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Hospital costs for patients with lower extremity cellulitis: a retrospective population-based study

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Abstract

Background—Hospital admissions for non-purulent lower extremity cellulitis (NLEC) are common and can be prolonged and costly. Newer treatment options and preventive strategies are expected to result in cost savings before implementation, but few studies have quantified the cost of conventional treatment.

Methods—Using the Rochester Epidemiology Project, the incidence of NLEC in Olmsted County, MN in 2013 was 176.6 per 100,000 persons. The subset of patients who required hospitalization for NLEC in 2013 was determined. Hospital admissions were analyzed retrospectively using standardized cost analysis within several relevant categories.

Results—Thirty-four patients had an average hospital length of stay of 4.7 days. The median total inpatient cost was \$7,341. The median cost per day was \$2,087, with 49% due to room and board. Antibiotics administered for treatment of NLEC contributed a median cost of \$75 per day of hospitalization, and laboratory and imaging test costs were \$73 and \$44, respectively, per day of hospitalization.

Conclusions—Hospitalizations for NLEC can be costly and prolonged with room and board accounting for much of the cost. Therefore, newer management strategies should seek to reduce hospital length of stay and/or avoid inpatient admission to reduce cost.

Keywords

Lower extremity cellulitis; cost; hospitalization; population-based; Rochester Epidemiology Project; inpatient

Introduction

Non-purulent lower extremity cellulitis (NLEC) is commonly seen in both inpatient and outpatient settings. Several studies have defined the incidence of NLEC, but few have attempted to determine the cost of inpatient management of this infection. The incidence of NLEC was approximately 199 per 100,000 person-years in the Olmsted County, Minnesota

Declarations of Interests

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population in 1999 with about 80 percent of the diagnoses made in the outpatient setting.[1] The NLEC incidence in this population was re-examined in the 2013 population after the emergence of community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA), with a decreased incidence of 176.6 per 100,000.[2] Despite evidence of a diminishing incidence of NLEC in our local population and in others[3], the prevalence of hospitalization among the local population remained stable (approximately 20%) for both cohorts.[1, 2] While the majority of care for NLEC occurs in ambulatory settings, the bulk of the overall costs are incurred in the hospital.[4] Inpatient treatment is recommended for moderate and severe skin and soft tissue infections, as well as for patients who are severely immunocompromised, may be poorly compliant, or those who have failed outpatient treatment.[5] The presence of other comorbidities and other active medical problems may also impact the decision to admit to the hospital.[6]

Determining inpatient costs of NLEC is important as new treatment strategies are implemented for more efficient care. Outpatient infusion centers have been popularized recently and have been cost effective for intravenous antibiotic administration when compared to inpatient admissions.[7] Similarly, home administration of intravenous antibiotics via home healthcare agencies aims to reduce costs. Moreover, prophylactic antibiotics have been effective in preventing NLEC recurrence,[8, 9] which commonly occurs in patients with a first episode of NLEC; additionally, prophylaxis can be cost effective, even after the first episode of NLEC.[10] Recently introduced antibiotics, including the long half-life lipoglycopeptides (oritavancin, telavancin and dalbavancin) also provide opportunities for effective treatment with the potential to avoid hospitalization and outpatient parenteral antibiotic therapy (OPAT) costs. In addition, “automatic” Infectious Disease consultation can improve outcome of NLEC patients diagnosed in the emergency department, by identifying cellulitis mimics[11, 12] (and avoiding antimicrobials), preventing hospitalization, and reducing recurrent episodes.[13]

NLEC is a significant burden on the healthcare system. With many treatment and prevention strategies that have been developed recently, it is important to determine the contemporary financial burden of treatment of NLEC. Quantifying the extent of that burden will assist in comparing new treatment or prevention strategies to current approaches. In this population-based study, costs associated with inpatient admission for NLEC were quantified by evaluating a regional cohort seen in 2013. This is the first population-based study to define the cost of hospital treatment of NLEC in the United States.

Methods

Investigators defined the incidence of NLEC in Olmsted County, MN with use of the Rochester Epidemiology Project (REP), a unique research infrastructure that links together nearly all of the medical records of the residents of Olmsted County, MN.[14] Cases were found by identifying potential encounters with relevant ICD-9 codes for cellulitis and abscess, excluding encounters utilizing procedural codes for abscess drainage (Supplementary Tables 1 and 2) and finally confirmed via manual review of the electronic medical records. Data from the year 2013 were examined to identify patients requiring hospitalization. Standardized costs for the patients’ billed services while in the hospital were

obtained from the Rochester Epidemiology Project Cost Data Warehouse[15] which applies Medicare reimbursement to professional services and multiplies service line hospital charges by Medicare cost report cost-to-charge ratios. Costs are reported in 2013 US dollars.

Examined costs included total hospitalization cost and hospitalization cost per day, relevant laboratory cost per day, relevant imaging cost per day, and antibiotic cost per day.

Laboratory tests included complete blood count, C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR), basic chemistry panels, streptococcal serologies, including antistreptolysin O (ASO) and DNase B titers, and blood cultures. Relevant imaging tests included lower extremity ultrasound, lower extremity plain radiography, and advanced imaging including computed tomographic scanning and magnetic resonance imaging). Relevant antibiotics included all oral, intravenous, and intramuscular antibiotics. Oral antibiotics included in the analysis were cephalexin, cefadroxil, levofloxacin, ciprofloxacin, moxifloxacin, clindamycin, dicloxacillin, penicillin VK, doxycycline, minocycline, metronidazole, amoxicillin-clavulanate, trimethoprim-sulfamethaxazole, linezolid, and amoxicillin. Intravenous antibiotics included ceftriaxone, cefazolin, cefepime, vancomycin, nafcillin, piperacillin/tazobactam, levofloxacin, ciprofloxacin, ertapenem, clindamycin, penicillin G potassium, aztreonam, linezolid, and ampicillin-sulbactam. The analysis also included the use of intramuscular ceftriaxone.

Results

Of 195 patients with confirmed NLEC episodes in the 2013 Olmsted County cohort, 34 required inpatient admission. The average LOS was 4.7 days (median 3.5 days; range, 1-16 days). Prolonged stay (hospitalization of more than five days[16]) occurred in 8 of the 34 inpatient admissions (33%). The median total standardized inpatient cost was \$7,341. The median total cost per day was \$2,087. Median daily laboratory costs were \$73.

Twenty-six (76%) patients underwent imaging of the lower extremity. Median daily imaging costs related to the lower extremity were \$44. The most frequent imaging study was duplex ultrasound scanning of the lower extremity vasculature (26 [43%] of 60 total imaging studies). The remainder included a variety of plain radiographs of the lower extremity. No patient underwent CT or MRI of the lower extremity. Patients who had lower extremity imaging had a mean total cost per day of \$2,306 as compared to a mean total cost per day of \$1,796 for those without imaging. Patients without lower extremity imaging also had a shorter average length of stay (3.25 days; 95% 2.27-4.22; vs. 5.11 days; 95% 3.48-6.74).

Median daily antibiotic costs related to NLEC were \$75 (Table 1). The vast majority of antibiotics were administered intravenously with only 26% of antibiotic doses being given orally (most commonly cephalexin). The most commonly administered antibiotic was intravenous vancomycin at 21% of administered doses. Both intravenous cefazolin and piperacillin-tazobactam were also commonly provided with 13% and 8% of administered doses respectively.

Total standardised costs varied widely from \$4,313 at the 25th percentile to \$11,733 at the 75th percentile. When normalized for the length of stay, data became more uniform with a

mean total cost per day of \$2,186, 25th percentile of \$1,773 and 75th percentile of \$2,574 (Table 1).

The cohort was divided into two groups, based on length of stay. Patients who were in the hospital more than 5 days had a mean cost per day of \$2,637 (95%: \$1,770 – \$3,504). The patients who were in the hospital for shorter stays had lower costs even when normalized for length of stay. These patients had a mean cost per day of \$2,047 (95%: \$1,839 to \$2,256).

Six inpatients underwent procedures which contributed to the total cost of their hospitalizations. The patients who received procedures while inpatient had an average cost per day of \$3,033 (95%: \$1,968-\$4,097). Those who did not have procedures had an average cost per day of \$2,005 (95%: \$1,822-\$2,187). The patient with the highest total hospital cost (\$66,669) also had the second longest length of stay at 14 days. The procedure costs for this patient were the highest in the cohort at a total of \$6,734. This hospital stay was complicated by *Staphylococcus aureus* blood stream infection and septic joints requiring multiple joint aspirations and debridement operations contributing to the high procedural costs. None of the patients who underwent inpatient procedures were hospitalized with the primary diagnosis of NLEC. All had procedures relating to their other diagnoses including closed reduction of fibular fracture, colonoscopic decompression, lumbar puncture and paracentesis.

Overall, the largest component of the hospital cost was room and board which accounted for, on average, 49% of the total cost with an average cost per day for room and board of \$1045.

Discussion

This is the first population-based investigation to evaluate the costs of inpatient treatment of NLEC in a well-defined, contemporary, American population. This study showed that inpatient treatment of cellulitis was costly, with the largest proportion of the cost due to daily room and board. The average cost per day increased as the LOS increased.

Published data that examine hospitalization for NLEC is sparse, although there have been several international attempts at quantifying the inpatient costs of NLEC. These have ranged in average length-of-stay (LOS) from 5.8 to 12.1 and total costs of 5346 Euro and AUS \$ 5,196.[4, 17] A recent American database analysis showed median cost of hospitalization for cellulitis (not limited to NLEC) of \$5,159 with median LOS of 2.88 days.[18] An American study of diabetic patients hospitalized with skin/soft tissue infections (SSTIs) had an average LOS of 7.8 days with an average cost of \$10,946 per hospitalization.[19] One previous attempt at quantifying the cost of hospitalization associated with SSTIs in diabetics estimated that soft tissue infection contributed approximately \$10,000 per hospitalization to the total charge.[17]

The average LOS in the current study was similar to that for other studies (between 5 and 8 days).[20, 21] Interventions, therefore, that limit or prevent recurrence of NLEC may be important in preventing hospitalization.

Expert opinion and published data suggest that prophylactic oral antibiotics reduce recurrences of NLEC.[5, 9] If the consistent use of prophylactic antibiotics results in fewer hospitalizations and shorter hospital stays, then they could have a significant impact on reducing the cost of NLEC. This has been suggested in cost analyses of the UK randomized controlled trials (PATCH I and II), which demonstrated that antibiotic prophylaxis is at least 62% cost effective to both the healthcare system and society.[8] Risk factor modification including treatment of lymphedema and tinea pedis is also recommended for reduction of cellulitis recurrence.[22]

Current inpatient costs related to antibiotics are relatively low compared to the proportion of costs from other management categories. The most effective strategy for reducing costs may be to simply treat patients without admission to the hospital with the use of outpatient infusion centers for intravenous antibiotics, if needed. This may be a more cost effective option than the use of the novel long half-life lipoglycopeptides which are currently very costly and achieve the same goal of avoiding inpatient admission. In general, outpatient parenteral antibiotic delivery is cost-effective and significantly less expensive than inpatient delivery of the same agents.[23, 24] In addition, patients who receive antibiotics through an OPAT program receive antibiotics for a shorter duration than those who remained hospitalized.[7] If OPAT therapy is selected, then early close outpatient follow-up will be needed.

This retrospective study is limited by the relatively small cohort of inpatient admissions for NLEC in this population in one year. Only 34 patients of 195 with confirmed NLEC diagnoses required hospitalization. The small sample size may limit the generalizability of these results. Additionally, the study likely underestimated the financial burden of NLEC as the vast majority of patients are treated without hospitalization and many may never seek healthcare. The retrospective nature of the study forces reliance on the accuracy of documentation rather than allowing the investigators to confirm diagnosis of NLEC in person. Coding practices differ across hospitals which may also lead to failure to capture all cases of NLEC. The relatively rural, Midwestern setting for this study likely has effects on costs as well as other confounding factors such as average length of stay. The study benefits from being population-based, including data from all the hospitals within the county.

Conclusions

This study demonstrated the standardized costs involved in the inpatient treatment of NLEC in a geographically-defined cohort in the Upper Midwest. The highest proportion of costs was not related to medications, interventions, or testing but rather miscellaneous charges related to inpatient admission, especially room and board. Cost-effective treatment of this disease should focus on prevention of NLEC recurrence, which is common in NLEC, and treatment strategies that include detailed ambulatory care management for the portion of patients who otherwise can be safely managed in this way.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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List of abbreviations

NLEC	Non-purulent lower extremity cellulitis
SSTI	Skin and soft-tissue infections
LOS	Length of stay
OPAT	Outpatient parenteral antimicrobial therapy
REP	Rochester Epidemiology Project

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Figure 1.
Distribution of length of stay in cohort.

Figure 2.
Total standardized cost of hospitalization vs. length of stay.

Figure 3.
Standardized costs by category.

Table 1

Distribution of Standardized Costs for Patients Hospitalized with NLEC (rounded to nearest dollar).

Category	25% Percentile	Median	Mean	75% Percentile
Total Cost	4,313	7,341	11,480	11,733
Total Cost/Day	1,773	2,087	2,186	2,574
Lab Cost/Day	58	73	77	97
Imaging Cost/Day	18	44	74	105
Antibiotic Cost/Day	40	75	87	114
Room and Board/Day	887	975	1,045	1,243