



Point-of-Care Ultrasonography by Pediatric Emergency Medicine Physicians

AMERICAN ACADEMY OF PEDIATRICS, Committee on Pediatric Emergency Medicine; SOCIETY FOR ACADEMIC EMERGENCY MEDICINE, Academy of Emergency Ultrasound; AMERICAN COLLEGE OF EMERGENCY PHYSICIANS, Pediatric Emergency Medicine Committee; WORLD INTERACTIVE NETWORK FOCUSED ON CRITICAL ULTRASOUND

Point-of-care ultrasonography is increasingly being used to facilitate accurate and timely diagnoses and to guide procedures. It is important for pediatric emergency medicine (PEM) physicians caring for patients in the emergency department to receive adequate and continued point-of-care ultrasonography training for those indications used in their practice setting. Emergency departments should have credentialing and quality assurance programs. PEM fellowships should provide appropriate training to physician trainees. Hospitals should provide privileges to physicians who demonstrate competency in point-of-care ultrasonography. Ongoing research will provide the necessary measures to define the optimal training and competency assessment standards. Requirements for credentialing and hospital privileges will vary and will be specific to individual departments and hospitals. As more physicians are trained and more research is completed, there should be one national standard for credentialing and privileging in point-of-care ultrasonography for PEM physicians.

abstract

FREE

This document is copyrighted and is property of the American Academy of Pediatrics and its Board of Directors. All authors have filed conflict of interest statements with the American Academy of Pediatrics. Any conflicts have been resolved through a process approved by the Board of Directors. The American Academy of Pediatrics has neither solicited nor accepted any commercial involvement in the development of the content of this publication.

Policy statements from the American Academy of Pediatrics benefit from expertise and resources of liaisons and internal (AAP) and external reviewers. However, policy statements from the American Academy of Pediatrics may not reflect the views of the liaisons or the organizations or government agencies that they represent.

The guidance in this statement does not indicate an exclusive course of treatment or serve as a standard of medical care. Variations, taking into account individual circumstances, may be appropriate.

All policy statements from the American Academy of Pediatrics automatically expire 5 years after publication unless reaffirmed, revised, or retired at or before that time.

www.pediatrics.org/cgi/doi/10.1542/peds.2015-0342

DOI: 10.1542/peds.2015-0342

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

Copyright © 2015 by the American Academy of Pediatrics. Published jointly in *Pediatrics* and *Annals of Emergency Medicine*.

INTRODUCTION

Point-of-care ultrasonography is a focused ultrasonography performed and interpreted at the patient's bedside by a health care provider in conjunction with his or her clinical examination. Point-of-care ultrasonography can expedite clinical decision-making, direct follow-up diagnostic imaging, aid in procedural guidance, and improve patient satisfaction.¹⁻⁶ Point-of-care ultrasonography is designed to answer specific yes or no questions in real time. The point-of-care ultrasonography examination has important qualities as an imaging modality. There is no need to transport a patient outside of the emergency department (ED), examinations can be performed at all hours, examinations may be repeated, and there is no ionizing radiation exposure. Moreover, it may help direct further evaluation so as to avoid unnecessary and costly testing.

Clinician-performed ultrasonography has been used and accepted since the 1960s, when obstetricians and cardiologists first adopted the technology. The use of ultrasonography by those specialists is endorsed by various professional radiology organizations.^{7,8} At present, nonphysician providers, such as nurses and prehospital care workers, are also using point-of-care ultrasonography as a part of their practice.⁹⁻¹⁷

MINIMIZING RADIATION EXPOSURE

One of the appealing aspects of ultrasonography is its inherent safety. It relies on sound waves and not x-rays to generate images. In many instances, computed tomography (CT) imaging or radiography are the optimal diagnostic modalities in the evaluation of the pediatric patient; however, there is an increasingly large body of literature emphasizing and delineating the risks of ionizing radiation, particularly from CT.¹⁸⁻³¹ Pediatric patients are particularly sensitive to ionizing radiation, given the larger organ-specific dosing they receive with each study, the increased susceptibility of these organs to radiation-induced cancer, and the increased life span over which children may develop radiation-induced cancers.²¹ In response to this risk, several national campaigns have been initiated to reduce the use of unnecessary CT imaging in pediatric patients. These include efforts by the Society for Pediatric Radiology,³² the National Council on Radiation Protection and Measurements,³³ the Food and Drug Administration,³⁴ and the National Cancer Institute.³⁵ In summary, when imaging is indicated, practitioners should attempt to optimize the use of nonradiating diagnostic modalities, such as ultrasonography.

INDICATIONS FOR POINT-OF-CARE ULTRASONOGRAPHY

PEM physicians can use point-of-care ultrasonography as a diagnostic or

procedural adjunct in the evaluation of patients in the ED. Diagnostic applications are those that assist in diagnosis and inform medical decision-making. Procedural applications may be “ultrasonography-assisted” or “static” or “ultrasonography-guided,” also referred to as “dynamic.” Static ultrasonography is defined as using ultrasonography before the procedure, identifying anatomic structures, and determining the ideal circumstances for the procedure to be performed. The procedure itself is performed without the use of ultrasonography. In contrast, in dynamic ultrasonography, the ultrasonography and procedure are performed simultaneously.

Clinical applications will be practice-specific and based on the patient population, incidence of disease, and the availability of resources, such as 24-hour attending radiologist coverage, availability of ultrasonography technicians, and distance/transfer times to facilities that can provide ultrasonography imaging. ED leaders should determine which point-of-care ultrasonography examinations will be most useful to their practice environments. Physicians would then apply for institutional privileges in those specific areas. There will be a natural transition period for physicians who did not receive point-of-care ultrasonography education as part of their graduate medical training. Therefore, the indications for which clinicians use point-of-care ultrasonography will evolve over time as the education is disseminated throughout the PEM community. Finally, clinicians should be aware that point-of-care ultrasonography is better used as a “rule in” and not a “rule out” diagnostic modality. The absence of an abnormal finding should not indicate a normal examination. For example, nonvisualization of an intussusception with high clinical concern must prompt further evaluation. Likewise, when findings

other than those sought to “rule in” a diagnosis are encountered, a more complete imaging evaluation is warranted.

POINT-OF-CARE ULTRASONOGRAPHY TRAINING, CREDENTIALING, AND PRIVILEGING

Before implementing a program in the ED, departmental leaders should identify a core group of individuals with expertise in point-of-care ultrasonography. This group is responsible for educating faculty and trainees as well as managing administrative tasks, such as outlining credentialing pathways and performing quality assurance image reviews. Standardized and universally accepted criteria for what designates a point-of-care expert are likely to evolve over time as advanced training programs are established. In departments or divisions without point-of-care ultrasonography-trained individuals, departmental leadership should consider sending an individual or group of individuals with interest to receive additional training in point-of-care ultrasonography. Alternatively, an expert from another department (eg, general emergency medicine, radiology) may assume these responsibilities and work collaboratively with ED leaders.

Point-of-care ultrasonography training varies depending on the practitioner’s previous education and practice environment. Until now, most PEM physicians have received little or no point-of-care ultrasonography instruction as part of their training. It is important that PEM fellowship programs provide adequate training, including measurements of competency for trainees. Point-of-care ultrasonography education is now an American Board of Pediatrics requirement for PEM fellowship programs.³⁶ Consensus education guidelines and a model curriculum were recently published.³⁷ There are

2 training pathways for physicians: a “training-based” pathway for current trainees and a “practice-based” pathway for faculty without previous experience. The details of such pathways are outlined in the accompanying technical report.³⁸

Before performing a point-of-care ultrasonography examination for medical decision-making, PEM physicians must demonstrate application-specific competency. During this “training” phase, the point-of-care ultrasonography expert should review all ultrasonography examinations in a timely manner. Practitioners can receive relevant feedback regarding their examinations. In addition, novice practitioners should be supervised at the bedside to ensure that the examinations are being performed correctly. Examination reviews and bedside supervision may be performed by a department or division “expert” or by another physician already credentialed to perform ultrasonography for that indication. These educational scans should not be used for medical decision-making or billing purposes, and this should be clearly communicated to patients and their families.

Given that a point-of-care ultrasonography examination is intended to be a focused examination, training requirements necessarily differ from those set forth by other specialty organizations, such as the American College of Radiology and others. A similar distinction was made in the 2002 training guidelines adopted by the American Society of Echocardiography, which outlined basic training requirements for anesthesiologists performing perioperative echocardiography, which differed from the more rigorous training needed for more consultative echocardiography performed by cardiologists.³⁹ Competency and subsequent

credentialing within a division or department may be achieved after performing a specified number, or range, of accurately performed and interpreted point-of-care ultrasonography examinations. With the lack of robust data supporting a specified number of examinations per indication, some guidelines suggest 25 to 50 examinations needed to achieve competency.⁴⁰ However, physicians should not interpret this recommendation as a “one-size-fits-all” approach, because examinations vary in difficulty and therefore may require more experience to establish competency. In addition, the number of examinations performed may not always best define competency. Because point-of-care ultrasonography incorporates both cognitive and psychomotor components, individual physicians may gain competency at varying rates that may be independent of a predetermined numerical goal and better assessed through simulation, observed structured clinical examinations, or direct observation during clinical shifts.

Hospital privileging committees should provide an opportunity for privileging in specific pediatric point-of-care ultrasonography examinations. Written requirements for privileging should be delineated. Building on the recommendations set forth by the American College of Emergency Physicians, when a physician applies for appointment or reappointment to the medical staff and for clinical privileges, the process should include assessment of current competency by the point-of-care ultrasonography director.⁴⁰ Because point-of-care ultrasonography is a relatively new technology for PEM physicians, some specialists and hospital privileging committees may not be familiar with the precedent already set forth for point-of-care ultrasonography and the benefits to patient care. Therefore, PEM physicians should

educate those who are unfamiliar with its use, citing the established literature attesting to emergency physicians’ ability to accurately perform and interpret point-of-care ultrasonography examinations.^{5,41-104} In addition, PEM physicians should consider collaboration with radiologists and expert sonographers when implementing point-of-care ultrasonography into their ED.

POINT-OF-CARE ULTRASONOGRAPHY DOCUMENTATION

Once PEM physicians are credentialed to perform point-of-care ultrasonography for a particular application, they can integrate the point-of-care ultrasonography examination into patient care. Details of the point-of-care ultrasonography examination must be documented at the time of performance in the medical record. Specifically, documentation should include the indication for the examination, structures/organs identified, and the interpretation.¹⁰⁵ If the study is inadequate, this finding should also be noted. Images should be archived, ideally electronically, and entered as part of the electronic health record for ease of retrieval and review.

RECOMMENDATIONS

1. PEM physicians should be familiar with the definition and application of point-of-care ultrasonography and the utility for patients in the ED.
2. Pediatric emergency physicians who integrate point-of-care ultrasonography in their patient care should be competent in point-of-care examinations that are specific and relevant to their clinical environment.
3. For EDs with a PEM point-of-care ultrasonography program, there must be a process in place for educating and assessing practitioner skill, maintaining quality assurance,

implementing quality improvement activities, and acquiring and maintaining hospital privileges.

4. PEM fellowship programs should have a structured point-of-care ultrasonography education curriculum and competency assessment for fellows in training.
5. Standardized, universally accepted criteria for what defines point-of-care ultrasonography expertise should be developed in the near future by national organizations such as the American Academy of Pediatrics, the Society for Academic Emergency Medicine, and/or the American College of Emergency Physicians.

SUMMARY

There is an increasing demand for PEM physicians to become adept in point-of-care ultrasonography. Mounting evidence supports the benefits to pediatric patients. This policy statement and accompanying technical report have been developed to define a structured and safe program for the integration and implementation of point-of-care ultrasonography by PEM physicians.

LEAD AUTHORS

Jennifer R. Marin, MD, MSc
Resa E. Lewis, MD

FINANCIAL DISCLOSURE/CONFLICT OF INTEREST

Dr Lewis has no financial disclosures or potential conflicts of interest. Dr Marin receives support from third Rock Ultrasound, LLC for serving as teaching faculty and received support from the Agency for Healthcare Quality and Research (R13HS023498) related to a conference on diagnostic imaging and from the National Institutes of Health (K12HL109068).

PEDIATRIC POINT-OF-CARE ULTRASOUND WORK GROUP

Jennifer R. Marin, MD, MSc, Chairperson
Resa E. Lewis, MD
Alyssa M. Abo, MD
Stephanie J. Doniger, MD, RDMS
Jason W. Fischer, MD, MSc
David O. Kessler, MD, MSc, RDMS
Jason A. Levy, MD, RDMS
Vicki E. Noble, MD, RDMS

Adam B. Sivitz, MD
James W. Tsung, MD, MPH
Rebecca L. Vieira, MD, RDMS

AMERICAN ACADEMY OF PEDIATRICS, COMMITTEE ON PEDIATRIC EMERGENCY MEDICINE, 2013–2014

Joan E. Shook, MD, MBA, FAAP, Chairperson
Alice D. Ackerman, MD, MBA, FAAP
Thomas H. Chun, MD, MPH, FAAP
Gregory P. Conners, MD, MPH, MBA, FAAP
Nanette C. Dudley, MD, FAAP
Susan M. Fuchs, MD, FAAP
Marc H. Gorelick, MD, MSCE, FAAP
Natalie E. Lane, MD, FAAP
Brian R. Moore, MD, FAAP
Joseph L. Wright, MD, MPH, FAAP

LIAISONS

Lee Benjamin, MD — *American College of Emergency Physicians*
Kim Bullock, MD — *American Academy of Family Physicians*
Elizabeth L. Robbins, MD, FAAP — *AAP Section on Hospital Medicine*
Toni K. Gross, MD, MPH, FAAP — *National Association of EMS Physicians*
Elizabeth Edgerton, MD, MPH, FAAP — *Maternal and Child Health Bureau*
Tamar Magarik Haro — *AAP Department of Federal Affairs*
Angela Mickalide, PhD, MCHES — *EMSC National Resource Center*
Cynthia Wright, MSN, RNC — *National Association of State EMS Officials*
Lou E. Romig, MD, FAAP — *National Association of Emergency Medical Technicians*
Sally K. Snow, RN, BSN, CPEN, FAEN — *Emergency Nurses Association*
David W. Tuggle, MD, FAAP — *American College of Surgeons*

STAFF

Sue Tellez

SOCIETY FOR ACADEMIC EMERGENCY MEDICINE (REVIEWERS)

Steven B. Bird, MD
Andra L. Blomkalns, MD
Kristin Carmody, MD
Kathleen J. Clem, MD, FACEP
D. Mark Courtney, MD
Deborah B. Diercks, MD, MSc
Matthew Fields, MD
Robert S. Hockberger, MD
James F. Holmes, Jr, MD, MPH
Lauren Hudak, MD
Alan E. Jones, MD
Amy H. Kaji, MD, PhD
Ian B. K. Martin, MD
Christopher Moore, MD, RDMS, RCMS
Nova Panebianco, MD, MPH

AMERICAN COLLEGE OF EMERGENCY PHYSICIANS, PEDIATRIC EMERGENCY MEDICINE COMMITTEE, 2013–2014

Lee S. Benjamin, MD, FACEP, Chairperson

Isabel A. Barata, MD, FACEP, FAAP
Kiyetta Alade, MD
Joseph Arms, MD
Jahn T. Avarello, MD, FACEP
Steven Baldwin, MD
Kathleen Brown, MD, FACEP
Richard M. Cantor, MD, FACEP
Ariel Cohen, MD
Ann Marie Dietrich, MD, FACEP
Paul J. Eakin, MD
Marianne Gausche-Hill, MD, FACEP, FAAP
Michael Gerardi, MD, FACEP, FAAP
Charles J. Graham, MD, FACEP
Doug K. Holtzman, MD, FACEP
Jeffrey Hom, MD, FACEP
Paul Ishimine, MD, FACEP
Hasmig Jinivizian, MD
Madeline Joseph, MD, FACEP
Sanjay Mehta, MD, Med, FACEP
Aderonke Ojo, MD, MBBS
Audrey Z. Paul, MD, PhD
Denis R. Pauze, MD, FACEP
Nadia M. Pearson, DO
Brett Rosen, MD
W. Scott Russell, MD, FACEP
Mohsen Saidinejad, MD
Harold A. Sloas, DO
Gerald R. Schwartz, MD, FACEP
Orel Swenson, MD
Jonathan H. Valente, MD, FACEP
Muhammad Waseem, MD, MS
Paula J. Whiteman, MD, FACEP
Dale Woolridge, MD, PhD, FACEP

FORMER COMMITTEE MEMBERS

Carrie DeMoore, MD
James M. Dy, MD
Sean Fox, MD
Robert J. Hoffman, MD, FACEP
Mark Hostetler, MD, FACEP
David Markenson, MD, MBA, FACEP
Annalise Sorrentino, MD, FACEP
Michael Witt, MD, MPH, FACEP

STAFF

Dan Sullivan
Stephanie Wauson

WORLD INTERACTIVE NETWORK FOCUSED ON CRITICAL ULTRASOUND BOARD OF DIRECTORS (REVIEWERS)

Vicki Noble, MD
Enrico Storti, MD
Jim Tsung, MD
Giovanni Volpicelli, MD

REFERENCES

1. Howard ZD, Noble VE, Marill KA, et al. Bedside ultrasound maximizes patient satisfaction. *J Emerg Med.* 2013;1–8
2. Jones AE, Tayal VS, Sullivan DM, Kline JA. Randomized, controlled trial of immediate versus delayed goal-directed

- ultrasound to identify the cause of nontraumatic hypotension in emergency department patients. *Crit Care Med*. 2004;32(8):1703–1708
3. Kirkpatrick AW, Sirois M, Ball CG, et al. The hand-held ultrasound examination for penetrating abdominal trauma. *Am J Surg*. 2004;187(5):660–665
 4. Liteplo AS, Marill KA, Villen T, et al. Emergency thoracic ultrasound in the differentiation of the etiology of shortness of breath (ETUDES): sonographic B-lines and N-terminal pro-brain-type natriuretic peptide in diagnosing congestive heart failure. *Acad Emerg Med*. 2009;16(3):201–210
 5. Melniker LA, Leibner E, McKenney MG, Lopez P, Briggs WM, Mancuso CA. Randomized controlled clinical trial of point-of-care, limited ultrasonography for trauma in the emergency department: the first sonography outcomes assessment program trial. *Ann Emerg Med*. 2006;48(3):227–235
 6. Moore CL, Copel JA. Point-of-care ultrasonography. *N Engl J Med*. 2011; 364(8):749–757
 7. American College of Radiology; American College of Obstetricians and Gynecologists; American Institute of Ultrasound in Medicine. ACR-ACOG-AIUM practice parameter for the performance of obstetrical ultrasound. 2007. Available at: www.acr.org/~media/ACR/Documents/PGTS/guidelines/US_Obstetrical.pdf. Accessed January 27, 2012
 8. American College of Cardiology; American Heart Association; American College of Physicians–American Society of Internal Medicine; American Society of Echocardiography; Society of Cardiovascular Anesthesiologists; Society of Pediatric Echocardiography. ACC/AHA clinical competence statement on echocardiography. *J Am Coll Cardiol*. 2003;41(4):687–708
 9. Blaivas M, Lyon M. The effect of ultrasound guidance on the perceived difficulty of emergency nurse-obtained peripheral IV access. *J Emerg Med*. 2006;31(4):407–410
 10. Brannam L, Blaivas M, Lyon M, Flake M. Emergency nurses' utilization of ultrasound guidance for placement of peripheral intravenous lines in difficult-access patients. *Acad Emerg Med*. 2004;11(12):1361–1363
 11. Chin EJ, Chan CH, Mortazavi R, et al. A pilot study examining the viability of a Prehospital Assessment with UltraSound for Emergencies (PAUSE) protocol. *J Emerg Med*. 2013;44(1):142–149
 12. Heegaard W, Hildebrandt D, Spear D, Chason K, Nelson B, Ho J. Prehospital ultrasound by paramedics: results of field trial. *Acad Emerg Med*. 2010;17(6): 624–630
 13. Henderson A, Andrich DE, Pietrasik ME, Higgins D, Montgomery B, Langley SEM. Outcome analysis and patient satisfaction following octant transrectal ultrasound-guided prostate biopsy: a prospective study comparing consultant urologist, specialist registrar and nurse practitioner in urology. *Prostate Cancer Prostatic Dis*. 2004;7(2):122–125
 14. Henderson SO, Ahern T, Williams D, Mailhot T, Mandavia D. Emergency department ultrasound by nurse practitioners. *J Am Acad Nurse Pract*. 2010;22(7):352–355
 15. Iregui MG, Prentice D, Sherman G, Schallom L, Sona C, Kollef MH. Physicians' estimates of cardiac index and intravascular volume based on clinical assessment versus transesophageal Doppler measurements obtained by critical care nurses. *Am J Crit Care*. 2003; 12(4):336–342
 16. Noble VE, Lamhaut L, Capp R, et al. Evaluation of a thoracic ultrasound training module for the detection of pneumothorax and pulmonary edema by prehospital physician care providers. *BMC Med Educ*. 2009;9(3). Available at: <http://biomedcentral.com/1472-6920/9/3>
 17. Walcher F, Weinlich M, Conrad G, et al. Prehospital ultrasound imaging improves management of abdominal trauma. *Br J Surg*. 2006;93(2):238–242
 18. Pearce MS, Salotti JA, Little MP, et al. Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study. *Lancet*. 2012;380(9840):499–505
 19. Brenner DJ, Hall EJ. Computed tomography—an increasing source of radiation exposure. *N Engl J Med*. 2007; 357(22):2277–2284
 20. Brenner D, Elliston C, Hall E, Berdon W. Estimated risks of radiation-induced fatal cancer from pediatric CT. *AJR Am J Roentgenol*. 2001; 176(2):289–296
 21. Brenner DJ. Estimating cancer risks from pediatric CT: going from the qualitative to the quantitative. *Pediatr Radiol*. 2002;32(4):228–1; discussion 242–244
 22. Brody AS, Frush DP, Huda W, Brent RL; American Academy of Pediatrics Section on Radiology. Radiation risk to children from computed tomography. *Pediatrics*. 2007;120(3):677–682
 23. Callahan MJ. CT dose reduction in practice. *Pediatr Radiol*. 2011;41(suppl 2):488–492
 24. Donnelly LF. Reducing radiation dose associated with pediatric CT by decreasing unnecessary examinations. *AJR Am J Roentgenol*. 2005;184(2): 655–657
 25. Fazel R, Krumholz HM, Wang Y, et al. Exposure to low-dose ionizing radiation from medical imaging procedures. *N Engl J Med*. 2009;361(9):849–857
 26. Fenton SJ, Hansen KW, Meyers RL, et al. CT scan and the pediatric trauma patient—are we overdoing it? *J Pediatr Surg*. 2004;39(12):1877–1881
 27. Frush DP, Donnelly LF, Rosen NS. Computed tomography and radiation risks: what pediatric health care providers should know. *Pediatrics*. 2003;112(4):951–957
 28. Hartin CW Jr, Jordan JM, Gemme S, et al. Computed tomography scanning in pediatric trauma: opportunities for performance improvement and radiation safety. *J Surg Res*. 2013; 180(2):226–231
 29. Nickoloff EL, Alderson PO. Radiation exposures to patients from CT: reality, public perception, and policy. *AJR Am J Roentgenol*. 2001;177(2):285–287
 30. Rajaraman P, Simpson J, Neta G, et al. Early life exposure to diagnostic radiation and ultrasound scans and risk of childhood cancer: case-control study. *BMJ*. 2011;342:d472. doi:10.1136/bmj.d472
 31. Linet MS, Kim K-P, Rajaraman P. Children's exposure to diagnostic medical radiation and cancer risk: epidemiologic and dosimetric

- considerations. *Pediatr Radiol.* 2009;39 (suppl 1):S4–S26
32. Slovis TL. Conference on the ALARA (as low as reasonably achievable) concept in pediatric CT: intelligent dose reduction. *Pediatr Radiol.* 2002;32(4):217–218
 33. Linton OW, Mettler FA Jr; National Council on Radiation Protection and Measurements. National conference on dose reduction in CT, with an emphasis on pediatric patients. *AJR Am J Roentgenol.* 2003;181(2):321–329
 34. Food and Drug Administration. FDA public health notification: reducing radiation risk from computed tomography for pediatric and small adult patients. *Pediatr Radiol.* 2002; 32(4):314–316
 35. National Cancer Institute. Radiation risks and pediatric computed tomography (CT): a guide for health care providers. Available at: <http://cancer.gov/cancerinfo/causes/radiation-risks-pediatric-ct>. Accessed October 26, 2011
 36. American Board of Pediatrics. *Pediatric Emergency Medicine: Subspecialty In-training, Certification, and Maintenance of Certification Examinations*. Chapel Hill, NC: American Board of Pediatrics; 2011. Available at: www.abp.org/sites/abp/files/pdf/emerg2011.pdf. Accessed February 17, 2015
 37. Vieira RL, Hsu D, Nagler J, Chen L, Gallagher R, Levy JA. Pediatric emergency medicine fellow training in ultrasound: consensus educational guidelines. *Acad Emerg Med.* 2013;20(3):300–306
 38. Marin JR, Lewiss RE; American Academy of Pediatrics; Society of Academic Emergency Medicine; American College of Emergency Physicians; World Interactive Network Focused On Critical UltraSound. Technical report: point-of-care ultrasonography by pediatric emergency medicine physicians. *Pediatrics.* 2015;135(4). Available at: www.pediatrics.org/cgi/content/full/135/4/e1113
 39. Cahalan MK, Stewart W, Pearlman A, et al. American Society of Echocardiography and Society of Cardiovascular Anesthesiologists task force guidelines for training in perioperative echocardiography. 2002; 15(6):647–652
 40. American College of Emergency Physicians. Emergency ultrasound guidelines. *Ann Emerg Med.* 2009;53(4): 550–570
 41. Fox JC, Boysen M, Gharahbaghian L, et al. Test characteristics of focused assessment of sonography for trauma for clinically significant abdominal free fluid in pediatric blunt abdominal trauma. *Acad Emerg Med.* 2011;18(5): 477–482
 42. Holmes JF, Gladman A, Chang CH. Performance of abdominal ultrasonography in pediatric blunt trauma patients: a meta-analysis. *J Pediatr Surg.* 2007;42(9):1588–1594
 43. Sola JE, Cheung MC, Yang R, et al. Pediatric FAST and elevated liver transaminases: an effective screening tool in blunt abdominal trauma. *J Surg Res.* 2009;157(1):103–107
 44. Squire BT, Fox JC, Anderson C. ABSCCESS: applied bedside sonography for convenient evaluation of superficial soft tissue infections. *Acad Emerg Med.* 2005;12(7):601–606
 45. Tayal VS, Hasan N, Norton HJ, Tomaszewski CA. The effect of soft-tissue ultrasound on the management of cellulitis in the emergency department. *Acad Emerg Med.* 2006; 13(4):384–388
 46. Sivitz AB, Lam SHF, Ramirez-Schrempp D, Valente JH, Nagdev AD. Effect of bedside ultrasound on management of pediatric soft-tissue infection. *J Emerg Med.* 2010;39(5):637–643
 47. Iverson K, Haritos D, Thomas R, Kannikeswaran N. The effect of bedside ultrasound on diagnosis and management of soft tissue infections in a pediatric ED. *Am J Emerg Med.* 2012;30(8): 1347–1351
 48. Marin JR, Dean AJ, Bilker WB, Panebianco NL, Brown NJ, Alpern ER. Emergency ultrasound-assisted examination of skin and soft tissue infections in the pediatric emergency department. *Acad Emerg Med.* 2013;20 (6):545–553
 49. Friedman DI, Forti RJ, Wall SP, Crain EF. The utility of bedside ultrasound and patient perception in detecting soft tissue foreign bodies in children. *Pediatr Emerg Care.* 2005;21(8): 487–492
 50. Chen L, Hsiao AL, Moore CL, Dziura JD, Santucci KA. Utility of bedside bladder ultrasound before urethral catheterization in young children. *Pediatrics.* 2005;115(1):108–111
 51. Witt M, Baumann BM, McCans K. Bladder ultrasound increases catheterization success in pediatric patients. *Acad Emerg Med.* 2005;12(4): 371–374
 52. Randazzo MR, Snoey ER, Levitt MA, Binder K. Accuracy of emergency physician assessment of left ventricular ejection fraction and central venous pressure using echocardiography. *Acad Emerg Med.* 2003;10(9):973–977
 53. Pershad J, Myers S, Plouman C, et al. Bedside limited echocardiography by the emergency physician is accurate during evaluation of the critically ill patient. *Pediatrics.* 2004;114(6). Available at: www.pediatrics.org/cgi/content/full/114/6/e667
 54. Longjohn M, Wan J, Joshi V, Pershad J. Point-of-care echocardiography by pediatric emergency physicians. *Pediatr Emerg Care.* 2011;27(8): 693–696
 55. Chen L, Hsiao A, Langhan M, Riera A, Santucci KA. Use of bedside ultrasound to assess degree of dehydration in children with gastroenteritis. *Acad Emerg Med.* 2010;17(10):1042–1047
 56. Chen L, Kim Y, Santucci KA. Use of ultrasound measurement of the inferior vena cava diameter as an objective tool in the assessment of children with clinical dehydration. *Acad Emerg Med.* 2007;14(10):841–845
 57. Perera P, Mailhot T, Riley D, Mandavia D. The RUSH exam: Rapid Ultrasound in SHock in the evaluation of the critically ill. *Emerg Med Clin North Am.* 2010;28 (1):29–56, vii
 58. Labovitz AJ, Noble VE, Bierig M, et al. Focused cardiac ultrasound in the emergent setting: a consensus statement of the American Society of Echocardiography and American College of Emergency Physicians. *J Am Soc Echocardiogr.* 2010;23(12): 1225–1230
 59. Kendall JL, Shimp RJ. Performance and interpretation of focused right upper quadrant ultrasound by emergency physicians. *J Emerg Med.* 2001;21(1): 7–13

60. Blaivas M, Harwood RA, Lambert MJ. Decreasing length of stay with emergency ultrasound examination of the gallbladder. *Acad Emerg Med*. 1999; 6(10):1020–1023
61. Freeman K, Dewitz A, Baker WE. Ultrasound-guided hip arthrocentesis in the ED. *Am J Emerg Med*. 2007;25(1): 80–86
62. LaRocco BG, Zlupko G, Sierzenski P. Ultrasound diagnosis of quadriceps tendon rupture. *J Emerg Med*. 2008; 35(3):293–295
63. Sisson C, Nagdev A, Tirado A, Murphy M, Suner S. Ultrasound diagnosis of traumatic partial triceps tendon tear in the emergency department. *J Emerg Med*. 2011;40(4):436–438
64. Weinberg ER, Tunik MG, Tsung JW. Accuracy of clinician-performed point-of-care ultrasound for the diagnosis of fractures in children and young adults. *Injury*. 2010;41(8):862–868
65. Durston W, Swartzentruber R. Ultrasound guided reduction of pediatric forearm fractures in the ED. *Am J Emerg Med*. 2000;18(1):72–77
66. Patel DD, Blumberg SM, Crain EF. The utility of bedside ultrasonography in identifying fractures and guiding fracture reduction in children. *Pediatr Emerg Care*. 2009;25(4):221–225
67. Chen L, Kim Y, Moore CL. Diagnosis and guided reduction of forearm fractures in children using bedside ultrasound. *Pediatr Emerg Care*. 2007;23(8): 528–531
68. Cross KP, Warkentine FH, Kim IK, Gracely E, Paul RI. Bedside ultrasound diagnosis of clavicle fractures in the pediatric emergency department. *Acad Emerg Med*. 2010;17(7):687–693
69. Chien M, Bulloch B, Garcia-Filion P, Youssfi M, Shrader MW, Segal LS. Bedside ultrasound in the diagnosis of pediatric clavicle fractures. *Pediatr Emerg Care*. 2011;27(11):1038–1041
70. Chaar-Alvarez FM, Warkentine F, Cross K, Herr S, Paul RI. Bedside ultrasound diagnosis of nonangulated distal forearm fractures in the pediatric emergency department. *Pediatr Emerg Care*. 2011;27(11):1027–1032
71. Ramirez-Schrempp D, Vinci RJ, Liteplo AS. Bedside ultrasound in the diagnosis of skull fractures in the pediatric emergency department. *Pediatr Emerg Care*. 2011;27(4):312–314
72. Rabiner JE, Friedman LM, Khine H, Avner JR, Tsung JW. Accuracy of point-of-care ultrasound for diagnosis of skull fractures in children. *Pediatrics*. 2013;131(6). Available at: www.pediatrics.org/cgi/content/full/131/6/e1757
73. Vieira RL, Levy JA. Bedside ultrasonography to identify hip effusions in pediatric patients. *Ann Emerg Med*. 2010;55(3):284–289
74. Shah VP, Tunik MG, Tsung JW. Prospective evaluation of point-of-care ultrasonography for the diagnosis of pneumonia in children and young adults. *JAMA Pediatr*. 2013;167(2): 119–125
75. Theodoro D, Blaivas M, Duggal S, Snyder G, Lucas M. Real-time B-mode ultrasound in the ED saves time in the diagnosis of deep vein thrombosis (DVT). *Am J Emerg Med*. 2004;22(3): 197–200
76. Magazzini S, Vanni S, Toccafondi S, et al. Duplex ultrasound in the emergency department for the diagnostic management of clinically suspected deep vein thrombosis. *Acad Emerg Med*. 2007;14(3):216–220
77. Jolly BT, Massarin E, Pigman EC. Color Doppler ultrasonography by emergency physicians for the diagnosis of acute deep venous thrombosis. *Acad Emerg Med*. 1997;4(2):129–132
78. Blaivas M, Theodoro D, Sierzenski PR. A study of bedside ocular ultrasonography in the emergency department. *Acad Emerg Med*. 2002; 9(8):791–799
79. Tayal VS, Neulander M, Norton HJ, Foster T, Saunders T, Blaivas M. Emergency department sonographic measurement of optic nerve sheath diameter to detect findings of increased intracranial pressure in adult head injury patients. *Ann Emerg Med*. 2007;49(4):508–514
80. Yoonessi R, Hussain A, Jang TB. Bedside ocular ultrasound for the detection of retinal detachment in the emergency department. *Acad Emerg Med*. 2010; 17(9):913–917
81. Riera A, Hsiao AL, Langan ML, Goodman TR, Chen L. Diagnosis of intussusception by physician novice sonographers in the emergency department. *Ann Emerg Med*. 2012; 60(3):264–268
82. Sivitz AB, Tejani C, Cohen SG. Evaluation of hypertrophic pyloric stenosis by pediatric emergency physician sonography. *Acad Emerg Med*. 2013;20 (7):646–651
83. Fox JC, Solley M, Anderson CL, Zlidenny A, Lahham S, Maasumi K. Prospective evaluation of emergency physician performed bedside ultrasound to detect acute appendicitis. *Eur J Emerg Med*. 2008;15(2):80–85
84. McRae A, Murray H, Edmonds M. Diagnostic accuracy and clinical utility of emergency department targeted ultrasonography in the evaluation of first-trimester pelvic pain and bleeding: a systematic review. *CJEM*. 2009;11(4): 355–364
85. Blaivas M, Sierzenski P, Plecque D, Lambert M. Do emergency physicians save time when locating a live intrauterine pregnancy with bedside ultrasonography? *Acad Emerg Med*. 2000;7(9):988–993
86. Stein JC, Wang R, Adler N, et al. Emergency physician ultrasonography for evaluating patients at risk for ectopic pregnancy: a meta-analysis. *Ann Emerg Med*. 2010;56(6):674–683
87. Randolph AG, Cook DJ, Gonzales CA, Pribble CG. Ultrasound guidance for placement of central venous catheters: a meta-analysis of the literature. *Crit Care Med*. 1996;24(12): 2053–2058
88. Miller AH, Roth BA, Mills TJ, Woody JR, Longmoor CE, Foster B. Ultrasound guidance versus the landmark technique for the placement of central venous catheters in the emergency department. *Acad Emerg Med*. 2002; 9(8):800–805
89. Keyes LE, Frazee BW, Snoey ER, Simon BC, Christy D. Ultrasound-guided brachial and basilic vein cannulation in emergency department patients with difficult intravenous access. *Ann Emerg Med*. 1999;34(6):711–714
90. Doniger SJ, Ishimine P, Fox JC, Kanegaye JT. Randomized controlled trial of ultrasound-guided peripheral intravenous catheter placement versus traditional techniques in difficult-access

- pediatric patients. *Pediatr Emerg Care*. 2009;25(3):154–159
91. Ferre RM, Sweeney TW. Emergency physicians can easily obtain ultrasound images of anatomical landmarks relevant to lumbar puncture. *Am J Emerg Med*. 2007;25(3):291–296
 92. Nomura JT, Leech SJ, Shenbagamurthi S, et al. A randomized controlled trial of ultrasound-assisted lumbar puncture. *J Ultrasound Med*. 2007;26(10):1341–1348
 93. Liebmann O, Price D, Mills C, et al. Feasibility of forearm ultrasonography-guided nerve blocks of the radial, ulnar, and median nerves for hand procedures in the emergency department. *Ann Emerg Med*. 2006;48(5):558–562
 94. Stone MB, Wang R, Price DD. Ultrasound-guided supraclavicular brachial plexus nerve block vs procedural sedation for the treatment of upper extremity emergencies. *Am J Emerg Med*. 2008;26(6):706–710
 95. Shiver S, Blaivas M, Lyon M. A prospective comparison of ultrasound-guided and blindly placed radial arterial catheters. *Acad Emerg Med*. 2006;13(12):1275–1279
 96. Plummer D, Brunette D, Asinger R, Ruiz E, D P. Emergency department echocardiography improves outcome in penetrating cardiac injury. *Ann Emerg Med*. 1992;21(6):709–712
 97. Gaspari RJ, Horst K. Emergency ultrasound and urinalysis in the evaluation of flank pain. *Acad Emerg Med*. 2005;12(12):1180–1184
 98. Watkins S, Bowra J, Sharma P, Holdgate A, Giles A, Campbell L. Validation of emergency physician ultrasound in diagnosing hydronephrosis in ureteric colic. *Emerg Med Australas*. 2007;19(3):188–195
 99. Burnside PR, Brown MD, Kline JA. Systematic review of emergency physician-performed ultrasonography for lower-extremity deep vein thrombosis. *Acad Emerg Med*. 2008;15(6):493–498
 100. Adhikari S, Blaivas M, Lyon M. Diagnosis and management of ectopic pregnancy using bedside transvaginal ultrasonography in the ED: a 2-year experience. *Am J Emerg Med*. 2007;25(6):591–596
 101. Adhikari S, Blaivas M, Lyon M. Role of bedside transvaginal ultrasonography in the diagnosis of tubo-ovarian abscess in the emergency department. *J Emerg Med*. 2008;34(4):429–433
 102. Blaivas M, Sierzenski P, Lambert M. Emergency evaluation of patients presenting with acute scrotum using bedside ultrasonography. *Acad Emerg Med*. 2001;8(1):90–93
 103. Nazeer SR, Dewbre H, Miller AH. Ultrasound-assisted paracentesis performed by emergency physicians vs the traditional technique: a prospective, randomized study. *Am J Emerg Med*. 2005;23(3):363–367
 104. Wiler JL, Costantino TG, Filippone L, Satz W. Ultrasound in emergency medicine. *J Emerg Med*. 2010;39(1):76–82
 105. Resnick J, Hoffenberg S, Tayal V, Dickman E. Ultrasound coding and reimbursement update 2009. Emergency Ultrasound Section. American College of Emergency Physicians. Available at: www.acep.org/content.aspx?id=32182. Accessed March 26, 2013, August 25, 2014

Point-of-Care Ultrasonography by Pediatric Emergency Medicine Physicians
AMERICAN ACADEMY OF PEDIATRICS, Committee on Pediatric Emergency
Medicine, SOCIETY FOR ACADEMIC EMERGENCY MEDICINE, Academy of
Emergency Ultrasound, AMERICAN COLLEGE OF EMERGENCY PHYSICIANS,
Pediatric Emergency Medicine Committee and WORLD INTERACTIVE
NETWORK FOCUSED ON CRITICAL ULTRASOUND
Pediatrics 2015;135:e1097
DOI: 10.1542/peds.2015-0342 originally published online March 30, 2015;

Updated Information & Services	including high resolution figures, can be found at: http://pediatrics.aappublications.org/content/135/4/e1097
References	This article cites 92 articles, 7 of which you can access for free at: http://pediatrics.aappublications.org/content/135/4/e1097#BIBL
Subspecialty Collections	This article, along with others on similar topics, appears in the following collection(s): Current Policy http://www.aappublications.org/cgi/collection/current_policy Committee on Pediatric Emergency Medicine http://www.aappublications.org/cgi/collection/committee_on_pediatric_emergency_medicine Emergency Medicine http://www.aappublications.org/cgi/collection/emergency_medicine_sub
Permissions & Licensing	Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at: http://www.aappublications.org/site/misc/Permissions.xhtml
Reprints	Information about ordering reprints can be found online: http://www.aappublications.org/site/misc/reprints.xhtml

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN®



PEDIATRICS®

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Point-of-Care Ultrasonography by Pediatric Emergency Medicine Physicians
AMERICAN ACADEMY OF PEDIATRICS, Committee on Pediatric Emergency
Medicine, SOCIETY FOR ACADEMIC EMERGENCY MEDICINE, Academy of
Emergency Ultrasound, AMERICAN COLLEGE OF EMERGENCY PHYSICIANS,
Pediatric Emergency Medicine Committee and WORLD INTERACTIVE
NETWORK FOCUSED ON CRITICAL ULTRASOUND

Pediatrics 2015;135:e1097

DOI: 10.1542/peds.2015-0342 originally published online March 30, 2015;

The online version of this article, along with updated information and services, is
located on the World Wide Web at:

<http://pediatrics.aappublications.org/content/135/4/e1097>

Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 345 Park Avenue, Itasca, Illinois, 60143. Copyright © 2015 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 1073-0397.

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN®

