Point-of-Care Ultrasonography for the Diagnosis of Pediatric Soft Tissue Infection

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Objectives To determine the test characteristics of point-of-care ultrasonography for the identification of a drainable abscess and to compare the test characteristics of ultrasonography with physical examination. In addition, we sought to measure the extent to which ultrasonography impacts clinical management of children with skin and soft tissue infections (SSTIs).

Study design We performed a prospective study of children with SSTIs evaluated in a pediatric emergency department. Treating physicians recorded their initial impression of whether a drainable abscess was present based on physical examination. Another physician, blinded to the treating physician's assessment, performed an ultrasound study and conveyed their interpretation and recommendations to the treating physician. Any management change was recorded. An abscess was defined as a lesion from which purulent fluid was expressed during a drainage procedure in the emergency department or during the 2- to 5-day follow-up period. We defined a change in management as correct when the ultrasound diagnosis was discordant from physical examination and matched the ultimate lesion classification.

Results Of 151 SSTIs evaluated among 148 patients, the sensitivity and specificity of point-of-care ultrasonography for the presence of abscess were 96% (95% CI 90%-99%) and 87% (74%-95%), respectively. The sensitivity and specificity of physical examination for the presence of abscess were 84% (75%-90%) and 60% (44%-73%), respectively. For every 4 ultrasound examinations performed, there was 1 correct change in management.

Conclusions Point-of-care ultrasonography demonstrates excellent test characteristics for the identification of skin abscess and has superior test characteristics compared with physical examination alone. *(J Pediatr 2016;169:122-7)*.

Superficial skin and soft tissue infections (SSTIs) are encountered commonly in emergency departments (EDs) and primary care settings, and account for over 14 million outpatient visits per year in the US.[1] Over the past decade, pediatric ambulatory and ED visits for SSTIs have increased and admission rates have doubled.[1-3] With the increasing incidence of SSTIs, which include abscess and cellulitis, the potential for misclassification has increased as well. Distinguishing cellulitis from abscess is important given their different courses, treatment, and outcomes.[4-7] This clinical distinction can be difficult based solely on history and physical examination alone.[8,9] Incorrect diagnosis may lead to unnecessary invasive procedures, exposure to the risks of sedation, inappropriate treatment, or unwarranted referrals.

For adult patients with SSTIs, the use of point-of-care ultrasonography demonstrates improved diagnostic accuracy over physical examination and results in changes in management.[10,11] Within pediatrics, the use of point-of-care ultrasonography is increasing, and a recent American Academy of Pediatrics policy statement supports the further integration of its use in pediatric emergency medicine.[12,13] Point-of-care ultrasonography is an ideal imaging modality for children as it is quick, noninvasive, and performed at the bedside.[14-18] Recent studies of point-of-care ultrasonography for pediatric SSTI, however, demonstrate less consistent findings compared with studies in adults, highlighting the need for further investigation. Prior studies in the area of point-of-care ultrasonography use for pediatric SSTI are limited by small sample size, inconsistent patient follow-up, variable sonographer training, and the lack of integration of findings into clinical decision making.[19-21]

Our primary objective was to evaluate the test characteristics of point-of-care ultrasonography for the diagnosis of abscess in children. In addition, we sought to compare the sensitivity and specificity of ultrasonography with physical examination, and to determine whether the use of ultrasound results in a real-time change in management for children with SSTIs. We hypothesized that point-of-care ultrasonography would have a higher sensitivity and specificity than physical examination for the diagnosis of abscess among children with SSTIs.

ED	Emergency department
SSTI	Skin and soft tissue infection

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Methods

We performed a single-center, prospective study with a convenience sample of patients presenting to an urban, tertiary care pediatric ED with a suspected SSTI. This study was approved by the institutional review board at our institution. Written informed consent was obtained from parents or guardians and written assent from patients older than 7 years.

Patients were eligible for the study if they were between the ages of 3 months and 21 years and presented with evidence of SSTI during a time in which an ultrasound-credentialed physician was available to perform a point-of-care ultrasound study. The use of ultrasonography was standard practice in our ED and used for clinical decision making during the study period. Subjects were identified by research coordinators, typically present in the ED from noon to midnight 7 days per week, based on chief complaints recorded on an electronic tracking board. Children with chief complaints of rash, cellulitis, abscess, skin problem, cyst, swelling or edema, and insect bite were assessed for eligibility. Children who had soft tissue infection of the face, hand, foot, anterior neck, perirectal region, or genitals were excluded from the study, as were patients with findings suggestive of a surgical wound infection, infection surrounding an indwelling catheter or tube, hidradenitis suppurativa, or suspected foreign body. Patients also were excluded if they had soft tissue ultrasonography or drainage procedure within 24 hours prior to arrival, or had significant comorbidities, such as immunocompromise or diabetes.

Study Protocol

All patients were evaluated by the treating physician (ie, a pediatric emergency medicine attending or fellow) prior to study enrollment. Once enrolled, but prior to performance of the study ultrasound, the treating physician completed a standardized questionnaire detailing specific aspects of the patient's history and physical examination and estimating the likelihood of a drainable abscess (<10%, 10%-25%, 26%-50%, 51%-75%, 76%-90%, or >90%). Lesions in the <10% and >90% group were classified as high certainty; those between 10% and 90% were classified as equivocal. The initial diagnosis (abscess or cellulitis) and management plan (medical management or drainage) were recorded prior to the performance of the study ultrasound.

A point-of-care ultrasound study was then performed by an ultrasound-credentialed physician, blinded to both the initial assessment and the management plan of the treating physician. Eight board-certified pediatric emergency medicine physicians and 2 pediatric emergency medicine fellows served as ultrasound-credentialed physicians for this study. All ultrasonographers met our division-required criteria for general and soft tissue ultrasonography credentialing: (1) attendance at a 1- to 2-day course or training during fellowship; and (2) independent, successful performance of at least 25 ultrasound examinations for the evaluation of abscess, which were reviewed for image quality and correct interpretation by the Director of Emergency Ultrasound.

A standardized sonographic protocol was used that included scanning of the soft tissue in 2 orthogonal planes (with saved digital videos), measurements of any fluid collection, and assessment with color flow Doppler to assess for internal vascularity. Abscess was characterized sonographically as a subcutaneous, anechoic, or heterogeneous hypoechoic collection with posterior acoustic enhancement and lack of internal vascularity. All ultrasound examinations were performed using a SonoSite Edge (SonoSite Inc, Bothell, Washington) machine with a high-frequency 13-6 MHz linear array transducer. For patients with multiple lesions, each lesion was assessed and analyzed separately. Based on the sonographic characteristics, the ultrasonographer determined if a fluid collection was present and recommended either medical management or drainage. To assess the interrater reliability of ultrasonography, a random sample of 10% of patients underwent an additional ultrasound examination by a second credentialed ultrasonographer; this test was not used to guide management decisions.

The ultrasonographer's findings and treatment recommendations were communicated to the treating provider and subsequent management decisions were at the discretion of the treating attending physician. A postultrasound datasheet was completed by the treating physician, recording if a drainage procedure was performed, if there was pus or purulent fluid expressed during the procedure, and if the use of ultrasonography altered the initial management plan.

The electronic medical record was queried to obtain information on microbiologic data, presence of fever, and ultimate treatment plan.

All patients were contacted by e-mail or phone (based on family preference) 2-5 days after the initial ED visit by a research coordinator, who had no knowledge of the initial ED visit details. Information regarding subsequent follow-up medical care and drainage procedures was ascertained.

Definitions

An abscess was defined as a lesion from which pus or purulent serosanguinous fluid was expressed during a drainage procedure, either while in the ED or during the 2- to 5-day follow-up period. A drainage procedure was defined as an incision and drainage or needle aspiration; lesions drained by manual decompression or unroofing were not defined as drainable abscesses. SSTI without a drainable abscess (ie, cellulitis) was defined as a soft tissue infection from which no pus was drained during a drainage procedure or for which no drainage procedure was performed during the ED visit or the follow-up period. By these criteria, lesions that had drainage procedures performed in the ED, regardless of outcome, were defined as either abscess or cellulitis irrespective of follow-up information.

A change in management was considered to have occurred in the following situations: (1) sparing a planned drainage procedure; or (2) performing a drainage that was not initially planned. We defined a change in management as correct if the ultrasonography diagnosis was discordant from physical