



# Surgeons' adherence to guidelines for surgical antimicrobial prophylaxis – a review

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## REVIEW

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## Abstract

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Surgical site infections are the most common nosocomial infection among surgical patients. Patients who experience surgical site infections are associated with prolonged hospital stay, rehospitalisation, increased morbidity and mortality, and costs. Consequently, surgical antimicrobial prophylaxis (SAP), which is a very brief course of antibiotic given just before the surgery, has been introduced to prevent the occurrence of surgical site infections. The efficacy of SAP depends on several factors, including selection of appropriate antibiotic, timing of administration, dosage, duration of prophylaxis and route of administration. In many institutions around the globe, evidence-based guidelines have been developed to advance the proper use of SAP. This paper aims to review the studies on surgeons' adherence to SAP guidelines and factors influencing their adherence. A wide variation of overall compliance towards SAP guidelines was noted, ranging from 0% to 71.9%. The misuses of prophylactic antibiotics are commonly seen, particularly inappropriate choice and prolonged duration of administration. Lack of awareness of the available SAP guidelines, influence of initial training, personal preference and influence from colleagues were among the factors which hindered the surgeons' adherence to SAP guidelines. Immediate actions are needed to improve the adherence rate as inappropriate use of SAP can lead to the emergence of a strain of resistant bacteria resulting in a number of costs to the healthcare system. Corrective

measures to improve SAP adherence include development of guidelines, education and effective dissemination of guidelines to targeted surgeons and routine audit of antibiotic utilisation by a dedicated infection control team.

### Key Words

Surgeon, adherence, compliance, surgical antimicrobial prophylaxis, antibiotic

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### What this study adds:

1. The surgeons' compliance to SAP guidelines and factors influencing the SAP guidelines adherence are thoroughly reviewed in the paper.
  2. It highlights that misuses of surgical prophylactic antibiotics are commonly seen around the globe and corrective measures are urgently needed to overcome the problem.
  3. It alerts the policy makers about various effective strategies to enhance the SAP adherence rate.
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### Introduction

Surgical site infections are the most common nosocomial infection among surgical patients.<sup>1</sup> The United States Centers for Disease Control (CDC) National Nosocomial Infection Surveillance (NNIS) system reported that 14% to 16% of nosocomial infections among hospitalised patients were contributed by surgical site infections, which were the third most frequently reported nosocomial infections.<sup>2</sup> Additionally, the National Healthcare Associated Infections prevalence survey conducted in Scotland from October 2005 to October 2006 revealed that surgical site infections were the second commonest healthcare associated infections, accounting for 15.9%.<sup>3</sup> Patients who experience surgical site infections are associated with prolonged hospital stay, rehospitalisation, increased morbidity and mortality, and costs.<sup>4,5</sup> Surgical site infections resulted in an average additional seven days of hospital stay and a cost of £3,246 per patient from one UK study.<sup>6</sup>



The introduction of antimicrobial prophylaxis has resulted in the reduction of surgical site infections. Surgical antimicrobial prophylaxis (SAP) refers to a very brief course of antibiotic given just before the surgery.<sup>1</sup> Thus, prophylactic antibiotic does not serve the purpose of preventing surgical site infections caused by postoperative contamination.<sup>1</sup> The goals of SAP are to reduce surgical site infection rates, using antibiotics based on evidence of effectiveness, minimising the alteration on the patient's normal bacterial flora, minimising adverse effects and causing minimal change to the patient's host defences.<sup>7</sup>

Guidelines for antibiotic prophylaxis have been designed worldwide to advocate the proper use of SAP.<sup>1,7-14</sup> For instance, the Greek Ministry of Health established a "Guidelines for Antimicrobial Prophylaxis and Therapy for Hospitalized Patients" in 2008.<sup>13</sup> Since the early 1990s, most hospitals in the Netherlands have implemented local hospital guidelines to improve the quality of SAP.<sup>14</sup> In USA, the American College of Cardiology/American Heart Association (ACC/AHA) have promulgated a guideline for antimicrobial prophylaxis in cardiac surgery.<sup>11</sup> The development of these guidelines was based on scientific evidence of the efficacy of SAP, which depends on several factors, including the selection of an appropriate antibiotic, the timing of administration, the dosage duration of prophylaxis and the route of administration.

Marginal differences appear between the SAP guidelines across countries and institutes.<sup>10-16</sup> These guidelines generally recommended that antimicrobial prophylaxis is indicated in surgical procedures associated with a high risk of infection (clean-contaminated or contaminated operations). Prophylaxis antimicrobials are not justified for clean procedures except those involving prosthetic placement due to the possibility of severe complications if postoperative infections involve the prosthesis. SAP is indicated for the following types of surgical procedures: cardiothoracic, gastrointestinal tract, head and neck (except clean procedures), neurosurgical, obstetric or gynaecologic, orthopaedic (except clean procedures), urologic, and vascular. Broad-spectrum agents are generally discouraged as there is limited evidence that such antibiotics are more effective than other options<sup>9</sup> and the widespread use of newer and broad-spectrum antibiotics may promote the emergence of antimicrobial resistant bacteria and super-infections.<sup>17,18</sup> Fukatsu et al. found that inappropriate use of third-generation cephalosporins for surgical prophylaxis was the major cause of the methicillin-resistant staphylococcus aureus (MRSA) outbreak in a ward.<sup>17</sup>

The efficacy of SAP relies on the timing of the drug administered so that bactericidal concentrations are

established in serum and tissues when an incision is made, and therapeutic concentrations in serum and tissue are maintained throughout the operation until at most a few hours after wound closure in the operating theatre.<sup>19</sup> A prospective clinical trial by Classen et al. showed that too early (2 to 24 hours before incision) or too late (during 3 hours and 3 to 24 hours after incision) delivery of the selected antibiotic were associated with a higher incidence of surgical site infections, 3.8%, 1.4% and 3.3% respectively as compared to 0.6% when antibiotics were received during two hours before incision.<sup>20</sup> Generally, the SAP guidelines recommended that the time of antimicrobial administration should be within 30–60 minutes before the skin incision.<sup>8, 11,14-16</sup>

Concerning the duration and dosage of prophylaxis, SAP guidelines generally recommended a single standard intravenous therapeutic dose of antibiotic in the majority of procedures.<sup>1,8,9,11</sup> Repeated doses were only indicated in special circumstances like prolonged surgery with a duration longer than the half-life of the antibiotic used or in major blood loss. This recommendation is based on published evidence, which suggested that short-duration prophylaxis is equally effective as longer-duration administration in preventing surgical site infections.<sup>1,9,10</sup> Studies also show that prolonged use of prophylaxis can lead to the emergence of resistant bacteria strain.<sup>21-23</sup> However, there is misconception among surgeons regarding the need for prolonged administration of antibiotic prophylaxis.<sup>24</sup>

Despite the emergence of antimicrobial-resistant bacteria, inappropriate SAP administration result in a number of further costs to the healthcare system. Ozugan et al. and Gorecki et al. reported an expense of US \$26,230.20 and US \$18,533 for inappropriate SAP use respectively.<sup>25,26</sup> In Malaysia, a direct cost of US \$12,057 due to inappropriate SAP used was reported by Gul et al.<sup>27</sup> Sasse et al. also reported that a potential saving of US \$6.1 million could be made if SAPs were given according to recommendations.<sup>28</sup> These additional expenses were associated with inappropriately prolonged duration of prophylaxis and irrational used of expensive agents when cheaper but equally effective drugs are available.<sup>25-28</sup>

#### **Aim of the review**

This paper aims to review the studies on surgeons' adherence to SAP guidelines and the factors influencing their adherence.

#### **Method**

A literature search was performed from September to December 2011 to identify published studies on the



surgeons' compliance to SAP guidelines and/or the factors influencing their adherence. The search strategy involved the use of Boolean connectors for combination of the terms 'surgeon', 'adherence', 'compliance', 'surgical', 'antimicrobial', 'antibiotic', 'prophylaxis', 'guideline', 'protocol' and 'influencing factor'. The search was limited to full text articles published in the English language from 1980 until December 2011. The year 1980 was the starting point as we could not retrieve any full text article before then. Electronic databases searched were those available in the authors' institution's library which included: Scopus, ISI Web of Knowledge, Pubmed, Science Direct, Springer Link, Proquest, Ebsco Host and Google Scholar. After excluding all the irrelevant articles and duplicated citations, a total of 25 articles<sup>10,14-16,18,25-27,29-45</sup> were included in the present review.

### Studies exploring surgeons' adherence to SAP guidelines

Evaluation of surgeons' compliance with SAP guidelines have been carried out in many institutions. A wide variation of overall adherence was noted, ranging from 0% to 71.9% in various types of surgical procedure.<sup>10,14-16,18,25-27,29-43</sup> However, the majority of the studies revealed an overall compliance of less than 50%.<sup>14-16,18,25,26,32-36,42,43</sup> A multicentre audit of elective procedures in 13 Dutch hospitals (n = 1,763) reported that only 28% of the procedures achieved full adherence to all parameters of the local hospital guidelines, which include choice of antibiotic, duration, dose, dosing interval and timing of first dose.<sup>14</sup> Several studies identify variable compliance rates between 26% to 41.7%.<sup>32,33,42</sup> Most of the studies observed a high frequency of inappropriate choice of antibiotic<sup>15,16,18,32,34,39,40</sup>, timing of administration<sup>10,14,15,34,39,42</sup> and duration of prophylaxis.<sup>10,15,16,26,27,33,34,36,38,42</sup> The indication of antimicrobial prophylaxis<sup>15,16,18,32-34,37</sup> and dosage of antibiotic<sup>14,15,31,32,40</sup> in most studies was more satisfactorily compliant than other criteria.

Studies assessing the proper indication for SAP found a variation of adherence rate from 68% to 100%.<sup>15,16,18,32-34,37</sup> The use of antibiotic prophylaxis for clean non-prosthetic uncomplicated surgery was noted in these studies although this practice is restricted by the SAP guidelines. Tourmousoglou et al. evaluate the adherence of general surgeons to national guidelines and found that prophylaxis was inappropriately given to 19% of patients who underwent clean operations such as inguinal hernia repairs without a mesh, breast operation and thyroidectomies.<sup>33</sup>

One of the common failings of antimicrobial prophylaxis adherence to guideline is the inappropriate choice of antibiotic. Most of the study findings demonstrated an adherence rate of less than 70% with respect to selection of antibiotic.<sup>15,16,18,32,34,39,40,42</sup> Whereas, only a few studies revealed that the selection of antibiotics was appropriate in

more than 80% of the surgical procedures.<sup>10,14,37,38</sup> The main discord with the SAP guideline was the use of agents having a broader spectrum of activity than recommended (third-generation cephalosporins, quinolones or amoxicillin-clavulanic acid instead of first- and second-generation cephalosporins).<sup>15,16,18,32,34,39,40,42</sup> A study by Askarian et al. using the American Society of Health-System Pharmacists (ASHP) guideline as a reference found that of 835 patients for whom a single agent was indicated, 595 (71.3%) received combination of two or more antibiotics.<sup>34</sup>

The surgeons' adherence to the timing of SAP administration ranged from 22.3% to 100%.<sup>10,14,15,18,26,29-32,34,36,38,39,42</sup> Among these studies, the administration of antibiotic prophylaxis was observed to be delayed or delivered too early. An observational study carried out by van Disseldorp et al. on 211 SAP therapies found that 63% were administered after the procedure, with an average delay of 6.9 hours while 15% of the antibiotics were administered on average of 8.8 hours before surgery.<sup>15</sup> A prospective study conducted by Lallemand et al. in 18 hospitals revealed that 61.4% of the patients who did not receive prophylaxis at the optimal time received it too late.<sup>18</sup> Another study of 236 patients who underwent cardiac surgery showed that 99.1% of these patients received prophylaxis within 60 minutes prior to skin incision as recommended by guidelines, but 97.0% of them received an unnecessary midnight dose of intravenous antibiotic the night prior to surgery.<sup>16</sup>

Considering the duration of antimicrobial prophylaxis, the concordance with the SAP protocol ranged from 0% to 98%, with most of the study findings showed a less than 50% compliance rate.<sup>10,14-16,18,26,30-34,36-40,42</sup> Prolonged duration of antimicrobial prophylaxis which led to unnecessary extra cost was commonly observed among the studies. A retrospective study by Gorecki et al. in a teaching hospital noted that the average duration of antimicrobial prophylaxis after 132 elective and 79 emergency operations was 3.3 and 5.7 days respectively. The total cost of these excessive duration SAP was US \$18,533.<sup>26</sup> Another study by Askarian et al. found an extra cost of US \$8,332 because of non-adherence to ASHP guideline with regards to prolonged duration of antimicrobial prophylaxis.<sup>34</sup> In this study, the duration of prophylaxis was consistent with the guideline recommendation for 5.8% (n = 53) of 908 patients for whom antimicrobial prophylaxis was both indicated and given. The average duration of SAP for the remaining 855 patients was 6.1 days.<sup>34</sup>



Most studies revealed an adherence rate of 80% or more for surgeons' compliance to the dosage of prophylaxis therapy.<sup>14,15,31,32</sup> A prospective audit of 1636 elective procedures in 13 Dutch hospital reported that the antibiotic dose was concordant with the local hospital guidelines for 89% (n = 1461) of the procedures.<sup>14</sup> Higher dose were administered in 8% (n = 123) of the procedures while lower dose were given in 1% (n = 15) of the surgery.<sup>14</sup>

#### **Studies exploring factors influencing SAP guidelines adherence**

The wide range of surgeons' adherence rate to SAP guidelines may be due to a variety of factors. The main barriers discussed by Van Kasteren et al. include lack of awareness of appropriate guidelines due to ineffective distribution of latest version, lack of consensus by the surgeons with the recommendation in the guidelines and logistical constraints in the surgical suite and in the ward.<sup>14</sup> Pons-Busom found that the reasons for non-adherence included unawareness of guidelines, disagreement with guidelines, forgetting that a SAP guideline had been developed and underestimation of infection rate.<sup>44</sup> Surgeons were also noted to have a misconception that high-end or multiple antibiotics and prolonged therapy are more effective in preventing surgical site infection when compared to a short course of narrow spectrum antibiotic.<sup>40</sup>

A study was conducted in Philippine General Hospital to evaluate the surgeons' knowledge and attitudes on the surgical antimicrobial prophylaxis guidelines.<sup>43</sup> The result showed that 46% of surgeons sampled had fair knowledge of the general SAP guidelines and 92.7% surgeons agreed that guidelines are good educational tools and also a convenient source of advice. Although quite a high number of surgeons claimed using clinical practice guidelines as a source of information for decision making, only 12.7% actually use the guidelines on a daily or weekly basis. A majority of surgeons (94.5%) stated that decision making relied on discussions with colleagues far more frequently than other information sources. Findings from the study concluded that although positive attitudes towards guidelines are shown, the impact on the practice is limited.<sup>43</sup>

In Canada, a survey has been carried out by Davis et al. to explore the practices and attitudes of surgeons towards the prevention of surgical site infections.<sup>45</sup> Of 231 responding surgeons, a majority (37%) performed surgical site infection prevention procedures based on evidence-based recommendations, 30% based on what they were taught and 11% followed hospital regulations. This study noted that most surgeons used prophylaxis, but the duration of prophylaxis was prolonged (more than 24 hours).<sup>45</sup>

Hosoglu et al. revealed that source of information used and subsequent decisions made by Turkish surgeons (n = 463) were based on department protocol (31%) and knowledge from initial training (29%).<sup>42</sup> Only 9.6% of surgeons used national or international guidelines as a source of information in deciding antibiotic prophylaxis. Common problems acknowledged in this study were patients not covered by health insurance leading to inappropriate antibiotic prophylaxis, and low availability of antibiotics in the hospital pharmacy affecting the choice of antibiotic.<sup>42</sup>

A survey conducted among Malaysian general surgeons (n = 96) found 40 respondents (42%) claimed that their basis of drug scheduling was influenced by medical literature.<sup>41</sup> However, of these 40 surgeons, only 9.5% administered a single dose of prophylactic antibiotic. Other factors affecting their drug scheduling was hospital guidelines (32%), personal preference (22%) and similar scheduling by colleagues (4%).<sup>41</sup> Around 30% of surgeons mentioned that there was no antibiotic policy at their hospital. This finding suggested that formal SAP protocols are either unavailable or poorly disseminated at their hospital.<sup>41</sup>

#### **Strategies to enhance SAP adherence**

Studies have been conducted in various institutes to facilitate the surgeons' adherence to SAP protocol.<sup>25,44,46,47</sup> Pons-Busom et al. developed a local guideline for antibiotic prophylaxis in elective surgery in a teaching hospital and performed a periodic cross-sectional audit on compliance with the guideline.<sup>44</sup> A multidisciplinary team which including an internist, a clinical microbiologist, and a pharmacist was formed to establish this guideline. The guideline was modified accordingly after being reviewed by members of an infection control committee and all surgeons. The final protocol was endorsed by the chair of the infection control committee and distributed to all surgical staffs. Fixed stocks of antibiotics were implemented in the operation rooms and an antibiotic prescribing form for SAP was developed. Antibiotics could only be supplied by the pharmacy upon request by using this form. The compliance with guideline increased significantly from 80.3% at the beginning of the study to 87.8% after one year.<sup>44</sup>

Educational intervention and a control system performed by the hospital pharmacist is one effective method to improve the SAP adherence. Gomez et al. implemented a control system in a teaching hospital by using a standardised SAP request form.<sup>46</sup> The form which included an automatic stop of prophylaxis was designed by the pharmacy and infection control department. The



use of this form was incorporated into the routine surgery schedule after an educational program was presented to all the surgical teams. Workshops, lectures and discussions were performed to educate the operation theatre, nursing and pharmacy staff in the use of this form. The form has to be completed for each surgical procedure and sent to the pharmacy. The pharmacy department will monitor and discontinue any course of SAP which was completed. Implementation of this system led to an improvement in the appropriate timing, duration and adequate antimicrobial regimen. The surgical site infection rate decreased from 3.2% to 1.9% after the establishment of this system.<sup>46</sup>

Improvement of SAP adherence was found in a prospective educational intervention study undertaken by Ozgun et al. in a university hospital.<sup>25</sup> In this study, data on inappropriate antimicrobial prophylaxis was collected, analysed and informed to the surgery teams. Separate discussion sessions were conducted to address the specific problems that occurred in each surgical branch.<sup>25</sup> Everitt et al. conducted an educational study targeting the choice and appropriate dosing of SAP for Caesarean operation.<sup>47</sup> A person-to-person education intervention was performed with all senior department leaders. A SAP order form which contained educational messages about appropriate antibiotic use was developed and implemented. There was a significant shift from the use of cefoxitin in 95% of the procedures to cefazolin in 100% of the operations at two years after the intervention, resulting in a cost-saving of US \$26,000 per year.<sup>47</sup>

## Conclusion

Studies from various countries have shown that optimal practice of SAP is not achieved. Compliance varied greatly from one hospital to another, by the parameter of prophylactic antibiotic such as indication, choice of agent, dose, timing, duration and types of procedure. Poor adherence has been observed particularly in the area of antibiotic selection, timing and duration of antimicrobial prophylaxis. The surgeons' adherence to SAP guidelines may be hindered by lack of awareness of available guidelines, lack of consensus with the guidelines, influence from initial training received in their medical school, personal preference, influence from their colleagues and lack of antibiotic policy implementation in the hospital. Findings from this review suggested that there is an urgent need to improve adherence to guidelines for SAP use. Development of local guidelines should be in collaboration with surgeons to achieve optimal adherence. An effective dissemination of guidelines should be ensured to reach the targeted surgeons. Educational programs such as seminars and workshops emphasizing the proper practice should be conducted from time to time to improve the degree of adherence. Other corrective measures

that can be employed include periodic auditing of surgical prophylaxis by the infection control team to enhance surgeons' adherence to recommended guidelines. Given a central role to the pharmacist in the administration, monitoring and intervention of antimicrobial prophylaxis is another effective solution to address the SAP adherence problem.

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## CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

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