A Physician-Driven Quality Improvement Stewardship Intervention Using Lean Six Sigma Improves Patient Care for Community-Acquired Pneumonia

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ABSTRACT

Introduction: The Infectious Diseases Society of America (IDSA) recommends a minimum of 5 days of antibiotic therapy in stable patients who have community-acquired pneumonia (CAP). However, excessive duration of therapy (DOT) is common. Define, measure, analyze, improve, and control (DMAIC) is a Lean Six Sigma methodology used in quality improvement efforts, including infection control; however, the utility of this approach for antimicrobial stewardship initiatives is unknown. To determine the impact of a prospective physician-driven stewardship intervention on excess antibiotic DOT and clinical outcomes of patients hospitalized with CAP. Our specific aim was to reduce excess DOT and to determine why some providers treat beyond the IDSA minimum DOT. **Methods:** A single-center, quasi-experimental quality improvement study evaluating rates of excess antimicrobial DOT before and after implementing a DMAIC-based antimicrobial stewardship intervention that included education, prospective audit, and feedback from a physician peer, and daily tracking of excess DOT on a Kaizen board. The baseline period included retrospective CAP cases that occurred between October 2018 and February 2019 (control group). The intervention period included CAP cases between October 2019 and February 2020 (intervention group). **Results:** A total of 123 CAP patients were included (57 control and 66 intervention). Median antibiotic DOT per patient decreased (8 versus 5 days; $p < 0.001$), and the proportion of patients treated for the IDSA minimum increased (5.3% versus 56%; $p < 0.001$) after the intervention. No differences in mortality, readmission, length of stay, or incidence of *Clostridioides difficile* infection were observed between groups. Almost half of the caregivers surveyed were aware that as few as 5 days of antibiotic treatment could be appropriate. **Conclusions:** A physician-driven antimicrobial quality improvement initiative designed using DMAIC methodology led to reduced DOT and increased compliance with the IDSA treatment guidelines for hospitalized patients with CAP reduced without negatively affecting clinical outcomes.

Keywords: pneumonia, antimicrobial stewardship, quality improvement

INTRODUCTION

Before the coronavirus disease 2019 (COVID-19) pandemic, community-acquired pneumonia (CAP) was the most frequent cause of infectious disease–related death in the United States.[1,2] Performance reimbursement measures set by the Centers for Medicare and Medicaid Services have promoted an increase in the rapid diagnosis of CAP and a concomitant rise in initiation of antimicrobial therapy for this pathology.[2,3] Because of its high incidence and the difficulty involved in discerning between its bacterial or viral etiology, pneumonia in hospitalized patients is the most common source of antibiotic use and overuse.[2–4] Antimicrobial resistance continues to plague society, and selective pressures from overuse of antibiotics is driving this problem. Physicians and other healthcare providers struggle to reduce antimicrobial overuse while still providing timely appropriate antibiotics to patients who need them. Asking healthcare providers to withhold antibiotics is difficult and potentially hazardous; however, convincing providers to limit excessive duration of therapy (DOT) may be feasible and appropriate.[5,6] The 2019 Infectious Disease Society of America (IDSA) and American Thoracic Society (ATS) CAP treatment guidelines recommend 5 days of antibiotic therapy for patients who have been afebrile for 48 to 72 hours and exhibit no more than one sign of clinical instability.[7] Longer treatment durations are recommended for patients who have clinical complications, show delayed clinical improvement, or have extrapulmonary infections. Of note, available evidence indicates that short antibiotic DOT for CAP is safe and effective.[5–8]

Unfortunately, compliance with the IDSA/ATS guidelines is disappointingly low. Between 2016 and 2019, two multicenter studies and one retrospective study that included a consortium of 43 Michigan hospitals found that inpatients with CAP received the minimum amount of antibiotics in only 5 to 32% of cases.[4,9,10] One study reported that prescriptions at discharge accounted for 93% of excess days of antibiotic use (antibiotic days), when patients were prescribed full antibiotic courses despite prior treatment during their hospital stay.[4] In addition to causing antibiotic resistance, prolonged courses of third-generation cephalosporins and fluoroquinolones have been associated with increased risk of *Clostridioides difficile* infection.[11–15] Fluoroquinolone use has also been associated with serious adverse events, including neuropathy, hypoglycemia, and aortic rupture and dissection (an injury to the innermost layer of the aorta).[16] Minimizing prolonged use of these drugs remains a particular concern in the Veterans Health Administration, where older male smokers constitute a majority of patients at increased risk for adverse aortic events.[17]

Antimicrobial stewardship programs aimed at curbing antimicrobial resistance are recommended by the Centers for Disease Control and Prevention and are mandated by the Joint Commission.[18,19] Methods for curtailing excess antibiotic use vary depending on the size of the organization, the scope of the problem, and the availability of funding. Common strategies include education, prospective audit and feedback review (PAFR), antimicrobial formulary restrictions, and syndrome-specific clinical order sets.[18] Antimicrobial stewardship goals dovetail with many institutional patient safety and quality improvement goals in that they all focus on ensuring safe and optimal antimicrobial therapy for patients who need it.[19] For pharmacists and infectious disease physicians, antimicrobial stewardship is a crossroads where the battle for judicious antimicrobial use meets quality improvement strategies. Unfortunately, not all hospitals have robust clinical pharmacy programs, and less than half have optimal antimicrobial stewardship programs in place.[18]

Previous studies have investigated the Lean Six Sigma DMAIC (define, measure, analyze, improve, and control) as a methodology to reduce healthcare-associated infections; however, no antimicrobial stewardship initiatives using this methodology have been described.[20–23] Therefore, we sought to use the DMAIC methodology to design a multifaceted, physician-driven antibiotic stewardship initiative for reducing excessive antibiotic DOT in patients hospitalized with CAP. Our primary objective was to measure antimicrobial DOT and excess antibiotic days for CAP inpatients before and after a physician-driven, DMAIC-based antibiotic stewardship intervention. Our quality improvement aim was to reduce the median antimicrobial DOT for veterans hospitalized with CAP by at least 1 day within a 5-month period. Secondary objectives included identifying the impact of the intervention on several clinical parameters, including median length of hospital stay, 30-day all-cause mortality, readmission rate, and *C difficile* infection rate.

METHODS

According to institutional policy, this quality improvement project was exempt from ethical approval and informed consent was not required.

Study Setting

The John D Dingle Veterans Affairs Medical Center (JDDVAMC) is a 120-bed urban hospital affiliated with the Wayne State University School of Medicine in Detroit, Michigan. At JDDVAMC, patients with CAP are admitted to internal medicine services and are cared for by one of five medical teams. Four teams comprise internal medicine residents and one team comprises nurse practitioners. All teams are supervised by academic hospitalist attending physicians. One pharmacist specializing in infectious diseases has practiced at the JDDVAMC since 2015, but the pharmacy does not provide routine PAFR for antibiotics prescribed for pneumonia patients, other than for fluoroquinolones or highly restricted antimicrobials, such as linezolid or
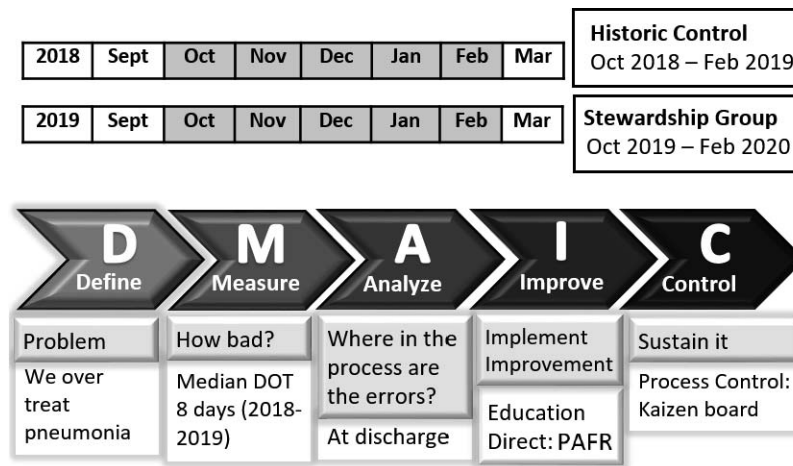
Figure 1. Quasi-experimental study design using DMAIC. DMAIC: define, measure, analyze, improve, and control; DOT: duration of therapy; PAFR: prospective audit and feedback review.

carbapenems. Briefly, PAFR is a process in which a trained expert (e.g., a pharmacist or infectious diseases physician) makes prescribing recommendations to healthcare providers when the therapy is deemed potentially inappropriate or suboptimal. Also, a separate ordering list for restricted antimicrobial drugs was initiated in October 2019; however, no syndrome-specific drug order set is currently in place for prescriptions for patients with CAP. The JDDVAMC also employs a chief resident in quality and safety (CRQS). The CRQS is an internal medicine resident in the fourth postgraduate year of training who focuses on teaching quality improvement and patient safety.

Study Design

We performed a single-center, pre–post, quasi-experimental quality improvement study evaluating patients before (October 2018 to February 2019; baseline period [control group]), and after (October 2019 to February 2020; intervention period [intervention group]) implementing a physician-driven antimicrobial stewardship initiative designed with the DMAIC methodology (Fig. 1). The "define, measure, and analyze" portions of the DMAIC were performed during the baseline period for the control group. Ishikawa diagrams and process maps were created for assessing the scope of errors and the process for prescribing that lead to excessive DOT. Control group pneumonia patients were identified by reviewing the history and physical and discharge summaries in the electronic medical record for patients who were discharged during the 5-month baseline period. Patients were included if they were aged 18 years and older and were admitted to the medical ward with a primary or secondary diagnosis of CAP, defined as signs and symptoms of pneumonia (both clinical and radiologic) at admission or within 48 hours of hospital presentation. Patients were excluded if they were diagnosed with any of the following conditions: healthcare-associated pneumonia, hospital-acquired pneumonia, ventilator-associated pneumonia, Legionnaires disease, empyema, pleural effusion requiring a chest tube, necrotizing pneumonia, bacteremia, an abandoned diagnosis of pneumonia (changed diagnosis), or any concomitant infection, such as urinary tract infection. Patients were also excluded if they had been admitted to the intensive care unit (ICU) on admission or during their stay or if respiratory cultures had grown *Staphylococcus aureus* or a nonfermenting, Gram-negative bacillus.

After analyzing the process in the baseline period, the "improve" portion of the DMAIC began with implementation of the antimicrobial stewardship intervention. The antimicrobial stewardship intervention consisted of two parts. First, monthly educational sessions were given during monthly resident orientation meetings. Educational materials consisted of one visual slide with information about excessive DOT and a 2-minute lecture presentation explaining that 5-day antibiotic DOT is appropriate for stable patients and that overtreatment most often occurs during the process of discharge. The second part consisted of PAFR, which was given by the CRQS physician to residents and nurse practitioners who were caring for CAP patients. To track the control aspect of the process, all patients treated for longer than the minimally necessary DOT were recorded daily on a Kaizen area improvement board in the hospitalist work room. In addition, providers who treated patients with CAP for longer than the minimum DOT during the intervention period were given a brief survey to explore their clinical rationale and to provide closed-loop feedback. Patients were identified for PAFR Monday–Friday by the CRQS through electronic medical record alerts indicating prescription orders for ceftriaxone, azithromycin, or a fluoroquinolone. Charts were reviewed to see whether antimicrobials were being given for presumed CAP as defined above, and feedback was given communicating that antibiotics should be discontinued 48 hours after patients are afebrile and have no
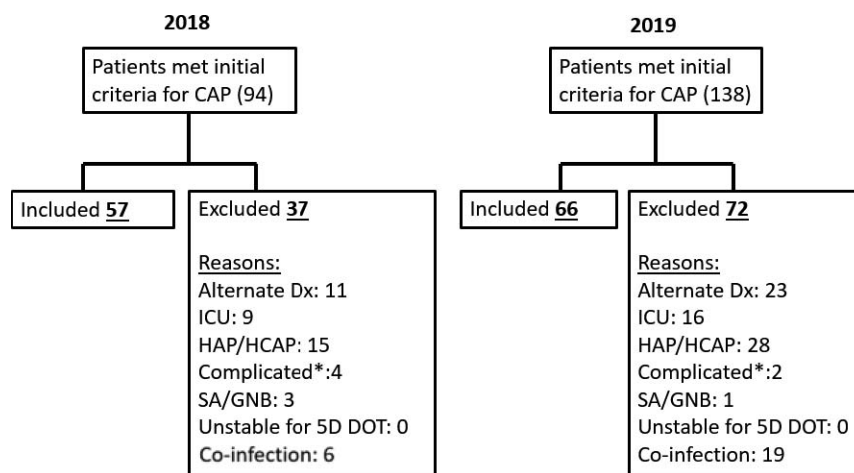
Figure 2. Patients included and excluded in the quasi-experimental study. *Complicated: empyema, necrotizing pneumonia, effusion requiring chest tube. CAP: community-acquired pneumonia; 5D DOT: 5-day duration of therapy; Dx: diagnosis; ICU: intensive care unit; HAP: hospital acquired pneumonia; HCAP: healthcare-associated pneumonia; SA: *Staphylococcus aureus*; GNB: Gram-negative bacilli.

more than one sign of clinical instability. Details outlining the IDSA definitions of clinical instability are in Supplemental Table S1, available online. In addition to the exclusion criteria listed above, if patients were not afebrile for 48 hours or had more than one sign of clinical instability, they were excluded and PAFR was not given.

Data Collection and Analysis

All outcomes were compared between the control and intervention groups. Descriptive statistics included median and IQR. Binary variables were compared using odds ratios and ordinal variables were compared with the Wilcoxon rank sum (Mann-Whitney U) test for non-parametric data. Statistical analysis was done using SPSS version 25 (IBM). Effects were considered significant if the *p*-value was less than 0.05. Clinical outcomes were evaluated through 30 days after discharge. The final patient included in the study was treated 20 days before the first known case of severe acute respiratory syndrome coronavirus 2 infection in the state of Michigan.

RESULTS

A total of 232 patients were admitted with CAP during the entire 10-month study period (94 in the baseline period and 138 in the intervention period). Of these, 123 were included in the analysis (57 in the control group and 66 in the intervention group). Detailed reasons for exclusion are outlined in Figure 2. The most common reasons for exclusion were pneumonia attributed to healthcare-associated pneumonia or hospital-acquired pneumonia (rather than CAP) and change of initial pneumonia diagnosis. Some patients had more than one reason for exclusion (e.g., in the ICU with a diagnosis of healthcare-associated pneumonia). Of note, no patients were excluded because of clinical instability or ongoing fever. Baseline characteristics of the two groups were

similar (Table 1), including similar chronic pulmonary disease rate, Charlson Comorbidity Index, severity of pneumonia on presentation as indicated by the CURB-65 score, and risk for multidrug resistant pathogens as indicated by the DRIP score (Table 1).

The median (IQR) antimicrobial DOT was significantly lower in the intervention group than in the control group: 5 (5–7) days versus 8 (7–9) days; $p < 0.001$ (Table 2). Excess antibiotic days beyond the IDSA/ATS minimum duration were reduced from 3 (2–4) days during the baseline period to 0 (0–2) days ($p < 0.001$) during the intervention period. The proportion of patients who were treated for the IDSA/ATS recommended minimum DOT increased from 5.3% in the baseline period to 56.1% in the intervention period ($p < 0.001$). The proportion of patients treated for 8 days (40.4% versus 7.6%; $p < 0.001$) or 10 days (14.1% versus 3%; $p = 0.042$) decreased (Fig. 3) after the intervention was implemented. Over the 5-month intervention period, cumulative days of excess antibiotics between the two groups were reduced from 180 days to 62 days. The incidence of 30-day all-cause mortality (3.5% control versus 2.5% intervention; $p = 0.772$) and rate of readmission (19.3% control versus 16.7% intervention; $p = 0.704$) did not significantly differ between groups. Median length of stay did not differ between groups and there were no episodes of *C difficile* infection. A run chart showing variation in the percentage of patients treated beyond the IDSA minimum monthly over time is provided in Supplemental Figure S1.

The CRQS provided PAFR to providers for 57 of 66 cases of CAP in the intervention group (86%), with nine not receiving PAFR because admission or discharge occurred during a weekend or holiday. When PAFR was provided, healthcare providers followed recommendations 60% of the time (34 of 57 cases of CAP). Provider rationale for treating CAP beyond the IDSA/ATS minimum is shown in Supplemental Table S2. In the 23

Table 1. Baseline characteristics between the historic group and stewardship group

	Historic Group (n = 57)	Stewardship Group (n = 66)	p-Value
Age (y), median (IQR)	67 (34–75)	71 (62–76)	0.204
Men, n (%)	54 (94.7)	65 (98.4)	0.272
Comorbidities			
Charlson Comorbidity Index, median (IQR)	6 (4–7)	6 (4–9.3)	0.116
Cerebrovascular accident, n (%)	6 (10.5)	8 (12.1)	0.781
Congestive heart failure, n (%)	17 (29.8)	21 (31.8)	0.239
Myocardial infarction, n (%)	8 (14)	18 (27.3)	0.078
Peripheral vascular disease, n (%)	7 (12.3)	15 (22.7)	0.134
Connective tissue disease, n (%)	2 (3.5)	5 (7.8)	0.343
Chronic pulmonary disease, n (%)	34 (59.6)	32 (48.5)	0.217
Liver disease (moderate/severe), n (%)	9 (15.8)	16 (24.2)	0.248
Kidney disease* (moderate/severe), n (%)	5 (8.7)	5 (7.6)	0.809
Dementia, n (%)	3 (5.2)	3 (4.5)	0.854
Peptic ulcer disease, n (%)	4 (7)	3 (4.5)	0.558
Clostridioides difficile (last 90 d), n (%)	0 (0)	0 (0)	N/A
Immunocompromised			
AIDS[¥] (CD4 cells < 200 cells/mm^3), n (%)	0 (0)	0 (0)	N/A
Diabetes, n (%)	20 (35)	23 (34.8)	0.978
Leukemia or lymphoma, n (%)	0 (0)	1 (1.5)	N/A
Solid tumor, n (%)	18 (31.6)	22 (33.3)	N/A
Laboratory results on admission			
WBC (10^3/μL), median (IQR)	8.9 (7–19.5)	8.7 (6.3–12.9)	0.119
WBC < 4 or > 11 (10^3/μL), n (%)	24 (42.1)	28 (42.4)	0.972
Blood urea nitrogen (mg/dL), median (IQR)	17 (13–28)	17 (14–23.5)	0.638
Lactate > 2 (mg/dL), median (IQR)	7 (12.3)	4 (6.1)	0.237
Medication or exposures, n (%)			
Antibiotics (last 30 d)	9 (15.8)	7 (10.6)	0.397
Antirejection medications	1 (1.8)	1 (1.5)	0.917
Chemotherapy (last 30 d)	1 (1.8)	6 (9.1)	0.116
Proton pump inhibitors	21 (36.8)	24 (36.4)	0.956
Steroids (chronic systemic)	2 (3.5)	2 (3)	0.882
Tumor necrosis factor-α blockers	0 (0)	4 (6.1)	N/A
Factors associated with admission severity or other risk			
CURB-65 score, median (IQR)	1 (0.5–2)	1 (1–2)	0.238
DRIP score, median (IQR)	1 (0–2)	1 (1.5–2)	0.401
Suspected or witnessed aspiration, n (%)	4 (7)	10 (15.2)	0.166

N/A, not applicable; WBC: white blood cell; CURB-65: confusion, uremia, respiratory rate, blood pressure, 65 years of age or older; DRIP: drug resistance in pneumonia.
*Defined as on hemodialysis, posttransplant, severe uremia, or creatinine > 3 mg/dL.
[¥]Defined as CD4 < 200 or an AIDS-defining illness.

Table 2. Antibiotic duration impact and clinical outcomes in the historic and stewardship groups

	Historic Group (n = 57)	Stewardship Group (n = 66)	p-value
Antibiotic duration			
Total DOT (d), median (IQR)	8 (7–9)	5 (5–7)	0.0001
Excess antibiotic days, median (IQR)	3 (2–4)	0 (0–2)	0.0001
Cumulative excess antibiotic days	180	62	N/A
Clinical outcomes			
30-d mortality, n (%)	2 (3.5)	3 (4.5)	0.772
30-d readmission, n (%)	11 (19.3)	11 (16.7)	0.704
Length of stay (d), median (IQR)	2 (2–3.5)	3 (2–4.25)	0.246
30-d *Clostridioides difficile*	0	0	NA

DOT: duration of therapy; N/A, not applicable.

instances when PAFR was not followed, miscounting the days of therapy was the most commonly cited reason for overtreating pneumonia (14 of 23 patients; 61%). The survey allowed for selection of multiple reasons to explain extended DOT. Only 3 of 23 patients were intentionally treated for a longer time because of continued respiratory symptoms, such as coughing or wheezing (Supplemental Table S2). Almost half (48%) of the providers surveyed were unaware that 5 days of antibiotics was appropriate for treating CAP. Of the 52% of providers who were aware of the 5-day treatment recommendation, eight (67%) had learned of this protocol during the stewardship intervention. Only four of 23 providers (17.4%) had learned about the 5-day minimum DOT for CAP from another source, such as from an infectious disease consult rotation or through their own reading.
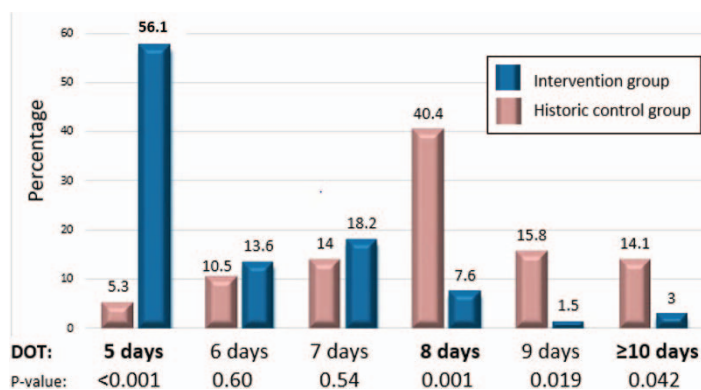
Figure 3. Duration of therapy in the historic control versus stewardship intervention groups. DOT: duration of therapy.

DISCUSSION

In this study, we showed that an antimicrobial stewardship initiative designed using the Lean Six Sigma DMAIC methodology and executed by a CRQS professional led to reduced excess days of antibiotic treatment for patients with CAP and an increased proportion of patients who were treated with antibiotics for the IDSA/ATS recommended minimum 5-day duration. The study indicated no differences in readmission, all-cause mortality, hospital length of stay, or *C difficile* infections after the intervention.

At least eight randomized clinical trials have shown that antibiotic DOT of 3 to 5 days for patients with CAP is as effective as longer antibiotic courses.[5,6] A post hoc analysis of a phase 3 trial in 2008 found that one dose of ceftriaxone cured 88% of CAP patients who subsequently received ineffective therapy, emphasizing just how unnecessary prolonged courses of antibiotics may be.[8] Foolad and colleagues[9] conducted one of the largest quasi-experimental studies to date evaluating the impact of a stewardship intervention on DOT and outcomes for CAP. Using a multifaceted model of education, CAP guideline expansion, and PAFR from clinical pharmacists, they observed a reduction in excessive DOT and an increase in the proportion of patients treated for the IDSA minimum duration, from 5.6 to 42%, all without an increase in mortality or readmissions.[9] Despite having been conducted at several large academic centers, almost all patients in that study (96% in the control group and 92% in the intervention group) met the criteria for 5 days of antibiotic therapy for CAP. Of note, we had a similar rate of baseline IDSA minimum treatment (5.3%), but we observed a greater increase in IDSA minimum duration treatment (56%) after our education-based intervention that included PAFR from a chief resident. Our Detroit patients had significantly more comorbidities (median Charlson Comorbidity Index of 6 in our study cohorts versus 1–2 in others); however, none met the IDSA/ATS fever or instability criteria for extending treatment beyond 5 days. It is notable that even with our high rates of cardiopulmonary comorbidities, the IDSA/ATS criteria for clinical instability, which would dictate longer treatment courses, were simply not met.

Ideally, an antimicrobial stewardship team should comprise pharmacists, clinical microbiologists, information technology experts, and infectious diseases physicians. Although several team members may be on an antimicrobial stewardship committee and partake in planning strategies at an institutional level, the daily duties and active interventions, such as PAFR, are most often performed by clinical pharmacists.[18] In centers like ours, only one such individual pharmacist monitors institutional use of restricted broad-spectrum antimicrobials while simultaneously rounding with the infectious diseases consult service; therefore, it is impossible for the pharmacist to monitor and provide feedback on every patient admitted with a common condition, such as pneumonia. A recent study in India evaluated the impact of a trainee-driven antimicrobial stewardship intervention in a resource-limited setting where there was a lack of robust clinical pharmacist services.[24] In this study, a team of infectious diseases physician trainees conducted stewardship activities that resulted in significantly increased blood culture sensitivity rates and reduced redundant anaerobic coverage without increasing mortality rates; however, DOT was not evaluated.[24] Our study represents the first similar study in the US using a physician-driven approach. Our study is unique in that we used a chief resident for conducting peer education and PAFR instead of a multidisciplinary team. Possible reasons for our success may be due to our focus on the education of pneumonia alone (as opposed to all infections) and use of a physician peer for delivering feedback.

There is significant overlap between antimicrobial stewardship and quality improvement initiatives. Many stewardship interventions use weak quality improvement strategies, such as education, but also include robust system engineering changes, including antibiotic order sets and formulary restrictions. Given this overlap, a stewardship initiative designed with a quality improvement methodology, such as DMAIC seems intuitive; however, none currently exist. Only four prior studies using Lean Six Sigma DMAIC to improve processes in infectious diseases have been published.[20–23] Although three were aimed at reducing nosocomial or healthcare-associated infections,[20–22] one aimed to increase hand hygiene compliance.[23] The Accreditation Council for Graduate Medical Education[25] has noted that clinical learning environments vary in their approach and ability to foster resident involvement in quality improvement projects. Given the Joint Commission requirement for health systems to document active antimicrobial stewardship efforts, trainee-driven stewardship initiatives represent an untapped approach for engaging residents in quality improvement efforts and experiential learning in hospitals throughout the country.

Aside from our DMAIC design and provider-to-provider approach, our study is unique in that we explored the caregiver rationale for treating CAP patients beyond the

IDSA minimum and used those findings as an opportunity for delivering closed-loop feedback. Trainees and nurse practitioners received PAFR from a chief resident who they saw on a day-to-day basis and with whom they already had a working relationship. We believe that this close working relationship contributed to a high rate of acceptance of the recommendations. For the providers who treated patients beyond the IDSA/ATS minimum duration, the most common reason was miscounting the days of treatment. The incidence of prolonged therapy being due to a counting mistake (rather than a conscious choice to treat patients for longer than recommended) underscores the willingness that caregivers had to accept the treatment recommendations provided by this antimicrobial stewardship initiative.

This study had several limitations. It was performed at a single center and included mostly older men with a high rate of cardiopulmonary disease. On the one hand, it is reassuring that patients at high risk for cardiopulmonary decompensation did not experience adverse effects with shorter antibiotic DOT; however, this may also have limited external validity for a younger female population. The stewardship initiative was quasi-experimental and observational in nature, which may have led to potential bias influencing the results. Providers were aware of the intervention and may have altered their behaviors accordingly (Hawthorne effect).[26] A limited time frame of 5 months for each phase may have resulted in variability in pneumonia cases. Most of the PAFRs were given to internal medicine trainees, who may have been reluctant not to follow directions provided by a chief resident. Last, PAFR is labor intensive, and many centers may not have a CRQS or other chief resident physician able to undertake such a task. Future directions include a plan to reevaluate the impact of the educational component and Kaizen board alone (without PAFR) and see whether success is sustained. However, these efforts are now hampered by the COVID-19 pandemic, which makes homogeneity between new pneumonia cohorts separated in time uncertain. New and concerning evidence is mounting that concomitant treatment with antibiotics is abundant in patients admitted with pneumonia due to COVID-19, despite the rarity of true bacterial coinfection.[27] This global pandemic has altered the evaluation and treatment of respiratory illness and has consumed significant inpatient hospitalization resources; therefore, it is more important than ever to limit overtreatment of bacterial pneumonia. Given the high incidence of CAP and limited number of clinical pharmacy personnel at many institutions, resident-driven stewardship interventions represent a novel opportunity to reduce excess antibiotic use while reinforcing provider-to-provider education in the process.

A physician-driven antimicrobial quality improvement initiative designed with the Lean Six Sigma DMAIC methodology and including monthly education and prospective audit and feedback led to reduced antibiotic duration of treatment in patients hospitalized with CAP without negatively affecting clinical outcomes.

Conclusions

A physician-driven antimicrobial quality improvement initiative designed with the Lean Six Sigma DMAIC methodology and including monthly education and prospective audit and feedback led to reduced antibiotic duration of treatment in patients hospitalized with CAP without negatively affecting clinical outcomes. Healthcare providers may be unaware that as few as 5 days of treatment can be used for treating CAP in many patients, but providers may alter antibiotic prescribing practices from interventions including peer-to-peer education and feedback.

Data Availability

Complete study data are available for analysis upon request by contacting the corresponding author.

Supplemental Material

Supplemental data are available online with the article.

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