicago, Illinois; Charlotte, North Carolina; Portland, Oregon*

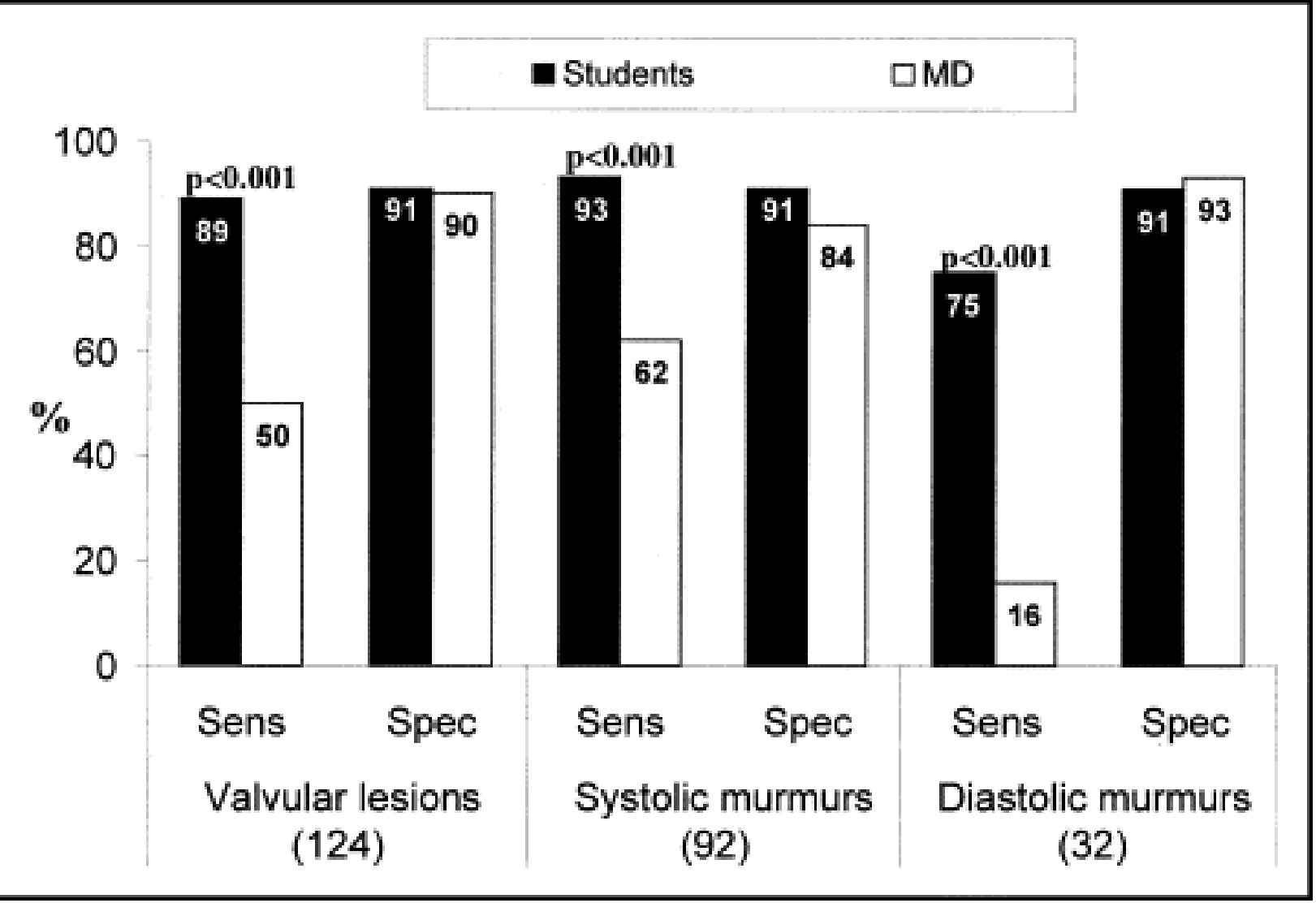
emergency medicine. In the emergency department, focused cardiac ultrasound has become a fundamental tool to expedite the diagnostic evaluation of the patient at the bedside and to initiate emergent treatment and triage decisions by the emergency physician. (J Am Soc Echocardiogr 2010;23:1225-30.)

Kobal SL, et al. Comparison of Effectiveness of Hand-Carried Ultrasound to Bedside Cardiovascular Physical Examination. *Am J Cardiol* 2005;96:1002-6

… The diagnostic accuracy of medical students using a hand-carried ultrasound device after 4 h of lecture and 18 h of practical performing and interpreting TTE to detect valvular disease, left ventricular dysfunction, enlargement, and hypertrophy was superior to that of experienced cardiologists performing cardiac physical examinations ($p<0.001$).



Medical students' (MS) and cardiologists' (MD) diagnostic accuracy for nonvalvular lesions. MSs were more accurate than board-certified cardiologists in diagnosing nonvalvular lesions. The most significant difference between groups was observed for diagnosing LV size & function. LVD = LV dysfunction; LVE = LV enlargement; RAP = elevated RA pressure; RVE = RV enlargement; PHT = pulmonary hypertension.



MSs' and cardiologists' (MD) diagnostic sensitivity (sens) & specificity (spec) for valvular lesions. The sens of students to recognize valvular lesions (111 valvular regurgitations and 13 valvular stenoses) was significantly superior to that of board-certified cardiologists for those that cause a systolic murmur (n = 92) as well as a diastolic murmur (n = 32). MSs' and cardiologists' spec were similar.

Utility and Diagnostic Accuracy of Hand-Carried Ultrasound for Emergency Room Evaluation of Chest Pain

Shaul Atar, MD, Alexander Feldman, MD, Aziz Darawshe, MD, Robert J. Siegel, and Tiberio Rosenfeld, MD

This study examined the utility and accuracy of immediate hand-carried echocardiography in patients presenting to the emergency room with chest pain and a normal or nondiagnostic electrocardiogram. Hand-carried echocardiography was highly concordant ($\kappa = 0.8$) with troponin T tests as well as the discharge diagnosis of acute coronary syndrome, had a 100% sensitivity for the detection of acute coronary syndrome, 93% specificity, and 71% and 100% positive and negative predictive values, respectively.

(Am J Cardiol 2004;94:408–409)

Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Heart Association®

Determinants of sensitivity and specificity of electrocardiographic criteria for left ventricular hypertrophy.

D Levy, S B Labib, K M Anderson, J C Christiansen, W B Kannel and W P Castelli

Circulation. 1990;81:815-820
doi: 10.1161/01.CIR.81.3.815
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

Print ISSN: 0009-7322. Online ISSN: 1524-4539

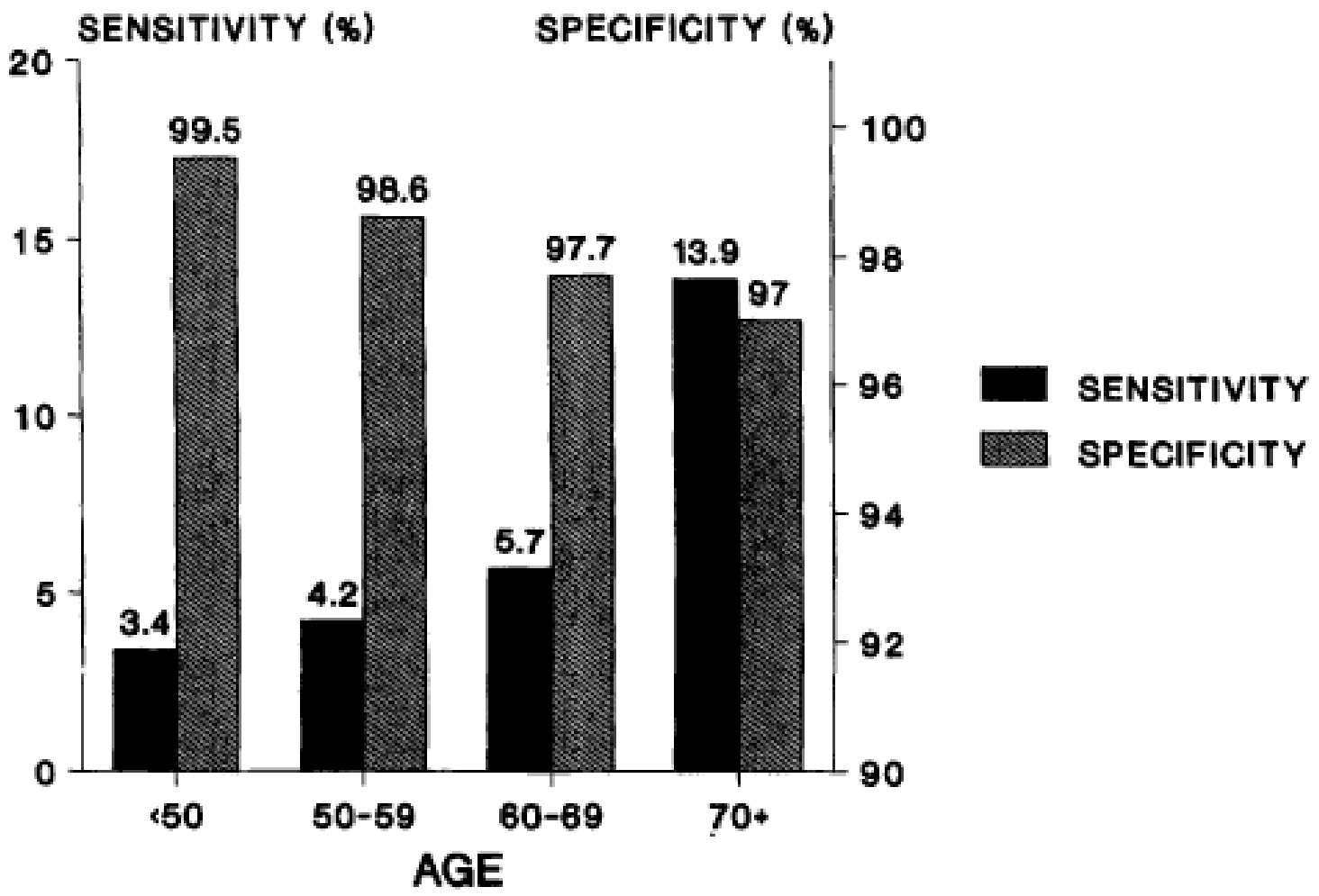


FIGURE 1. *Bar graph showing sensitivity and specificity of electrocardiogram for echocardiographically determined left ventricular hypertrophy according to age. Trends for increasing sensitivity and declining specificity with advancing age are statistically significant* ($p<0.0001$, *both sexes combined, sex-adjusted).*

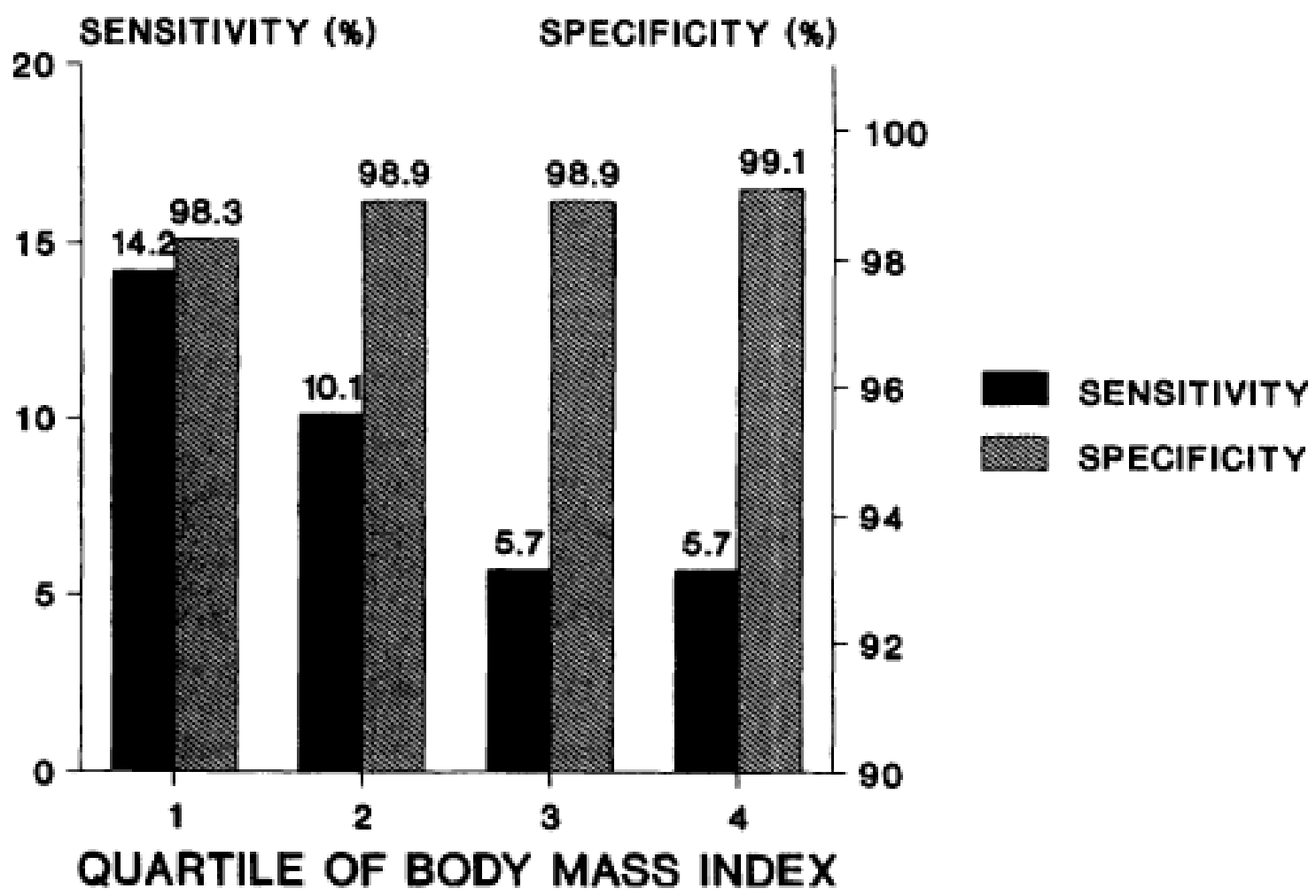


FIGURE 2. *Bar graph showing sensitivity and specificity of electrocardiogram for echocardiographically determined left ventricular hypertrophy according to body mass index, a measure of obesity. Trend for declining sensitivity with increasing body mass index is statistically significant* ($p<0.05$, *both sexes combined, sex-adjusted).*

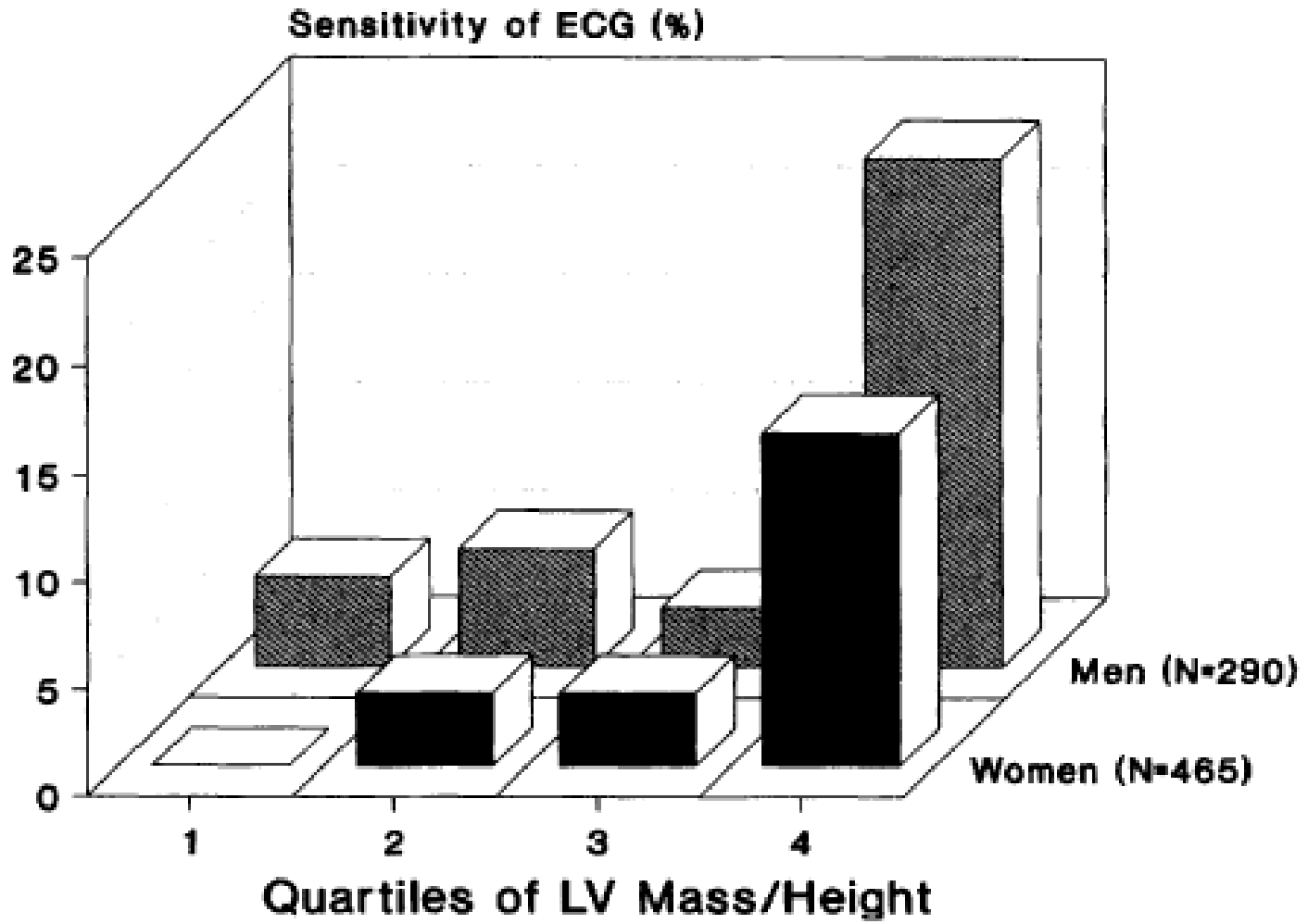


FIGURE 3. *Three-dimensional bar graph showing sensitivity of electrocardiogram according to quartiles of severity of echocardiographically determined left ventricular hypertrophy. Trend for increasing sensitivity with increasing left ventricular mass is statistically significant* ($p=0.0006$ *in men,* $p<0.0001$ *in women).*

Sensitivity* and Specificity* of Framingham Criteria for ECG LVH, According to Quartiles of Body Mass Index and Echocardiographic Criteria† Used to Define LVH

	BMI Quartile 1	BMI Quartile 2	BMI Quartile 3	BMI Quartile 4
Men	(*n*=510)	(*n*=512)	(*n*=508)	(*n*=509)
LVM criteria for echo LVH				
Prevalence of echo LVH	5.88	9.18	11.02	22.99
Sensitivity of ECG	20.00	10.64	3.57	9.40
Specificity of ECG	96.88	98.28	98.01	98.98
LVM/BSA criteria for echo LVH				
Prevalence of echo LVH	8.24	9.57	9.25	16.11
Sensitivity of ECG	16.67	10.20	6.38	12.20
Specificity of ECG	97.01	98.27	98.26	98.83
LVM/Ht criteria for echo LVH				
Prevalence of echo LVH	6.47	9.77	12.40	28.68
Sensitivity of ECG	18.18	10.00	4.76	8.22
Specificity of ECG	96.86	98.27	98.20	99.17
Women	(*n*=661)	(*n*=659)	(*n*=663)	(*n*=657)
LVM criteria for echo LVH				
Prevalence of echo LVH	3.33	8.65	17.35	37.60
Sensitivity of ECG	13.64	8.77	6.96	4.05
Specificity of ECG	99.53	99.67	99.45	98.78
LVM/BSA criteria for echo LVH				
Prevalence of echo LVH	5.90	8.50	15.99	24.96
Sensitivity of ECG	10.26	8.93	7.55	6.71
Specificity of ECG	99.68	99.67	99.46	99.19
LVM/Ht criteria for echo LVH				
Prevalence of echo LVH	3.33	7.89	18.70	39.73
Sensitivity of ECG	13.64	9.62	6.45	4.21
Specificity of ECG	99.53	99.67	99.40	98.99

Expectations of Students at CUHK

- Read the TTE primer sent to you by Dr. Ho before rotation
- 1st day of A & IC rotation, must attend the a.m. lecture and p.m. workshop
- Each student will be assigned to see one cardiac surgery patient during the 1st week, and again during the 2nd week. Cardiac OT is OT 5-8.
- On both occasions, find out who the **senior** anaesthetist is and call him/her **the day before (not earlier)** and ask to be paged when he/she is ready to see his/her cardiac patient. When paged, go see the patient with him/her (usually on Ward 7C)
- You will be expected to conduct a TTE on the 2 patients you see. You will be scored each time
- Write an anaesthesia exam, which will contain TTE questions, at the end of the rotation
- Complete an evaluation of your TTE learning experience

Expectations of Students continued

- There are certain days when the supervisor for overseeing your TTE is not the senior anaesthetist. Connie will contact you.
- There will be days when there are no cardiac OT. You will see non-cardiac patients. Connie will contact you.

Advantages of ultrasound

- Safe (no known side effects)
- Fast
- Non-invasive (except for TEE and transvaginal echo)
- Minimal discomfort (similar amount of pressure as auscultation with stethoscope)
- Excellent qualitative and quantitative data

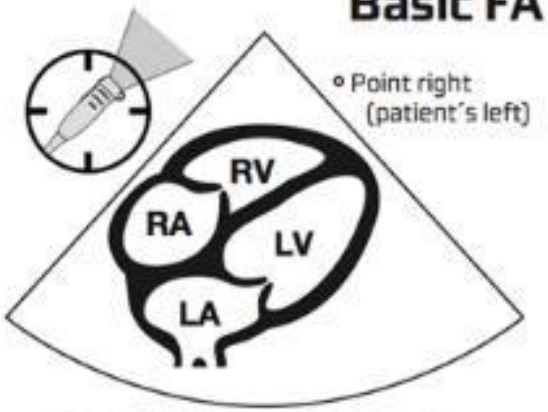
Use of Point-of-Care ultrasound

- Echocardiography
- Focused Assessment with Sonography for Trauma
- Abdominal exam
- Pelvic exam
- Lung scan
- Deep vein thrombosis
- Arterial and venous cannulation
- Nerve block for anesthesia and pain management

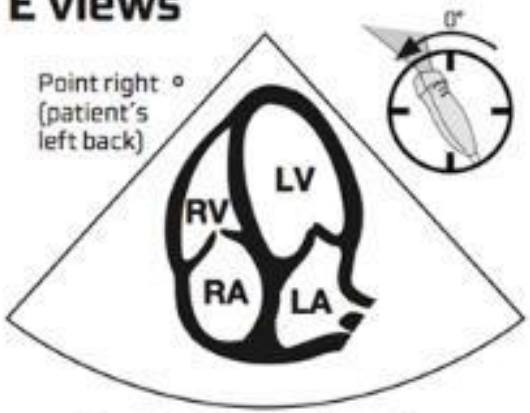
Indications for echocardiography

- Murmur
- Hypotension (volume status, tamponade, myocardial dysfunction, valvular stenosis and insufficiency, etc.)
- Pericardial fluid
- Atrial fib/flutter (thrombus)
- Aortic dissection
- Shunts
- Volume status
- Dyspnea

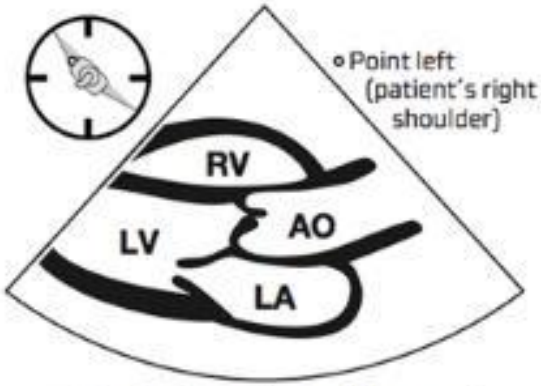
Basic FATE views



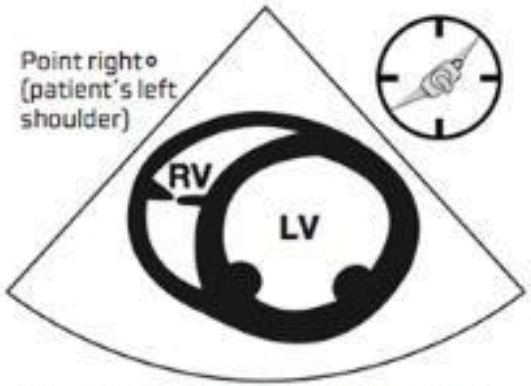
Pos 1: Subcostal 4-chamber



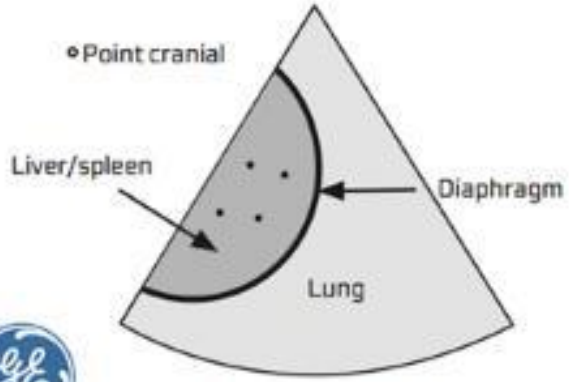
Pos 2: Apical 4-chamber



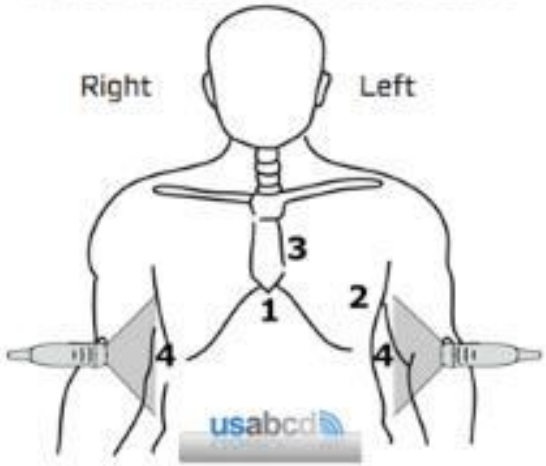
Pos 3: Parasternal long axis



Pos 3: Parasternal LV short axis



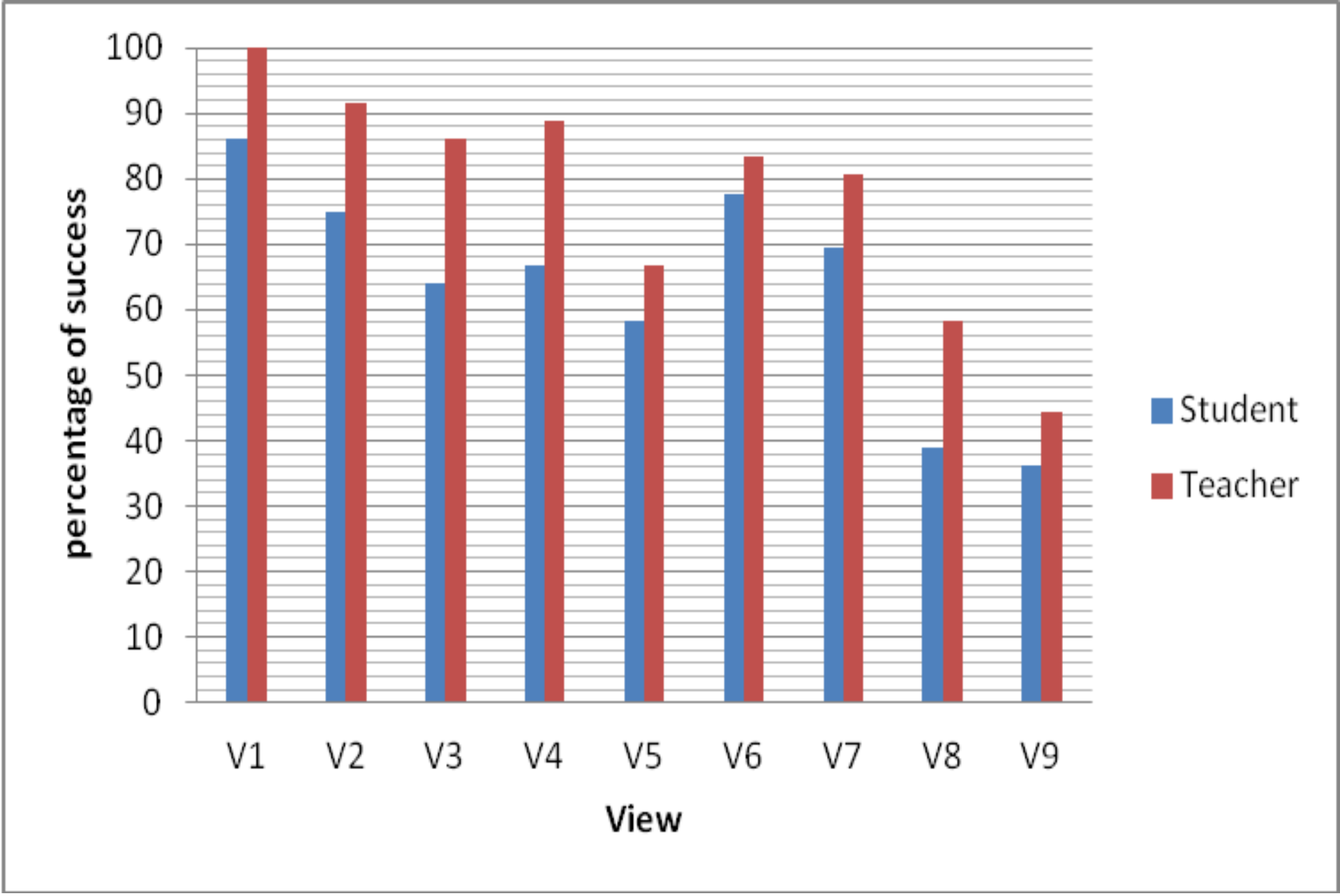
Pos 4: Pleural scanning



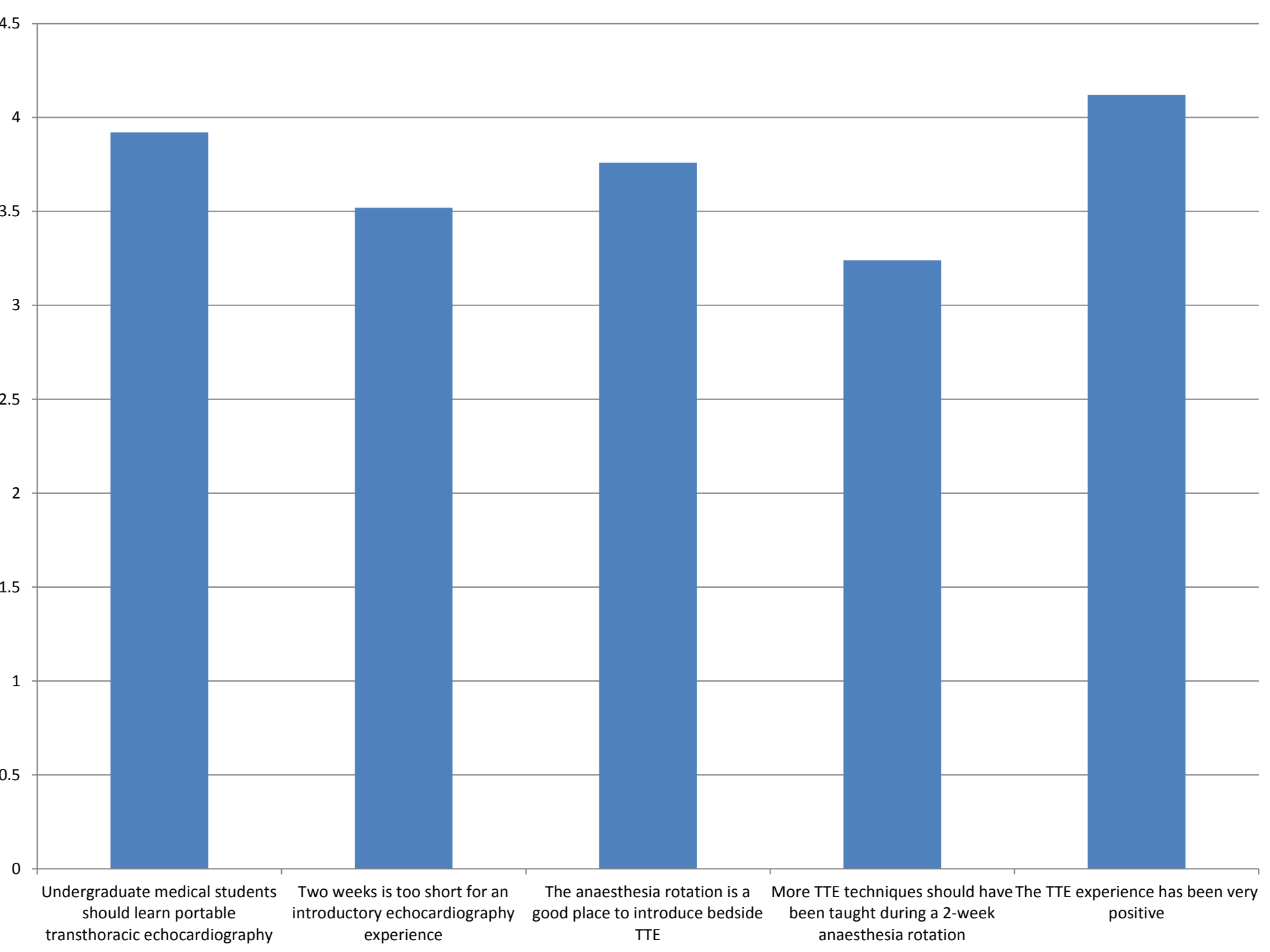
View1= parasternal LAX view
View2= SAX (LV SAX pap muscle)
View3= presence or absence of the major LV dysfunction
View4= parasternal SAX (AV short axis)
View5= presence or absence of AV calcification
View6= apical 4-chamber view
View7= subcostal 4-chamber view
View8= IVC
View9= diameter of the IVC

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	week1score	89.3133	36	19.44677	3.24113
	week2score	89.9361	36	14.95290	2.49215


100
90
80
70
60
50
40
30
20
10
0
percentage of success
V1
V2
V3
V4
V5
V6
V7
V8
V9
View
Student
Teacher

	Strongly disagree 1	Disagree 2	Neu-tral 3	Agree 4	Strongly agree 5
Undergraduate medical students should learn portable transthoracic echocardiography					
Two weeks is too short for an introductory echocardiography experience					
The anaesthesia rotation is a good place to introduce bedside TTE					
More TTE techniques should have been taught during a 2-week anaesthesia rotation					
The TTE experience has been					


4.5
4
3.5
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2.5
2
1.5
1
0.5
0
Undergraduate medical students should learn portable transthoracic echocardiography
Two weeks is too short for an introductory echocardiography experience
The anaesthesia rotation is a good place to introduce bedside TTE
More TTE techniques should have been taught during a 2-week anaesthesia rotation
The TTE experience has been very positive

Not a ZERO-SUM situation

ICONIC Imange in medicine and nursing

A father and mother in China kissing their dying little girl goodbye. In <1 hour, 2 small children in the next room are able to live thanks to the girl's kidneys and liver.