Published in final edited form as:

J Healthc Qual. 2016 ; 38(6): 359–369. doi:10.1097/JHQ.0000000000000070.

Clinical Study of an Online Tool for Standardizing Hospital Care

Mary J Burgess¹, Mark J Enzler², Deanne T Kashiwagi², Andi J Selby³, M Rizwan Sohail², Paul R Daniels², Brian D Lahr², Farrell Lloyd², and Larry D Baddour²

¹University of Arkansas for Medical Sciences, Little Rock, Arkansas

²Mayo Clinic, Rochester, Minnesota

³Mercy Clinic, 3126 S. Jackson, Ave., Joplin, Missouri

Abstract

We assessed if use of an online clinical decision support tool improved standardization and quality of care in hospitalized patients with lower extremity cellulitis (LEC). This was a 14-month pre-intervention and post-intervention study of 85 LEC admissions. There was significantly higher usage of the online LEC care process model (CPM) in the post-intervention phase ($p < 0.001$). There was a trend toward higher rates of appropriate antibiotic regimen in the post-intervention group both initially and at discharge ($p = 0.063$ for both). A sensitivity analysis of CPM users vs. non-users demonstrated a significantly higher rate of appropriate initial antibiotics prescribed when the CPM was used ($p < 0.001$). Use of this online CPM was associated with improved standardization, as demonstrated by increased ordering of an appropriate initial antibiotic regimen for hospitalized patients with LEC.

Keywords

Lower extremity cellulitis; CPM; online tool; standardization of care

Introduction

Background

Quality improvement in hospitals continues to be increasingly important in the new millennium, with a focus to improve safety measures and provide optimal patient care. A major impetus in this movement was the Institute of Medicine (IOM) report, “To Err is Human: Building a safer health system,” which was released in 1999 and spurred patient safety initiatives nationwide (1, 2). Multiple subsequent reports have been released by IOM, including “Best Care at Lower Cost: The Path to Continuously Learning Health Care in America,” which was released in 2012 and provides specific strategies to achieve better quality in healthcare at lower costs(3). One of the patient care improvement targets in this document focuses on strategies to integrate clinical decision support tools into patient care.

Corresponding Author: Mary J. Burgess MD, University of Arkansas for Medical Sciences, 4301 W. Markham Avenue, Little Rock, Arkansas, 72205; Ph 501-686-5585; Fax 501-686-5549; mjburgess@uams.edu; Alternate address: 7413 Palm Beach Avenue, Benton, Arkansas, 72091.

Declaration of Conflicting Interests: The authors declare that there is no conflict of interest.

As part of quality efforts, AskMayoExpert (AME) was developed, which is an online, clinical support tool that contains clinical decision algorithms termed “care process models” (CPMs). The lower extremity cellulitis (LEC)CPM (Figure 1), which was created for the AME site in 2010, includes a detailed algorithm that guides healthcare providers in appropriate antimicrobial selection, as well as ordering of laboratory studies and microbiologic cultures, when treating patients with LEC.

We evaluated the impact of using the online CPM clinical decision support tool versus not using the CPM during care of patients hospitalized for management of LEC. The primary aim of the study was to compare the initial antibiotic regimen prescribed for patients in the pre-intervention phase versus the post-intervention phase, and to perform a sensitivity analysis of all LEC admissions, comparing when the CPM was used versus not used by medical providers. This study also compared discharge antibiotic prescribing, imaging utilization, and laboratory screening ordered by medical providers when they treated hospitalized adults with LEC. We also gathered data on the frequency of requests for an Infectious Diseases (ID) consult.

Methods

The study was a pre-intervention and post-intervention study of all adult, 18 years or older, LEC admissions to Mayo Clinic Hospital, St. Mary's campus in Rochester, MN. We analyzed a convenience sample of medical providers' treatment of consecutive admissions for LEC starting August 1, 2012 until September 30, 2013. The pre-intervention phase occurred from August 1, 2012 to February 28, 2013 and the post-intervention phase from March 1, 2013, to September 30, 2013. We also completed a sensitivity analysis by pooling data over the two phases and comparing CPM users versus non-users. We received a waiver of consent from the Institutional Review Board.

The LEC admissions were tracked daily using the emergency department computer-generated report for cellulitis admissions. A total of 396 admissions occurred during the study, and 301 were excluded based on exclusion criteria. Exclusion criteria were based on exclusions provided in the LEC CPM, as the CPM was not applicable in those cases. Exclusion criteria included cellulitis in a location other than the lower extremity, preceding trauma or bite, preceding water exposure, diagnosis of abscess or skin ulcer, myositis, necrotizing infection, or cellulitis in an immunocompromised host. Immunocompromised host is not defined in the CPM. For purposes of the study, it was defined as absolute neutrophil count < 500, HIV with CD4 < 200 cells/mcl, prednisone dose > 20 mg daily, TNF alpha inhibitor, rheumatologic illness on immunosuppressive medications and history of transplant on anti-rejection medications.

Of the 95 patients included, 43 were pre-intervention and 52 were post-intervention. Of these, 10 were excluded due to lack of research authorization. The state of Minnesota requires that patients be provided the option to opt out of research requiring review of private health information, which is separate from the IRB waiver of consent, and 10 cases had declined research authorization; the remainder included 37 in the pre-intervention and 48 in the post-intervention analysis.

During the post-intervention phase, medical providers who were treating an LEC case received a communication reminder on hospital day 2 regarding availability of the LEC CPM. The CPM use was tracked via an automated report, which recorded the online use of the CPM by provider name, date and time.

To analyze the prescribing and ordering data during the two phases and in the sensitivity analysis, the EMR generated for each patient during the hospitalization for cellulitis was reviewed and the variables were recorded in the REDCap database (4). The data abstracted from the EMR included antibiotic administration record, both initial antibiotic choice and antibiotics, radiologic imaging utilization, laboratory studies, culture data, ID consult request and re-admission for relapsing cellulitis.

The primary aim of the study was evaluation of standardization of care by assessing if an appropriate initial antibiotic regimen was prescribed for LEC. The appropriate antibiotic was defined by the CPM (Figure 1). Per CPM, the recommended antibiotic for patients who did not receive prior antibiotics is cefazolin. For the patients with a beta-lactam allergy, known methicillin-resistant *Staphylococcus aureus* (MRSA) infection or colonization, or purulent drainage, vancomycin was recommended instead of cefazolin. For patients who had received prior antibiotic treatment for LEC, vancomycin and cefepime were recommended in the CPM. Vancomycin and ciprofloxacin combination was recommended as an alternative for patients with cephalosporin allergy. Prescribing of an appropriate regimen was defined as the antibiotic regimen administered by Day 2 of hospitalization. If the patient was discharged before Day 2, then it was defined as the regimen prescribed on Day 1.

Secondary aims included comparison of orders for radiologic imaging, laboratory studies, microbiologic culture data, and ID consult requests, as recommended per the CPM (Figure 1). Only the radiologic orders of the admitting medical teams were evaluated; the emergency department imaging was not included in the analysis.

The treatment failures were compared between pre-intervention and post-intervention groups and as a sensitivity analysis between CPM users and non-users. This was assessed by measuring the need to broaden antibiotic therapy from the initial antibiotic choice or re-admission for cellulitis relapse within 30 days of discharge.

Statistical analysis

Descriptive statistics on baseline data were reported as median and range for skewed continuous variables, mean and standard deviation for non-skewed continuous variables, or as absolute number and percentage for discrete variables. For patient demographics, CPM use and quality of care measures, data were compared between pre-intervention and post-intervention LEC admissions using standard two-sample tests: a Chi-square or Fisher's Exact Test was performed on categorical data, or a t-test or Wilcoxon Rank Sum test for numerical data. Since the intervention was merely a reminder and did not guarantee utilization of the CPM, these primary comparisons cannot directly assess the effect of CPM usage on quality of care. Therefore, although uncontrolled for possible group imbalances, a sensitivity analysis comparing all admissions with and without CPM use (pooling over the pre- and post-intervention phases) was performed. A p-value <0.05 was considered statistically

significant. All analyses were performed using the SAS statistical software package (version 9.3, SAS Institute Inc., Cary, NC).

Results

Demographic and baseline characteristics of LEC patients are summarized in Table 1 according to pre- and post-intervention phase (n=37 and 48, respectively). There were more LEC admissions with a history of malignancy in the pre-intervention group compared to the post-intervention group (14% vs. 0%, p=0.009). Otherwise, the groups did not differ significantly.

During the pre-intervention phase, the CPM was utilized in 14% (5/37) of all LEC patient admissions. During the post-intervention phase, the CPM utilization significantly increased to 50% (24/48) of all LEC admissions (p<0.001). There was an increase in CPM use by staff physicians from 0% (0/37) to 25% (12/48) (p=0.001), and by resident or fellows from 7% (2/28) to 44% (15/34), (p=0.001). The numbers of mid-level providers or students were too few to assess changes in CPM utilization (Table 2).

The initial antibiotic prescribed by Hospital Day 2 was appropriate, as defined per the CPM, in 24% (9/37) of the admissions during the pre-intervention phase and in 44% (21/48) of the admissions in the post-intervention phase (p=0.063). The discharge antibiotic was appropriate, as defined per the CPM, in 24% (9/37) of the pre-intervention LEC admissions and 44% (21/48) of post-intervention admissions (p=0.063).

There were no significant differences in secondary outcomes including orders for laboratory assays, blood cultures, imaging studies, or requests for ID consult by inpatient medical providers when comparing pre- and post-intervention admissions. Consistent with CPM recommendations, blood cultures were obtained in the majority of admissions in both pre- and post-intervention groups (81% vs. 77%, respectively; p=0.655). Also recommended per the CPM, complete blood count (CBC) was obtained in all patients and serum creatinine was obtained in all but one patient. Erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) were not recommended in the CPM, and orders for these studies did not change significantly from pre- to post-intervention phases. Imaging was also not recommended, and orders by the medical providers were observed in roughly half of admissions in both phases.

In the sensitivity analysis, there were a total of 85 LEC admissions analyzed during the 14 months, and the CPM was utilized during 29 of them. The appropriate antibiotic was prescribed by Hospital Day 2 in 62% (18/29) of admissions when the CPM was utilized as compared to 21% (12/56) when it was not used (p<0.001). The appropriate antibiotic was prescribed at discharge in 48% (14/29) when the CPM was utilized versus 29% (16/56) when it was not utilized (p=0.071). Based on CPM group comparisons, no significant differences were observed in the secondary outcomes (Table 3).

There was no significant difference in the need to broaden antibiotic therapy or in readmission rates, when comparing the pre- and post-intervention groups. However, from the sensitivity analysis, there was a significant difference in need for broadening coverage of

antibiotics between CPM users and non-users. Antibiotics were broadened in 14% (4/29) in the CPM group versus 2% (1/56) in the non-CPM group ($p=0.044$).

Discussion

The results of this study demonstrate that the online clinical decision support tool, the LEC CPM, can help to achieve standardization of care goals in patients hospitalized with LEC, particularly more appropriate antibiotic selection. When the CPM was utilized, the results demonstrated that its use was associated with increased prescribing of the recommended initial antibiotic regimen, as defined by the CPM, for adult patients hospitalized with LEC. There was also a trend toward improvement in appropriateness of the discharge antibiotic regimen when the CPM was used by medical providers. However, increased utilization of the CPM was not associated with a reduction in other hospital orders, including radiologic imaging or laboratory orders for inflammatory markers.

The clinical failure rate was increased in the CPM user group in the sensitivity analysis as demonstrated by a significant increase in the need to broaden antibiotic regimen. It is possible that this increase did not represent antibiotic failure and that providers became anxious if erythema, for example, did not regress within one day after antibiotics were initiated. Additionally, this failure definition favors a regimen that is overly broad at initiation. Additional study of this observation is needed.

The results importantly demonstrate the difficulty encountered when trying to implement a clinical tool to standardize care. We had the unique ability to measure the use of this online clinical decision support tool, via a computer generated report of provider online access. We demonstrated that LEC CPM use increased in the post-intervention phase of this study. Although the CPM use increased from 14% to 50% of all patient admissions, this resulted in medical providers still not utilizing the online tool for half of all LEC admissions despite personalized reminders. This demonstrates the difficulty in increasing use of a patient care tool.

This finding is not unique to our study. One of the obstacles previously identified in providing optimal, standardized patient care has been the difficulty in translating clinical research and professional guidelines into clinical practice. For example, the CRUSADE quality initiative program highlighted the extensive collaboration needed to promote implementation of the 2002 American College of Cardiology NSTEMI (non-ST elevation myocardial infarction) guidelines (5). Furthermore, clinical standardization tools have had variable success and have been difficult to adapt to other healthcare centers or across a spectrum of diseases (5-10). To date, no single healthcare delivery tool has been shown to increase standardization of care while maintaining or reducing costs, and thereby increasing value. This study is one of the first to assess uptake of an online clinical decision support tool that is available at all work computers when the healthcare providers log-in to a computer. In our intervention, we tried to increase implementation with a personalized reminder to the healthcare providers. We had some success, with a significant increase in use, but reaching only 50% utilization of the CPM online clinical decision support tool.

We did not assess the reasons for utilizing or not utilizing the LEC CPM. It should be noted that the CPM was applicable in only 24% (95/396) of patient admissions for LEC. It is possible that developing a habit of using such a tool is difficult when it cannot be applied to patient care in the majority of admissions. Additionally, lower LEC CPM use rates overall may indicate that once the providers have reviewed the LEC CPM, they do not need to continually refer to it with future cases, leading to a lower measured LEC CPM utilization rate.

Prior studies have been completed in both inpatient and outpatient settings to evaluate the impact of care models that align with the skin and soft tissue infection (SSTI) guidelines by the Infectious Diseases Society of America (IDSA) (11) and the Centers for Disease Control (CDC). These have been pre-intervention versus post-intervention studies, after institutional guidelines were implemented for treatment of SSTIs and have generally shown a positive impact on antibiotic selection (12-15). This study is unique in that it assessed an online clinical decision support tool that is accessible at all times of day. We were also able to measure the actual use of the online CPM and associate its use with each patient admission, allowing better assessment of the impact of this intervention.

Limitations

This was a quasi-experimental pre- and post-intervention study. Medical provider use of the CPM was not randomized, so comparisons are prone to biases from confounding effects. However, given the significant increases in both CPM use and appropriate antibiotic administration in the post-intervention phase, one could speculate that these two results are linked. Additionally, sensitivity analysis showed similar results of appropriate antibiotic administration in CPM users, supporting our pre- and post-intervention findings.

It is possible that use of the CPM was underestimated. The use of the LEC CPM by medical providers was voluntary, and therefore, the CPM use was ascertained from a computer-generated user report, which recorded access of the CPM by provider name and date. Only medical providers with electronic documentation recorded in the EMR could be identified as providing care to the patient, so it is possible that a team member reviewed the CPM for the rest of the team during clinical rounds and that person did not complete electronic documentation. For example, since this is a resident teaching facility, one resident member of the team will often be in charge of the portable computer during rounds. The hospitalist, non-resident teams employ a clinical assistant who has a similar role.

St. Mary's Hospital is a tertiary referral center, so referral bias could occur, due to possible patient transfer of more complicated cases of cellulitis to this hospital. This seems less likely in the cases of cellulitis, and especially since we excluded cases of complicated cellulitis, including those associated with trauma, bites, water exposure and immunosuppression.

A final limitation of this study is that the measurement of re-hospitalization within 30 days may not capture all patients, as they could be readmitted to a hospital other than St. Mary's Hospital, the site of the study. We were only able to capture re-hospitalization at St. Mary's Hospital.

Conclusion

Nationally, the incidence of SSTIs has increased, and has been associated with an increasing incidence of community-acquired MRSA, increasing age of the population, and increasing incidence of predisposing co-morbidities (obesity, lymphatic and/or venous compromise, chronic skin conditions, and toe-web disease) (16-19). With an increasing burden on the healthcare system, opportunities for optimizing healthcare resources and improving standardization of care are present.

As we look to the future, the IOM report “Best Care at Lower Cost: The Path to Continuously Learning Health Care in America,” identified clinical decision support tools as a care improvement target (3). In addition, of the 12 quality measures in the clinical care domains of the fiscal year 2014 Centers for Medicare and Medicaid Services (CMS) Value-based Purchasing program, four are related to appropriate antibiotic prescribing: initial antibiotic selection for community-acquired pneumonia in immunocompetent patients, prophylactic antibiotic received within one hour prior to surgical incision, prophylactic antibiotic selection for surgical patients, and prophylactic antibiotics discontinued within 24 hours after surgery end time (20). Antimicrobial stewardship programs may not be sufficient in meeting these quality goals, as these programs typically focus on prescribing formulary antibiotics or an antibiotic based on culture results, and not the most appropriate antibiotic based on the clinical disease.

A patient point of care tool, such as this online CPM, may help to standardize patient care and optimize treatment in these areas. It could provide healthcare providers not only with the appropriate choices for antimicrobial administration, but also with the appropriate timing of administration and discontinuation. This study showed that an online clinical decision support tool has the potential to aid in achieving some of these goals. More research is needed to improve implementation.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This publication was made possible by CTSA Grant Number UL1 TR000135 from the National Center for Advancing Translational Sciences (NCATS), a component of the National Institutes of Health (NIH). Its contents are solely the responsibility of the authors and do not necessarily represent the official view of NIH.

References

1. Steff ME. To Err is Human: Building a Safer Health System in 1999. *Frontiers of Health Services Management*. 2001; 18(1):1–2. [PubMed: 11589119]
2. Stelfox HT, Palmisani S, Scurlock C, Orav EJ, Bates DW. The “To Err is Human” report and the patient safety literature. *Quality & safety in health care*. 2006; 15(3):174–8. [PubMed: 16751466]
3. Medicine Io. Best Care at Lower Cost: The Path to Continuously Learning in America Recommendations. Washington D.C.: National Academy of Science; Sep. 2012
4. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)--a metadata-driven methodology and workflow process for providing translational

research informatics support. *Journal of biomedical informatics*. 2009; 42(2):377–81. [PubMed: 18929686]

5. Blomkalns AL, Roe MT, Peterson ED, Ohman EM, Fraulo ES, Gibler WB. Guideline implementation research: exploring the gap between evidence and practice in the CRUSADE Quality Improvement Initiative. *Academic Emergency Medicine*. 2007; 14(11):949–54. [PubMed: 17967956]
6. Fiel S. Guidelines and critical pathways for severe hospital-acquired pneumonia. *Chest*. 2001; 119(2 Suppl):412S–8S. [PubMed: 11171778]
7. Jain R, Kralovic SM, Evans ME, Ambrose M, Simbartl LA, Obrosky DS, et al. Veterans Affairs initiative to prevent methicillin-resistant *Staphylococcus aureus* infections. *New England Journal of Medicine*. 2011; 364(15):1419–30. [PubMed: 21488764]
8. Marra AR, Cal RGR, Silva CV, Caserta RA, Paes AT, Moura DF Jr, et al. Successful prevention of ventilator-associated pneumonia in an intensive care setting. *American Journal of Infection Control*. 2009; 37(8):619–25. [PubMed: 19559503]
9. Mehta RH, Montoye CK, Faul J, Nagle DJ, Kure J, Raj E, et al. Enhancing quality of care for acute myocardial infarction: shifting the focus of improvement from key indicators to process of care and tool use: the American College of Cardiology Acute Myocardial Infarction Guidelines Applied in Practice Project in Michigan: Flint and Saginaw Expansion. *Journal of the American College of Cardiology*. 2004; 43(12):2166–73. [PubMed: 15193675]
10. Schelenz S, Tucker D, George C, Daly S, Hill M, Roxburgh J, et al. Significant reduction of endemic MRSA acquisition and infection in cardiothoracic patients by means of an enhanced targeted infection control programme. *Journal of Hospital Infection*. 2005; 60(2):104–10. [PubMed: 15866007]
11. Stevens DL, Bisno AL, Chambers HF, Everett ED, Dellinger P, Goldstein EJC, et al. Practice guidelines for the diagnosis and management of skin and soft-tissue infections. *Clinical Infectious Diseases*. 2005; 41(10):1373–406. [Erratum appears in *Clin Infect Dis*. 2006 Apr 15;42(8):1219 Note: Dosage error in article text], [Erratum appears in *Clin Infect Dis*. 2005 Dec 15;41(12):1830]. [PubMed: 16231249]
12. Jenkins TC, Knepper BC, Sabel AL, Sarcone EE, Long JA, Haukoos JS, et al. Decreased antibiotic utilization after implementation of a guideline for inpatient cellulitis and cutaneous abscess. *Archives of Internal Medicine*. 2011; 171(12):1072–9. [PubMed: 21357799]
13. Parnes B, Fernald D, Coombs L, Dealleaume L, Brandt E, Webster B, et al. Improving the management of skin and soft tissue infections in primary care: a report from State Networks of Colorado Ambulatory Practices and Partners (SNOCAP-USA) and the Distributed Ambulatory Research in Therapeutics Network (DARTNet). *J Am Board Fam Med*. 2011; 24(5):534–42. [PubMed: 21900436]
14. Daly JM, Levy BT, Ely JW, Swanson K, Bergus GR, Jogerst GJ, et al. Management of skin and soft tissue infections in community practice before and after implementing a “best practice” approach: an Iowa Research Network (IRENE) intervention study. *J Am Board Fam Med*. 2011; 24(5):524–33. [PubMed: 21900435]
15. Lazzarini L, Pellizzer G. Erysipelas-cellulitis of the leg: impact of the application of a guideline in an infectious diseases unit. *Journal of Chemotherapy*. 2011; 23(6):378. [PubMed: 22233827]
16. Halpern J, Holder R, Langford NJ. Ethnicity and other risk factors for acute lower limb cellulitis: a U.K.-based prospective case-control study. *British Journal of Dermatology*. 2008; 158(6):1288–92. [PubMed: 18341662]
17. Karppelin M, Siljander T, Vuopio-Varkila J, Kere J, Huhtala H, Vuento R, et al. Factors predisposing to acute and recurrent bacterial non-necrotizing cellulitis in hospitalized patients: a prospective case-control study. *Clinical Microbiology & Infection*. 2010; 16(6):729–34. [PubMed: 19694769]
18. Lewis SD, Peter GS, Gomez-Marin O, Bisno AL. Risk factors for recurrent lower extremity cellulitis in a U.S. Veterans Medical Center population. *American Journal of the Medical Sciences*. 2006; 332(6):304–7. [PubMed: 17170620]
19. McNamara DR, Tleyjeh IM, Berbari EF, Lahr BD, Martinez J, Mirzoyev SA, et al. A predictive model of recurrent lower extremity cellulitis in a population-based cohort. *Archives of Internal Medicine*. 2007; 167(7):709–15. [PubMed: 17420430]

20. Services DoHaH. , editor. Services CfMaM. Hospital Value-based Purchasing Program. Mar. 2013

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Figure 1.
A screenshot of the lower extremity cellulitis care process model (LEC CPM). By clicking on a box/diamond, healthcare providers can obtain more specific recommendations, as shown in the boldly outlined insets of “Order tests” and “Begin IV medical therapy.” Used with permission of Mayo Foundation for Medical Education and Research.

Table 1
Demographic and baseline characteristics of LEC patients

Variable	Pre-Intervention (n=37)	Post-Intervention (n=48)	P-value
Age at admission	63.3±20.8	63.8±20.8	0.919
Male gender	22 (59%)	26 (54%)	0.626
BMI > 30	23 (62%)	34 (71%)	0.399
Admission temperature > 38.2 C	1 (3%)	1 (2%)	1.000*
<i>Co-morbid conditions</i>			
H/o Tinea pedis	2 (5%)	6 (13%)	0.267
H/o Lymphedema	16 (43%)	14 (29%)	0.178
H/o Dermatitis	19 (51%)	16 (33%)	0.094
H/o Malignancy	5 (14%)	0 (0%)	0.009
H/o LE cellulitis	15 (41%)	18 (38%)	0.776
H/o Other Cellulitis	5 (14%)	2 (4%)	0.120
Diabetes mellitus	7 (19%)	12 (25%)	0.505
<i>Physical Examination</i>			
Tinea pedis	8 (22%)	14 (29%)	0.431
Edema	30 (81%)	37 (77%)	0.655
Dermopathy	17 (46%)	31 (65%)	0.086
Prior antibiotics	11 (30%)	23 (48%)	0.090

Table 2
Comparison of pre-intervention and post-intervention phases

Variable	Pre-Intervention (n=37)	Post-Intervention (n=48)	P-value
Any AME use Day 1 or 2	5 (14%)	24 (50%)	<.001
AME use by consultant	0 / 37 (0%)	12 / 48 (25%)	0.001
AME use by resident/fellow	2 / 28 (7%)	15 / 34 (44%)	0.001
AME use by mid-level	2 / 8 (25%)	0 / 3 (0%)	1.000 *
AME use by student	3 / 6 (50%)	2 / 4 (50%)	1.000
Antibiotics administered correct per AME	9 (24%)	21 (44%)	0.063
Imaging after admission	18 (49%)	26 (54%)	0.614
U/S after admission	9 / 18 (50%)	20 / 26 (77%)	0.064
Plain radiograph after admission	8 / 18 (44%)	10 / 26 (38%)	0.691
CT after admission	2 / 18 (11%)	6 / 26 (23%)	0.312
MRI after admission	2 / 18 (11%)	3 / 26 (12%)	0.965
Total Imaging studies ~			0.619
0	5 (14%)	5 (10%)	
1	13 (35%)	16 (33%)	
2	11 (30%)	15 (31%)	
3	5 (14%)	8 (17%)	
4	1 (3%)	2 (4%)	
5+	2 (5%)	2 (4%)	
Blood cultures	30 (81%)	37 (77%)	0.655
<i>Laboratory screening</i>			
CBC	37 (100%)	48 (100%)	
Creatinine	36 (97%)	48 (100%)	0.435 *
ESR	17 (46%)	20 (42%)	0.693
CRP	22 (59%)	29 (60%)	0.929
ID consultation	8 (22%)	15 (31%)	0.322
Antibiotics at discharge correct per AME	9 (24%)	21 (44%)	0.063
Total duration antibiotics *	5.0 (1.0, 7.0)	5.0 (1.0, 7.0)	0.619
Total number of antibiotics ~			0.572
1	9 (24%)	5 (10%)	
2	7 (19%)	17 (35%)	
3	7 (19%)	16 (33%)	
4	7 (19%)	8 (17%)	
5	7 (19%)	2 (4%)	

Variable	Pre-Intervention (n=37)	Post-Intervention (n=48)	P-value
Length of hospital stay [*]	2.0 (0.0, 12.0)	2.0 (0.0, 36.0)	0.795
<i>Failure:</i>			
Were antibiotics escalated during hospitalization?	2 (5%)	3 (6%)	0.870
Readmission w/in 30 days for cellulitis	1 (3%)	2 (4%)	1.000 [*]

^{*} Median (Min, Max); K-W rank sum test

[~] N (%); K-W rank sum test

Table 3
Sensitivity analysis, comparison of all LEC admissions when the CPM was not used versus used

Variable	No CPM Use (n=56)	CPM Use (n=29)	P-value
Age at admission	61.5±20.8	67.7±20.1	0.187
Male gender	30 (54%)	18 (62%)	0.454
BMI 30	34 (61%)	23 (79%)	0.084
Admission temperature 38.2 C	1 (2%)	1 (3%)	1.000 *
<i>Co-morbid conditions</i>			
H/o Tinea pedis	7 (13%)	1 (3%)	0.175
H/o Lymphedema	23 (41%)	7 (24%)	0.121
H/o Dermatitis	28 (50%)	7 (24%)	0.022
H/o Malignancy	4 (7%)	1 (3%)	0.657 *
H/o LE cellulitis	24 (43%)	9 (31%)	0.289
H/o Other Cellulitis	6 (11%)	1 (3%)	0.248
Diabetes mellitus	10 (18%)	9 (31%)	0.167
<i>Physical Examination</i>			
Tinea pedis	13 (23%)	9 (31%)	0.435
Edema	43 (77%)	24 (83%)	0.523
Dermopathy	31 (55%)	17 (59%)	0.774
Prior antibiotics	21 (38%)	13 (45%)	0.513
Antibiotics administered correct per AME	12 (21%)	18 (62%)	<.001
Imaging after admission	29 (52%)	15 (52%)	0.996
U/S after admission	20 / 29 (69%)	9 / 15 (60%)	0.552
Plain radiograph after admit	11 / 29 (38%)	7 / 15 (47%)	0.576
CT after admission	5 / 29 (17%)	3 / 15 (20%)	0.822
MRI after admission	3 / 29 (10%)	2 / 15 (13%)	1.000 *
Total Imaging studies ~			0.969
0	5 (9%)	5 (17%)	
1	21 (38%)	8 (28%)	
2	18 (32%)	8 (28%)	
3	8 (14%)	5 (17%)	
4	1 (2%)	2 (7%)	
5+	3 (5%)	1 (3%)	
Blood cultures	45 (80%)	22 (76%)	0.631
<i>Laboratory screening</i>			
CBC	56 (100%)	29 (100%)	

Variable	No CPM Use (n=56)	CPM Use (n=29)	P-value
Creatinine	55 (98%)	29 (100%)	1.000 [*]
ESR	25 (45%)	12 (41%)	0.774
CRP	34 (61%)	17 (59%)	0.852
ID consult	14 (25%)	9 (31%)	0.553
Antibiotics at discharge correct per AME	16 (29%)	14 (48%)	0.071
Total duration antibiotics [*]	5.0 (2.0, 7.0)	5.0 (1.0, 7.0)	0.373
Total number of antibiotics [~]			0.050
1	13 (23%)	1 (3%)	
2	15 (27%)	9 (31%)	
3	15 (27%)	8 (28%)	
4	8 (14%)	7 (24%)	
5	5 (9%)	4 (14%)	
Length of hospital stay [*]	2.0 (0.0, 32.0)	3.0 (0.0, 36.0)	0.269
<i>Failure</i>			
Were antibiotics escalated during hosp	1 (2%)	4 (14%)	0.044 [*]
Readmission w/in 30 days for cellulitis	2 (4%)	1 (3%)	1.000 [*]

^{*} Median (Min, Max); K-W rank sum test

[~] N (%); K-W rank sum test