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Original Article

Antibiotic stewardship program (ASP) implementation is more effective than the national action plan for rational drug use

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Abstract

Introduction: In this study, we investigated the long-term effects of different antibiotic stewardship programs on surgical prophylaxis (SP) and the continuation of SP at discharge prescription in two general surgery clinics.

Methods: We retrospectively examined SP practices in the general surgery clinics of two hospitals. In Clinic A, a modified antibiotic stewardship program (mASP) was implemented, while in Clinic B, practices were conducted within the scope of the National Action Plan for Rational Drug Use (NAPRDU). A cross-sectional comparison was made by including quarterly data from both clinics for the years 2013, 2016, 2018, and 2023.

Results: When the SP practices in clinics A and B were analyzed in detail according to year, we found that SP indication, SP use for > 24 hours, antibiotic use in prescription, and all stages of SP (prescription and non-prescription) improved for both clinics except for the time of SP administration ($p < 0.05$). Moreover, a significantly greater and faster improvement in these parameters was found in clinic A than in clinic B.

Conclusions: Our study showed that the mASP and the NAPRDU have positive long-term effects on SP practices in general surgery clinics and the implementation of SP in discharge prescriptions. However, in clinics where mASP was applied, SP practices generally improved faster and more effectively, especially in terms of the antibiotics prescribed in discharge.

Key words: Antimicrobial stewardship; surveillance; long-term results.

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Introduction

Inappropriate antibiotic use (IAU) is a major public health problem around the world and is a difficult habit to correct [1]. IAU may lead to the development of drug resistance in microorganisms, an increase in drug-related costs, loss of labor force, and the incidence of adverse events [2]. About 30–50% of antibiotic use occurs during surgical prophylaxis (SP) applications in surgical clinics and serious noncompliance is reported during these SP applications [3,4]. When the publications related to SP practices in Turkey were examined, we found serious rates of noncompliance in SP practices; we also found that SP practices are used in discharge prescriptions [5,6]. Therefore, preventing IAU in surgical clinics is very important to prevent drug resistance and patient safety

To prevent IAU, the National Action Plan for Rational Drug Use (NAPRDU) was implemented in 2014 in Turkey. A national survey study was conducted about four years after the implementation of the NAPRDU, in which only general surgeons participated. The survey reported that serious errors occurred in the application of SP and that SP was even continued in discharge prescriptions [7]. In the 2018 NAPRDU workshop, it was stated that there was insufficient progress concerning the use of medication in general, but studies will continue in the 2018–2022 period [8]. However, no information was obtained in this workshop regarding the SP practices of general surgeons. Therefore, new information about the current SP practices of general surgeons and the long-term efficacy of the NAPRDU needs to be shared.

Some studies have reported that hospitals or clinics implement antibiotic stewardship program (ASP) by

developing local strategies to reduce IAU. Although IAU generally decreases when ASP is implemented, its effectiveness decreases over time [9,10]. Additionally, in most of these studies, the effectiveness of ASP was examined a few years after it was implemented; for this reason, the long-term effectiveness (5–10 years of data) of ASP also needs to be investigated [11]. In a study conducted in the general surgery clinic (clinic A) of a hospital in 2014, the researchers reported that they applied inappropriate SP at a high rate and continued to use SP in discharge prescriptions [6]. Therefore, they organized a modified ASP (mASP) in their clinic in 2015 and implemented it in 2016 [12]. Although the efficacy of this mASP has increased over the years, further investigations need to be conducted on the long-term results. Therefore, to assess the long-term results of implementing mASP more clearly, the authors planned to compare the data with those of the general surgery clinic (clinic B) of another hospital with similar demographic characteristics. Since no additional local ASP application was performed in clinic B other than NAPRDU, the data obtained were comparable to the data from the general surgery clinic where mASP was applied. Our study was the first to compare two different ASP applications (mASP and NAPRDU) in terms of SP and discharge prescriptions in general surgery clinics. Additionally, the data obtained were also important because they showed the long-term results of applying two ASP techniques for 8–10 years.

Materials and methods

In this study, we compared the data from the general surgery clinics of two hospitals with similar demographic structures and close to each other, which had the characteristics of tertiary-level training and research hospitals. We examined SP practices in the general surgery clinics of both hospitals. Elective patients with clean and clean-contaminated wounds were included in the study. The data on patients were obtained by retrospectively reviewing patient records from patient files. The criteria used to compare the stages of SP were as follows: a) timing of SP, b) application of SP with the correct indication, c) application of SP for > 24 hours, d) continuation of antibiotics in discharge prescriptions, and e) examination of the total accuracy of all stages of SP without and with discharge prescriptions.

A cross-sectional comparison included data from the last three months (October, November, and December) of clinics A and B for 2013, 2016, 2018, and 2023. As 2014 was a new year for the NAPRDU, data from 2013 (pre-ASP and pre-NAPRDU periods) were obtained as baseline data for clinics A and B. Since mASP training was conducted in clinic A from mid-2015 to early 2016, data from the last three months of 2016 were analyzed to determine the initial effects of mASP (intervention period). The last three months of 2018 were defined as the post-ASP period. After 2019, most surgical team leaders, infectious disease specialists who participated in the ASP, and resident physicians left the hospital. Therefore, data from the last three months of 2023 were analyzed to evaluate long-term outcomes (long-term ASP period). To compare the data between the two clinics, data from the same periods were also obtained for clinic B.

The first hospital was SBU Izmir Tepecik Training and Research Hospital, where the general surgery clinic (clinic A, consisting of three separate clinics and an organ transplant clinic) started implementing mASP in 2016. Following a protocol, a surgical team leader reminded their patients of the correct SP rules during rounds. Additionally, when resident doctors administered incorrect SP to the patients of the surgical team leader, the surgical team leader corrected the incorrect decision in front of other doctors during rounds. The surgical team leader did not intervene in incorrect SP procedures administered by other specialist physicians to their patients. Moreover, no sanctions or penalties were imposed on doctors (residents or specialists) who administered incorrect SP, and computer systems did not restrict the use of SP. Details about this practice have been described in detail in the previously published article [12].

The second hospital was SBU Izmir Bozyaka Training and Research Hospital, and no local ASP was implemented in the general surgery clinic (Clinic B, consisting of three separate clinics and an organ transplant clinic similar to Clinic A). This hospital had an infection control committee and a team working on rational antibiotic use (similar to hospital A) within the scope of the NAPRDU. The infection control committee annually organized a one-hour seminar on appropriate antibiotic use in various surgical branches. Additionally, all surgical branch doctors received mandatory online training within the scope of the NAPRDU. In these training sessions, informative videos on SP were shown, and an exam was held after the training. Teams working to improve rational antibiotic use met twice a year to evaluate the SP practices of the hospital, provide feedback to the clinics, and remind them of the SP guidelines in writing.

The exclusion criteria were as follows: patients who underwent surgery for emergency diseases, immunosuppressed patients, patients who initially had

Table 1. Wound groups and operation types according to years.

	2013		2016		2018		2023	
	A clinic, n (%)	**B clinic, n (%)**	**A clinic, n (%)**	**B clinic, n (%)**	**A clinic, n (%)**	**B clinic, n (%)**	**A clinic, n (%)**	**B clinic, n (%)**
Clean	**154 (46.6)**	**183 (60.5)**	**183 (57.2)**	**192 (54.1)**	**219 (56.3)**	**215 (55.5)**	**256 (61.1)**	**225 (50.1)**
Hernia	76 (23.0)	114 (37.7)	99 (27.9)	115 (35.9)	160 (44.4)	154 (39.1)	179 (33.9)	191 (45.6)
Thyroid	45 (13.6)	49 (16.2)	43 (12.1)	44 (13.8)	43 (11.9)	30 (7.7)	48 (10.7)	17 (4.1)
Breast	33 (10.0)	20 (6.6)	41 (11.5)	33 (10.3)	16 (4.4)	31 (8.0)	29 (6.5)	17 (4.1)
Clean-contaminated	**176 (53.4)**	**119 (39.4)**	**172 (42.8)**	**128 (45.9)**	**141 (43.7)**	**174 (44.5)**	**193 (38.9)**	**194 (49.9)**
Colorectal	29 (8.8)	12 (4)	24 (6.8)	19 (5.9)	17 (4.7)	6 (1.5)	27 (6.0)	16 (3.8)
Gastric	22 (6.7)	5 (1.7)	27 (7.6)	7 (2.2)	15 (4.2)	3 (0.8)	22 (4.9)	14 (3.3)
Laparoscopic cholecystectomy	125 (37.9)	102 (33.8)	121 (34.1)	102 (31.9)	109 (30.3)	165 (42.4)	144 (32.1)	164 (39.1)
Total	**330 (100%)**	**302 (100%)**	**355 (100%)**	**320 (100%)**	**360 (100%)**	**389 (100%)**	**449 (100%)**	**419 (100%)**

a clean or clean-contaminated wound class but were found to have an abscess at surgery, patients who suffered major contamination during surgery and developed contaminated wounds, and patients with contaminated or dirty wounds from the beginning.

Statistical analysis

Descriptive statistics were used to summarize the data obtained from the study. Categorical variables were summarized as numbers and percentages. The Pearson Chi-square test was conducted to compare the differences between categorical variables by group. All statistical analyses were conducted using SPSS version 25.0, and results were considered to be statistically significant at $p < 0.05$.

Results

Elective patients with clean and clean-contaminated wounds who underwent surgery in October, November, and December 2013, 2016, 2018, and 2023 were included in the study. In total, 2924 patients, including 1494 patients in clinic A and 1430 patients in clinic B, were included in the study. When the patient data from 2013, the year in which the NAPRDU and mASP were not yet implemented, were compared for clinics A and B, more patients with clean-contaminated wounds were recorded in clinic A, while the proportion of patients with clean wounds was greater in clinic B ($p < 0.001$). In the following years, no significant difference was found between the number of clean and clean-contaminated patients in both clinics ($p > 0.05$). The information on patients is presented according to wound group and operation type in Table 1.

When both clinics were compared, the rates of correct timing of SP, indication for SP, and accuracy in all stages of SP (with and without including discharge prescriptions in the calculation) were similar in 2013 ($p > 0.05$). However, the rates of SP use > 24 hours and antibiotic use in discharge prescriptions were significantly higher in clinic A ($p < 0.05$). The changes in the SP implementation stages of the clinics over the years are shown in Table 2.

When the long-term results (year 2023) of clinics A and B were analyzed separately, the parameters related to the time of SP administration remained stable in both clinics. However, a significant improvement was found in clinics A and B in all other SP stages except for the time of SP administration ($p < 0.05$) (Table 2). However, when the two clinics were compared with each other in terms of long-term results, we found that Clinic A showed significantly greater improvement than Clinic B in all other SP stages except for the time of SP administration. Upon investigating the stages of SP, in 2023, the rates of correct indication of SP in clinics A and B were 67.3–56.8% ($p < 0.001$), the rates of continuing SP for > 24 hours were 15.4–23.4% ($p < 0.003$), and the rate of total compliance with SP (without discharge prescription) was 56.1–42.5% ($p < 0.000$) and 52.3–26.5% ($p < 0.000$) when discharge prescriptions were added to the calculation of total compliance rates to SP and 12–48.4% ($p < 0.000$) when discharge prescriptions of patients who were administered SP were analyzed. When the success rates of two clinics from 2013 to 2023 are compared, SP

Table 2. Changes in the SP implementation stages of the clinics over the years.

	2013			2016			2018			2023		
	A clinic n (%)	**B clinic n (%)**	***p***	**A clinic n (%)**	**B clinic n (%)**	***p***	**A clinic n (%)**	**B clinic n (%)**	***p***	**A clinic n (%)**	**B clinic n (%)**	***p***
SP timing	265 (80.3)	241 (79.8)	0.87	287 (80.8)	262 (81.9)	0.73	298 (82.7)	311 (79.9)	0.33	366 (81.5)	336 (80.2)	0.59
Compliance with right indication	184 (55.8)	154 (51)	0.23	223 (62.8)	176 (54.4)	0.026	246 (68.3)	194 (49.9)	0.000	302 (67.3)	238 (56.8)	0.001
> 24 h SP	195 (59.1)	118 (39.1)	0.000	89 (25.1)	161 (50.3)	0.000	28 (7.8)	155 (39.8)	0.000	69 (15.4)	98 (23.4)	0.003
Antibiotic prescribing after discharge	261 (79.1)	199 (65.9)	0.000	82 (23.1)	279 (87.2)	0.000	39 (10.8)	226 (58.1)	0.000	54 (12.0)	203 (48.4)	0.000
Total SP compliance ratio (without discharge prescription)	41 (12.4)	53 (17.5)	0.07	135 (38.0)	88 (27.5)	0.02	209 (58.1)	126 (32.4)	0.000	252 (56.1)	178 (42.5)	0.000
Total SP compliance ratio (with discharge prescription)	30 (9.1)	38 (12.6)	0.157	115 (32.4)	13 (4.1)	0.000	193 (53.6)	63 (16.2)	0.000	235 (52.3)	111 (26.5)	0.000

SP: surgical prophylaxis.

Table 3. The success rates of two clinics in the SP stages from 2013 to 2023 and the difference in success rates between the clinics.

	A clinic (%)	B clinic (%)	Difference (%)
SP timing	1.2	0.4	0.8
Compliance with right indication	11.5	5.8	5.7
> 24 h SP	43.7	15.7	28
Antibiotic prescribing after discharge	67.1	17.5	49.6
Total SP compliance ratio (without discharge prescription)	43.7	25	18.7
Total SP compliance ratio (with discharge rescription)	43.2	13.9	29.3

SP: surgical prophylaxis.

timing and compliance with the right indication were the practices with the least percentage difference between the two clinics (0.8-5.7% respectively), while the greatest percentage difference was in the prescription of antibiotics in the discharge prescriptions of patients who were administered SP (49.6%). Table 3 shows the success rates of two clinics in the SP stages from 2013 to 2023 and the difference in success rates between the clinics.

Discussion

Our findings revealed that the long-term results of both NAPRDU and mASP were effective in correcting noncompliance with the administration of SP. The results also showed that local mASP applied in the general surgery clinic corrected SP compliance rates faster and more effectively than NAPRDU.

In clinics, A and B, the accuracy rates increased at all stages of SP except for the time of antibiotic administration, and these rates were maintained over the long term. However, the accuracy rates of Clinic A in SP applications were significantly higher than those of Clinic B by 2023. Additionally, while the improvement in clinic B was slower in recent years, a significant portion of the improvement in clinic A occurred in 2016 when mASP was introduced. Although it can be inferred from these results that mASP is more effective than NAPRDU, it would not be entirely accurate to say this since NAPRDU was implemented in hospitals across the country, it cannot be ruled out that clinic A may have been positively affected by these practices. This is because, in a Cochrane study, it was stated that for ASPs to be considered successful, SP implementation should increase by at least 15% as per the guidelines [13]. In clinic B, where NAPRDU was applied, nearly 15% improvement was recorded in all SP stages except for the time of SP administration and the indication of SP. Therefore, the combined efficacy of mASP and NAPRDU in clinic A provided better results than NAPRDU used alone in clinic B. However, there are important differences between the two applications. First, in clinic A, where mASP was applied, about eight years have passed since the start of the study. During this process, even though most of the doctors who participated in the study had left the hospital, the success rate of mASP remained high, contrary to the literature [14]. Additionally, mASP was not supported by any institution or organization, including Hospital A, after 2019. Although studies have reported that the success of ASP decreases when restrictive practices or educational activities are terminated [9,10], the success of mASP has continued over a long period, contrary to the literature. On the other hand, although NAPRDU policies have been actively implemented for about 10 years and supported by the state, they have been less successful in the long term. These data showed that the mASP method is simple and sustainable [12], and it can be successfully implemented with the willingness of the implementers and their belief in SP practices [15].

In our study, both ASP practices were successful in the long term when total compliance rates to the SP were analyzed (with and without the inclusion of discharge prescriptions in the calculation). Upon investigating the total compliance rates in detail, we found that Clinic A showed better results than Clinic B when discharge prescriptions were not included in the calculation of the total rate of compliance to SP. However, the percentage difference between them was not large. On the other hand, when discharge prescriptions were included in the calculation of the total rate of compliance to SP, the difference between clinic A and clinic B increased. When this difference caused by the antibiotics prescribed in the discharge prescriptions of patients who underwent SP was analyzed, we found that clinic A was more successful than clinic B. These findings showed the effectiveness of mASP, especially in discharge prescriptions. The NAPRDU states that SP should not be administered for > 24 hours, and therefore, it indirectly states that SP should not be included in discharge prescriptions. However, there is no explicit statement in the NAPRDU about the discontinuation of SP in discharge prescriptions. The most important difference between mASP and NAPRDU is that the surgical team leader warns that antibiotics should not be written in the discharge prescriptions of patients with SP and sets an example for other colleagues by acting this way. Since

this process focuses on discharge prescriptions, fewer antibiotics are prescribed in the prescriptions of patients being administered SP. The results of our study showed the importance of paying attention to discharge prescriptions, which are usually overlooked during the evaluation of SP practices [5–7,12,16,17]. The success of the implemented mASP in terms of antibiotic rates in the discharge prescriptions of patients who were administered SP without additional resources in the long term is encouraging because the mASP we implemented can be easily integrated into other clinics.

In the beginning, clinic A had significantly higher rates of SP use > 24 hours than clinic B. In the last period of the study, although there was a significant decrease in the > 24 hours SP utilization rates in both clinics, there was more improvement in clinic A than in clinic B. The NAPRDU and mASP also emphasize that using SP for > 24 hours is unnecessary. In this respect, although mASP is not theoretically different from NAPRDU, this finding suggests that mASP helps develop a greater awareness of prolonged antibiotic use. Globally, young junior residents prescribe most of the drugs used in hospitals [18]. In the mASP practice, residents monitor that the surgical team leader does not administer SP for > 24 hours to their patient and does not prescribe antibiotics in the discharge prescription. In this way, they witness that a surgeon who will be a role model for them takes responsibility for SP implementation in routine functioning and plays a central role in administering SP [4]. On the other hand, in practices conducted by infection control committees or appropriate antibiotic use teams, someone outside the surgical team makes decisions about the patient under the surgeon's responsibility. Additionally, surgical doctors see these teams only a few times a year and do not perform SP practices together with these teams in routine functioning. This causes the NAPRDU to remain at the theoretical level, unlike mASP. Trainings that remain at the theoretical level either fail to provide the desired level of change in SP implementation [19] or are relatively less successful over a long time, as found in our study.

Other parameters examined in this study included performing SP at the right time and with the right indication. In both groups, the rates of SP at the right time did not change significantly over the years. On the other hand, although both groups showed success from a statistical perspective, the parameter with the weakest success was the application of SP with the correct indication. Factors other than general surgeons play a role in these parameters. The most important of these factors is the anesthesia team. Although SP is primarily organized by general surgeons, intravenous antibiotic administration to patients during the perioperative period is performed by the anesthesia team. At this stage, increasing awareness of the anesthesia team about SP administration may improve the indications for SP, especially the timing of SP [20]. Nurses also play an important role in SP applications [21,22]. In clinics A and B, nurses were in charge of transferring the patients and the antibiotics to be administered to the patients from the clinics to the operating room. Therefore, when antibiotics are prescribed to patients in the group who are not administered antibiotics at the SP, nurses can stop the transfer of this antibiotic before it reaches the anesthesia team. This situation is very important because although not mentioned in our study, the biggest problem related to the administration of SP with the correct indication in both clinics was the routine administration of antibiotics to groups that were not supposed to receive SP. This implementation showed that junior residents in both clinics routinely administered SP to most patients regardless of the indication. These findings suggested that the anesthesia team also administered antibiotics to every patient who was sent antibiotics for SP regardless of the indication. Our study emphasizes the importance of efforts to improve these areas in both the mASP and the NAPRDU.

Limitations

Although patient records were collected prospectively, our study was a retrospective review. Additionally, data from more hospitals are needed for a more accurate evaluation of the NAPRDU.

Conclusions

To summarize, our study showed that mASP and NAPRDU have positive long-term effects on SP practices in general surgery clinics. However, SP practices generally improved faster and more effectively in the clinic where mASP was applied, especially in terms of prescribing antibiotics at discharge. Our results showed that introducing a local ASP suitable for hospitals that follow the NAPRDU guidelines may be an effective strategy to improve SP practices more rapidly.

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Conflict of interests

No conflict of interests is declared.

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