FUJIFILM
Value from Innovation

SONOSITE

Patient Safety

The Evidence for Ultrasound Guidance During Invasive Procedures

Any patient. Anywhere. Anytime.

Introduction

This booklet highlights selected benefits and evidence for incorporating ultrasound guidance for 12 invasive procedures that are frequently performed by physicians and nurses throughout the hospital. Through data from clinical research studies, this booklet presents how point-of-care ultrasound impacts quality of care, patient safety, cost reduction, efficiency, and patient satisfaction.

About FUJIFILM Sonosite

FUJIFILM Sonosite, Inc. is the innovator and world leader in bedside and point-of-care ultrasound, and an industry leader in ultra-high frequency micro-ultrasound technology. Headquartered near Seattle, the company is represented by a global distribution network in over 100 countries. Sonosite's portable, compact systems are expanding the use of ultrasound across the clinical spectrum by cost-effectively bringing high-performance ultrasound to the point of patient care. Since its inception in April 1998, Sonosite's ultra lightweight and robust products have led the point-of-care ultrasound market with more than 125,000 systems installed worldwide. Sonosite's systems are used by over 21 medical specialties and provide physicians with the tools they need to improve patient safety and more efficient workflows, while cost effectively bringing high performance ultrasound to the point of patient care.

Benefit Guide

Quality of Care

Improved patient care through increasing accuracy and success when performing an invasive procedure.

Patient Safety

Improved patient outcomes through a reduction in procedure associated complications.

Cost Reduction

A reduction in the costs associated with the care of a patient undergoing an invasive procedure.

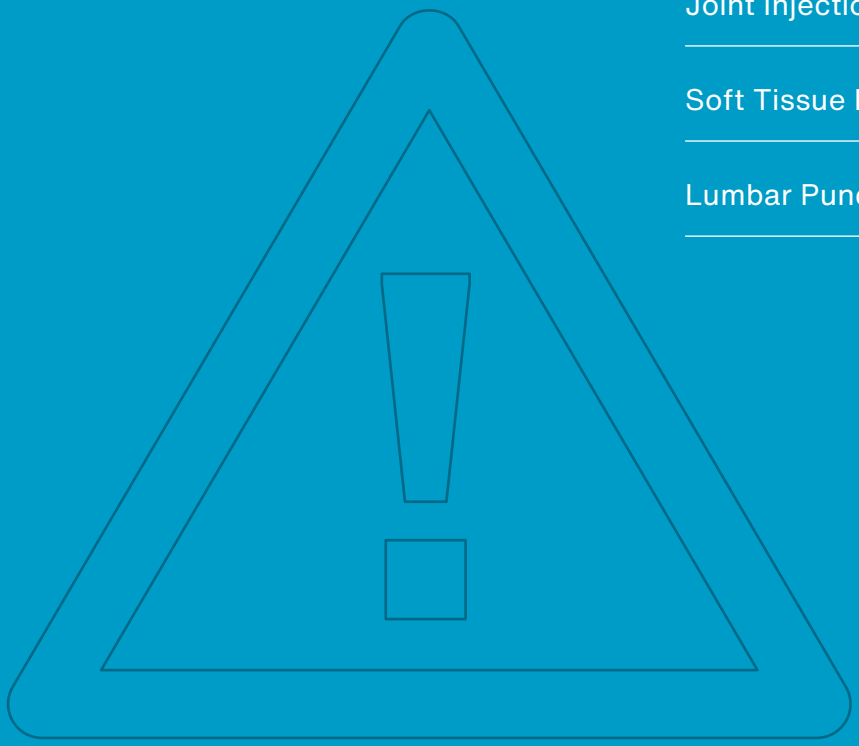
Efficiency

An improvement in measureable workflow factors such as time, throughput, and attempts.

Patient Satisfaction

Patients rated their invasive procedure experience as more positive.

Contents



Central Venous Catheter (CVC)

Benefits

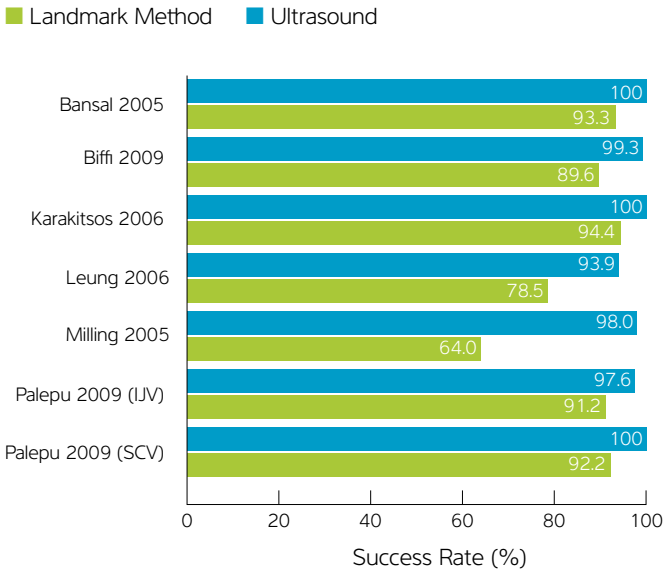
Quality – A 54% reduction in average number of attempts with ultrasound guidance compared to landmark technique. (Miller AH, et al.)

Safety – A complete elimination in the occurrence of iatrogenic pneumothorax with ultrasound guidance. (Karakitsos D, et al.)

Cost Reduction – A reduction in the $17,312 excess charge and 4.38 days in excess length of stay due to an iatrogenic pneumothorax. (Zhan C, et al.)

Efficiency – A 78% reduction in the length of procedure time with ultrasound guidance compared to landmark technique. (Miller AH, et al.)

Central Venous Access Success Rate, by Study



Selected Evidence

1. Karakitsos D, et al. **Real-time ultrasound-guided catheterisation of the internal jugular vein: a prospective comparison with the landmark technique in critical care patients.** Crit Care 2006;10(6):R162.
2. Leung J, et al. A. **Real-time ultrasonographically-guided internal jugular vein catheterization in the emergency department increases success rates and reduces complications: A randomized, prospective study.** Ann Emerg Med 2006;48(5):540-547.
3. Miller AH, et al. **Ultrasound guidance versus the landmark technique for the placement of central venous catheters in the emergency department.** Acad Emerg Med 2002;9(8):800-5.
4. Peabody CR, Mandavia D. **Deep needle procedures: improving safety with ultrasound visualization.** Journal of patient safety. 2017 Jun;13(2):103.
5. Wu SY, et al. **Real-time two dimensional ultrasound guidance for central venous cannulation: a meta-analysis.** Anesthesiology 2013;118(2):361-5.
6. Zhan C, et al. **Excess length of stay, charges, and mortality attributable to medical injuries during hospitalization.** JAMA 2003;290(14):1868-74.

CMS Hospital Acquired Conditions List

iatrogenic pneumothorax continues to be on the CMS hospital acquired condition list. Hospitals will not receive additional payments to cover the cost associated with this iatrogenic complication.

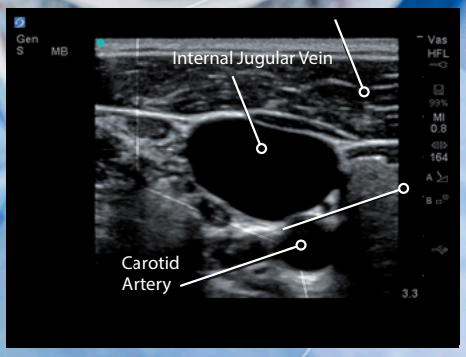
"The Agency for Healthcare Research and Quality highlighted ultrasound guided central lines as a key intervention that should be implemented immediately into twenty-first century patient care. This focus on patient safety will promote procedural ultrasound as it enables trained operators toward a "one stick" standard."

REFERENCE: Approved by ACEP Board of Directors. ACEP policy statement: emergency ultrasound imaging criteria compendium. Dallas, TX: American College of Emergency Physicians, 2006.

Endorsed by

ACGME	Accreditation Council for Graduate Medical Education in Pulmonary Disease and Critical Care Medicine (Internal Medicine)
AHRQ	Agency for Healthcare Research and Quality
AANA	American Association of Nurse Anesthetists
ABIM	American Board of Internal Medicine
ACCP	American College of Chest Physicians
ACEP	American College of Emergency Physicians
ACS	American College of Surgeons
ASA	American Society of Anesthesiologists
AVA	Association for Vascular Access
CDC	Centers for Disease Control and Prevention
ESPEN	The European Society for Clinical Nutrition and Metabolism
NICE	National Institute for Health and Clinical Excellence

Transverse Internal Jugular



Central Venous Catheter (CVC)

The Central Line Solution

Add ultrasound-guidance to the Institute for Healthcare Improvement (IHI) Central Line Bundle to address both Central Line Associated Blood Stream Infections (CLABSI) and mechanical complications, such as pneumothorax.

The 6-Point Bundle

Central line bundles such as the 5-point bundle endorsed by the IHI have been shown to decrease the rate of central line associated bloodstream infections:

1. Hand hygiene
2. Maximal barrier precautions
3. Chlorhexidine skin antisepsis
4. Optimal catheter site selection
5. Daily review of line necessity, with prompt removal of unnecessary lines

   The addition of a 6th point, ultrasound guidance of line placement, which the AHRQ and NICE recommends to reduce mechanical complications creates the comprehensive 6-point bundle.
6. Ultrasound Guidance for line placement.

⚠ **Safety –** 66% decrease in CLABSI over 18 months with the introduction of the 5-point bundle during the Keystone Project. (Pronovost P, et al.)

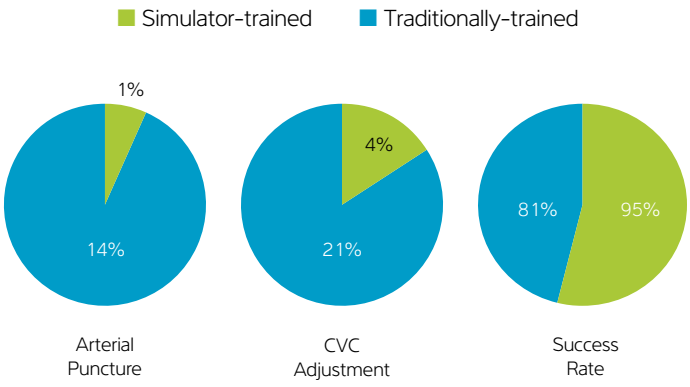
$ **Cost Reduction –** A decrease in the $5436.42 to $44,079* estimated attributable costs per bloodstream infection. (IHI)

* adjusted to represent inflation.

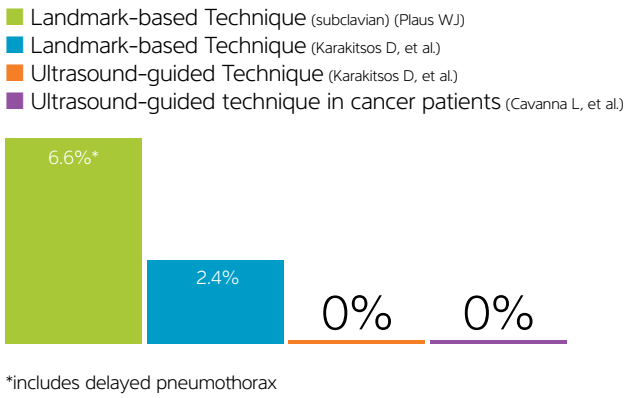
Simulator Training

⚠ **Patient Safety –** Simulator-based training for residents reduced the rate of CLABSI by 84.5% in the medical intensive care unit. (Barsuk JH, et al.)

The Effect of Simulator Training on Actual CVC Placement by Residents in the MICU



Occurrence of Pneumothorax



*includes delayed pneumothorax

Need help on starting a CVC management program?

Check out our comprehensive guide:
The SonoSite Solution for Safer CVC Insertion.

www.sonositesolutions.com

0%

Occurrence of iatrogenic pneumothorax with the use of ultrasound guidance

(Karakitsos D, et al.)

Selected Evidence

1. Barsuk JH, et al. **Simulation mastery learning reduces complications during central venous catheter insertion in a medical intensive care unit.** Crit Care Med 2009;37(10):2697-701.
2. Barsuk JH, et al. **Use of simulation-based education to reduce catheter-related bloodstream infections.** Arch Intern Med 2009;169(15):1420-3.
3. Cavanna L, et al. **Ultrasound-guided central venous catheterization in cancer patients improves the success rate of cannulation and reduces mechanical complications: a prospective observational study of 1,978 consecutive catheterizations.** World journal of surgical oncology. 2010 Dec;8(1):91.
4. How-to Guide: Prevent Central Line-Associated Bloodstream Infections (CLABSI). Cambridge, MA: Institute for Healthcare Improvement; 2012. (Available at www.ihi.org)
5. Plaus WJ. **Delayed pneumothorax after subclavian vein catheterization.** J Parenter Enteral Nutr 1990; 14(4):414-5.
6. Pronovost P, et al. **An intervention to decrease catheter-related bloodstream infections in the ICU.** N Engl J Med 2006;355(26):2725-32.

Peripheral IV (PIV)

Benefits

Quality – A 54% reduction in the number of attempts with ultrasound guidance compared to landmark technique. (Constantino TG, et al.)

Safety – Prevention of central line placement in 85% of patients with difficult IV access. (Au A, et al.)

Cost Reduction – The introduction of a registered nurse ultrasound-guided peripheral IV program reduced the number of one-time use PICC lines, saving approximately $200,000 per year at their institution. (Miles G, et al.)

Patient Satisfaction – 69% of patients rated the ultrasound-guided peripheral IV as much better than previous IVs. (Schoenfeld EM, et al.)

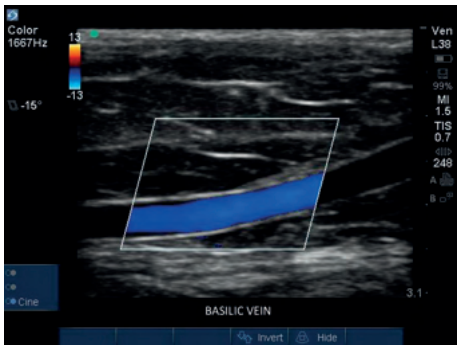
Selected Evidence

1. Au AK, Rotte MJ, Grzybowski RJ, Ku BS, Fields JM. **Decrease in central venous catheter placement due to use of ultrasound guidance for peripheral intravenous catheters.** Am J Emerg Med. 2012 Nov;30(9):1950-4.
2. Constantino TG, et al. **Ultrasonography-guided peripheral intravenous access versus traditional approaches in patients with difficult intravenous access.** Ann Emerg Med 2005;46(5):456-61.
3. Egan G, Healy D, O'Neill H, Clarke-Moloney M, Grace PA, Walsh SR. **Ultrasound guidance for difficult peripheral venous access: systematic review and meta-analysis.** Emerg Med J. 2013 Jul;30(7):521-6.
4. Gregg SC, et al. **Ultrasound-guided peripheral intravenous access in the intensive care unit.** J Crit Care 2010;25(3):514-9.
5. Miles G, Salcedo A, Spear D. **Implementation of a successful registered nurse peripheral ultrasound-guided intravenous catheter program in an emergency department.** J Emerg Nurs. 2012 Jul;38(4):353-6.
6. Schoenfeld EM, et al. **Ultrasound-guided peripheral intravenous access in the emergency department: patient-centered survey.** West J Emerg Med 2011;12(4):475-7.

99%

success rate of insertion with ultrasound guidance (Gregg SC, et al.)

Longitudinal Basilic Vein



Need help on starting an Ultrasound-guided Peripheral IV program?

Check out The SonoSite Solution for Difficult PIVs.

www.sonositesolutions.com

Endorsed by

ACEP	American College of Emergency Physicians
AIUM	American Institute of Ultrasound in Medicine
ASE	American Society of Echocardiography
SCA	Society of Cardiovascular Anesthesiologists
BEST	Best Evidence Statement
ENA	Emergency Nurses Association

Peripherally Inserted Central Catheter (PICC)

Benefits

Quality – There was 100% success for ultrasound-guided PICC insertions versus 82% for blind (landmark-based) attempts. (Parkinson, et al.)

Safety – A reduction in the rate of thrombosis with the use of ultrasound compared to palpation technique. (Stokowski G, et al.)

Cost Reduction – 24% decrease in PICC placement cost when ultrasound was incorporated into PICC team's process. (Robinson MK, et al.)

Efficiency – In a recent RCT involving pediatric patients, success in the first puncture attempt was higher in the ultrasound group (90.5%) than in the control group (47.6%), and the median time spent on the procedure was 30 minutes faster for the ultrasound group. (de Carvalho Onofre, et al.)

Selected Evidence

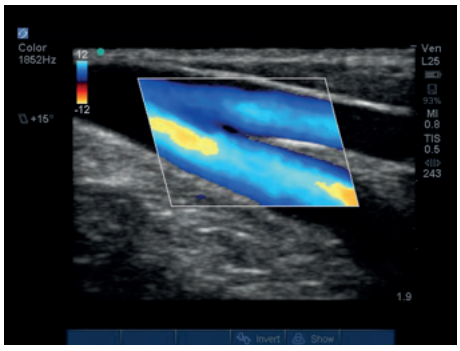
1. de Carvalho Onofre PS, et al. **Placement of peripherally inserted central catheters in children guided by ultrasound: a prospective randomized, and controlled trial.** Pediatric Critical Care Medicine. 2012 Sep 1;13(5):e282-7.
2. Lamperti M, et al. **International evidence-based recommendations on ultrasound-guided vascular access.** Intensive Care Med. 2012;38(7):1105-1117.
3. Parkinson R, Gandhi M, Harper J, Archibald C. **Establishing an ultrasound guided peripherally inserted central catheter (PICC) insertion service.** Clin Radiol 1998;53:33– 6.
4. Robinson MK, et al. **Improved care and reduced costs for patients requiring peripherally inserted central catheters: the role of bedside ultrasound and a dedicated team.** JPEN J Parenter Enteral Nutr 2005;29(5):374-9.
5. Stokowski G, et al. **The use of ultrasound to improve practice and reduce complication rates in peripherally inserted central cather insertions.** J Infus Nurs 2009;31(3):145-55.

80%

decrease in wait-time for PICC placement when bedside ultrasound was incorporated into PICC team's process.

(Robinson MK, et al.)

Cephalic Venous Confluence



Endorsed by

AANA	American Association of Nurse Anesthetists
AVA	Association for Vascular Access
ACCP	American College of Chest Physicians
ACEP	American College of Emergency Physicians
ESPEN	The European Society for Clinical Nutrition and Metabolism
NHS	NHS Greater Glasgow and Clyde GG&C
ASE	American Society of Echocardiography
SCA	Society of Cardiovascular Anesthesiologists
AIUM	American Institute for Ultrasound in Medicine

Arterial Cannulation

Benefits

Quality – Increased first pass success rate during radial artery cannulation by 71% with ultrasound guidance compared to palpation. (Shiloh AL, et al.)

Safety – A 86% reduction in the occurrence of a hematoma with ultrasound guidance compared to palpation for radial artery cannulation. (Shriver S, et al.)

Efficiency – The median time to success using ultrasound during radial artery cannulation was 3.3 minutes versus 10.4 minutes with the landmark-based technique. (Anantasit, et al.)

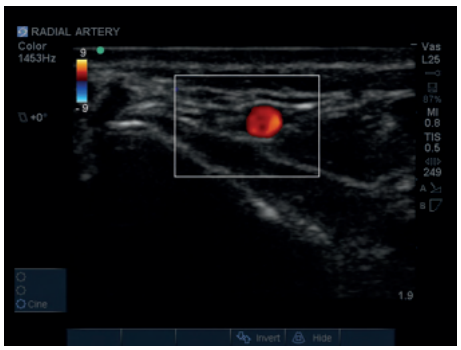
Selected Evidence

1. Anantasit N, Cheeptinnakorntaworn P, Khositseth A, Lertbunrian R, Chantra M. **Ultrasound Versus Traditional Palpation to Guide Radial Artery Cannulation in Critically Ill Children: A Randomized Trial.** Journal of Ultrasound in Medicine. 2017 Dec 1;36(12):2495-501.
2. Seto AH, et al. **Real-time ultrasound guidance facilitates femoral arterial access and reduces vascular complications: FAUST (The Femoral Arterial Access with Ultrasound Trial).** JACC CardioVasc Interv 2010;3(7):751-8.
3. Shiloh AL, et al. **Ultrasound-guided catheterization of the radial artery:a systematic review and meta-analysis of randomized controlled trials.** Chest 2011;139(3):524-9.
4. Shriver S, et al. **A prospective comparison of ultrasound-guided and blindly placed radial arterial catheters.** Acad Emerg Med 2006;13(12):1275-9.

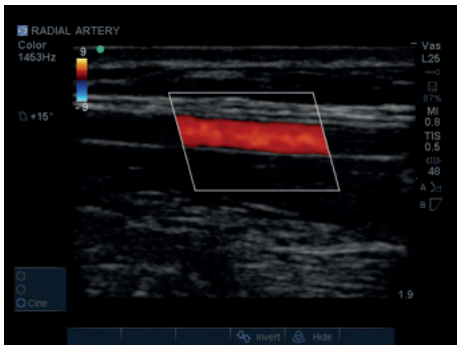
Related applications

Angiography; Angioplasty; Aortic Endograft Placement; Embolization; Intra-arterial Thrombolyisis; Endovascular Stenting; Cardiac Ablation; Cardiac Catherization; Cardiac Ablation

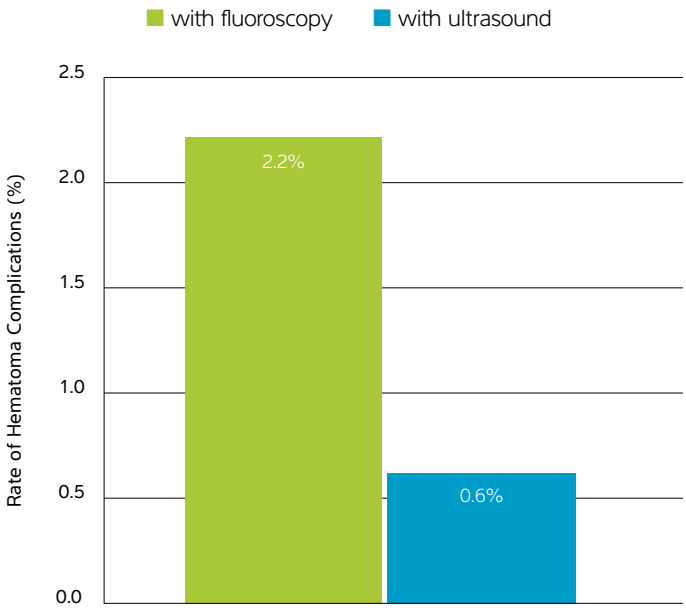
Transverse View Radial Artery

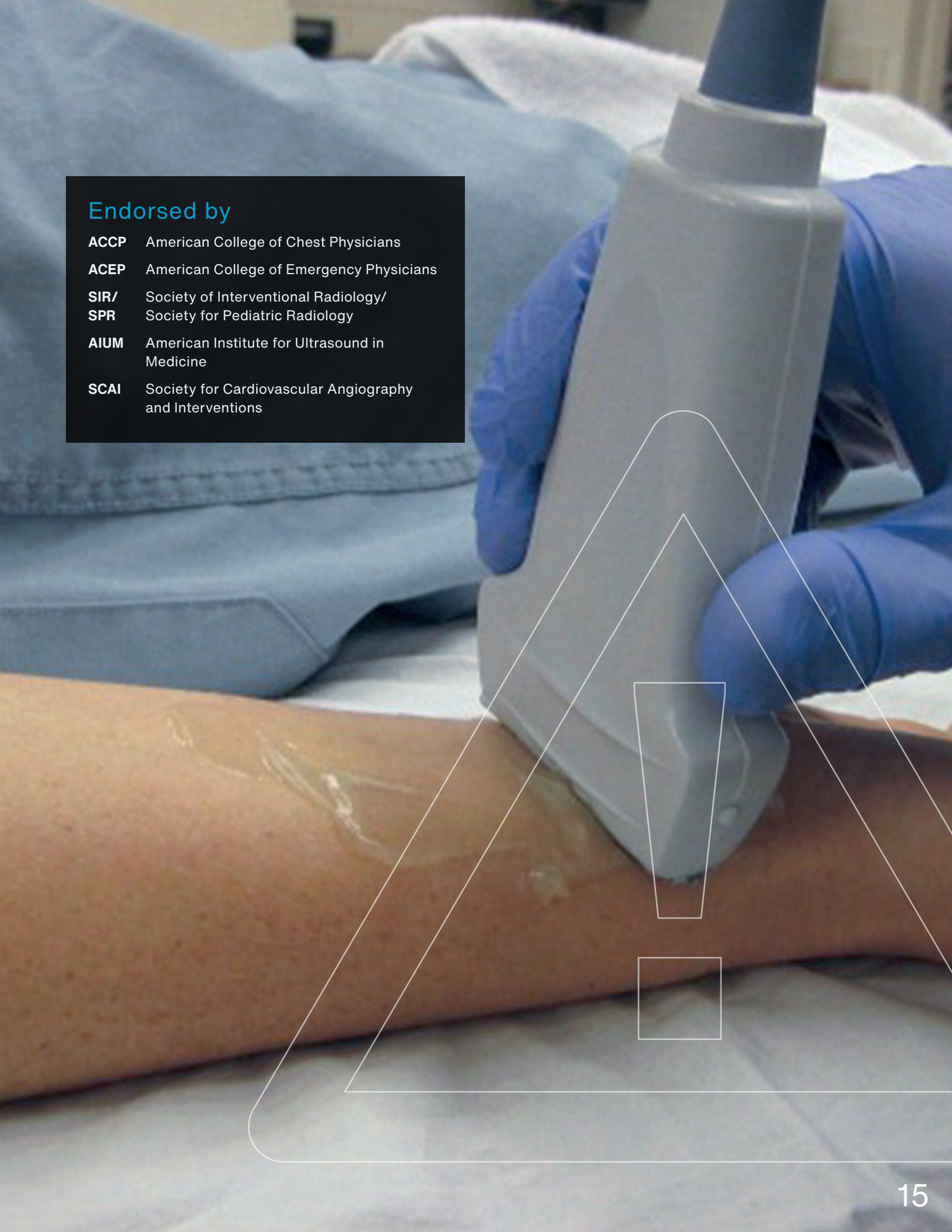


Longitudinal View Radial Artery



The Effect of Ultrasound Guidance on Hematoma Complications during Femoral Arterial Cannulation





Endorsed by

ACCP	American College of Chest Physicians
ACEP	American College of Emergency Physicians
SIR/ SPR	Society of Interventional Radiology/ Society for Pediatric Radiology
AIUM	American Institute for Ultrasound in Medicine
SCAI	Society for Cardiovascular Angiography and Interventions

Nerve Blocks: Epidural, Regional Anesthesia

Benefits

Quality – Increase in the nerve block duration by 25% with ultrasound guidance compared to peripheral nerve stimulation. (Abrahams MS, et al.)

Safety – A significant decrease in risk of vascular puncture (risk ratio of .16) with ultrasound compared to peripheral nerve stimulation. (Abrahams MS, et al.)

A review of 9 RCTs, confirms there is a lower predicted frequency of pneumothorax associated with ultrasound-guided in supraclavicular blocks. (Neal, J)

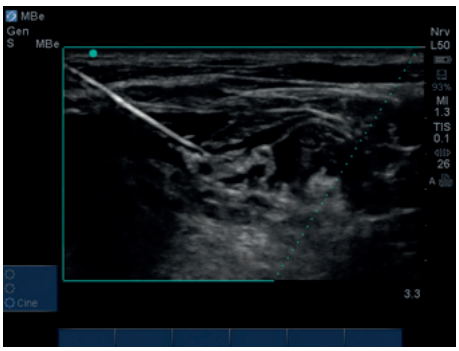
Efficiency – 29% faster onset time with ultrasound guidance compared to peripheral nerve stimulation. (Abrahams MS, et al.)

Patient Satisfaction – A 99.5% reduction in post-operative pain score with the use of ultrasound guidance for a nerve block compared to general anesthesia. (O'Donnell DB, et al.)

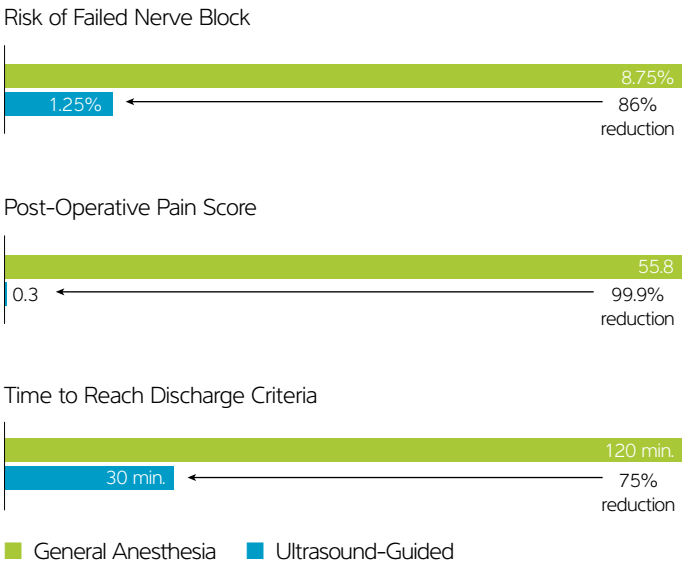
Selected Evidence

1. Abrahams MS, et al. **Ultrasound guidance compared with electrical neurostimulation for peripheral nerve blocks: a systematic review and meta-analysis of randomized controlled trials.** Br J Anaesth 2009;102(3):408-17.
2. Carvalho JC, et al. **Ultrasound-facilitated epidurals and spinals in obstetrics.** Anesthesiol Clin 2008;26(1):145-58, vii-viii.
3. Neal, Joseph M. **Ultrasound-guided regional anesthesia and patient safety: update of an evidence-based analysis.** Regional anesthesia and pain medicine 41.2 (2016): 195-204.
4. O'Donnell DB, et al. **Ultrasound-guided axillary brachial plexus block with 20 milliliters local anesthetic mixture versus general anesthesia for upper limb trauma surgery: an observer-blinded, prospective, randomized, controlled trial.** Anesth Analq 2009;109(1):279-83.

Femoral Nerve Block



The Effect of Ultrasound Guidance in Regional Anesthesia



Endorsed by

AANA	American Association of Nurse Anesthetists
NICE	National Institute for Health and Clinical Excellence
ASRA	American Society of Regional Anesthesia and Pain Medicine
ESRA	European Society of Regional Anaesthesia and Pain Therapy

Pain Medicine

Benefits

Quality – Clinical successful block achieved in 9 out of 10 third occipital nerve block cases with ultrasound guidance. (Eichenberger U, et al.)

Safety – With the use of ultrasound guidance, 100% needle tip placement in the joint space during facet joint infiltrations in the cadaver study. (Galiano K, et al.)

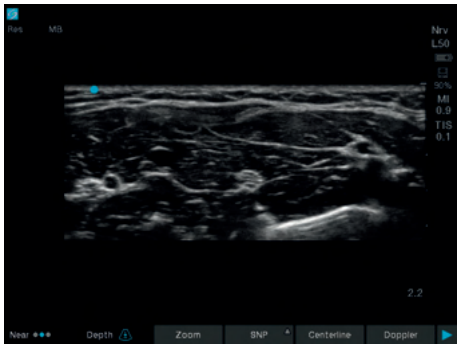
Efficiency – Direct visualization with ultrasound of the nerve reduces the need for 3 needle placements traditionally needed with fluoroscopically guided third occipital blocks. (Eichenberger U, et al.)

Patient Satisfaction – There was a significant reduction in pain and a decreased amount of rescue analgesia (morphine sulfate) in elderly patients with hip-fractures when an ultrasound-guided nerve block was performed. (Beaudoin, et al.)

Selected Evidence

1. Beaudoin FL, et al. **A Comparison of Ultrasound-guided Three-in-one Femoral Nerve Block Versus Parenteral Opioids Alone for Analgesia in Emergency Department Patients With Hip Fractures: A Randomized Controlled Trial.** Academic Emergency Medicine 20.6 (2013): 584-591.
2. Choi S, et al. **Evidence base for the use of ultrasound for upper extremity blocks: 2014 update.** Regional anesthesia and pain medicine 41.2 (2016): 242-250.
3. Eichenberger U, et al. **Sonographic visualization and ultrasound-guided block of the third occipital nerve.** Anesthesiology 2006;104(2):303-8.October 2011.
4. Galiano K, et al. **Ultrasound guidance for facet joint injections in the lumbar spine: a computed tomography-controlled feasibility study.** Anesth Analg 2005;101(2):579-83.
5. Neal JM, et al. **The ASRA evidence-based medicine assessment of ultrasound-guided regional anesthesia and pain medicine: executive summary.** Regional anesthesia and pain medicine.
2010 Mar 1;35(2):S1-9.
6. Rudd RA, et al. **Increases in Drug and Opioid-Involved Overdose Deaths—United States, 2010–2015.** MMWR Morb Mortal Wkly Rep. ePub: 16 December 2016.

Median Nerve Forearm



Every day, 91 Americans die from an opioid overdose, ultrasound-guided nerve blocks can be an alternative to opioids.

Check out The SonoSite Solution for ultrasound-guided nerve blocks. (Rudd et al.)

www.sonositesolutions.com

Endorsed by

AANA American Association of Nurse Anesthetists

ASRA American Society of Regional Anesthesia and Pain Medicine

ESRA European Society of Regional Anaesthesia and Pain Therapy

AAFPS Asian Australasian Federation of Pain Societies

The analysis of 47 **RCTs**, supports the use of ultrasound over other nerve localization techniques in upper extremity blocks. The analysis shows:

Efficiency: improved in block performance time, and shortening sensory block onset

Quality: improved first pass success, and overall block success

Safety: decreased incidence of vascular puncture

Thoracentesis

Benefits

Quality – Overall, ultrasound prevented possible accidental organ puncture in 10% of all cases and increased the rate of accurate sites by 26%. (Diacon AH, et al.)

Safety – The use of bedside ultrasound was associated with a 38.7% reduction in likelihood of hemorrhage when compared to the landmark technique (Mercaldi, et al.)

Cost Reduction – A 20% reduction in hospitalization costs for a thoracentesis performed without complications. (Mercaldi CJ, et al.)

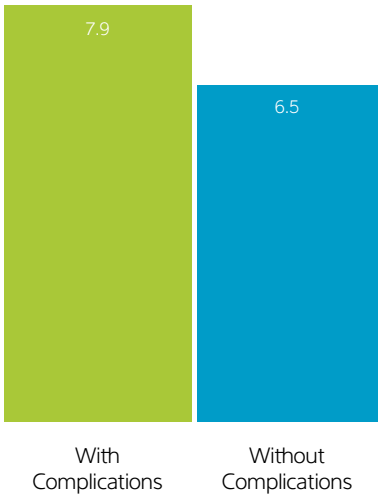
Selected Evidence

1. Barnes TW, et al. **Sonographically guided thoracentesis and rate of pneumothorax.** J Clini Ultrasound. 2005;33(9):442-6.
2. Diacon AH, et al. **Accuracy of pleural puncture sites: prospective comparison of clinical examination with ultrasound.** Chest 2003;123(2):436-41.
3. Mercaldi CJ, et al. **The clinical and economic advantages of ultrasound guidance among patients undergoing thoracentesis [abstract].** National Patient Safety Foundation Patient Safety Congress 2011. May 2011.
4. Mercaldi CJ, et al. **Ultrasound guidance decreases complications and improves the cost of care among patients undergoing thoracentesis and thoracentesis.** CHEST Journal 143.2 (2013): 532-538.

52%

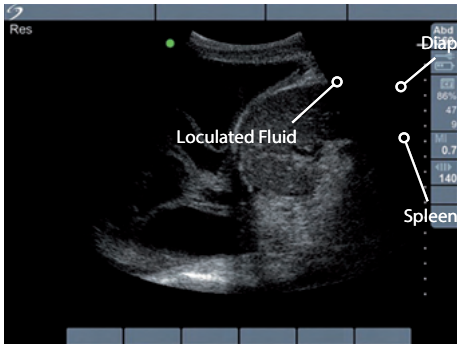
decrease in the occurrence of an iatrogenic pneumothorax complication with the use of ultrasound guidance. (Barnes TW, et al.)

Length of Stay (Days)



(Mercaldi CJ, et al.)

Loculated Pleural Effusion



Need help starting an Ultrasound-guided Thoracentesis program?

Check out The SonoSite Solution for Safer Thoracentesis.

www.sonositesolutions.com

Endorsed by

ABIM	American Board of Internal Medicine
ACCP	American College of Chest Physicians
ACEP	American College of Emergency Physicians
ACGME	Accreditation Council for Graduate Medical Education in Pulmonary Disease and Critical Care Medicine (Internal Medicine)
BTS	British Thoracic Society
CADTH	Canadian Agency for Drugs and Technologies in Health
SIR	Society of Interventional Radiology
SCCM	Society of Critical Care Medicine
WIN-FOCUS	World Interactive Network Focused on Critical Ultrasound

Paracentesis

Benefits

Quality – Increased success rate from 65% to 95% with the use of ultrasound compared to the traditional technique. (Nazeer SR, et al.)

Safety – A 68% reduction in bleeding complications following a paracentesis procedure with ultrasound guidance. (Mercaldi CJ, et al.)

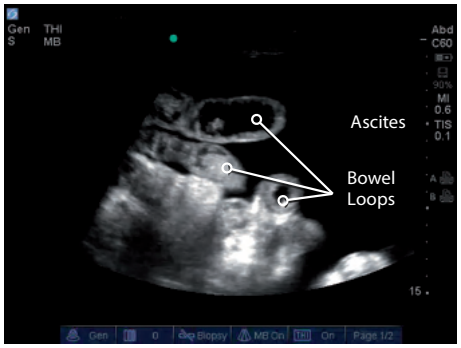
Doppler ultrasonography prior to paracentesis can identify these vessels before the procedure and its use has been advocated in the literature to avoid major hemorrhagic complications. (Sekiguchi H, et al.)

Cost Reduction – A 45% reduction in the length of stay for a paracentesis performed without complications. (Mercaldi CJ, et al.)

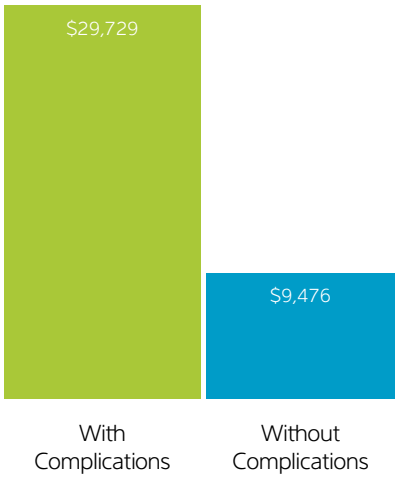
Selected Evidence

1. Mercaldi, Catherine J, and Stephan F. Lanes. **Ultrasound guidance decreases complications and improves the cost of care among patients undergoing thoracentesis and paracentesis.** CHEST Journal 143.2 (2013): 532-538.
2. Nazeer SR, et al. **Ultrasound-assisted paracentesis performed by emergency physicians vs. the traditional technique: a prospective, randomized study.** AM J Emerg Med 2005;23(3):363-7.
3. Peabody CR, Mandavia D. **Deep needle procedures: improving safety with ultrasound visualization.** Journal of patient safety. 2017 Jun;13(2):103.
4. Sekiguchi H, et al. **Making paracentesis safer: a proposal for the use of bedside abdominal and vascular ultrasonography to prevent a fatal complication.** CHEST Journal 143.4 (2013): 1136-1139.

Ascites



Hospitalization Costs



(Mercaldi CJ, et al.)

Need help on starting an Ultrasound-guided Paracentesis program?

Check out The SonoSite Solution for Safer Paracentesis.

www.sonositesolutions.com

Endorsed by

ACCP American College of Chest Physicians

ACEP American College of Emergency Physicians

AASLD American Association for the Study of Liver Diseases

ESICM European Society of Intensive Care Medicine

SCCM Society of Critical Care Medicine

Pericardiocentesis

Benefits

Quality – 97% success rate of removing pericardial fluid and/or relieving tamponade with echo guidance. (Tsang TSM, et al.)

Safety – "The overall total complication rate of 4.7% was substantially lower than that reported for blind pericardiocenteses, for which morbidity approached 20% and mortality rates were as high as 6%." (Tsang TSM, et al.)

Efficiency – 89% first attempt success rate at gaining access into the pericardial space with echo guidance. (Tsang TSM, et al.)

Selected Evidence

1. Osranek M, et al. **Hand-carried ultrasound-guided pericardiocentesis and thoracentesis.** J AM Soc Echocardiogr 2003;16(5):480-4.
2. Porter TR, et al. **Guidelines for the use of echocardiography as a monitor for therapeutic intervention in adults: a report from the American Society of Echocardiography.** Journal of the American Society of Echocardiography. 2015 Jan 1;28(1):40-56.
3. Tsang TSM, et al. **Clinical and echographic characteristics of significant pericardial effusions following cardiothoracic surgery and outcomes of echo-guided pericardiocentesis for management: Mayo clinical experience, 1979-1998.** CHEST 1999 Aug;116(2):322-31.
4. Tsang TSM, et al. **Consecutive 1127 therapeutic echocardiography guided pericardiocenteses: clinical profile, practice patterns, and outcomes spanning 21 years.** Mayo Clin Proc 2002;77(5):429-36.

96%

success rate of decompressing loculated effusions with echo guidance

(Tsang TSM, et al.)

Pericardial Effusion

Endorsed by

ASE	American Society of Echocardiography
ACEP	American College of Emergency Physicians
ESC	European Society of Cardiology
EACTS	The European Association for Cardio-Thoracic Surgery
SCCM	Society of Critical Care Medicine

The ASE Guidelines State:

"For pericardiocentesis, echocardiographic monitoring has replaced fluoroscopy at many centers because of its ability to detect and guide needle and catheter placement ..."

Joint Injections/Arthrocentesis

Benefits

Quality – In a review of 6 studies, ultrasound guided injections in the foot and ankle were universally 100% accurate compared to 58%-85% for landmark guided injections (Daniels, et al.)

Safety – Ultrasound provides direct visualization of the neurovascular structures during hip injections. (Sofka CM, et al.)

Cost Reduction – 8% decrease in cost/patient/year and a 33% decrease in cost/responder/year* for a hospital outpatient with ultrasound guidance compared to palpation. (Sibbitt WL, et al.)

Patient Satisfaction – 33% less absolute procedural pain with ultrasound compared to palpation. (Sibbitt WL, et al.)

Selected Evidence

1. Daniels EW, et al. **Existing Evidence on Ultrasound-Guided Injections in Sports Medicine.** Orthopaedic journal of sports medicine. 2018 Feb 15;6(2):2325967118756576.
2. Daley EL, et al. **Improved injection accuracy of the elbow, knee and shoulder: does injection site and imaging make a difference? A systematic review.** Am J Sports Med 2011;39(3):656-62.
3. Sibbitt WL, et al. **A randomized controlled trial of the cost-effectiveness of ultrasound-guided intraarticular injection of inflammatory arthritis.** J Rheumatol. 2011;38(2):252-63.
4. Sofka CM, et al. **Ultrasound-guided adult hip injections.** J Vasc Interv Radiol 2005;16(8):1121-3.

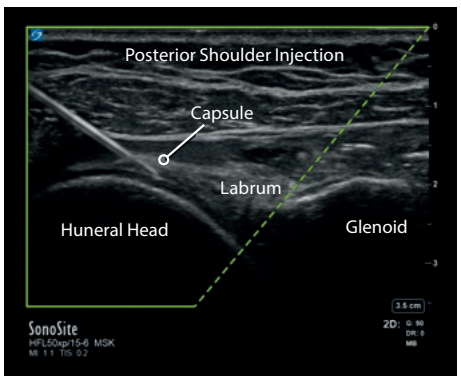
* "Responders were defined as an asymptomatic joint (VAS < 2 cm) at 2 weeks" (Sibbitt WL, et al).

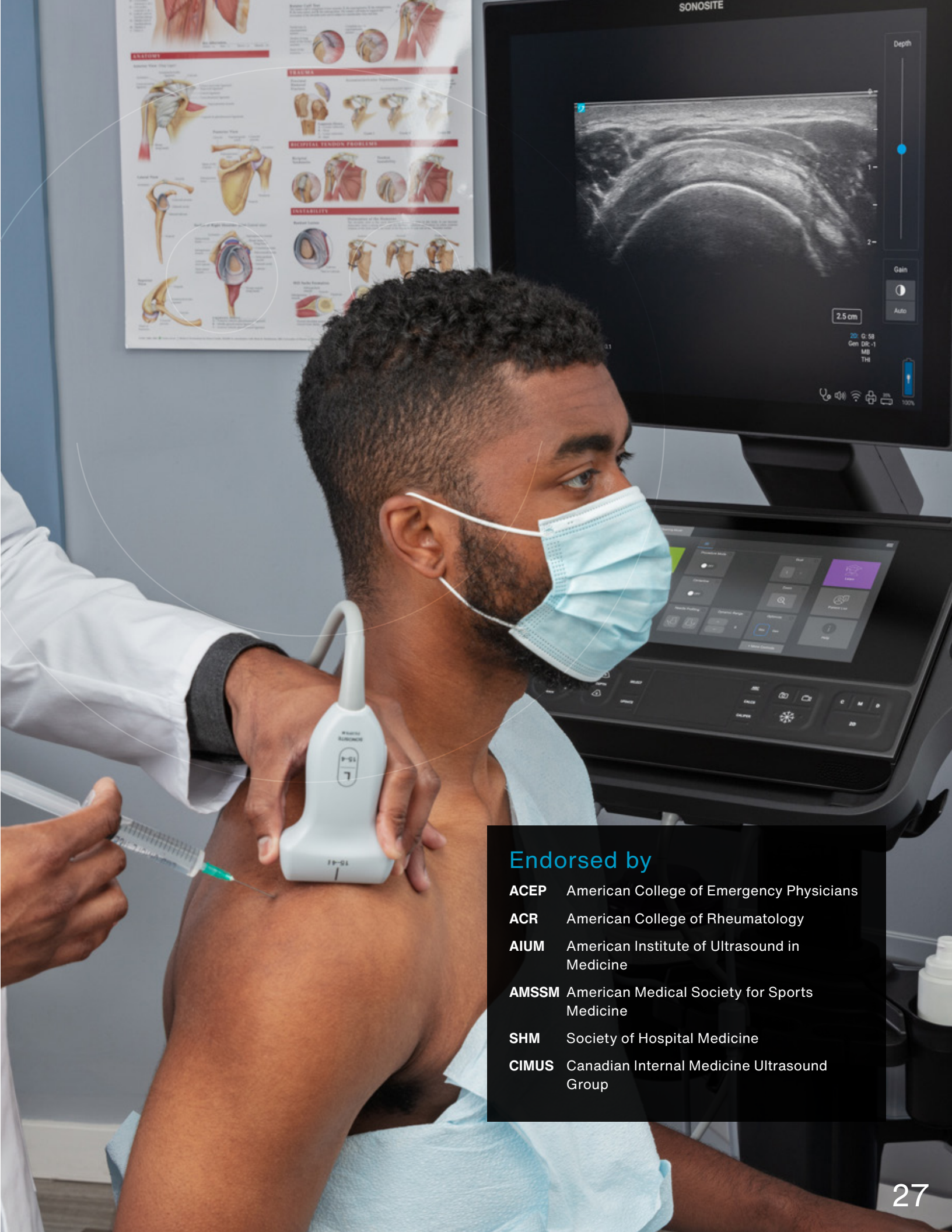
33%

less absolute procedural pain with ultrasound compared to palpation

(Sibbitt WL, et al.)

Posterior Shoulder Joint Injection





Endorsed by

ACEP	American College of Emergency Physicians
ACR	American College of Rheumatology
AIUM	American Institute of Ultrasound in Medicine
AMSSM	American Medical Society for Sports Medicine
SHM	Society of Hospital Medicine
CIMUS	Canadian Internal Medicine Ultrasound Group

Soft Tissue Procedures

Benefits

Quality – A 37% decrease in the rate of inadequate specimens for fine needle aspiration biopsies of thyroid nodules with ultrasound guidance compared to palpation. (Izquierdo R, et al.)

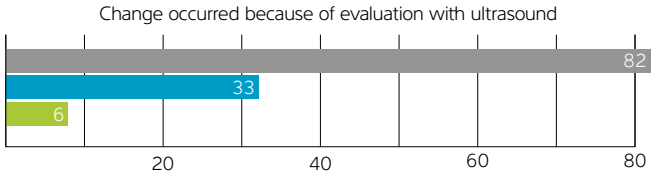
Safety – 95.8% agreement of US-guided 14-gauge core needle biopsy results, surgical excision findings, and follow-up results. (Schueller G, et al.)

Efficiency – A 37% decrease in room time and a 31% decrease in physician time with ultrasound guidance compared to stereotactic technique for breast biopsy. (Mainiero MB, et al.)

Patient Satisfaction – 93% of patients were satisfied with the ultrasound-guided breast procedure. (Evans KD)

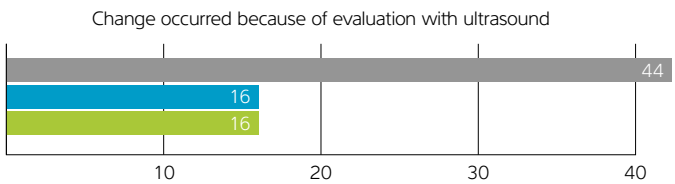
Pre-Test for patients with Cellulitis: Believed No Need for Drainage

- Total Patients
- Actually needed drainage
- Received further diagnostics or consultation



Pre-Test for patients with Cellulitis: Believed Further Drainage Needed

- Total Patients
- No longer believed needed drainage
- Received further procedure guidance, diagnostic tests, or consultation



Selected Evidence

1. Davis J, et al. **Diagnostic accuracy of ultrasonography in retained soft tissue foreign bodies: a systematic review and meta-analysis.** Academic Emergency Medicine. 2015 Jul 1;22(7):777-87.
2. Evans KD. **Investigating patient satisfaction as an outcome for ultrasound-guided breast procedures.** J Diagn Med Sonog 1998;14(3):107-112.
3. Izquierdo R, et al. **Comparison of palpation versus ultrasound-guided fine-needle aspiration biopsies of thyroid nodules in an outpatient endocrinology practice.** Endocr Pract 2006; 12(6):609-14.
4. Mainiero MB, et al. **Preferential use of sonographically guided biopsy to minimize patient discomfort and procedure time in a percutaneous image-guided breast biopsy program.** J Ultrasound Med 2002;21(11):1221-6.
5. Schueller G, et al. **US-guided 14-gauge core-needle breast biopsy: results of a validation study in 1352 cases.** Radiology. 2008;248(2):406-13.
6. Tayal VS, et al. **The effect of soft-tissue ultrasound on the management of cellulitis in the emergency department.** Acad Emerg Med 2006;13(4):384-8.

Example applications

- Fine Needle Aspirations
- Foreign Body Removal
- Incision and Drainage
- Soft Tissue Biopsy

56%

Ultrasound changed the management of patients with cellulitis in 56% of cases.

(Tayal VS, et al.)

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AASLD American Association for the Study of Liver Diseases

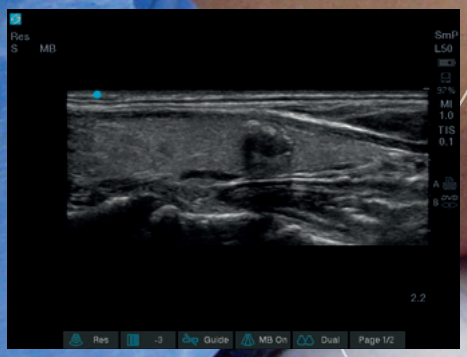
ACEP American College of Emergency Physicians

AIUM American Institute of Ultrasound in Medicine

ASBS American Society of Breast Surgeons

BSG British Society of Gastroenterology

Thyroid Nodule



Lumbar Puncture

Benefits

Quality – In all patients, ultrasound landmarks were 1.32 times more likely to be successful than palpation landmarks. (Nomura JT, et al.)

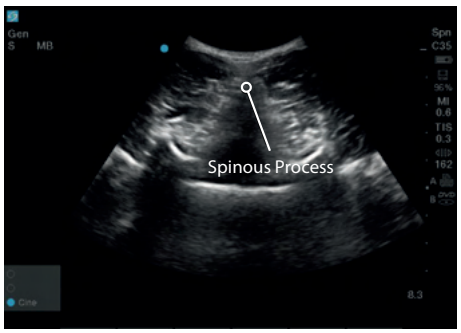
Safety – Provides visualization of cord structures in neonates and infants preventing accidental puncture without exposure to ionizing radiation. (Coley BD, et al.)

Efficiency – In 87.9% of scans, 4-5 relevant structures were identified in less than 1 minute. (Ferre RM, et al.)

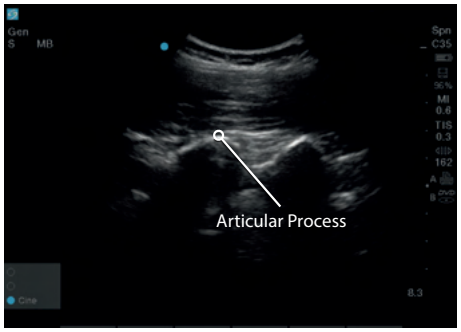
Selected Evidence

1. Coley BD, et al. **Diagnostic and interventional ultrasonography in neonatal and infant lumbar puncture.** Pediatr Radiol 2001;31(6):399-402.
2. Ferre RM, et al. **Emergency physicians can easily obtain ultrasound images of anatomical landmarks relevant to lumbar puncture.** AM J Emerg Med 2007;25(3):291-6.
3. Nomura JT, et al. **A randomized controlled trial of ultrasound-assisted lumbar puncture.** J Ultrasound Med 2007;26(10):1341-8.
4. Perlas A, et al. **Lumbar neuraxial ultrasound for spinal and epidural anesthesia: a systematic review and meta-analysis. Regional anesthesia and pain medicine.** 2016 Mar 1;41(2):251-60.
5. Williams S, et al. **How to do it: bedside ultrasound to assist lumbar puncture.** Practical Neurology 2017;17:47-50.

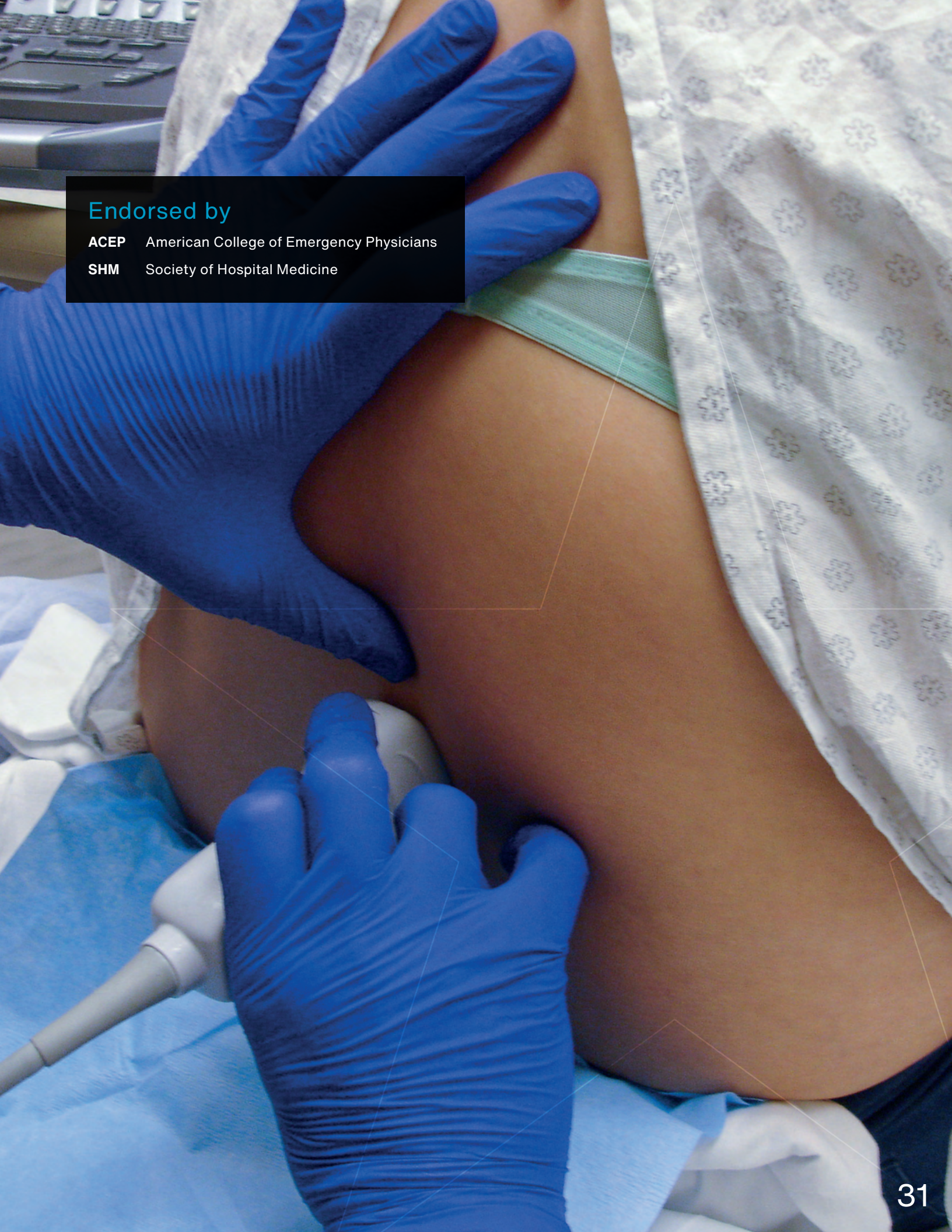
Transverse View Spinous Process



Longitudinal View Spinous Processes With Inter Spinous Space



In a **meta-analysis** with **14 RCTs** the number needed to treat using ultrasound guided lumbar punctures to reduce one failure was 16. There was a significant reduction in the number of attempts and needle reductions when using ultrasound. (Perlas et al.)



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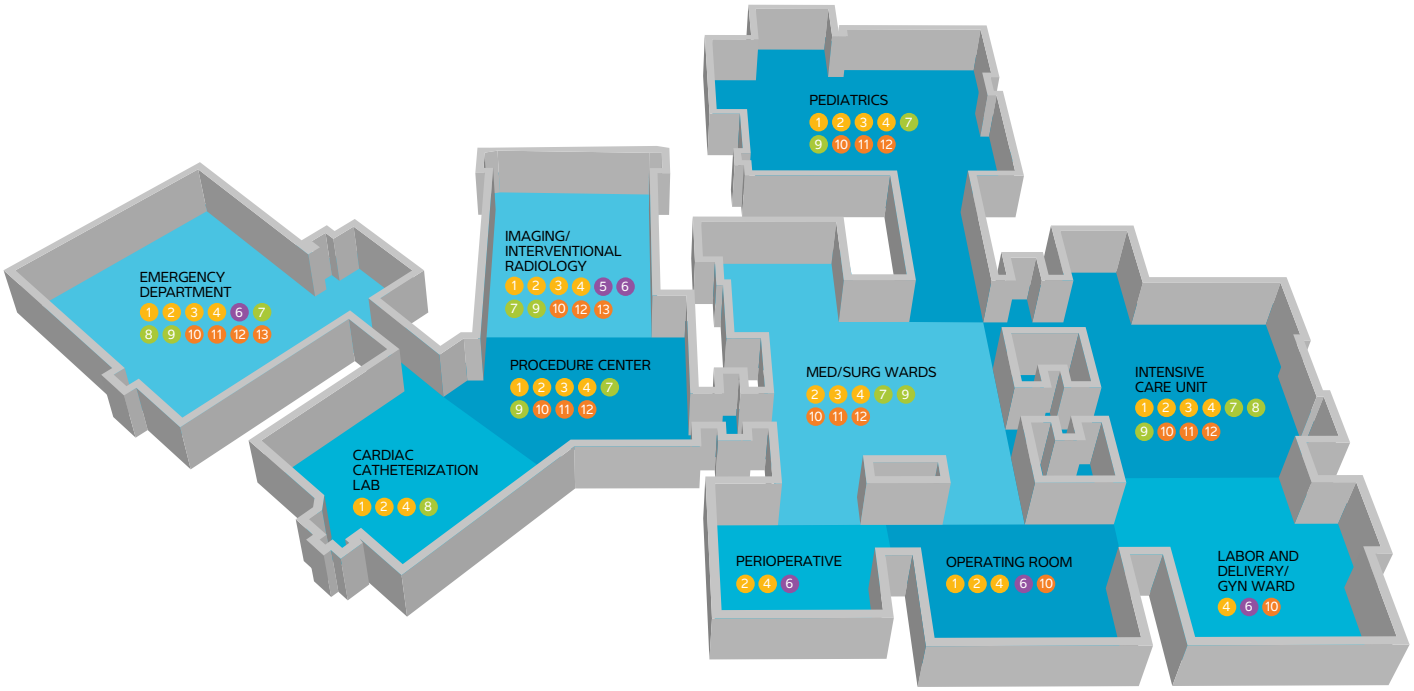
SHM Society of Hospital Medicine

Utilization of ultrasound guidance during invasive procedures within the hospital



Patient Safety: The Evidence for Ultrasound Guidance During Invasive Procedure is designed to be a resource for medical professionals. It is made available to clinicians for assistance in making informed decisions and is not intended to replace sound judgment and consultation with medical colleagues. Patient Safety does not define, limit, expand, or otherwise purport to establish the legal standard of care. We recognize there are acceptable variations from these procedures and protocols, which may also satisfy the standard of care. The information and opinions provided here are believed to be accurate in the best judgment available to the authors, but readers are responsible for any risks associated with use of this information.

Procedure Key

VASCULAR ACCESS

1. Arterial Cannulation
2. Central Venous Catheter (CVC)
3. Peripherally Inserted Central Catheter (PICC)
4. Peripheral IV

NERVE BLOCKS

5. Nerve Block-Chronic Pain
6. Nerve Block-Epidural; Regional Anesthesia

CAVITY DRAINAGE

7. Paracentesis
8. Pericardiocentesis
9. Thoracentesis

OTHER PROCEDURES

10. Biopsies and Soft Tissue Aspirations/Drainage
11. Joint Injections/Arthrocentesis
12. Lumbar Puncture
13. Foreign Body Extraction

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