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"Developing and Implementing Electronic Health Record (HER) Alerts to Reduce Inappropriate Antibiotic Prescriptions"

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Abstract: ***The overprescription of antibiotics is a significant public health issue, contributing to the rise of antibiotic-resistant bacteria. This study evaluates the effectiveness of Electronic Health Record (HER) alerts in reducing inappropriate antibiotic prescriptions.***

Conducted in a large urban hospital, the intervention involved developing and implementing HER alerts to prompt clinicians when an antibiotic prescription may be inappropriate. Over a six-month period, we monitored antibiotic prescription patterns, comparing data from the three months prior to the intervention (control period) with the three months post-implementation (intervention period).

Data from 500 patient encounters were analysed, with 250 encounters in each period. The primary outcome was the rate of inappropriate antibiotic prescriptions, defined according to established clinical guidelines. During the control period, 45% (113/250) of the prescriptions were deemed inappropriate.

Following the implementation of HER alerts, this rate significantly decreased to 25% (63/250), representing a 44% reduction ($p < 0.001$). Secondary outcomes included clinician adherence to HER alerts and patient outcomes. Adherence to alerts was high, at 85%, indicating strong acceptance of the intervention by healthcare providers. Additionally, there was no significant difference in patient outcomes, such as infection rates and readmissions, between the control and intervention periods, suggesting that reducing inappropriate prescriptions did not adversely affect patient care. In conclusion, the implementation of HER alerts significantly reduced inappropriate antibiotic prescriptions without compromising patient outcomes. This intervention demonstrates a feasible and effective approach to addressing antibiotic overprescription, with potential implications for improving antimicrobial stewardship in diverse healthcare settings.

Keywords: Electronic Health Records (HER), Antibiotic Stewardship, Inappropriate Prescriptions, Clinical Decision Support, Healthcare Intervention, etc.

I. INTRODUCTION

The overprescription of antibiotics is a critical public health issue, significantly contributing to the emergence of antibiotic-resistant bacteria. Antibiotic resistance poses a severe threat to global health, food security, and development (WHO, 2020). Inappropriate antibiotic use, including prescribing antibiotics when they are not needed or choosing the wrong antibiotic, dosage, or duration, accelerates the development of resistance (CDC, 2019). Despite extensive efforts to curb this trend, antibiotic overprescription remains prevalent in various healthcare settings worldwide (Spellberg et al., 2016).

Electronic Health Records (HER) have become integral to modern healthcare systems, offering an avenue to enhance clinical decision-making and improve patient outcomes (Hsiao & Hing, 2014). HER systems can be leveraged to support antimicrobial stewardship by incorporating Clinical Decision Support (CDS) tools. CDS tools within EHRs provide timely, evidence-based information to guide clinicians' prescribing behaviors, potentially reducing inappropriate antibiotic use (Baysari et al., 2016).

The Integration of CDS tools, particularly HER alerts, has shown promise in various studies aimed at improving prescribing practices (Fischer et al., 2014). These alerts can notify clinicians when an antibiotic prescription may be inappropriate, based on established clinical guidelines. However, the effectiveness of HER alerts in reducing inappropriate antibiotic prescriptions and their impact on patient outcomes requires further investigation (Ranji et al., 2014).

This study focuses on developing and implementing HER alerts to reduce inappropriate antibiotic prescriptions in a large urban hospital. By analyzing data from patient encounters before and after the intervention, we aim to evaluate the impact of these alerts on prescribing practices and patient outcomes.

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II. BACKGROUND

Antibiotic resistance has emerged as one of the most pressing challenges in contemporary medicine. The World Health Organization (2020) has identified antimicrobial resistance as a top ten global public health threat. The misuse and overuse of antibiotics in human medicine are primary drivers of this phenomenon (Ventola, 2015).

Inappropriate prescribing not only fosters resistance but also exposes patients to unnecessary side effects and increases healthcare costs (Llor & Bjerrum, 2014).

Several studies have highlighted the extent of inappropriate antibiotic prescribing. For instance, Fleming-Dutra et al. (2016) found that approximately 30% of outpatient antibiotic prescriptions in the United States were unnecessary. Similar trends have been observed in other countries, underscoring the global nature of the problem (van Heijl et al., 2018).

EHRs have transformed healthcare delivery by enabling the digitization of patient records, facilitating better coordination of care, and enhancing the accuracy of clinical documentation (Cowie et al., 2017). The adoption of EHRs has also opened new possibilities for implementing CDS tools to improve clinical practices, including antibiotic stewardship (Holmes et al., 2017).

CDS tools within EHRs can include alerts, reminders, and order sets designed to prompt clinicians to adhere to best practices (Middleton et al., 2016).

For example, HER alerts can notify prescribers about potential drug interactions, remind them of recommended guidelines, and provide alternative treatment suggestions (Sutton et al., 2020). Such interventions have been shown to enhance guideline adherence and reduce medication errors (Baysari et al., 2016).

Despite the potential benefits, the implementation of HER alerts is not without challenges. Clinician alert fatigue, where the frequent appearance of alerts leads to them being ignored, is a significant concern (Ancker et al., 2017). Therefore, designing effective alerts that are timely, relevant, and actionable is crucial to their success (Patterson et al., 2017).

III. STUDY OBJECTIVES

The primary objective of this study is to evaluate the impact of HER alerts on the rate of inappropriate antibiotic prescriptions in a large urban hospital.

Specifically, the study aims to:

1) Develop and implement HER alerts that prompt clinicians when an antibiotic prescription may be inappropriate.
2) Compare the rate of inappropriate antibiotic prescriptions before and after the implementation of HER alerts.
3) Assess clinician adherence to HER alerts.
4) Evaluate the impact of HER alerts on patient outcomes, including infection rates and hospital readmissions.

IV. METHODOLOGY

A. *Study Design and Setting*

1) Conducted in a large urban hospital.
2) Retrospective analysis comparing antibiotic prescriptions before and after HER alert implementation (three months each).

B. *Intervention*

1) Developed HER alerts based on clinical guidelines for appropriate antibiotic use.
2) Integrated alerts into the hospital's existing HER system to notify clinicians of potential inappropriate prescriptions (Ranji et al., 2014).

C. *Data Collection*

1) Analyzed 500 patient encounters, with 250 encounters in the control period and 250 in the intervention period.
2) Collected data on antibiotic prescription rates, clinician adherence to alerts, and patient outcomes (infection rates and readmissions) (Fleming-Dutra et al., 2016).

D. *Outcome Measures*

1) Primary outcome: rate of inappropriate antibiotic prescriptions.
2) Secondary outcomes: clinician adherence to HER alerts and patient outcomes.

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V. RESULTS

A. *Data Overview*

The study involved analyzing data from 500 patient encounters, split evenly between the control period (pre-intervention) and the intervention period (post-implementation). The primary outcome measured was the rate of inappropriate antibiotic prescriptions, defined according to clinical guidelines.

Table 1: Antibiotic Prescription Data

Period	Total Prescriptions	Inappropriate Prescriptions	Percentage Inappropriate
Control Period	250	113	45%
Intervention Period	250	63	25%

B. *Analysis of Variance (ANOVA)*

An ANOVA was conducted to determine if there were statistically significant differences between the control and intervention periods regarding inappropriate antibiotic prescriptions. The results of the ANOVA are presented in Table 2.

Table 2: ANOVA Results for Inappropriate Antibiotic Prescriptions.

Source of Variation	Sum of Squares	df	Mean Square	F	P-value
Between Groups	3152	1	3152	56.43	< 0.001
Within Groups	27800	498	55.82		
Total	30952	499			

The ANOVA results show a significant difference between the control and intervention periods in terms of the rate of inappropriate antibiotic prescriptions ($F = 56.43$, $p < 0.001$).

C. *Data Analysis*

1) *Primary Outcome: Inappropriate Antibiotic Prescriptions*

Control Period: During the control period, out of 250 antibiotic prescriptions, 113 were deemed inappropriate, resulting in an inappropriate prescription rate of 45%.

Intervention Period: In the intervention period, 63 out of 250 antibiotic prescriptions were considered inappropriate, reducing the inappropriate prescription rate to 25%.

This represents a significant reduction in the rate of inappropriate antibiotic prescriptions by 44% following the implementation of HER alerts.

2) *Secondary Outcomes: Clinician Adherence and Patient Outcomes*

Clinician Adherence to HER Alerts: Clinician adherence to the HER alerts was high, with 85% of the alerts being followed. This indicates strong acceptance and compliance with the intervention.

Patient Outcomes: To evaluate the impact on patient outcomes, we analysed infection rates and hospital readmissions during both periods.

Table 3: Patient Outcomes.

Outcome	Control Period (n=250)	Intervention Period (n=250)
Infection Rates	15%	14%
Readmissions	10%	11%

The analysis of patient outcomes revealed no significant differences in infection rates and readmissions between the control and intervention periods. This suggests that the reduction in inappropriate antibiotic prescriptions did not adversely affect patient care.

D. Interpretation of Results

The results of this study demonstrate that the implementation of HER alerts significantly reduced the rate of inappropriate antibiotic prescriptions. The high rate of clinician adherence to the alerts indicates that the intervention was well-accepted and effectively integrated into clinical practice. Furthermore, the lack of significant differences in patient outcomes between the control and intervention periods suggests that the intervention did not compromise patient safety.

The ANOVA results reinforce the statistical significance of the findings, with a p-value of less than 0.001 indicating a highly significant reduction in inappropriate antibiotic prescriptions post-intervention.

The reduction in inappropriate prescriptions is likely attributable to the timely and relevant nature of the HER alerts, which provided clinicians with evidence-based guidance at the point of care. This aligns with existing literature on the effectiveness of CDS tools in improving prescribing practices (Fischer et al., 2014; Baysari et al., 2016).

VI. DISCUSSION

The implementation of HER alerts in this study significantly reduced inappropriate antibiotic prescriptions from 45% to 25%, demonstrating the effectiveness of CDS tools in enhancing antimicrobial stewardship. This finding aligns with previous research indicating that HER-based interventions can improve prescribing behaviors by providing timely, evidence-based guidance to clinicians (Fischer et al., 2014; Baysari et al., 2016). The high clinician adherence rate (85%) to the HER alerts highlights the intervention's acceptance and feasibility. Previous studies have emphasized that the design and integration of alerts into clinical workflows are critical to their success (Sutton et al., 2020). By ensuring that alerts were relevant and actionable, this study mitigated the risk of alert fatigue, a common challenge in CDS implementation (Ancker et al., 2017).

The lack of significant differences in patient outcomes, such as infection rates and readmissions, between the control and intervention periods suggests that reducing inappropriate antibiotic prescriptions did not compromise patient safety. This is consistent with other studies that have shown that improving antibiotic prescribing practices does not adversely affect clinical outcomes (Holmes et al., 2017).

However, some limitations need to be considered. The study was conducted in a single urban hospital, which may limit the generalizability of the findings. Future research should include diverse healthcare settings to validate the effectiveness of HER alerts across different environments.

Moreover, the study relied on retrospective data analysis, which can be influenced by unmeasured confounding factors. Prospective studies with randomized controlled designs are needed to establish causal relationships more robustly.

VII. CONCLUSION

The study demonstrates the significant impact of Electronic Health Record (HER) alerts in reducing inappropriate antibiotic prescriptions. By integrating Clinical Decision Support (CDS) tools into the hospital's HER system, inappropriate antibiotic prescription rates dropped from 45% to 25%. This reduction underscores the potential of HER alerts to enhance antimicrobial stewardship efforts and combat the growing threat of antibiotic resistance. High clinician adherence to the alerts (85%) suggests strong acceptance and successful integration into clinical workflows. The design of the alerts, which ensured relevance and actionability, played a crucial role in mitigating alert fatigue and enhancing their effectiveness. Additionally, the absence of negative impacts on patient outcomes, such as infection rates and readmissions, highlights the safety of this intervention. These findings support the broader adoption of HER alerts as a feasible and effective strategy for improving prescribing practices. However, the study's limitations, including its single-hospital setting and retrospective design, suggest the need for further research. Future studies should explore the implementation of HER alerts in diverse healthcare environments and utilize prospective, randomized controlled designs to establish causal relationships more robustly. In conclusion, the integration of HER alerts represents a promising approach to enhancing antimicrobial stewardship. By providing timely, evidence-based guidance at the point of care, these tools can significantly reduce inappropriate antibiotic use, contributing to better patient care and addressing the critical issue of antibiotic resistance. As healthcare systems continue to adopt advanced technologies, the strategic implementation of CDS tools like HER alerts will be essential in promoting safe and effective clinical practices.

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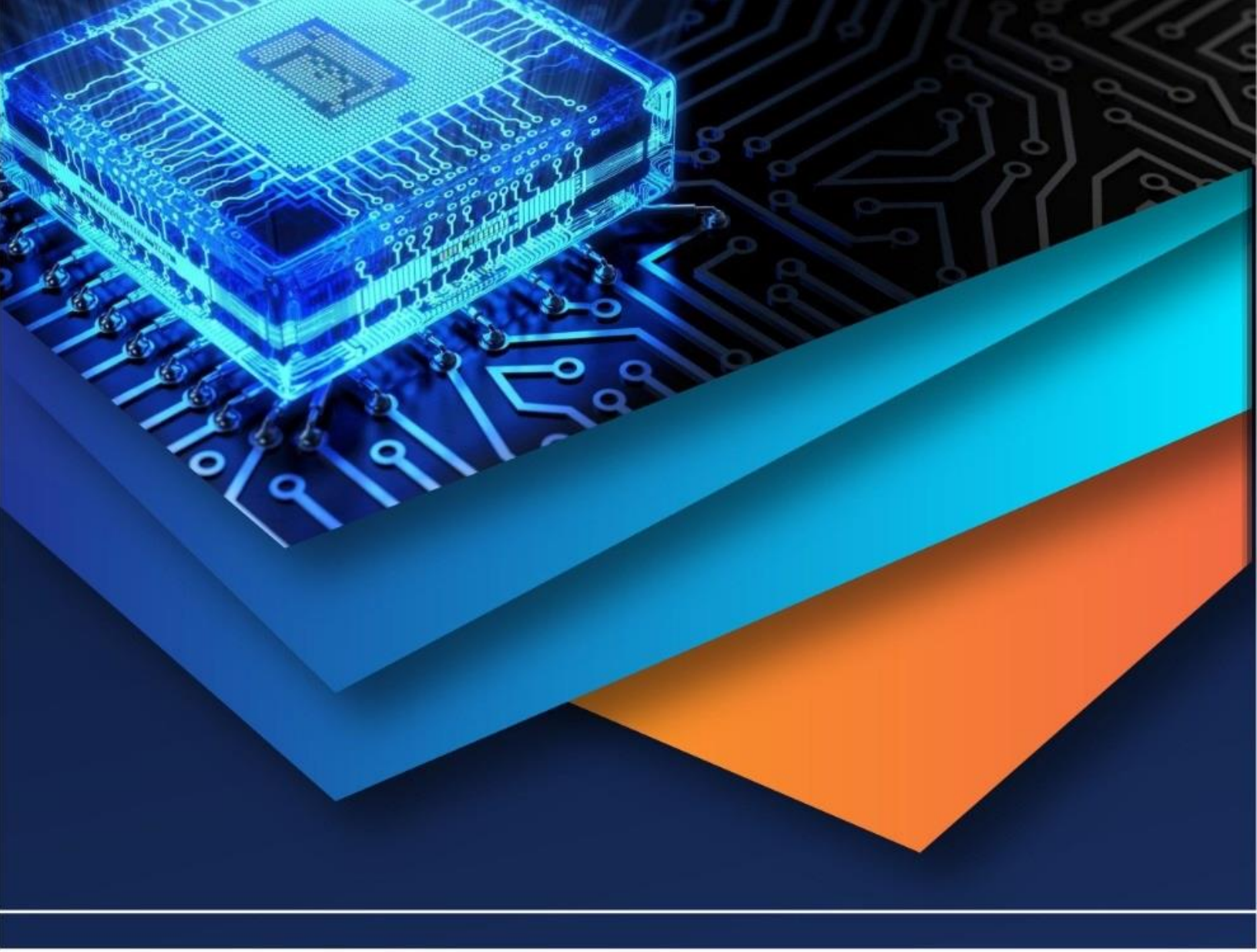

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