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Quality Improvements of Antimicrobial Prophylaxis in Coronary Artery Bypass Grafting

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Background. **Although the principles of antibiotics prophylaxis are well established, more than 60% of hospitals that joined the international quality indicator project failed to discontinue the use of prophylactic antibiotics within 24h after coronary artery bypass grafting (CABG). Our specific aims are to disseminate the gain obtained from breakthrough series model in knee arthroplasty and abdominal hysterectomy to increase the rate of prophylactic duration not longer than 24h in patients with CABG.**

Methods. **The control and intervention groups enrolled 55 and 78 patients with CABG before and after the project. Measurements were prophylactic interval and duration, surgical site infection, hospital and antibiotics costs. Two strategies were developed. The key cardiac surgeon was invited to attend quality improvement activities. Knowledge and rationale of medical quality indicators would thus be communicated. Secondly, we proposed a regional symposium in which a level of competition was subconsciously established, and practitioners would present their level of compliance.**

Results. **Instances of prophylactic interval within 1h prior to incision were significantly increased from 66.7% to 97.4%. Rates of prophylactic duration less than 24h were significantly increased from 2.8% to 66.1%. The average hospital cost was reduced by 16.4%, and antibiotics cost was reduced by 91.8%. No significant changes in surgical site infection within 30 d of CABG were observed.**

Conclusions. **We successfully disseminated the gain of breakthrough project in improving antimicrobial prophylaxis to CABG. By implementing this model, we are able to optimize the timing and duration of antimicrobial prophylaxis in patients with CABG to a level above worldwide average.**

Key Words: **prophylactic antibiotics; breakthrough model; medical quality; international quality indicator project; Taiwan quality indicator project; coronary artery bypass grafting.**

INTRODUCTION

Timing and duration of antibiotic prophylaxis are important determinants for the effectiveness of the prophylaxis [1–9]. National Surgical Infection Prevention Projects of United States suggested infusion of the first antimicrobial dose should be stated within 60 min before surgical incision and prophylactic antimicrobial agents should be discontinued within 24 h of the end of surgery [10]. A recent review in surgical infection regarding appropriate use of antibiotics in cardiac surgical procedures showed that prolonged antibiotic use (>48 h) failed to improve surgical site infection rates (SSI), but increased antimicrobial resistance and developed of *C. difficile* diseases [11]. Harbarth *et al.* found that continuing antimicrobial prophylaxis beyond 48 h after coronary artery bypass graft (CABG) surgery was ineffective in reducing SSI. It also increased antimicrobial resistance, and, therefore, should be avoid [12]. Guidelines of the Society of Thoracic Surgeons for antibiotic delivery for cardiac surgery concluded that antibiotic prophylaxis of 48 h duration was effective and single-dose prophylaxis or 24 h prophylaxis might be as effective as 48 h prophylaxis [13]. Manian *et al.*

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further demonstrated that duration of postoperative antibiotic treatment of more than 1 d was significantly associated with methicillin-resistant *Staphylococcus aureus* (MRSA) SSI [14] . Percentage of patients with antibiotics discontinued within 24 h post-operation had therefore become an important measure for compliance with Medicare Guidelines for CABG surgical infection prevention [9].

However, data from International Quality Indicator Projects (IQIP) showed that only 37.74% of patients with CABG surgery in the fourth quarter of 2008 had their prophylactic antibiotics discontinued within 24 h of incision. Most cardiac surgeons argue that [11] the cardiac surgical population differs from all others by virtue of the use of cardiopulmonary bypass and systemic hypothermia, the relatively long operative times, and the frequent use of central venous access and indwelling tubes. As a result, it has become common practice among many cardiac surgeons to continue prophylactic antibiotics for extended lengths of time. Not surprisingly, cardiovascular surgeons in our hospital also do not feel confident in reducing duration of prophylactic antibiotics to 24 h.

We joined an inaugural Breakthrough Quality Improvement Project in Taiwan between September and November of 2006. The project was held by the Taiwan Joint Commission on Hospital Accreditation to improve the antimicrobial prophylaxis for knee arthroplasty and abdominal hysterectomy. Six teams from different areas of Taiwan were invited. The original Breakthrough Series (BTS) model developed by Institute for Health Improvement (IHI) in Massachusetts was followed. The BTS was an interdisciplinary learning process to bridge the gaps in daily clinical care. It stressed collaboration and execution of established recommendations. Our results showed that instances of prophylactic timing within 1 h prior to incision were significantly increased from 59.5% to 87.6% for knee arthroplasty ($n = 192$) [15] and 69.3% to 92.4% for abdominal hysterectomy ($n = 72$) [16]. The proportions of patients with prophylactic duration less than 24 h were significantly increased from 0% to 14.7% and 25% to 100%, respectively. The length of hospital stay, hospital costs, and antibiotic costs were all reduced. Basedon these achievements, we would like to implement the process and disseminate the gain to patients with CABG.

For demonstrating our model of improvement, Plan-Do-Study-Act (PDSA) cycle (Table 1) was used to present implementation of our quality improvement measure. It was also known as the Deming cycle, Shewhart cycle, or Learning and Improvement cycle. The PDSA cycle is helpful to answer the questions of "What are we trying to accomplish?" and "How will we know that a change is an improvement?" It also helped us in developing a change, testing or adapting to a change idea, implementing a change, and disseminating the change to the rest of system.

TABLE 1

Plan-Do-Study-Act Cycle

Plan	1. Objective
	2. Questions and predictions (why)
	3. Plan to carry out the cycle (who, what, where, when)
Do	4. Carry out the plan
	5. Document problems and unexpected observations
	6. Begin analysis of the data
Study	7. Complete the analysis of data
	8. Compare data with predictions
	9. Summarize what was learned
Act	10. What changes are to be made
	11. Continuous improvement
	12. Next cycle

METHODS

Plan

To improve the use of surgical prophylactic antibiotics in CABG, including (1) to increase the proportion of patients with antimicrobial prophylaxis initiated within 1 h before incision; (2) to increase the proportion of patients whose antimicrobial prophylaxis is discontinued within 24 h after incision; (3) to decrease the hospital stay and cost of antimicrobial usage in the division of cardiovascular surgery of a 1000-bed tertiary-care hospital in eastern Taiwan. Three cardiac surgeons and nine cardiologists are available in this hospital. Concurrent regional population is around 577,415 people.

Do

Pervious strategies and processes learned from knee arthroplasty and abdominal hysterectomy were implemented to CABG. The major changes are that we become more focused on the motivation of cardiac surgeons in CABG antimicrobial prophylaxis.

1. The key cardiac surgeon was invited to attend regular institutional quality improving activities. Knowledge and rationale of medical quality indicators were purposely delivered.
2. A regional symposium on surgical prophylactic antibiotics was held according to the schedule of key cardiac surgeon to guarantee his attendance. Nationally well known experts in surgical infection control were invited to give talks regarding antimicrobial prophylaxis.
3. Recommendations compatible with adequate references [10, 12–14, 17] were provided to change the original behavior in surgical antimicrobial prophylaxis for CABG patients. It is recommended to use cefazolin 1 g, intravenous infusion 3–5 min, for patients with body weight less than 80 kg (2 g if BW $>$ 80 kg) 30–40 min prior to incision. Same dose of cefazolin are administrated every 3 h before surgical wound closure. The antibiotic is discontinued before 24 h after the initial dose and no oral antibiotic is prescribed. For patients who are allergic to β-lactam, clindamycin and vancomycin are considered. However, the infusion time required is 10–60 min for clindamycin and more than 60 min for vancomycin.
4. Organizing a team in which senior leader (superintendent), supporting units (administrating, financial, information techniques, and other technical expertise, etc.), system leader