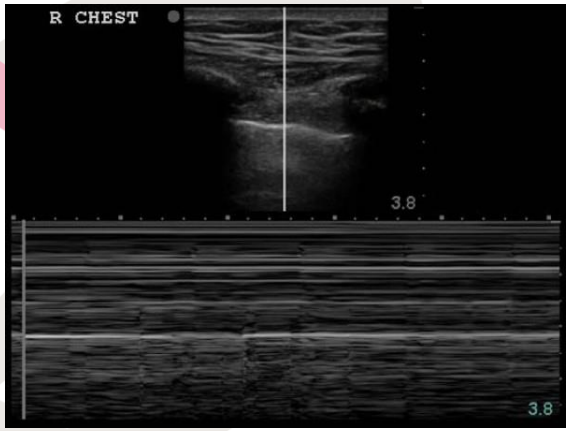
Non-Physician Point of Care Ultrasound Use in a Retrieval Environment



Dave Tingey, ASM
Retrieval Paramedic Practitioner

Overview

- Literature review
- Paramedic US use in Australia
- Benefits
- Challenges
- Future directions

Literature review

Ultrasound for the Air Medical Clinician

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Introduction

Recent advances in technology have made the use of ultrasound (US) a possibility in air medicine. A handheld US machine that appears promising as a diagnostic tool within the helicopter theater was developed recently (Sonosite Corp., Bothell, Wash.). Several air medical programs have begun using US as the focused abdominal sonography for trauma (FAST) examination during helicopter transport.[1,2]

Diagnostic US greatly enhances the evaluation of patients with a variety of presentations. After its rapid evolution during the previous decade and wide availability in operating suites and emergency departments, US technology now is being introduced into the out-of-hospital arena. Many patients who present with unstable or time-critical medical problems require on-the-spot diagnosis and intervention. These patients may benefit from rapid, goal-directed, limited ultrasonography performed and interpreted by flight clinicians.

We integrated the use of a Sonosite 180 US device in our flight program at Life Link III in April 2001. This article describes our training program for flight clinicians, proposes a platform for subsequent program development, and shares the results of our experience in air medicine.

Methods

Our objectives were to develop a US training program for air medical clinicians using focused US examinations and assess the competencies of each clinician 1 year later. We conducted a prospective observational study on critical patients transported by Life Link III between July 1, 2001, and July 1, 2002.

Life Link III (LLIII) is a full-service transport program that provides both ground and air critical care services to a tri-state region. LLIII provides more than 6000 ground transports and 1600 air medical flights per year using a registered nurse and paramedic configuration to staff critical care transports. The study site was the St. Paul air medical base of LLIII, which provides more than 800 critical care air transports per year.

During the evaluation portion of our study, all patients that had an US performed were included. A SonoSite 180 was used to conduct the examinations. All images were captured and then downloaded into a PC format and read by one of the authors (Heegaard). All studies were performed within a Bell 222 helicopter. We received no financial assistance from the SonoSite Corp.

Ultrasound Training

The training program was developed by one of the authors (Plummer) with a focus on a narrow US examination with specific indications, such as hypotension, change in vital signs, high clinical suspicion, etc. The course consisted of 7 hours of didactic and hands-on training designed for a dedicated crew of 10 flight nurses and paramedics. All flight nurses and paramedics had more than 5 years of clinical experience. The course began with a general introduction to US, US physics, and the use of US within an emergency air medical practice. Emergent US topics then were divided into echocardiography, abdominal US, pelvic and obstetrical US, and the FAST examination. Each topic was followed by a demonstra-

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Heegaard et al (2004)

- Training:
  - Introduction 30 mins
  - Echocardiography 60 mins
  - Abdominal and aorta 60 mins
  - Pelvic and obstetric 60 mins
  - FAST exam 30 mins
  - Clinical bedside training 3 hours

Heegaard et al, (2004)

	6 weeks	1 year
Theoretical knowledge	82%	71%
Correct scanning technique	87%	94%

Heegaard, et al (2004):

Challenges identified:

- Interventions performed in flight
- Short flight times
- Restricted access in RW aircraft

Paramedic application of ultrasound in the management of patients in the prehospital setting: a review of the literature

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ABSTRACT

Objectives Recently, attempts have been made to identify the utility of ultrasound in the management of patients in the prehospital setting. However, in the UK there is no directly relevant supporting evidence that prehospital ultrasound may reduce patient mortality and morbidity. The evidence available to inform this debate is almost entirely obtained from outside the UK, where emergency medical services (EMS) routinely use doctors as part of their model of service delivery. Using a structured review of the literature available, this paper examines the evidence to determine 'Is there a place for paramedic ultrasound in the management of patients in the prehospital setting?'

Method A structured review of the literature to identify clinical trials which examined the use of ultrasound by non-physicians in the prehospital setting.

Results Four resources were identified with sufficient methodological rigour to accurately inform the research question.

Conclusion The theoretical concept that paramedic-initiated prehospital ultrasound may be of benefit in the management of critically ill patients is not without logical conceptual reason. Studies to date have demonstrated that with the right education and mentorship, some paramedic groups are able to obtain ultrasound images of sufficient quality to positively identify catastrophic pathologies found in critically ill patients. More research is required to demonstrate that these findings are transferable to the infrastructure of the UK EMS, and in what capacity they may be used to help facilitate optimal patient outcomes.

INTRODUCTION

The potential benefits of centralised trauma care in the UK were first suggested over a decade ago,[1 2] and have been reiterated several times in various publications since.[3–7] Recently, the National Audit Office examined the effectiveness of the planning and delivery of trauma services across the patient pathway, and the quality of trauma care provided in the UK.[8] It found that nationally insufficient headway has been made in improving the standards of trauma care and that more impetus should be placed on the development of 'trauma networks'. The report also recommends that ambulance trusts develop 'by-pass' protocols to ensure that severely injured patients are delivered to the most appropriate hospital, which may not necessarily be the nearest. Inevitably, therefore, these reforms will lead to greater prehospital (PH) travelling times,[9] longer periods of patient management in the PH setting and, perhaps inevitably, a short-term increase in the clinical risk to which patients are exposed. In direct response to these reforms, paramedics will be required to make more complex decisions regarding the most appropriate receiving unit for each patient, and consequently will require more complex diagnostic tools, such as focused ultrasound (US), to allow this.

It has been suggested that focused US examination could augment PH clinical examination and ongoing management of critically injured trauma patients.[10] Point of care US is a limited, focused assessment which is normally performed by a clinician to answer specific questions about the patient's immediate condition. US may assist in identifying abnormal conditions where visualisation of the internal anatomy is required to confirm or refute a suspected diagnosis.[11]

Attempts have been made to identify the utility of US in the management of patients in the PH setting.[12] PH medicine relies heavily on physical assessment to obtain a provisional diagnosis; yet physical assessment alone has been demonstrated to be insufficient to achieve high specificity in accurately diagnosing some conditions.[13] Theoretically, if US were to be adopted in the PH setting, patient management may be improved,[14] and an expedited patient journey to the most appropriate definitive care could be facilitated,[15] which combined could provide improvements in patient morbidity and mortality.

In the UK there is no current, directly relevant supporting evidence that prehospital ultrasound (PHUS) may reduce patient mortality and morbidity. The evidence available originates almost entirely from outside the UK, where typical models of primary (responding to emergency calls) and secondary (step up transfer) response incorporate a medical doctor. Generally the Emergency Medical Services (EMS) model of response of in the UK is paramedic led, and rarely utilises medical doctors, so it seems prudent that when considering the feasibility of introducing PHUS in the UK, it is investigated primarily from the aspect of the ambulance paramedic, as the most commonly encountered PH practitioner.

However, the scant evidence base and lack of tailored training and competence-based assessment for PHUS inhibits progression in this area of imaging for UK EMS. It has been suggested that given appropriate training and proctored support, non-physician responders could incorporate US examination into their routine assessment of patients.[16] Yet the inception of such programmes is

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Brooke, et al (2010):

- 4/24 PHUS papers relevant to Paramedic practice in UK
- Generally small studies
- Findings promising - good accuracy and retention

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Acquisition and interpretation of focused diagnostic ultrasound images by ultrasound-naive advanced paramedics: trialling a PHUS education programme

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ABSTRACT

Objective This trial investigated whether advanced paramedics from a UK regional ambulance service have the ability to acquire and interpret diagnostic quality ultrasound images following a 2-day programme of education and training covering the fundamental aspects of lung ultrasound.

Method The participants were tested using a two-part examination; assessing both their theoretical understanding of image interpretation and their practical ability to acquire diagnostic quality ultrasound images. The results obtained were subsequently compared with those obtained from expert physician sonographers.

Results The advanced paramedics demonstrated an overall accuracy in identifying the presence or absence of pneumothorax in M-mode clips of 0.94 (CI 0.86 to 0.99), compared with the experts who achieved 0.93 (CI 0.67 to 1.0). In two-dimensional mode, the advanced paramedics demonstrated an overall accuracy of 0.78 (CI 0.72 to 0.83), compared with the experts who achieved 0.76 (CI 0.62 to 0.86). In total, the advanced paramedics demonstrated an overall accuracy at identifying the presence or absence of pneumothorax in prerecorded video clip images of 0.82 (CI 0.77 to 0.86), in comparison with the expert users of 0.80 (CI 0.68 to 0.89). All of the advanced paramedics passed the objective structured clinical examination and achieved a practical standard considered by the examiners to be equivalent to that which would be expected from candidates enrolled on the thoracic module of the College of Emergency Medicine level 2 ultrasound programme.

Conclusion This trial demonstrated that ultrasound-naive practitioners can achieve an acceptable standard of competency in a simulated environment in a relatively short period of time.

Over the past 15 years, focused ultrasound has proven to be a useful adjunct to physical assessment for a number of conditions in emergency medicine[1] and is routinely found in most emergency departments (ED). The College of Emergency Medicine (CEM) includes ultrasound as a prerequisite skill for those pursuing a career in the ED, and therefore ultrasound is considered an essential component of the training programme.[2]

Over recent years ultrasound systems have become smaller, lighter and more robust, and as a consequence there has been increased interest in the potential of ultrasound, and specifically in its potential to influence the patient journey in the prehospital setting.[3] Literature from several parts of continental Europe and the USA demonstrates that prehospital ultrasound (PHUS) is entirely feasible.[4 5]

Prehospital assessment currently relies heavily upon physical assessment, which has been proved to be unreliable in a number of conditions,[5] and therefore the development of an adjunct to normal assessment may well offer a real potential to reduce long-term mortality and morbidity.[6] However, this theoretical postulate as yet remains untested in a health infrastructure similar to that of the UK. The evidence available to inform this debate is almost entirely obtained from outside the UK, where typical models of primary (responding to emergency calls) and secondary (step up transfer) response incorporate a medical doctor. In the UK, almost all prehospital care is initiated by an ambulance paramedic, and therefore it could be argued that the evidence already generated has limited applicability to the UK health economy. It may be that the demonstrable benefits of ultrasound in the prehospital setting abroad could be translated into the prehospital setting in the UK, but the evidence base is currently lacking as ultrasound examination is not a skill currently possessed by UK paramedics. Therefore, before a systematic enquiry into the potential benefits of PHUS in the operational setting is possible, it is first necessary to establish whether UK paramedics have the necessary cognitive, psychomotor and affective capacity to acquire the necessary skills to incorporate ultrasound examination into their routine assessment of patients after a short programme of education and training.

This trial is believed to be the largest UK investigation to assess whether this group of ultrasound-naive clinicians has the ability to use focused ultrasound in a simulated environment, following a suitably tailored programme of education. It is envisaged that this study will be a pilot for a future investigation, utilising a larger cohort of advanced paramedics and focusing on a larger spectrum of injuries in which ultrasound has been proved to aid diagnosis.

METHODS

This prospective observational cohort study was undertaken as a collaborative venture between the University of Liverpool and the North West Ambulance Service NHS Trust. Following National Research Ethics Service approval, an email was sent to all 36 advanced paramedics employed by the North West Ambulance Service NHS Trust by the study author, which requested an expression of interest from volunteers who would like to be involved in the trial. Ten positive responses were received, and prospective participants were

Brooke, et al (2011):

- 10 Advanced Practice Paramedics
- 2 days training – SLS detection
- Assessment of LUS images and clips
- Overall accuracy equal to US "expert"
- Sensitivity 85% / specificity 81% for PTx
- Exceeded CEM (UK) L2 US standard

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Brief Report

Ultrasound detection of the sliding lung sign by prehospital critical care providers

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Abstract

Background: The presence of the sonographic sliding lung sign (SLS) is a sensitive indicator for the absence of a pneumothorax.

Objective: The aim of this study was to determine if prehospital critical care providers (PHCPs) can acquire and maintain the necessary skills to determine the presence or absence of the SLS following a brief tutorial.

Methods: This was a blinded randomized observational trial using a cadaveric model. The model was randomized to esophageal intubation (negative SLS) or tracheal intubation (positive SLS), and a SonoSite 180 plus (Bothel, WA) machine was used for the examination. After a 9-month period, the PHCPs were reevaluated without additional instruction.

Results: There were 8 PHCPs. A total of 6 intubations were performed yielding a total of 48 trials. The presence or absence of the SLS was correctly identified in 46 of the 48 trials, resulting in a sensitivity and specificity of 96.9% (95% confidence interval [CI], 89.6%-99.1%) and 93.8% (95% CI, 93.8%-79.3%), respectively. At the 9-month follow-up, 7 of the original PHCPs were available to participate. A total of 8 intubations were performed yielding a total of 56 trials. The presence or absence of the SLS was correctly identified in all 56 trials, resulting in a sensitivity and specificity of 100% (95% CI, 93.6%-100%).

Conclusion: Prehospital critical care providers can accurately determine the presence or absence of the sonographic SLS following a brief tutorial and retain the skill set following a 9-month interval.

1. Introduction

Prehospital care providers (PHCPs) are of paramount importance in rapidly recognizing and treating life-threatening conditions such as tension pneumothorax (PTX). Fortunately, this condition can be effectively treated with needle decompression or tube thoracostomy [1]. If a critically injured patient is going to survive, however, PHCPs must recognize the presence of a tension PTX and treat appropriately. Historically, decisions to decompress the chest have been made based on physical examination, but physical examination skills are often compromised when working in noisy and at times austere environments [2]. A suboptimal physical examination may lead to delays in chest decompression or result in unnecessary treatment when a PTX is not present [3,4].

Ultrasound (US) technology via the focused assessment with sonography in trauma (FAST) examination has empowered clinicians with additional tools to more rapidly evaluate and disposition trauma patients [5]. As a result of

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Lyon et al, (2012)

- 8 HEMS Critical Care Paramedics and Nurses
- 25 minute instruction
- Assessment of SLS detection in ventilated cadavers
- Sensitivity 96.9% / specificity 93.8% (CI 95%)

Lyon, et al (2012)

- 9 month follow up
- Average clinical use <1 / month
- 56 trials (28 with SLS)
- Sensitivity & specificity 100% (CI 95%)

US During Transport?

- Pre / post transport scans
  - No approvals for use in flight
  - Easily secured for transport
  - Prevention of deterioration in flight?
- USS during transport
  - Reduced scene time
  - Ongoing assessment of pathology / Rx

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EMA

BRIEF REPORT

Use of point-of-care ultrasound by a critical care retrieval team

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Abstract

Point-of-care ultrasound in the prehospital and retrieval environments has now become possible owing to decreased size and weight, and increasing robustness of some ultrasound machines. This report describes the initial experience of point-of-care ultrasound by an Australian critical care retrieval service using a portable ultrasound machine.

Key words: *critical care, patient transport, point-of-care, prehospital, retrieval, ultrasound.*

Introduction

Retrieval medicine is a continuously evolving medical subspecialty in Australia. Having a critical care specialist retrieve and transport patients with significant potential morbidity and mortality has been shown to improve patient outcome.[1,2]

Point-of-care ultrasound is a limited, goal-directed examination performed to answer specific clinical questions. Critical care specialists use ultrasound for focused assessment by sonography in trauma (FAST) and abdominal aortic aneurysm (AAA) diagnosis, as well as to answer specific clinical questions, such as, presence of ectopic pregnancy,[3] presence of gallstones.[4] Ultrasound is also used to aid in invasive procedures, such as, central line placement,[5] pericardial aspiration,[6] to minimize iatrogenic complications and improve procedure success rates.

With increasing ultrasound use in emergency medicine, intensive care and anaesthesia, it is logical that those specialists who use ultrasound in these environments should consider the applicability of this technology in the other areas that they work in, notably the prehospital and retrieval environment.[6,7]

Retrieval physicians could potentially improve critical patient care with access to point-of-care ultrasound in a number of ways:

- Early diagnosis[7,8] and commencement of appropriate treatment
- Decreased risk of iatrogenic injury in patients requiring invasive procedures
- Enhanced accuracy of communication with receiving hospitals on likely management and personnel requirements
- Decreased time to definitive care

Royal Adelaide Hospital (RAH) Mediflight (Adelaide, Australia) is a hospital-based critical care retrieval service that performs prehospital and interhospital medical retrievals for critically ill patients. Retrieval teams consist of a doctor and nurse from one of the

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Mazur et al, (2007)

- 60 USS on 48 Pts
- Diagnostic vs procedural
- Helicopter primary - 11/12 scans performed in flight
- Road / FW / RW used

Emergency ultrasound in the prehospital setting: the impact of environment on examination outcomes

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ABSTRACT

This study aimed to compare ultrasound examinations performed within a land ambulance (stationary and moving) with those completed in a simulated emergency department (ED) to determine the feasibility of undertaking ultrasound examinations within the UK prehospital care environment. The findings suggest that abdominal aortic aneurysm and extended focused assessment with sonography in trauma emergency ultrasound examinations can be performed in the stationary or moving land ambulance environment to a standard consistent with those performed in the hospital ED.

The use of ultrasound in the hospital emergency department (ED) environment is relatively new, but rapidly becoming a widely established diagnostic procedure. Ultrasound is commonly used as an adjunct to clinical assessment in patients with abdominal or chest trauma, suspected abdominal aortic aneurysm (AAA), or during interventions (including vascular access or nerve bock). The first published study on the use of ultrasound in emergency medicine for the assessment of abdominal injury was published in 1974.[1] Since then a number of studies have demonstrated its value in a range of acute and critical care situations.[2–7]

The reconfiguration of hospital services, as part of strategic plans to improve patient outcomes in the UK, is changing the landscape of acute and emergency hospital provision.[8 9] These changes will vary the medical skills and hospital resources available to support emergency care (eg, vascular, orthopaedic or neurosurgery) and will impact not only on ED service delivery but also on prehospital care and interhospital patient transfers.

The proposed changes may accentuate the risks associated with increased ambulance journey times to an appropriate ED or secondary transfers between sites.[10] These in turn may potentially decrease standards of care and ultimately impact on patient morbidity and mortality. In order to maximise the appropriateness of the initial hospital admission and minimise the potential for secondary transfer, accurate and timely prehospital assessment is essential. It has been proposed that an ultrasound examination could increase the effectiveness of the prehospital assessment in patients with abdominal/chest trauma or those with suspected AAA, thereby improving patient care and clinical outcomes.[11] As a result, a small number of authors have suggested that the extension of ultrasound examination from the ED to the prehospital setting could be advantageous.[12 13]

This study aimed to compare ultrasound examinations performed within a land ambulance (stationary and moving) with those completed in a simulated ED to determine the feasibility of undertaking ultrasound examinations within the UK prehospital care environment.

METHODS

This was an experimental repeatability study with ethical approval from the National Research Ethics Service. Four health professionals (two consultant emergency physicians and two sonographers) with substantial experience of performing emergency ultrasound examinations within the ED undertook ultrasound examinations in a moving land ambulance, stationary land ambulance and simulated standard ED facility on three occasions on the same day. The ambulance was a standard double manned vehicle, and suitable restraints (seatbelts) were used when appropriate. To reduce the risks associated with testing new equipment in a moving ambulance in normal traffic systems, ultrasound examination in the moving ambulance took place on a military airfield away from public highways. However, speed and direction were varied during each examination in order to simulate an urban environment. The ultrasound equipment was temporarily secured to part of the internal frame of the ambulance to reduce risk to ambulance occupants and permit the operator the use of both hands.

Two separate standard emergency ultrasound examinations were conducted: extended focused assessment with sonography in trauma (EFAST) (including limited assessment of the chest potentially to identify pneumothoraces) and AAA assessment. A Sonosite Nanomaxx (SonoSite, Inc., Bothell, WA) ultrasound machine with a 3.5 MHz curvilinear transducer was used to complete all examinations. Two healthy volunteer patients with similar physiques were recruited to eliminate the effect of body habitus on ultrasound procedure and facilitate the analysis of inter and intraobserver variability. Patient 1 was a 57-year-old man, 177.5 cm in height and weighing 82 kg. Patient 2 was a 43-year-old man, 172.5 cm in height and weighing 84.8 kg.

The quality of ultrasound images produced by participants in terms of anatomical display was independently assessed by an experienced clinical academic sonographer using an agreed proforma. All examination images were graded satisfactory (1), unsatisfactory (0) or indeterminate (2) with respect to anatomical display.

RESULTS

A total of 72 ultrasound examinations was performed (36 EFAST and 36 AAA). Using Fisher's

Snaith et al (2011)

- Road transport vs ED
- EFAST + AAA
- Time to complete / quality of scan
- PHUS results comparable to ED

Queensland Ambulance Service

Clinical practice procedures

Pre-hospital ultrasound

Version 1.0 – September 2011

Authorisation to practice

Pre-hospital ultrasound

Trained ICP officers approved by the Medical Director

ICP

Pre-hospital ultrasonography is a growing field in the assessment of trauma and critically ill patients.[1] It includes focused assessment of sonography for trauma (FAST), lung ultrasound and focused echocardiography. The QAS currently utilises this modality in proof of concept trials.

Indications

- FAST and lung scanning
  - blunt trauma
  - penetrating trauma
- Focused echo
  - cardiac arrest

Contraindications

- Nil in this setting

Precautions

- FAST is a dynamic investigation. Clinical judgment continues to guide patient therapy irrespective of ultrasound findings.

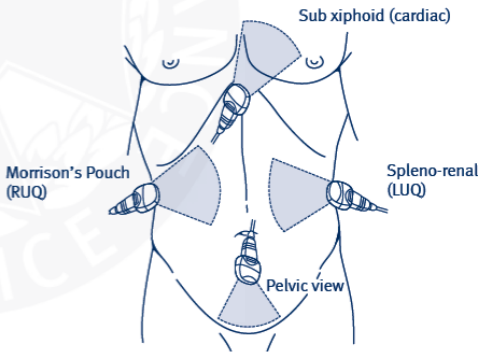
Additional information

FAST

FAST is a portable ultrasound examination used for trauma patients to determine whether there is any fluid within the abdomen and/or pericardium.[2] In the trauma setting this fluid is assumed to represent blood and is visualised as anechoic (black) on the ultrasound.

Four views comprise a FAST scan:

- Morrison's pouch – right upper quadrant (hepatorenal space)
- splenorenal space – left upper quadrant
- subxiphoid pericardial view
- pelvic view – longitudinal and transverse.



MedSTAR Retrieval Practitioner Program

> Retrieval Practitioner

- Nurse / paramedic

> 5 day program

> Supervised practice

- ED / ICU / retrieval

> Autonomous practice

MedSTAR Retrieval Practitioner Program

Current use:

- Line insertion
- EFAST
- Lung US
- RUSH
- AAA

Credentialling for Non-Physician Practitioners

Australasian Society of Ultrasound Medicine (ASUM)

- Certificate of Allied Health Performed Ultrasound (CAHPU)
- Endorsed by ACEM, RACS, RANZCOG, CICM, Sports Medicine and FRACP
- On line modules / proctored scans / log book

Multi-skilled Team

- Able to perform tasks in parallel
- Physician not required to perform all assessments / procedures
- Results in rapid assessment, treatment and transport
- Some medical trainees not trained or skilled in U/S
- RN / PM expanded scope of practice

Challenges

- Limited opportunity for clinical application
- Unsupervised scans - applicability of findings
- Acceptance of findings by others
- Accreditation / credentialing

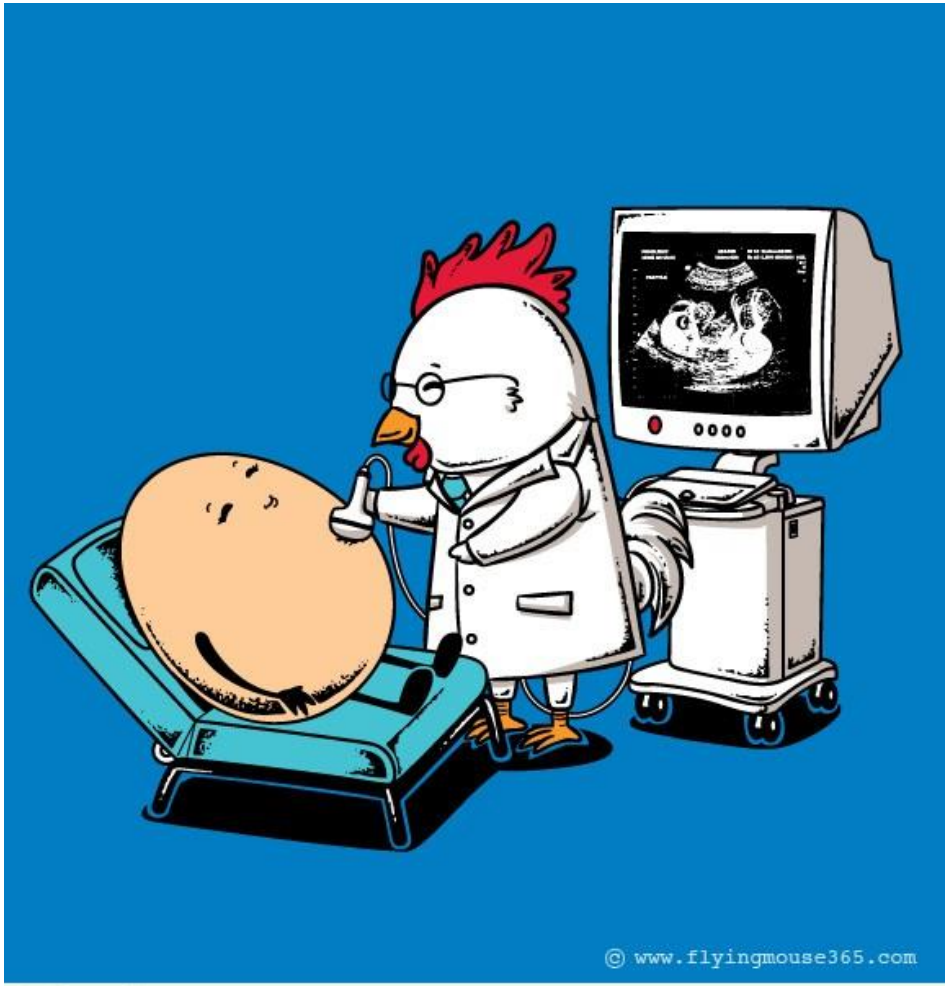
Future Directions

- PE - thrombolysis
- Optic nerve sheath US
  - raised ICP
- Transcranial US
  - stroke
- Technological improvements
  - “Smart phone” US

Summary

- US effective by non-physician providers
  - Improves diagnostic accuracy
  - Improves procedural safety
  - Standard of care?
- Competency possible with minimal training
- Wider use possible with technological advances

Questions?

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