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Original Article

A new antibiotic stewardship program approach is effective on inappropriate surgical prophylaxis and discharge prescription

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Abstract

Introduction: This study aims to evaluate the efficacy of a new antimicrobial stewardship program (ASP) on surgical antibiotic prophylaxis (SP) and antibiotics in discharge prescriptions used as a continuation of SP.

Methodology: The study included elective patients with clean and clean-contaminated wounds. The accuracy of the assigned SP was evaluated according to international guidelines. Primary outcome measures comprised appropriateness of prophylactic antibiotic indication, correct timing of initial dose, discontinuation of SP within 24 hours, and antibiotic prescription at discharge. A secondary outcome measure was to determine whether the effect of ASP was sustained long-term.

Results: The total compliance rate for all stages of SP increased from 8% to 52.1% after the intervention ($p < 0.05$). When analyzed according to individual SP components, it was found that although ASP did not change first dose timing rates, it did affect the rates of prophylactic antibiotic indication, discontinuation of SP within 24 hours and antibiotic prescription at discharge, with statistical significance ($p < 0.05$). In addition, ASP continued to increase its effectiveness throughout the 3rd year.

Conclusions: Based on the findings of our study, it seems clear that the modified ASP introduced in our general surgery clinic can be used effectively and simply; in addition, this ASP increases its efficacy with time.

Key words: antibiotic stewardship program; surgical antibiotic prophylaxis; general surgery; discharge prescription.

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Introduction

Antibiotic resistance is a public health problem that threatens the whole world. One of the major factors causing this resistance is the inappropriate use of antibiotics [1]. Studies show that about half of the antibiotics prescribed in hospitals are employed inappropriately [2], while approximately 15% of antibiotics in hospitals are used for surgical antibiotic prophylaxis (SP) by surgical clinics [3,4]. Many examples of unsuitable use of SP can be seen both throughout the world and in our country, Turkey [5-8]. Moreover, considering the recent increase in antibiotic resistant pathogens on surgical wards [9], the importance of preventing the inappropriate use of SP becomes even more urgent. In a study we conducted in our own clinic, we found that our SP usage was highly inappropriate, and that these incorrect SP applications had even been continued onto the patients' discharge prescriptions [10]. For this reason, we decided to introduce an antibiotic stewardship program (ASP) to our clinic. Cohrane Reviews state that ASPs are mainly composed of enablement and restriction applications of varying combinations, and emphasize that alternative new methods should be shared in the literature [11]. In addition, an examination of literature reveals publications that evaluate ASP in surgical branches collectively [6,7,12], but no ASP study carried out solely in the general surgery clinic to evaluate SP practice together with discharge prescriptions. Therefore, in our current study, SP practice is examined together with discharge prescriptions. Another important point is that our ASP differs slightly from other ASP studies in the literature. Consequently, the purpose of our study was to determine whether applying this modified ASP approach in our general surgery clinic could reduce the rates of antibiotic use in inappropriate SP as well as in our discharge prescriptions. For the first time, these results show that a modified ASP approach can be successful in the general surgery clinic.

Methodology

Settings

This study was carried out in the general surgery clinic of SBU Izmir Tepecik Training and Research Hospital, a tertiary training and research hospital serving as a reference hospital in the region. Local ethics committee approval was obtained for this study. (14 / 2017-47). Previous to this study (in the pre-intervention phase), rational drug use training was held in all clinics by the infection control committee, but no ASP had been put in place.

Study design

The pre-intervention period of the study comprises data from June 2014- May 2015. The intervention was carried out between July 2015 and January 2016, with the post-intervention period between 2016-2019. Data from the first post-intervention year (2016-2017) was evaluated in order to examine any early effects of the program. In order to ascertain continuity of the ASP effect, third year (2018-2019) data was also analyzed. Data was collected from electronic media files.

Study cohort

All patients with clean and clean-contaminated wounds, undergoing elective surgery in our general surgery department, were included in the study. In this study, age, gender, type of surgery and length of hospital stay were assessed along with indications for SP, duration of SP, correct preoperative timing of SP, use of SP over 24 hours and the discharge prescriptions of these patients.

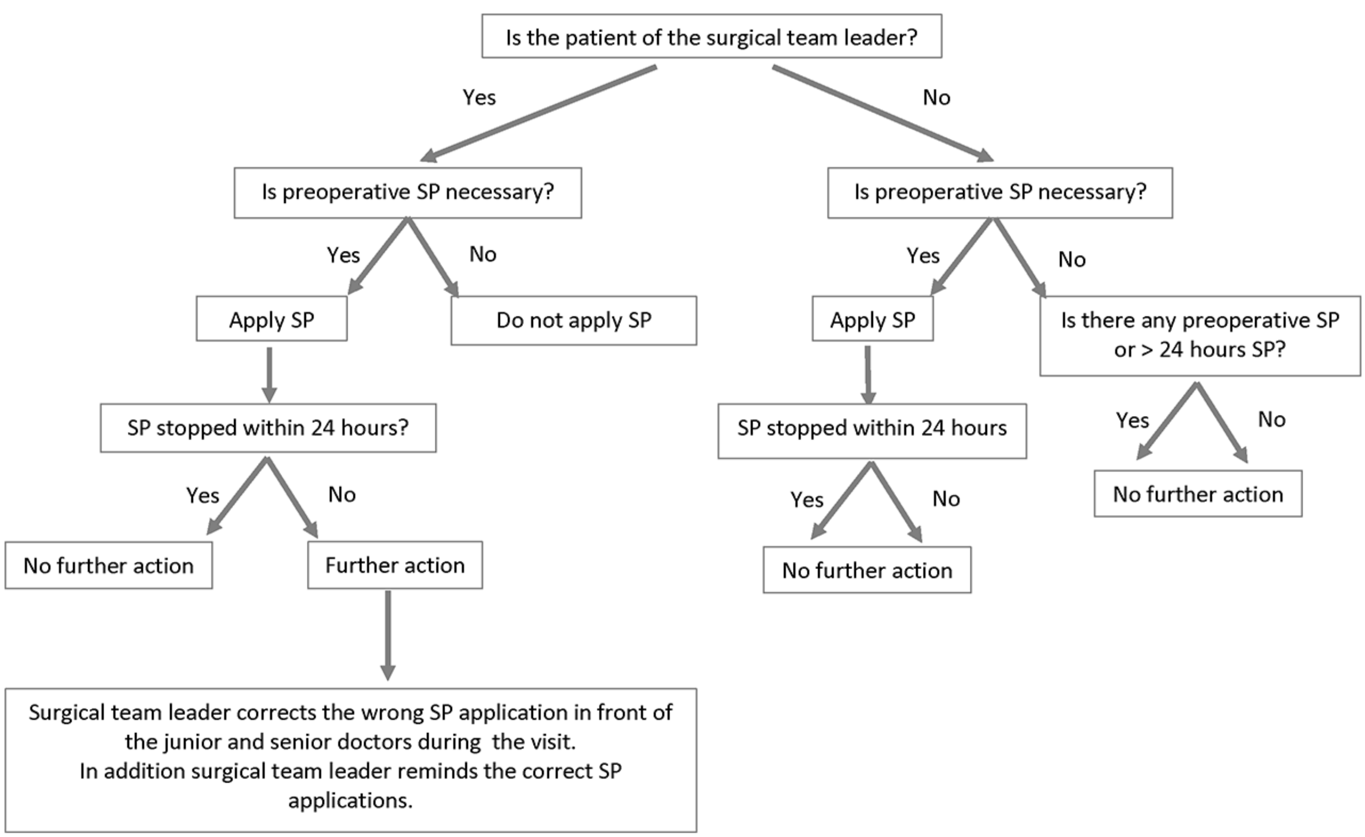
Exclusion criteria

Patients admitted as emergency, those with contaminated or dirty wounds and those taking antibiotics for another reason (e.g. wound infection, urinary tract infection, pneumonia) were not included in the study.

Intervention

In the intervention phase, local guidelines were updated by two members of the infection control committee (SK, SA). At least one general surgery team leader was appointed to be responsible for the ASP in each general surgery clinic. In order to implement ASP, periodic training sessions were planned to supervise and regulate applications of the SP by surgical team leaders and to provide feedback to the infection control committee. The planned ASP was presented to the hospital chief (GA) and the head of the general surgery services (CA) and their opinions were taken. After that,

Figure 1. The modified ASP which we use in our patients with clean and clean-contaminated wound class is outlined.



all doctors in the general surgery clinic underwent a one-day training session on SP principles. Interestingly, when the planned ASP was explained in the meeting, it received a negative reaction from specialist physicians who did not want to accept any supervision or change to their SP habits. At the meeting it was determined that:

a) senior doctors wished to continue giving SP longer than 24 hours postoperatively and to prescribe antibiotics for discharge prescriptions

b) the above-mentioned procedures were to be carried out by junior doctors, at the request of senior doctors

c) senior doctors did not wish others to interfere in their SP decisions

Faced with these important barriers, the original ASP had to be abandoned and a new more acceptable ASP developed. In ASP protocols described in the literature, training sessions are generally given collectively, based on either educational materials or experts from different branches who come to visit at regular intervals and provide feedback [9,12,13]. Generally, methods to restrict antibiotic usage include approaches such as the use of computer-aided programs, consultation prior to writing a prescription [11], or adherence to a check-list [9]. However, instead of collective training, we asked team leaders to recap current SP principles during visits with their patients. In addition, we asked them to be models to other physicians by demonstrating that they were implementing SP principles in their patients as routine practice. As an SP restriction, it was decided that clean and clean-contaminated cases would not be given SP longer than 24 hours and that discharge prescriptions would not include antibiotics. However, unlike other restrictive methods in the literature, in any case of SP being administered for over 24 hours or if antibiotics were added to the discharge prescription, no verbal or written sanction was imposed on the physician. In addition, there was no computer program or checklist to monitor the application of the SP. For this reason, we called this restrictive but non-compelling approach 'passive-restrictive' approach. Figure 1 describes the modified ASP with outline.

Outcome measures

As a primary outcome, we planned to measure changes at all stages of SP (SP indication, timing of delivery of the first dose, discontinuation of SP within 24 hours, and antibiotic prescription at discharge).

As a secondary outcome, we aimed to determine whether the effect of ASP continued long term.

Statistical methods

Statistical analyses were performed using the Rstudio software version 0.98.501 via R language. Variables were investigated using visual (histograms, probability plots) and analytical methods (Kolmogorov-Simirnov/Shapiro-Wilk test) to determine normal distribution. Descriptive analyses were presented using frequency, means and standard deviations for normally distributed variables (indication, application time, etc.). As the variables showed a normal distribution ($p > 0.05$), an independent t-test and ANOVA (post hoc test; Tukey) were used to compare the continuous variables between the groups. Pearson Chi-Square or Chi-square with Yates correction test were used for categorical variables. A value of $p < 0.05$ was considered statistically significant.

Results

A total of 3,771 patients were included in this study: 1,205 patients during the pre-intervention period; 1,216 patients in the first year of post-intervention and 1,350 patients in the third year of post-intervention. Although the mean hospitalization period was significantly higher

Table 1. Patient characteristics and clinical outcome. Pre- and post- intervention periods.

Variable	Pre-intervention	Post-intervention 1st year	Post-intervention 3rd year
No of patients	n = 1205	n = 1216	n = 1350
Age, mean ± SD (range)	50.9 ± 14.6 (18-92)	50.0 ± 14.3 (18-95)	50.5 ± 14.4 (18-92)
Male / Female	545/660	571/645	631/719
Mean length of hospital stay (d) (± SD)	1.94 ± 1.95	2.15 ± 1.91	1.82 ± 1.63
Postoperative SP (d) (± SD) (range)	1.54 ± 2.19 (0-9)	0.69 ± 1.7 (0-12)	0.3 ± 1.2 (0-9)
Surgeries done, n (%)			
Breast	136 (11.2%)	61 (5.0%)	75 (5.5%)
Thyroid	194 (16.1%)	127 (10.4%)	162 (12%)
Hernia repair	305 (25.3%)	381 (31.3%)	408 (30.2%)
Cholecystectomy	529 (43.9%)	503 (41.3%)	579 (42.8%)
Gastric	75 (6.2%)	84 (7%)	71 (5.2%)
Colorectal	66 (5.4%)	58 (4.7%)	54 (4%)

Table 2. Changes in the pre-intervention and post-intervention periods of SP (surgical antibiotic prophylaxis).

Parameters	Before training (n = 1205) %	First year after training (n = 1216) %	Third year after training (n = 1350) %	Between groups p-value	t calculated		
					t1	t2	t3
Total SP compliance ratio	8	32.7	52.1	p < 0.05	16.6	10.2	29.1
Compliance with indication for SP	55.6	62.1	64.5	p < 0.05	3.3	4.7	1.3*
Compliance with timing of the first dose	81.9	82.4	83.7	p > 0.05*	0.3*	0.9*	1.1*
SP > 24 hour	60.2	19.7	7.5	p < 0.05	22.4	9.0	33.3
Antibiotic prescribing after discharge	80.6	23.4	9.4	p < 0.05	34.5	9.7	51.4

t_1: Before training *vs*. first year after training; t_2: first year after training *vs*. third year after training; t_3: Before training *vs*. third year after training; *NS: Not Significant; Significant cut off: $t_{(df:n1+n2-2;a=0.05)} = 1.96 < t_{calculated}$.

in the first year of post-intervention ($p < 0.05$), the duration of hospitalization in the third post-intervention year was similar to that of the preintervention period ($p > 0.05$). In addition, the SP applied postoperatively in the hospital, decreased in amount significantly in both the first and the third year after the ASP was introduced ($p < 0.05$). Table 1 shows the characteristics of the patients and the clinical results of the study in detail.

During the post-intervention phase of the study, significant changes were recorded in the rate of total compliance with SP; the correct 'as indicated' use of SP before surgery; cessation of SP within 24 hours; and the prescription of antibiotics on discharge ($p < 0.05$). However, ASP did not have any significant effect on timing of the first preoperative dose (Table 2).

When rates for complete and accurate SP are broken down according to the various surgical groups, the least compliance is observed in thyroidectomy, cholecystectomy and colo-rectal operations. In thyroidectomy and low-risk cholecystectomy, in most cases, non-compliance with SP was due to preoperative antibiotic treatment, whereas in colorectal surgery it was usually due to the postoperative continuance of antibiotics. Table 3 shows the total compliance rates for SP according to the type of surgery.

Discussion

This study shows that practical training and a passive-restrictive approach in the general surgery clinic can reduce inappropriate antibiotic usage during SP and on discharge prescriptions of clean and clean-contaminated patients. These findings are of critical importance since our modified ASP produced successful results despite differing from other ASPs in the literature.

Our study shows a significant increase in total SP compliance rates after ASP and this increase continued into the long term. In the pre-intervention phase of our study, the rate at which all stages of SP were adhered to was found to be lower than that of other studies from our country [6,14], Greece [15] and France [16]. However, only one [6] of these studies included the monitoring of discharge prescriptions. The exclusion of discharge prescriptions from the other studies may be interpreted in two ways: either no such problem exists in the associated hospitals, or this is an issue still to be addressed.

The Cochrane review considers a 15% increase in compliance with the guidelines after ASP to be significant [11] and in the post-intervention phase of our study, a total compliance rate increase of 44.1% was obtained. Clearly, varying rates of success may be linked to the differing types of stewardship programs. In one study, a single surgeon was assigned to be in charge of ASP in the surgical clinics, similar to our own study; in addition, regular training, visits and feedback were provided by the infection control team [6]. In another study, regular training was given, while in the

Table 3. Compliance rates in all stages of surgical antibiotic prophylaxis according to operations.

	2014-2015		2016-2017		2018-2019	
	Appropriate n (%)	Not appropriate n (%)	Appropriate n (%)	Not appropriate n (%)	Appropriate n (%)	Not appropriate n (%)
Breast	31 (22.7%)	105 (87.3%)	41 (67.2%)	20 (32.8%)	58 (77.3%)	17 (22.7%)
Thyroid	31 (15.9%)	163 (84.1%)	2 (1.5%)	125 (98.5%)	14 (4.9%)	148 (95.1%)
Hernia	1 (0.3)	304 (99.7%)	265 (69.5%)	116 (30.5%)	361 (88.5%)	47 (11.5%)
Cholecystectomy	29 (6.7%)	400 (93.3%)	117 (23.6%)	386 (76.4%)	221 (38.1%)	358 (61.9%)
Gastric	3 (4%)	72 (96%)	15 (17.8%)	69 (82.2%)	46 (64.8%)	25 (35.2%)
Colorectal	1 (1.5%)	65 (98.5%)	0 (0%)	58 (100%)	3 (5.5%)	51 (94.5%)
Total	96 (8%)*	1109 (92%)	441 (36.5%)*	774 (63.5%)	703 (52.1%)*	646 (47.9%)

*Total compliance rates according to the years.

operating theatres SP was supervised by the anesthesiologists [9]. In both cases, the stewardship program increased total compliance rates. However, in a study by Ozgun et al., who only held training meetings and distributed brochures, this education program had no effect on the total compliance rates [12].

In our own hospitals, instead of holding conventional training meetings and distributing written brochures, we focused our guidance on practical training carried out by team leaders during their patient visits and rounds. In the study by Ozgun et al., it is probable that the attempt to conduct training in all surgical clinics (general surgery, orthopedics, gynecology etc) and the theoretical nature of the education provided might have prevented success. On the other hand, Çakmakçı suggests that more successful compliance could be achieved by ensuring that surgeons take an active role in ASPs and with the full participation of surgical leaders [17]. Our study seems to support this view. In our study, both the team leaders giving the training and those receiving training were surgeons. In addition, we believe that the team leaders' adherence to SP principles in routine practice has positively affected other participants. In the end, the success of ASP depends primarily on the willingness of its practitioners [18].

In the post-intervention phase of our study, it became clear that the rate of compliance with SP has increased as time progresses, an important finding in conflict with other publications that indicate a decrease in ASP activity when the particular stewardship program [19,20] or financial support is discontinued [21]. Moreover, our study differs from and is more advantageous than classical restrictive programs. In these classical approaches, costly software and full/part-time employees are required to supervise the program. However, the passive-restrictive practices of our study are not bound by strict rules and do not require constant monitoring. Another advantage of our study is that the team leaders can easily continue their practical training during routine practice. By this means, ASP can be implemented without problems caused by shortage of assembly time, place, or personnel; and without disruption of everyday work routines.

In order to increase our total compliance rates for SP, all stages of SP use should be examined and optimized. The ASP applied in our study led to no significant improvement in terms of timing of the first dose. This finding is similar to a study by Saied et al. [13], where a center with high optimal timing ratios at the outset of the program made no significant development. Also, in our study, although the rate of correctly administered preoperative antibiotics increased in the first year post-intervention, this increase could not be continued into the third year. When these data were analyzed in detail, a particularly high rate of preoperative antibiotic treatment was observed in thyroidectomies and low-risk cholecystectomies. These findings suggest that there are major problems with the preoperative administration of SP in our clinics. It is likely that these issues result from our limiting participation in the program to general surgeons only, rather than involving other health personnel. Actually, the participation of nurses and anesthesists in the ASP is crucial and could increase success rates [22,23].

According to the results of this study, our stewardship program led to a significant decrease in the duration of postoperative antibiotic usage as well as a reduction in the antibiotics prescribed in discharge prescriptions. A study by Bozkurt et al. determined that SP was prescribed for longer than necessary in 77% of cases in the pre-intervention phase, while this rate decreased to 47.7% in their post-intervention phase [6]. In contrast, in the study by Ozgun et al., whose ASP was only informative, SP > 24 hours usage rate increased in the post-intervention phase [12]. The literature contains a limited number of publications concerning discharge prescriptions applied as a continuation of SP. In fact, Bozkurt et al. seems to be the only study to investigate the relationship between discharge prescriptions for antibiotics and the introduction of an ASP [6]. In their study, the rate of antibiotic prescriptions given on discharge decreased from 17.4% to 5.5% in the post-intervention period; thus, more successful results were achieved in this study than in our own. However, their study population was quite different from ours, and included not only the general surgery clinic, but also all surgical branches, achieving a total decrease of about 12%. In our study, both the SP > 24 hours and the rate of inappropriately prescribed antibiotics on discharge prescriptions decreased by more than 50%, so that SP administration time was also significantly decreased. This success was achieved through the assimilation of appropriate SP principles by the junior resident who wrote most of the prescriptions.

At this point, we wish to draw attention to an interesting point. In the pre-intervention phase, approximately 85% of all prescriptions were written by junior physicians, but in the post-intervention phase, this rate increased to comprise almost all prescription writing. Here the following question should be asked: if most of the prescriptions are prepared by these junior doctors, why do high rates of inappropriate SP after colo-rectal surgery still persist? A likely explanation is that some experts have taken advantage of the vulnerability of this adapted ASP program. In other words, rather than being seen to oppose the passive-restrictive approach by writing an inappropriate prescription, senior staff members produced alternate solutions by requiring junior doctors to write the prescription they wanted. This finding demonstrates how difficult it is for professionals to change established behaviors and attitudes toward antibiotic use, and underlines the need for training on the use of appropriate antibiotics to be given to physicians before these behavioral patterns form [24]. For this reason, in future studies, a more detailed investigation into which particular surgery groups are less likely to adhere to an ASP, as well as the reasons why physicians do not use appropriate SP, can help to identify barriers to establishing a viable ASP.

Conclusion

Based on the findings of our study, we emphasize that the ASP introduced in our general surgery clinic, can be used effectively and simply; in addition, the effectiveness of this ASP increases with time. Furthermore, our adapted 'restrictive- passive' ASP approach could be considered as an alternative to existing ASP methods in the literature, especially in general surgery clinics without adequate financial or electronic infrastructure.

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