

*Full Length Research Paper*

# Prophylactic use of antibiotics for clean operative procedures

Lidao Bao<sup>1</sup>, Xianhua Ren<sup>1</sup>, Yi Wang<sup>1</sup> and Nan Wang<sup>2\*</sup>

<sup>1</sup>Department of Pharmacy, Affiliated Hospital of Inner Mongolia Medical College, Hohhot 010059, China.

<sup>2</sup>Department of Stomatology, Affiliated Hospital of Inner Mongolia Medical College, Hohhot 010059, China.

Accepted 11 October, 2011

**To present the current situation of prophylactic use of antibiotics for clean operative procedures in the department of surgery of our hospital, a total of 2000 cases with clean operative procedures were randomly selected from January 2011 to June 2011 and reviewed. Results showed all patients received prophylactic use of antibiotics (100%), which was performed at 0.5 to 2 h before surgery in 1204 cases (60.2%), at >2 h before surgery in 452 cases (22.6%), before and during surgery in 19 cases (0.95%) and after surgery in 325 cases (16.25%). Cephalosporin antibiotics were the most frequently used in 1883 cases (94.15%). Combination application of antibiotics was found in 254 cases (12.7%). The indications for prophylactic use of antibiotics in patients undergoing clean operative procedures are extensive, high-level antibiotics are used, the time of antibiotic delivery is improper and the post-operative application of antibiotics is long. Therefore, it is imperative to control the improper prophylactic application of antibiotics and develop strict principles for prophylactic application of antibiotics.**

**Key words:** Rational drug use, prophylactic therapy, antibiotics, clean operative procedure.

## INTRODUCTION

In the surgical field, the preventive effect of antibiotics on the surgical site infection (SSI) is indubitable. Proper prophylactic application of antibiotics can not only help to reduce the SSI but decline the incidence of drug resistance. However, not all surgery requires prophylactic antibiotics. It is necessary to share microbiological data and provide an adequate education to reduce the antibiotic consumption and enable a better and rational antibiotic consumption (Evirgen et al., 2011). SSI refers to the infection of surgical incision or deep organ/space following surgery, including incision infection, brain, abscess peritonitis, etc. SSI accounts for 15% of hospital acquired infection and 35 to 40% of infections in the department of surgery. According to the Cruse statistics, the incidence of wound infection was about 1% in clean operative procedure (Surgery Branch of Chinese Academy of Medical Sciences and Editorial Board of Chinese Journal of Surgery, 2006). 2 to 5% of patients undergoing clean extra-abdominal operations and up to

20% undergoing intra-abdominal operations will develop an SSI (Auerbach, 2001). Currently, the peri-operative prophylactic use of antibiotic is very common in clean operative procedures. The efficacy of antimicrobial prophylaxis for prevention of SSIs was established in the 1960s and has since been demonstrated repeatedly (Polk and Lopez-Major, 1969; Classen et al., 1992). In the present study, a total of 2000 cases with clean operative procedures were randomly selected from January 2011 to June 2011 and retrospectively reviewed. Our results present the current situation of prophylactic use of antibiotics in clean operative procedures and provide evidence for the development of principles for prophylactic antibiotics in clean operative procedures and for the standardization of prophylactic antibiotics.

## MATERIALS AND METHODS

### Patients

A total of 2000 patients receiving clean operative procedures were recruited from January 2011 to June 2011, with a mean age of 42 ± 18 years old. The patients' characteristics and information on

\*Corresponding author. E-mail: wang20100922@hotmail.com.

antibiotics were recorded and reviewed.

**Information for reviewing**

**Patients' characteristics**

Name, gender, age, body weight, case number and hospitalization days, diagnosis, surgery name, date for surgery, the time of surgery initiation and completion.

**Information on antibiotics**

The name, formulation, dose, usage, total dose, date for antibiotic initiation and completion and durations of pre-operative and post-operative antibiotics.

**Cost**

Total cost for hospitalization, cost for medicine and cost for antibiotics.

**Assessment**

The questionnaire was employed to standardize the methods for analysis of patients in peri-operative period. The aforementioned information was retrospectively analyzed. The clean wound was defined as surgeries without involvement in the inflammation region, respiratory tract, gastrointestinal tract, urogenital tract and closed traumatic surgeries (Surgery Branch of Chinese Academy of Medical Sciences and Editorial Board of Chinese Journal of Surgery, 2006). Prophylactic use of antibiotics is usually not necessary in clean operative procedures. The indications for prophylactic use of antibiotics were surgeries with clean-contaminated incisions or some surgeries with contaminated incisions, such as surgeries involving gastrointestinal tract, respiratory tract or female reproductive tract or those with application of artificial materials/artificial devices, such as artificial heart valve replacement surgery, artificial vascular grafting, artificial joint replacement and surgery for incisional hernia using artificial materials. In addition, when the clean major surgery lasted for a long time, it was massively invasive or involved in important organs, the wound infection could cause severe consequence, and thus, prophylactic use of antibiotics was also recommended. These surgeries included craniotomy, cardiac surgery, major vascular surgery, portosystemic shunt, devascularization and splenectomy. Patients with high risk for infection were also treated with antibiotics for prevention. These patients included those with advanced age, diabetes, compromised immune function, malnutrition, etc. Absence of the aforementioned conditions indicates that the indication for prophylactic antibiotics was unclear. The rationality of prophylactic antibiotics was evaluated according to the "guiding principles for clinical application of antibacterial", previously reported in literatures and the actual situation in our hospital.

**RESULTS**

**General information**

There were 1181 males (59.05%) and 819 females (40.95%) with a mean age of 47 years (range: 15 to 82 years). The longest hospitalization days were 32 days

and the shortest were 2 days with a mean hospitalization days of 13.8 days.

**Application and types of antibiotics**

All patients received prophylactic treatment with antibiotics (100%). Prophylactic antibiotics were prescribed, 2571 (including combination treatment) among the first 15 types of antibiotics. Cephalosporins were the most frequently used antibiotics in 1883 patients (94.15%) (Table 1).

**Duration of prophylactic antibiotics and use of prophylactic antibiotics in different departments**

Prophylactic antibiotics were administered at 0.5 to 2 h before surgery in 1204 cases (60.2%), at >2 h before surgery in 452 cases (22.6%), before and during surgery in 19 cases (0.95%) and after surgery in 325 cases (16.25%). Post-operatively, prophylactic antibiotics were applied for <2 days in 69 cases (3.45%), for 3 to 7 days in 115 cases (10.25%) and for >7 days in 51 cases (2.55%). The use of prophylactic antibiotics in different departments is as shown in Table 2.

**DISCUSSION**

**Selection of prophylactic antibiotics in clean operative procedures**

In some clean operations such as body surface surgeries in the head, neck, trunk and limbs, inguinal hernia repair without artificial materials, thyroid adenoma resection, excision of breast fibroadenoma, etc., prophylactic antibiotics are largely unnecessary (Surgery Branch of Chinese Academy of Medical Sciences and Editorial Board of Chinese Journal of Surgery, 2006). When the clean major surgery lasts for a long time and is massively invasive and/or patients have high risk factors of infection, the possible infection may be very severe and thus, prophylactic antibiotics are recommended. In the present study, only 45 patients have evident clinical presentations of post-operative infection, but all patients received prophylactic use of antibiotics. In some patients, the indications for prophylactic antibiotic were unclear.

**Types of prophylactic antibiotics**

The selection of antibiotics should be based on the common pathogens, types of incision, risk factors, etc. In principle, broad-spectrum, effective (bactericide but not bacteriostat) antibiotics are recommended and safety as well as inexpensiveness is also considered.

**Table 1.** Types, frequency and constituent ratio of prophylactic antibiotics.

General name	Frequency	Constituent ratio (%)
Cefodizime sodium injection	545	27.25
Cefmenoxime injection	384	19.23
Cefoperazone / tazobactam sodium injection	265	13.25
Cefpiramide sodium injection	231	11.55
Meropenem injection	205	10.25
Cefamandole nafate for injection	186	9.32
Flucloxacillin sodium injection	174	8.75
Sulbenicillin Sodium injection	149	7.45
Levofloxacin injection	121	6.05
Latamoxef sodium injection	102	5.18
Cefonicid injection	65	3.25
Cefotiam injection	48	2.42
Azithromycin injection	39	1.95
Cefpodoxime dry mixture	30	1.56
Ceftriaxone injection	27	1.35

**Table 2.** The use of prophylactic antibiotics in different departments (top 10).

Department	Number of patients	Number of antibiotic treatment	Proportion (%)
Pediatrics	23	25	100.00
Urology	42	43	97.67
Stomatology	74	77	96.10
General surgery ward C	95	102	93.14
Respirology ward B	74	82	90.24
Gynecology ward C	71	85	83.53
General surgery ward D	84	101	83.17
Otolaryngology	98	122	80.33
Emergency surgery	68	89	76.40
Gynecology ward A	56	75	74.67
Mean	-	-	87.53

Cephalosporins meet these requirements (Surgery Branch of Chinese Academy of Medical Sciences and Editorial Board of Chinese Journal of Surgery, 2006; Page et al., 1993). In the present study, cephalosporins were the frequently applied antibiotic, which is consistent with the earlier principle. However, the following problems should be addressed:

1. As shown in Table 1, the majority of patients were treated with cefodizime sodium injection. According to the guidelines for peri-operative antibiotic prophylaxis (Surgery Branch of Chinese Academy of Medical Sciences and Editorial Board of Chinese Journal of Surgery, 2006), staphylococcus is the predominant pathogen in the surgeries for cardiovascular diseases, head, neck, chest and abdominal wall injuries, soft tissue injury in limbs and bones (Hauser et al., 2006). Therefore, the first generation cephalosporins including ceftazidime

and cephadrine are preferred, and the third generation cephalosporins are not recommended. However, cefodizime sodium, one of the third generation cephalosporins, is the common antibiotic applied in our hospital for prophylaxis showing the irrationality.

2. In clinical practice, prophylactic antibiotics are usually bactericides. As shown in Table 1, application of azithromycin injection for prophylaxis in some patients was improper. Azithromycin belongs to macrolide antibiotics and acts on the 50S ribosomal subunit in the bacteria to inhibit the protein synthesis. Therefore, azithromycin is a bacteriostat (Chen et al., 2005; Dellinger et al., 1994). 3. As shown in Table 1, in some patients, third generation cephalosporins are used for prophylaxis, which is not consistent with the recommendation in the guidelines for peri-operative antibiotic prophylaxis. Thus, we should strictly control the indications for prophylactic use of antibiotics which can

avoid the occurrence of drug resistance.

In the department of pediatrics, the patients were relatively young, and some were even several months old. The physiological functions are largely immature and the resistance against stimuli is weak. Therefore, these patients had high risk for post-operative infection, which is the indication for prophylactic use of antibiotics. This was why prophylactic use of antibiotics was performed in all these patients.

### Time of prophylactic use of antibiotics

According to the “guiding principles for clinical application of antibiotics”, prophylactic use of antibiotics should be performed 0.5 to 2 h before surgery or during the anesthesia in patients receiving clean operative procedures. This strategy can assure the antibiotic concentration to kill the bacteria entering the wound during the surgery. When the duration of surgery is longer than 3 h or volume of blood loss is >1500 ml, a second application of antibiotics can be carried out during the surgery (Chinese Medical Association et al., 2005; Cipolla et al., 2011). The optimal time for prophylactic use of antibiotics is 0.5 to 2 h before surgery. In the present study, this was performed in 1204 cases (60.2%) meeting the requirement. In addition, prophylactic use of antibiotics was carried out >2 h in 452 cases (22.6%) and after surgery in 325 (16.25%), which are not beneficial for infection prevention (Collaborative Group, 2003). Therefore, the time of prophylactic use of antibiotics should be standardized. In addition, 19 patients (0.95%) received additional treatment with antibiotics during the surgery, the duration of which was longer than 3 h. Thus, this was proper application of prophylactic antibiotics.

### Duration of prophylactic use of antibiotics

According to the “guiding principles for clinical application of antibiotics”, the antibacterial effect of antibiotics should cover the whole surgical procedures and 4 h after surgery but lasts no longer than 24 h. In certain patients, this effect can last longer than 48 h. When the duration of clean surgery is short (<2 h), pre-operative use of antibiotics once is enough. In the present study, application of antibiotics was performed at <2 days in 69 cases (3.45%), at 3 to 7 days in 115 cases (10.25%) and > 7 days in 51 cases (2.55%). In the majority of patients, the duration of prophylactic application of antibiotics was longer than 48 h, showing a relatively long use of prophylactic antibiotics. In addition, oral administration of antibiotics replaced intravenous treatment with antibiotics, which was improper strategy for infection prevention. The clinicians should perform prophylactic use of antibiotics according to the recommendations in The “guiding principles for clinical application of

antibiotics”.

### Refining the management measures for prophylactic use of antibiotics in clean operative procedures

The current “guiding principles for clinical application of antibiotics” is not strict in the prophylactic use of antibiotics and the management measures do not involve the principles for every type of surgery. Consequently, the ratio of an inappropriate antibiotic usage in our hospital is high and the antibiotic consumption ratio is excessive. Therefore, it is necessary to develop management measures for prophylactic use of antibiotics for our hospital in the co-operation of Pharmacy Division and Department of Surgery based on the “guiding principles for clinical application of antibiotics”, which may help to standard the application of prophylactic antibiotics. In addition, the inspectors should irregularly sample and analyze the cases receiving prophylactic use of antibiotics, present the results to organization of rational use of medicines and supervise the proper application of antibiotics.

### Conclusion

The antibiotic in the Department of Surgery is a double-edged sword. The proper application of antibiotics can not only effectively prevent post-operative infection and promote recovery but avoid waste of resources. However, improper application of antibiotics may not only cause drug resistance but result in unwanted damage to patients.

### REFERENCES

- Auerbach AD (2001). Prevention surgical site infections. In: Shozania KG, Duncan BW, McDonald KM et al, editors. Making health care safer: a critical analysis of patient safety practices. Evidence Report/Technology Assessment 43. AHRQ Publication 01-EO58. Rockville, MD: Agency for Healthcare Research Quality, pp. 221-244.
- Chen XQ, Jin YY, Tang G (2005). New pharmacology. 15th Edition. Beijing: People's Medical Publishing House. p. 87.
- Chinese Medical Association, Pharmacy Professional Advisory Committee of Chinese Hospital Association, Hospital Pharmacy Advisory Committee of Chinese Pharmaceutical Association (2005). Guiding Principles for Clinical Application of Antibiotics. *Adver. Drug. React. J.*, 7(5): 42
- Classen DC, Evans RS, Pestotnik SL, Horn SD, Menlove RL, Burke JP (1992). The timing of prophylactic administration of antibiotics and the risk of surgical-wound infection. *N. Engl. J. Med.*, 326:281-286.
- Collaborative Group (2003). Guidance for Application of Antibiotics for Prevention of Surgical Infection (Draft). *Chin. J. Surg.*, 41(7): 552-554
- Dellinger EP, Gross PA, Barrett TL, Krause PJ, Martone WJ, McGowan JE, Sweet RL, Wenzel RP (1994). Quality standard for antimicrobial prophylaxis in surgical procedures. *Infectious Diseases Society of America. Clin. Infect. Dis.*, 18(3): 422-7.
- Evirgen O, Onlen Y, Ertan O (2011). The intensity of antibiotic usage in the university hospital and the investigation of an inappropriate use of antibiotics. *Bratisl. Lek. Listy.*, 112(10): 595-8
- Cipolla D, Giuffrè M, Mammina C, Corsello G (2011). Prevention of

- nosocomial infections and surveillance of emerging resistances in NICU. *J. Matern. Fetal. Neonatal. Med.*, 24: 23-6.
- Hauser CJ, Adams CA, Eachempati SR (2006). Council of the Surgical Infection Society. Surgical Infection Society guideline: prophylactic antibiotic use in open fractures: An evidence-based guideline. *Surg. Infect. (Larchmt)*, 7(4): 379-405.
- Page CP, Bohnen JM, Fletcher JR, McManus AT, Solomkin JS, Wittmann DH (1993). Antimicrobial prophylaxis for surgical wounds: guidelines for clinical care. *Arch. Surg.*, 128(1): 79-88.
- Polk HC, Lopez-Major JF (1969). Postoperative wound infection: a prospective study of determinant factors and prevention. *Surgery*, 66: 97-103.
- Surgery Branch of Chinese Academy of Medical Sciences, Editorial Board of Chinese Journal of Surgery (2006). Guideline for Perioperative Antibiotic Prophylaxis. *Chin. J. Surg.*, 44(23): 1594.