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Concise Communication

Multifaceted intervention for improving antimicrobial prescription at discharge in the emergency department

Yasuaki Tagashira MD, PhD[1,2], Manaka Goto MD[1], Reiko Kondo MD[1] and Hitoshi Honda MD, PhD[1]

[1]Division of Infectious Diseases, Tokyo Metropolitan Tama Medical Center, Tokyo, Japan and [2]Department of Microbiology, Juntendo University Graduate School of Medicine, Tokyo, Japan

Abstract

The frequent prescription of antimicrobials, such as at discharge from the emergency department, calls for optimizing this practice through modifying physicians' prescribing behavior. A 1-year, multifaceted intervention implemented in an emergency department decreased the mean monthly antimicrobial prescription rate at discharge and increased the proportion of appropriate prescriptions.

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Antimicrobial agents are among the most frequently prescribed medications in the emergency department, but at least 30% of prescriptions at discharge (APD) were unnecessary.[1–3] Antimicrobial misuse poses significant problems, including adverse drug-reaction development,[4] increased incidence of *Clostridioides difficile* infections,[5] emerging antimicrobial resistance,[6] and increasing healthcare costs.[7] Antimicrobial stewardship programs (ASP) are essential to optimizing antimicrobial use, regardless of the type of facility or healthcare setting.

Previous studies identified various factors, especially physician-related factors, including older age and surgical subspecialties, associated with antimicrobial misuse.[3,8] In the emergency department as well, effective strategies are needed to modify prescribing behaviors to optimize antimicrobial therapy. The present study demonstrated that an ASP team implementing a multifaceted intervention can promote appropriate antimicrobial use and reduce antimicrobial prescriptions in the emergency department.

Material and methods

Study design and setting

The present study was a before-and-after trial conducted at Tokyo Metropolitan Tama Medical Center, a tertiary-care center in Tokyo. The study period included a 1-year preintervention period (January 2016 to December 2016) followed by a 1-year ASP implementation period (October 2018 to September 2019). Our institution has had an inpatient ASP led by a multidisciplinary team since April 2014 but no ASP for outpatient settings, including the emergency department.

Antimicrobial stewardship program in the emergency department

The present, multifaceted intervention, aimed at APD in the emergency department, consisted of (1) an educational session about common infectious diseases encountered in the emergency department and the ASP concept; (2) an evidence-based treatment pocket guide, including antimicrobial indications, choices, dosages, dosage intervals, safety information for pregnant patients, and antimicrobial recommendations based on various guidelines and textbooks (Supplementary Table 1 online); (3) antimicrobial order sets for common infectious diseases in the electronic medical records (EMRs); (4) monthly reports on the proportion of overall appropriate APD and rate of overall APDs per 1,000 visits distributed to all physicians by hospital e-mail; and (5) postprescription review and feedback (PPRF) provided on week days by the designated infectious disease (ID) physician assigned to each case, who tracked data on prescriptions on week days using the EMR and reviewed each emergency department–related instance of APD to determine whether it was in line with the standard antimicrobial practices for the emergency department in the pocket guide. An e-mail with positive feedback was sent to physicians if their prescription was considered appropriate. If the prescription was considered a case of misuse, the designated ID physician contacted the prescriber within 1–2 business days to discuss how to optimize prescription practices for each patient. The designated ID physician on the ASP team (Y.T.) conducted the intervention and another ID physician (H.H.) reviewed the content of the educational session and the pocket guide.

Antimicrobial misuse was defined as an APD failing to meet the criteria outlined in the pocket guide. Misuse was further classified as unnecessary, inappropriate, or suboptimal use based on the previously mentioned criteria (Supplementary Table 2 online).[1,9] All APD not meeting the classification of misuse were considered appropriate.

Selection of participants

All patients who visited the emergency department during the study period were initially enrolled. Among these, records of

Author for correspondence: Yasuaki Tagashira E-mail: y.tagashira@gmail.com
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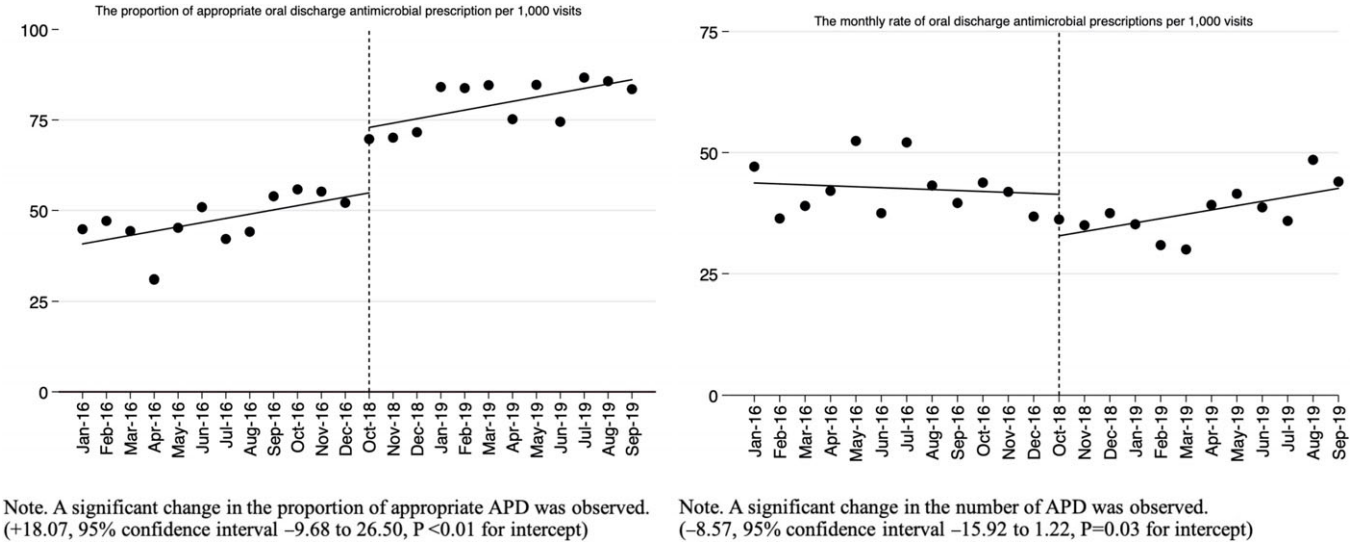

Fig. 1. Changes in the proportion of appropriate APD and the monthly rate of overall antimicrobial prescription.

patients discharged home or to a living facility (eg, long-term care facility) with an APD from the emergency department were extracted for analysis. If the patients visited the emergency department multiple times within 30 days of their initial visit, only the first visit was included. If the patients visited the emergency department multiple times after the 30-day period, all visits for independent episodes of infection were included. We excluded patients who had received a diagnosis of an infectious disease prior to their emergency department visit and had received an APD and those who were hospitalized later on the same day as their visit to the emergency department.

Data collection

A list of potentially eligible patients and their basic demographic data were obtained from the hospital administration. After excluding patients meeting the exclusion criteria, patient characteristics, antimicrobial prescriptions, and the prescribers' diagnosis were obtained from the EMR of the eligible patients. Prescriber information, including their primary service, sex, and postgraduate year (PGY), was also tracked.

Outcomes

The primary outcome was the change in the average proportion of monthly APD, misuse with respect to the type of infectious disease in the emergency department, and the average rate of monthly APD per 1,000 visits in the emergency department.

Statistical analysis

Segmented regression in interrupted time-series analysis (ITSA) was used to assess changes in the monthly proportion of all types of prescription and the monthly rate of APD per 1,000 visits. The requirement for patient consent was waived because the study was an institutional quality improvement project. The institutional review board at Tokyo Metropolitan Tama Medical Center approved the study.

Results

APD in the emergency department

In total, 70,093 patients visited the emergency department during the study period; of these, 36,308 and 33,785 patients visited during the preintervention period and the intervention period, respectively. Moreover, 164 patients (0.2%) were excluded (Supplementary Fig. 1 online), leaving 1,555 (4.3%) and 1,280 (3.8%) patients with an APD in the respective periods who were finally enrolled for analysis.

Characteristics of the patients and prescribing physicians

Supplementary Tables 3 and 4 summarize the baseline characteristics of the patients and prescribers, respectively. The median patient age was 48 years (range, 16–91), and 55.8% were female. During the preintervention period, 276 physicians prescribed antimicrobials in the emergency department; the median PGY was 6 years (range, 2–40) and 36.3% were female. During the intervention period, 250 physicians who potentially prescribed antimicrobials in the emergency department were identified. The median PGY was 4 years (range, 2–44 years) and 35.4% were female. In-person lectures were held, and a treatment guide was given to most prescribers (246 of 250; 98.4%) in the emergency department prior to the intervention. PPRF was performed for all the prescriptions during the intervention period.

Changes in antimicrobial practice

The average monthly proportion of appropriate APD was 47.2% in the preintervention period (January 2016–December 2016), whereas it significantly increased to 79.5% in the intervention period (October 2018–September 2019) (Fig. 1).

The ITSA revealed an immediate increase in the number of appropriate APD per 1,000 visits (+18.07; 95% CI, 9.68–26.50; $P = <.001$ for intercept), but no significant change in the trend was noted (+0.24; 95% CI, −1.19 to 1.24; $P = .97$ for trend). The immediate improvement in the proportion of appropriate APD was due mainly to a reduction in unnecessary APD

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Table 1. Details of Antimicrobial Prescription at Discharge (APD) in the Emergency Department (N = 2,835)

Prescribed Antimicrobial Agents	Preintervention Period (N = 1,555), No. (%)	No. Per 1,000 Visits	Intervention Period (N = 1,280), No. (%)	No. Per 1,000 Visits
Penicillins	667 (42.9)	18.4	607 (47.4)	18.0
Cephalosporins	364 (23.4)	10.0	297 (23.2)	8.8
Fluoroquinolones	211 (13.6)	5.8	67 (5.2)	2.0
Trimethoprim-sulfamethoxazole	127 (8.2)	3.5	181 (14.1)	5.4
Macrolides	83 (5.3)	2.3	31 (2.4)	0.9
Clindamycin	11 (0.7)	0.3	15 (1.2)	0.4
Tetracyclines	6 (0.4)	0.2	12 (0.9)	0.4
Metronidazole	3 (0.2)	0.08	6 (0.5)	0.2
Fosfomycin	3 (0.2)	0.08	0	0
Penicillins + macrolides	54 (3.5)	1.5	57 (4.5)	1.7
Penicillins + fluoroquinolones	7 (0.5)	0.2	2 (0.2)	0.06
Combination therapy with anaerobic coverage[a]	13 (0.8)	0.3	2 (0.2)	0.06
Others[b]	7 (0.5)	0.2	2 (0.2)	0.06

[a]Combination therapy with anaerobic coverage includes penicillins + clindamycin (n = 0 in the preintervention period, n = 2 in the intervention period), cephalosporins + clindamycin (n = 5, n = 0), fluoroquinolones + metronidazole (n = 4, n = 0), trimethoprim-sulfamethoxazole + metronidazole (n = 2, n = 0), and fluoroquinolones + clindamycin (n = 2, n = 0).

[b]Others include double fluoroquinolones (n = 1), amoxicillin + minocycline (n = 1), amoxicillin + trimethoprim-sulfamethoxazole (n = 1), cephalexin + trimethoprim-sulfamethoxazole (n = 1), cephalexin + minocycline (n = 1), minocycline + metronidazole (n = 1), and trimethoprim-sulfamethoxazole + levofloxacin (n = 1) in the preintervention period, and penicillins + trimethoprim-sulfamethoxazole (n = 1) and penicillin + cefaclor (n = 1) in the intervention period.

(−16.41; 95% CI, −23.90 to −8.92; $P < .01$ for intercept). The trend in monthly APD per 1,000 visits is shown in Figure 1. The mean monthly APD rates were 42.7 per 1,000 visits in the preintervention period (January 2016–December 2016) and 37.7 per 1,000 visits in the intervention period (October 2018–September 2019). ITSA demonstrated that the intervention was followed by an immediate decrease in the monthly APD rate per 1,000 visits (−8.57; 95% CI, −15.92 to 1.22; $P = .03$ for intercept). However, an increasing trend in APD was observed in the intervention period (+1.08; 95% CI, 0.10–2.07; $P = .03$) (Supplementary Table 5 online).

During the intervention period, 250 physicians issued an APD at least once (Supplementary Table 6 online), and 139 physicians (55.6%) committed at least 1 misuse of APD. Among the latter, 97 physicians (69.8%) prescribed antimicrobials appropriately on the next occasion.

During both segments of the study period, penicillins were the most commonly prescribed antimicrobials (Table 1). The changes in the cumulative numbers of prescriptions per 1,000 visits from the preintervention to the intervention period were 5.8 to 2.0 per 1,000 visits (changes in proportion, −65.5%) for fluoroquinolones and 3.5 to 5.4 per 1,000 visits (changes in proportion, +25.7%) for trimethoprim-sulfamethoxazole.

Discussion

The current study demonstrated that a multifaceted intervention aimed at optimizing APD in the emergency department at a Japanese tertiary-care center led to an immediate increase in the proportion of appropriate, monthly APD as well as an immediate reduction in the number of monthly APD per 1,000 visits. Moreover, the designated ID physician was chiefly responsible for conducting the intervention, thus ensuring effective antimicrobial stewardship despite the relatively limited human resources available.

Regarding improvements in the proportion of appropriate prescriptions, educational sessions led by an ID physician and the pocket guide on common infectious diseases provided a better understanding of ASP goals and clarified the indications for antimicrobial use for each type of infectious disease. These efforts likely had the effect of rapidly changing prescribing behaviors. Moreover, timely postprescription review with feedback from an ID physician for each prescription and periodic feedback via monthly reports may have contributed to maintaining the high proportion of appropriate APD in the intervention period. Feedback from the ID physicians also included appropriate infectious disease treatment options and updated knowledge and evidence pertaining to individual patients. Apparently, more than two-thirds of physicians who had at least 1 episode of APD misuse prescribed antimicrobials appropriately on their next prescribing occasion. Positive feedback thus can be seen as contributing to this development.

The number of monthly APD decreased by 11.7% in the intervention period. Moreover, ITSA demonstrated an immediate decrease in the prescription rate most likely resulting from the intervention. However, the change in average monthly APD demonstrated an unfavorable, increasing trend in the intervention period, possibly due to an incidental increase in infectious disease diagnoses (eg, urinary tract infections and superficial skin and soft tissue infections) that unquestionably required antimicrobial therapy (Supplementary Table 7).

In the present study, we also demonstrated an ∼66% reduction in the fluoroquinolone prescription rate in the intervention period (Table 1), possibly owing to a decrease in the unnecessary use of fluoroquinolones or switching to different antimicrobial agents which were considered to be more appropriate.

Although the proportion of unnecessary APD decreased significantly after the intervention, the average monthly proportion of inappropriate and suboptimal APD did not. An analysis of the prescribing details showed that 32 (13%) of 250 prescribing physicians had at least 2 episodes of inappropriate or suboptimal APD despite

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the intervention, and 8 (25%) of the 32 physicians repeated the inappropriate prescriptions for same infectious diseases during the intervention period.

This study has several limitations. Because it was conducted at a single center in Japan, the findings may not be generalizable to other institutions with different healthcare systems. The PPRF may have been subject to the Hawthorne effect, leading prescribers to be more inclined to document infectious disease diagnoses requiring antimicrobials in the EMR, thus skewing the results. The gap between the preintervention period and the intervention period was 2 years, which may have affected the pattern of antimicrobial consumption or antimicrobial prescribing practices in the emergency department prior to our intervention. Moreover, the antimicrobial stewardship guidelines on selected infectious diseases issued in 2017 by the Japanese Ministry of Health, Labour, and Welfare may also have influenced the overall antimicrobial prescribing practices in outpatient settings, including the emergency department. However, a nationwide database study revealed that the national guidelines appeared to have no significant impact on antimicrobial use in outpatient care.[10] In the present study, we were unable to assess the length of the APD or changes in prescriptions after the results of cultures done in the emergency department became available because most patients received an antimicrobial prescription for only a few days before receiving follow up from their primary care provider. The relationship between prescribers' individual level, training year, and subspecialty on interventions was not statistically accessed because of insufficient prescriber variables. Finally, the impact of the multifaceted intervention on the emergence of antimicrobial resistance remains unclear due to the inability to track the incidence of multidrug-resistant organisms after the patients' visit to the emergency department.

In conclusion, the multifaceted intervention in the emergency department increased the proportion of appropriate APD and moderately decreased the monthly rate of APD in general. The intervention was able to be implemented even by a small number of personnel. The initiative led to behavioral changes among prescribers and maintained a high proportion of appropriate antimicrobial prescriptions. The importance of such initiative taking and the ASP team's commitment were crucial to the success of the intervention. Further interventions are needed to strengthen ASP in the emergency department.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/ice.2020.1436

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Conflicts of interest. All the authors report no potential conflicts of interest relevant to the study.

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