ARCHIVES OF HELLENIC MEDICINE: ISSN 11-05-3992

ORIGINAL PAPER
ΕΡΕΥΝΗΤΙΚΗ ΕΡΓΑΣΙΑ

# Chemoprophylaxis and the consumption of antibiotics in surgical practice

ARCHIVES OF HELLENIC MEDICINE 2008, 25(5):605–608
ΑΡΧΕΙΑ ΕΛΛΗΝΙΚΗΣ ΙΑΤΡΙΚΗΣ 2008, 25(5):605–608

**K. Alexiou,**[1]
**G. Antsaklis,**[1]
**E. Konstantinidou,**[1]
**E. Giannitsioti,**[2]
**A. Antoniadou,**[2]
**J. Karanikas,**[1]
**H. Giamarellou**[2]

*[1]Department of Surgery, "Sismanoglion" General Hospital, Athens*
*[2]4th Department of Internal Medicine, University of Athens, Athens, Greece*

Χημειοπροφύλαξη και κατανάλωση αντιβιοτικών στη Χειρουργική

*Περίληψη στο τέλος του άρθρου*

OBJECTIVE **Surgical site infections (SSI) remain among the main causes of postoperative morbidity, prolonging hospitalization and increasing the cost of medical treatment in surgical units. In the present study the consumption of antibiotics was compared in a surgical department before and after the implementation of a pilot program, consisting of the administration of 1–3 doses of antibiotics to patients undergoing elective abdominal surgery.** METHOD **A pilot program was applied of the administration of antibiotic chemoprophylaxis to patients undergoing elective abdominal surgery. Administration of the first dose of antibiotic was made after the induction of anesthesia and up to two further doses of antibiotic were administered postoperatively. This regime was put into effect for a time period of two months (May and June 2002), after which the results were compared with the respective months of the previous year, before the program implementation (May and June 2001), in respect to the consumption and the cost of antibiotic treatment during patient's hospitalization.** RESULTS **Statistical analysis of the results showed a decrease of the hospitalization cost without increasing patient morbidity. In addition, the pilot program improved the effectiveness of the newer antibiotics restriction program, as their consumption was reduced by 53% and their acquisition cost by 47%.** CONCLUSIONS **Administration of chemoprophylaxis intraoperatively, with up to two doses postoperatively, can be safely applied in patients undergoing elective abdominal surgery, reducing the use of antibiotics and decreasing hospitalization cost, without affecting patient morbidity.**

**Key words**

Antibiotics
Chemoprophylaxis
Cost
Surgery

*Submitted 15.2.2007*
*Accepted 26.11.2007*

Postoperative surgical site infections (SSI) remain a major problem in surgery. Infective complications not only disrupt patients' postoperative course, but also increase the total expenses of hospital care. Antibiotic chemoprophylaxis in elective surgical procedures has been shown to reduce infective complications postoperatively.[1,2] Surgical prophylaxis guidelines include the administration of one dose of an antibiotic intraoperatively but this is often not implemented, leading to antibiotic overuse and misuse in surgical departments (>50% of total hospital overuse).[3] It is generally accepted that the unrational use of antibiotic regimes for the prevention of surgical infectious complications increases the likelihood of development of resistant bacteria. Such resistant bacteria may lead to combined and prolonged antimicrobial coverage,[4,5] which not only worsens the patients' clinical status, but also delays hospital discharge and increases expenses for both medical treatment and nursing.

The present study was performed in the Surgical Department of the "Sismanoglion" General Hospital of Athens, Greece when pilot program was put into effect. Antibiotic consumption in the clinic was compared before and after the pilot program, which consisted of the administration of 1 to 3 doses of antibiotics to patients undergoing elective abdominal surgical procedures.

## MATERIAL AND METHOD

### Patients

All patients who were candidates for elective abdominal surgery were considered eligible for the study. Patients were excluded from further consideration if there was a history of any antibiotic administration within 48 hours prior to surgery, if there was evidence of preexisting infection, and if the patient was pregnant or immunosuppressed.

## The pilot program

Comparison was made of the antibiotics prescribed and consumed (volume and cost), during the time period May and June 2001, before application of the pilot program, and during May and June 2002, i.e. the same time period, after the pilot program was put into effect. The specific time period was chosen because at this time most of the medical personnel had realized its usefulness and therefore had started the application of the chemoprophylactic antibiotic treatment in elective surgical procedures, instead of giving systematic antibiotic administration postoperatively. The parameters followed by the pilot program were: type of operation, prescribed antibiotics, time of administration of surgical prophylaxis (pre-, intra-, postoperatively) and total number of doses given as prophylaxis and SSI.

The pilot program included elective operative procedures of the upper abdomen (open and laparoscopic cholecystectomy, gastric surgery) and the lower abdomen (enterectomy, colectomy) and aimed in comparing 1 and 3 doses of prophylaxis. In all cases, patients received one dose of antibiotic intraoperatively intravenously and were randomly assigned to receive either two or no doses of antibiotic postoperatively. In upper abdominal procedures a second generation cephalosporin, either cefuroxime, or ceforanide was used, whereas in lower abdominal procedures ticarcillin-clavulanic acid was administered.

The total costs of antibiotic treatment for the two time periods were calculated from the records of the hospital procedures (43%) performed in May 2002 were included in the pilot program (23 of 37 abdominal procedures in total, i.e. 62%), while in June 2002 from a total of 55 patients only 26 elective abdominal procedures (47%) were included (26 of 32 abdominal procedures in total, i.e. 81%). The vast majority of patients, who were not included in the program, received more than 3 doses of antibiotics. Analysis of the data (tab. 1) showed a statistically significant decline in total antibiotic consumption by 19.5% between May 2001 and May 2002, and by 59% between June 2001 and June 2002 ($P<0.05$). Patients who were included in the pilot program and received a total of 1–3 doses of antibiotic did not present a higher proportion of postoperative SSI than patients who were operated on before the application of the pilot program, as no SSI were recorded during May–June 2002 (30 days follow-up).

The reduction of total antibiotic consumption in the surgical unit for the two time periods in 2001 and 2002 is represented in table 1.

## Cost of antimicrobial regimens-economic evaluation

The Information Technology Department of "Sismanoglion" General Hospital and the hospital pharmacy records provided the cost of the total antibiotics consumed in the surgical unit for the two time periods of May–June 2001 and 2002 (tables 2, 3).

When the pilot program was applied, the reduction in antibiotic consumption during the period May–June 2002 was considered to be cost-effective for the same period, as is shown in table 3. Comparing the results, the total cost effectiveness for antibiotic consumption for the period May–June 2002 was demonstrated by a 21% reduction of the hospital expenses for antibiotic acquisition cost. All the newer antibiotics (carbapenems, monobactams, third and fourth generation cephalosporins, quinolones,[6] glycopeptides, linezolid, synercid) were under an antibiotic policy restriction program[7] and not used for surgical prophylaxis.

The pilot program increased the effectiveness of the newer antibiotic restriction program, as their consumption was reduced by 53% and their acquisition cost by 47%.

**Table 1.** Comparison of daily defined doses (DDDs) of antibiotics/100 bed-days.

| | DDDs /bed-days (per 100 bed-days) | | Change | $x^2=4$ $P<0.05$ |
|---|---|---|---|---|
| | 2001 | 2002 | | |
| May | 777/1007=77.16 | 563/906=62.14 | -19.5% | |
| June | 710/1023=69.40 | 288/1005=28.65 | -59% | |

**Table 2.** Economic evaluation of total antibiotic consumption in the surgical unit, 2001.

| 2001 | May | June | Total |
|---|---|---|---|
| Antibiotic (cost in €) | 8,557.72 | 8,217.24 | 16,774.96 |
| Newer antibiotics under restriction (cost in €) | 5,068.57 | 3,877.69 | 8,946.26 |
| Total (€) | 13,626.29 | 12,094.93 | 25,721.22 |

**Table 3.** Economic evaluation of total antibiotic consumption in the surgical unit, 2002.

| 2002 | May | June | Total |
|---|---|---|---|
| Antibiotic (cost in €) | 7,911.67 | 7,661.50 | 15,573.17 |
| Newer antibiotics under restriction (cost in €) | 1,925.78 | 2,796.22 | 4,722.00 |
| Total (€) | 9,837.45 | 10,457.72 | 20,295.17 |

## DISCUSSION

Antimicrobial prophylaxis can lower the incidence of SSI after certain operations, thus reducing patient morbidity, hospital stay, antibiotic usage and mortality due to sepsis. An effective prophylactic regime should be directed against the most likely infecting organisms, but need not be active against every potential pathogen. Infection can be prevented when effective concentrations

are present in the blood and the tissue during and shortly after the procedure. Therefore, antimicrobial prophylaxis should begin just before the operation: beginning earlier is unnecessary and potentially dangerous, beginning later is less effective. A single-dose prophylaxis after the induction of anesthesia is sufficient.[8] In the present study second generation cephalosporins were used for upper abdominal procedures and tircacillin-clavulanic acid for lower abdominal procedures, according to microbial resistance rates in the specific settings. Antibiotic regimes were demonstrated to be effective prophylactic agents in the frame of the pilot program, while a significant decrease in hospitalization expenses was observed[9] through reduction in antibiotic cost. Several authors refer to third generation cephalosporins for prophylactic antibiotic administration, claiming a broad coverage against pathogenic bacteria, which ensures less likelihood of postoperative morbidity and ultimately more savings, avoiding major postoperative infections. Ceftriaxone in particular, far exceeds the sales and the cost of any other drug given for prophylaxis. Its use is justified in high-risk patients, but it is very difficult to identify such patients in elective procedures.[10] Most authors accept that second generation cephalosporins[11] and ticarcillin-clavulanic acid[12] in upper and lower abdominal surgery respectively are effective in preoperative chemoprophylaxis and also cost-effective,[13,14] as is also shown in this study. In this study, the application of the pilot program showed that one dose of prophylactic antibiotic, or a maximum of three doses in total, reduced total antibiotic consumption in the study unit and that was not only cost-effective but also safe for the patients.

In conclusion, administration of one or three doses of antibiotic as surgical prophylaxis is safe for the patients and contributes limiting non-rational antibiotic consumption in surgery. It also proves to be cost-effective, which is a very important parameter in patient hospitalization.

## ΠΕΡΙΛΗΨΗ


### Χημειοπροφύλαξη και κατανάλωση αντιβιοτικών στη Χειρουργική



Κ. ΑΛΕΞΙΟΥ,[1] Γ. ΑΝΤΣΑΚΛΗΣ,[1] Ε. ΚΩΝΣΤΑΝΤΙΝΙΔΟΥ,[1] Ε. ΓΙΑΝΝΙΤΣΙΩΤΗ,[2] Α. ΑΝΤΩΝΙΑΔΟΥ,[2] Ι. ΚΑΡΑΝΙΚΑΣ,[1] Ε. ΓΙΑΜΑΡΕΛΛΟΥ[2]

*[1]Χειρουργική Κλινική, «Σισμανόγλειο» Γενικό Νοσοκομείο, [2]4η Παθολογική Κλινική, Πανεπιστήμιο Αθηνών, Αθήνα*



*Αρχεία Ελληνικής Ιατρικής 2008, 25(5):605–608*



**ΣΚΟΠΟΣ** Οι λοιμώξεις του χειρουργικού πεδίου αποτελούν ακόμα στις ημέρες μας σημαντικό παράγοντα μετεγχειρητικής νοσηρότητας και συγχρόνως αιτία παράτασης των ημερών νοσηλείας και του κόστους της θεραπείας στις χειρουργικές μονάδες. Στην παρούσα μελέτη συγκρίθηκε η κατανάλωση των αντιβιοτικών σκευασμάτων σε μια χειρουργική κλινική πριν και μετά από την εφαρμογή ενός πιλοτικού προγράμματος, με τη χορήγηση 1–3 δόσεων αντιβιοτικών σε ασθενείς που υποβλήθηκαν σε προγραμματισμένη χειρουργική επέμβαση κοιλίας. **ΥΛΙΚΟ-ΜΕΘΟΔΟΣ** Εφαρμόστηκε ένα πιλοτικό πρόγραμμα χορήγησης μίας δόσης αντιβιοτικής χημειοπροφύλαξης σε ασθενείς που επρόκειτο να υποβληθούν σε προγραμματισμένη χειρουργική επέμβαση κοιλίας. Η χορήγηση της πρώτης δόσης έγινε με την εισαγωγή στην αναισθησία και χορηγήθηκαν έως και δύο επιπλέον δόσεις μετεγχειρητικά για το χρονικό διάστημα δύο μηνών (Μάιος και Ιούνιος 2002). Κατόπιν, συγκρίθηκαν οι αντίστοιχοι μήνες του προηγούμενου έτους πριν από την εφαρμογή του προγράμματος (Μάιος και Ιούνιος 2001), ως προς την κατανάλωση και το κόστος της αντιβιοτικής αγωγής στο σύνολο της νοσηλείας των ασθενών. **ΑΠΟΤΕΛΕΣΜΑΤΑ** Η στατιστική ανάλυση των αποτελεσμάτων ανέδειξε ελάττωση του κόστους νοσηλείας, χωρίς αύξηση των μετεγχειρητικών λοιμώξεων. Επιπλέον, η εφαρμογή του πιλοτικού προγράμματος αύξησε την αποτελεσματικότητα του προγράμματος των υπό περιορισμό αντιβιοτικών, καθώς η κατανάλωσή τους περιορίστηκε στο 53%, ενώ το κόστος τους στο 47%. **ΣΥΜΠΕΡΑΣΜΑΤΑ** Η χορήγηση χημειοπροφύλαξης διεγχειρητικά έως και δύο δόσεων μετεγχειρητικά μπορεί να εφαρμοστεί με ασφάλεια σε ασθενείς που πρόκειται να υποβληθούν σε προγραμματισμένη χειρουργική επέμβαση κοιλίας, καθώς περιορίζεται η άσκοπη χρήση των αντιβιοτικών, ελαττώνεται το κόστος της νοσηλείας, ενώ δεν παρατηρείται αύξηση της νοσηρότητας των ασθενών.



**Λέξεις ευρετηρίου:** Αντιβιοτικά, Κόστος, Χειρουργική, Χημειοπροφύλαξη

## References


1. GRUBER UF, ELKE R, WIDMER M, TRIPPEL M, GERBER H. Should antibiotic prevention be used in biliary tract surgery? *Schweiz Med Wochenschr* 1983, 113:558–559
2. LIPPERT H, GASTINGER J. Antimicrobial prophylaxis in laparoscopic and conventional cholecystectomy. Conclusions of a large prospective multicenter quality assurance study in Germany. *Chemotherapy* 1998, 44:355–356
3. CAREY B, CRYAN B. Antibiotic misuse in the community – a contributor to resistance? *Ir Med J* 2003, 96:43–44, 46
4. HOWARD DH. Resistance-induced antibiotic substitution. *Health Econ* 2004, 13:585–595
5. FURUKAWA K, ONDA M, SUZUKI H, MARUYAMA H, AKIYA Y, ASHIKARI M ET AL. The usefulness of conducting investigations on intra-abdominal bacterial contamination in digestive tract operations. *Surg Today* 1999, 29:701–706
6. MARSHALL D, GOUGH J, GROOTENDORST P, BUITENDYK M, JASZEWSKI B, SIMONYI S ET AL. Impact of administrative restrictions on antibiotic use and expenditure in Ontario: Time series analysis. *J Health Serv Res Policy* 2006, 11:13–20
7. OZKURT Z, EROL S, KADANALI A, ERTEK M, OZDEN K, TASYARAN MA. Changes in antibiotic use, cost and consumption after an antibiotic restriction policy applied by infectious disease specialists. *Jpn J Infect Dis* 2005, 58:338–343
8. GEROULANOS S, MARATHIAS K, KRIARAS J, KADAS B. Cephalosporins in surgical prophylaxis. *J Chemother* 2001, 1:23–26
9. TIN LY, PITRE M, CONLY JM. Retrospective analysis of the clinical and economic outcomes of twice-daily dosing of cefotaxime in a Canadian tertiary care institution. *Diagn Microbiol Infect Dis* 1995, 22:135–140
10. SMYTH ET, BARR JG, O'NEILL CA, HOGG GM. An assessment of the hidden and total antibiotic costs of four parenteral cephalosporins. *Pharmacoeconomics* 1995, 8:541–550
11. ROTMAN N. Antibiotic prophylaxis in abdominal surgery. *Chirurg* 1990, 116:401–403
12. CUTHBERTSON AM, McLEISH AR, PENFOLD JC, ROSS H. A comparison between single and double dose intravenous Timentin for the prophylaxis of wound infection in elective colorectal surgery. *Dis Colon Rectum* 1991, 34:151–155
13. JONES RN. Review of cefotaxime sodium for surgical prophylaxis. A model for the evolution toward single-dose or short-course cost-effective regimens. *Diagn Microbiol Infect Dis* 1991, 14:190
14. PLOSKER GL, FOSTER RH, BENFIELD P. Cefotaxime. A pharmacoeconomic review of its use in the treatment of infections. *Pharmacoeconomics* 1998, 13(1Pt 1):91–106



*Corresponding author:*

E. Konstantinidou, "Sismanoglion" General Hospital, 1 Sismanogliou street, GR-151 26 Maroussi, Greece
e-mail: elkonstantinidou@mailbox.gr