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# Impact of Outpatient vs Inpatient ABSSSI Treatment on Outcomes: A Retrospective Observational Analysis of Medical Charts Across US Emergency Departments

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# Impact of Outpatient vs Inpatient ABSSSI Treatment on Outcomes: A Retrospective Observational Analysis of Medical Charts Across US Emergency Departments

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***Background.*** The objective of this study was to characterize treatment of patients with acute bacterial skin and skin structure infections (ABSSSIs) and describe the association between hospital admission and emergency department (ED) visits or readmissions within 30 days after initial episode of care (IEC).

***Methods.*** This was a retrospective, observational, cohort study of adults with ABSSSI who presented to an ED between July 1, 2012, and June 30, 2013. Patient, health care facility, and treatment characteristics, including unplanned ED visits or readmissions, were obtained through manual chart review and abstraction. Adjusted logistic regression analysis examined likelihood of all-cause unplanned ED visits or readmissions between admitted and nonadmitted patients.

***Results.*** Records from 1527 ED visits for ABSSSI from 40 centers were reviewed (admitted, n = 578 [38%]; nonadmitted, n = 949 [62%]). Admitted patients were typically older (mean age, 52.2 years vs 43.0 years), more likely to be morbidly obese (body mass index > 40 kg/m$^2$; 17.3% vs 9.1%), and had more comorbidities (Charlson Comorbidity Index ≥ 4; 24.4% vs 6.8%) compared with those not admitted. In the primary analysis, adjusted logistic regression, controlling for comorbidities and severity of illness, demonstrated that there was a similar likelihood of all-cause unplanned ED visits or readmissions between admitted and nonadmitted patients (odds ratio, 1.03; 95% confidence interval, 0.74–1.43; $P = .87$).

***Conclusions.*** ABSSSI treatment pathways leveraging outpatient treatment vs hospital admission support similar likelihood of unplanned 30-day ED visits or readmissions, an important clinical outcome and quality metric at US hospitals. Further research regarding the decision criteria around hospital admission to avoid potentially unnecessary hospitalizations is warranted.

**Keywords.** cellulitis; erysipelas; hospital costs; hospitalization; infections; risk factors; skin diseases.

Acute bacterial skin and skin structure infections (ABSSSIs), or complicated skin and soft tissue infections (cSSTIs), include a range of skin and skin structure infections, such as cellulitis/erysipelas, wound infections, and major cutaneous abscesses. Gram-positive pathogens, including *Staphylococcus aureus* (both methicillin-resistant [MRSA] and methicillin-sensitive strains) and *Streptococcus pyogenes*, are the most common cause of culture-positive ABSSSI [1–3]. Less frequently, other *Streptococcus* spp., *Enterococcus faecalis*, or Gram-negative bacteria are implicated.

Acute bacterial skin and skin structure infections are a common reason for emergency department (ED) visits [4, 5]. Although guidelines were developed that support outpatient management of ABSSSIs for appropriate patients [6], hospital admissions in the United States due to primary diagnosis of skin and skin structure infections increased from 1.6% in 2005 to 2.0% of patients in 2011 [7]. Furthermore, institutional consistency and guidelines have not yet been optimized; clinician practices regarding the decision to provide outpatient or inpatient treatment may vary greatly even within a single institution [8, 9]. Although hospital admission may be a strategy that is used in an effort to ensure optimal outcomes, whether admission improves outcomes requires further investigation [9, 10]. This is especially true because antibiotic stewardship programs that leverage outpatient treatment pathways and novel antibiotic therapy may affect treatment strategy, improve patient outcomes, and reduce costs [11–13].

This study describes the patient, health care facility, and treatment characteristics of those with ABSSSIs and the likelihood of unplanned 30-day ED visits or readmissions among patients

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who were admitted vs patients who were not admitted to the hospital after their initial ED visit. The main purpose of this study was to evaluate whether treatment location (ie, hospital admission vs outpatient treatment) was a predictor of unplanned 30-day ED visits or readmissions after initial ABSSSI treatment.

## METHODS

### Study Design and Study Setting

This was a retrospective, observational cohort study of adult patients with ABSSSI who presented to an ED between July 1, 2012, and June 30, 2013, across 40 ED sites in the United States. Each institution developed a systematic process to identify ≥30 patients meeting study eligibility criteria. Of those patients, at least 10% were required to have been admitted to the hospital. The initial episode of care (IEC) was defined as the initial hospital or ED visit up to the point of hospital or ED discharge. As a result, it is possible that a patient could have spent multiple days in the ED before discharge.

All collected data were obtained by manual medical chart review and were de-identified before collation to comply with current Health Insurance Portability and Accountability Act of 1996 (HIPAA) regulations. Institutional review board approval was obtained for each site. Patient consent was not required due to the retrospective nature of the study. The study met the ethical principles of the Declaration of Helsinki.

The study was sponsored by Allergan plc (Dublin, Ireland). Because most authors were employees of Allergan at the time of study conduct and analysis, the study sponsor was involved in the study design, conduct, and analysis and in critical review and approval of the manuscript.

### Study Population

Adult patients aged ≥18 years were included if they had an ED diagnosis with ≥1 relevant International Classification of Diseases (ICD)-9 codes: 681.XX (cellulitis and abscess of finger and toe), 682.XX (other cellulitis and abscess), 686.XX (other local infections of skin and subcutaneous tissue), 958.3X (posttraumatic wound infection—not elsewhere classified), or 998.5X (postoperative infection—not elsewhere classified) [7].

Patients were excluded if they had a diagnosis of necrotizing fasciitis (ICD-9 code: 728.86), gas gangrene (040.0), or gangrene (785.6), as these severe infections are not consistent with the definition of ABSSSI [1]. Patients were excluded if there was any evidence of fungal infection (alone or in combination with a bacterial infection) or if the ABSSSI was solely due to Gram-negative bacteria defined microbiologically. Patients with known or suspected HIV infection and a CD4 count <200 cells/$mm^3$, or with past or current AIDS-defining condition and unknown CD4 count, were also excluded.

### Key Outcome Measures

Patient, health care facility, and treatment characteristics, including unplanned ED visits or hospitalizations within 30 days of the IEC, were obtained through manual chart review and the abstraction process. Patient-level data were de-identified at the source and aggregated into a single database for analysis.

#### *Patient and Health Care Facility Characteristics*

Patient demographics and clinical characteristics that were collected included age, sex, skin infection type, body mass index (BMI), Charlson Comorbidity Index (CCI), health insurance type, Systemic Inflammatory Response Syndrome (SIRS) criteria (≥2 criteria: temperature >38°C [100.4°F] or <36°C [96.8°F]; heart rate >90 beats/minute; respiratory rate ≥20 breaths/minute or partial carbon dioxide pressure [$PaCO_2$] ≤32 mmHg; white blood cell count [WBC] ≥12 000/$mm^3$ or ≤4000/$mm^3$; and suspected or proven infection), history of ABSSSI within 30 days, hospitalization within 90 days, known history of MRSA, systemic antibiotic use within 90 days of IEC, and current or past intravenous drug use [IVDU]). Patients were classified as admitted at the IEC if they were admitted as an inpatient to an intensive care unit (ICU), a unit other than the ICU, or transferred to another hospital. Patients were classified as not admitted at the IEC if they were transferred to an observational bed/unit (from a resource use perspective, these patients are not considered admitted), discharged to their home, left the ED against medical advice, transferred to a skilled nursing facility or long-term care, or if they died before any admission or discharge proceeding.

Health care facility characteristics included geographic region, hospital organization type (academic vs community), bed capacity, hospital observation unit status (dedicated observation unit vs interspersed throughout hospital), hospital-owned outpatient infusion center affiliation, integrated delivery system affiliation, accountable care organization affiliation, and number of full-time equivalents for antibiotic oversight/stewardship in the ED.

#### *Treatment Characteristics*

Treatments for ABSSSI received during the IEC and at discharge were described, including whether a lesion culture was obtained, whether an incision and drainage were performed, or whether a peripherally inserted central catheter (PICC) was placed. Antibiotic therapy received during the IEC and at discharge was recorded. Antibiotic therapy was classified as recommended or not recommended (Supplementary Table 1) by 2 investigators (P. Brandon Bookstaver and Timothy C. Jenkins) based on the Infectious Diseases Society of America (IDSA) guidelines for empiric skin and soft tissue infection treatment [14–16]. The duration of antibiotic therapy and the most common therapies at the IEC and at discharge were described [14].

#### *Unplanned 30-Day ED Visits or Readmissions*

Patients who had an unplanned visit to the ED or hospitalization for any cause within 30 days of IEC discharge were defined

as experiencing an unplanned 30-day ED visit or readmission. In addition to all-cause unplanned 30-day ED visits or readmissions, skin infection–related unplanned 30-day ED visits or readmissions were assessed.

#### Data Analysis

Descriptive statistics were conducted on the patient, health care facility, and treatment characteristics using counts and percentages for categorical variables and means and standard deviations for continuous variables. Both all-cause and skin infection–related unplanned 30-day ED visits or readmissions were similarly described.

Unadjusted (ie, univariate) and multivariate logistic regression with adjustment for confounding variables were used to estimate the likelihood of both all-cause and skin infection–related unplanned 30-day ED visits or readmissions comparing patients who were admitted and those who were not admitted to the hospital. In accordance with causal inference methodology, all variables chosen for logistic regression models occurred before the decision to admit or not admit was expected to be made. The outcome for all-cause unplanned 30-day ED visits or readmissions was used as our primary analysis, as it has been assessed previously as an important clinical outcome and part of hospital quality assessment, whereas the outcome for skin infection–related unplanned 30-day ED visits or readmissions was used as a secondary analysis. For the primary and secondary analyses, variables were selected for adjustment using stepwise logistic regression (Model 1); additional variables were selected to include a second model based on clinical and epidemiologic rationale (Model 2). For the initial stepwise logistic regression (Model 1), variables that met the threshold ($P \leq .30$) were utilized based on univariate analyses. Forward stepwise selection determined the final models. The primary predictor variable (admission status after the IEC) was forced into the stepwise logistic regression analysis for the final model.

Missing data were not imputed; thus, analyses were undertaken using available data only. Statistical significance was defined as $P < .05$. All analyses were conducted using SAS statistical software (SAS, version 9.3; SAS Institute, Cary, NC).

## RESULTS

#### Patient Characteristics

In total, records from 1527 patients with ED visits for ABSSSIs from 40 centers were included in the analysis: 37.9% of patients (578/1527) were admitted to the hospital at the IEC, whereas 62.1% (949/1527) were not admitted at the IEC (Figure 1). Among admitted patients, 547/578 (94.6%) were non-ICU admissions, 29/578 (5.0%) were admitted to the ICU, and 2/578 (0.3%) were transferred to another hospital or destination was not specified. Of the patients who were not admitted, 894/949 (94.2%) were discharged home, 38/949 (4.0%) were transferred to an observation bed/unit, 9/949 (0.9%) departed against medical advice, and 8/949 (0.8%) were transferred to a skilled nursing facility or long-term care. Patient demographics and clinical characteristics are shown in Table 1. Patients who were admitted were older (mean age, 52.2 years vs 43.0 years), were more likely to be morbidly obese (BMI > 40 kg/m$^2$; 17.3% vs 9.1%), and had more comorbidities (CCI ≥4; 24.4% vs 6.8%). The majority of the overall cohort presented with cellulitis (50.4%) and had evidence of limited comorbidity (CCI 0 or 1; 52.1% admitted patients vs 84.1% nonadmitted patients). Admitted patients exhibited a greater severity of infection (as assessed by the presence of SIRS; 32.7% vs 5.6%) than those who were not admitted.

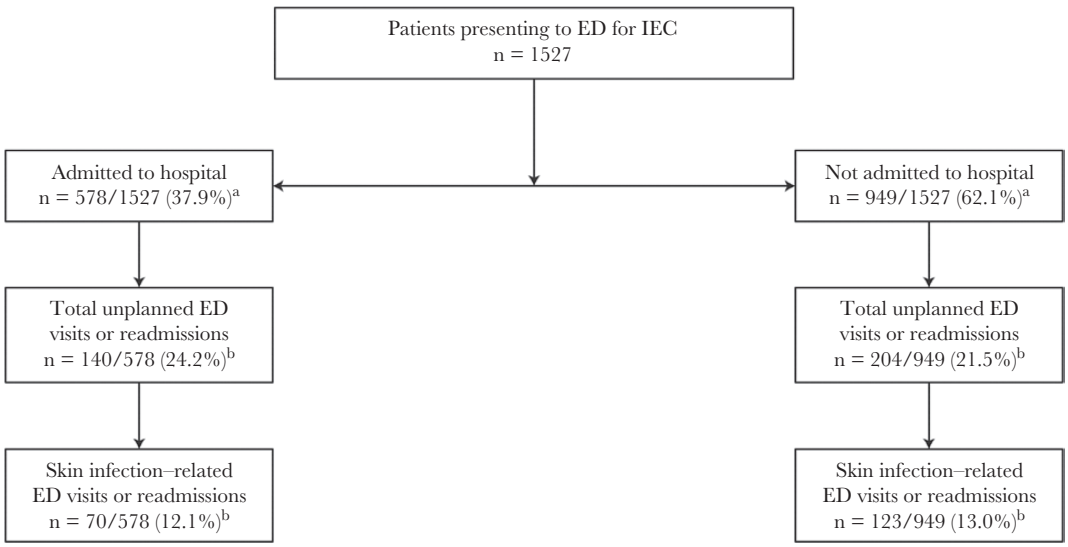



**Figure 1.** Treatment pathway following the ED visit for the IEC and unplanned 30-day ED visits or readmissions. [a]An unplanned ED visit or readmission is an unplanned visit to the ED or an unplanned hospital admission within 30 days of discharge from the ED or hospital after the IEC. [b]Indicates percentage of patients from the total subgroup in the arm of treatment pathway. Abbreviations: ED, emergency department; IEC, initial episode of care.

**Table 1. Patient and Treatment Characteristics Stratified by Admission Status**

| | Admitted (n = 578; 37.9%) | Not Admitted (n = 949; 62.1%) | Total (n = 1527) |
|---|---|---|---|
| **Patient characteristic** | | | |
| Mean (±SD) age,[a] y | 52.2 (±17) | 43.0 (±17) | 46.5 (±18) |
| Sex, n (%) | | | |
| Male | 315 (54.5) | 506 (53.3) | 821 (53.8) |
| Skin infection type,[a,b] n (%) | | | |
| Cellulitis | 332 (57.4) | 437 (46.1) | 769 (50.4) |
| Major abscess | 160 (27.6) | 407 (42.9) | 567 (37.1) |
| Surgical site infection or traumatic wound | 81 (14.0) | 92 (9.7) | 173 (11.3) |
| BMI,[a,b] n (%) | | | |
| <30 kg/m$^2$ | 283 (49.0) | 423 (44.6) | 706 (46.2) |
| 30–40 kg/m$^2$ | 173 (29.9) | 286 (30.1) | 459 (30.1) |
| >40 kg/m$^2$ | 100 (17.3) | 86 (9.1) | 186 (12.2) |
| CCI score,[a] n (%) | | | |
| 0 | 174 (30.1) | 650 (68.5) | 824 (54.0) |
| 1 | 127 (22.0) | 148 (15.6) | 275 (18.0) |
| 2 | 62 (10.7) | 74 (7.8) | 136 (8.9) |
| 3 | 74 (12.8) | 12 (1.3) | 86 (5.6) |
| 4+ | 141 (24.4) | 65 (6.8) | 206 (13.5) |
| Health insurance type,[a,b] n (%) | | | |
| Commercial | 164 (28.4) | 256 (27.0) | 420 (27.5) |
| Medicaid | 84 (14.5) | 163 (17.2) | 247 (16.2) |
| Medicare | 126 (21.8) | 93 (9.8) | 219 (14.3) |
| Self-pay | 103 (17.8) | 282 (29.7) | 385 (25.2) |
| Others[c] | 80 (13.8) | 98 (10.3) | 178 (11.7) |
| Met initial SIRS criteria,[a,b,d] n (%) | 189 (32.7) | 53 (5.6) | 242 (15.9) |
| History of ABSSSI within 30 d before IEC,[a,b] n (%) | 137 (23.7) | 103 (10.9) | 240 (15.7) |
| Hospitalization within 90 d before IEC,[a,b] n (%) | 169 (29.2) | 99 (10.4) | 268 (17.6) |
| Known history of MRSA, n (%)[a,b] | 91 (15.7) | 78 (8.2) | 169 (11.1) |
| Systemic antibiotic use within 90 d before admission,[a,b] n (%) | 238 (41.2) | 194 (20.4) | 432 (28.3) |
| Current/past IVDU,[a,b] n (%) | 73 (12.6) | 57 (6.0) | 130 (8.5) |
| **Treatment characteristic** | | | |
| Lesion culture obtained,[a,b,e] n (%) | 283 (49.0) | 187 (19.7) | 470 (30.8) |
| Gram-positive culture[f] | 198/283 (70.0) | 136/187 (72.7) | 334/470 (71.1) |
| MRSA[g] | 108/198 (54.6) | 64/136 (47.1) | 172/334 (51.5) |
| Incision and drainage performed on abscess,[a] n (%) | 204 (35.3) | 362 (38.2) | 566 (37.1) |
| PICC insertion,[a,b] n (%) | 96 (16.6) | 6 (0.6) | 102 (6.7) |
| **Antibiotic therapy at IEC** | | | |
| Antibiotic therapy at IEC,[a] n (%) | 568 (98.3) | 451 (47.5) | 1019 (66.7) |
| Receipt of guideline-recommended antibiotic therapy during IEC,[h,i] n (%) | | | |
| IDSA only | 205 (36.1) | 355 (77.7) | 560 (55.0) |
| Non-IDSA only | 50 (8.8) | 55 (12.2) | 105 (10.3) |
| Both IDSA and non-IDSA[j] | 313 (55.1) | 41 (9.1) | 354 (34.7) |
| **Antibiotic therapy at discharge** | | | |
| Antibiotic therapy at discharge,[a] n (%) | 476 (82.4) | 848 (89.4) | 1324 (86.7) |
| Receipt of guideline-recommended antibiotic therapy at discharge,[h,i] n (%) | | | |
| IDSA only | 301 (63.2) | 780 (92.0) | 1081 (81.7) |
| Non-IDSA only | 116 (24.4) | 47 (5.5) | 163 (12.3) |
| Both IDSA and non-IDSA[j] | 59 (12.4) | 21 (2.5) | 80 (6.0) |

Abbreviations: ABSSSI, acute bacterial skin and skin structure infection; BMI, body mass index; CCI, Charlson Comorbidity Index; ED, emergency department; IDSA, Infectious Diseases Society of America; IEC, initial episode of care; IVDU, intravenous drug use; MRSA, methicillin-resistant *Staphylococcus aureus*; PICC, peripherally inserted central catheter; SIRS, systemic inflammatory response syndrome.

[a]Statistically significant difference between those admitted and those not admitted after the initial visit to the ED ($P < .05$).

[b]Data not available for all patients; percentage was calculated using total patients in that category (ie, admitted, not admitted, or total) as the denominator.

[c]Includes those with ≥2 insurance types and those with Tricare.

[d]Patients not admitted were not given a full set of vital signs and/or laboratory tests.

[e]Infections solely due to Gram-negative bacteria were excluded (applies to whole analysis, per exclusion criteria in the "Methods").

[f]The percentage of patients was calculated from those patients for whom a lesion culture was obtained.

[g]The percentage of patients was calculated from those patients for whom a Gram-positive culture was obtained.

[h]The percentage of patients was calculated from those patients given antibiotic treatment.

[i]Statistical analysis testing was not performed for this variable.

[j]Includes patients whose antibiotic was recorded as an antifungal or "other" during the IEC and at discharge.

### Health Care Facility Characteristics

Included patients were primarily from facilities located in the South (43.4% of patients) or Midwest (27.8% of patients) geographic regions of the United States, a majority of which were academic medical centers (66.0% of patients) (Table 2; Supplementary Figure 1). Participating centers from the Midwest or Northeast regions of the United States and hospitals affiliated with an Integrated Delivery Network or Accountable Care Organization included more admitted patients in the study than other centers. Patients were less likely to be admitted if they presented at an ED with antibiotic oversight/stewardship activities (42% vs 49%).

### Treatment Characteristics

Mean (±SD) time spent in the ED was 0.3 ± 2.5 days (7.6 ± 59.7 hours); admitted patients had a mean (±SD) length of hospital stay of 5.5 ± 7.3 days (132 ± 175 hours). Treatment characteristics were stratified by admission status and are shown in Table 1. Admitted patients were significantly more likely to have a culture obtained from a lesion during the IEC when compared with patients who were not admitted (49.0% [283/578] vs 19.7% [187/949]). Admitted patients were significantly more likely to either have a PICC line placed (16.6% vs 0.6%; $P < .05$) or be given antibiotic therapy during the IEC (98.3% vs 47.5%; $P < .05$) compared with nonadmitted patients. Of those patients, a significantly greater percentage of admitted patients received non-IDSA-recommended antibiotic therapy in conjunction with empirical IDSA-recommended antibiotic therapy at the IEC when compared with patients who were not admitted (55.1% vs 9.1%; $P < .05$). There was no significant difference in the percentage of patients that received antibiotic therapy at

**Table 2. Health Care Facility Characteristics Stratified by Admission Status**

| Health Care Facility Characteristic | Admitted (n = 578; 37.9%), n (%) | Not Admitted (n = 949; 62.1%), n (%) | Total (n = 1527), n (%) |
|---|---|---|---|
| Geographic region[a] | | | |
| Midwest | 209 (36.2) | 216 (22.8) | 425 (27.8) |
| Northeast | 94 (16.3) | 84 (8.9) | 178 (11.7) |
| South | 204 (35.3) | 458 (48.3) | 662 (43.4) |
| West | 71 (12.3) | 191 (20.1) | 262 (17.2) |
| Hospital/organization type | | | |
| Academic medical center | 396 (68.5) | 611 (64.4) | 1007 (66.0) |
| Community | 182 (31.5) | 338 (35.6) | 520 (34.1) |
| Bed capacity, No. of beds[a] | | | |
| <250 | 21 (3.6) | 55 (5.8) | 76 (4.9) |
| 250–399 | 37 (6.4) | 83 (8.8) | 120 (7.9) |
| 400–749 | 346 (59.9) | 572 (60.3) | 918 (60.1) |
| ≥750 | 174 (30.1) | 239 (25.2) | 413 (27.1) |
| Hospital observation unit status[a,b] | | | |
| Dedicated observation unit | 345 (59.7) | 473 (49.8) | 818 (53.6) |
| Interspersed throughout hospital | 176 (30.5) | 357 (37.6) | 533 (34.9) |
| Hospital-owned outpatient infusion center affiliation[a,b] | | | |
| Yes | 444 (76.8) | 667 (70.3) | 1111 (72.8) |
| No | 108 (18.7) | 250 (26.3) | 358 (23.4) |
| Integrated delivery system affiliation[a,b] | | | |
| Yes | 271 (46.9) | 338 (35.6) | 609 (39.9) |
| No | 100 (17.3) | 232 (24.5) | 332 (21.7) |
| Accountable care organization affiliation[a,b] | | | |
| Yes | 394 (68.2) | 516 (54.4) | 910 (59.6) |
| No | 73 (12.6) | 273 (28.8) | 346 (22.7) |
| Antibiotic oversight/stewardship activities in the ED[a,b] | | | |
| Yes | 245 (42.4) | 467 (49.2) | 712 (46.6) |
| No | 319 (55.2) | 468 (49.3) | 787 (51.5) |
| No. of FTEs for antibiotic oversight[a,b] | | | |
| 0 | 17 (2.9) | 42 (4.4) | 59 (3.9) |
| >0–1 | 172 (29.8) | 431 (45.4) | 603 (39.5) |
| >1–2 | 174 (30.1) | 222 (23.4) | 396 (25.9) |
| >2–3 | 66 (11.4) | 87 (9.2) | 153 (10.0) |
| >3–4 | 36 (6.2) | 9 (0.95) | 45 (2.9) |

Abbreviations: ED, emergency department; IEC, initial episode of care; FTE, full-time equivalent.

[a]Statistically significant difference between those admitted and those not admitted after the initial visit to the ED ($P < .05$).

[b]Data on facility characteristics were not available for all patients.

discharge between admitted and nonadmitted patients (82.4% vs 89.4%). The majority of both admitted and nonadmitted patients received IDSA-recommended antibiotic therapy at discharge, without concomitant antibiotic therapy that is not recommended by the IDSA (63.2% vs 92.0%, respectively). The most common antibiotic treatments administered to patients at the IEC and discharge are shown in Supplementary Table 2. Admitted patients received intravenous (IV) vancomycin most commonly at the IEC and oral trimethoprim/sulfamethoxazole at discharge; nonadmitted patients most commonly received oral trimethoprim/sulfamethoxazole at the IEC and discharge. Of note, admitted patients were more likely to have had a history of ABSSSI within 30 days before the IEC (23.7% vs 10.9%), hospitalization within 90 days before the IEC (29.2% vs 10.4%), and a history of MRSA (15.7% vs 8.2%).

The mean (±SD) durations of antibiotic therapy during the IECs of admitted and nonadmitted patients were 5.8 ± 4.8 days and 2.0 ± 2.7 days, respectively ($P < .05$) (Figure 2). The mean (±SD) durations of antibiotic therapy at discharge of admitted and nonadmitted patients were 13.8 ± 15.4 days and 10.6 ± 4.7 days, respectively ($P < .05$) (Figure 2). The mean (±SD) total duration of antibiotic therapy, including both IEC and discharge antibiotics, was significantly longer for those who were admitted vs those who were not admitted (19.4 ± 16.9 days vs 12.8 ± 5.5 days; $P < .05$) (Figure 2).

#### Unplanned 30-Day ED Visits or Readmissions

The proportion of patients experiencing all-cause unplanned ED visits or readmissions to the ED or hospital within 30 days was similar for admitted vs nonadmitted patients (24.2% [140/578] vs 21.5% [204/949]) and for patients experiencing skin infection–related unplanned ED visits or readmissions (12.1% [70/578] vs 13.0% [123/949]) (Figure 1).

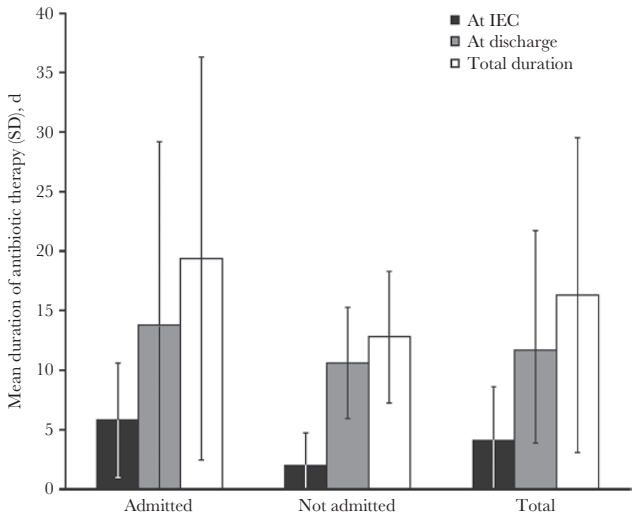



**Figure 2.** Duration of antibiotic treatment. Abbreviation: IEC, initial episode of care.

#### *All-Cause Unplanned ED Revisits or Readmissions*

For the primary analysis (Figure 3), unadjusted logistic regression demonstrated that there was similar likelihood of all-cause unplanned 30-day ED visits or readmissions between admitted and nonadmitted patients (odds ratio [OR], 1.17; 95% confidence interval [CI], 0.91–1.49; $P = .22$). For the adjusted logistic regression for the primary analysis using Model 1 and adjusted for covariates* (described in Supplementary Table 3), admission status at the IEC was not significantly associated with all-cause unplanned 30-day ED visits or readmissions (OR, 1.03; 95% CI, 0.74–1.43; $P = .87$). Admission status at the IEC was also not significantly associated with all-cause unplanned ED visits or readmissions (OR, 1.02; 95% CI, 0.46–2.22; $P = .97$) using Model 2, which was adjusted for additional clinically relevant covariates[†] (described in Supplementary Table 3).

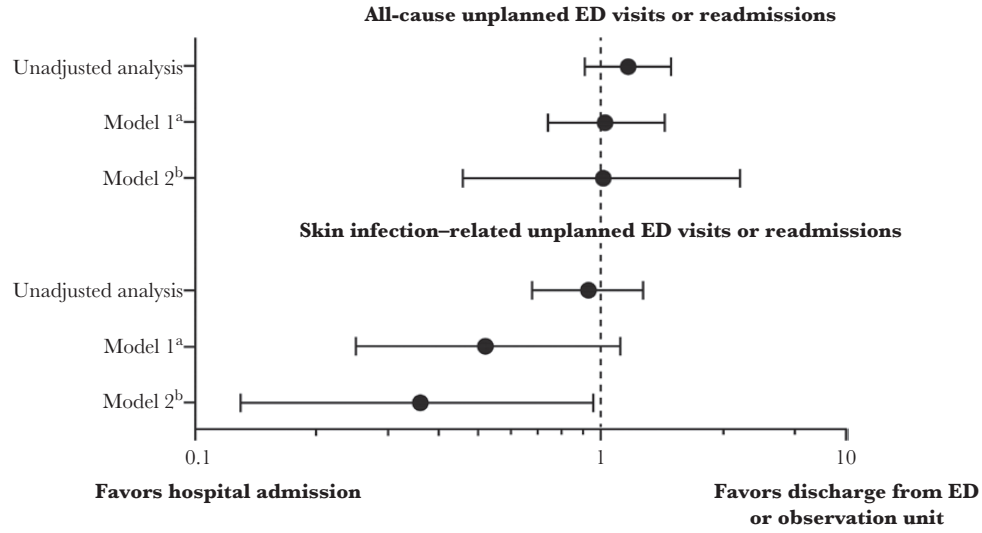
*Model 1 covariates: admission status at the IEC; BMI; hospitalization within 90 days before this admission; known history of MRSA, including colonization; hospital type (community, academic medical center); accountable care organization affiliation.

[†]Model 2 was adjusted for the covariates in Model 1, along with additional clinically relevant covariates: age; health insurance type; sex; geographical location; CCI; current/past IV drug use; history of ABSSSI within 30 days; systemic antibiotic use within 90 days before this admission; met initial SIRS criteria; infection type; patient disposition; hospital-owned outpatient facility; number of full-time equivalents for antibiotic oversight; bed capacity; incision and drainage performed on abscess; receipt of antibiotic therapy; pathogen was cultured.

#### *Skin Infection–Related Unplanned ED Revisits or Readmissions*

Similar results were supported for the secondary analysis assessing the likelihood of skin infection–related unplanned 30-day ED visits or readmissions (OR, 0.93; 95% CI, 0.68–1.27; $P = .63$) (Figure 3). For the adjusted logistic regression for the secondary analysis, admission status was not statistically associated with skin infection–related unplanned 30-day ED visits or readmissions (OR, 0.52; 95% CI, 0.25–1.12; $P = .10$) using Model 1 adjusted for covariates[‡] (described in Supplementary Table 4). However, after adjusting for additional clinically relevant covariates (Model 2),[§] results supported a decreased likelihood of skin infection–related 30-day ED visits or readmissions among admitted vs nonadmitted patients (OR, 0.36; 95% CI, 0.13–0.96; $P = .04$). Among clinically relevant covariates, none were individually found to be significant; the combination of covariates likely drove significance, rather than 1 covariate.

[‡]Model 1 covariates: admission status at the IEC; BMI; CCI; history of ABSSSI within 30 days; known history of MRSA, including colonization; met initial SIRS criteria;




| Analysis | OR (95% CI) | *P* Value |
|---|---|---|
| All-cause unplanned ED visits or readmissions | | |
| Unadjusted analysis | 1.17 (0.91–1.49) | .22 |
| Model 1: Stepwise logistic regression | 1.03 (0.74–1.43) | .87 |
| Model 2: Addition of clinically relevant variables to Model 1 | 1.02 (0.46–2.22) | .97 |
| Skin infection–related unplanned ED visits or readmissions | | |
| Unadjusted analysis | 0.93 (0.68–1.27) | .63 |
| Model 1: Stepwise logistic regression | 0.52 (0.25–1.12) | .10 |
| Model 2: Addition of clinically relevant variables to Model 1 | 0.36 (0.13–0.96) | .04 |

**Figure 3.** Logistic regression models: likelihood of all-cause and skin infection–related unplanned 30-day ED visit or readmission. [a]Model 1 was the stepwise logistical regression analysis and included the covariates listed in Supplementary Tables 3 and 4 under Model 1. [b]Model 2 included the addition of clinically relevant variables and included the covariates listed in Supplementary Tables 3 and 4 under Model 2. Abbreviations: ABSSSI, acute bacterial skin and skin structure infection; CI, confidence interval; ED, emergency department; OR, odds ratio.

infection type; hospital geographical location; accountable care organization affiliation; patient disposition; incision and drainage performed on abscess.

[$]Model 2 was adjusted for the covariates in Model 1, along with additional clinically relevant covariates: age; health insurance type; sex; current/past IV drug use; hospitalization within 90 days before this admission; systemic antibiotic use within 90 days before this admission; hospital type (community, academic medical center); hospital-owned outpatient facility; number of full-time equivalents for antibiotic oversight; bed capacity; receipt of antibiotic therapy; pathogen was cultured.

## DISCUSSION

Our results support a similar likelihood of unplanned 30-day ED visits or readmissions among patients admitted to the hospital for ABSSSI treatment vs patients who received outpatient treatment, after controlling for patient characteristics and severity of illness. It is the largest observational study to date in an ABSSSI patient population presenting to EDs, describing ABSSSI treatment and clinical outcomes for 1527 patients across 40 US EDs. Because we found similar outcomes among admitted vs nonadmitted patients, our results highlight the need for improved transitions of care to the outpatient setting to prevent unnecessary or prolonged inpatient care.

The current treatment paradigm for ABSSSI has included routine hospital admission for the purpose of delivering IV antibiotic therapy for patients, as no standard criteria have been developed to assist clinicians with the decision of who should be admitted for advanced care [17]. Hospital admission may be required to provide appropriate care for ABSSSI patients with septic shock, complicating comorbid conditions, or those at risk of acute deterioration. However, unnecessary hospitalizations place patients at increased risk for adverse events and hospital-acquired infections, are economically burdensome, and may not be associated with optimal outcomes [3, 18]. In addition, hospital readmissions have come under the spotlight as critical measures in hospital outcomes and are tied to hospital reimbursement [11, 19].

Our primary results support that hospital admission, compared with discharge from the ED, may not affect the likelihood

of all-cause unplanned 30-day ED visits or readmissions, an important clinical outcome and quality metric for US hospitals. These study results may help to reassure clinicians that outpatient management for ABSSSI does not necessarily result in a higher likelihood of follow-up care within 30 days of the initial ED presentation. Focusing on identifying the appropriate criteria for hospital admissions and integrating these criteria into care pathways should reduce or prevent readmissions. However, further research is warranted, specifically for skin infection–related ED visits or readmissions, to identify significant predictors of follow-up care. In 1 of the 4 regression models, patients who were admitted were significantly less likely to receive skin infection–related follow-up care. Although the other 3 models were not significant in this comparison, these results further support the opportunity to improve outpatient care pathways in addition to identifying appropriate criteria for hospital admission criteria.

Improving antibiotic stewardship practices in the ED to optimize antibiotic therapy and assist in transitions of care is important. The substantial amount of non–IDSA guideline–concordant antibiotic therapy in the admitted group and the extended duration of antibiotic therapy in both the admitted and nonadmitted populations highlight the need for ongoing antibiotic stewardship among patients with ABSSSI. Augmenting hospital- and ED-based antibiotic stewardship programs or the development and integration of care process models would be 2 methods to reduce unnecessarily broad-spectrum antibiotic use and total duration of therapy [20, 21]. Antibiotic stewardship comprises "coordinated intervention programs" designed to improve and measure the appropriate use of antibiotic agents by promoting empiric selection of the optimal antibiotic drug regimen (eg, dosing, duration of therapy, and route of administration) [22]. These programs have been shown to reduce inappropriate antibiotic use, conserve resources, optimize treatment duration, decrease treatment-related adverse events, and improve the rates of antibiotic susceptibilities to targeted antibiotics [9, 23–25]. Failure to use antibiotics that are guideline-recommended or use of inappropriate antibiotics, such as the use of broad-spectrum antibiotics for most cases of ABSSSI, is associated with increasing drug resistance, adverse events, and other unintended consequences including *Clostridium difficile* infection [26, 27]. Although these programs have primarily been used in the inpatient setting, antibiotic stewardship programs also play a role in EDs [23, 24]. Furthermore, novel antibiotic therapies such as long-acting parenteral antibiotics may offer an alternative outpatient therapy in patients where complicating factors do not necessitate hospitalization yet require IV therapy. Long-acting therapy could reduce traditional institutional barriers to coordinating outpatient treatment, facilitating improved stewardship practices [20, 21, 28].

This study is not without limitations. The lack of randomization may have contributed to selection bias. Data were collected through manual review of medical records, where the process may have imparted subjectivity or misclassification of ABSSSI. The primary analysis was completed using available data; missing information was not imputed. In our comparison of unplanned 30-day ED visits or readmissions with the primary predictor variable of admission status, we controlled for multiple clinical variables in our model but did not perform a propensity score–matched analysis. Despite adjusting for many confounding variables, there may be residual confounding because admitted and nonadmitted patients likely have additional clinically important differences not captured in this study. Patients who died also could not be included for an unplanned 30-day ED visit or readmission. However, because the number was low (n = 2; <1%), those patients were not excluded from the overall calculations, which was not expected to substantially affect the results. Another limitation was that patients may have visited a different ED or hospital that was not captured in our data set. Although we cannot determine the number of patients for whom this circumstance would apply, the Healthcare Cost and Utilization Project [29] has estimated the all-cause readmission across US hospitals to be 11.2% [29]. Because the percentage of readmission in this study was 22% for admitted patients and 24% for patients not admitted, we do not believe that this limitation severely affected our study. Furthermore, the percentage of readmission in this study was similar to previously reported estimates of 30-day readmissions among patients presenting to the ED with a skin and soft tissue infection [30]. Because of the study design, we were unable to determine causality regarding why certain groups of hospitals (centers from the Midwest and Northeast regions of the United States and hospitals affiliated with an Integrated Delivery Network or Accountable Care Organization) included more admitted patients in the study than other centers or why patients were less likely to be admitted if they presented at an ED with antibiotic oversight/stewardship activities.

## CONCLUSIONS

Acute bacterial skin and skin structure infection treatment pathways leveraging outpatient treatment vs hospital admission support similar likelihood of unplanned 30-day ED visits or readmissions, an important clinical outcome and quality metric at US hospitals. Further research regarding the decision criteria around hospital admission, as well as implementation of antibiotic stewardship programs to facilitate transitions of care, is warranted to avoid potentially unnecessary or prolonged hospital stays.

### Supplementary Data

Supplementary materials are available at *Open Forum Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

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