Adherence to guidelines for antibiotic prophylaxis in general surgery: a critical appraisal

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Received 24 April 2007; returned 2 July 2007; revised 11 September 2007; accepted 2 October 2007

Objectives: To evaluate the adherence of general surgeons to guidelines for antimicrobial prophylaxis. This study was held from January 2000 until October 2000 in a General Surgery Clinic in a hospital in Athens, Greece.

Methods: Eight hundred and ninety-eight patients were enrolled and operated on electively. Questionnaires concerning demographic data, health status, type of surgery (clean and clean-contaminated) and parameters of antibiotic prophylaxis (antibiotic choice, route, dose, timing of first dose, timing of operative redosing and duration of prophylaxis) were completed.

Results: Of the patients, 44.8% underwent a clean surgical operation and 55.2% underwent a clean-contaminated surgical operation. Inguinal hernia repair and laparoscopic cholecystectomy were the commonest operations in each category. Second-generation cephalosporins were the most frequently prescribed antibiotics, in 67%. Although, only 78.5% of procedures required prophylaxis, it was administered in 97.5%, so it was not justified and inappropriately administered in 19%. It was revealed that 100% of patients received antibiotic prophylaxis on time. The choice of antimicrobial agent was appropriate in 70% and the duration of prophylaxis was optimal in 36.3%. The overall compliance rate of surgeons with guidelines for antibiotic prophylaxis was 36.3%.

Conclusions: Adherence to separate aspects of guidelines for surgical prophylaxis has to be improved. The duration of antibiotic prophylaxis was the main parameter of interest. Interventions have to be made about the development, distribution and adoption of adequate guidelines in collaboration with surgeons.

Keywords: compliance, antimicrobial prophylaxis, surgical operations

Introduction

Surgical-site infections are the second commonest nosocomial infection.¹ Up to 2% to 5% of patients undergoing clean extra-abdominal operations and up to 20% of patients undergoing intra-abdominal operations will develop a surgical-site infection.²

The basic principle of antimicrobial prophylaxis in surgery is to achieve adequate serum and tissue drug levels that exceed, for the duration of the operation, the MICs for the organisms that are likely to be encountered during the operation.³ The selection of an appropriate antimicrobial agent depends on the identification of the most likely pathogens that are associated with a specific surgical operation.³ The timing of antibiotic prophylaxis is considered to be optimal if it is administered between 30 and 60 min before incision.³ A single dose of an antimicrobial agent is sufficient for most surgical operations.⁵ The prolonged use of prophylactic antimicrobials is associated with the emergence of resistant bacterial strains.⁷

Although the principles of antimicrobial prophylaxis in surgery are clearly established and several guidelines have been published, the implementation of these guidelines is problematic...
among surgeons. The purpose of this study was to assess the adherence of general surgeons to major aspects of surgical prophylaxis in a large hospital in Greece.

Materials and methods

Study population

This prospective study was performed in the Department of General Surgery in a large hospital in Athens, Greece. From January 2000 until October 2000, 898 patients were included in the study. The population of the study was sequential. The criteria for inclusion in the study were the following: (i) all surgical operations were elective; and (ii) surgical operations were clean or clean-contaminated, according to the classification of the National Academy of Sciences—National Research Council criteria. In addition to this, patients with non-perforated or non-gangrenous appendicitis were included in the study. Patients were excluded from the study if they were operated on urgently and if their operations were classified as contaminated or dirty. The operations were performed by different surgeons during the period of 10 months.

Data collection

The study was conducted on a real-time basis. Files were reviewed while the patients were in the post-operative period and still in hospital. The collection of data for every patient was obtained from the first day of admission, pre-operatively and post-operatively, using pre-coded questionnaires. The questionnaire included personal data, medical history, the type of operation and details about antimicrobial surgical prophylaxis. The following aspects of surgical prophylaxis were examined: the antibiotic agent, the route of administration, the dosage, the timing of administration, the timing of operative redosing and the duration of prophylaxis. The surgeon-investigator did not intervene in patient’s care in any way.

The appropriateness of antibiotic prophylaxis was determined by ‘Guidelines for Antimicrobial Prophylaxis and Therapy for hospitalized patients’ that were composed by the Central Committee of Nosocomial Infections of the Greek Ministry of Health in 2000. This booklet provided recommendations about the usage of specific antimicrobials for certain operations and it was distributed to doctors by the Ministry of Health. A synopsis of ‘Guidelines for Antimicrobial Prophylaxis and Therapy for Hospitalized Patients’ is presented in Table S1 [available as Supplementary data at JAC Online (http://jac.oxfordjournals.org)].

There was no standard protocol in the wards or in the operating room, specifying antimicrobial agents for certain procedures, based on the interpretation of the guidelines.

The courses of antimicrobial drugs were evaluated. If more than one drug was prescribed for a single operation, all parameters for each drug were evaluated separately. Any divergence from the guidelines in the prescription of one of the drugs led to a final assessment of the prophylactic course as discordant with the guidelines. If an antibiotic was given while it was not indicated, the parameters such as antibiotic choice, dose, duration, dosing interval and timing were also evaluated.

Analysis

Data were entered and analysed with SPSS 11.0 (SPSS Inc., Chicago, IL, USA). Rates of baseline clinical characteristics are reported as means with SDs or frequencies and percentages. For discrete variables, \( \chi^2 \) or Fisher’s exact test were used. Comparison of continuous variables was performed with Student’s \( t \)-test or Kruskal–Wallis test. Significance levels were set at \( P < 0.05 \).

Results

Between January 2000 and October 2000, 898 patients were included in the study. Of these patients, 402 (44.8%) underwent a clean surgical operation and 496 patients (55.2%) underwent a clean-contaminated operation. The population of the study consisted of 496 men and 402 women. The mean age of the population was 58.8 ± 15.2 years (mean ± SD) and the range of ages was between 15 and 90 years old.

Inguinal hernia repair was the most frequent clean surgical operation (16% of clean operations) and laparoscopic cholecystectomy was the commonest clean-contaminated operation (24% of clean-contaminated operations). The duration of the majority of surgical operations (88.4%) did not exceed 3 h. Clean and clean-contaminated operations are summarized in Table 1.

Antibiotic prophylaxis was received by 876 patients (97.5%). Thirty different drugs or combinations of drugs were used. The most frequently prescribed categories of antibiotics were cephalosporins (74.7%) and penicillins (22%). Most patients (67%) received second-generation cephalosporins. The single drug that was most frequently used was ceforanide (31.2%). The antimicrobials that were used for prophylaxis are summarized in Table 2.

Antibiotic prophylaxis was indicated in 78.5% of patients, but in our survey, it was administered to 97.5% of patients so it was inappropriately given to 19% of patients, especially clean operations such as inguinal hernia repairs without a mesh, breast operations and thyroidectomies. Only 2.5% of patients did not receive antibiotic prophylaxis appropriately.

In our survey, three different parameters of appropriateness of prophylaxis such as the antimicrobial agent, the timing of administration of first dose and the duration of prophylaxis were assessed in 78.5% of operations. Antibiotic prophylaxis was justified and appropriately administered in these operations. Regarding the antimicrobial agent, 70% of patients (494/706) received an antimicrobial that was recommended by guidelines. Evaluating the timing of administration of first dose of prophylaxis, it was indicated that the anaesthesiologists administered the antimicrobials to all patients (100%) intravenously during induction of anaesthesia. Finally, regarding the duration of antimicrobial prophylaxis, 36.3% of patients (256/706) received antimicrobial prophylaxis according to the recommendations based on guidelines (one dose or two doses if it was necessary). Guideline adherence on antibiotic duration ranged from 36% in clean to 36.4% in clean-contaminated operations.

The mean duration of antibiotic prophylaxis was 2.6 ± 1.4 days with a wide range of variation from one or two doses of antimicrobials, if it was necessary, during the day of operation till more than 10 days. The duration of antimicrobial prophylaxis, for clean, clean-contaminated and the total number of operations, is summarized in Table 3.

The prolonged duration of antibiotic prophylaxis was the main parameter of interest in our study. From the evaluation of the three parameters, it was concluded that the compliance rate of surgeons with guidelines on antibiotic prophylaxis was 36.3%.
Analysing the compliance rates for the commonest surgical operations, it was obvious that they varied a lot. It was estimated to be 100% for laparoscopic inguinal hernia repairs, 96.6% for laparoscopic cholecystectomies, 66.6% for open inguinal hernia repairs and 0% for thyroidectomies. The compliance rates with guidelines on antibiotic prophylaxis are demonstrated for surgical operations (clean and clean-contaminated) in Table 4.

**Discussion**

The evidence for effectiveness of perioperative antibiotic prophylaxis is well established. Despite this, surveys have shown that optimal practice is not achieved in many hospitals.10

Three parameters of appropriateness of antibiotic prophylaxis such as antimicrobial agent, timing of administration of first dose and duration of prophylaxis were evaluated in our study. Seventy per cent of the patients received an antimicrobial regimen that was recommended by the guidelines. A substantial number of antimicrobials were used unnecessarily as 30 different drugs or combinations of drugs were used. Similar problems were described in a study from Belgium where 234 different regimens were used in the antimicrobial prophylaxis of 19 746 surgical patients.11 Overall, 100% of patients received antimicrobial prophylaxis on time in our study. This success was attributed to the routine of initiation of prophylaxis by anaesthesiologists at the time of induction of anaesthesia. The main parameter of interest in our study was the prolonged duration of antibiotic prophylaxis. Overall, only 36.3% of the patients received one or two doses of antibiotic prophylaxis where it was necessary, according to guidelines. Although existing evidence fails to support longer duration of usage of prophylactic antimicrobial agents, prolonged administration beyond 24 h is common.12 There is a major misconception among surgeons about the need for prolonged administration of antimicrobial prophylaxis.1 This item was analysed by Dr Barie during a roundtable discussion about ‘Antibiotic Prophylaxis in Surgery—2005 and Beyond’ and he clearly stated that ‘even though we have strong data, nothing seems to have changed. We cannot get surgeons to give up their post-operative prophylactic antibiotics’.13

A very interesting issue in our study was that the compliance rate with guidelines for antibiotic prophylaxis was 0% for colorectal, breast, thyroid and lung surgery. In aortic aneurysm repair, the compliance rate was lower than that in vascular surgery, although the same surgeons operated. We did not ask the vascular surgeons why that happened but we supposed that the reasons for that were the following: the fear of surgical-site...
infections, the complexity of operations and the extended duration of operations.

The guidelines, which were composed by the Greek Ministry of Health, clearly demonstrated the antibiotic agent, the duration and all the parameters for colorectal, breast, thyroid, lung, aortic aneurysm repair and the rest of surgical operations. In clean surgery (inguinal without a mesh, breast and thyroid surgery), antibiotic prophylaxis was not recommended.9,14 Besides in colorectal surgery, antibiotic prophylaxis should consist of mechanical bowel preparation and administration of parenteral antibiotics at induction of anaesthesia.3,15,16 Especially for colorectal surgery in our study, the most frequently prescribed antibiotic regimens were ceforanide with metronidazole (33 of 83 colorectal cases), piperacillin with metronidazole (19 of 83 cases) and cefamandole with metronidazole (17 of 83 cases). It was established that the compliance rate (0%) among GI surgeons was related principally to the duration of antibiotic prophylaxis as they gave antibiotics for many days. The surgeons were accustomed to following their ‘own guidelines’ as they had been trained in a wrong way in the past and it was counterintuitive for them to accept the new evidence and the new guidelines about antibiotic prophylaxis.17 Especially in clean surgery, the surgeons gave antibiotic prophylaxis in cases, even though it was not recommended.9,14 The surgeons were afraid of surgical-site infections so they used longer courses of antibiotics as they falsely believed that keeping antibiotics in the bloodstream of a post-operative patient was a good precaution against infection.17

The results from this study continue to document the challenges of disseminating evidence-based knowledge systematically into clinical practice. Testing the feasibility and acceptance of clinical guidelines among surgeons is very important for their effective implementation.18 Although guidelines are revised regularly, it is observed that there is a lack of awareness of these revised versions by surgeons. The electronic distribution of guidelines and the existence of a standard protocol specifying antimicrobials for specific operations on prescription charts in every ward and operating room would improve the whole situation.19

It is essential for surgeons to be aware of the results of their performance about their adherence to guidelines for antibiotic prophylaxis in order to get improvement. The results of our study should be discussed with the surgical teams and efforts should be made into evaluating why the surgeons did not follow the National Guidelines. The recommendations for improving the compliance of surgeons with Guidelines are presented in Table S2 [available as Supplementary data at JAC Online (http://jac.oxfordjournals.org/)].

If adherence to guidelines is not improved, it is clearly established that the incidence of surgical-site infections will increase and new antimicrobial-resistant bacteria will emerge.20,21 Surgical-site infections result in a number of costs: to the patient, to the healthcare system and to the community. In a study by Leaper et al., it was estimated that 30 million surgical procedures were conducted in Europe each year and the possible range for the number of cases of surgical-site infections per year fell between 450 000 and 6 000 000. These surgical-site infections could be costing European healthcare systems between 1.47 and 19.1 billion Euros.22

### Table 3. Duration of antibiotic prophylaxis

<table>
<thead>
<tr>
<th>Duration</th>
<th>Clean operations</th>
<th>Clean-contaminated operations</th>
<th>All operations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>1 dose or 2 doses, if necessary (day of surgery)</td>
<td>114</td>
<td>36</td>
<td>142</td>
</tr>
<tr>
<td>2–3 days</td>
<td>100</td>
<td>31.6</td>
<td>17</td>
</tr>
<tr>
<td>4–5 days</td>
<td>50</td>
<td>15.8</td>
<td>109</td>
</tr>
<tr>
<td>6–7 days</td>
<td>45</td>
<td>14.2</td>
<td>88</td>
</tr>
<tr>
<td>8–9 days</td>
<td>5</td>
<td>1.6</td>
<td>26</td>
</tr>
<tr>
<td>&gt;10 days</td>
<td>2</td>
<td>0.8</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>316</td>
<td>100</td>
<td>390</td>
</tr>
</tbody>
</table>

### Table 4. Compliance rates with guidelines on antibiotic prophylaxis in surgical operations

<table>
<thead>
<tr>
<th>Surgical operations</th>
<th>n/Na</th>
<th>Compliance rates (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laparoscopic inguinal hernia repair</td>
<td>7/7</td>
<td>100</td>
</tr>
<tr>
<td>Splenectomy</td>
<td>22/22</td>
<td>100</td>
</tr>
<tr>
<td>Vascular bypass</td>
<td>20/22</td>
<td>91</td>
</tr>
<tr>
<td>Embolectomy</td>
<td>12/18</td>
<td>66.6</td>
</tr>
<tr>
<td>Umbilical hernia repair</td>
<td>6/10</td>
<td>60</td>
</tr>
<tr>
<td>Diaphragmatic hernia repair</td>
<td>3/5</td>
<td>60</td>
</tr>
<tr>
<td>Inguinal hernia repair</td>
<td>24/36</td>
<td>66.6</td>
</tr>
<tr>
<td>Abdominal aorta aneurysm repair</td>
<td>2/48</td>
<td>4.2</td>
</tr>
<tr>
<td>Thyroidectomy</td>
<td>0/34</td>
<td>0</td>
</tr>
<tr>
<td>Breast surgery</td>
<td>0/15</td>
<td>0</td>
</tr>
<tr>
<td>Lung surgery</td>
<td>0/11</td>
<td>0</td>
</tr>
<tr>
<td>Laparoscopic cholecystectomy</td>
<td>114/118</td>
<td>96.6</td>
</tr>
<tr>
<td>Open cholecystectomy</td>
<td>20/106</td>
<td>18.9</td>
</tr>
<tr>
<td>Pancreatic surgery</td>
<td>2/15</td>
<td>13.3</td>
</tr>
<tr>
<td>Appendectomy</td>
<td>5/79</td>
<td>6.3</td>
</tr>
<tr>
<td>Gastric surgery</td>
<td>2/32</td>
<td>6.3</td>
</tr>
<tr>
<td>Liver surgery</td>
<td>0/4</td>
<td>0</td>
</tr>
<tr>
<td>Colorectal surgery</td>
<td>0/83</td>
<td>0</td>
</tr>
</tbody>
</table>

a/n/N, no. of patients who received antimicrobial prophylaxis according to guidelines/no. of patients undergoing operation.
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There are limitations in the study. The first limitation concerns the inclusion of appendectomies in the study population. The characterization of non-perforated and non-gangrenous appendectomies was based on surgeon’s judgement, as it was not possible to find the whole number of histological reports of the specimens of appendices. Another limitation is that only patients from one surgical clinic participated in the study so the results are representative only of one clinic.

In conclusion, this study showed that adherence to guidelines for surgical prophylaxis must be improved. To achieve optimal adherence, antibiotic policy makers should develop evidence-based guidelines in collaboration with surgeons, guarantee an effective distribution of guidelines and perform periodic cross-sectional analyses about their adoption in wards in the same hospital and also between hospitals.

Acknowledgements

Parts of this article were presented in abstract form at the Nineteenth European Congress on Surgical Infections, Athens, Greece, 2006.

Funding

This study was supported by internal funding.

Transparency declarations

None to declare.

Supplementary data

Tables S1 and S2 are available as Supplementary data at JAC Online (http://jac.oxfordjournals.org/).

References