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BRIEF REPORT

Improving Management of Hospitalized Adults With Uncomplicated Cellulitis or Cutaneous Abscess

Erica Housman,[1] Sarah E. Livings,[4] Alex Knee,[2] and Jennifer Schimmel[3]

[1]Department of Pharmacy, [2]Office of Research, and [3]Division of Infectious Diseases, Baystate Medical Center, Springfield, Massachusetts; and [4]Department of Pharmacy, Penn State Milton S. Hershey Medical Center, Hershey, Pennsylvania

Implementation of a guideline for the management of hospitalized adults with uncomplicated skin and soft-tissue infections may decrease unnecessary antibiotic use. For cellulitis, treatment with vancomycin and broad-spectrum antibiotics decreased significantly. For cutaneous abscess, treatment with broad-spectrum antibiotics decreased significantly. There were no differences in rates of treatment failure, recurrence, or adverse events.

Keywords. cellulitis; guideline; vancomycin.

An update to the Infectious Diseases Society of America guidelines for the diagnosis and management of skin and soft-tissue infections (SSTIs) was published in 2014 [1]. Incision and drainage (I and D) is still recommended as primary therapy for cutaneous abscess with the addition of empiric oral anti-methicillin-resistant *Staphylococcus aureus* (MRSA) antibiotics for more severe cases. More importantly, the update makes a clear distinction between cutaneous abscess and cellulitis, recommending β-lactam (or clindamycin) therapy for cellulitis. However, in clinical practice, due to concern for MRSA and other less common pathogens, many individuals admitted to the hospital for cellulitis treatment are often given vancomycin and broad-spectrum antibiotics, even in cases of uncomplicated cellulitis without abscess. Vancomycin use comes with well defined risks, including phlebitis and nephrotoxicity. Broad-spectrum antibiotics can also have deleterious effects leading to *Clostridium difficile* infection or an increase in resistant organisms; excess costs related to broad-spectrum antibiotics may arise from subsequent infections, resistant organisms, prolonged length of stay, and increased drug costs [2–4].

Prior studies have shown improved appropriate antimicrobial choices for SSTIs with the implementation of a guideline and educational efforts, specifically decreasing the coverage of Gram-negative and anaerobic organisms, without adverse effects on clinical outcomes [5]. For this study, a guideline was created that prompts providers to differentiate cellulitis and cutaneous abscess to decrease the use of vancomycin for those patients with the former diagnosis. The guideline also does not encourage broad-spectrum antibiotics for either condition (Supplementary Appendix A).

METHODS

This was an observational study conducted at a single academic, tertiary care, 716-bed hospital. After the publication of an institutional guideline for the management of hospitalized adults with uncomplicated SSTIs, this study compared pre- and postimplementation treatment of patients with uncomplicated cellulitis (nonpurulent cellulitis) or cutaneous abscess. The guideline was disseminated during a lecture series provided by members of the antimicrobial stewardship team and posted on the institution's intranet. In addition, directed computerized order entry care sets were implemented in the Emergency Department.

Patients 18 years of age and older were identified if they were discharged during 1-year periods before and after implementation. The groups include patients between January 1 and December 31, 2011 (preimplementation) or April 1, 2013 and March 31, 2014 (postimplementation) with a principal diagnosis of cellulitis or cutaneous abscess using *International Classification of Diseases, 9th Revision* (ICD-9) coding data. For patients with multiple hospitalizations for cellulitis or cutaneous abscess during the study period, only the initial admission was considered.

Patients were excluded if they were transferred from an outside hospital, left against medical advice, or were identified as having complicated cellulitis. Complicated cellulitis included infection of diabetic or chronic ulcer, surgical site infection, periorbital or orbital cellulitis, perirectal abscess or cellulitis, sepsis, bacteremia, human or animal bites, burns, or severe immunosuppression. Severe immunosuppression was defined as an absolute neutrophil count <500, a $CD4^+$ count <200, a history of organ transplantation, or high-dose corticosteroids (20 mg/day of prednisone or equivalent for 2 or more weeks).

Received 24 January 2017; editorial decision 27 April 2017; accepted 8 June 2017.

Correspondence: E. Housman, PharmD, Department of Pharmacy, Baystate Medical Center, 759 Chestnut Street (HS4531), Springfield, MA 01199 (erica.housman@baystatehealth.org).

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DOI: 10.1093/ofid/ofx094

Selected demographics and principal diagnosis code were extracted electronically from the hospital billing system. Manual review of the electronic medical record was used to verify discharge diagnosis and to obtain information about patient presentation at time of admission, drainage procedures, inpatient management of cellulitis, discharge antibiotic therapy, and subsequent encounters within the health system in the first 30 days after discharge. The protocol was approved by the institutional review board before data collection.

The primary endpoint was the proportion of uncomplicated cellulitis treated with at least 1 dose of vancomycin. The secondary endpoints included proportion of uncomplicated cellulitis or cutaneous abscess treated with at least 1 dose of broad-spectrum antibiotics, duration of intravenous (IV) antibiotic treatment, duration of all antibiotic treatment, length of stay, clinical failure, and all-cause 30-day rehospitalization. Broad-spectrum antibiotics included carbapenems, fluoroquinolones, β-lactam with β-lactamase inhibitors, and second and above generation cephalosporins. Clinical failure included treatment failure or recurrence. Treatment failure was defined as the need to change antibiotics or an abscess requiring additional I and D within 7 days after therapy initiation. Recurrence was defined as the need to reinitiate antibiotics within 30 days of completing an initial treatment course. Safety endpoints were also evaluated and included nephrotoxicity, infusion-related reactions, and phlebitis. Nephrotoxicity was defined as at least a 50% increase in serum creatinine or at least a 50% decrease in creatinine clearance calculated using the Cockcroft-Gault equation. Study endpoints were reported for 2 distinct groups: nonpurulent cellulitis and cutaneous abscess.

Statistical Analysis

For binary outcomes, we used logistic regression and reported predicted percentages and 95% confidence intervals (CIs) before and after implementation of the guideline. Of particular concern were possible confounding effects of prior outpatient treatment and infectious diseases (ID) consults. Therefore, they were evaluated in a multivariable logistic regression model, and adjusted estimates are presented only if these factors were significant in the model. To evaluate trends after the intervention, we performed a non-parametric test for trend over the quarterly time points in the postperiod. For time outcomes, we used median regression to account for skewness in the data and reported the median durations and 95% CIs before and after the implementation. Separate analyses were conducted for the cellulitis and abscess groups with statistical significance set at an alpha of 0.05. In terms of power for our primary outcome, assuming a baseline vancomycin use of 75% and a 20% decrease from pre- to posttime periods, 98 subjects per group were needed to meet 80% power with a 2-sided alpha of 0.05. Analysis was conducted using Stata version 14.2 (StataCorp, LP, College Station, TX).

RESULTS

Study Population

A total of 820 patients met the inclusion criteria for this study. Three hundred thirty-nine patients were excluded for the following reasons: 256 had complicated cellulitis, 6 had necrotizing fasciitis, 51 transferred from an outside hospital, 21 left against medical advice, and 5 for "other" reasons. This resulted in a final analytic sample size of 290 subjects with cellulitis and 191 subjects with abscess. The cellulitis patient population was predominantly white (77%) males (51%) with a median age of 61 years. In the postperiod, there was an 11% lower prevalence of prior outpatient therapy (47% vs 36%) and approximately 12% more ID consults (19% vs 31%). The cutaneous abscess population was also predominantly white (59%) males (58%) with a median age of 38 years. In the postperiod, there was approximately a 5% lower prevalence of prior outpatient therapy (43% vs 38%) and 10% more ID consults (12% vs 22%). For all groups, the median duration of symptoms before presentation was 4 days. Otherwise, there were no meaningful clinical differences between the groups.

Primary and Secondary Endpoints

For uncomplicated cellulitis, treatment with vancomycin decreased significantly as evidenced by an absolute decrease of 12.8% (95% CI, −20.8 to −4.8) after implementation of the guideline (Table 1). For patients with abscess, we observed a nonsignificant increase in vancomycin use of 0.5% (95% CI, −9.1 to 10.1). Potential confounders fell out of the multivariable model; therefore, adjusted models are not presented. In regards to trends over time after implementation of the guideline, quarterly vancomycin use was 71% (22 of 31), 89% (40 of 45), 79% (22 of 28), and 75% (24 of 32) (p-trend = .931) among those with cellulitis and 88% (14 of 16), 71% (20 of 28), 96% (27 of 28), and 100% (14 of 14) (p-trend = .044) among those with abscess.

When evaluating the impact of guideline implementation on broad-spectrum antibiotics, we observed an 11.2% decrease (95% CI, −22.3 to −0.2) from pre- to posttreatment among the cellulitis group as well as a 17.6% decrease (95% CI, −31.1 to −4.1) in the abscess group (Table 1). Multivariable models controlling for both prior outpatient therapy and ID consult frequency suggested a greater difference in the cellulitis group (14.5% decrease [95% CI, −25.3 to −3.6], P = .012) as well as the abscess group (19.4% decrease [95% CI, −32.5 to −6.3], P = .006). In regards to trends over time after implementation of the guideline, quarterly broad-spectrum antibiotics use was 13% (4 of 31), 29% (13 of 45), 43% (12 of 28), and 44% (14 of 32) (p-trend = .005) among those with cellulitis and 25% (4 of 16), 25% (7 of 28), 29% (8 of 28), and 43% (6 of 14) (p-trend = .289) among those with abscess.

There were no differences in the duration of IV therapy, duration of all antibiotic treatment, or length of stay (Table 1). In addition, no statistical or clinically meaningful differences were

Table 1. Change in Outcomes Over Time for Patients With Cellulitis or Abscess

	Cellulitis (n = 290)			Abscess (n = 191)		
Outcomes	Pre 154 (53.1%)	Post 136 (46.9%)	*P* Value	Pre 105 (55.0%)	Post 86 (45.0%)	*P* Value
Vancomycin Use,[a] Percent (95% CI)	92.2 (88.0–96.4)	79.4 (72.6–86.2)	.002	86.7 (80.2–93.2)	87.2 (80.2–94.3)	.912
Broad-Spectrum Antibiotic Use,[b] Percent (95% CI)	42.9 (35.0–50.7)	31.6 (23.8–39.4)	.049	46.7 (37.1–56.2)	29.1 (19.5–38.7)	.014
Duration of IV therapy, days[b]; median (95% CI)	2.7 (2.4–3.1)	2.7 (2.3–3.0)	.828	2.5 (2.0–2.9)	2.5 (2.0–3.0)	.942
Duration of antimicrobial therapy (days)[b]; median (95% CI)	9.5 (9.0–10.0)	10.0 (9.5–10.5)	.190	10.0 (9.3–10.7)	10.0 (9.2–10.8)	1.0
Length of stay (days)[b]; median (95% CI)	3.6 (3.2–3.9)	3.7 (3.3–4.0)	.706	3.0 (2.6–3.4)	2.8 (2.3–3.2)	.572
Clinical failure, percent (95% CI)[a]	9.1 (4.6–13.6)	11.8 (6.3–17.2)	.457	3.8 (0.1–7.5)	1.2 (−1.1 to 3.4)	.282
Treatment failure, n (%)	2 (1.3)	4 (2.9)	—	1 (1.0)	1 (1.2)	—
Recurrence, n (%)	12 (7.8)	12 (8.8)	—	3 (2.9)	1 (1.2)	—
Adverse events, percent (95% CI)[a]	7.8 (3.6–12.0)	7.4 (3.0–11.7)	.888	6.7 (1.9–11.4)	15.1 (7.5–22.7)	.064
Nephrotoxicity	2 (1.3)	4 (2.9)	—	4 (3.8)	3 (3.5)	—
Infusion-related reactions	7 (4.6)	5 (3.7)	—	3 (2.9)	10 (11.6)	—
Phlebitis	3 (2.0)	4 (2.9)	—	1 (1.0)	0	—
30-day all-cause rehospitalization[a]	10.4 (5.6–15.2)	14.0 (8.1–19.8)	.352	1.0 (−0.9 to 2.8)	2.3 (−0.9 to 5.5)	.462

Abbreviations: CI, confidence interval; IV, intravenous.

[a]Percentages and 95% CIs predicted using logistic regression.

[b]Medians and 95% CI predicted using median regression.

observed in regards to clinical failure, adverse events, or 30-day all-cause rehospitalization.

DISCUSSION

Skin and soft tissue infections accounted for almost 630 000 hospitalizations in the United States in 2009, an increase from 590 000 hospitalizations in 2006 and almost double the incidence 10 years prior [6–8]. Cutaneous abscesses are more likely to be caused by *S aureus*, which could be initially treated with either vancomycin or trimethoprim/sulfamethoxazole.

Published literature has assessed the treatment of uncomplicated cellulitis without abscess, demonstrating that 96% of the patients treated with a β-lactam antibiotic alone responded clinically and did not require coverage for MRSA [9]. This suggests that cellulitis is most likely caused by *Streptococcus* species, and it is often not necessary to treat empirically for MRSA infection in individuals who have uncomplicated cellulitis without a cutaneous abscess.

After provider education and implementation of a guideline for the treatment of uncomplicated cellulitis and cutaneous abscess, we were able to show a significant decrease in (1) vancomycin use for cellulitis and (2) broad-spectrum antibiotic use for both cellulitis and cutaneous abscess. Despite less use of these broad-spectrum antibiotics, there were no increases in clinical failure, 30-day readmissions, or adverse effects. This is important to patient care because it exposes fewer patients to unnecessary broad-spectrum antibiotics.

We did observe variability in quarterly usage rates after the implementation. Unfortunately, the effect appears to have waned over time, particularly for broad-spectrum antibiotic use among patients with cellulitis; a phenomenon commonly described in antimicrobial stewardship literature [10]. Regular educational efforts may be necessary to sustain the effects of such an intervention. Although we observed an increasing trend in vancomycin use among patients with abscess, use in this group is clinically preferred and therefore not concerning.

CONCLUSIONS

The limitations of this study include its retrospective design and the use of ICD-9 codes to identify patients, which may have resulted in missing patients due to miscoding. Post-discharge data available for review came only from practices associated with our institution; therefore, follow-up visits to other hospitals or providers outside of this system would have been missed. Finally, the generalizability of the data may be limited by the high use of vancomycin at baseline, although the trend of treating uncomplicated cellulitis more broadly than necessary is likely not unique to our institution. The results of this study demonstrate that provider education and guideline development can successfully influence the treatment of cellulitis but may require continuous educational efforts to have a sustained effect on provider habits and patient care.

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.

Acknowledgments

Financial support. The authors received institutional support through a medical education grant from Pfizer.

Potential conflicts of interest. All authors: No reported conflicts of interest. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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