Prehospital POCUS

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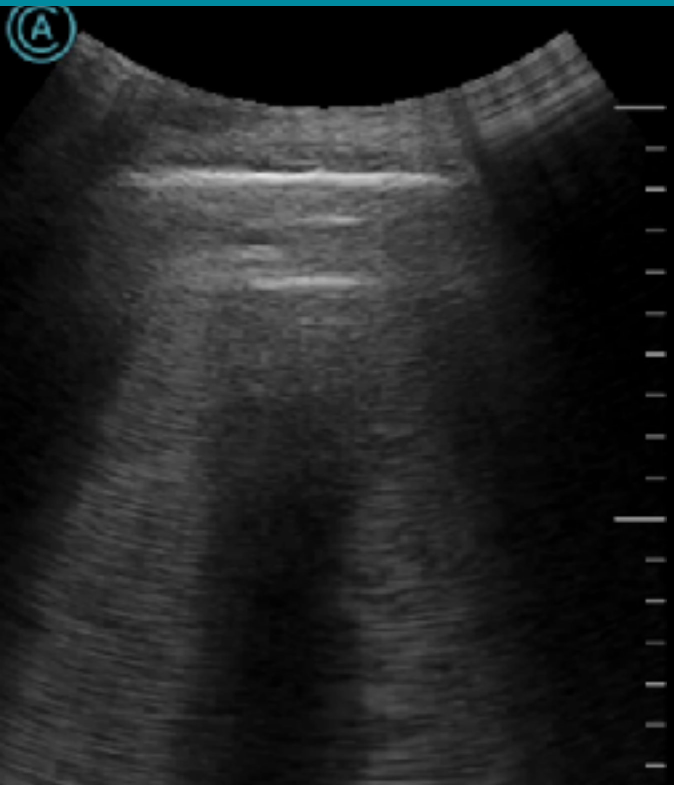
POCUSacademy.com

居家POCUS應用

胸腔



泌尿

IVC

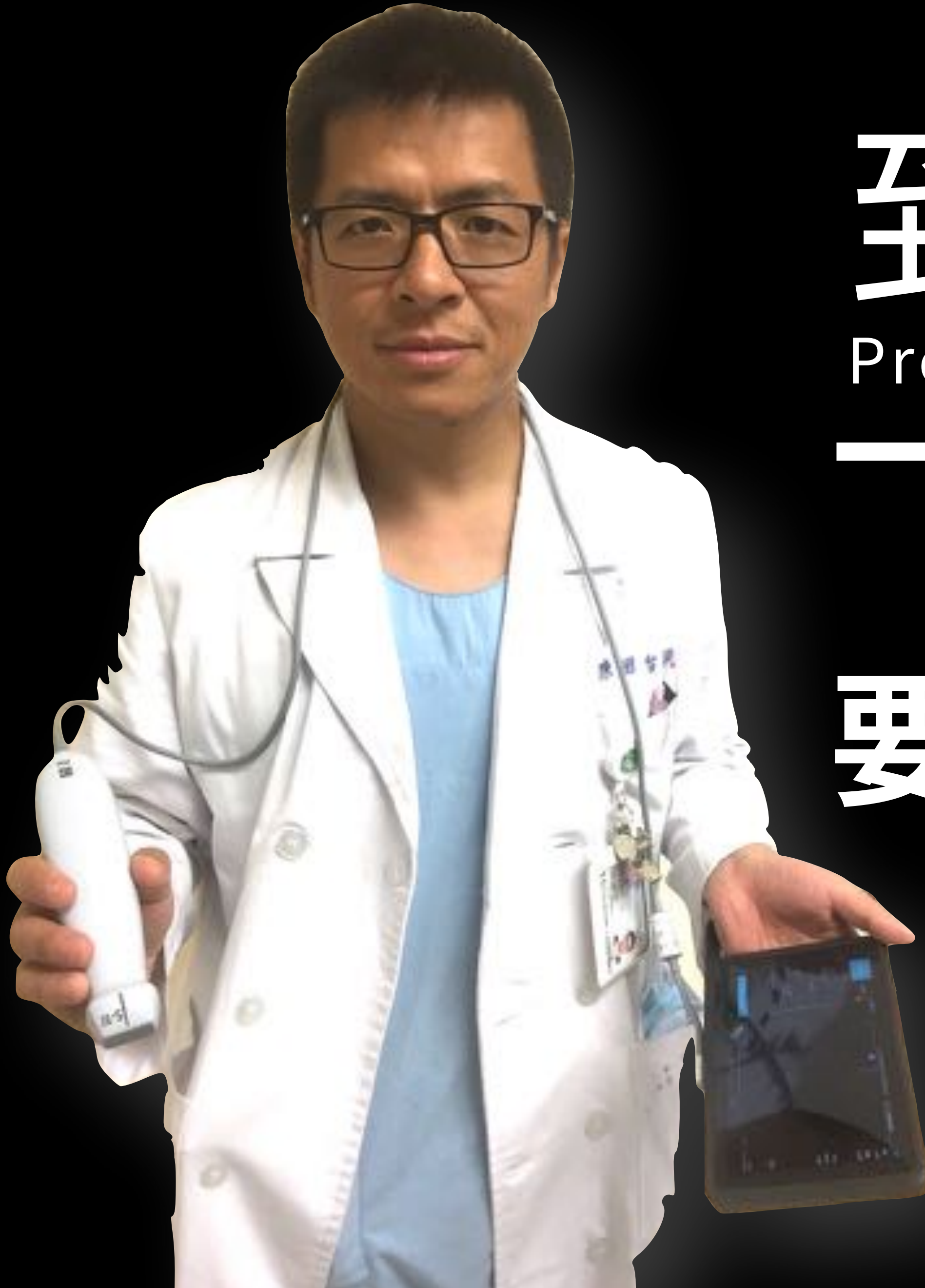
台灣在宅醫療學會

Taiwan Society of Home Health Care


SBS

Prehospital POCUS

Prehospital POCUS -Taipei City 2020



到 院前超音波

Prehospital ultrasound

要做什麼？

Taipei City EMT-P
20200929

I-AIM掃描目標

Indication (point)適應症

Acquire
擷取影像

Interpret
判讀影像

Make decision
決定治療方向

Bahner DP, et al. J Ultrasound Med 2012

Shock摸不到脈搏

PEA心臟有在跳嗎?

Acquire
心臟介面

Interpret
搏動有無

Make decision
急救流程

Bahner DP, et al. J Ultrasound Med 2012

到 院前超音波

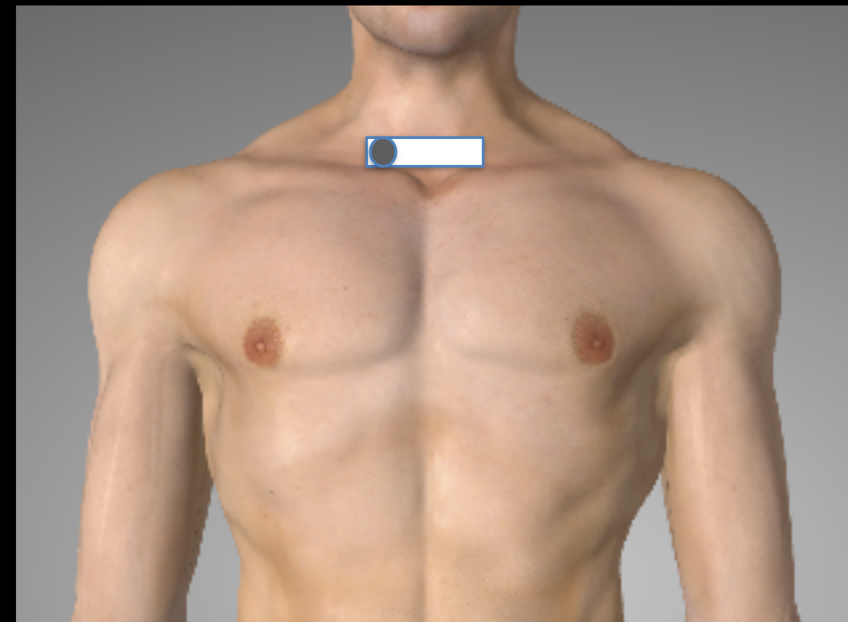
Prehospital ultrasound

氣(A) **Airway / 插管一根管**

胸(B) **Breathing/滑動與氣胸**

心(C) **Circulation/心搏與積液**

血(D) **Diaphragm/肋膜與血胸**



到 院前超音波

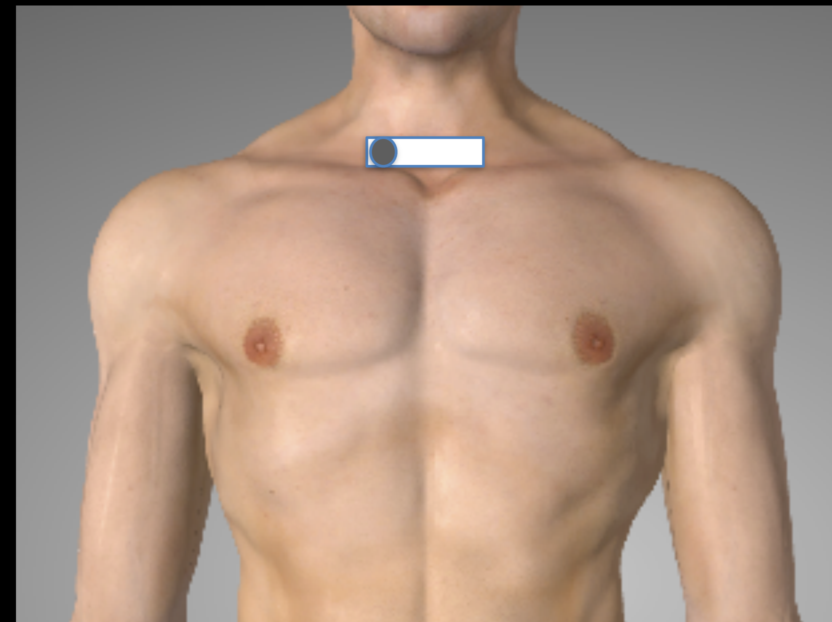
Prehospital ultrasound

氣(A) Airway / 插管一根管

胸(B) Breathing/滑動與氣胸

心(C) Circulation/心搏與積液

血(D) Diaphragm/肋膜與血胸



到 院前超音波

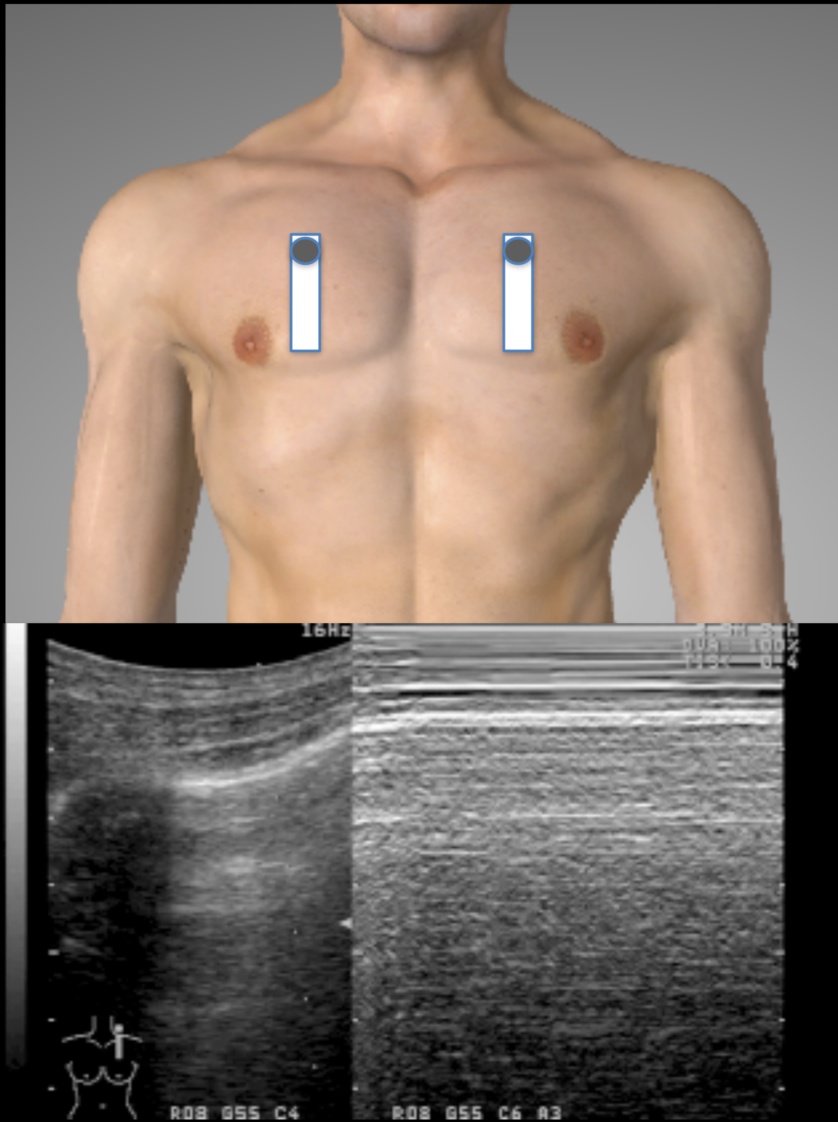
Prehospital ultrasound

氣(A) Airway / 插管一根管

胸(B) Breathing/滑動與氣胸

心(C) Circulation/心搏與積液

血(D) Diaphragm/肋膜與血胸



到 院前超音波

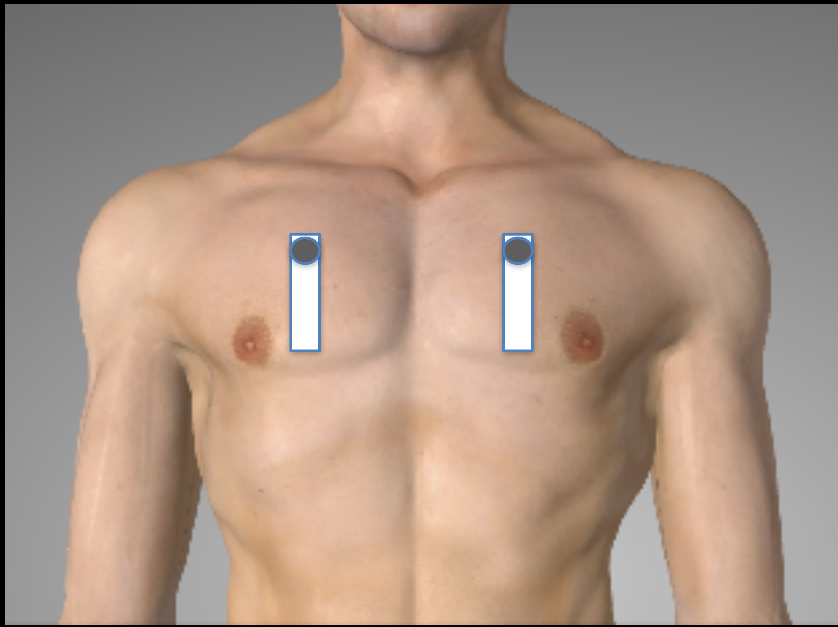
Prehospital ultrasound

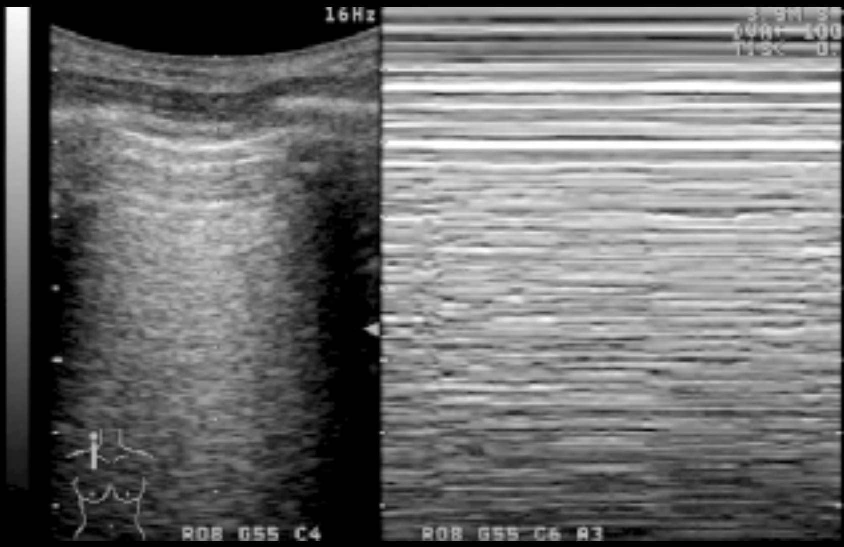
氣(A) Airway / 插管一根管

胸(B) Breathing/滑動與氣胸

心(C) Circulation/心搏與積液

血(D) Diaphragm/肋膜與血胸





到 院前超音波

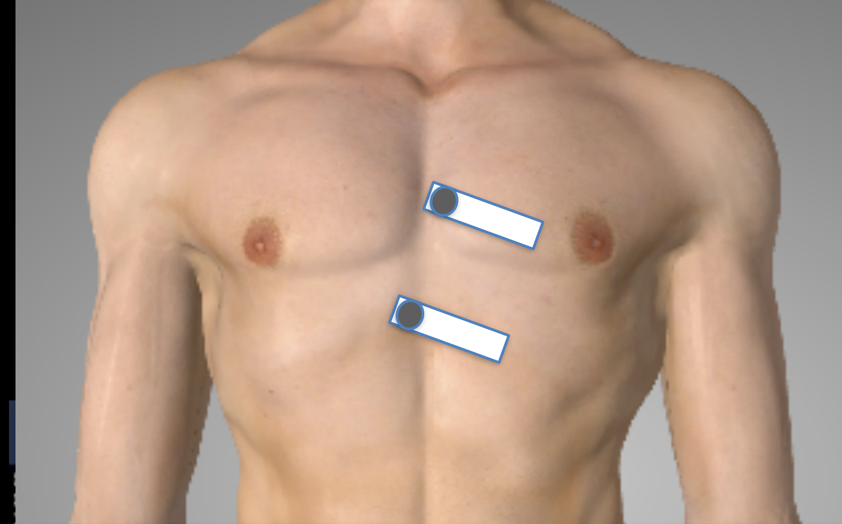
Prehospital ultrasound

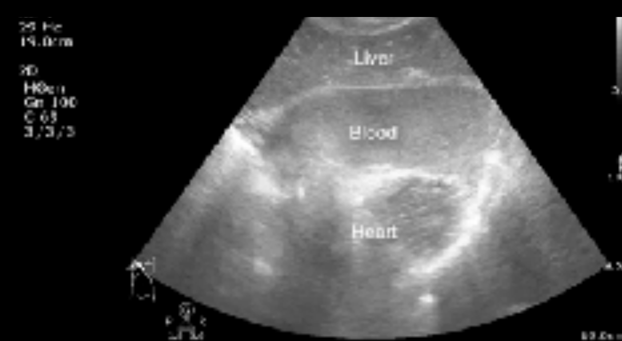
氣(A) Airway / 插管一根管

胸(B) Breathing/滑動與氣胸

心(C) Circulation/心搏與積液

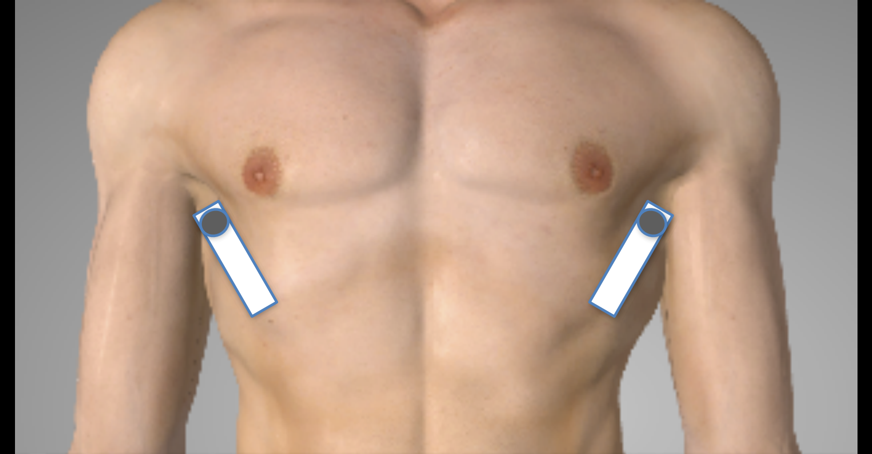
血(D) Diaphragm/肋膜與血胸





到 院前超音波

Prehospital ultrasound



氣(A) Airway / 插管一根管

胸(B) Breathing/滑動與氣胸

心(C) Circulation/心搏與積液

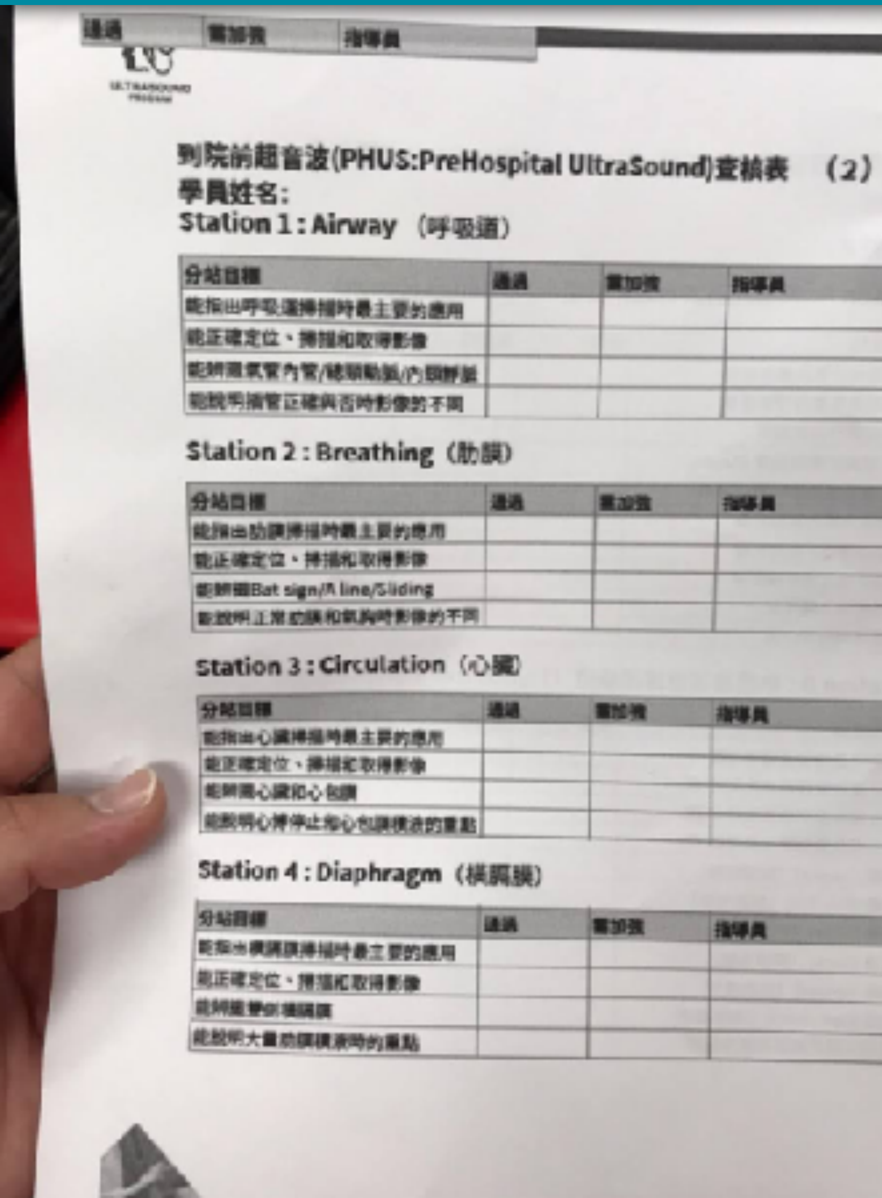
血(D) Diaphragm/肋膜與血胸

Prehospital POCUS -Taipei City 2020




Tele-ultrasound

Taipei City - EMTP



通過	需加強	指導員

到院前超音波(PHUS:PreHospital UltraSound)查核表 （2）

學員姓名:

Station 1 : Airway （呼吸道）

分站目標	通過	需加強	指導員
能指出呼吸道掃描時最主要的應用			
能正確定位、掃描和取得影像			
能辨識氣管內管/總頸動脈/內頸靜脈			
能說明插管正確與否時影像的不同			

Station 2 : Breathing （肋膜）

分站目標	通過	需加強	指導員
能指出肋膜掃描時最主要的應用			
能正確定位、掃描和取得影像			
能辨識Bat sign/A line/Sliding			
能說明正常肋膜和氣胸時影像的不同			

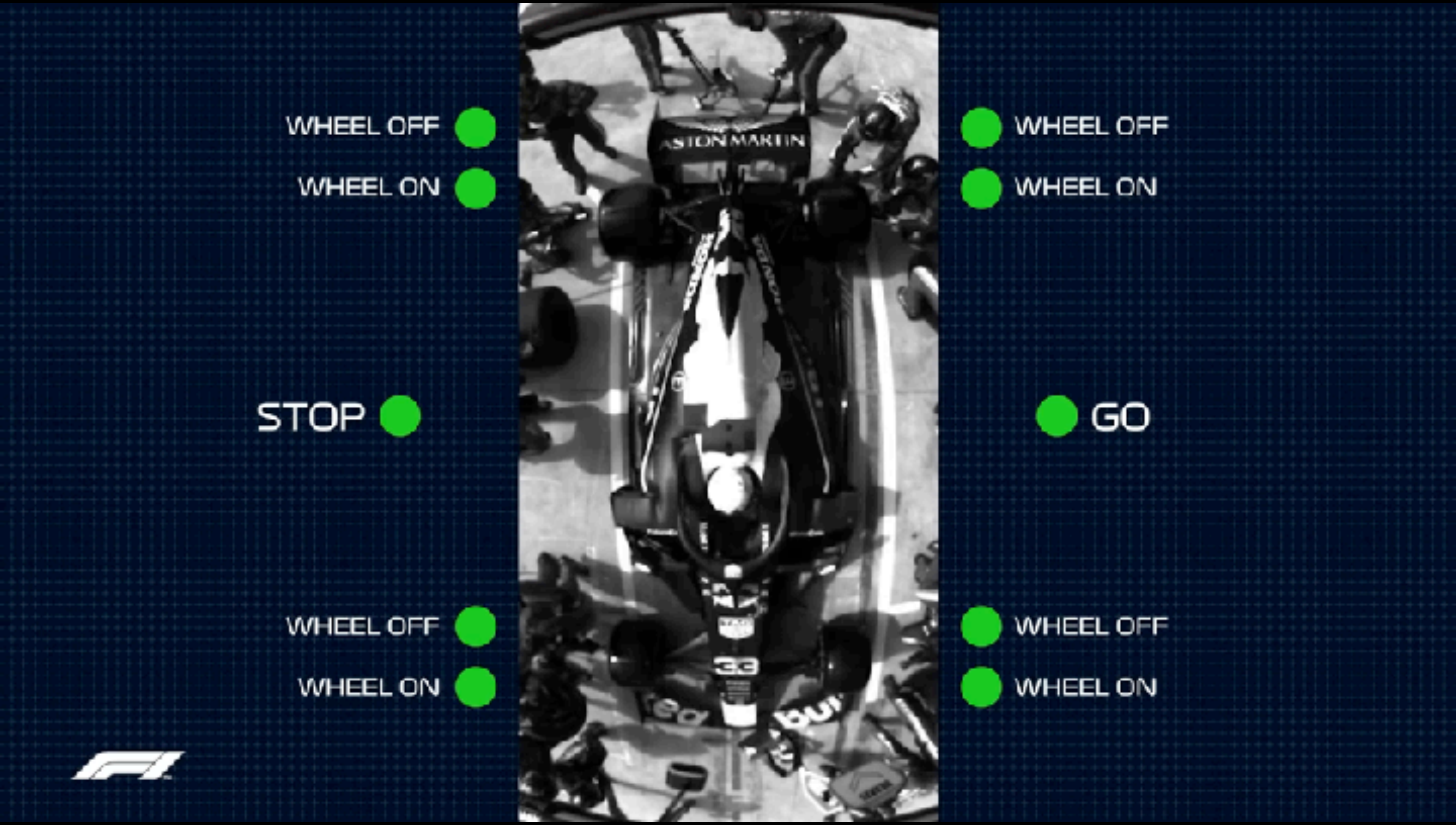
Station 3 : Circulation （心臟）

分站目標	通過	需加強	指導員
能指出心臟掃描時最主要的應用			
能正確定位、掃描和取得影像			
能辨識心臟和心包膜			
能說明心搏停止和心包膜積液的重點			

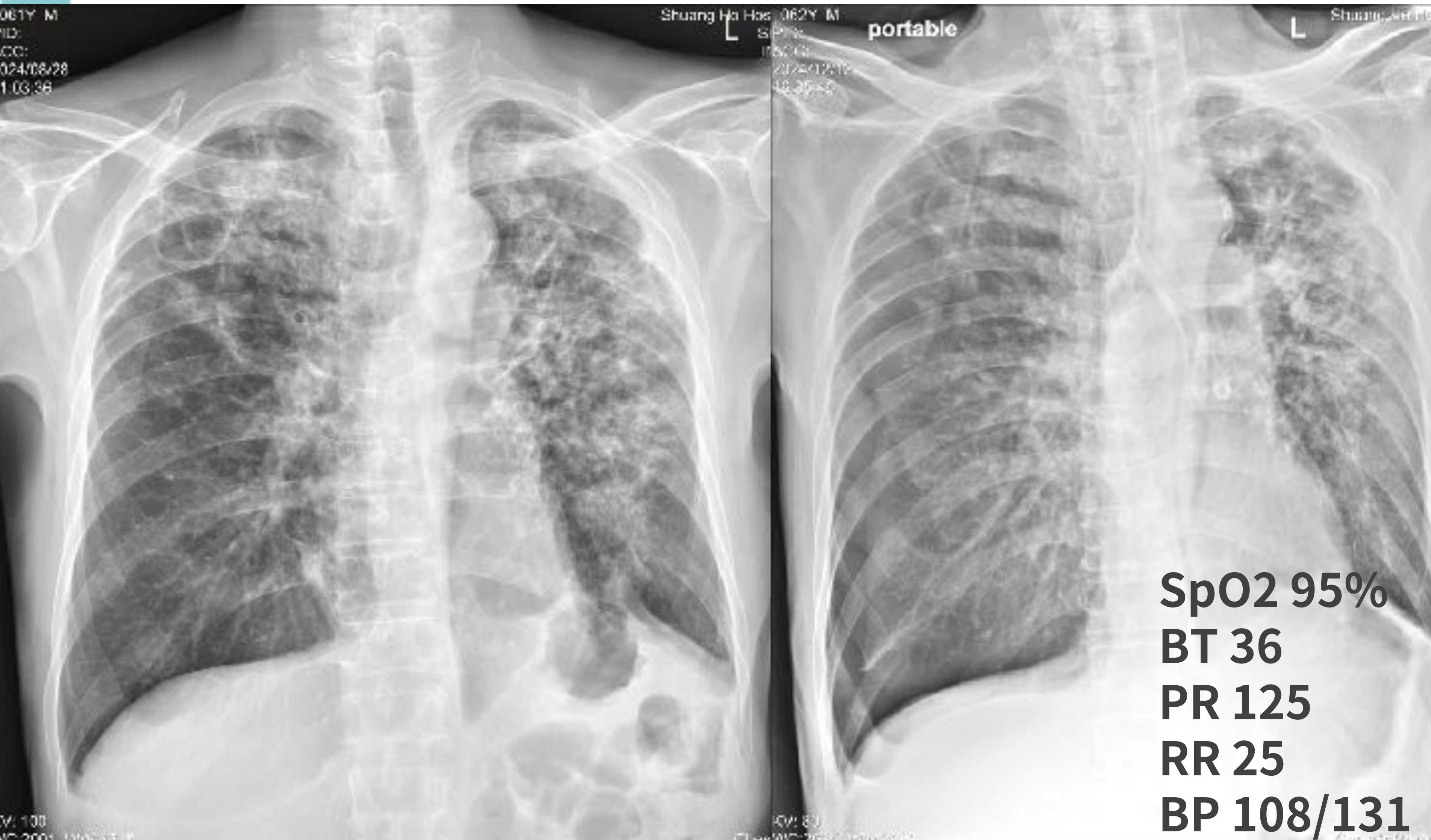
Station 4 : Diaphragm （橫膈膜）

分站目標	通過	需加強	指導員
能指出橫膈膜掃描時最主要的應用			
能正確定位、掃描和取得影像			
能辨識雙側橫膈膜			
能說明大量肋膜積液時的重點			

Quality assurance

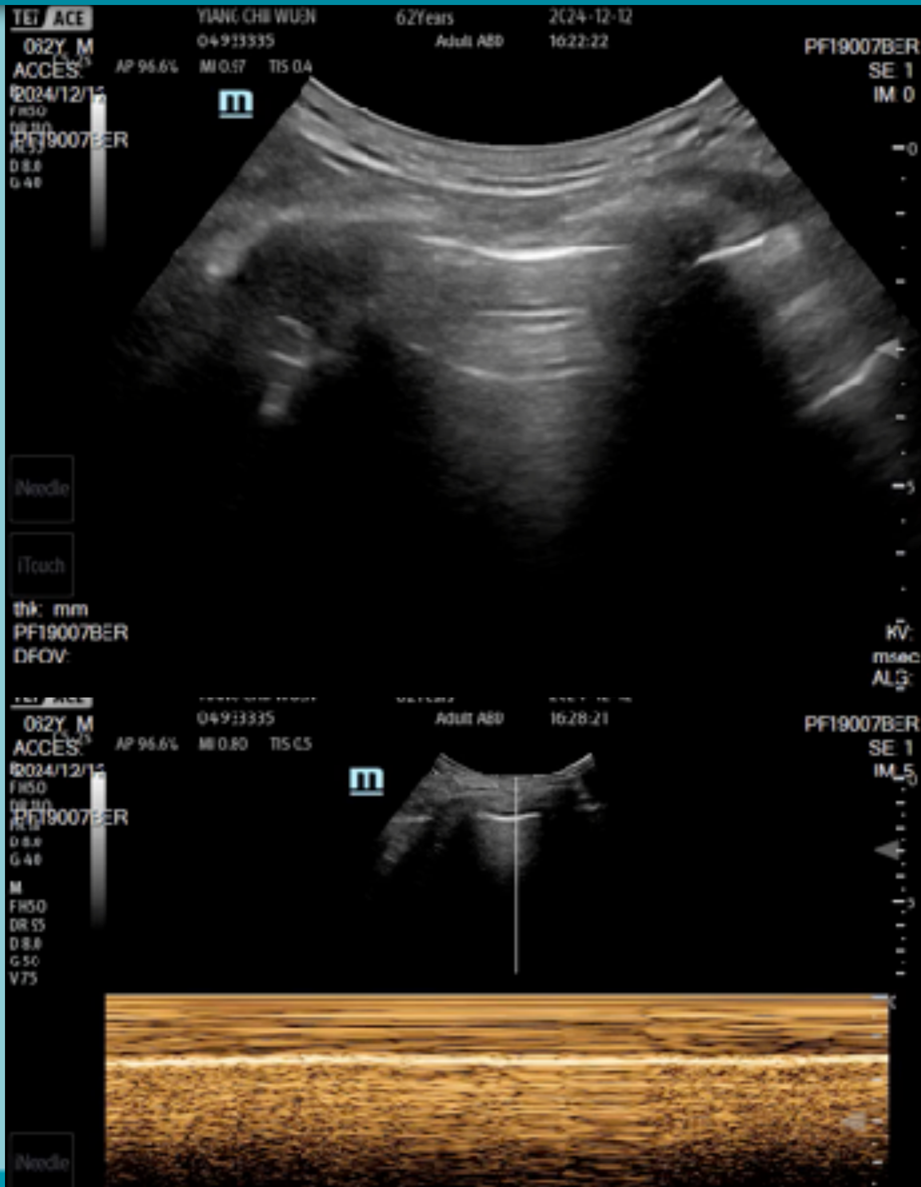

WHEEL OFF
WHEEL ON
WHEEL OFF
WHEEL ON
STOP
GO
WHEEL OFF
WHEEL ON
WHEEL OFF
WHEEL ON
ASTON MARTIN
33

62M, Pul TB under treatment, SOB for 30 mins
16:16



SpO2 95%
BT 36
PR 125
RR 25
BP 108/131

AMS / SpO2 78% after portable



Tension pneumothorax s/p pigtail drainage

Ketelaars et al. Crit Ultrasound J (2018) 10:17
https://doi.org/10.1186/s13089-018-0099-y

Critical Ultrasound Journal

REVIEW Open Access

ABCDE of prehospital ultrasonography: a narrative review

Rein Ketelaars[1,2*], Gabby Reijnders[3], Geert-Jan van Geffen[1,2], Gert Jan Scheffer[1] and Nico Hoogerwerf[1,2]

Abstract

Prehospital point-of-care ultrasound used by nonradiologists in emergency medicine is gaining ground. It is feasible on-scene and during aeromedical transport and allows health-care professionals to detect or rule out potential harmful conditions. Consequently, it impacts decision-making in prioritizing care, selecting the best treatment, and the most suitable transport mode and destination. This increasing relevance of prehospital ultrasonography is due to advancements in ultrasound devices and related technology, and to a growing number of applications. This narrative review aims to present an overview of prehospital ultrasonography literature. The focus is on civilian emergency (trauma and non-trauma) setting. Current and potential future applications are discussed, structured according to the airway, breathing, circulation, disability, and environment/exposure (ABCDE) approach. Aside from diagnostic implementation and specific protocols, procedural guidance, therapeutic ultrasound, and challenges are reviewed.

Keywords: Prehospital, Ultrasonography, Diagnostic imaging, Emergency medical services, Air ambulances, Emergency medicine, Review

Table 1 BLUE protocol profiles. Lichtenstein [39]

P#	Profile name	Location	Appearance	Implication/diagnosis
1	A-profile	Anterior chest wall	Lung sliding—visualization of the movement of the visceral pleura against the parietal pleura with respiration A-lines—an indication of the presence of air below the parietal pleura[a]	Normal lung surface
2	B-profile		Lung sliding Lung rockets—a pattern of three vertical B-lines caused by edema in the interlobular septa[b]	Pulmonary edema
3	B'-profile		No lung sliding—in the B' profile lung sliding is abolished by the deposition of fibrin caused by pneumonia Lung rockets	Pneumonia
4	A/B-profile		Unilateral lung rockets—indicative for a (unilateral) pneumonia and does not correspond with generalized pulmonary edema	Pneumonia
5	C-profile	Anterior chest wall	Anterior lung consolidation—anteriorly located, therefore unlike to be caused by hemodynamic pulmonary edema or embolism	Pneumonia
6	A-profile without DVT[c]		Lung sliding A-lines[a] No DVT	Normal
	A-no-V-PLAPS profile	Posterolateral chest wall	Lung sliding A-lines[a] No DVT PLAPS[c]—posterolateral alveolar and/or pleural syndrome—pulmonary consolidation and pleural effusion	Pneumonia
7	A-profile with DVT[c]		Lung sliding A-lines[a] DVT	Pulmonary embolism
8	A'-profile	Anterior chest wall	No lung sliding—lung sliding abolished by separation of the visceral pleura from the parietal pleura A-lines—an indication of the presence of air below the parietal pleura[a]	Pneumothorax when the mandatory 'lung point'[d] is visualized
9	A-profile without DVT and no PLAPS (nude profile)		Lung sliding A-lines[a] No DVT	Asthma or COPD

Fluid administration limited by lung sonography

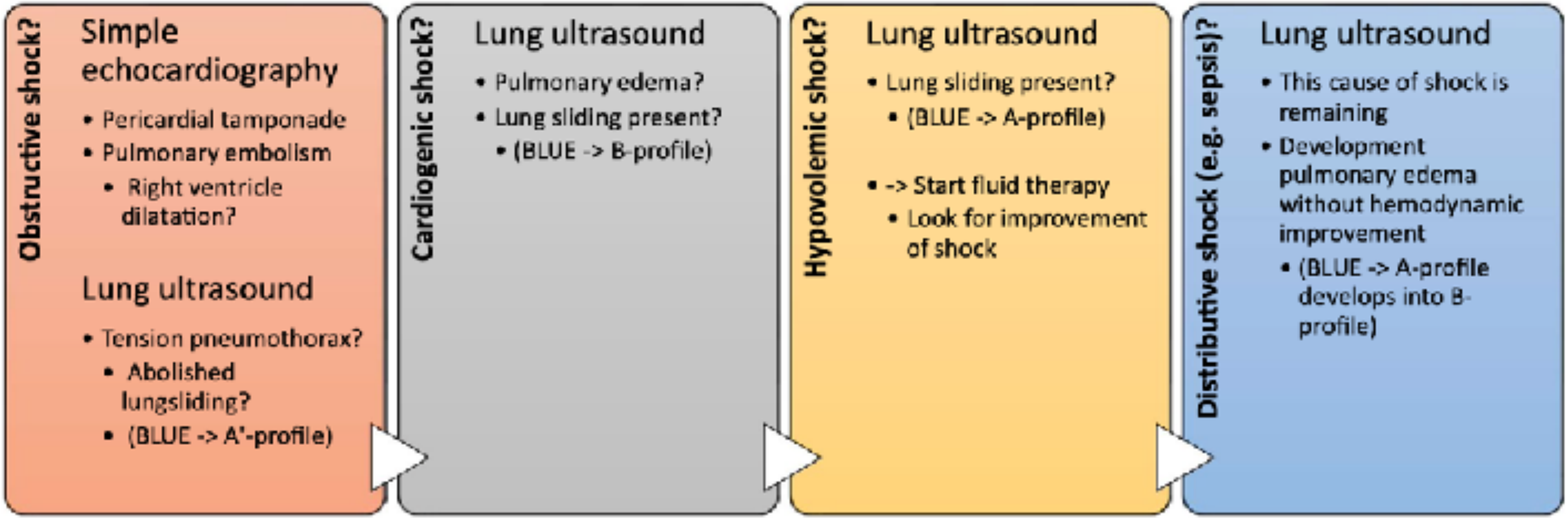


Fig. 6 FALLS protocol. This diagram is an adaptation of the work by Dr. Lichtenstein [39]. Firstly, this diagram shows the type of shock the focus is on. Secondly, the type of ultrasound examination is shown. Thirdly, possible diagnoses to consider are shown including their appearance in terms of the BLUE protocol. Every cause of shock is sequentially excluded for expediting the diagnosis of distributive (septic) shock. *FALLS* fluid administration limited by lung sonography, *BLUE* bedside lung ultrasound in emergency, BLUE and the A, B, and A′ profile are explained in Table 1, items 1, 2, and 8, respectively

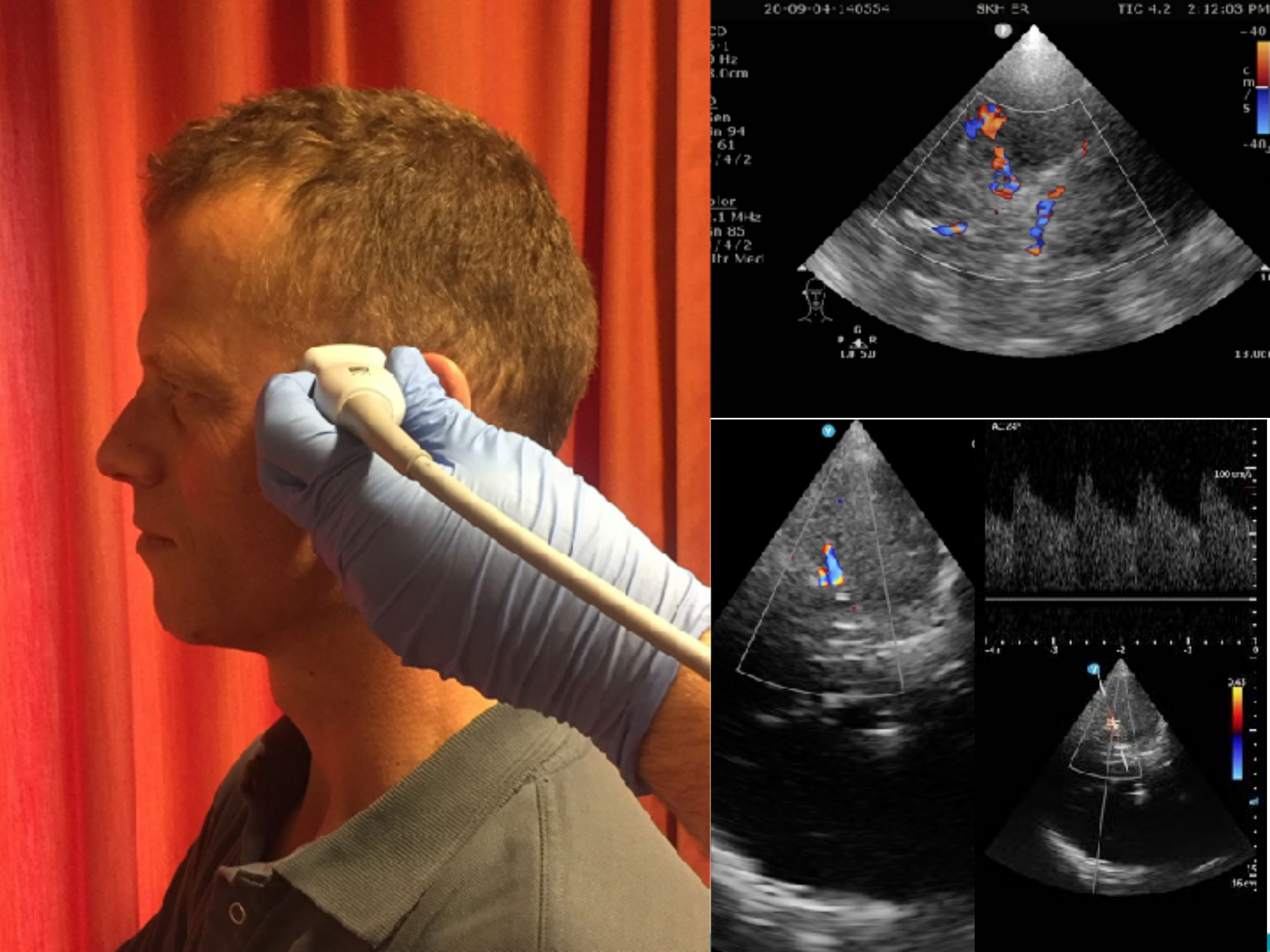
Disaster triage: CAVEAT protocol

Table 2 The CAVEAT protocol. Stawicki et al. [135]

Urgency	Step	Examination	Focus on	Looking for
CAVEAT protocol				
Primary assessment (mandatory)	1	Evaluation of the pleura	Chest	Pneumothorax
	2	Complete FAST examination	Abdomen Costophrenic recesses	Hemoperitoneum Hemothorax
	3	Inferior Vena Cava assessment	Collapsibility index	Volume depletion
Secondary assessment (optional)	4	Upper- and lower extremities	Long bones; regions of pain, tenderness, or deformity	Major fractures eligible for more accurate reduction and stabilization Fractures to prioritize utilization of radiographic resources, or achieve even more accurate triage

CAVEAT sonographic evaluation of the chest, abdomen, vena cava, extremities for acute triage, *FAST* focused assessment with sonography for trauma

This table shows the suggested order of examinations in the CAVEAT protocol. Specific components may depend on the operators' skill level and on the individual


20-09-04-140554
SKH ER
TIC 4.2
2:12:03 PM
100 cm/s
16cm


POCUS
All about A,B,C!
A
Airway/Tubes
CTM Location?
ET Tube Position?
NGT Placement?
B
Breathing
Sliding/PTx?
Interstitial Fluid?
Pneumonia?
Diaphragm
C
Circulation
LV Function?
LV/RV association?
Valves/Veg's?
IVC / Fluids?
D
Disability
ONSD?
Trans-cranial Doppler
Carotid Doppler
CRITICALCARE
NORTHAMPTON.COM
@WILKINSONJONNY
E
Everything Else
Ascites?
Kidneys?
AAA?!
Bladder?
DVT?

Bøtker et al. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine (2018) 26:51
https://doi.org/10.1186/s13049-018-0518-x

Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine

REVIEW Open Access

The role of point of care ultrasound in prehospital critical care: a systematic review

Morten Thingemann Bøtker[1,2*], Lars Jacobsen[3,4], Søren Steemann Rudolph[5,6] and Lars Knudsen[2]

Abstract

Background: In 2011, the role of Point of Care Ultrasound (POCUS) was defined as one of the top five research priorities in physician-provided prehospital critical care and future research topics were proposed; the feasibility of prehospital POCUS, changes in patient management induced by POCUS and education of providers. This systematic review aimed to assess these three topics by including studies examining all kinds of prehospital patients undergoing all kinds of prehospital POCUS examinations and studies examining any kind of POCUS education in prehospital critical care providers.

Methods and results: By a systematic literature search in MEDLINE, EMBASE, and Cochrane databases, we identified and screened titles and abstracts of 3264 studies published from 2012 to 2017. Of these, 65 studies were read in full-text for assessment of eligibility and 27 studies were ultimately included and assessed for quality by SIGN-50 checklists. No studies compared patient outcome with and without prehospital POCUS. Four studies of acceptable quality demonstrated feasibility and changes in patient management in trauma. Two studies of acceptable quality demonstrated feasibility and changes in patient management in breathing difficulties. Four studies of acceptable quality demonstrated feasibility, outcome prediction and changes in patient management in cardiac arrest, but also that POCUS may prolong pauses in compressions. Two studies of acceptable quality demonstrated that short (few hours) teaching sessions are sufficient for obtaining simple interpretation skills, but not image acquisition skills. Three studies of acceptable quality demonstrated that longer one- or two-day courses including hands-on training are sufficient for learning simple, but not advanced, image acquisition skills. Three studies of acceptable quality demonstrated that systematic educational programs including supervised examinations are sufficient for learning advanced image acquisition skills in healthy volunteers, but that more than 50 clinical examinations are required for expertise in a clinical setting.

Conclusion: Prehospital POCUS is feasible and changes patient management in trauma, breathing difficulties and cardiac arrest, but it is unknown if this improves outcome. Expertise in POCUS requires extensive training by a combination of theory, hands-on training and a substantial amount of clinical examinations – a large part of these needs to be supervised.

Keywords: Prehospital, Ultrasound, Critical care, Trauma, Cardiac arrest, Dyspnea, Point of care, Education, Systematic review

Trauma

Difficult breathing

Cardiac arrest

Review Paper

SAGE Open Medicine

SAGE Open Medicine
Volume 8: 1–6

DOI: 10.1177/2050312120932706
journals.sagepub.com/home/smo
SAGE

Prehospital point-of-care ultrasound: A transformative technology

Colton B Amaral, Daniel C Ralston and Torben K Becker

Abstract

Point-of-care ultrasound at the bedside has evolved into an essential component of emergency patient care. Current evidence supports its use across a wide spectrum of medical and traumatic diseases in a variety of settings. The prehospital use of ultrasound has evolved from a niche technology to impending widespread adoption across emergency medical services systems internationally. Recent technological advances and a growing evidence base support this trend. However, concerns regarding feasibility, education, and quality assurance must be addressed proactively. This topical review describes the history of prehospital ultrasound, initial training needs, ongoing skill maintenance, quality assurance and improvement requirements, available devices, and indications for prehospital ultrasound.

SAGE Open Med. 2020 doi: 10.1177/2050312120932706

Table 1. Ultrasound applications commonly used in prehospital emergency care.

Exam type	Indications	Examples of clinical use
Extended Focused Assessment with Sonography for Trauma (eFAST)	Multi-system trauma	Evaluation for free intraperitoneal fluid or pneumothorax after blunt trauma with advanced notification of the receiving trauma center
Transthoracic echocardiography	Respiratory distress, chest pain, and cardiac arrest	Termination of resuscitation in a patient with cardiac arrest and no cardiac motion identified after 20 mins of resuscitative efforts
Lung ultrasound / Bilateral Lung Ultrasound in Emergency (BLUE) protocol[4]	Respiratory distress	Differentiation between pulmonary edema, suspected pulmonary infection, or pneumothorax in a patient with undifferentiated shortness of breath and a history of congestive heart failure and chronic obstructive pulmonary disease
Rapid Ultrasound in SHock (RUSH) protocol: evaluation of pericardium, left ventricular function, right ventricular size, inferior vena cava, lung ultrasound, evaluation of pleural and abdominal cavity, abdominal aorta ultrasound, proximal deep veins of the lower extremities[2]	Non-traumatic shock	Ruling in pulmonary embolism in a patient with hypotension who is found to have right ventricular enlargement and a deep venous thrombosis
Airway	Endotracheal intubation	Confirmation of endotracheal tube placement after prehospital rapid sequence intubation
Vascular access	Difficult vascular access with non-emergent need for intravenous fluids	Placement of an ultrasound-guided peripheral intravenous catheter
Musculoskeletal	Suspected fracture or dislocation	Diagnosis of radius fracture in a wilderness medical environment

SAGE Open Med. 2020 doi: 10.1177/2050312120932706

Dewar et al. The Ultrasound Journal (2022) 14:23
https://doi.org/10.1186/s13089-022-00270-w

The Ultrasound Journal

ORIGINAL ARTICLE Open Access

Prehospital portable ultrasound for safe and accurate prehospital needle thoracostomy: a pilot educational study

Zachary E. Dewar[1*], Stephanie Ko[1,2], Cameron Rogers[3], Alexis Oropallo[1], Andrew Augustine[1], Ankitha Pamula[1] and Christopher L. Berry[1]

Abstract

Background: Simulated needle thoracostomy (NT) using ultrasound may reduce potential injury, increase accuracy, and be as rapid to perform as the traditional landmark technique following a brief educational session. Our objective was to determine if the use of an educational session demonstrating the use of handheld ultrasound to Emergency Medical Services (EMS) staff to facilitate NT was both feasible, and an effective way of increasing the safety and efficacy of this procedure for rural EMS providers.

Methods: A pre/post-educational intervention on a convenience sample of rural North American EMS paramedics and nurses. Measurement of location and estimated depth of placement of needle thoracostomy with traditional landmark technique was completed and then repeated using handheld ultrasound following a training session on thoracic ultrasound and correct placement of NT.

Results: A total of 30 EMS practitioners participated. Seven were female (23.3%). There was a higher frequency of dangerous structures underlying the chosen location with the landmark technique 9/60 (15%) compared to the ultrasound technique 1/60 (1.7%) ($p = 0.008$). Mean time-to-site-selection for the landmark technique was shorter than the ultrasound technique at 10.7 s (range 3.35–45 s) vs. 19.9 s (range 7.8–50 s), respectively ($p < 0.001$). There was a lower proportion of correct location selection for the landmark technique 40/60 (66.7%) when compared to the ultrasound technique 51/60 (85%) ($p = 0.019$). With ultrasound, there was less variance between the estimated and measured depth of the pleural space with a mean difference of 0.033 cm (range 0–0.5 cm) when ultrasound was used as compared to a mean difference of 1.0375 cm (range 0–6 cm) for the landmark technique (95% CI for the difference 0.73–1.27 cm; $p < 0.001$).

Conclusions: Teaching ultrasound NT was feasible in our cohort. While time-to-site-selection for ultrasound-guided NT took longer than the landmark technique, it increased safe and accurate simulated NT placement with fewer identified potential iatrogenic injuries.

Keywords: Pneumothorax, Tension pneumothorax, Emergency medical services, Point-of-care ultrasound, Trauma, Needle decompression, Needle thoracostomy, POCUS

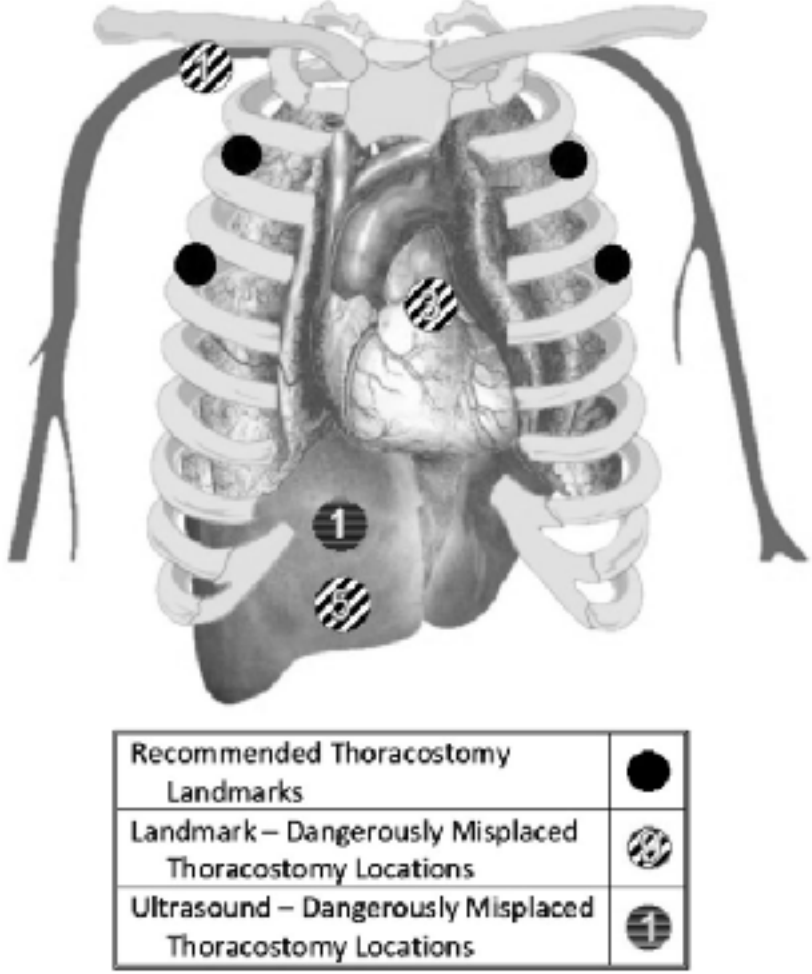


Table 2 Outcome measurements by the use of ultrasound as compared to the landmark technique

	Ultrasound (n = 60)	Landmark (n=60)	*p*
Dangerous underlying structure	1/60 (1.7%)	9/60 (15%)	0.008
Time to completion, s			
Mean (SD)	19.9 (10.6)	10.7 (7.1)	< 0.001
Median (range)	17 (7.8–50)	9.21 (3.35–45)	
Correct placement*	51/60 (85%)	40/60 (66.7%)	0.019

*Defined as in the correct interspace and midline location specified for the attempt

Reuter et al. The Ultrasound Journal (2023) 15:20
https://doi.org/10.1186/s13089-023-00315-8

The Ultrasound Journal

ORIGINAL ARTICLE

Open Access

Detecting cervical esophagus with ultrasound on healthy voluntaries: learning curve

Paul-Georges Reuter[1,2*], Chris Ballouz[3], Thomas Loeb[3], Tomislav Petrovic[4] and Frédéric Lapostolle[4]

Abstract

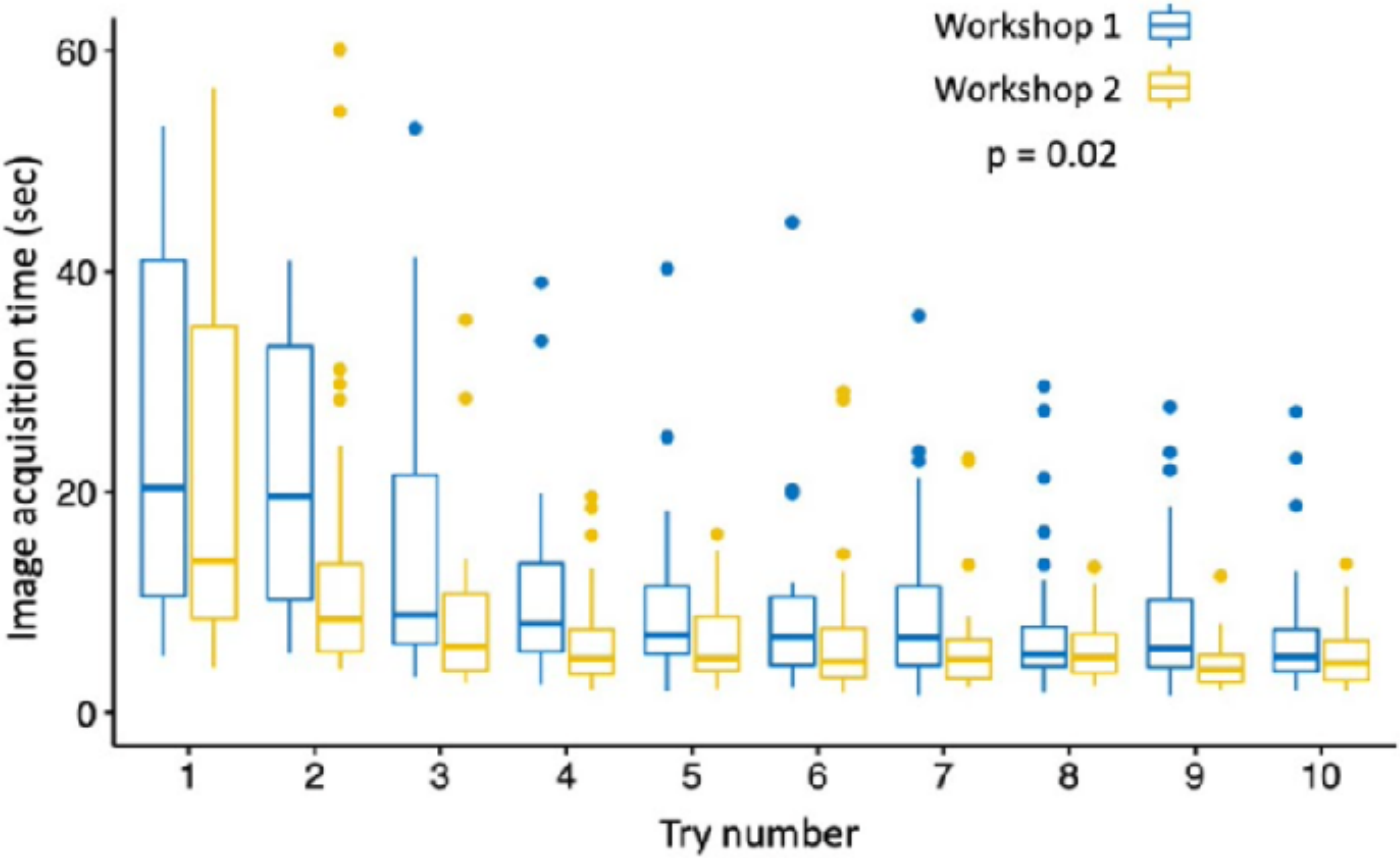
Background The objective of this study was to determine the learning curve of tracheal–esophageal ultrasound by prehospital medical and paramedical staff.

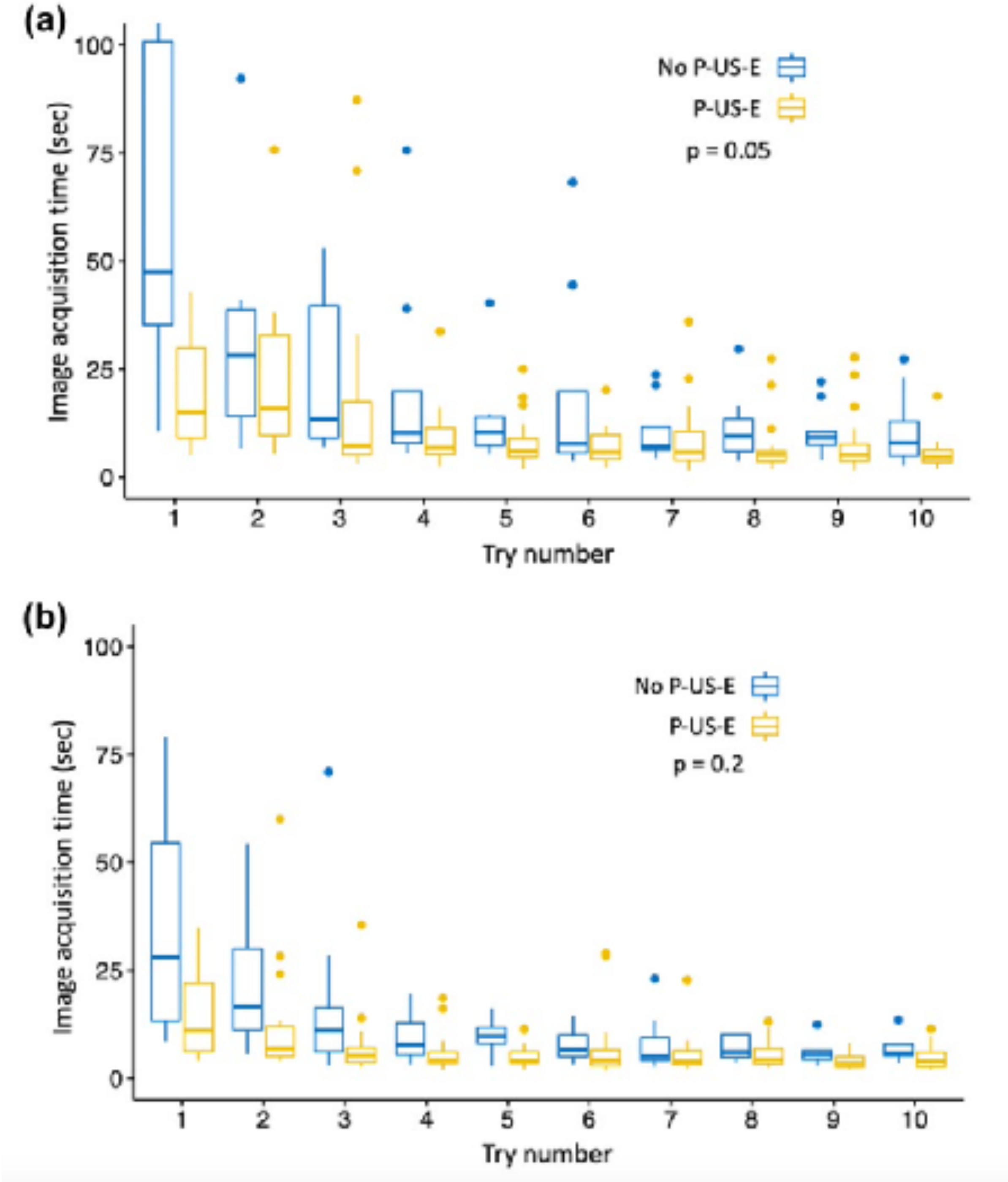
Methods A single-center prospective study was carried out at a French EMS (SAMU 92). Volunteer participants first received a short theoretical training through e-learning, followed by two separate hands-on workshops on healthy volunteers, spaced one to two months apart. Learners were timed to obtain the tracheal–esophageal ultrasound target image 10 consecutive times. The first workshop was intended to perform a learning curve, and the second was to assess unlearning. The secondary objectives were to compare performance by profession and by previous ultrasound experience.

Results We included 32 participants with a mean age of 38 (±10) years, consisting of 56% men. During the first workshop, the target image acquisition time was 20.4 [IQR: 10.6;41] seconds on the first try and 5.02 [3.72;7.5] seconds on the 10th ($p<0.0001$). The image acquisition time during the second workshop was shorter compared to the first one ($p=0.016$). In subgroup analyses, we found no significant difference between physicians and nurses ($p=0.055$ at the first workshop and $p=0.164$ at the second) or according to previous ultrasound experience ($p=0.054$ at the first workshop and $p=0.176$), counter to multivariate analysis ($p=0.02$).

Conclusions A short web-based learning completed by a hands-on workshop made it possible to obtain the ultrasound image in less than 10 s, regardless of the profession or previous experience in ultrasound.

Keywords Tracheal ultrasound, Endotracheal tube placement, Education, Simulation, Learning curve


Workshop 1
Workshop 2
p = 0.02
Image acquisition time (sec)
60
40
20
0
1
2
3
4
5
6
7
8
9
10
Try number



10 times

< 10 secs

Albaroudi *et al. The Ultrasound Journal* (2024) 16:10
https://doi.org/10.1186/s13089-024-00360-x

The Ultrasound Journal

REVIEW **Open Access**

Can absence of cardiac activity on point-of-care echocardiography predict death in out-of-hospital cardiac arrest? A systematic review and meta-analysis

Omar Albaroudi[1*], Bilal Albaroudi[1], Mahmoud Haddad[2], Manar E. Abdle-Rahman[3], Thirumoorthy Samy Suresh Kumar[1], Robert David Jarman[1,5] and Tim Harris[2,6]

Poor prognosis

Trauma mortality 100%

Abstract

Aim The purpose of this systematic review and meta-analysis was to evaluate the accuracy of the absence of cardiac motion on point-of-care echocardiography (PCE) in predicting termination of resuscitation (TOR), short-term death (STD), and long-term death (LTD), in adult patients with cardiac arrest of all etiologies in out-of-hospital and emergency department setting.

Methods A systematic review and meta-analysis was conducted based on PRISMA guidelines. A literature search in Medline, EMBASE, Cochrane, WHO registry, and ClinicalTrials.gov was performed from inspection to August 2022. Risk of bias was evaluated using QUADAS-2 tool. Meta-analysis was divided into medical cardiac arrest (MCA) and traumatic cardiac arrest (TCA). Sensitivity and specificity were calculated using bivariate random-effects, and heterogeneity was analyzed using I^2 statistic.

Results A total of 27 studies (3657 patients) were included in systematic review. There was a substantial variation in methodologies across the studies, with notable difference in inclusion criteria, PCE timing, and cardiac activity definition. In MCA (15 studies, 2239 patients), the absence of cardiac activity on PCE had a sensitivity of 72% [95% CI 62–80%] and specificity of 80% [95% CI 58–92%] to predict LTD. Although the low numbers of studies in TCA precluded meta-analysis, all patients who lacked cardiac activity on PCE eventually died.

Conclusions The absence of cardiac motion on PCE for MCA predicts higher likelihood of death but does not have sufficient accuracy to be used as a stand-alone tool to terminate resuscitation. In TCA, the absence of cardiac activity is associated with 100% mortality rate, but low number of patients requires further studies to validate this finding. Future work would benefit from a standardized protocol for PCE timing and agreement on cardiac activity definition.

Keywords Emergency medicine, Resuscitation, Cardiac arrest, Ultrasound, Echocardiography, Point-of-care, Death, Survival, PoCUS, OHCA, CPR

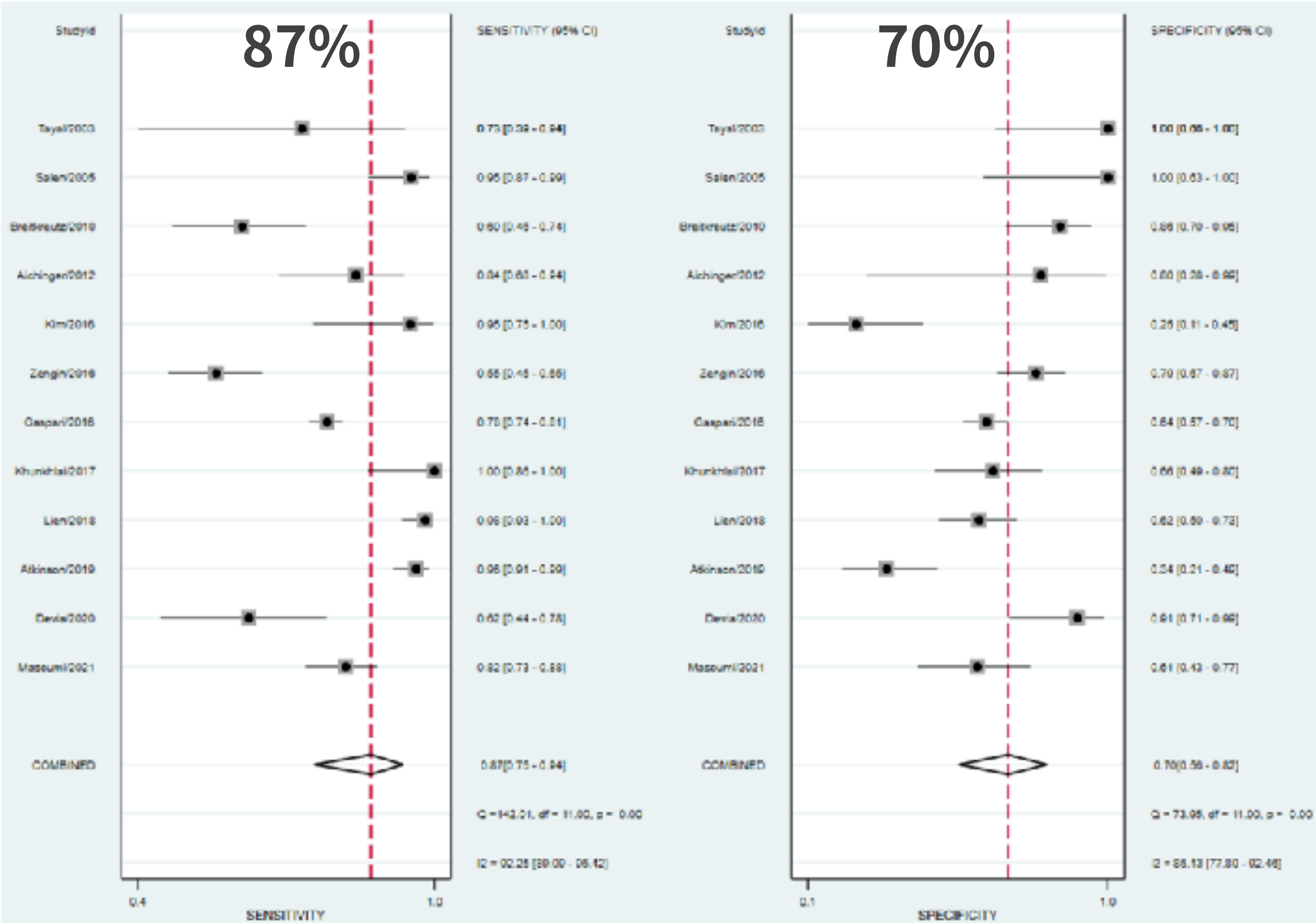


Fig. 2 Forest plot of sensitivity and specificity for TOR outcome in MCA group

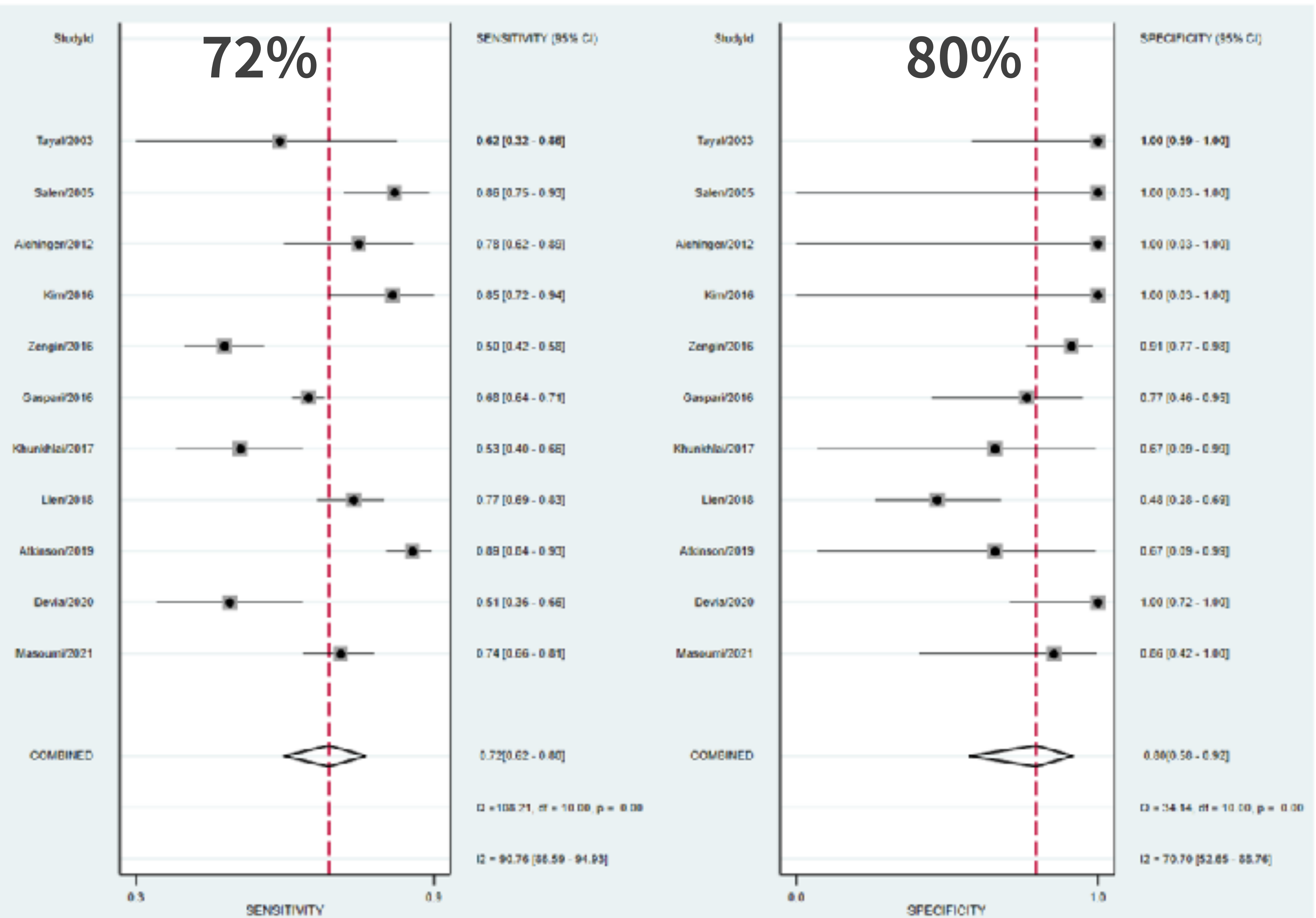


Fig. 4 Forest plot of sensitivity and specificity for LTD outcome in MCA group

Spe 100% for TCA

International Journal of Paramedicine

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REVIEW

PREHOSPITAL STANDARDS FOR POINT-OF-CARE ULTRASOUND: A BRIEF NATIONAL REVIEW

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Keywords: Prehospital, standards, POCUS, ultrasound, quality, accreditation, emergency medical services, EMS, paramedicine

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ABSTRACT

Background: Point-of-care ultrasound (POCUS) has become an increasingly recognized tool for the rapid bedside assessment of undifferentiated patients. With the advent of affordable portable devices, this tool has expanded to the prehospital world, offering an opportunity to improve patient care prior to arrival in the emergency department.

Methods: To assess how this tool has become incorporated into paramedical care in Canada, we conducted a cross-sectional survey of paramedical regulating bodies across nine of Canada's ten provinces to investigate POCUS accreditation, licensing, scope of practice, and quality assurance regulation for paramedics in Canada.

Results: Overall, few provincial paramedical licensing bodies include POCUS in the scope of practice for prehospital practitioners, and those who do are not involved with POCUS training, licensing, or quality assurance.

Conclusions: Our findings highlight the need for defined national competence standards and quality assurance metrics to ensure safe and effective use of POCUS in the prehospital environment.

Province	Regulating body	Presence of POCUS accreditation processes	Quality assurance and ongoing POCUS privileging	Scope of practice
Alberta	Alberta College of Paramedics	None	None	Not specified
British Columbia	Emergency Medical Assistants Licensing Board	None	None	Not specified
Manitoba	College of Paramedics Manitoba	Specific to employer, for ACPs and CCPs only	Additional training and quality assurance maintained by the employer	Within scope for ACPs and CCPs
New Brunswick	Paramedic Association of New Brunswick	None	None	Out of scope
Newfoundland and Labrador	Newfoundland and Labrador Paramedicine Regulator	None	None	None
Nova Scotia	College of Paramedics of Nova Scotia	College would verify additional employer-provided training is adequate to Accreditation Canada Standard	Accreditation Canada Standards	Employer specific
Ontario	Ontario Ministry of Health	None	None	None
Prince Edward Island (PEI)	Emergency Medical Services Board of PEI	None	None	None
Saskatchewan	Saskatchewan College of Paramedics	CCPs only, employer-specific	Set provincially, individual employer is responsible for annual evaluation and quality improvement	Focused Assessment with Sonography for Trauma (FAST) scans

Table 2. Summary of POCUS accreditation, quality assurance, and scope of practice standards for paramedics in Canadian provinces. ACP: advanced care paramedic; CCP: critical care paramedic.

van der Geest et al.
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Scandinavian Journal of Trauma,
Resuscitation and Emergency Medicine

ORIGINAL RESEARCH **Open Access**

Prehospital ultrasound constitutes a potential distraction from the observation of critically ill patients: a prospective simulation study

75% distraction

Yael van der Geest[1], Luca Marengo[2], Roland Albrecht[2], Philipp K. Buehler[4], Pedro D. Wendel-Garcia[1], Daniel A. Hofmaenner[4] and Urs Pietsch[2,5,6*]

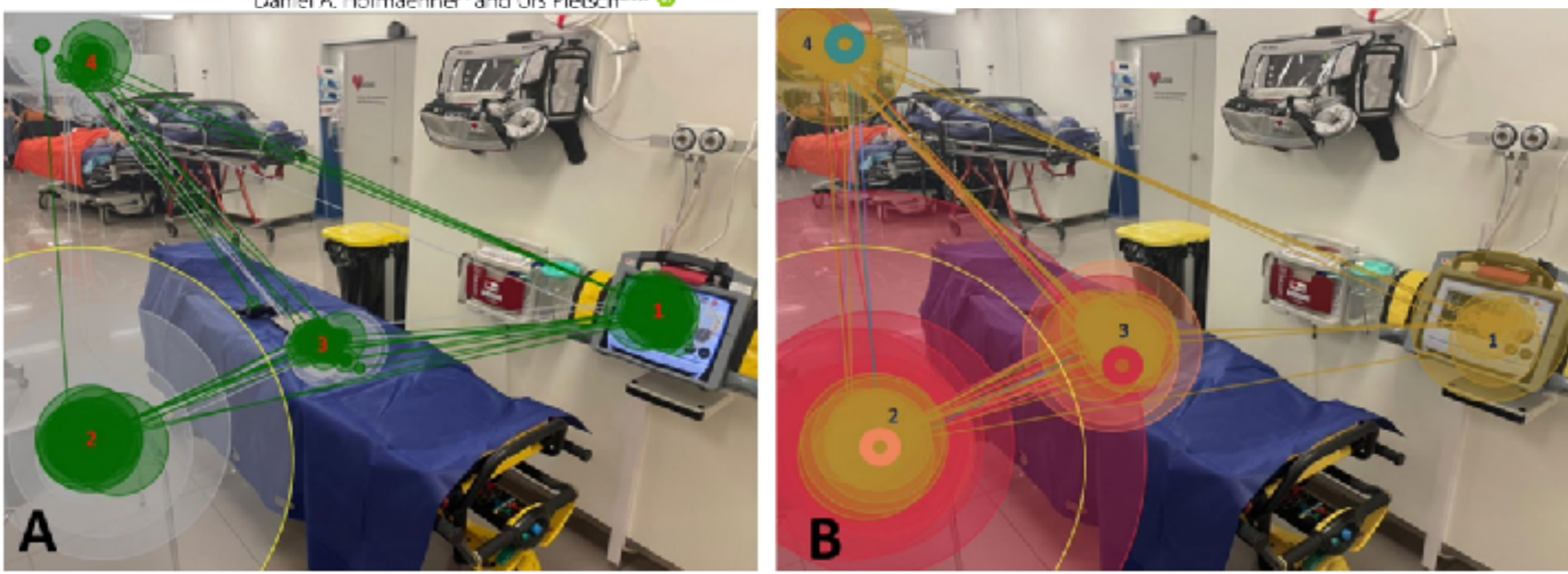

Fig. 1 Heatmap of overall gaze behavior. Areas of interest: 1 = patient monitor, 2 = ultrasound screen, 3 = patient, 4 = blank (irrelevant fixations, e.g. on the floor). **A** Heatmap of 'red' group (i.e. participants who recognised desaturation); **B** Heatmap of 'blue' group (i.e. participants who did not recognise desaturation)

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The utility of point-of-care ultrasound in targeted automobile ramming mass casualty (TARMAC) attacks☆

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Table 1
List of high profile TARMAC attacks in Western countries in the recent years.

Year	Country	Location	Vehicle	Deaths	Injured	Motive
2018	Germany	Münster	Camper Van	3	20	Mental Illness [1]
2017	Australia	Melbourne	SUV	1	19	Mental Illness [2]
2017	USA	New York City, NY	Pickup truck	8	12	Terrorism [3]
2017	Spain	Barcelona/Cambrils	Vans (2)	14	100+	Terrorism [4]
2017	USA	Charlottesville, VA	Car	1	40+	Terrorism [5]
2017	England	London Bridge	Truck, 7.5 tons	8 (5 stabbed)	48	Terrorism [6]
2017	Sweden	Stockholm	Truck, 30 tons	5	14	Terrorism [7]
2017	USA	Times Square, New York City, NY	Car	1	20	Intoxication/mental illness [8]
2016	Germany	Berlin	Truck, 25+ tons	12	56	Terrorism [9]
2016	France	Nice	Truck, 9 tons	87	434	Terrorism [10]
2015	USA	Stillwater, OK	Car	4	46	Mental illness [11]
2015	Austria	Graz, Austria	Car	3	36	Terrorism [12]

Table 2
Proposed Implementation of POCUS in the prehospital and hospital-based emergency services during MCI.

Prehospital-*Implementation*
1) Prioritization of patients in need of emergent/urgent interventions using POCUS
   a) Pneumothorax, hemoperitoneum, pericardial effusion

2) Re-triaging of patients with concerning mechanisms of injuries but lack of objective injuries by POCUS

Prehospital-*Barriers*
1) Competing with other wireless access/bandwidth during time of crisis in sending images for interpretation if acquired but not interpreted at the scene
2) Need for transmission of a signal in an area where wireless access is not available or permitted
3) Limited battery power
4) Environmental conditions – excessive heat/cold/rain
5) Access to qualified personnel to acquire imaged

Hospital-based-*Implementation*
1) POCUS triage team in the emergency department to assist in patient triage
   a) Confirm the diagnosis requiring emergent or urgent operative intervention
      i) Globe rupture
      ii) Vascular injuries
      iii) Solid organ hemorrhage
      iv) Pulmonary/Cardiac injuries

   b) Confirm the absence of above diagnoses

2) POCUS as a force multiplier to cross sectional imaging evaluation of patients
   a) Reserve the use of CT scanning for high morbidity/mortality injuries
      i) Assess for intracranial operative intervention injury

3) POCUS to reassess patients
   a) Reassess patients to enhance tertiary trauma reevaluation

Hospital-based-*Barriers*
1) A disproportional availability of POCUS in a higher volume and higher acuity ED during TARMAC response
2) Limited time and resources required to document the POCUS results to be available to the other treating providers
3) Limited number of well-trained Emergency physician sonographers

決定傷害形態、嚴重度和立即醫療需求

提升現場檢傷正確性和合適轉送

最佳化醫療院所有限資源的分配

PLOS ONE

RESEARCH ARTICLE

Point-of-care ultrasound use in austere environments: A scoping review

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Austere and Extreme Environments				
Military medicine and conflict zones	**Prehospital (including Emergency Medical Services)**	**Resource-limited settings including low- and middle-income countries**	**Microgravity in outer space**	**High altitude and mountains**
Focused assessment for sonography in trauma (FAST)	Lung (pneumothorax, hemothorax)	Abdominal (obstetrics, biliary, bowel/ appendix, FAST, etc.)	Abdominal (biliary, appendix/bowel, obstetrics, etc.)	High altitude pulmonary edema (HAPE), pneumothorax
Lung (pneumothorax, hemothorax)	Cardiac (pericardial effusion, standstill in cardiac arrest)	FASH exam for tuberculosis (pericardial/ pleural effusion, ascites, abdominal lymph nodes, splenic/liver lesions)	Nephrolithiasis, bladder	Musculoskeletal (fractures, tendons)
Cardiac	Abdominal (FAST, aorta)	Splenomegaly, ONSD in malaria	Deep venous thrombosis	Soft tissue
Soft tissue/MSK (foreign body, abscess, tendons, joints)	fractures	Cardiac (congenital or acquired structural disease, wall-motion abnormality, right ventricular dilation, etc.)	Musculoskeletal (tendons)	Optic nerve sheath diameter (ONSD)
Procedural (nerve blocks, vascular access)	Procedural (vascular access, gastric tube, needle thoracostomy, pericardiocentesis)	Lung (B lines, effusion, consolidation)	Spinal (disc herniation)	
		Volume assessment of IVC	Ocular (Corneal abrasion, retinal detachment)	
		Soft tissue (abscess, foreign body)	Cardiac	
		Procedural	Lung	
			Procedural	

https://doi.org/10.1371/journal.pone.0312017.t002

WILDERNESS & ENVIRONMENTAL MEDICINE 2021; 32(2): 204–9

CASE REPORT

Point-of-Care Ultrasound Diagnosis of Acute High Altitude Illness: A Case Report

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With the advent of high-quality portable ultrasound machines, point-of-care ultrasound (POCUS) has gained interest as a promising diagnostic tool for patients with high altitude illness. Although POCUS is used successfully in hospital environments to detect interstitial pulmonary edema and increased intracranial pressure, the relationship between specific sonographic criteria and high altitude illness is still unclear. We report the case of a healthy 32-y-old male who developed acute respiratory distress and neurologic impairment at 4321 m while participating in a high altitude medical research expedition. We discuss the potential of POCUS to diagnose acute high altitude illness by lung ultrasound, optic nerve sheath diameter measurement, and echocardiography. Ultrasound in combination with clinical findings helped us to exclude relevant differential diagnoses, start on-site treatment, and organize an evacuation. We used serial clinical and ultrasound examinations to assess the patient over time. Although its role in high altitude medicine needs further investigation, we believe that POCUS can be a valuable tool to aid clinical decision-making in remote, high altitude environments.

Keywords: high altitude pulmonary edema, high altitude cerebral edema, acclimatization, ataxia

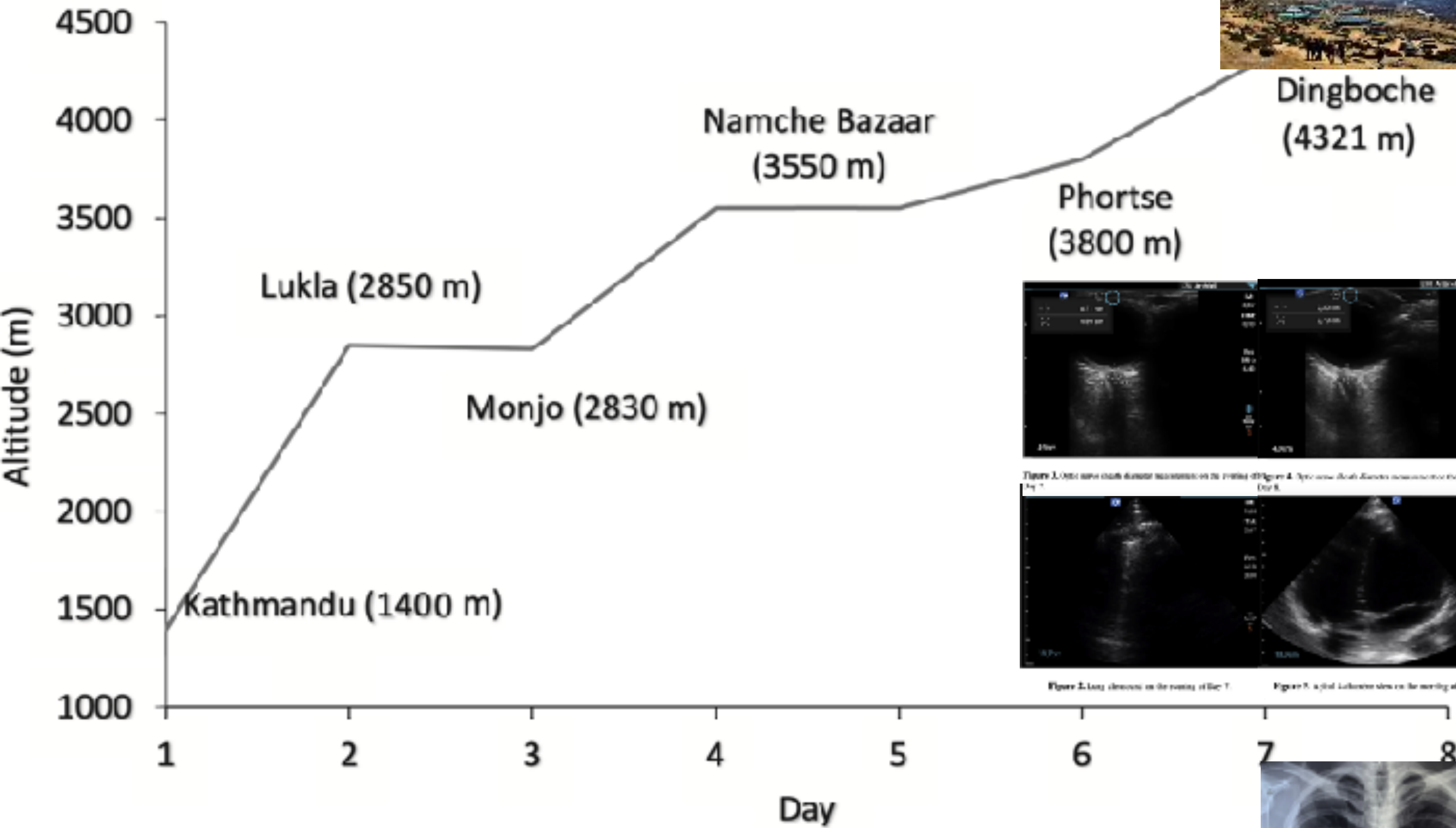


Figure 1. Ascent profile of the patient.

Application of Point-of-care Ultrasound for Screening Climbers at High Altitude for Pulmonary B-lines

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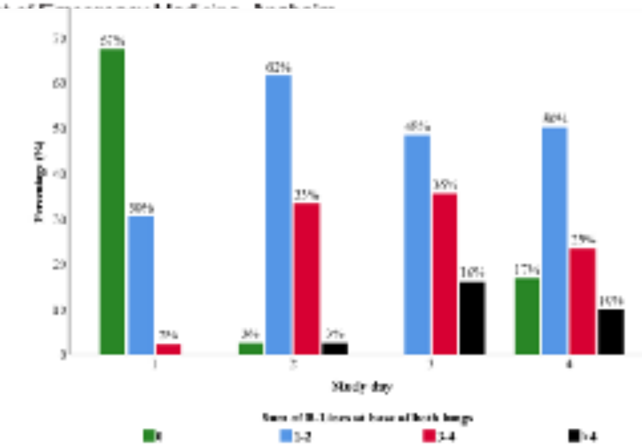

Figure 1. Distribution of the sum of B-lines at the base of both lungs over four days at altitude.

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DOI: 10.5811/westjem.2022.11.54300

Introduction: High-altitude pulmonary edema (HAPE) occurs as a result of rapid ascent to altitude faster than the acclimatization processes of the body. Symptoms can begin at an elevation of 2,500 meters above sea level. Our objective in this study was to determine the prevalence and trend of developing B-lines at 2,745 meters above sea level among healthy visitors over four consecutive days.

Methods: We performed a prospective case series on healthy volunteers at Mammoth Mountain, CA, USA. Subjects underwent pulmonary ultrasound for B-lines over four consecutive days.

Results: We enrolled 21 male and 21 female participants. There was an increase in the sum of B-lines at both lung bases from day 1 to day 3, with a subsequent decrease from day 3 to day 4 ($P<0.001$). By the third day at altitude, B-lines were detectable at base of lungs of all participants. Similarly, B-lines increased at apex of lungs from day 1 to day 3 and decreased on day 4 ($P=0.004$).

Conclusion: By the third day at 2,745 meters altitude, B-lines were detectable in the bases of both lungs of all healthy participants in our study. We assume that increasing the number of B-lines could be considered an early sign of HAPE. Point-of-care ultrasound could be used to detect and monitor B-lines at altitude to facilitate early detection of HAPE, regardless of pre-existing risk factors. [West J Emerg Med. 2023;24(2)359–362.]

Original Article

Role of Point-of-Care Ultrasound in Grading the Severity and Early Diagnosis of High-altitude Pulmonary Edema at a Peripheral Hospital

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Abstract

Background and Aims: Troops deployed at high-altitude area (HAA) suffer from various high-altitude illnesses (HAIs) including high-altitude pulmonary edema (HAPE). There are various criteria to diagnose and assess the severity of HAPE, but point-of-care ultrasound (POCUS) of the lung has also been used in isolation by physicians. The aim is to assess whether POCUS of the lung improves the ability to diagnose the severity of HAPE. **Methodology:** A retrospective, cross-sectional descriptive study was planned for the patients treated for HAPE ($n = 46$) at our hospital from January 2019 to March 2020. Prehospital admission data, hospital admission data, and discharge data for the first-time inductees and reinductees were collected from the central hospital admission registry and central database of the medical department and intensive care unit. **Results:** The incidence of HAPE was 2.2 per 1000. First-time inductees ($n = 30$) were affected more when compared to reinductees ($n = 16$) and the maximum were at the third stage of HAA. POCUS of the lung facilitated the diagnosis of the six patients with mild HAPE with no positive radiological features. **Conclusions:** POCUS of the lung should be routinely used by the medical officers deployed at high altitudes. It will increase the diagnostic rate of HAPE with meticulous grading of the severity, thereby aiding in formulating the case-specific treatment protocol.

Keywords: Acclimatization, chest X-ray, high-altitude pulmonary edema, lung ultrasound, point-of-care ultrasound

Table 2: Diagnostic criteria of high-altitude pulmonary edema

Criteria number	Criteria	Findings
1	Recent ascent to high altitude (>3000 m); the presence of palpitations, chest tightness, dyspnea, and cough with or without white foamy sputum	
2	Local, unilateral, or bilateral coarse breath sounds, with or without local moist rales, central cyanosis, tachycardia (>100/min), and tachypnea (>24/min)	
3	Radiological findings	Chest X-ray- decreased pulmonary transmittance, increased or obscure lung markings, ground glass-like changes, or patchy shadows in the lung

Table 3: Modified Severity Grading Criteria of high-altitude pulmonary edema

Criteria's	Mild	Moderate	Severe
Symptoms and signs	Dyspnea and cough with white foamy sputum may occur after intermediate manual labor	Dyspnea, chest pain, chest tightness, and cough with a large amount of white foamy sputum occur after mild manual labor	Patients can not lie in the supine or prone position. They may have a pale complexion cold sweat on the forehead, serious dyspnea, and a heavy cough with a large amount of white or pink foamy sputum
Lung auscultation	Shows local moist rales in a unilateral lung	Extensive moist rales are noted in the bilateral lower lung or unilateral lung	Rales of small, intermediate, and large bubbles are extensive in the bilateral lungs and are accompanied by the sound of boiling water
Vital parameters	Respiratory rate ≤24 breaths/min Heart rate <100 beats/min and there is no arrhythmia	Respiratory rate is >24 breaths/min Heart rate is >110 beats/min and is accompanied by arrhythmia	Respiratory rate is >30 breaths/min Heart rate is >120 beats/min and is accompanied by arrhythmia
Chest X-rays	Flocculent shadows occupy <1/4 of the lung. The shadows are confined to the right lower lobe and are spotty or patchy	Shows patchy or flocculent shadows covering 1/2 of the lung	Reveals asymmetric cloudy shadows covering 1/2 of >the bilateral lungs
CT scan chest	Increased and enlarged lung markings	Ground glass-like changes or nodule-like shadows	Scattered or isolated alveolar edema of the terminal bronchioles
Routine blood tests	Normal	The white blood cell count and neutrophil count are slightly increased	The white blood cell count is around 10 $\times 10^9$/L
Lung ultrasound (B-lines)	6-15	16-30	>30

Source: Zhou Q. Standardization of Methods for Early Diagnosis and On-Site Treatment of High- Altitude Pulmonary Edema. Pulm Med 2011. p. 1-9.[8]
CT: Computed tomography

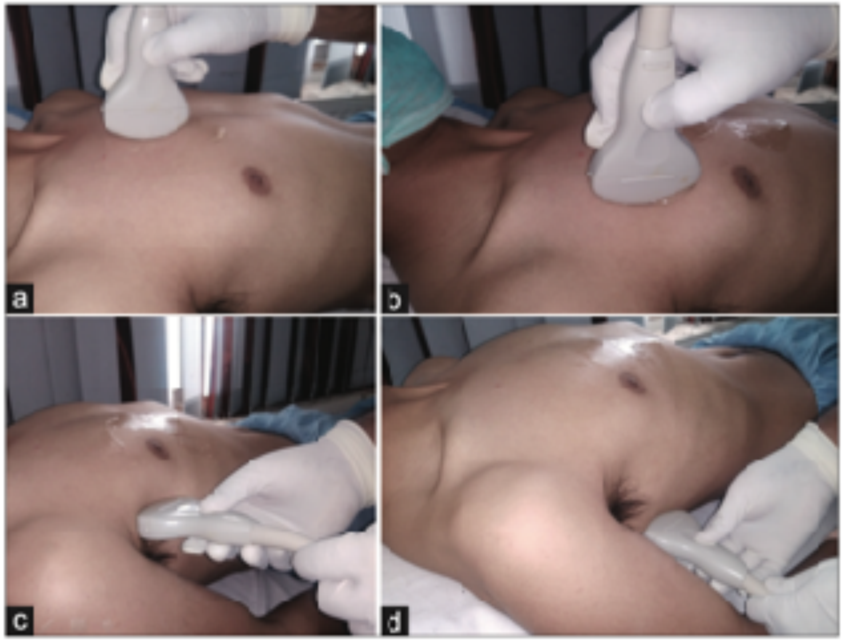

Figure 1: Lung ultrasound scanning for B-lines in various areas (a) Parasternal area (b) Midclavicular area (c) Anterior axillary area (d) Mid axillary area

Table 5: Distribution of data based on type of inductees and at various stages of high altitude

Description	Mild HAPE	Moderate HAPE	Severe HAPE	Total HAPE
Type of inductees				
First-time inductees	14	8	8	30
Reinductee's	6	3	7	16
Stages of HAA				
First stage	5	5	12	22
Second stage	Nil	Nil	1	1
Third stage	15	6	2	23

First stage is from 2700 to 3600 m, Second stage is from 3600 to 4500 m, third stage is >4500 m. HAA: High-altitude area, HAPE: High-altitude pulmonary edema

Table 4: Radiological assessment of severity of high-altitude pulmonary edema, employing X-ray of the chest, lung ultrasound, and computed tomography chest

Findings	Mild HAPE	Moderate HAPE	Severe HAPE
No of patients	20	11	15
Chest X-ray	Flocculent shadows varied from <1/4 to <1/2 of the lung. These spotty or patchy shadows were confined to the right lower lobe in 12 patients, right lower and middle lobe in 5 patients, and in left lower lobe in 3 patients	Showed patchy or flocculent shadows covering >1/2 of the right lung in 10 patients and complete right lung in 1 patient	Showed asymmetric cloudy shadows covering 1/2 of > the bilateral lungs in 10 patients and >1/2 of both lungs in 5 patients
Lung ultrasound (B-lines)	5-15	16-30	>30
CT chest	All 20 patients showed Increased and enlarged lung markings	Findings varied between ground glass-like changes or nodule-like shadows	Findings varied between scattered or isolated alveolar edema of the terminal bronchioles

HAPE: High-altitude pulmonary edema, CT: Computed tomography

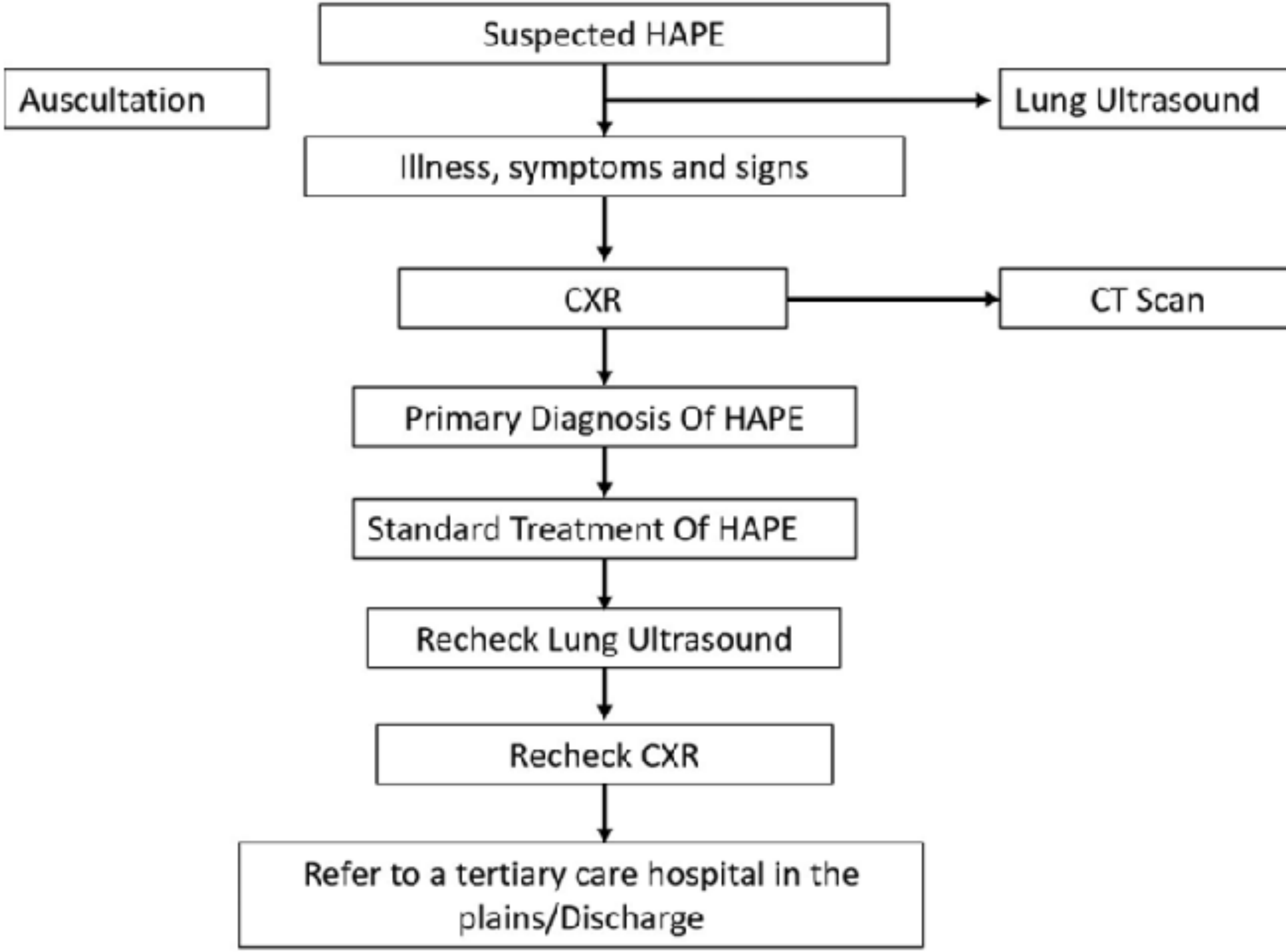

Figure 2: Treatment algorithm of High-altitude pulmonary edema


POCUS
All about A,B,C!
A
Airway/Tubes
CTM Location?
ET Tube Position?
NGT Placement?
B
Breathing
Sliding/PTx?
Interstitial Fluid?
Pneumonia?
Diaphragm
C
Circulation
LV Function?
LV/RV association?
Valves/Veg's?
IVC / Fluids?
D
Disability
ONSD?
Trans-cranial Doppler
Carotid Doppler
CRITICALCARE
NORTHAMPTON.COM
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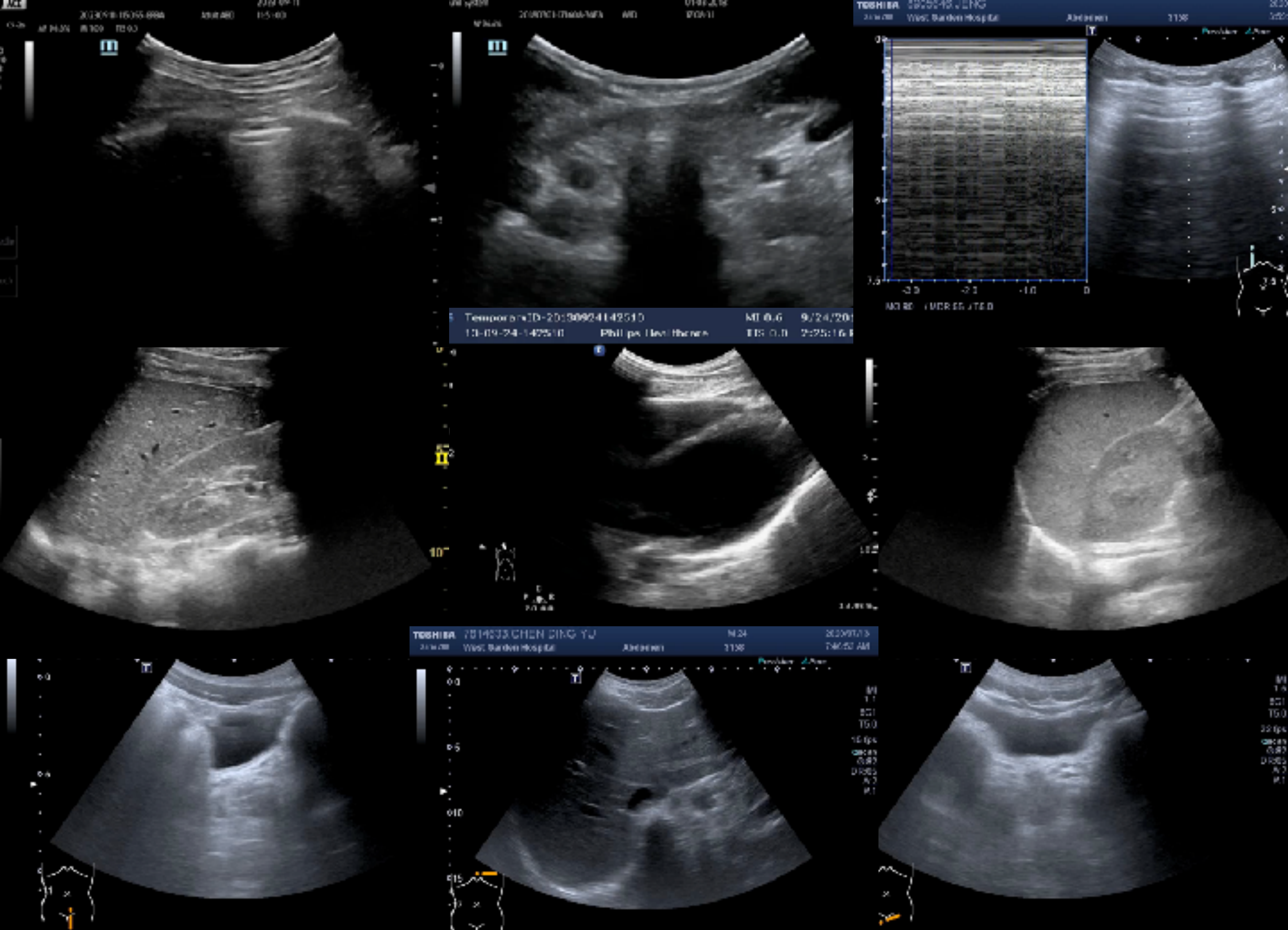
Ascites?
Kidneys?
AAA?!
Bladder?
DVT?



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