Basic and Clinical Pharmacy Research
Volume 1, Issue 1, No. 1
Published online August 29 2022

Sanderman Publishing House

Analysis of pharmaceutical intervention effect of prophylactic antibiotics in type I incisions in a hospital

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Abstract. Objective: To analyze the pharmaceutical intervention effect of prophylactic antibiotics in type I incisions. Methods: A total of 3 899 patients undergoing type I incision surgery in a hospital from January 1 to December 31, 2018, were selected as the group before the pharmaceutical intervention, and 4 346 patients from January 1 to December 31, 2019, as the group after pharmaceutical intervention. The proportion and rationality of prophylactic antibiotics were compared between the two groups. Results: Compared with those before the pharmaceutical intervention, the proportion and rationality of prophylactic antibiotics, selection of antibiotic varieties, and rationality of drug course in type I incisions were significantly improved after pharmaceutical intervention ($P < 0.05$). Conclusion: Pharmaceutical intervention can reduce the proportion of prophylactic antibiotics in type I incisions and improve the rationality of prophylactic antibiotics.

Keywords. Type I incision, antibiotics, prophylactic use, pharmaceutical intervention.

Type I incisions, also known as clean surgery, are that the surgical organ is a sterile part of the human body, without local inflammation or lesion and involving no organs connected with the external environment, such as the respiratory tract, digestive tract, and urogenital tract. Since the surgical site is not contaminated, prophylactic antibiotics are not usually needed, except under certain special circumstances [1]. According to the *Notice on Further Strengthening the Management of Clinical Application of Antibiotics* issued by the Ministry of Health in 2011 [2] and the special rectification of antibiotics, the utilization rate of prophylactic antibiotics in patients undergoing type I incision surgery should not exceed 30%. Studies have shown that this goal has been achieved in only 34.85% of hospitals in China, where there are also several problems, such as inappropriate varieties of prophylactics, improper timing of administration, and too long drug course [3]. To standardize the prophylactic use of antibiotics in the perioperative period of type I incision, promote rational use of antibiotics, and curb bacterial resistance, a hospital has carried out pharmaceutical intervention in all links of prophylactic use of antibiotics in the perioperative period of type I incisions since 2019. This study statistically analyzed the prophylactic use of antibiotics in type I incisions before and after pharmaceutical intervention in this hospital, providing a reference for further standardizing and managing prophylactic antibiotics in the perioperative period of type I incisions and the basis for the rational use of antibiotics.

1. Data and methods

1.1. Data source

Patients undergoing type I incision surgery were selected from the hospital's medical record database, of which a total of 3 899 cases from January 1 to December 31, 2018, were included in the group before the pharmaceutical intervention, and 4 346 cases from January 1 to December 31, 2019, in the group after pharmaceutical intervention. Data, such as patients' basic information, diagnostic information, and medical advice, were extracted.

1.2. Methods

1.2.1. Interventions:

With *Guiding Principle of Clinical Application of Antibacterials (2015 Edition)* [1], *National Special Program for Clinical Practice of Antibacterial Drugs in 2012* [4], *National Guidelines for Antimicrobial Therapy (2nd Edition)* [5], *The Sanford Guide to Antimicrobial Therapy* [6], *New Materia Medica* [7] and other relevant documents, guidelines and monographs as standards, clinical pharmacists collected the problems in the prophylactic use of antibiotics in the perioperative period of type I incisions in this hospital, analyzed the reasons, formulated effective improvement measures and supervised their implementation. They regularly entered wards and participated in ward rounds, consultations, and case discussions; they assisted clinicians in the rational use of antibiotics in the perioperative period, and actively answered questions raised by them; they monitored the drug use in the perioperative period and gave timely interventions when finding irrational drug use. Special comments were made every month on the prophylactic use of antibiotics in the perioperative period of type I incisions, and cases of irrational use were reported to the Quality Control Department and Medical Department for publicity, feedback, and penalty, and were included in the department performance evaluation. The Clinical Pharmaceutics Room, in cooperation with the Medical Department and Quality Control Department, organized training on the rational use of antibiotics.

1.2.2. Rationality evaluation:

With *Guiding Principle of Clinical Application of Antibacterials (2015 Edition)* [1] and other relevant documents, guidelines, and monographs [4-7] as standards, the included type I incision surgery cases were summarized and analyzed

and the proportion of prophylactics was calculated based on surgical departments, and the selection of varieties of prophylactics, timing of administration, intraoperative addition, usage and dosage, and drug course of cases receiving prophylactics were rationally commented and summarized for analysis.

1.3. Statistical method

SPSS 25.0 software was used for data processing and analysis, and Excel 2007 was used for auxiliary drawing. Measurement data were expressed by the mean and standard deviation ($x \pm s$) and were compared by two independent sample *t-tests*; enumeration data were expressed by frequency and ratio and were compared by four-fold table data or R × C table data chi-square test. $P < 0.05$ was considered statistical difference.

2. Results

2.1. Baseline data

A total of 8 245 cases undergoing type I incision surgery were included in this study, which was divided into the group before intervention (2018, n = 3899) and the group after intervention (2019, n = 4346) according to the timing of pharmaceutical intervention. The baseline data of the two groups are shown in Table 1. There were no significant differences in the gender, age, and department distribution of cases between the two groups ($P > 0.05$).

Table 1. Comparison of baseline data of the two groups

Variable		Group before intervention (2008, n = 3 899)	Group after intervention (2019, n = 4 346)	Statistics*	P
Gender	Female	2128	2429	1.432	0.231
	Male	1771	1917		
Age (year)		52.61±20.31	53.13±20.58	1.154	0.249
Department distribution	First Orthopedics Department (Upper Limbs)	560	645		
	Second Orthopedics Department (Lower Limbs)	885	911		
	Third Orthopedics Department (Spine)	345	380		
	Brain Surgery Department	47	64		
	Breast Department	448	513		
	General Surgery Department	440	597	18.224	0.051
	Ophthalmology Department	988	1024		
	Urological Surgery Department	33	41		
	Gynecology Department	50	64		
	Department of Plastic Surgery and Wound Repair	46	44		
	Other	57	63		

Note: *. Enumeration data: the gender and department distribution were compared by chi-square test; measurement data: the age was compared by *t*-test (the age of both groups was in normal distribution and was homogeneous in variance).

2.2. Proportion of prophylactics

In this hospital, the proportion of prophylactic antibiotics in type I incision surgery before pharmaceutical intervention was 35.24%, and that after the pharmaceutical intervention was 23.95%, as shown in Table 2. There were statistical differences in the proportion of prophylactic antibiotics in type I incision surgery before and after pharmaceutical intervention ($P < 0.001$), in which the proportion significantly decreased after the pharmaceutical intervention, compared with that before pharmaceutical intervention.

Table 2. The proportion of prophylactics in type I incision surgery [n (%)]

Year	No prophylactics	Prophylactics	Total	X^2	p
2018	2525 (64.76)	1374 (35.24)	3899	126.411	<0.001
2019	3305 (76.05)	041(23.95)	4364		

2.3. Rationality evaluation of prophylactic use of antibiotics

Before and after the pharmaceutical intervention, irrational prophylactic use of antibiotics in type I incision surgery mainly included improper drug selection and improper drug course, other types, such as improper frequency of administration and improper single dosage, also appeared occasionally, as shown in Table 3. The irrationality rate of prophylactic use of antibiotics was 26.13% before pharmaceutical intervention and 18.54% after the pharmaceutical intervention, showing statistical differences between the two groups ($P < 0.05$); in addition, there were also statistical differences between the two groups in the selection of antibiotic varieties and rationality of drug course ($P < 0.05$), in which the rationality of prophylactic use was significantly improved after pharmaceutical intervention, compared with that before the pharmaceutical intervention, as shown in Table 4.

Table 3. Irrational prophylactics in type I incision surgery [*n* (%)]

Types of irrational drug use	2018	2019
Improper drug selection	252 (18.34)	78 (7.49)
Unreasonable intraoperative addition	0 (0.00)	1 (0.10)
Improper usage and dosage	1 (0.07)	17 (1.63)
Improper drug course	224 (16.30)	139 (13.35)
Total cases of irrational drug use	359 (26.13)	193 (18.54)

Note: Some cases involve several types of irrational use of prophylactics.

Table 4. Comparison of the rationality of prophylactic antibiotics before and after pharmaceutical intervention [*n* (%)]

Drug comment items		Irrational	Rational	X^2	*P*
Irrational drug use	Before intervention	359 (26.13)	1015 (73.87)	19.341	<0.001
	After intervention	193 (18.54)	848 (81.46)		
Drug selection	Before intervention	252 (18.34)	1122 (81.66)	59.077	<0.001
	After intervention	78 (7.49)	963 (92.51)		
Drug course	Before intervention	224 (16.30)	1150 (83.70)	4.036	<0.045
	After intervention	139 (13.35)	902 (86.65)		

2.4. Selection of antibiotic varieties

In this hospital, prophylactic antibiotics in type I incision surgery before and after pharmaceutical intervention were mainly first and second-generation cephalosporins, of which cefazolin and cefuroxime with high evidence of evidence-based medicine were mostly used. Third-generation cephalosporins selected as prophylactics significantly decreased after pharmaceutical intervention (2019), compared with those before pharmaceutical intervention (2018), while other antibiotics, such as penicillins, quinolones, lincosamides, cephamycins, and oxacephems, were also occasionally used to prevent postoperative infections, as shown in Table 5.

Table 5. Types of prophylactic antibiotics in type I incision surgery [*n* (%)]

Type of antibiotics	2018	2019
First and second-generation cephalosporins (cefazolin/cefuroxime)	827 (60.19)	723 (69.45)
First and second-generation cephalosporins (non-cefazolin/cefuroxime)	159 (11.57)	181 (17.39)
Third generation cephalosporins	295 (21.47)	64 (6.15)
Penicillins	45 (3.28)	52 (5.00)
Lincosamides	31 (2.26)	15 (1.44)
Other	17 (1.24)	6 (0.58)
Total	1374 (100.00)	1041(100.00)

2.5. Course of prophylactics

In this hospital, the course of prophylactic antibiotics in type I incision surgery did not exceed 24 h before and after pharmaceutical intervention for most cases, for most of whom the course did not exceed 48 h, as shown in Table 6.

Table 6. The course of prophylactics in type I incision surgery [*n* (%)]

Course	2018	2019
< 24h	806 (58.66)	668 (64.17)
24-48h	220 (16.01)	181 (17.39)
>48h	348 (25.33)	192 (18.44)
total	1374 (100.00)	1041 (100.00)

3. Discussion

3.1. Proportion and indicators of prophylactics

In general, prophylactic antibiotics are not required in type I incision surgery, except under the circumstances where the scope of surgery is large, the duration of the operation is long, the operation involves important organs, foreign matters are implanted or there are high-risk factors for infection [1]. A document [1] requires that the rate of prophylactic use of antibiotics in patients undergoing type I incision surgery should not exceed 30%. Compared with that before the pharmaceutical intervention, the proportion of prophylactic antibiotics in type I incision surgery met the requirement established by the Ministry of Health after the pharmaceutical intervention, and this proportion significantly decreased after the pharmaceutical intervention.

Although the rate of prophylactic use of antibiotics in type I incision surgery after pharmaceutical intervention met the requirement, the proportion was still high in some surgical departments while some cases had no strong indication for prophylactic use of antibiotics, suggesting that the rational use of prophylactic antibiotics needs to be further strengthened in some surgical departments.

3.2. Selection of prophylactic varieties

The possible contaminant bacteria in type I incision surgery include *staphylococcus aureus* and coagulase-negative *staphylococcus* [8], and prophylactics should be the first and second-generation cephalosporins, of which the first-generation cephalosporin with evidence of evidence-based medicine is mainly cefazolin, and the second-generation cephalosporin is mainly cefuroxime [1]. Nevertheless, before the pharmaceutical intervention, the proportion of the third-generation cephalosporin (mainly ceftriaxone) as prophylactics in type I incision surgery, especially orthopedic surgery was as high as 21.47% in this hospital. After participating in clinical ward rounds, clinical pharmacists found two main reasons for this situation: on the one hand, the third-generation cephalosporins cover Gram-negative bacteria and have a better effect on them, compared to the first and second-generation cephalosporins, and are popular among clinicians with their broad antibacterial spectrum; however, no clear limitations are set on the antibiotic varieties in type I incisions in the *Guiding Principle of Clinical Application of Antibacterials (2014 Edition)*, and it is reasonable to select the third generation cephalosporins as prophylactics in type I incision surgery, and thus some clinicians are used to using third-generation cephalosporins as the prophylactics in type I incision surgery; on the other hand, ceftriaxone with a long half-life can be used as a prophylactic once a day, which is convenient and efficient. After the pharmaceutical intervention, the proportion of first and second-generation cephalosporins, especially cefazolin and cefuroxime with high evidence of evidence-based medicine, selected as prophylactics in type I incision surgery significantly increased, and the rationality in the selection of antibiotic varieties was significantly improved. In particular, the proportion of third-generation cephalosporins as prophylactics for orthopedic surgery significantly decreased. However, improper selection of antibiotics remained in a small number of cases in this hospital, which should be continuously intervened in the future.

3.3. Usage and dosage

The usage and dosage of prophylactics in type I incision surgery in this hospital were mainly based on relevant instructions, guidelines, and monographs. Only a small number of patients undergoing type I incision surgery in this hospital were judged to have the improper frequency of prophylactic administration (that is, first and second-generation cephalosporins were administered once a day). After communication with relevant clinical departments and doctors, clinical pharmacists found that this was because a small number of clinicians believed giving prophylactics once a day was enough. In the future, training and control should still be strengthened in the frequency of administration of antibiotics in this hospital.

3.4. Timing and intraoperative addition of prophylactics

In general, the intravenous infusion of prophylactics in type I incision surgery should be started with 0.5-1 h before incision of the skin and mucosa or at the beginning of anesthesia [1]. Since the execution time of medical advice cannot be accurately recorded in this hospital's information system, whether the timing of preoperative administration is appropriate is mainly judged by checking whether medical advice is noted to be executed 0.5-1 h before operation. This should be improved in the future.

In 2019, among patients undergoing type I incision surgery, one receiving orthopedic surgery and given ceftriaxone as the prophylactic was judged to have irrational intraoperative addition because the drug was added once during operation since the duration of operation exceeded 3 h. According to the *Guiding Principle of Clinical Application of Antibacterials (2015 Edition)*, drugs should be added once during operation if the duration of the operation is more than 3 h or more than twice the half-life of the drug used, or the adult blood loss is more than 1 500 ml; however, the duration of this operation did not exceed twice the half-life (5.4-10.9 h) of ceftriaxone, and the adult blood loss was more than 1 500 ml, so intraoperative addition was not needed [1,9]. Training and control should also be strengthened in this area in the future.

3.5. Course of prophylactics

The prophylaxis time in type I incision surgery should not exceed 24 h. Before and after the pharmaceutical intervention, the irrational course of prophylactics was the main type of irrational prophylactic use in this hospital. After deeply knowing the facts, clinical pharmacists found that clinicians were used to prolonging the prophylactic antibiotics in operations for elderly patients, with long duration and with implantation of foreign matters. After the pharmaceutical

intervention, the rationality of the course of prophylactics in type I incision surgery was improved, but this was still an area that needs to be mainly intervened with pharmaceutical services in the future.

In conclusion, results have been achieved in the pharmaceutical intervention of prophylactic antibiotics in type I incision surgery in this hospital, but there is still irrational drug use, such as too long prophylaxis and irrational selection of antibiotic varieties. In addition, the timing of administration cannot be accurately controlled due to the imperfect information system in this hospital. The management of rational clinical use of antibiotics is a long-term and lasting task, which requires the cooperation of administrative, pharmaceutical, and clinical departments. On the one hand, it is very necessary to implement scientific pharmaceutical intervention; on the other hand, full play should also be given to the role of the hospital's information system. In this way can we promote the improvement of the clinical application and management levels of antibiotics.

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