CdL Medicina eChirurgia Università di Ferrara

Corso Integrato di Metodologia Clinica

Aula 6, Polo Didattico Nuovo Arcispedale S. Anna

Ferrara, 17 maggio 2018

L'Ecografia *Bedside* :
Il Fonendoscopio del Terzo Millennio

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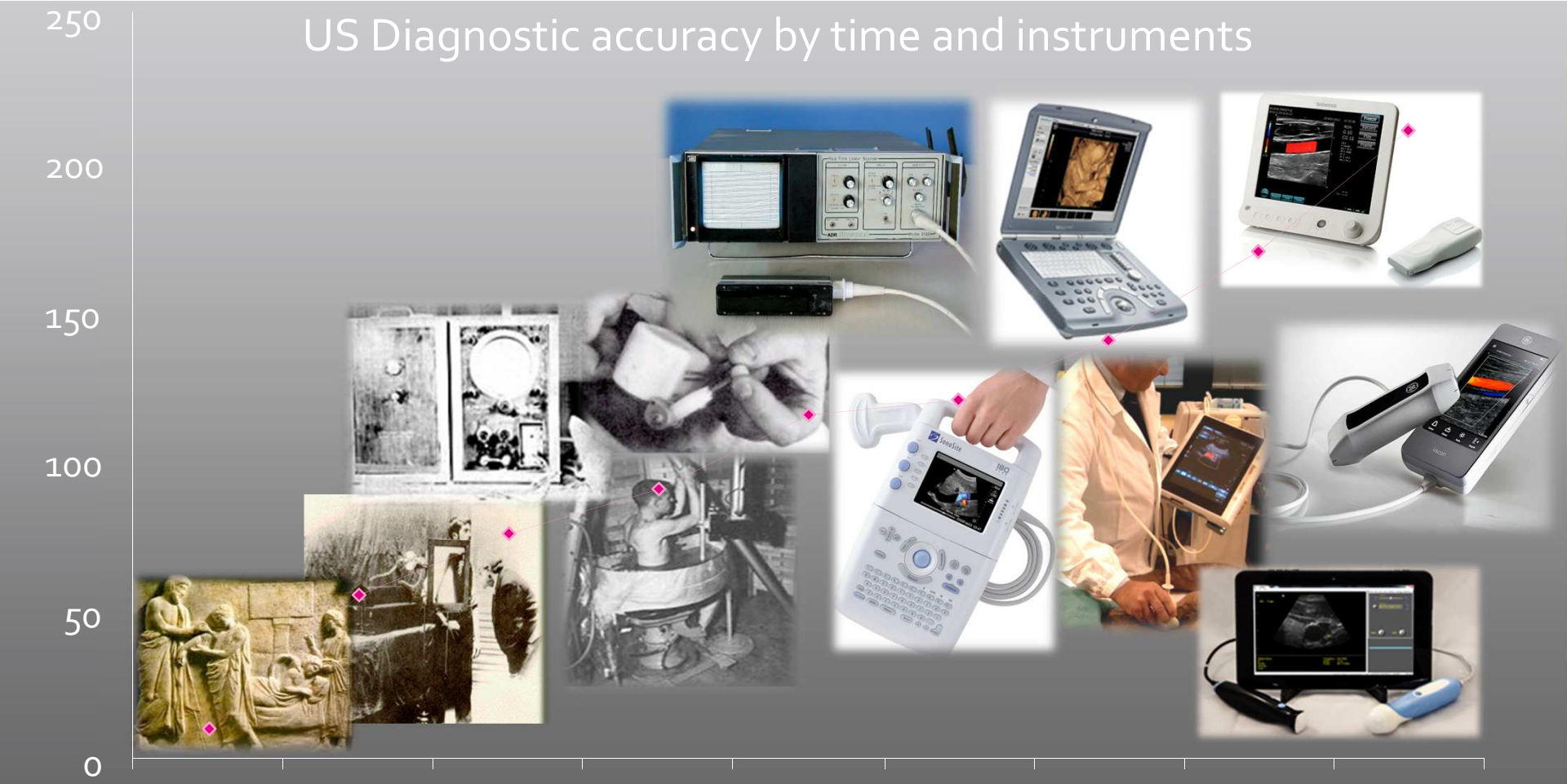
The clinical examination

From Hippocrates' Inspection to Palm/Tab/WiFi US-CD Visit

Accuracy



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Bedside Ultrasound

A 15 yrs Work in Progress

History – 1

- *Roeland JR.* A personal ultrasound imager (ultrasound stethoscope). A revolution in the physical cardiac diagnosis! *Eur Heart J 2002;23:523-7.*
- *Duvall WL, et al.* Can hand-carried ultrasound devices be extended for use by the noncardiology medical community**?** *Echocardiography 2003;20: 471-6.*
- *Hellman DB, et al.* The rate at which residents learn to use hand-held echocardiography at the bedside. *Am J Med 2005;118:1010-8.*
- *Beaulieu Y, et al.* Bedside ultrasonography in the ICU: part 1.*Chest 2005 Aug;128(2):881-95*.
- *Croft LB, et al.* Echocardiography . A pilot study of the clinical impact of hand-carried cardiac ultrasound in the medical clinic. *Echocardiography 2006;23:439-46.*

Bedside Ultrasound

A 15 yrs Work in Progress

History - 2

- *Martin LD, et al.* Hand-carried ultrasound performed by hospitalists: does it improve the cardiac physical examination? *Am J Med 2009;122:35-41.*
- *Alpert, et al*. Should a hand-carried ultrasound machine become standard equipment for every internist? *Am J Med 2009;122:1-3.*
- *Medd D*. Bedside ultrasound: part of the physical examination. *Am J Med 2010;123:e11.*
- *Rempell JS.* Using lung ultrasound to differentiate patients in acute dyspnea in the prehospital emergency setting *Crit Care 2011;15: 161.*
- *Razi R, et al.* Bedside hand-carried ultrasound by internal medicine residents versus traditional clinical assessment for the identification of systolic dysfunction in patients admitted with decompensated heart failure. *J Am Soc Ecocardiogr 2011;12:1319-24.*
- *Blois B.* Office-based ultrasound screening for abdominal aortic aneurysm. *Can Fam Physician. 2012; 58: e172–e178.*
- *Gillman MN et al*. Portable bedside ultrasound: the visual stethoscope of the 21st century. *Scand J Trauma Resusc Emerg Med. 2012; 20: 18.*
- *Bahner DP, et al*. Integrated medical school ultrasound: development of an ultrasound vertical curriculum *Crit Ultrasound J 2013; 5:6.*

Bedside Ultrasound

A 15 yrs Work in Progress

History – 3

- *Bhagra A, et al*. Point-of-Care US for Primary Care Physicians and General Internists. *Mayo Clin Proc* 2016; 91(12):1811-1827.
- *Henrard G.* Echography at the **point of care** : stethoscope of the future for the General Practitioner ? *Rev Med Liege. 2017 Apr;72(4):181-186.* ***Review****.*
- *Tsou PY, et al.* Accuracy of point-of-care focused echocardiography in predicting outcome of resuscitation in cardiac arrest patients. A systematic review and meta-analysis. *Resuscitation. 2017 May;114:92-99.*
- *Feilchenfeld Z, et al.* Ultrasound in undegraduate medical education: a systematic and critical review. *Med Educ.* 2017 Apr;51(4):366-378.
- *Ablordeppey EA, et al.* Diagnostic accuracy of Central Venous Catheter Confirmation by Bedside Ultrasound vs. Chest Radiography in Critically ill patients: a Systematic Review and Meta-analysis. *Crit* ***Care*** *Med*. 2017 Apr;45(4):715-724.
- *Kimura BJ.* Point-of-care cardiac ultrasound techniques in the physical examination: better at the bedside. *Heart.* 2017 Jul;103(13):987-994.

Bedside Ultrasound

A 15 yrs Work in Progress

History – 4

- *Shreshta GS, et al.* Role of **point of care** US in the management of sepsis and septic shock. *Rev RecentCclin Trials. 2018 Apr 12(doi: 10.2174).*
- *Kruisselbrink R, et al.* Diagnostic ccuracy of point-of-care gastric ultrasound *Resuscitation. 2018 April5 (doi: 10.1213).*
- *McGivery K, et al.* Emergency Department Ultrasound for the detection of B-lines in the early detection of acute decompensated Heart failure: a sustematic review and meta-analysis. *CJEM* 2018 Apr 5 (Doi: 10.1017)
- *Choy JY, et al.* Accuracy of Bedside Ultrasound for the diagnosis of Skull Fractures in Children aged 0-4 years. *Pediatr Emerg Care. 2018* Apr 24 (doi: 10.1024).
- *Bortcosh W, et al.* New Directions in point-of-care Ultrasound at the crossroads of pediatric emergency and critical care. *Curr Opin Pediatr 2018, 30(3): 350-8.*

Bedside Ultrasound

The EFSUMB Point of View: Echoscopy what is it for?

- **Echoscopy**

"Only one answer (yes/no) to solve a specific clinical question"

- Any scanner: pocket size included

- **Point Of Care US - POCUS**
(Moore C, NEJM 2011)

"Ultrasonography performed bedside and interpreted directly by the clinician"

- **Adequate knowledge** of ultrasonography by the operator

- US scanner capable for this setting

Table 1

Clinical Situation	Clinical Question	Echoscopic answer
Abdominal enlargement. Obesity or ascites?	Free abdominal fluid?	YES or NO
Area of Pulmonary dullness at percussion	Presence of pleural effusion?	YES or NO
Tachycardia, low cardiac tones, low voltages on EKG	Pericardial effusion?	YES or NO
Pulsating mass in epigastrium at palpation	Aortic aneurysm?	YES or NO
Marked decrease or lack of urinary bladder output	Bladder overdistension?	YES or NO
Worsening of renal function	Hydronephrosis?	YES or NO
Jaundice	Dilated intrahepatic biliary tree?	YES or NO
Suspected mass at abdominal palpation	Mass confirmed?	YES or NO
Fluid aspiration required	Fluid confirmation and location prior to aspiration / drainage	Choice of the puncture site
Reduction of urinary output in patients with urinary catheter	Catheter correctly placed in the urinary bladder?	YES or NO
Enlarged spleen?	Measure spleen length, longer than normal?	YES or NO
Suspected cholecistitis	Large gallbladder stones?	Yes or NO

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Piscaglia F, et al. Ultraschall in Med 2013

Bedside Ultrasound in Internal Medicine

SIMI US Working Group: Bedside US Training Program

Echoscopy vs POCUS

Echoscopy

- Pleural, pericardial,peritoneal effusions (p/a, extent)
- Wet or dry lung (p/a
- Dilated heart ventricles (p/a)
- Severe cardiac systolic dysfunction (p/a)
- Collapsible inferior vena cava (p/a)
- Palpable or suspected abdominal mass (p/a, solid vs liquid)
- Atrophy or megaly of abdominal viscera (p/a)
- Hydrops of the gallbladder (p/a, large stones)
- Hydronephrosis (p/a)
- Intestinal and biliary obstruction (p/a)
- Abdominal aortic aneurysm (p/a)
- Bladder outlet obstruction (p/a)
- Thoracentesis, paracentesis US-assisted
- Catheter into the bladder* (p/a)

p/a: presence/absence

*also performed by nursing staff

Point of Care US

•1° Module: Fundamentals in US

Fundamentals of clinical bedside esamionation-Bedside US devices-Indication for referral to 2° Opinion or expert levels - CEUS

• 2° Module: Neck nodules

Nodule of the neck: clinical approach-normal US findings Salivary Gland Disease-Thyroid Nodule-Superficial lympha denopathy

• 3° Module: Cardio-respiratory diseases

Dyspnoea:clinical approach-Normal US findings-Pleural and Pericardial effusions-Interstitial Pathology-Pleural/Pulmonary Consolidation-PNX-Dimension Cardiac Chambers-Inspective EF-SevereValvulopathy-US-guidedThoracentesis

• 4° Module: Abdominal Diseases

Acute Abdomen:Clinical Approach-Normal US findings Ascites&Abdominal Masses-Focal lesions (>2cm)-Jaundice Cholelithiasis-Cholecystitits-Cholangitis-Renal Failure Hydronephrosis-Renal Stones –Abdominal Aortic Aneurysm Bowel Obstruction-Appendicitis-Diverticulitis-IBD-Tumours US-guided Paracentesis

• 5° Module: Limb Edema

“Swollen” Leg: Clinical Approach-Normal US findings Deep Venous Thrombosis (DVT)

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Arienti V, et al. Intern Emerg Med 2014

Bedside Ultrasound in Internal Medicine

Echoscopy vs POCUS: Instruments features

Feature	*Echoscopy*	*POCUS*
Form factor	Pocket/probe	Tablet/Handheld
Mobility/Weight	Max/300-800g	Med/1-1,5 kg
Technical data	Instant on, Simple presets, CD+/-	HiRes CDI, Beam Steering, Needle visual
Resolution	Low-Moderate	Moderate-High
Cost	3-8,000 €	15-25,000 €

Kimura BJ. Heart 2017

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Market analysis

Ultrasound worldwide 2011-2017

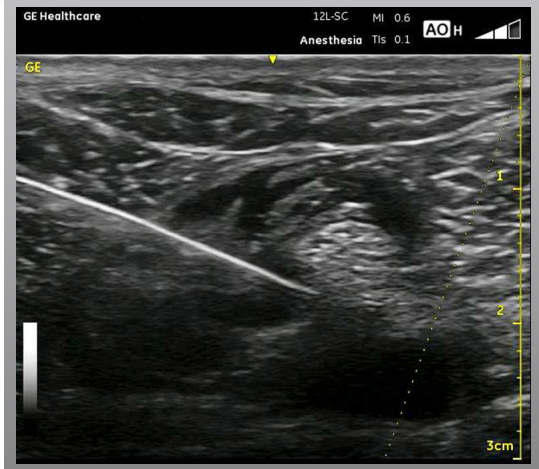
- Market of medical ultrasound devices (Markets and Markets)
  - 2011: $5.6 billions
  - 2017: predicted to reach *$8.1 billions*
- Fastest-growing market categories
  - US systems for EM, anesthesiology and interventional musculoskeletal applications
- Worldwide demand for portable *Point-of-Care* diagnostic tools
  - smaller device size
  - low cost
  - better image quality

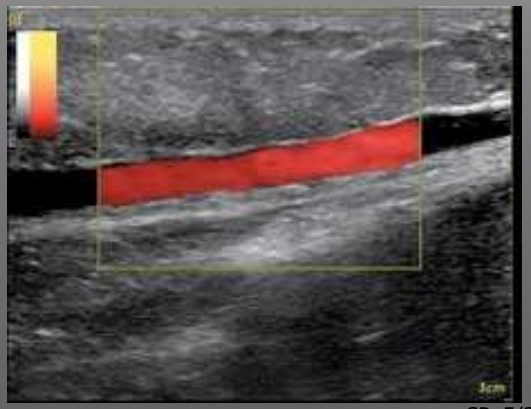
Bedside Ultrasound in Internal Medicine

General Electric -POCUS

Venue 40

High Resolution
Images with Reliability





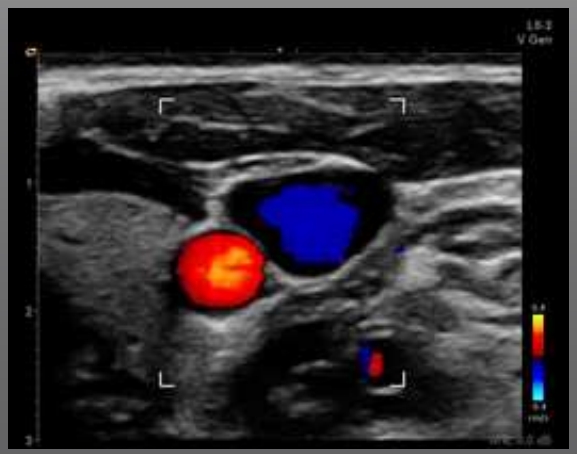
Bedside Ultrasound in Internal Medicine

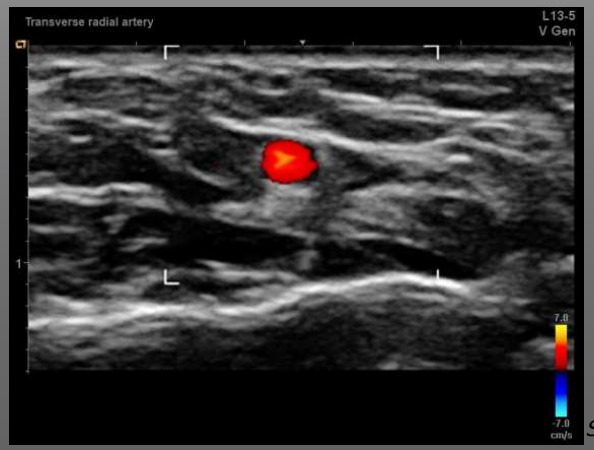
Siemens Acuson - POCUS

SIEMENS

Modern Healthcare,
Meet Modern Technology.

ACUSON Freestyle Ultrasound System





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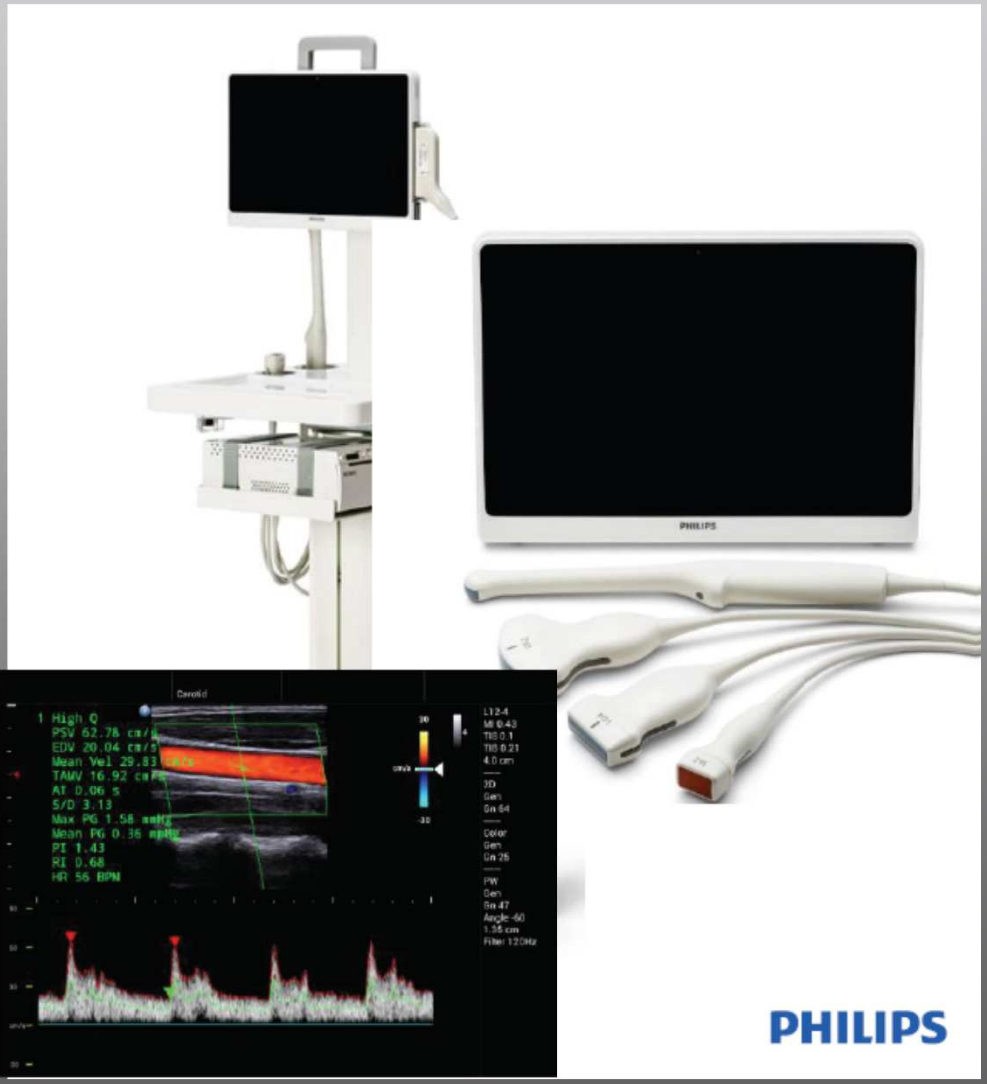
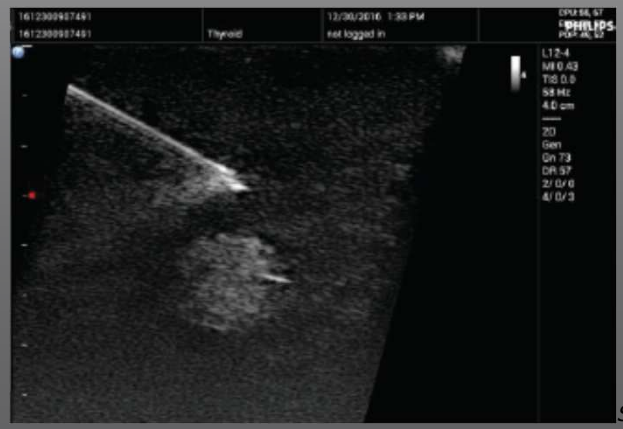
Bedside Ultrasound in Internal Medicine

Philips - POCUS



InnoSight



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Bedside Ultrasound in Internal Medicine

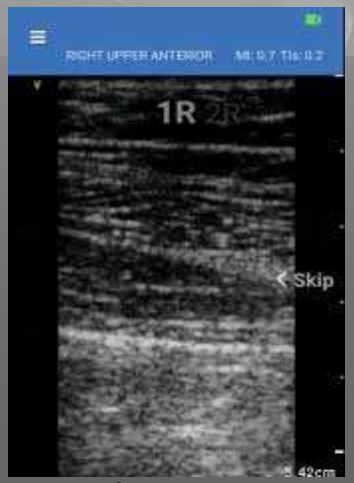
General Electric - Echoscopy

GE Healthcare

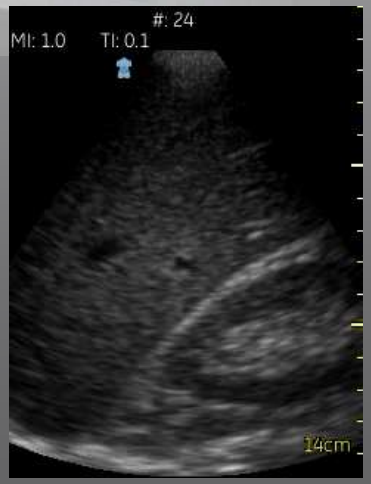
Vscan Extend™

Vscan

Thyroid



Lung



Liver

Heart

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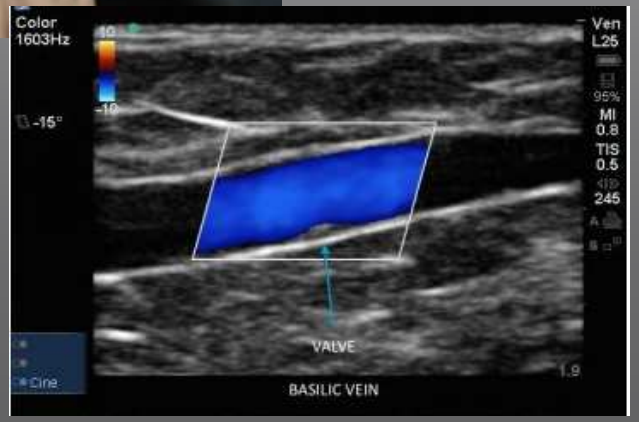
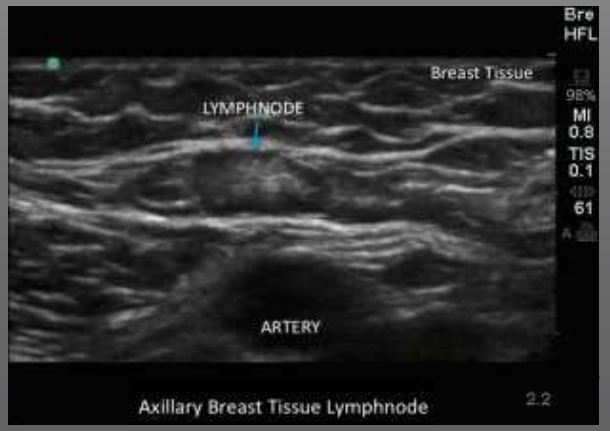
Bedside Ultrasound in Internal Medicine

SonoSite FujiFilm Echoscopy

- Ergonomic one-handed operation allows for easy manipulation of image settings, especially useful in crowded environments or inside vehicles when space is a premium
- Small in size does not mean compromise on image. The iViz combines DirectClear Technology, advanced image processing (SonoHD3) and a high-resolution display
- The SonoSite iViz is manufactured using aircraft aluminum with beveled edges protecting the display and device from ingress. All systems and transducers are drop-tested to 1m (3 feet).
- Transducers are IPX-7 rated meaning they are fully submergible in water.





Bedside Ultrasound in Internal Medicine

Philips - Echoscopy

- The *Lumify* app and all three transducers (L12-4, C5-2, and S4-1) completed rigorous environmental and durability testing to ensure reliability for emergency, critical care, and ambulance use.
- The S4-1 transducer and cable weighs 152 grams and is smaller than a smartphone, adding to its versatility and mobility.
- Beyond integrating with everyday technology, such as off-the-shelf, compatible smart devices, Lumify also uses cloud-enabled technology to connect with PACS, shared networks and IT health systems.

Interson SeeMore™

USB probes: 7.5 MHz Linear and 3.5 MHz Sector

SR 7.5-24.0 MHz

GP 3.5 – 5.0MHz

- Plugs into the *USB 2.0 port* of any MS Windows laptop or tablet, with "*instant-on*" function
- Fully Digital B mode, 256 shades of gray scale. Real time, 15 frames per second. No Doppler

- SeeMore software is installed on the computer and the probe(s) are connected. After the USB drivers are automatically installed, the SeeMore application may be opened to control the probe and display real-time images.
- Auto Scan mode. Save, send, and print images. Built in measurements, calculations, and patient reports.
- Windows 7 or Windows 8 OS
- Minimum processor – 2.5 GHz (or 1.6 GHz if Intel - i5)
- Minimum RAM – 4 GB
- USB 2.0 port
- Minimum Display - 1366 X 768 resolution, 32 bit color, IPS

Panasonic Thoughbook

Hand held PC-CF-H2 Health

- Windows® 8 or 7 pro Intel® Core™ i5 3437U vPro™ Processor
- 4GB DDR3L SDRAM (max. 8GB), 500GB HDD (SATA) or 128GB SSD, Intel® HD Graphics 4000, USB 3.0, LAN and Serial Port , WLAN Advanced-N 6235 802.11 a/b/g/n, 3G Mobile Broadband (HSPA+)
- 10.1" sunlight-viewable TFT plus LCD, 1024 x 768 res, with Dual Touch (up to 6.000cd/m² reflective brightness)
- Vibration and shock resistant (90 cm drop), Water , alcohol wipe and dust resistant
- Lightweight 1.58kg, 274mm × 268mm × 58mm
- Dual hot swappable batteries (up to 7 hrs life)
- Integrated Barcode Reader , Contact Smartcard Reader, 3MP Camera, GPS, Fingerprint Reader

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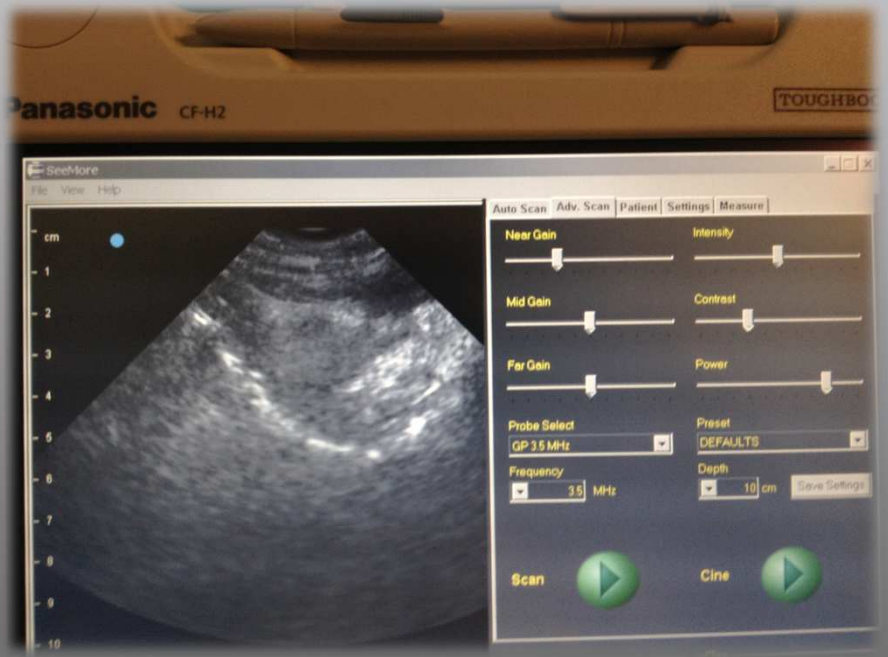
USB-probe/Handheld PC US System

Interson GP 3.5 MHz &Panasonic Thoughbook CF-H2

The system setup



The SeeMore™ software imaging

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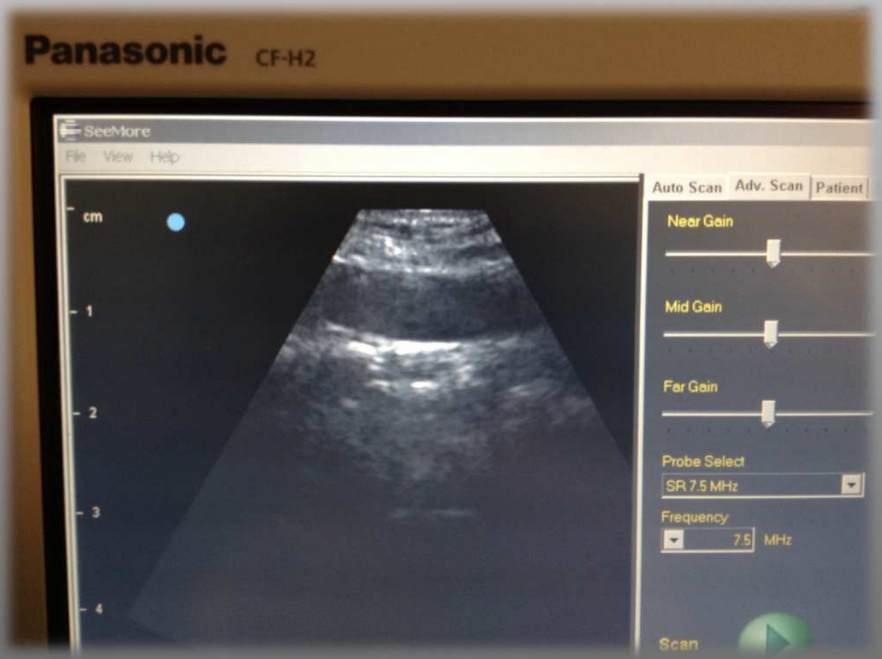
USB-probe/Handheld PC US System

Interson SR 7.5 MHz &Panasonic Thoughbook CF-H2

The system setup



The SeeMore™ software imaging

USB-probe/Handheld PC US System

Cost-Effectiveness of USB-probe Echoscopy for allocation at admission in Internal Medicine

- **Background**
  - Internal Medicine Departments in Italy are now undergoing a huge process of reorganization according with different levels of care (high, medium, low)
- **Purpose**
  - To verify the cost-effectiveness of USB-probe-tablet echoscopy with respect to standard handheld ultrasound machines (HUS) for patient allocation in areas with different level of care
- **Material & Methods I**
  - In April 2013 we started a sixth months prospective survey to assess the impact of bedside ultrasound performed by internists on the appropriateness of allocation and outcome of patients admitted to Internal Medicine A (1400 admissions/year).

Pretolani S, Aluigi L. Euroson, Stuttgart 9-12 october 2013

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USB-probe/Handheld PC US System

Cost-Effectiveness of USB-probe Echoscopy for allocation at admission in Internal Medicine

- **Material and Methods II**
  - As in this setting USB-probe-tablet devices have not tested yet, we perform a second study along with the former, to determine the *diagnostic power* and *cost-effectiveness* of this device with respect to standard HUS used in the survey.
  - any patient admitted from ED to Medicine A underwent an *echoscopy with USB-probe-tablet* (SeeMore USB 3.5 and 7.5MHz probes connected with a Panasonic CF-H2 Thoughbook).
  - A *5 minutes* thorax, abdomen and calf echoscopy was performed to identify specific items to allocate patients to the high level of care area, such as: a) B-lines at thorax scanning for pulmonary edema; b) gallbladder hydrops or kidney hydronephrosis for acute abdome; c) venous thrombosis (CUS). Immediately after the same internist performed a standard HUS to confirm the previous diagnosis.

USB-probe/Handheld PC US System

Cost-Effectiveness of USB-probe Echoscopy for allocation at admission in Internal Medicine

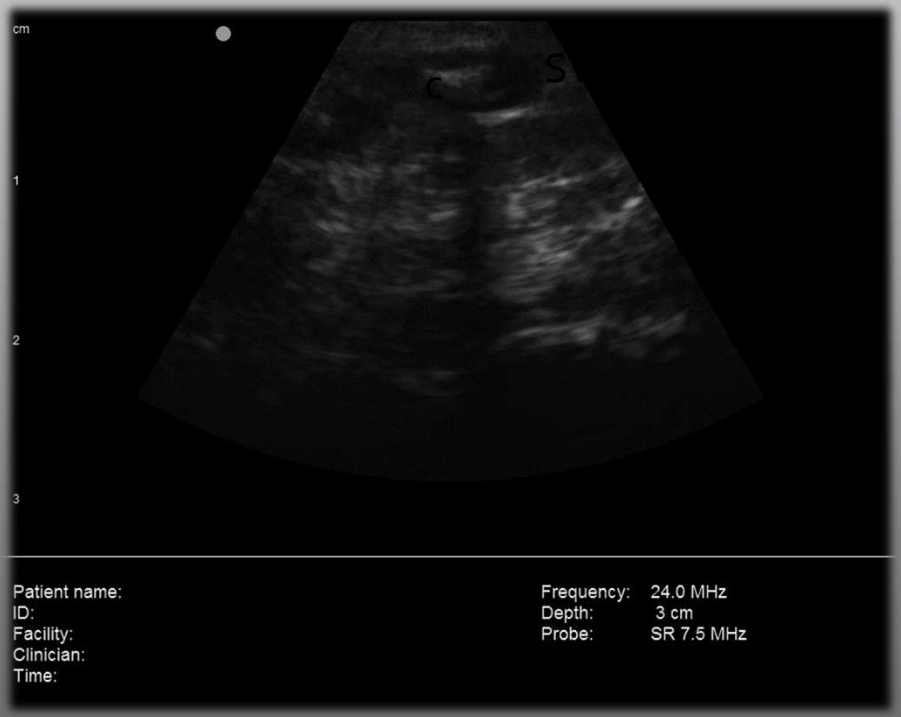
- **Material and Methods III**
  - Contingency tables and chi square test were used for statistical analysis.
- **Results**
  - from April 5th to 26th we examined *86 consecutive patients* (48 F, 38 M, 45-94 yrs). The final diagnoses with the two different US systems (Echoscopy vs HUS) were:
  - Pulmonary edema: 16 vs 19/86 (p=ns)
  - Gallbladder hydrops: 9 vs 12/86 p=ns)
  - Pleural effusion: 15 vs 15/86 (p=ns)
  - Hydronephrosis: 12 vs 14/86 (p=ns)
  - Deep venous thrombosis: 4 vs 6/86 (p=ns)

Pretolani S, Aluigi L. Euroson, Stuttgart 9-12 october 2013

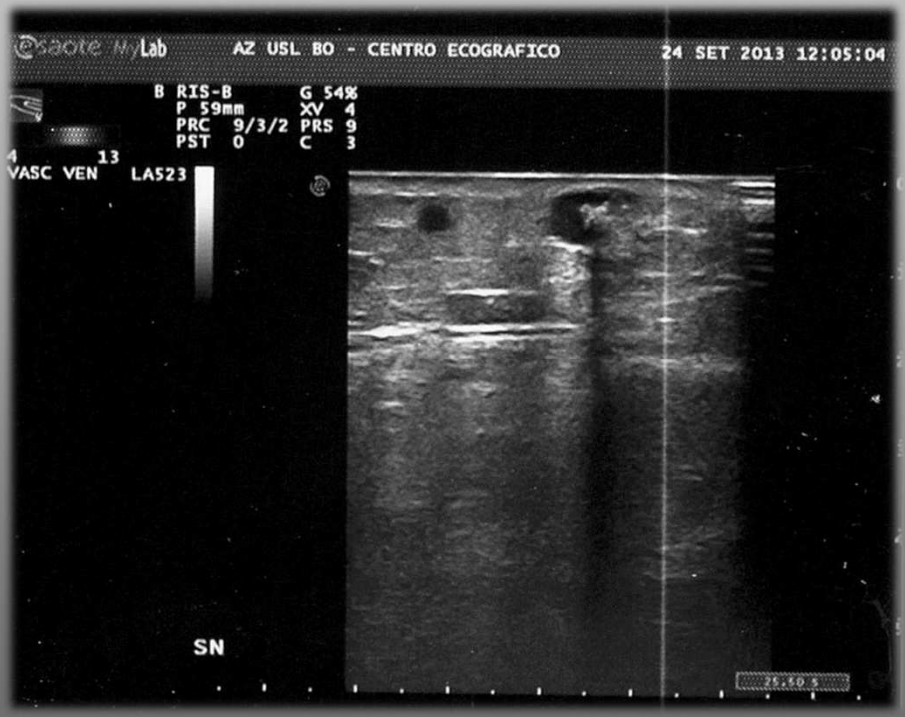
USB-probe Echoscopy vs. Handheld POCUS

Head to head comparison

Echoscopy



POCUS



Superficial venous thrombosis (SVT) with calcification (c)

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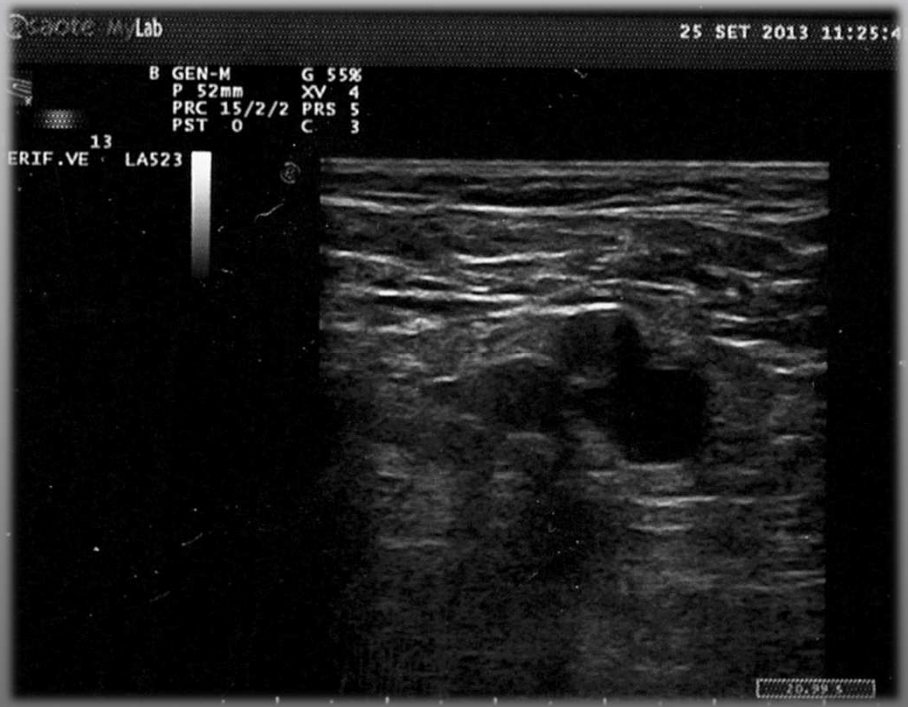
USB-probe Echoscopy vs. Handheld POCUS

Head to head comparison

Echoscopy

POCUS



"*Mickey Mouse sign*": the great saphenous vein (GSV) and the accessory saphenous vein (ASV) join the common femoral vein (CFV)

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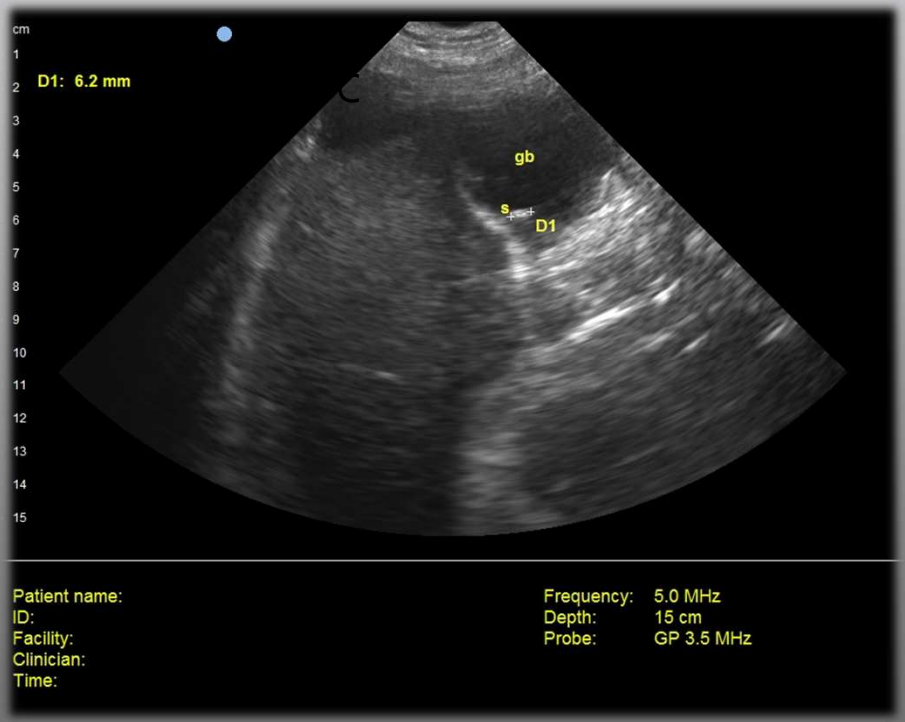
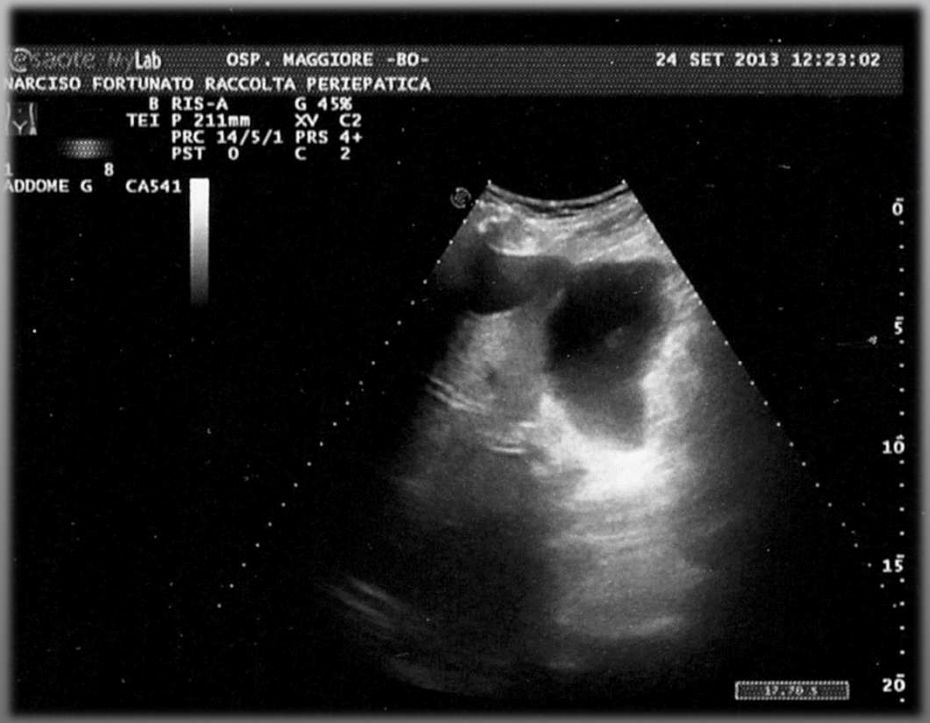
USB-probe Echoscopy vs. Handheld POCUS

Head to head comparison

Echoscopy



POCUS



Subdiaphragmatic septic fluid collection (FC) and gallbladder cholecystitis with stone (D1)

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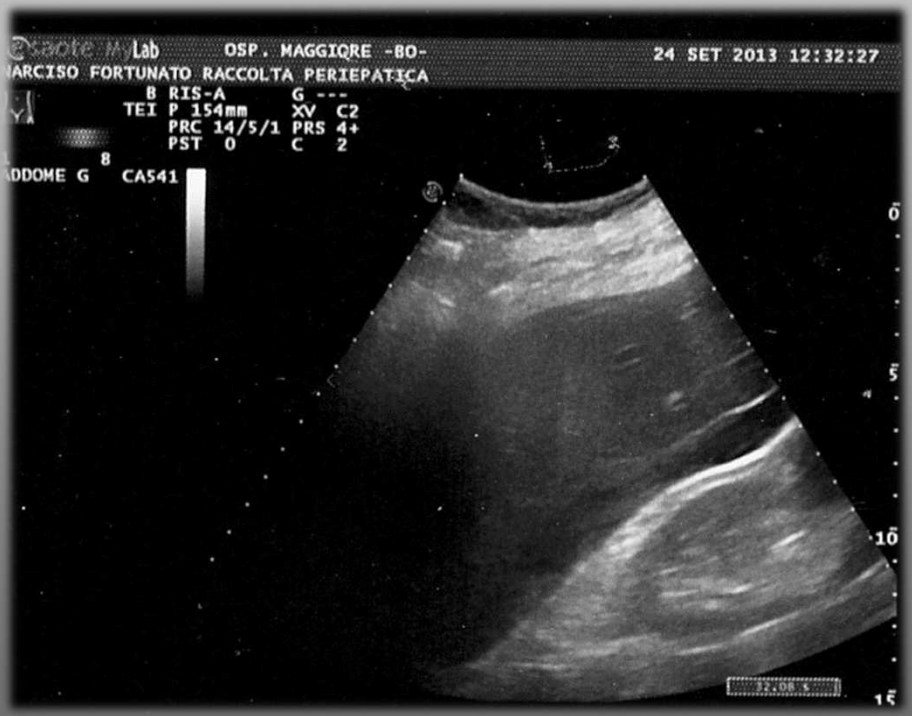
USB-probe Echoscopy vs. Handheld POCUS

Head to head comparison

Echoscopy

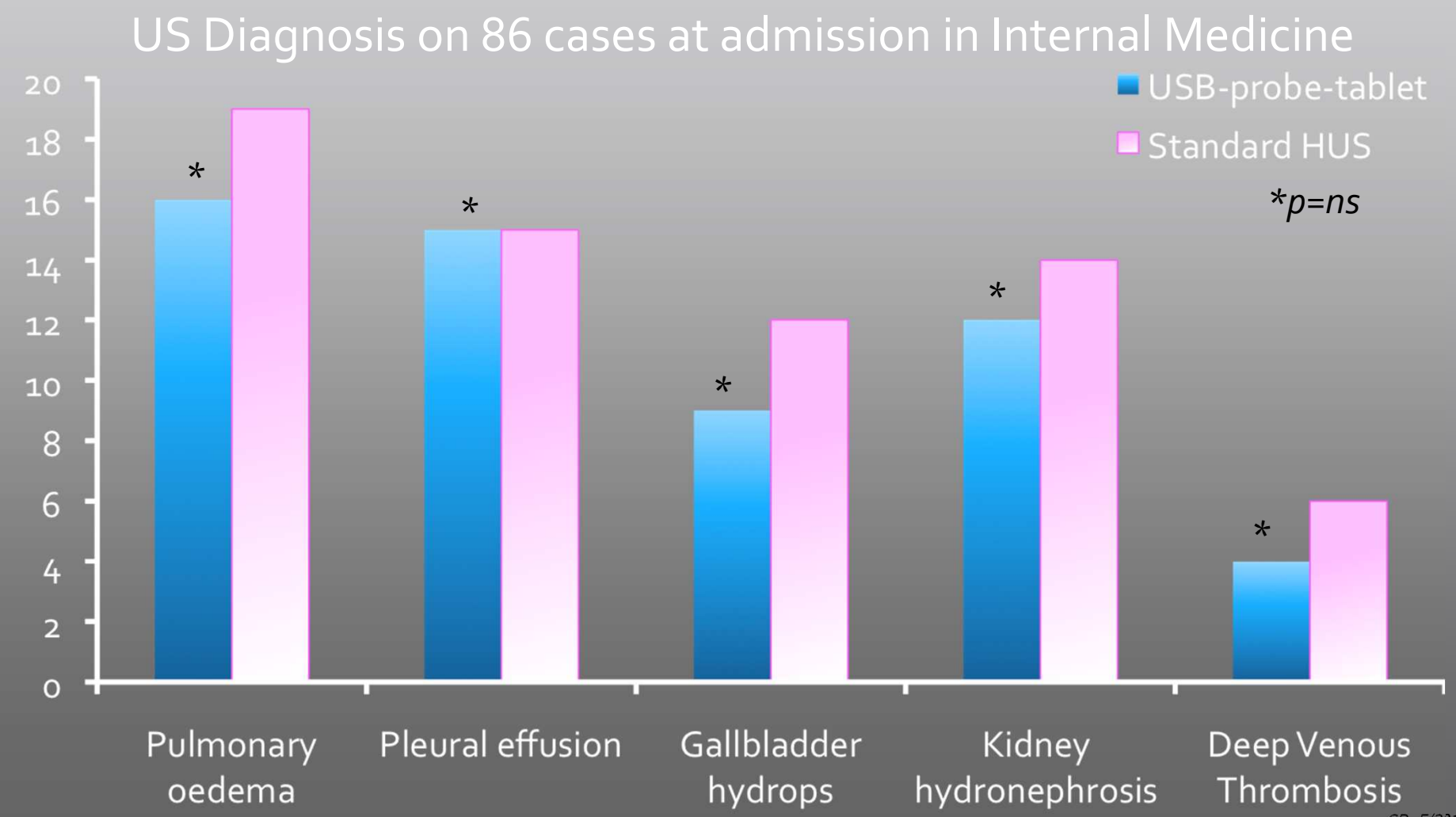
POCUS



Right liver lobe (D1): hypoechoic intrahepatic fluid collection (AB)

Bedside Ultrasound in Internal Medicine

USB-probe Tablet Echoscopy vs Standard Handheld-US



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S. Pretolani, L. Aluigi, IUA, Rome 2013

USB-probe Ultrasound

Pros and Cons

PROS

- Very light and small US probe/tablet system **(200+5-600 g)**
  - *Patientside vs. bedside*
- Fast and simple use
  - *Instant on (10-15sec), U-button record video, cloud ready, PDF mail reports*
- Low price
  - *1/3 to ¼ vs. POCUS systems* ***(3,500 -5,000 USD)***

CONS

- No Doppler *(but…coming)*
- *Lower resolution* vs. POCUS systems *(but..coming)*

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Bedside Ultrasound in Internal Medicine

Future New Applications in the Core of Specialty

One-day Educational Courses of Clinical *POCUS* Ultrasound

- **Metabolic syndrome**
  - *Kohn N, et al. Bedside Ultrasound in the diagnosis of non alcoholic fatty liver disease. W J Gastroenterol 2014*
- **Deep Vein Thrombosis**
  - *Pedraza-Garcia, et al. Comparison og the accuracy of Emergency Department POCUS in the diagnosis of lower extremities DVT. J Emerg Med 2018*
- **Nutritional assessment in Critical illness and dementia**
  - *Mourtzakis M, et al. Bedside Ultrasound Measuremets of skeletal muscle. Curr Opin Clin Nutr Metab Care 2014*

- ***E per sapere come fare l'ecografia clinica?***
- ***www.ecpgrafiabologna.org !***

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