



## Reinforcing good practice: Implementation of guidelines at hospital G. Pini



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### ARTICLE INFO

#### Keywords:

Surgical site infections  
Antibiotic prophylaxis  
Surveillance  
Arthroplasty

### ABSTRACT

**Introduction:** Surgical site infections (SSIs) in orthopaedic surgery are a demanding complication for the patient and in terms of economics. Many guidelines (GLs) are available on antibiotic prophylaxis as an effective preventive measure; however, these GLs are often ignored in practice. A surveillance study of SSIs in arthroplasty, promoted by the Italian Study Group of Hospital Hygiene of the Italian Society of Public Health (SitiI), showed a high percentage of non-adherence to GLs on antibiotic prophylaxis.

**Objectives:** The purpose of this study was to review the existing GLs, share them within the hospital and then monitor their implementation.

**Materials and methods:** Information and training are considered to be great tools for implementation and sharing of GLs, which leads to significant improvements in clinical practice. A multidisciplinary team comprising infectious disease specialists, orthopaedic surgeons, nurse epidemiologists and public health specialists was established at the G. Pini Hospital in Milan to revise GLs, and to organise educational events for their implementation, sharing and dissemination. A checklist was devised for monitoring purposes.

**Results:** GLs were presented to orthopaedic surgeons and nurse coordinators during two educational events. Meetings were organised in each unit to present the results of the surveillance of SSIs in arthroplasty and to discuss the reasons why the prophylaxis regimens adopted were not consistent with GLs. It was emphasised that the most important issue, on which there is consensus in the scientific literature, was related to the duration of prophylaxis beyond 24 h. The review process for GLs was presented and pocket-sized GLs were given to surgeons. The importance of documenting on medical record any deviations from the GLs was emphasised.

**Conclusions:** Any changes in behaviour in clinical practice must be monitored and evaluated regularly. The monitoring of GLs in terms of correct choice of drug, timing of administration and duration of prophylaxis is made using a special checklist on a representative sample of medical records.

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### Introduction

Healthcare-associated infections (HAIs) cause approximately 16 million additional days of hospitalisation every year, which is an average of 4 days per infection. The annual cost of HAIs in Europe is approximately 7 billion Euros, assuming an average cost

of 435 Euros per day. The third most common HAIs are Surgical Site Infections (SSIs), which comprise between 15% and 25% of all HAIs [1].

SSIs after arthroplasty are severe complications for the patient and in terms of economics: they are associated with an increase in morbidity and mortality, doubled risk of hospital readmission in the following year, and additional costs for the National Health Service in terms of prolonged hospital stays (an average of 9 additional days), associated diagnostic procedures and therapeutic revisions [2,3].

The development of SSIs after orthopaedic surgery is estimated to more than double the direct costs of hospitalisation: the cost for

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revision of an infected hip prosthesis is 2.8 times higher than that for a regular (normal hip prostheses) revision and 4.8 times higher than that for a primary implant [4,5]. Like all HAIs, SSIs are preventable [6]. Many studies have shown that surveillance programmes and correct antibiotic prophylaxis are effective in prevention of SSIs [7–12].

There is evidence to indicate that a correct perioperative prophylaxis, with an appropriate choice of drug and timing of administration, is effective in the prevention of SSIs. There are many national and international guidelines (GLs) on antibiotic prophylaxis; however, the administration of prophylaxis remains diverse and there are high rates of non-adherence to GLs [13–17]. This increases the risk of adverse events and the selection of resistant microbes, thereby driving up health costs [18–20].

Nowadays, according to a grading that distinguishes six levels of evidence of efficacy (I–VI) and five grades of recommendation (A–E), perioperative antibiotic prophylaxis is classified by the National System for Guidelines (SNLG) as “strongly recommended” for hip (evidence IA) and knee (evidence IIIA) prosthesis implantation, because “it clearly reduces morbidity related to most serious complications and hospital costs, and it is likely to reduce the overall consumption of antibiotics” [21]. The spectrum of the selected drug should be active against the likely contaminants (evidence: category IA). In orthopaedic surgery, pathogens isolated from most postoperative infections are gram positive-bacteria like coagulase negative *Staphylococci*, particularly *Staphylococci epidermidis* and *Staphylococci aureus*, while other microorganisms, such as *Enterococci*, *Streptococci*, and gram-negative bacteria including *Escherichia coli*, *Pseudomonas*, and *Klebsiella* are less common [22–28].

G. Pini Hospital in Milan participated in the surveillance programme of SSIs in arthroplasty (ISChIA) promoted by the Italian Study Group of Hospital Hygiene (GISIO) of the Italian Society of Public Health (SitiI) and financed by the Centre for Disease Control (CCM) of the Italian Ministry of Health. This programme included an assessment of the level of adherence to antibiotic prophylaxis GLs and showed that there was non-complete adherence to current GLs. A review of the existing GLs was conducted to produce a shared document and monitor its implementation.

## Materials and methods

In the ISChIA programme, perioperative antibiotic prophylaxis in arthroplasty was administered in 94% of cases (282 cases) and administration of prophylaxis was adherent to existing hospital GL in only 36% of cases. In 109 cases (36.3%), prophylaxis continued beyond 24 h after surgery, which contradicts the GLs, and this occurred without explicit justification on medical record. In 46 cases (15.3%), recommendations relating to the timing of administration before surgical incision were not met. For 19 interventions (6.3%), medical records showed no preoperative prophylaxis. Further deviations from the GLs were as follows: the chosen antibiotic was not recommended in the GLs (12 cases; 4%); postoperative timing of administration (where applicable) was not respected (12 cases; 4%); the administered postoperative dose was higher than indicated in the GLs (7 cases; 2.3%); the administered preoperative dose was lower than recommended (5 cases; 1.7%), and two drugs with an overlapping spectrum of action were co-administered although the GLs recommend they should be administered individually or in combination with other drugs (4 cases; 1.3%). In 28 cases, more than one of the above mismatches was found.

These data were considered to be unacceptable, so the application of prophylaxis was assessed and procedure was revised. The knowledge and application of GLs in each unit were surveyed using a specific form devised by the medical managers at

the hospital. The following information was collected for each type of intervention: availability of GLs (if any) and their implementation; healthcare professional in charge of prescribing prophylaxis; healthcare professional in charge of administering prophylaxis; and place and time of administration. These data were gathered during an interview with the nursing coordinator and/or a physician of the unit.

The results of the survey showed that the antibiotic prophylaxis GLs were present in only two of 16 of the units and the GLs were rarely applied; moreover, there were differences in the application of GLs between and within units. In most of the units (14 out of 16), the administration of antibiotic prophylaxis was reported to continue beyond 24 h after surgery. All those interviewed reported that antibiotic prophylaxis was generally prescribed by a physician and administered by a nurse in the Operating Room or at the unit level (this was the case when Teicoplanin was given).

A multidisciplinary team comprising two infectious disease specialists, orthopaedic surgeons, an infection control nurse and doctors from the health management department was designated to review the existing hospital GLs for antibiotic prophylaxis. Information and education events were planned to enable implementation, sharing and dissemination of revised GLs. A specific checklist was devised for monitoring purposes:

- 
- Intervention
  - Intervention code
  - Antibiotic prophylaxis administration
  - Drug consistent with GLs
  - Preoperative timing respected
  - Preoperative dosage respected
  - Postoperative timing respected
  - Postoperative dosage respected
  - Prophylaxis stopped within 24 h after intervention
  - Prophylaxis consistent with GLs
  - Justification on medical record
- 

The level of knowledge of doctors was reassessed one year after the review. The Oncologic, Paediatric and Rheumatologic Orthopaedics Surgery units were excluded from the test because of specific antibiotic prophylaxis indications for the patients in these units. A total of 53 physicians were invited to complete the survey on antibiotic prophylaxis GLs. Answers to the test were anonymous. The survey was uploaded online using SurveyMonkey<sup>®</sup> software. The main aims were that the test should be informative, to check the knowledge gained after the introduction of revised GLs; and operative, to provide information to direct the planning of educational programmes.

## Results

As mentioned above, antibiotic prophylaxis was generally prescribed by a physician and administered by a nurse in the Operating Room; however, there was intra- and inter-unit variation in standards for the same intervention. The most important issue, on which there is consensus in the scientific literature, was the lack of compliance with duration of prophylaxis, which often continued beyond 24 h after intervention.

The available literature on antibiotic prophylaxis in orthopaedics was reviewed and local GLs were integrated; a proposal for new GLs was then discussed and shared during two training events. The meetings were attended by 16 nurses, six nurse coordinators, one head of SITRA, 60 orthopaedic surgeons, two pharmacists and two physiotherapists. The Infection Control

**Table 1**

Guidelines: pocket-sized version.

Type of surgery	Antibiotics and administration modality	Pre-surgery dose	Post-surgery dose	Patient allergic to beta-lactams
Without device implantation				
Removal, suture or incision of hand muscles, tendons or fasciae	Normally no antibiotic prophylaxis			
Removal or demolition of cutaneous or subcutaneous lesion	If ASA grade $\geq 3$ or clinical necessity:	2 g	None	Normally no antibiotic prophylaxis
Other procedures (repair, section or plastic) on muscles, tendons or fasciae	– Cefazolin			– Clindamycin 600 mg
Arthroscopic meniscectomy				
Arthroscopic synovectomy				
With device or biological components implantation			None	
No prosthetic osteoarticular surgery (osteotomy, exostosis, bone cysts)				
Anterior cruciate ligament reconstruction, synovectomy with arthrotomy	– Cefazolin	2 g	Only if major surgery or long-lasting surgery: 1 g after 6 h, then 1 g every 8 h for 24 h after surgery	Clindamycin 600 mg (before surgery), then 600 mg after 6 h and then 600 mg every 8 h for 24 h after surgery
Ankle or foot arthrodesis				
Arthroplasty				
Hip	– Cefazolin:	2 g	1 g after 6 h and then 1 g every 8 h for 24 h after surgery	Teicoplanin 10 mg/kg or Vancomycin 15 mg/kg
Knee	– If revision surgery or presence of risk factors			
Shoulder	Teicoplanin or vancomycin + tobramycin	10 mg/kg or 15 mg/kg (max 1 g) + 300 mg (400 mg if weight > 90 kg)	None	
Other minor				

Committee approved the final document, “Guidelines: Perioperative Antibiotic Prophylaxis (LG/02 CIO).” This document summarises the information on drugs and administration of antibiotic prophylaxis by type of intervention, provides indications on prescription and administration, and describes the personnel involved and their responsibilities.

Meetings to discuss and propose GLs were organised in each unit, including a meeting with the chief anaesthesiologist. The results of the surveillance of SSIs in arthroplasty in the hospital were presented at these meetings, and the reasons why the prophylactic regimens adopted were not considered consistent with GLs were explained. The revised GLs were described and a pocket-sized version was given to all participants (Table 1). The importance of justifying on medical records the use of any drug or regimen that differed to the GLs was emphasised.

Staff training occurred in January and February 2012. GLs were presented to each unit for a total of 16 meetings. Meeting dates were chosen with the agreement of all unit directors to enable the participation of every surgeon and nurse coordinator. From March onwards, the correct implementation of local GLs was assessed using a specific checklist. Prophylaxis registered on medical records was considered to be inconsistent with GLs if it met any of the following criteria:

- Missing record of antibiotic administration (recommended for this type of intervention).
- Treatment inconsistent with that recommended, with no explicit reasons on medical record.
- Incorrect timing of preoperative administration.
- Incorrect preoperative dosage.
- Postoperative administration (when not recommended).
- Incorrect timing of postoperative administration (when recommended).
- Duration of prophylaxis over 24 h after the intervention.

From March to May 2012, a total of 124 medical records were evaluated, which corresponds to 5% of the monthly admission rate.

Prophylaxis was consistent with GLs for 71 medical records (50%). A further 49 medical records were reviewed during June to August 2012, and another 46 were evaluated in September to November 2012: again the number of medical records evaluated during these time periods corresponded to 5% of monthly admissions. During June to August 2012, GLs were followed in only 55% of cases analysed.

Any deviations from the GLs were analysed by the Medical Director and the Hospital Risk Manager, and discussed with the physicians of the units involved. Two 6-h educational events on SSI prevention were presented to nurses working in the Operating Room. A multidisciplinary team, including infectious disease specialists, engineers, public health doctors and nurses, were involved and addressed the issue from their points of view. During the meetings, correct administration of antibiotic prophylaxis was discussed to raise awareness among the audience. It was made clear that nurses who administer the antibiotics to patients can check and report any mistake in prescriptions, thus providing quality control and enabling correct clinical practice. In September to November 2012, 63% of cases analysed were consistent with GLs.

Medical personnel were invited in October 2012 to complete a survey about GLs for antibiotic prophylaxis.

There were eight questions about perceived changes after the introduction and dissemination of GLs for antibiotic prophylaxis. All participants had previously received the revised GLs and 68% reported an influence on their clinical practice. There were specific questions related to prophylaxis in arthroplasty, suture of hand muscles, arthrodesis of the foot and intraoperative administration of antibiotics. A total of 47 out of 54 physicians (88%) completed the survey. Single answers were correct for over 50% of participants (Fig. 1).

[Note for Production: the following changes are required on Fig. 1 – ‘PROFILAXIS’ to ‘PROPHYLAXIS’; ‘SOMMINISTRATION’ to ‘ADMINISTRATION’].

The survey shows that the training was effective, although further training or reminders are needed over time (Fig. 2). In particular, prolongation of prophylaxis over 24 h was no longer

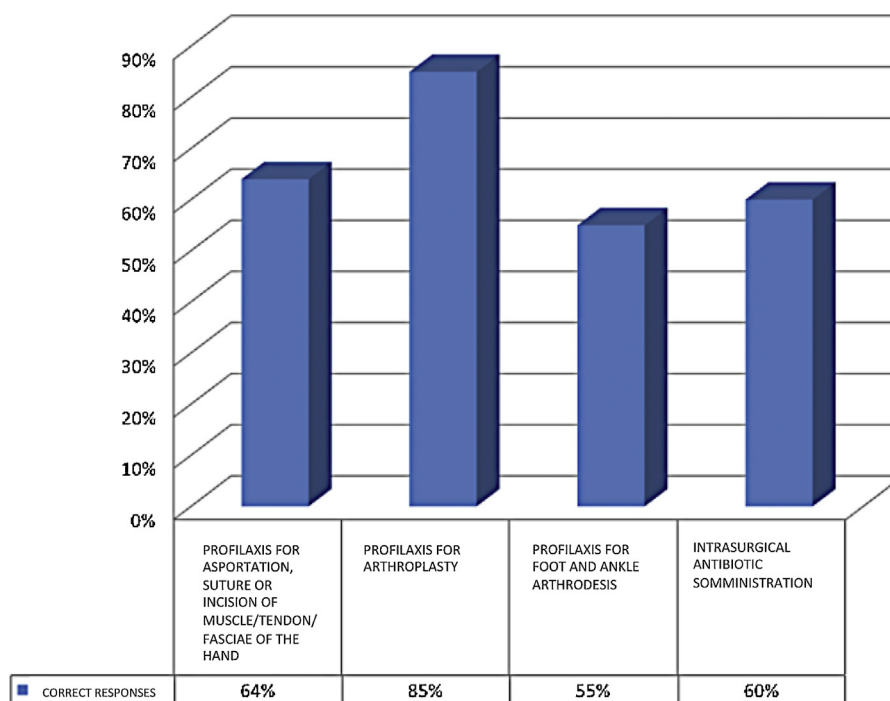


Fig. 1. Online survey results.

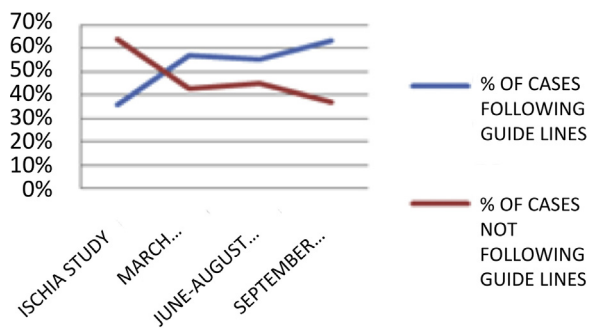


Fig. 2. Trends in consistency and inconsistency with guidelines.

detected and there was a decrease in the use of drugs not recommended in the GLs. Mistakes that persisted after the training included the timing of administration, the dosage (particularly in the post-intervention period, when recommended), and the use of short-term prophylaxis in operations for which it is not recommended, such as arthroscopies (Table 2).

[Note for Production: please change 'GUIDE LINES' to 'GUIDE-LINES' on Fig. 2; also, the x-axis labels are not very clear, can these be better aligned?].

**Discussion**

*Staphylococci*, particularly *S. epidermidis* and *S. aureus*, are commonly found in SSIs, while other microorganisms, such as *Enterococci*, *Streptococci*, and gram-negative bacteria including *E. coli*, *Pseudomonas*, and *Klebsiella* are less common [22–28]. Consequently, first generation cephalosporins, such as cefazolin, are the suggested first choice drugs [21,24,29]. Several studies show that the implementation of antibiotic prophylaxis is still extremely variable, despite the presence of national, regional and local GLs; antibiotics are used excessively and often inappropriately [30–35].

An average of 1.4 errors per patient has been recorded in the administration of antibiotic prophylaxis and this correlates with

the incidence of SSIs [20]. As well as being ineffective in the prevention of SSIs, the inappropriate use of antibiotics has negative effects on the patient and the hospital microbial ecosystem, which increases the pharmaceutical expense 10-fold [31]. A preoperative, single-dose prophylaxis is adequate [36,37]; prolongation of prophylaxis beyond the first 24 h after surgery is not justified [38–48]. Prolonged use of antimicrobials for prophylaxis is potentially harmful because it fosters the emergence of resistant bacterial strains, which has negative effects on the patient in terms of toxicity and possible development of *Clostridium difficile* infections, and on the community [49,50], and also increases healthcare costs [51,34].

Critical issues that were identified during the surveillance at the G. Pini Institute were: incorrect drug selection, inappropriate timing of administration and prolonged administration (over 24 h). The local GLs were revised to show that each healthcare professional has a responsibility for the correct administration of antibiotic prophylaxis and to emphasise that the physician is in charge of prescribing prophylaxis on the sheet of therapy (FUT). To reduce the possibility of mistakes, the FUT should indicate the selected drug, and the preoperative and postoperative dose. Prescriptions that are not consistent with local GLs in terms of type of drug and duration should be justified in detail on medical record with the specific description of the patient's risk factors, as listed in the GLs. The antimicrobial dose for prophylaxis must produce serum and tissue concentrations that are higher than the Minimal Inhibitory Concentration (MIC) for the likely contaminants. Such effective concentrations must be sustained for the entire duration of surgery.

Results of the surveillance in the current study show that personnel training was effective in improving administration of antibiotic prophylaxis because there were no mistakes in the administration of prophylaxis beyond 24 h after surgery, and in only a few cases was the selected drug used not recommended in the GLs. Oversights persist in the timing of administration: sometimes this is because of incorrect completion of the FUT. Furthermore, our surveillance shows how important are continuous training and feedback of results in improving clinical practice in this area.

**Table 2**  
Overall results and types of mistakes.

March–May			
Reasons	Frequency	% of total (124)	% of not following guidelines (53)
Incorrect timing	40	32	75
Unjustified prophylaxis	11	9	21
Incorrect dose	1	1	2
Incorrect drug	1	1	2
Therapy sheet mistyped	0	0	0
June–August			
Reasons	Frequency	% of total (49)	% of not following guidelines (22)
Incorrect timing	9	18	41
Unjustified prophylaxis	7	14	32
Incorrect dose	2	4	9
Incorrect drug	0	0	0
Therapy sheet mistyped	4	8	18
September–November			
Reasons	Frequency	% of total (46)	% of not following guidelines (17)
Incorrect timing	9	19	53
Unjustified prophylaxis	4	9	24
Incorrect dose	2	4	12
Incorrect drug	2	4	12
Therapy sheet mistyped	0	0	0



## Conclusion

The main purpose of GLs is to reduce variability of behaviour in clinical practice: this is most easily achieved when GLs are shared. A French study in which surgeons were interviewed about the reasons for non-adherence to antibiotic GLs showed that the GLs were tailored to meet clinical needs and that non-application was because of negligence or lack of organisation [34]. It is therefore important to encourage all staff members to focus on organisational issues and to be involved in, or aware of, the assignment of specific responsibilities [52]. Personnel training is an effective tool and local consensus is essential for the effective implementation of protocols [53]. Equally important is the dissemination of results to enable assessment and comparison of procedures and training [54]. In future months, new training events will be provided, a test of knowledge will be planned, and the correct implementation of prophylaxis GLs will be monitored on a quarterly basis.

## Conflict of interest

The authors have no conflicts of interest to declare. No financial support has been received by the authors for the preparation of this manuscript.

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