

# Evaluation of the Impact of Antibiotic Stewardship Program on Antibiotics Utilization

## as Surgical Prophylaxis at a Secondary Hospital in United Arab Emirates

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### Abstract

**Background:** Overuse or misuse of antibiotics, especially broad-spectrum antibiotics, may result in nosocomial infections leading to increased mortality rate, extended hospital stay, and cost. The antibiotic Stewardship Program (ASP) introduce to combat the irrational use of antibiotics.

**Objective:** To evaluate the effectiveness of the newly implemented surgical prophylaxis (SAP) guidelines

**Materials & Methods:** This study was a retrospective, hospital-based study. It conducts over five years, one year before implementation of ASP and four years after implementation. Out of 3290 patients operated on during the five-year study period, 1756 patients who received SAP has compared and analysed

**Results:** The percentage of patients who received SAP improved in years four and three after ASP reaching 56.6% and 56.7%, respectively, compared to pre-ASP 53.6%. The most frequently used SAP in pre-ASP was amoxicillin with clavulanic acid at 44%, which decreased to 0% in the fourth year, compared to Cefazolin which was 0% and increased to 83% in the fourth year. The appropriateness of selecting SAP was improved from 42% pre-ASP to 97% in the fourth year. Appropriated timing of SAP was in pre-ASP 81% reach to 98% in the fourth year. Appropriate SAP duration was noticeably enhanced from 46% pre-ASP to 98% post the fourth year. The incidence rate of surgical site infection (SSI) decreased from 34.82% in pre-ASP to 7.99%, 17.91%, 5.40%, and 3.71% in the first, second, third, and fourth post-ASP years, respectively.

**Conclusions:** Four years of Implementing SAP guidelines have significantly improved the prescribing practice of SAP and minimise SSI.

### Introduction

Nowadays, antibiotics are considered the most common therapeutic agents prescribed internationally as well as nationally. However, overuse or misuse of antibiotics, especially broad-spectrum antibiotics, may result in adverse drug reactions such as nosocomial infections leading to increased mortality rate, extended hospital stay, and increased cost.

Rational prescribing of antibiotics plays a crucial role in reducing global antibiotic resistance. Resistance to antibiotics is currently a severe problem as inappropriate usage of antibiotics, and irrational prescribing are the main reasons microorganisms develop resistance to various antibiotic agents. Unfortunately, the limited discovery of new antimicrobial agents threatens the global ability to treat common infectious disease agents while antimicrobial resistance has continued to increase. In addition, the rise of resistant bacteria rates such as methicillin-resistant *Staphylococcus aureus*, vancomycin-resistant *Enterococcus*, and extended-spectrum  $\beta$ -lactamase producing gram-negative bacteria makes it a more vital sign that developing other strategies to reserve the current antibiotic is a need.

So, hospitals have introduced the Antibiotic Stewardship Program (ASP) to combat the irrational use of antibiotics. Surgical site infection has related to inappropriate surgical antimicrobial prophylaxis (SAP) usage before surgical procedures. First- and second-generation cephalosporins are the most recommended as SAP. All SAP should be administered within 60 min before skin incision, except for vancomycin and ciprofloxacin, which should administer within 60-120 min of incision, duration should not be exceeded 24 hours postoperatively.

ASP was introduced in 1996; the main reason was to improve the rationality of antibiotics prescribed by healthcare, and reduction of antibiotic resistance rates and costs. (Dyar, et al. 2017)

In the Gulf countries, in the year 2014, the Gulf Cooperation Council Center for Infection Control (GCC-IC) established a strategic plan to combat antimicrobial resistance in each country. In United Arab Emirates (UAE), in 2010, the UAE's Antimicrobial Resistance Surveillance System (AMRSS) was established, collecting and reporting data from the different healthcare facilities across the country's seven emirates. Data represent that antimicrobial resistance surveillance from Abu Dhabi, UAE, shows a high prevalence of multidrug-resistance pathogens (El-Lababidi, et al. 2019). Furthermore, ASP was recently initiated at the level of private and governmental hospitals sector, with the main aim of improving the rationality of antimicrobial prescribing, improving patient health outcomes, and reducing the rate of resistance. However, literature published data on the utilization of SAP surgical prophylactic antibiotics in UAE hospitals are limited (Alshehhi, et al. 2021).

### Methodology

#### Study design and setting

A retrospective, hospital-based study that reviewed the patient's antibiotics before operational surgery. Data was collected over five years, one year before the implementation of ASP (April 2017-March 2018) and four years after implementation (April 2018-March 2022). Out of 3290 patients operated on during the five-year study period, 1756 patients who received surgical antibiotics prophylactic has compared and analyzed.

#### Data collection

Patients enrolled in the present study were based on the inclusion/exclusion criteria. Inclusion criteria: patients of either gender who are above 13 years undergoing any surgical procedure, from April 2017 to March 2022 with at least one antibiotic agent as surgical prophylaxis. Exclusion Criteria: patients with significant renal and hepatic diseases, immunocompromised, or with a history of current malignancy

The appropriateness of surgical antibiotic prophylaxis was assessed based on the DHF antibiotic stewardship policy. For each surgical procedure, the following data have been studied: selected surgical antibiotic prophylaxis used, the antibiotic administration time within 60 minutes before incision (60 minutes to 120 minutes for vancomycin and ciprofloxacin), and the discontinuation of the prophylactic antibiotic within 24 hours after the surgical operation. The antibiotic prophylaxis has been considered appropriate if the selected antibiotic, the timing, and the duration of administration were consistent with DHF guidelines.

### Results

#### Antibiotic surgical prophylaxis

We recorded 3290 patients who operated in DHF during the five years of the study period. The percentage of patients who received prophylaxis improved in years four and three of ASP implementation, reaching 56.6% and 56.7%, respectively, compared to pre-ASP (53.6%). The most frequently used prophylaxis antibiotic in the pre-implementing group was amoxicillin with clavulanic acid and cefuroxime in the post-implementing group. The distribution of antibiotics used per year in the study is presented in table 1 and figure 1.

Year of ASP implement	Cefazolin	Ceftriaxone	Cefuroxime	Amoxicillin-clavulanate	Others
Post fourth year (N=300)	249 (83%)	8 (2%)	41 (14%)	0	2 (1%)
Post Third year (N=315)	82 (26%)	48 (15%)	176 (55%)	3 (1%)	6 (3%)
Post Second year (N=378)	10 (3%)	46 (12%)	293 (77%)	26 (7%)	3 (1%)
Post First year (N=393)	0	30 (8%)	321 (81%)	40 (10%)	2 (1%)
One year pre ASP (N=370)	0	52 (14%)	154 (41%)	162 (44%)	2 (1%)
Total	341	184	985	231	15

Table 1. The distribution of antibiotics used per year

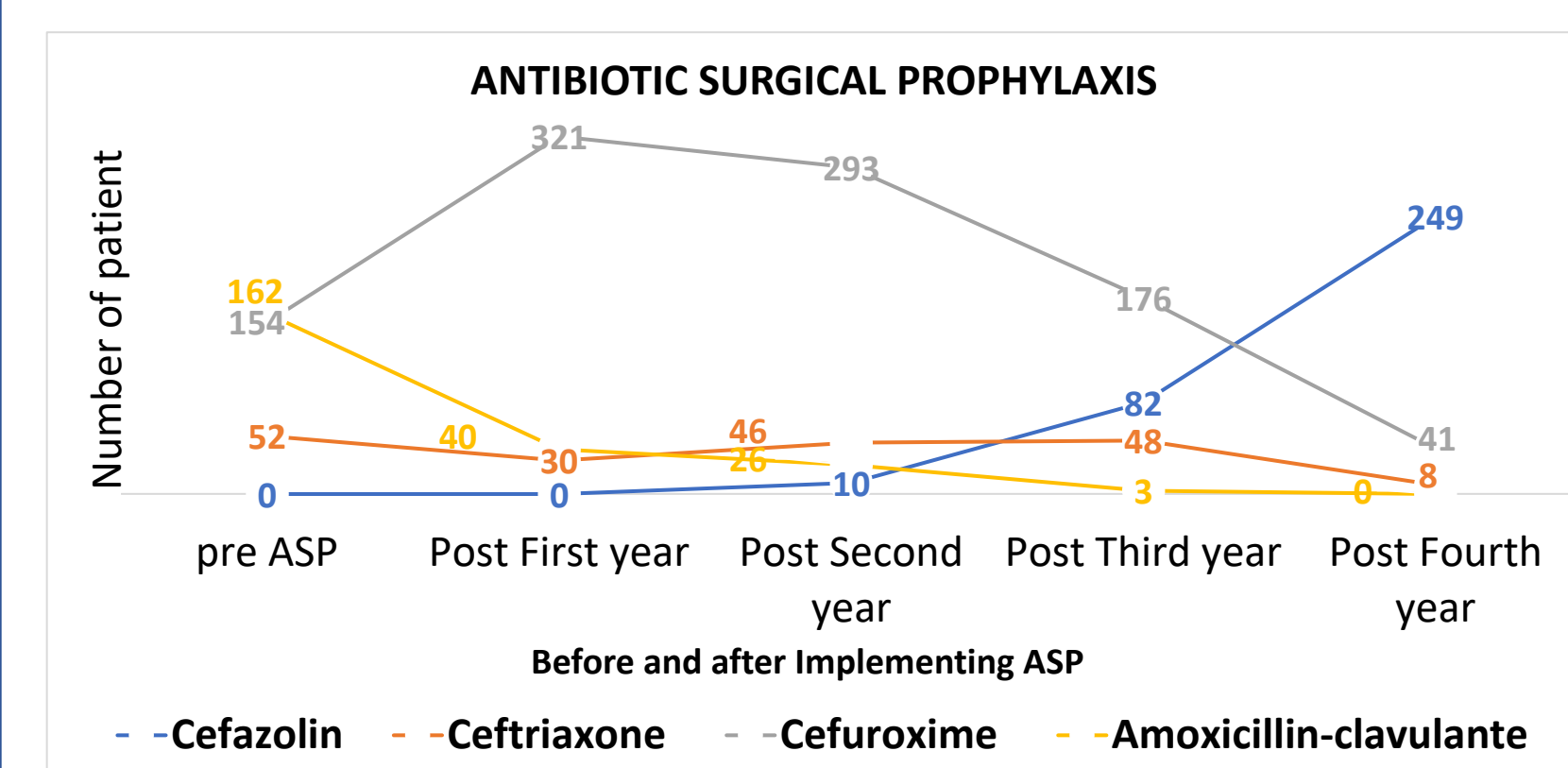


Figure 1. The distribution of antibiotics used per year

#### Appropriateness of surgical prophylaxis drug selected timing of administration and duration

Table 2 shows the percentage of the appropriateness of selecting, timing and duration of SAP. The appropriate prophylaxis has improved through the years after starting the ASP implementation as appropriateness was before ASP at 42%, post first year at 82%, second post year at 80%, third post year at 83% and post fourth year reaching 97%.

Appropriated timing of SAP administration was one-year pre-ASP 81%, post-first year 96%, post-second year 88%, post-third year 78%, and fourth post-year 98%. The appropriate timing varied from 0 to 120 min depending on the half-life of the prophylaxis antibiotics. All SAP must administer within 60 minutes before skin incision, except for vancomycin and ciprofloxacin, which must administer within 60-120 minutes of skin incision.

The percentage of appropriate SAP duration was noticeably enhanced since it was only 46% appropriated one year before the ASP implementation, then first post year 64%, second post year 91%, third post year 96%, and fourth post year reaching 98%. Duration should not exceed 24 hours postoperatively, and it has not recommended in many procedures.

Total compliance in all three parts (SAP selecting, timing, and duration) significantly increased from 36% before ASP to 81% in the post-first year ASP, 86% in the second year, 85% in the third year, and 97% in the fourth year.

Appropriateness of Surgical Antimicrobial Prophylaxis	Selected Drug	Timing	Duration	Pre ASP (n=370)	Post First year (n=393)	Post Second year (n=378)	Post Third year (n=315)	Post fourth year (n=300)
				N (%), Point estimate (95% CI)	N (%), Point estimate (95% CI)	N (%), Point estimate (95% CI)	N (%), Point estimate (95% CI)	N (%), Point estimate (95% CI)
Appropriateness	Appropriate	154 (42%, 0.41)	323 (82%, 0.82)	303 (80%, 0.8)	260 (83%, 0.82)	292 (97%, 0.97)		
	Not Appropriate	216 (58%, 0.58)	70 (18%, 0.18)	75 (20%, 0.2)	55 (17%, 0.17)	8 (3%, 0.03)		
Timing	Appropriate	298 (81%, 0.80)	378 (96%, 0.96)	331 (88%, 0.87)	245 (78%, 0.77)	293 (98%, 0.97)		
	Not Appropriate	72 (19%, 0.19)	15 (4%, 0.04)	47 (12%, 0.12)	70 (22%, 0.22)	7 (2%, 0.03)		
Duration	Appropriate	172 (46%, 0.46)	254 (64%, 0.64)	345 (91%, 0.91)	302 (96%, 0.95)	294 (98%, 0.98)		
	Not Appropriate	198 (54%, 0.53)	139 (36%, 0.35)	33 (9%, 0.09)	13 (4%, 0.04)	6 (2%, 0.02)		
Total compliance		624 (36%)	955 (81%)	979 (86%)	807 (85%)	879 (97%)		

Table 2. the percentage of the appropriateness of selecting, timing and duration of SAP.

#### Surgical site infection incidence rate

A total of 3290 patients were identified, of whom 718 and 2572 were classified as belonging to the pre- and post-implementation groups, respectively. After the change in the antibiotic prophylaxis policy's, data analysis revealed that the overall SSI incidence rate decreased from 34.82% in the pre-ASP group to 7.99%, 17.91%, 5.40%, and 3.71% for the first, second, third and fourth post-ASP years, respectively.

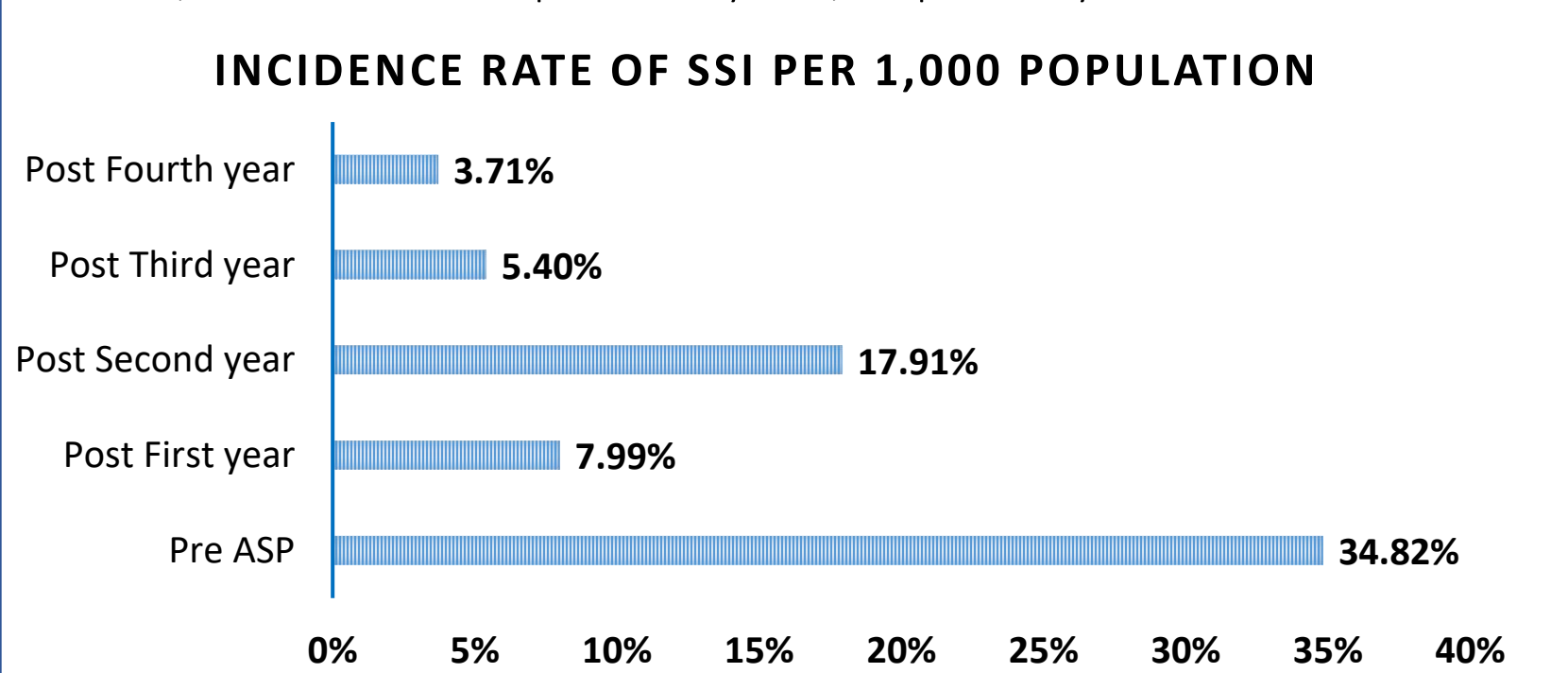


Figure 2. SSI incidence rate per 1000 population.

### Discussion

This study aimed to evaluate surgical antibiotics prophylaxis and to determine the incidence of surgical site infection after implementing the antibiotic stewardship program. Half of the patients received SAP 1756 (53.3%). Inappropriately, prescribing antibiotics for the prevention of SSI is a continuous and prevalent issue that was raised in a study done in Northeast Ethiopia, as (82.8%) received SAP even though it was indicated for (66.5%) (Moges et al., 2020).

In the period before implanting the ASP, it has been found a substantial proportion of inappropriate surgical antibiotic prophylaxis. Most antibiotic surgical prophylaxis prescribed were amoxicillin with clavulanic acid, followed by cefuroxime and ceftriaxone. Our study shows that the practice of prescribing preoperative surgical antibiotic before ASP were against the American Society of Health-System Pharmacists' (ASHP) recommendation to select narrower SAP. Prescribing a broader antibiotic spectrum as prophylaxis might develop patients' adverse events and antimicrobial resistance (AMR). Comparable findings were documented in studies conducted in a tertiary-level care hospital in the UAE, and in Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia, both were prescribed ceftriaxone as ASP more than cefuroxime (Halawi et al., 2018; Vippadapu et al., 2022)

One year following the ASP implementation, the percentage of amoxicillin with clavulanic acid dropped from (44%) to (10%), also cefuroxime percentage was prescribed more after one year (41% to 81%) compared to ceftriaxone percentage which diminution (14% to 8%). The percentage of selecting the more appropriate SAP per the national guideline and ASHP was drastically improved through the years reaching the optimum in post-fourth years of ASP; first-generation cephalosporins were the highest followed by the second-generation, cefazolin (83%), cefuroxime (14%), and minimal were prescribed with third generation ceftriaxone (2%). These results go along with other countries that implement Antibiotic stewardship. In Italy, a study reviews the intervention of ASP over 14 surgical departments after 6 years of implementation between 2013 and 2019, they found that percentage of ASHP guideline adherence improved from 36.6% to 57.9% overall (Segala et al., 2020).

Regarding the appropriate timing of SAP administration of antibiotics, the data collected in the present study was considerably enhanced through the years 81%, 96%, 88%, 78%, and 98%. The percentage in the post-third year 78%, was lower than expected. The reasons are related to the effect of the covid pandemic in that year, as shortages of nursing, anesthesia, and physicians affects the process of monitoring the timing leading to delays in the administration of SAP, especially in the first five months of the pandemic where surgical operations were only for emergency cases and scheduled c-section. Before the Covid-19 pandemic, the OT nurse was responsible to administer the SAP in the operation theater but once the number of nursing was minimized in OT to cover the Isolation ward and the field hospital, the timing of SAP was delayed after the incision. To overcome this issue ASP, decide to administer the prophylactic antibiotic in the ward before reach to the operation theater. Many countries react the same and postpone elective operations during the first few months of the pandemic

Appropriateness of proper SAP duration should not exceed 24 hours postoperatively, and it has not been recommended in many procedures to extend the duration up to 24 hours. In this study it was noticeably enhanced since it was only 46% one year before the ASP implementation, then 64%, 91%, 96%, and 98% respectively. Antibiotic stewardship implementation of a surgical protocol appears to be effective in encouraging adherence to surgical antibiotic prophylaxis protocols. A one-year post ASP results in significant adherence in duration is not extended beyond 24 hours. Redosing was monitored well and the duration between the two doses was managed well after releasing the surgical prophylaxis protocols. Exceeding a duration of more than 24 hours postoperatively was recognized in other studies.

### Conclusions

Four years of Implementing ASP guidelines have significantly improved the prescribing practice of SAP. Following ASP has positively influenced the risk of SSIs in general surgery. The first-generation Cefazolin has shown a reduced incidence of surgical infection compared to Amoxicillin with clavulanic acid and second-generation cephalosporin Cefuroxime as surgical prophylaxis. Appropriate choice of surgical prophylaxis remains the essential point among perioperative infection prevention bundles. However, continuous monitoring of surgical prophylaxis appropriateness will keep the current improvement and enhance it more.

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