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Predictors of Oral Antibiotic Treatment Failure for Non-Purulent Skin and Soft Tissue Infections in the Emergency Department

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Abstract

Introduction

Current guideline recommendations for optimal management of non-purulent skin and soft tissue infections (SSTIs) are based on expert consensus. There is a lack of evidence to guide emergency physicians regarding selection of patients for oral versus intravenous antibiotic therapy. The primary objective was to identify predictors associated with oral antibiotic treatment failure.

Methods

We performed a health records review of adults (age ≥18 years) with non-purulent SSTIs treated at two tertiary care emergency departments (EDs). Oral antibiotic treatment failure was defined as any of the following after a minimum of 48 hours of oral therapy due to worsening infection: (i)

hospitalization; (ii) change in class of oral antibiotic; or (iii) switch to intravenous therapy. Multivariable logistic regression was used to identify predictors independently associated with oral antibiotic treatment failure.

Results

We enrolled 500 patients [mean age 64 years, 279 male (55.8%) and 126 (25.2%) with diabetes]. Of 288 patients who had received a minimum of 48 hours of oral antibiotics, there were 85 oral antibiotic treatment failures (29.5%). Tachypnea at triage (odds ratio [OR] = 6.31, 95% CI = 1.80 to 22.08), chronic ulcers (OR = 4.90, 95% CI = 1.68 – 14.27), history of MRSA colonization or infection (OR = 4.83, 95% CI = 1.51 to 15.44), and cellulitis in the past 12 months (OR = 2.23, 95% CI = 1.01 to 4.96) were independently associated with oral antibiotic treatment failure

Conclusion

This is the first study to evaluate predictors of oral antibiotic treatment failure for non-purulent SSTIs treated in the ED. Tachypnea at triage, chronic ulcers, history of MRSA colonization or infection and cellulitis within the past year were independently associated with oral antibiotic treatment failure. Emergency physicians should consider these risk factors when deciding on oral versus intravenous antimicrobial therapy for outpatient management of non-purulent SSTIs.

Introduction

Uncomplicated, non-purulent skin and soft tissue infections (SSTIs) are bacterial infections of the superficial epidermis and dermis (erysipelas) or deeper dermis and subcutaneous tissue (cellulitis) in which patients experience redness, pain and induration of the involved skin. Non-purulent and purulent SSTIs are a common clinical problem, accounting for up to 3% of all emergency department

(ED) visits in the United States, translating to 3.4 million visits.[1,2] Although Canadian data are lacking, a single Vancouver ED diagnosed 2,234 patients with a SSTI, which accounted for 2% of all ED visits.[3] Once the diagnosis of a non-purulent SSTI is made, the emergency physician must select the appropriate antibiotic agent, dose, duration and route (oral or intravenous).

Due to a lack of high quality evidence, empiric treatment guidelines regarding antimicrobial route are based on expert opinion.[4-6] Selecting the appropriate antibiotic route for outpatient management is a key decision point. Oral therapy holds several advantages over the parenteral route, including: lower risk of complications, decreased cost, increased patient convenience and comfort.[7-9] Intravenous therapy is usually selected if a patient has failed oral therapy, is systemically unwell (e.g. fever and tachycardia) or has a severe infection based on the clinician's impression. The main advantage of the intravenous route is optimizing bioavailability, which is especially useful in patients with swallowing difficulty or a gastrointestinal malabsorption syndrome. The intravenous route is costlier, less convenient for patients and has an added risk of adverse events. There are currently no studies that have aimed to identify predictors associated with treatment failure of oral antibiotic therapy. Identification of such predictors would allow emergency physicians to better select patients that require intravenous antibiotics.

The primary objective of this study was to identify risk factors associated with oral antibiotic treatment failure for non-purulent SSTIs. A secondary objective was to describe the ED management of adult patients with non-purulent SSTIs.

Methods

Study Design and Setting

We performed a health records review of consecutive adult patients presenting to the ED with diagnosis and management of a non-purulent SSTI. The study population was enrolled from the Ottawa Hospital EDs, both are tertiary care adult EDs with a combined 170,000 patient visits annually. Some patients were referred to the local outpatient parenteral antibiotic therapy (OPAT) hospital clinic, which operates three days a week and is run by six infectious disease physicians. These patients received intravenous antibiotics in the community with the local homecare program (community care access centre; CCAC). The Ottawa Health Science Network Research Ethics Board approved the protocol without the need for informed consent.

Population

We enrolled a consecutive sample of patients meeting eligibility criteria that presented to the ED over a seven-month period (January 1 – July 31, 2016). Eligible patients were adults (age ≥ 18 years) presenting to the ED and diagnosed with a non-purulent SSTI that was treated with either oral or intravenous antibiotics. We excluded patients for the following reasons: (i) patients presenting for a follow-up visit (i.e. not the index ED visit for this clinical problem); (ii) age < 18 years; (iii) a diagnosis of a purulent skin abscess where an incision and drainage procedure was performed; (iv) infected ulcers without surrounding cellulitis or erysipelas; and (v) necrotizing infections.

Study Protocol and Data Abstraction

In order to minimize bias, we took specific steps with respect to case selection, abstractor training, definition of variables, use of a standardized case record form, regular meetings and oversight of abstractors in accordance with accepted methodology for chart reviews.[10-13] We identified eligible

cases by International Classification of Diseases, 10th revision, Canada (ICD-10-CA) diagnosis codes of L03* (cellulitis, unspecified) and A46 (erysipelas). Relevant patient data were obtained from the electronic health record [physician and nursing notes, OPAT clinic records].

The principal investigator (KY) trained two medical students (JM, DR) on the use of the electronic health records system. All variables and the primary outcome of interest were explicitly defined (see supplementary appendix) a priori. We used a standardized case record form (see supplementary appendix) to abstract data. The case record form was piloted to remove ambiguous items and ensure the data collection instrument was robust. The data abstractors held regular monthly meetings to resolve any disagreements by consensus. The principal investigator monitored the performance of the data abstractors by reviewing 25% of the sample. Cohen's kappa statistic was used to assess interobserver agreement for patient eligibility and the primary outcome.

Outcome Measures

The primary outcome was treatment failure with oral antibiotics. There is currently no validated definition of treatment failure in the literature. The Food and Drug Administration recommends that clinical response to treatment should be assessed at 48 to 72 hours from initiating therapy.[14] When surveyed, a majority of Canadian emergency physicians selected 48 hours as the optimal timeframe for determining if treatment failure had occurred following initiation of antibiotic therapy.[15] After review of the literature[16-22] and discussion with local experts in emergency medicine and infectious disease, we reached consensus on a treatment failure definition. Treatment failure with oral antibiotics was defined as any of the following outcomes occurring after a minimum of 48 hours of oral antibiotics and at no later than 14 days from the index ED visit: (i) subsequent hospital admission for a SSTI; (ii) a change in class of oral antibiotic owing to progression of infection and not due to intolerance or allergy; or (iii) a change in antibiotic route from oral to intravenous therapy owing to progression of infection and not due to intolerance or allergy.

A secondary outcome of interest was treatment failure with intravenous antibiotics. This was defined as any of the following outcomes after a minimum of 48 hours of intravenous antibiotics and at no later than 14 days from the index ED visit: (i) subsequent hospital admission for a SSTI; or (ii) a change in class of intravenous antibiotic owing to progression of infection and not due to intolerance or allergy.

Baseline demographics and clinical data were abstracted as follows: patient age and gender; co-morbidities; ED triage vital signs; and infection characteristics. We anticipated that accurate infection dimensions (length and width) might not be consistently recorded on patient charts. As an alternative measure of infection size, the Lund-Browder burn chart was used to estimate the percent body surface area of affected skin. [23,24] ED treatment variables were abstracted as follows: (a) antibiotic agent and dose; and (b) setting for subsequent intravenous antibiotics (if chosen). Adverse outcomes included antibiotic events and intravenous catheter-related events.

Statistical Analysis

The prevalence of non-purulent SSTIs in the ED population, the proportion of patients who received oral versus intravenous therapy, and the patients who had a treatment failure were calculated. Continuous data are presented as means with standard deviations or medians with an interquartile range (IQR, Q1 – Q3) for normally and non-normally distributed data, respectively. Categorical data are presented as proportions with 95% confidence intervals.

We employed univariate analyses to examine all clinical variables hypothesized to be risk factors for treatment failure with oral antibiotic therapy (see supplementary appendix). Variables with p-values of 0.10 or less were considered for multivariable analysis. A backwards selection procedure was used to obtain a multivariable logistic regression model to determine clinical predictors independently

associated with the primary outcome of treatment failure with oral antibiotics. The Hosmer-Lemeshow statistic was used to assess model fit. SAS (version 9.4) was used for descriptive statistics, univariate and multivariable logistic regression analysis.

Sample Size

Previous studies have suggested that a minimum of ten events per variable is required to avoid biased estimates when developing multivariable prediction models.[25-27] We estimated that no more than five predictor variables would be included in a model to predict treatment failure with oral antibiotics. Based on the ten events per variable rule of thumb, a minimum of 50 treatment failures would be required to develop a robust model. Treatment failure rates reported in the literature range from 6 – 37%.[28] Previously published studies in Canadian EDs have indicated that the approximate treatment failure rate of SSTIs with antibiotics ranges from 18.7 – 20.5%.[16,17] Assuming a conservative estimate of an 18% treatment failure rate, 270 patients would be required to obtain a minimum of 50 oral antibiotic treatment failures. We estimated that up to 40% of patients might be treated with intravenous therapy. Therefore, we determined an overall sample size of 500 patients would ensure that we surpassed the minimum required number of patients treated with oral antibiotics. During the analysis, we chose to offer six variables into the multivariable model, which was appropriate given that there were 85 oral antibiotic treatment failure events.

Results

Over the seven-month study period, 666 cases were screened for eligibility and 500 patients met the inclusion criteria (Figure 1). The kappa statistic for included cases between the primary investigator (KY) and each abstractor (JM and DR) was 0.96 (95% CI 0.93 – 0.99) and 0.91 (95% CI 0.86 – 0.97), respectively. The kappa statistic for the primary outcome of oral antibiotic treatment failure was 0.94 (95% CI 0.90 – 0.98). Of the 500 enrolled patients, 126 (25.2%) had diabetes and 87 (17.4%) had a

history of cellulitis in the prior 12 months (Table 1). The most common location of infection was the leg (54.2%) and most infections (80.2%) were estimated using a Lund-Browder burn chart to be <5% total body surface area.

Of the total cohort, 354 patients (70.8%) received an intravenous antibiotic in the ED, with 148 patients (29.6%) admitted to hospital for further parenteral therapy. The most common oral agent used was cephalexin and the most common parenteral agent was cefazolin (see supplementary appendix). Of patients receiving intravenous antibiotics, 20.6% received two or more antibiotics.

Of the 352 patients that were managed as outpatients, the majority (61.4%) received solely oral antibiotic prescriptions (Table 2). An important proportion of patients sent home (19.9%) received an intravenous antibiotic dose in the ED but were discharged with an oral antibiotic prescription. Of the 222 patients receiving oral antibiotic prescriptions, cephalexin was the most commonly selected medication (77.4%). Of the 136 patients receiving outpatient intravenous antibiotics, 99 patients (72.8%) were referred to the OPAT clinic for follow up with an infectious disease consultant. A minority was asked to follow up with their primary care provider or return to the ED for follow up. Among the 136 patients who were discharged with outpatient intravenous therapy, cefazolin (68.4%) was the most commonly prescribed.

A significant number of outpatients (40.6%) returned to the ED within 14 days (Table 3). The majority of patients returned for scheduled repeat intravenous antibiotics. A small proportion of unscheduled visits (5.4%) was for a worsening infection that required hospital admission. There were few adverse events for outpatients: 2.8% with a dislodged or blocked peripheral intravenous line; 1.7% of with gastrointestinal symptoms and 0.6% of with a rash attributed to the prescribed antibiotic.

For the 99 patients referred to the OPAT clinic, 85.8% of patients attended their appointment (see supplementary appendix). Emergency physicians diagnosed cellulitis with a high degree of accuracy (96.5%), with only three patients having an alternate diagnosis assigned by the infectious disease physicians. The median time to follow up for the first OPAT clinic visit was 4 days and there was a median of 2 clinic visits. Patients received a median duration of 7 days of intravenous antibiotics.

Of 288 patients who were treated with at least 48 hours of oral antibiotics, 85 patients (29.5%) suffered an oral antibiotic treatment failure (Table 4). There were 68 patients (80.0%) identified as a treatment failure at the initial ED visit. Treatment failures were managed as follows: 51 patients (60.0%) were switched to outpatient intravenous antibiotics; 30 patients (35.3%) were hospitalized for intravenous therapy; and 4 patients (4.7%) were switched to a different class of oral antibiotic. Of 212 patients treated with at least 48 hours of intravenous antibiotics, 12 patients (5.7%) suffered an intravenous antibiotic treatment failure.

Predictors associated with oral antibiotic treatment failure using multivariable logistic regression are shown in Table 5. Tachypnea at triage (odds ratio [OR] = 6.31, 95% CI = 1.80 to 22.08), chronic ulcers (OR = 4.90, 95% CI = 1.68 – 14.27), history of MRSA colonization or infection (OR = 4.83, 95% CI = 1.51 to 15.44), and cellulitis in the past 12 months (OR = 2.23, 95% CI = 1.01 to 4.96) were found to be independently associated with oral antibiotic treatment failure. The Hosmer-Lemeshow chi-square test yielded a p-value of 0.604 (χ^2 = 1.853, degrees of freedom = 3) and the C-statistic was 0.709. This indicates that our model has good fit.

Discussion

Interpretation of Results

This study describes adult patients presenting to the ED for non-purulent SSTIs. We identified potential risk factors for failure with oral antibiotics. Tachypnea at triage, chronic ulcers, history of MRSA colonization or infection and cellulitis within the past year were independently associated with oral antibiotic treatment failure. Tachypnea at triage is one of the components of the systemic inflammatory response syndrome and is a marker of severe illness.[29] Chronic ulcers imply poor healing that may require intravenous therapy to treat associated cellulitis, whereas patients with prior cellulitis may be prone to more severe infections. Both of these factors were identified as predictors of overall treatment failure in a recent study.[17] Patients with a history of MRSA may be initially treated with inappropriate antibiotics, leading to worsening infection and the eventual requirement for intravenous therapy. These risk factors may be considered as potential considerations for intravenous therapy.

Nearly one-third of patients were admitted to hospital for further management. We observed considerable practice variation with respect to selection of antimicrobial route and agent. A number of patients received a single intravenous dose in the ED followed by outpatient oral therapy, despite a lack of evidence to support this approach. The variability in treatment approach reinforces the lack of agreement amongst emergency physicians on the optimal approach to therapy for this common clinical condition.

We found an oral antibiotic treatment failure rate of 29.5%, which was higher than expected. Murray et al.[16] reported an oral antibiotic treatment failure rate of 6.8%, but this was a small sample size (2 of 29 patients). Peterson et al.[17] reported an oral antibiotic treatment failure rate of 21.0%. However, neither study used a strict time cutoff in their definition of treatment failure. The high treatment

failure and hospital admission rates are of concern. These findings may in part reflect the lack of evidence to guide emergency physicians on the optimal antimicrobial agent and route.

Previous Studies

The most recent Infectious Disease Society of America guidelines suggest intravenous antibiotics for 'moderate' (signs of systemic illness) or 'severe' (failed oral therapy, signs of systemic illness, clinical signs of deeper infection, or immunocompromised) infections.[4] The British Clinical Resource Efficiency Support Team (CREST) guidelines recommend oral therapy in 'Class I' patients, defined as having no signs of systemic toxicity and no 'uncontrolled' co-morbidities, which was not explicitly defined.[5] Due to a lack of evidence, these guidelines are based on expert opinion. A study by Peterson et al. identified predictors of failure with outpatient antibiotics for cellulitis, but did not distinguish between oral versus intravenous routes.[17] A recent survey of Canadian emergency physicians revealed that 94.4% of respondents would consider a clinical decision rule to predict oral antibiotic treatment failure.[15] To date, evidence regarding the optimal route of antimicrobial therapy for non-purulent SSTIs is lacking.

Strengths

This is the first study to identify potential predictors associated with oral antibiotic treatment failure for non-purulent SSTIs. There was excellent agreement between data abstractors for both inclusion of patients and the primary outcome. The study findings may better guide emergency physicians to determine when oral antibiotic treatment failure is likely – and when to select intravenous therapy at the onset of treatment.

Limitations

This health records review has several potential limitations. First, potentially clinically important variables (infection size and obesity) may have been inaccurate or not documented. Obtaining accurate measures of infection size was not possible as it was seldom documented in the medical record. We instead attempted to estimate infection size using a Lund-Browder burn chart as a surrogate for total body surface area of affected skin. Obesity may have not been consistently documented in the medical chart. We attempted to mitigate this by reviewing all electronic health records in the 6 months prior to and after the index visit to identify if this co-morbidity was documented.

Second, the data abstractors were not blinded to the study outcome. This is unlikely to have resulted in significant bias as the primary outcome was strictly defined using a 48-hour cutoff for consideration of treatment failure. In addition, there was excellent inter-observer agreement for the primary outcome. We attempted to minimize bias by training abstractors, holding regular meetings, validating 25% of charts, defining variables a priori, and using a standardized case record form in accordance with accepted methodology for chart reviews.[10-13]

Third, there is no validated definition of oral antibiotic treatment failure. Following a review of the literature[14-22,30] we developed a definition after discussion and consensus among local experts in emergency medicine and infectious disease. Fourth, these results may not be generalizable to communities that lack OPAT resources. Fifth, there was a small amount of missing data (<2.5%), which was assumed to be missing completely at random. We handled the missing data using a complete case analysis. Lastly, due to the nature of the study design, we were unable to measure treatment adherence.

Clinical Implications

Several risk factors associated with oral antibiotic treatment failure were identified. We feel that such factors should be considered when deciding on the optimal route of therapy. Ultimately, our findings highlight that further studies are critical to improve treatment of this common clinical condition. Our findings reveal important clinical implications, having demonstrated significant practice variability with respect to selection of antimicrobial agent and route. This variation in treatment approach coupled with a high hospital admission rate is likely due to a lack of evidence-based recommendations for optimal therapy.

Research Implications

Future research should involve a prospective study to further assess these potential risk factors for treatment failure identified in our study and ideally derive a clinical decision rule to guide emergency physicians on the optimal route of antimicrobial therapy. Furthermore, studies examining rationale for selecting intravenous therapy would provide better insight regarding physician decision-making.

Conclusions

This is the first study to evaluate predictors of oral antibiotic treatment failure for non-purulent SSTIs in the ED. We observed a high hospital admission rate and practice variability regarding antimicrobial agent and route. Tachypnea at triage, chronic ulcers, history of MRSA colonization or infection and cellulitis within the past year were independently associated with oral antibiotic treatment failure. Emergency physicians should consider these risk factors when deciding on oral versus intravenous antimicrobial therapy for patients with non-purulent SSTIs.

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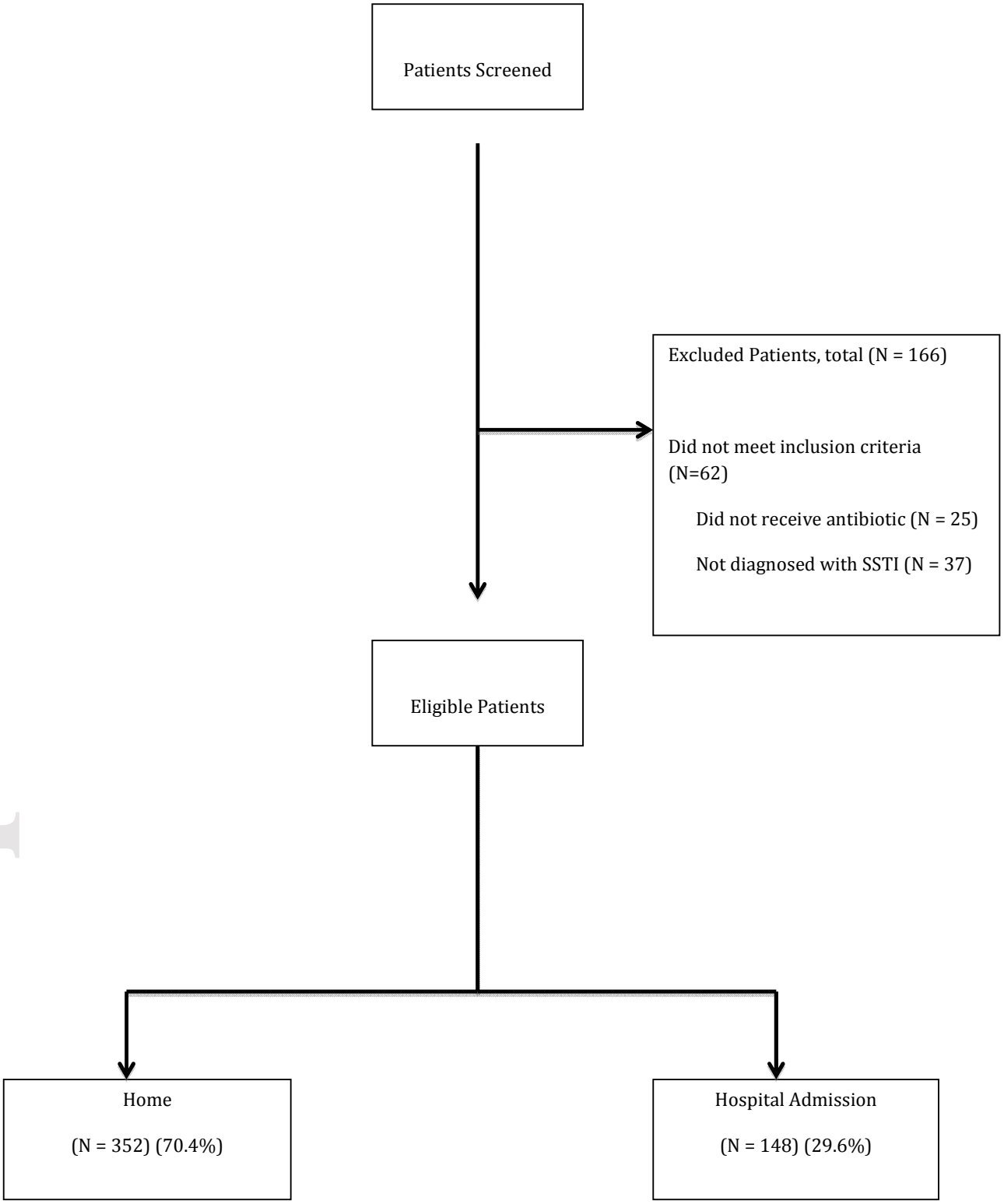
Figures

Figure 1. Flow Diagram of Patient Eligibility and Outcomes



Tables

Table 1. Baseline Characteristics of Adults with Non-Purulent Skin and Soft Tissue Infections (SSTIs) seen in the Emergency Department

Variable	N = 500
Age (years), mean ± SD	64 ± 19
Range	18 – 98
Male (%)	279 (55.8)
Hospital Site (%)	
TOH Civic Campus	278 (55.6)
TOH General Campus	222 (44.4)
Co-morbidities	
Diabetes mellitus	126 (25.2)
Cellulitis in past 12 months	87 (17.4)
Coronary artery disease	58 (11.6)
Congestive heart failure	48 (9.6)
History of MRSA infection or colonization	43 (8.6)
Peripheral vascular disease	40 (8.0)
Liver disease	37 (7.4)
Chronic kidney disease	35 (7.0)
Active cancer	34 (6.8)
Lymphedema	33 (6.6)
Obesity	27 (5.4)
Injection drug use	14 (2.8)
Organ transplant recipient	4 (0.8)

Taking antibiotics at the time of ED presentation	
Oral	85 (17.0)
IV	13 (2.6)
Triage Vital Signs	
Temperature, °C (mean ± SD)	36.6 ± 0.9
Heart Rate, beats/min (mean ± SD)	87 ± 19
Blood Pressure, mmHg (mean ± SD)	136 ± 24
Respiratory Rate, breaths/min (median, IQR)	18, 16 – 18
Oxygen Saturation, % (median, IQR)	97, 96 – 98
Infection Location (%)	
Leg	271 (54.2)
Foot	85 (17.0)
Arm	51 (10.2)
Hand	37 (7.4)
Face	29 (5.8)
Torso	22 (4.4)
Groin	5 (1.0)
Infection Characteristics (%)	
Chronic leg ulcers	56 (11.2)
Surgical site infection	30 (6.0)
Bite	12 (2.4)
Size	
TBSA <5%	401 (80.2)

TBSA 5 – 10%	97 (19.4)
TBSA >10%	2 (0.4)
Laboratory Tests	
White blood cell count ordered (%)	378 (75.6)
White blood cell count, $\times 10^9$/L (median, IQR)	9.2, 7 – 13

SD = standard deviation; IQR = interquartile range; TOH = The Ottawa Hospital; MRSA = methicillin resistant *Staphylococcus aureus*; ED = emergency department; IV = intravenous; TBSA = total body surface area

Table 2. Antibiotic Treatment for 352 Patients Discharged from the ED

Outpatient Management	**Number of Patients, N=352** **N (%)**
Prescribed oral antibiotics	216 (61.4)
Prescribed IV antibiotics	130 (36.9)
Prescribed oral and IV antibiotics	6 (1.7)
Oral antibiotic in ED and sent home on oral antibiotic	146 (41.5)
IV antibiotic in ED and sent home on IV antibiotic*	136 (38.6)
IV antibiotic in ED and sent home on oral antibiotic	70 (19.9)
Intended location for outpatient IV antibiotics	
CCAC and OPAT clinic	99 (28.1)
CCAC only	26 (5.6)
ED	11 (2.2)
Oral antibiotics prescribed	222 (63.1)
Cephalexin	172 (48.9)
Clindamycin	19 (5.4)
Amoxicillin-Clavulanate	13 (3.7)

Trimethroprim-sulfamethoxazole	7 (2.0)
Ciprofloxacin	5 (1.4)
Doxycycline	5 (1.4)
Amoxicillin	1 (0.3)
IV antibiotics prescribed	136 (38.6)
Cefazolin	93 (26.4)
Ceftriaxone	31 (8.8)
Clindamycin	4 (1.1)
Vancomycin	3 (0.8)
Meropenem	1 (0.3)
Multiple IV Antibiotics	4 (1.1)

IV = intravenous, CCAC = community care access centre; OPAT = outpatient parenteral antibiotic therapy; ED = emergency department

***6 patients were discharged with both intravenous and oral antibiotics**

Table 3. Adverse Events for 352 Patients Discharged from the ED

Adverse Events	**Number of Patients, N = 352** **N (%)**
Return to the ED within 14 Days	143 (40.6)
Reason for return ED visit	
Repeat antibiotics	60 (17.0)
For re-evaluation of SSTI and no admission	39 (11.1)
Unrelated medical problem	21 (6.0)
For SSTI and hospital admission	19 (5.4)
Diagnosed with abscess requiring I&D	4 (1.1)
Adverse device events	
Dislodged/blocked peripheral IV line	10 (2.8)
Thrombophlebitis, line infection or bacteremia	0 (0)
Adverse antibiotic events	
Nausea and/or vomiting	4 (1.1)
Rash	2 (0.6)
Diarrhea	2 (0.6)

ED = emergency department; IV = intravenous; SSTI = skin and soft tissue infection; I&D = incision and drainage

Table 4. Treatment Failure with Oral Antibiotics (N = 85 of 288 Patients Treated with a Minimum of 48 Hours of Oral Therapy)

Oral Antibiotic Treatment Failures	Number of Patients, N = 85 N (%)
Patient outcomes	
Switched to outpatient IV antibiotics	51 (60.0)
Hospitalized for IV antibiotics	30 (35.3)
Switched to outpatient oral antibiotics of different class	4 (4.7)
Treatment failure on initial ED visit*	
Treatment failure on return ED visit within 14 days	68 (80.0)
IV antibiotic in the ED followed by oral prescription	17 (20.0)
Oral antibiotic in ED followed by oral prescription	12 (14.1)
	5 (5.9)

*Patient was already on ≥48 hours of oral antibiotic therapy at time of index ED visit

IV = intravenous; ED = emergency department

Table 5. Predictors Associated with Oral Antibiotic Treatment Failure Using Multivariable Logistic Regression (N = 288)

Predictor Variable	Adjusted OR	95% CI	P Value
Tachypnea at triage (RR>20)	6.31	1.80 – 22.08	0.004
Chronic ulcers	4.90	1.68 – 14.27	0.004
History of MRSA colonization or infection	4.83	1.51 – 15.44	0.008
Cellulitis in the past 12 months	2.23	1.01 – 4.96	0.05
Chronic kidney disease	2.60	0.82 – 8.22	0.10
Diabetes mellitus	1.70	0.87 – 3.32	0.12
The Hosmer-Lemeshow chi-square test yielded a p-value of 0.604 (χ^2 = 1.853, degrees of freedom = 3). C-statistic = 0.709. This indicates no evidence of poor fit.			

RR = respiratory rate; MRSA = methicillin resistant *Staphylococcus aureus*; OR = odds ratio; CI = confidence interval

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