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Original Research

Impact of a clinical pharmacist driven antimicrobial stewardship program at a tertiary care hospital in the United Arab Emirates

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Abstract

Background: This study aimed to evaluate the influence of an antimicrobial stewardship program (ASP) driven by a clinical pharmacist on antimicrobial use, cost, and susceptibilities at a tertiary care hospital in the United Arab Emirates (UAE). **Methods:** A single-centre quasi-experimental design was employed, comparing pre-intervention and post-intervention phases of clinical pharmacist-driven ASP. The intervention involved the integration of clinical pharmacists into the ASP team, participating in medication reviews, providing prescriber education, and actively engaging in antimicrobial decision-making. Data were collected on quarterly antimicrobial utilisation, antimicrobial susceptibilities and antimicrobial cost. **Results:** Following the implementation of the clinical pharmacist-driven ASP, there was a significant reduction in ASP-focused antimicrobial utilisation, with a particular decline in the usage of broad-spectrum agents, Carbapenems, Fluoroquinolones, and Antifungals. Significant changes in the susceptibilities of some bacteria were noted. Significant decreases in antimicrobial expenditures were observed. **Conclusion:** The findings suggest that integrating clinical pharmacists into the antimicrobial stewardship program at the tertiary care hospital in the UAE substantially impacted optimising antimicrobial use. This model emphasises the crucial role of clinical pharmacists in promoting judicious antimicrobial prescribing practices, ultimately contributing to improved antimicrobial use and the prevention of antimicrobial resistance.

Keywords: antimicrobial stewardship; clinical pharmacist; tertiary care hospital; United Arab Emirates; antimicrobial utilization; antimicrobial cost

BACKGROUND

Antimicrobial resistance (AMR) is a global public health and development threat. Antimicrobial stewardship (AMS) is a coordinated effort to promote the appropriate use of antimicrobials, including antibiotics, antifungals, antivirals, antimalarial, and anthelmintic, with the goal of reducing AMR.[1,2] AMS programs are designed to optimize antimicrobial use, improve patient outcomes, reduce the spread of AMR, and decrease healthcare costs.[3,12] Evidence suggests that AMS programs are effective in increasing compliance with antibiotic policy, reducing the duration of treatment, and decreasing the incidence of healthcare-associated infections.[1]

The World Health Organization (WHO) has been working with countries in the Middle East to develop and implement strategies to address antimicrobial resistance (AMR).[7] The WHO has also been working with the Gulf Cooperation Council (GCC) countries, including the UAE, to develop a regional action plan for AMR.[7] The plan aims to strengthen the capacity of countries to prevent and control AMR, improve surveillance and research, and promote the rational use of antimicrobials.[7]

The UAE has been actively working towards combating AMR through the establishment of the UAE Higher Committee for Antimicrobial Resistance.[10] The committee has established several technical sub-committees, including a National Sub-Committee for Antimicrobial Resistance Surveillance, which has led to the creation of a network of laboratories for AMR surveillance. The UAE's National AMR Surveillance Report for 2020 highlights the current levels of AMR among relevant and priority pathogens in the UAE.[10]

The Joint Commission has released new and revised requirements for antibiotic stewardship, which will apply to all Joint Commission-accredited hospitals and critical access hospitals from January 1, 2023 (The Joint Commission, 2023). According to the Joint Commission, Pharmacists qualified through education, training, or experience in infectious diseases (ID) and/or AMS should be recognised as appropriate leaders, or co-leaders, of AMS programs (ASPs)(The Joint Commission, 2023).

Pharmacists' knowledge and importance in leading ASP implementation efforts were specifically recognized in 2019, when "drug expertise" was changed to "pharmacist expertise" as a Centers for Disease Control and Prevention (CDC) Core Element for Hospital Antimicrobial Stewardship Programs.[2] The CDC also emphasizes the importance of pharmacist expertise as a priority for Hospital Core Element Implementation and in expanded guidance for settings beyond acute care.[2]

All pharmacy professionals can contribute to AMS through various activities. Whereas studies suggest that pharmacists

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with formal ASP responsibilities perform more intermediate and advanced metric interventions than pharmacists without formal ASP responsibilities.[4] The study by Hashad N et al has identified a shortage of relevant specialized personnel such as infectious diseases (ID) physicians, clinical pharmacists, and microbiologists in UAE. This, together with a lack of dedicated time allocated to ASP, contributed to an increased workload, and was considered a barrier to implementation. Thus the main limitation was shortage of clinical pharmacist who is dedicated to ASP activities.[6]

The impact and outcomes of clinical pharmacists driven antimicrobial stewardship programs (ASPs) are recognized globally.[2,5,8] However, in UAE, the impact of clinical pharmacist driven antimicrobial stewardship program remains unexplained.

In this tertiary care hospital, where the study is conducted, the program operated with oversight from various healthcare professionals, primarily physicians and infection control teams. The program, while well-intentioned, faced challenges in terms of absence in measuring the effectiveness, no adherence to guidelines, high resource utilization and the lack of a dedicated clinical pharmacy presence. With the establishment of clinical pharmacy responsibilities in antimicrobial stewardship, a transformative shift occurred. Clinical pharmacists assumed formal roles and responsibilities, participating actively in patient care rounds, conducting post prescription reviews, and implementing targeted interventions such as de-escalation strategies and educational programs. The program's structure underwent modifications, introducing formalized processes and procedures.

This study aimed to quantify the impact of clinical pharmacist-driven ASP on antimicrobial utilisation, cost and antimicrobial susceptibility.

METHODOLOGY

This was a quasi-experimental study, assessed the impact of a clinical pharmacist-driven antimicrobial stewardship program at a tertiary care hospital in UAE focused mainly on the hospitalized adult patients. The study encompassed a defined timeframe, divided into two distinct phases: pre-intervention phase (July 2021 – June 2022) and post-intervention phase (July 2022 – June 2023) of the antimicrobial stewardship program led by clinical pharmacists.

During the pre-intervention phase, when a physician was leading the ASP committee in the absence of clinical pharmacist, baseline data were meticulously collected, encompassing detailed information on antimicrobial utilization patterns, and resistance profiles.

Subsequently, the clinical pharmacist-driven program was formally introduced, involving active participation of ID clinical pharmacists in daily patient care rounds, post prescription reviews, educational initiatives, and collaborative efforts with other healthcare professionals. The post-intervention phase was initiated, during which data collection persisted with the same parameters as the pre-intervention phase. ID clinical pharmacists were joining multidisciplinary rounds, provided expertise on antimicrobial stewardship, dosing optimization, therapeutic drug monitoring, drug de-escalation based on culture and susceptibility result and drug interactions. This practice ensures that the prescribed antimicrobial therapy is appropriate, tailored to the patient's specific needs, and aligned with current guidelines. After a physician prescribes antimicrobial therapy, ID clinical pharmacists conducted a thorough reviews of the prescription. They assessed elements such as drug choice, diagnosis, dosage, and route of administration, duration of therapy, de-escalation and potential adverse effects. This review process is recommended as a priority interventions tool in ASP to identify opportunities for optimization, ensuring that patients receive the most effective and safest treatment regimens.[3] ID clinical pharmacists engaged in ongoing education for healthcare professionals. They provided training sessions every quarter in a year, offered guidance on antimicrobial use, resistance patterns, and provider-based interventions and assessed their overall knowledge of ASP by an annual survey. ID clinical pharmacists collaborated closely with other healthcare professionals, including infectious diseases physicians and microbiologists. Through interdisciplinary teamwork, they reviewed and updated clinical practice guidelines and treatment protocols. Timeline has been specified in table 1. Data were collected on quarterly antimicrobial utilisation, antimicrobial susceptibilities and antimicrobial cost.

Data collection and analysis

Utilization data for ASP focused antimicrobials were obtained for July 2021 to June 2023 from a database using the hospital electronic health system and transferring the data to a spreadsheet (Excel; Microsoft, Redmond, WA). We compared the cost which is provided by pharmacy purchase department, and bacterial susceptibility using antibiogram pattern which is

Table 1. Timeline and description of antimicrobial stewardship program interventions

Month - Year	ASP Intervention	Description
July - 2022	Development of key performance indicators	A measurable metrics that reflect the effectiveness and impact of the program's interventions on antimicrobial use and compliance to facility specific clinical guidelines
January - 2023	Post prescription review	A systematic evaluation of antimicrobial prescriptions conducted after the initial decision to prescribe antibiotics to a patient. This review process typically involved clinical pharmacists assessing the appropriateness of antimicrobial therapy based on various factors, including the patient's clinical condition, microbiological data, and antimicrobial stewardship guidelines. (CDC, 2019)
March - 2023	ASP trainings every quarter	A series of antimicrobial stewardship training session for physicians, nursing and pharmacy team

provided by microbiologists.ASP focused antimicrobial refers to a broad-spectrum antimicrobial medication (refer table 2) that is intentionally reserved for specific situations or conditions under pre-authorization process. This process is a part of the antimicrobial stewardship program (ASP) and a proactive step taken before prescribing certain antimicrobial medications. This process involves obtaining approval or authorization from a designated authority, such as an infectious disease specialist or a physician with expertise in antimicrobial stewardship, before initiating the use of specific antimicrobials. The goal is to ensure the prudent and targeted use of these medications to combat antimicrobial resistance and preserve their effectiveness.

Table 2. List of ASP focused antimicrobials

Classifications	**Medication Information**
Carbapenems	Meropenem
	Ertapenem
4th Cephalosporins	Cefepime
5th Cephalosporins	Ceftalorine
	Ceftobiprole
Combination B-lactam B-lactamase inhibitor	Ceftazidime-Avibactam
	Ceftolozane-Tazobactam
	Piperacillin-Tazobactam
Quinolones	Moxifloxacin
	Ciprofloxacin
	Levofloxacin
Glycopeptides	Vancomycin
	Teicoplanin
Glycylcycline	Tigecycline
Lipopeptides	Linezolid
Polymyxin E	Colistin
Echinocandins	Caspofungin
	Anidulafungin
Azoles	Isavuconazole
Polyene	Liposomal Amphotericin B

Medication orders were summed per medication per quarter in grams using the total number of doses and dose per administration. The grams were then converted to census normalized DDD (defined as grams per 1,000 patient days) using World Health Organization (WHO) definitions.[14]

The Statistical Package for Social Sciences program (IBM-SPSS), version 29, was used to enter and analyze the data. Testing for data normality was done via the Kolmogorov–Smirnov test. Paired t-test was used for normally distributed data, while the Wilcoxon test was used for non-normally distributed data. For all tests, *p*-values < 0.05 were considered significant.

RESULTS

In this study, the means of ASP focused antimicrobials utilization were 122 DDD per 1,000 patient days and 86 DDD per 1,000 patient days for the Pre phase and post phase periods, respectively, which is a 29% decrease (p =.001). Significant findings in medication utilization between the periods included an 11% decrease in fluoroquinolone use (p = .015) and a 40% decrease in carbapenem use (p = .012). Further details on medication utilization can be found in Table 3.

Total antimicrobial cost showed an annual saving of $161,658 ($p$ = .001) (Figure 1).

Changes in susceptibility were observed between the pre-phase and post-phase periods for *E. Faecalis*, *P. aeruginosa*, *E. coli*, and *K. pneumonia*. Notably, *P. aeruginosa* demonstrated a 2% increase in susceptibility to meropenem (p = .001).

Table 3. Pre antimicrobial stewardship program (Pre-ASP) and ASP defined daily doses of stewardship-focused antibiotics

Antimicrobial Group	**DDD/1000 patient days Pre-Intervention Phase**	**DDD/1000 patient days Post-Intervention Phase**	**% Change**	**P value**
Carbapenems	**432**	**260**	**-0.40**	**0.012**
Meropenem	214	84		
Ertapenem	217	176		
Non carbapenem antipseudomonal B-lactam	**814**	**846**	**+0.04**	**0.07**
Cefepime	86	38		
Ceftazidime-Avibactam	121	97		
Ceftolozane-Tazobactam	1	28		
Piperacillin-Tazobactam	606	682		
Fluoroquinolones	**139**	**124**	**-0.11**	**0.015**
Moxifloxacin	7	9		
Ciprofloxacin	57	56		
Levofloxacin	74	59		
MRSA	**207**	**197**	**-0.05**	**0.026**
Vancomycin	42	129		
Teicoplanin	3	5		
Tigecycline	40	5		
Linezolid	112	39		
Ceftalorine	7	7		
Ceftobiprole	3	13		
Antifungals	**733**	**220**	**-0.70**	**0.014**
Caspofungin	54	7		
Anidulafungin	141	112		
Isavuconazole	244	48		
Liposomal Amphotericin B	294	53		

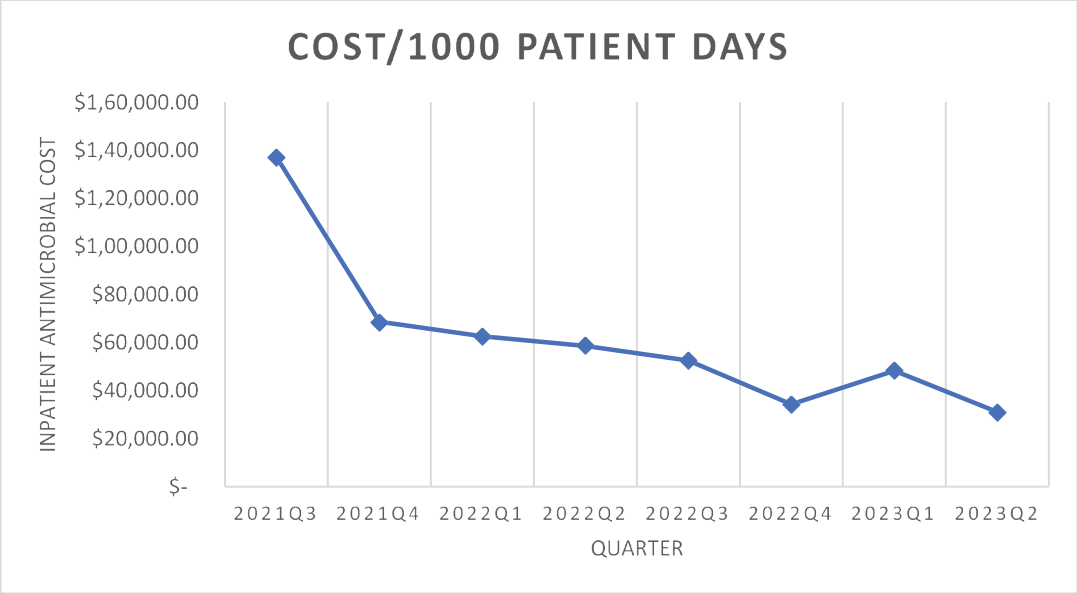

Figure 1. Financial trends of stewardship-focused antibiotics. Fiscal Year (FY) for following year begins in July of the previous calendar year

DISCUSSION

The objective of this study was to analyze alterations in the patterns of antimicrobial utilization and the consequent changes in bacterial susceptibility and drug expenses within our institution after the implementation of clinical pharmacist led Antimicrobial Stewardship Program (ASP). Changes that were noted encompassed shifts in antimicrobial utilization, antimicrobial cost, and bacterial susceptibility. ASP interventions aimed at accomplishing these changes consisted of improving implementation of pre-authorization, conducting prospective audits with feedback (post-prescription review), optimizing doses, converting from intravenous to oral antimicrobial therapy, updating guidelines for empiric therapy, creating clinical pathways, and providing education to clinicians.

After the implementation of clinical pharmacist driven antimicrobial stewardship program (ASP), the average utilization of ASP-focused antibiotics decreased by 29%. These findings align with those of other studies included in a meta-analysis, demonstrating a reduction in Defined Daily Doses (DDD) per 1,000 patient days ranging from 11% to 38% due to stewardship interventions.[9]

During the observed periods, ASP led to several changes in clinical pathways that we believe influenced shifts in therapy and subsequently impacted antibiotic utilization. Notably, two changes involved a transition in the preferred empiric therapies for Community Acquired Pneumonia (CAP) and Hospital-Acquired Pneumonia/Ventilator-Associated Pneumonia (HAP/VAP). These modifications presented an opportunity for cost savings by switching from piperacillin-tazobactam to ceftriaxone in CAP and from meropenem to piperacillin-tazobactam or cefepime in HAP/VAP. This shift coincided with our antibiogram indicating nearly equal efficacy for cefepime, piperacillin-tazobactam, and meropenem against *Pseudomonas aeruginosa*. These changes in preferred agent did consistently translate into susceptibility changes, as we noted a 3% and 2% increase in *P. aeruginosa* susceptibility to piperacillin-tazobactam and meropenem, respectively. As per facility microbiology annual report, there is a 25% reduction in *carbapenem resistant P. aeruginosa* (CRE PsA). This phenomenon has been described by a study by[11], a large statistically significant association was found between lower carbapenem use and reduced incidence rates of *carbapenem-resistant P. aeruginosa*.

The integration of clinical pharmacists into the ASP program proved instrumental in data-driven decision-making, leveraging their expertise in pharmacotherapy. The results were remarkable, with measurable reductions in antimicrobial resistance, and enhanced healthcare resource utilization. The collaborative, interdisciplinary approach fostered by clinical pharmacists contributed to the program's success. Continuous improvement initiatives, including ongoing education and adaptation to changing resistance patterns, showcased the dynamic and responsive nature of the antimicrobial stewardship program with the formal involvement of clinical pharmacy. Challenges were addressed proactively, marking a positive shift in the overall impact and effectiveness of the program. The evolution from a physician-centric model to a comprehensive, interdisciplinary approach led by clinical pharmacists underscores the critical role they play in optimizing antimicrobial use and improving patient care.

This study has certain limitations. While the ASP assessed outcomes related to resistance, antibiotic utilization, and financial impact, it did not address crucial ASP clinical objectives aimed at enhancing the safe and effective use of antibiotics to improve patient outcomes. The absence of measurements for clinical outcomes restricts the ability to draw comprehensive conclusions regarding the overall effectiveness of the ASP in this

aspect. The financial analysis did not endeavor to account for changes in costs associated with certain antibiotics achieving generic status during the study period or alterations in purchase contracts. Lastly, although not commonly considered in stewardship literature, our study did not consider changes in our infection control and prevention program or the potential impact of drug shortages during the study period, factors that could have measurable effects on resistance, antibiotic utilization, and financial expenditures related to antibiotics.

In conclusion, after implementation of a clinical pharmacist driven ASP, there were significant reductions in utilization, substantial cost savings, and decrease in CRE PsA rates. These results align with the objectives of minimizing unnecessary antibiotic exposure to patients, reducing resistance rates, and reducing avoidable healthcare expenditures. These findings contribute to the ongoing rationale for sustaining and extending our stewardship program, and this evaluation serves as a model that can be adopted by similar stewardship programs.

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