Impact of Updated Empiric Antibiotic Order Sets on Outcomes in Pneumonia and Sepsis at South Shore Hospital, Chicago: A Pre–Post Comparative Study

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ABSTRACT:

Background: Pneumonia and sepsis remain leading causes of morbidity and mortality in hospitalized patients. Timely and appropriate empiric antibiotic therapy is critical for improving outcomes. Electronic health record (EHR)-embedded order sets are designed to standardize prescribing practices and improve adherence to evidence-based guidelines.

Objective: To evaluate the impact of updated empiric antibiotic order sets on clinical outcomes and prescriber adherence in patients with pneumonia and sepsis.

Methods: A single-center pre–post interventional study was conducted among adult patients hospitalized with pneumonia or sepsis. Primary outcomes included length of stay (LOS), duration of therapy (DOT), and 30-day infection-related readmission. The secondary outcome was strict prescriber adherence to order set recommendations. Continuous variables were analyzed using independent t-tests and reported as mean ± standard deviation, while categorical variables were analyzed using chi-square tests.

Results: Among patients with pneumonia, adherence significantly decreased following implementation (43.8% vs 16.9%, p=0.0018). Mean DOT increased from 4.59 ± 3.63 days to 6.98 ± 4.54 days (p=0.0013), while LOS decreased from 14.94 ± 9.38 days to 12.20 ± 8.92 days without statistical significance (p=0.092). In sepsis patients, adherence remained unchanged (40.4% vs 38.0%, p=0.965), with no significant differences in LOS or DOT. No significant differences were observed in 30-day readmission rates.

Conclusion: Implementation of updated empiric antibiotic order sets did not improve adherence or clinical outcomes. These findings highlight the importance of workflow integration and prescriber engagement in antimicrobial stewardship efforts.

INTRODUCTION:

Pneumonia and sepsis continue to represent significant contributors to morbidity, mortality, and healthcare utilization worldwide. In the United States alone, pneumonia accounts for over one million hospitalizations annually and remains a leading cause of death, while sepsis contributes to more than 250,000 deaths each year. Despite advances in diagnostic tools and supportive care, inappropriate or delayed empiric antibiotic therapy remains a major determinant of poor outcomes in both conditions.

Early and appropriate empiric antibiotic selection has been consistently associated with improved survival, particularly in sepsis, where even short delays in effective therapy can significantly increase mortality. In pneumonia, inappropriate antibiotic selection and excessive treatment duration have been linked to prolonged hospital stays, increased healthcare costs, and higher rates of antibiotic-related adverse events, including Clostridioides difficile infection.

Beyond mortality and morbidity, pneumonia and sepsis impose a substantial economic burden on the healthcare system. Hospitalizations related to these conditions are associated with increased costs due to prolonged length of stay, intensive care utilization, and complications related to inappropriate antibiotic use. In addition, excessive or inappropriate antibiotic prescribing contributes to the growing global threat of antimicrobial resistance, which has been identified as a major public health concern.

Antimicrobial stewardship programs have therefore prioritized optimizing antibiotic selection, dosing, and duration. Clinical practice guidelines from organizations such as the Infectious Diseases Society of America (IDSA) and the Surviving Sepsis Campaign provide evidence-based recommendations for empiric therapy. However, translating these guidelines into real-world

practice remains a challenge due to variability in provider behavior, diagnostic uncertainty, and system-level barriers.

Electronic health record (EHR)-embedded order sets have emerged as a key strategy to address this gap. By standardizing empiric antibiotic selection and incorporating guideline-based recommendations directly into the prescribing workflow, order sets aim to reduce variability and improve adherence. Several studies have demonstrated improvements in prescribing practices following order set implementation. However, the effectiveness of these tools in real-world settings, particularly in community hospitals, remains inconsistent.

This study evaluates the impact of updated empiric antibiotic order sets on both clinical outcomes and prescriber adherence at a community hospital, with the goal of identifying whether implementation alone is sufficient to improve stewardship outcomes.

METHODS:

This study was a single-center, retrospective pre–post interventional analysis conducted at South Shore Hospital in Chicago. The study population included adult patients aged 18 years or older who were admitted with a primary diagnosis of pneumonia or sepsis, as identified through ICD-10 coding and confirmed by chart review.

Patients were divided into two groups: a pre-intervention cohort consisting of patients treated prior to implementation of the updated order sets, and a post-intervention cohort consisting of patients treated after implementation. Patients were excluded if they were pregnant, transferred from another acute care facility, documented allergy to all recommended empiric regimens or had incomplete clinical data.

The intervention consisted of the implementation of updated empiric antibiotic order sets within the hospital's EHR system. These order sets were developed in alignment with national guidelines, including the 2019 IDSA/ATS guidelines for pneumonia and the Surviving Sepsis Campaign guidelines, and were tailored to the institution's local antibiogram. Educational sessions and in-service training were provided to prescribers and nursing staff at the time of rollout.

The pre-intervention arm of the study consisted of patient EHR data from June 2025 to August 2025. A washout period was incorporated between September and November 2025 to minimize contamination between groups and allow for adequate provider exposure to the updated order sets. The post-intervention arm consisted of EHR data from December 2025 to February 2026. Data collection was performed through retrospective review of the electronic health record, with all patient identifiers removed to ensure confidentiality. Each patient encounter was evaluated for inclusion based on predefined diagnostic criteria and documentation consistency. Key variables such as antibiotic selection, duration of therapy, and readmission status were verified across multiple components of the patient record, including medication administration records, progress notes, and discharge summaries.

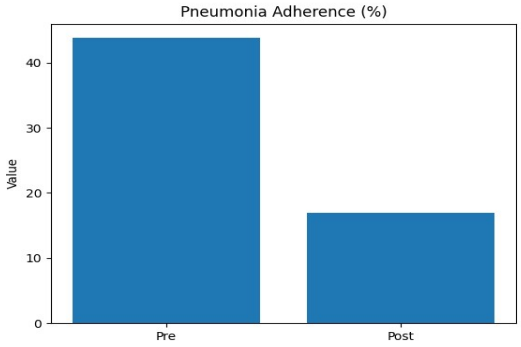
Primary outcomes included length of hospital stay (LOS), defined as the total number of days from admission to discharge; duration of antibiotic therapy (DOT), defined as the total number of days a patient received systemic antibiotic treatment; and 30-day infection-related readmission, defined as rehospitalization within 30 days for a similar or related infectious diagnosis.

The secondary outcome was prescriber adherence to the updated order sets. Strict adherence was defined as empiric antibiotic selection that matched the recommended regimen in the order set without deviation.

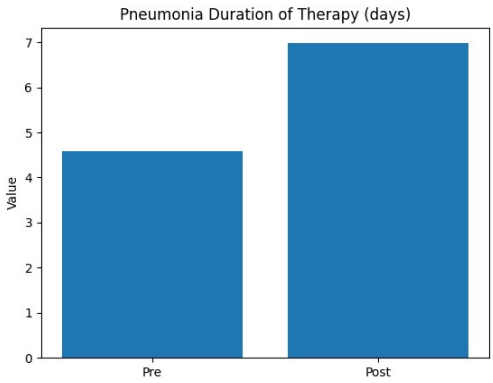
Categorical variables analyzed in this study included prescriber adherence (adherent vs non-adherent), 30-day readmission (yes vs no), and diagnosis category (pneumonia vs sepsis). These variables were expressed as frequencies and percentages and compared using chi-square tests. Continuous variables such as LOS and DOT were expressed as mean ± standard deviation and analyzed using independent t-tests. A p-value of less than 0.05 was considered statistically significant.

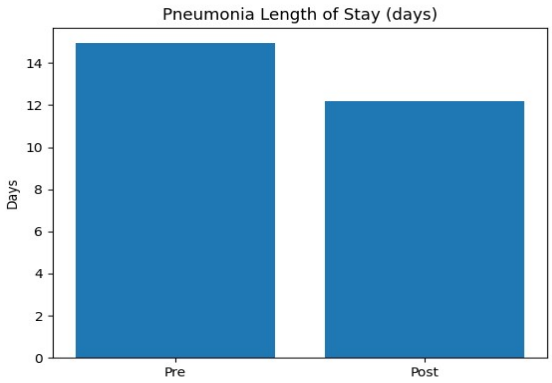
RESULTS:

In the pneumonia cohort, implementation of the updated order sets was associated with a significant decrease in prescriber adherence, from 43.8% in the pre-intervention group to 16.9% in the post-intervention group (p=0.0018). This finding was unexpected given the intended purpose of the intervention.

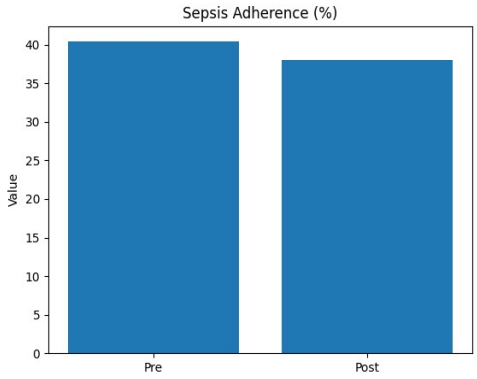


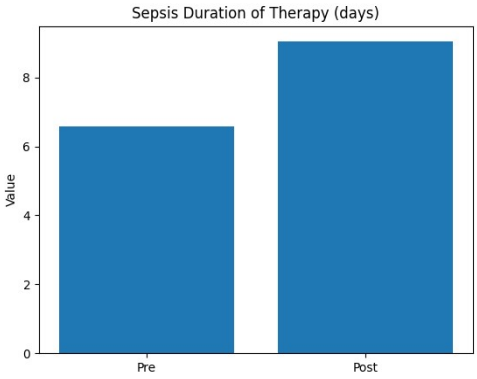
Duration of therapy for pneumonia increased significantly following implementation, with mean DOT rising from 4.59 ± 3.63 days pre-intervention to 6.98 ± 4.54 days post-intervention (p=0.0013). In contrast, mean length of stay decreased from 14.94 ± 9.38 days to 12.20 ± 8.92 days; however, this difference did not reach statistical significance (p=0.092).

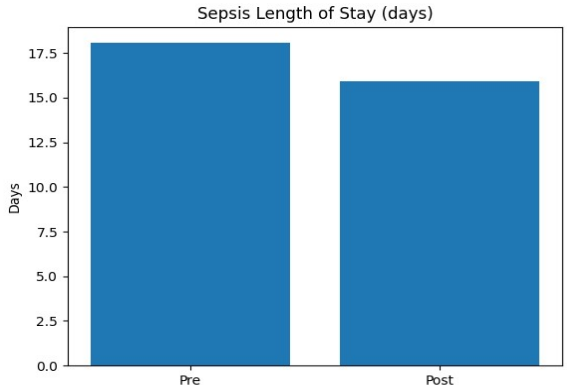




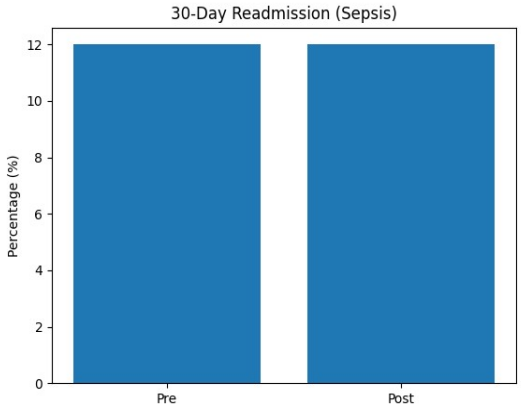
In the sepsis cohort, no significant changes were observed in prescriber adherence, which remained relatively stable (40.4% pre-intervention vs 38.0% post-intervention, p=0.965). Duration of therapy increased from 6.58 ± 5.38 days to 9.04 ± 8.54 days, although this difference was not statistically significant (p=0.086). Similarly, length of stay decreased from 18.06 ± 10.55 days to 15.94 ± 8.86 days without reaching statistical significance (p=0.274).

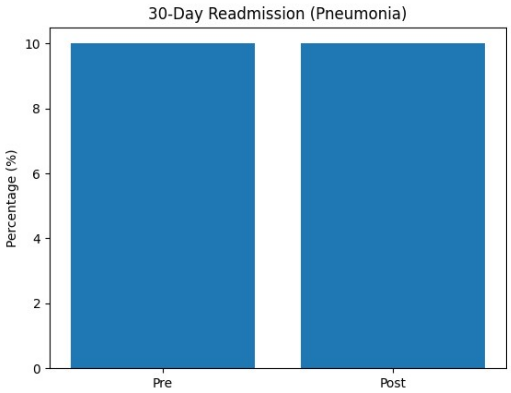






Thirty-day infection-related readmission rates did not differ significantly between pre- and post-intervention groups in either cohort. Analysis of this outcome was limited to patients with complete follow-up data.





Pneumonia: No statistically significant difference reported between pre and post groups.

Sepsis: No statistically significant difference reported between pre and post groups.

Overall, while modest improvements in length of stay were observed, these changes were not statistically significant. In contrast, the increase in duration of therapy, particularly among pneumonia patients, represents a clinically meaningful finding with implications for antimicrobial stewardship. The lack of improvement in readmission rates further supports the

conclusion that the intervention did not result in measurable improvements in short-term patient outcomes.

DISCUSSIONS:

This study evaluated the real-world impact of updated empiric antibiotic order sets on clinical outcomes and prescriber behavior in a community hospital setting. Contrary to expectations, the intervention did not result in improved adherence or clinical outcomes and was associated with a significant decrease in adherence in pneumonia patients.

These findings contrast with prior studies that have demonstrated improvements in guideline-concordant prescribing following order set implementation. For example, Pham et al. reported a significant increase in appropriate antibiotic prescribing for community-acquired pneumonia following implementation, with adherence improving substantially.[14] Similarly, Ballard et al. demonstrated improved compliance with antimicrobial guidelines and reduced variability in prescribing practices across hospital systems.[8]

However, the results of the present study highlight the variability in effectiveness of such interventions across institutions. This discrepancy supports the concept of an implementation gap rather than a failure of the intervention itself. This observation aligns with existing literature suggesting that the success of antimicrobial stewardship interventions is highly dependent on local implementation strategies and institutional engagement rather than the presence of decision-support tools alone.[5]

One potential explanation is workflow misalignment. If order sets are not seamlessly integrated into the clinical workflow, providers may bypass them in favor of more familiar prescribing patterns. Additionally, EHR usability challenges may limit accessibility and reduce utilization.

Prior studies evaluating clinical decision support systems have identified usability and workflow disruption as key barriers to adoption.[8]

Prescriber autonomy also plays a critical role. Clinicians often rely on clinical judgment, particularly in complex cases where standardized recommendations may not fully capture patient-specific factors. This can lead to deviations from order set recommendations, even in the presence of evidence-based guidance.[5]

Alert fatigue is another contributing factor. Frequent exposure to EHR alerts may desensitize providers, leading to reduced engagement with decision-support tools. This phenomenon has been widely described in the literature as a major limitation of EHR-based interventions and contributes to decreased responsiveness to clinical alerts over time.[8]

An additional consideration is the mismatch between standardized protocols and real-world clinical complexity. Patients often present with comorbidities, prior antibiotic exposure, or atypical features that may necessitate individualized decision-making. As a result, providers may perceive order sets as insufficiently flexible, leading to intentional deviation from recommended regimens.

The observed increase in duration of therapy raises further concerns. This finding suggests that order sets may not effectively reinforce guideline-recommended durations or that prescribers may default to longer courses due to clinical uncertainty. Prolonged antibiotic use contributes to antimicrobial resistance, increased risk of adverse drug events, and higher healthcare costs, as demonstrated in prior studies evaluating antibiotic overuse in hospitalized patients.[12]

The findings of this study have important implications for antimicrobial stewardship programs. Order sets should not be viewed as standalone interventions but rather as components of a broader, multifaceted strategy that includes education, audit and feedback, and real-time clinical

decision support. Evidence suggests that stewardship programs incorporating these elements are more effective in achieving sustained improvements in antibiotic prescribing practices.[5]

The findings of this study highlight a critical gap between guideline-based intervention design and real-world implementation. Despite the availability of structured, evidence-based order sets, prescriber adherence decreased following implementation, suggesting that accessibility alone does not ensure utilization. This underscores the importance of behavioral and system-level factors in influencing prescribing practices.

At South Shore Hospital, it is recognized that order set utilization is not consistently integrated into routine physician workflow. As a result, providers may default to familiar prescribing patterns rather than engaging with structured decision-support tools. This reflects a broader challenge in antimicrobial stewardship, where passive interventions often fail to achieve meaningful behavior change without active reinforcement mechanisms.

These findings suggest that the effectiveness of antimicrobial stewardship interventions is highly dependent on implementation strategy rather than the intervention itself. Successful programs often incorporate multifaceted approaches, including prospective audit and feedback, real-time clinical decision support, and provider education. In contrast, standalone tools such as order sets may have limited impact when not embedded within a broader stewardship framework. This distinction is critical, as it shifts the focus from tool development to system-level optimization.

Strengths of this study include its real-world setting and evaluation of both clinical and stewardship outcomes. However, several important limitations should be considered. First, there was a change in the emergency department (ED) physician group at South Shore Hospital in January 2026, which occurred during the study period. This transition may have introduced variability in prescribing practices, as the incoming physicians may not have been adequately

oriented to the updated empiric antibiotic order sets. Notably, this new group did not receive the formal in-service education that accompanied the initial rollout of the order sets. As a result, the observed lack of improvement in adherence and outcomes may, in part, reflect differences in provider familiarity and training rather than the effectiveness of the intervention itself.

Second, the sample size in this study was relatively small, which may have limited the statistical power to detect meaningful differences between the pre- and post-intervention groups. Smaller sample sizes increase the risk of type II error and may obscure clinically relevant effects of the intervention on outcomes such as length of stay, duration of therapy, and readmission rates.

Finally, this study utilized a retrospective pre–post design rather than a prospective, randomized controlled methodology. As such, no formal power calculation was performed to determine the optimal sample size, and the study is inherently subject to selection bias, confounding variables, and variability in clinical documentation. Unlike randomized controlled trials, retrospective analyses cannot fully account for differences in patient characteristics, disease severity, or provider decision-making, all of which may have influenced the observed outcomes.

Collectively, these limitations highlight the need for prospective, adequately powered studies with standardized provider education to better evaluate the true impact of antimicrobial stewardship interventions.

Future research should focus on optimizing implementation strategies, improving EHR usability, and integrating active stewardship interventions to enhance effectiveness. Prospective studies evaluating multifaceted approaches will be essential to determine the most effective strategies for improving antibiotic prescribing and patient outcomes.

CONCLUSSION:

Implementation of updated empiric antibiotic order sets in this study did not result in improved prescriber adherence or clinical outcomes, and was associated with an increase in duration of therapy. These findings suggest that the presence of structured, evidence-based order sets alone is insufficient to drive meaningful changes in prescribing behavior or patient outcomes. Rather, they underscore the importance of effective implementation strategies, including integration into clinical workflow, provider engagement, and reinforcement through active antimicrobial stewardship interventions.

The results of this study support the concept of an implementation gap, wherein the effectiveness of clinical decision-support tools is limited not by their design, but by their adoption and utilization in real-world practice. Addressing this gap will require a multifaceted approach that combines optimized EHR usability, targeted provider education, and ongoing audit and feedback mechanisms. Future prospective, adequately powered studies are warranted to evaluate the impact of such comprehensive stewardship strategies on antibiotic use and clinical outcomes.

Conflict of Interest: The authors declare no conflicts of interest.

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