Clinical failure in abscess treatment: the role of ultrasound and incision and drainage

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Abstract

Purpose Skin and soft tissue abscesses are commonly treated in emergency departments (ED). The use of bedside ultrasound may improve patient outcomes. The primary objective of this study was to examine the relationship between ultrasound use and risk of treatment failure in ED patients treated for abscesses.

Methods In this multi-center observational study, we reviewed medical records of adult patients evaluated for abscesses. Demographics, infection characteristics, treatments rendered, use of ultrasound (for diagnosis and/or treatment) and follow-up data were collected from electronic medical record review. Treatment failure, the primary outcome, was defined as any surgical intervention after the initial ED visit. Multivariable logistic regression tested whether incision and drainage utilizing ultrasound was associated with reduced treatment failure.

Results We identified 609 patients diagnosed with abscesses over a 22-month period. Of them 75% were treated with incision and drainage, 55% had an ultrasound and 15% failed treatment. Multi-variable analysis demonstrated an 8% probability of failure with ultrasound plus incision and drainage, 14% with blind incision and drainage and 25% without incision and drainage. Individuals with incision and drainage performed were 50% less likely to fail treatment (RR 0.53, 95%CI 0.35–0.81) and 70% less likely to fail treatment (RR 0.30, 95%CI 0.18–0.51) with ultrasound and incision and drainage.

Conclusions The use of ultrasound in diagnosing and or/treating patients with abscesses in the ED is associated with decreased treatment failure risk when utilized with incision and drainage. Consideration of ultrasound use in other studies which assess treatment methods in relation to patient outcomes may be warranted.

Keywords Abscess · Treatment failure · Emergency service hospital · Skin · Adult · Ultrasonography

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Résumé

Objectif Les abcès de la peau et des tissus mous sont couramment traités dans les services d'urgence (SU). L'utilisation de l'échographie au chevet du patient peut améliorer les résultats des patients. L'objectif principal de cette étude était d'examiner la relation entre l'utilisation de l'échographie et le risque d'échec du traitement chez les patients des urgences traités pour des abcès.

Méthodes Dans cette étude d'observation multicentrique, nous avons examiné les dossiers médicaux des patients adultes évalués pour les abcès. Les données démographiques, les caractéristiques de l'infection, les traitements rendus, l'utilisation de l'échographie (pour le diagnostic et/ou le traitement) et les données de suivi ont été recueillies à partir de l'examen des dossiers médicaux électroniques. L'échec du traitement, le critère de jugement principal, a été défini comme toute intervention chirurgicale après la visite initiale au service d'urgence. Une régression logistique multivariable a permis de vérifier si l'incision et le drainage par ultrasons étaient associés à une réduction de l'échec du traitement.

Résultats Nous avons identifié 609 patients diagnostiqués avec des abcès sur une période de 22 mois. Parmi eux, 75 % ont été traités par incision et drainage, 55 % ont eu une échographie et 15 % ont échoué le traitement. L'analyse multivariée a démontré une probabilité d'échec de 8 % avec échographie plus incision et drainage, 14 % avec incision et drainage aveugle et 25 % sans incision et drainage. Les personnes chez qui l'on a pratiqué une incision et un drainage avaient 50 % moins de risques d'échouer le traitement (RR 0,53, 95 % IC 0,35-0,81) et 70 % moins de risques d'échouer le traitement (RR 0,30, 95 % IC 0,18-0,51) avec l'échographie et l'incision et le drainage.

Conclusions L'utilisation de l'échographie pour le diagnostic et/ou le traitement des patients atteints d'abcès aux urgences est associée à une diminution du risque d'échec du traitement lorsqu'elle est utilisée avec l'incision et le drainage. Il peut être justifié d'envisager l'utilisation de l'échographie dans d'autres études qui évaluent les méthodes de traitement en fonction des résultats pour les patients.

Clinician's capsule

What is known about the topic?

In controlled research settings, ultrasound use is beneficial in abscess treatment.

What did this study ask?

What is the relationship between ultrasound use and risk of treatment failure in emergency department patients treated for abscesses?

What did this study find?

Multi-variable analysis demonstrated an 8% chance of failure with ultrasound and incision and drainage, 14% with incision and drainage alone and 25% without incision and drainage.

Why does this study matter to clinicians?

Ultrasound use in conjunction with incision and drainage should be considered to improve patient outcomes when treating abscesses in emergency departments.

induration) can be visualized via ultrasound and differentiate these infection types [2].

Clinical trial data have shown that ultrasound in conjunction with physical examination improved subcutaneous abscess detection [3]. The utility of ultrasound was further explored in another clinical trial which found patients treated without ultrasound were more likely to fail treatment. However, these trials looked at ultrasound solely for diagnosis [3] or solely for treatment [4] and were limited to patients treated with incision and drainage. Ultrasound may be used for diagnosis, treatment, or both, and abscesses may be treated without incision and drainage due to lack of visualization or clinical preference towards conservative management. Consequently, the generalizability of these findings and the utility of ultrasound in pragmatic ED practice is unclear. We hypothesize that ultrasound use in the suspected abscess population will be associated with decreased treatment failure. Therefore, we aimed to examine ultrasound use in ED patients with abscesses by comparing differences in treatment failure between patients with abscesses treated/diagnosed with and without ultrasound.

Introduction

Skin and soft structure infections, including cellulitis and cutaneous abscess, are commonly treated in emergency departments (EDs) [1]. The distinction between an abscess and cellulitis is important for treatment decisions, but difficult to assess clinically. Well-documented sonographic qualities of purulence (shape, size, cavities, surrounding

Methods

Study setting and population

This multi-center retrospective cohort consisted of patients ≥ 18 years presenting to any of four EDs with a suspected abscess over a 22-month period. All sites used linked

Table 1 Emergency department treatment characteristics according to treatment failure status

Type	No treatment failure (<i>n</i> = 518) <i>n</i> (%)	Repeat incision and drainage; treatment failure (<i>n</i> = 91) <i>n</i> (%)	<i>p</i> value
Ultrasound done	293 (56.6)	44 (48.4)	0.15
No ultrasound done	225 (43.4)	47 (51.6)	0.15
Incision and drainage done	407 (78.6)	51 (56.0)	<0.001
Ultrasound plus incision and drainage	207 (39.9)	18 (19.7)	0.002
IV Abx in ED	78 (15.1)	15 (16.5)	0.73
Home Abx	361 (69.7)	61 (67.0)	0.61
Home MRSA Abx	224 (43.2)	42 (46.2)	0.61

IV intravenous; ED emergency department; Abx antibiotics; Penicillin/I penicillin inhibitor combination; MRSA Home Abx Antibiotics given that cover methicillin-resistant *Staphylococcus aureus*

electronic medical records and perform ultrasound by hospital-credentialed ED physicians. Institutional Review Board approved this study and STROBE guidelines for reporting cross-sectional studies were followed [5].

Patients with suspected abscess defined as: (1) incision and drainage performed; (2) ultrasound was performed for suspected abscess; or (3) patient was discharged with “abscess” diagnosis, were identified from ED electronic medical record in an effort to include abscesses treated without incision and drainage. Abscess presence was confirmed by: (1) incision and drainage evidence of purulence; (2) physical examination evidence of purulence; (3) ultrasound evidence of abscess cavity; or, (4) physical examination findings of abscess. Post-surgical infection, foreign body, animal bite, paronychia, dental, genital, and peri-tonsillar abscesses were excluded.

Data collection

Abstractors were uniformly trained, blinded to study objectives, and met regularly with investigators to review coding rules. Structured and standardized chart review was conducted using REDCap electronic data capture [6]. To reduce the potential for systematic error, and to mitigate bias, study design, data collection, abstractor training and monitoring were conducted according to recommendations outlined by Kaji et al. [7].

Patient characteristics, medical history, and ED course (chief complaint, infection characteristics, treatment) were extracted from the initial ED visit. Ultrasound variables collected included abscess depth from skin surface, and three-dimensional measurement. Data to determine if ultrasound was used during diagnosis, treatment, or both were not available.

Charlson Comorbidity Index (CCI) was used to rank patient’s comorbidities [8]. Infectious Disease Society of America (IDSA) guidelines were used to classify the severity of infection upon presentation [9].

Outcome measure

Our primary study outcome was treatment failure, defined a priori based on previous experience, as incision and drainage after initial visit, within a 30-day follow-up period [4] and assessed by comprehensive review of the electronic medical record (including ED, inpatient hospitalization, outpatient clinics, specialty, surgery, and primary care records). A subsequent incision and drainage done at a pre-planned follow-up or reassessment visit which was documented in the index visit was not considered to be treatment failure.

Data analysis

Chi-square and Student’s *t* test assessed differences between those with and without treatment failure. Unadjusted and multivariable logistic regression tested whether incision and drainage utilizing ultrasound was associated with reduced treatment failure. We used an interaction term with ultrasound and incision and drainage, comparing those with incision and drainage done with ultrasound and without ultrasound to those without incision and drainage. A priori selected covariates included age, gender, IDSA score (mild, moderate, or severe), and prescribed antibiotics. Covariates with *p* < 0.10 from unadjusted bivariate analysis were also included (truncal location, CCI score, and physician noted induration). Model fit was assessed using ROC curve and goodness of fit test. All analyses used Stata Version 13.1.

Results

Cohort characteristics

We identified 1226 patients with suspected abscesses, of which 823 met our definition of abscess. Additionally, 214 patients had no follow-up data in our electronic medical

record and were excluded since treatment outcomes could not be determined (Supplemental Fig. 1). Of the final cohort ($n=609$), 75% underwent incision and drainage and 55% had an ultrasound.

Overall, 15% of patients underwent incision and drainage during the follow-up period; and comprised the treatment failure group. Those with and without treatment failure did not differ by age, gender, race, or infection location (Supplemental Table 1). The failure group had higher comorbidity burden and fewer physical signs of induration (Supplemental Table 1).

Univariate results: treatment characteristics

Of 337 patients with ultrasound, only 54% had three-dimensional abscess measurements. Of these 182, 22 failed treatment and showed increased abscess depth was associated with treatment failure.

More patients treated without initial incision and drainage failed treatment (Table 1). Incision and drainage were utilized in those with and without treatment failure (56.0% and 78.6% respectively ($p<0.001$)) (Table 1). Incision and drainage plus ultrasound was also used in those with and without treatment failure [19.7% and 39.9% respectively ($p=0.002$)]. The only antibiotic treatments that differed significantly between those who did and did not fail treatment were ED first-generation cephalosporin, and home Bactrim.

Bivariate and multivariable results: treatment failure risk

In unadjusted estimates, patients treated solely with antibiotics were twice as likely to fail treatment as those with an incision and drainage [risk ratio (RR) 2.11, 95% confidence interval (CI) 1.42–3.15]. Individuals with an incision and drainage and no ultrasound were 50% (RR 0.53, 95%CI 0.35–0.81) less likely to fail treatment. When ultrasound was implemented in addition to incision and drainage, patients were 70% less likely to fail treatment (RR 0.30, 95%CI 0.18–0.51).

After controlling for demographic and clinical factors, both incision and drainage and incision and drainage plus ultrasound significantly reduced the risk of treatment failure.

The adjusted predicted probability of treatment failure was 25% with no incision and drainage, 14% with incision and drainage, and 8% with ultrasound plus incision and drainage.

Discussion

Interpretation of findings, comparison to previous studies, and implications

The importance of ultrasound and incision and drainage for abscess is demonstrated. Although a statistically significant positive effect of ultrasound alone was not detected, we observed less treatment failure when incision and drainage and ultrasound were both used. In multivariable modeling, there was a significant interaction between ultrasound and incision and drainage. These findings together further support the utility of ultrasound in ED practice in addition to incision and drainage. We also generalized the findings of prior clinical trials to a pragmatic ED cohort; in this less controlled environment, a positive association between ultrasound with incision and drainage and successful treatment remains [4].

Through modeling we found a 9% reduction in treatment failure risk with the use of incision and drainage and a 17% risk reduction with the use of ultrasound and incision and drainage. We speculate this decrease in treatment failure associated with ultrasound in conjunction with incision and drainage may be due to ultrasound correctly identifying abscess location and depth, thereby improving incision and drainage efficiency. Treatment failure was associated with increased abscess depth, and a lack of observed induration, supporting the importance of visualization of purulence. The importance of abscess visualization with incision and drainage for patient outcomes is also supported by prior research [10].

Strengths and limitations

The strengths of this study include pragmatic design, use of standardized data collection, and multivariable modeling. However, selection bias may be present from cohort identification, and from exclusion due to lack of follow-up data. We

were unable to determine when ultrasound was conducted in relation to other treatments including incision and drainage, why physicians used ultrasound, and how ultrasound use may have influenced conservative treatment. A minority of patients were treated without incision and drainage (25%). Due to power constraints, we could not definitively assess the impact of ultrasound in this group.

Conclusion

Our results show that ultrasound with incision and drainage may contribute to improved patient outcomes when compared with incision and drainage alone, not just in control research settings, but also in pragmatic ED settings.

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Declarations

Conflicts of interest None of the authors have any conflict of interest or competing interests.

Ethics approval The study was approved by the University of Massachusetts Medical School Institutional Review Board.

Ethical standards This retrospective chart review study involving data collected for clinical purposes was conducted in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The Human Investigation Committee (IRB) of University of Massachusetts Medical School approved this study.

Consent to participate Due to the retrospective deidentified nature of this study, the approving IRB did not require consent.

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