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ORIGINAL ARTICLE

Implementation of a hospital-wide project for appropriate antimicrobial prophylaxis

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Abstract The aim of this study was to confirm the effect of implementing a hospital-wide project for appropriate use of antimicrobial prophylaxis (AMP) to reduce the rate of antibiotic-resistant organisms. Fifteen different manuals for each surgical department have been simultaneously implemented since February 2007. Compliance rate was compared between pre- and postintervention periods (3 months for each period). As an effect of this intervention, we analyzed changes in the rates of *Pseudomonas aeruginosa* and methicillin-resistant *Staphylococcus aureus* among organisms isolated postoperatively. The number of operations was 1,627 in both periods. Among patients whose surgeries were longer than 3 h in duration, 75% received an additional intraoperative antimicrobial dose in the postintervention period and 23% in the preintervention period ($P < 0.001$). Although most patients received postoperative AMP with an interval of q12 h in the preintervention period, 63% of the patients received AMP with an interval of q8 h in the postintervention period. The duration of AMP use was reduced from 2.4 ± 1.9 to 1.6 ± 1.5 days ($P < 0.001$). Forty-seven percent of patients discontinued AMP within 24 h and 81% within 48 h. Isolation rates of *P. aeruginosa* among all gram-negative organisms significantly decreased from 13% (68/538 patients) to 7.3% (37/509 patients) ($P = 0.004$). Execution of a hospital-wide project to promote the appropriate use of AMP, including shortening the duration of AMP use, was useful to decrease the rate of *P. aeruginosa* isolated postoperatively.

Keywords Antimicrobial prophylaxis · Antibiotic resistance · *Pseudomonas aeruginosa* · Methicillin-resistant *Staphylococcus aureus*

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Introduction

Perioperative antimicrobial prophylaxis (AMP) has proven to be effective in reducing the incidence of surgical site infections (SSI) in many operative procedures [1–3]. However, inappropriate use of AMP, in terms of prolonged duration and use of incorrect antibiotics, develops resistant microorganisms [4]. Especially in Japan, prolonged administration of antibiotics has been a nationwide issue of concern regarding AMP [5]. In addition, incorrect timing of prophylaxis and the lack of re-dosing for prolonged surgery reduces its efficacy [6]. Therefore, the quality of AMP has been the subject of many audits and intervention studies, and national guidelines have been developed to support its correct use.

Wick et al. [7] have suggested that the implementation of quality measures was useful to reduce SSI in colorectal patients. van Kasteren et al. [8] found that the intervention led to improved quality of surgical prophylaxis and reduced antibiotic use and costs without impairing patient outcome. Manniën et al. [9] reported that the overall SSI rate tended to decrease from 5.4% to 4.5% with the

intervention of an optimized and restrictive antibiotic prophylaxis policy.

Although many articles have demonstrated the effectiveness of intervention using AMP, the target of those studies was limited to surgical wards [1, 3, 4, 7, 10, 11]. Few reports of hospital-wide attempts to improve AMP use have been presented [8, 9, 12]. In addition, the endpoints of most studies were the reduction of SSI. Few studies have confirmed the reduction of postoperative infection with antimicrobial-resistant organisms, such as *Pseudomonas aeruginosa* or methicillin-resistant *Staphylococcus aureus* (MRSA) by appropriate AMP.

The combination of effective antimicrobial stewardship with a comprehensive infection control program has been shown to limit the emergence and transmission of antimicrobial-resistant bacteria. In our institution, hospital-wide intervention using AMP was conducted by the antimicrobial stewardship team. The purposes of this study were to evaluate the results of the intervention on the adherence to AMP manuals (process outcome) and the effect on the rate of antibiotic-resistant organisms isolated from postoperative infections (clinical outcome).

Patients and methods

This study was conducted in the Hospital of Hyogo College of Medicine (1,044 beds). This prospective intervention study, with a before-and-after design, was performed in 15 different surgical departments. The antimicrobial stewardship team from the Department of Infection Control and Prevention prepared 15 individual manuals, 1 for each department, in December 2006. An infection control doctor and certified pharmacist prepared the manuals with a physician in each department during a period of 1 month. With approval of the revised manuals by the physicians and chief surgeons in each department, appropriate use of AMP according to the manuals began simultaneously in the 15 surgical departments in February 2007. These procedures were performed in the following departments: neurosurgery, urology, dermatology, 1st (Hepato-biliary Pancreatic Department of Surgery) and 2nd (Lower Gastrointestinal Department of Surgery) departments of surgery, orthopedic surgery, nephrology, cardiovascular surgery, otolaryngology, dental surgery, obstetrics and gynecology, thoracic surgery, ophthalmology, emergency and critical care medicine, and plastic surgery.

The criteria for inclusion in the study were clean or clean-contaminated wounds. Patients with nonperforated or nongangrenous appendicitis were included in the study. Exclusion criteria were as follows: procedures for which AMP is generally accepted as unnecessary, operations classified as contaminated or dirty wounds, patients with an allergy to beta-lactam antibiotics, patients with renal dysfunction, and patients less than 12 years old.

The manual recommends the selection of an inexpensive nontoxic antibiotic with a limited spectrum, an intravenous single dose for clean wounds, and discontinuation of AMP within 1 day for clean-contaminated wounds. As exceptions, more than 1-day prophylaxis was permitted in cardiovascular surgery, pancreaticoduodenectomy, thoracic esophageal resection, and reconstructive surgery of the head and neck. Selection of antibiotic agents was determined depending on each surgical procedure. AMP was administered within 60 min before the incision, and repeated dosing was recommended when surgery continued for more than 3 h after the first dose; thereafter, additional doses were administered every 4 h intraoperatively. Although nurses administered AMP under the direction of a surgeon in the preintervention period, an anesthesiologist took charge of AMP in the operating suite in the postintervention period.

Data were collected between February 2006 and April 2006 (preintervention period) and between February 2007 and April 2007 (postintervention period). Data were extracted from medical, anesthetic, and nursing records and the hospital pharmacy database. To identify an improved process outcome, the rate of patients who initiated AMP within 60 min before the incision, the rate of patients who received appropriate additional AMP for prolonged surgery, the rate of patients with an adequate interval of administration of AMP (q8 h) after surgery, and the duration of AMP were compared between pre- and postintervention periods. The appropriateness of AMP was determined by the "Guideline for prevention of surgical site infection, 1999," established by the Hospital Infection Control Practices Advisory Committee [13], and "Guidelines for implementation of clinical studies on surgical antimicrobial prophylaxis (2007)" [14].

Antimicrobial use was analyzed quantitatively by calculating the defined daily doses (DDD) per 100 operative procedures. DDDs were obtained from the ATC/DDD Index 2003 of the WHO Collaborating Center for Drugs Statistics Methodology [15]. Total antibiotics costs were calculated from the price of drugs from the Japanese manufacturer's price list. As a clinical outcome of intervention, we investigated the rates of *Pseudomonas aeruginosa* and MRSA among all postoperative isolates in surgical departments between pre- and postintervention periods. Monthly isolation of these antibiotic-resistant organisms over time was also evaluated.

After the postintervention period, each department received feedback of its AMP data. The department's auditing report was discussed with surgeons, anesthetists, pharmacists, microbiologists, and nurses. In addition, educational meetings were organized for medical staff.