Isolation of bacteria in surgical site infections and determination of their sensitivity to commonly prescribed antibiotics

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Post-operative wounds can be contaminated by bacteria from endogenous and/or exogenous microbial flora. As a result, the surgical site infection (SSI) is a dreaded complication because it could compromise the benefit of surgery, biasing the intervention's success chances and generating additional costs. A prospective study was conducted in three public hospitals in Yaoundé. It was aimed at contributing to the safety of the inpatients. This study specifically consisted in isolation of bacteria associated to SSIs, evaluation of the influence of various factors on these bacteria and invitro determination of their sensitivity profile to commonly prescribed antibiotics. During the study period, 1201 patients underwent various surgical procedures. SSIs developed in 110 (9.2%) patients. Infections were superficial located in 68.2% of cases and deep location in 31.8% of cases. The isolated bacteria were Gram-negative rods (62.4%) and Gram-positive cocci (37.6%), distributed as follows: Enterobacteriaceae (41.2%), Staphylococcus aureus (15.3%), Pseudomonas spp. (14.1%), Enterococcus spp. (12.9%), coagulase-negative staphylococci (CoNS, 5.9%), Streptococcus spp. (1.8%), and others (8.8%). These bacteria presented a global-sensitivity rate of less than 30% to the commonly prescribed antibiotics in three hospitals.

Key words: Surgical site infection, SSI, bacteria, prescribed, antibiotics.

INTRODUCTION

Hospitalization can expose a patient to clinical complications. These complications include nosocomial infections which are prominent in both developed and developing countries (Amenu et al., 2011; Gibbons et al., 2011; Jido and Garba, 2012). Nosocomial infections are defined as diseases clinically or microbiologically identifiable, contracted by a patient during a stay in hospital (Veyssier et al., 1998). They are a real public health issue due to their frequency and socio-economic impact (Harrop et al., 2012; Turtiainen et al., 2010). One of the most common nosocomial infections is the surgical site infection (SSI).

SSIs can be defined as infections that develop in the operated area. It is classified as incisional (superficial and deep) or organ/space (Amenu et al., 2011). It is considered as nosocomial when it occurs within 30 days of surgery or the year following the establishment of an implant or a prosthetic material (Santos et al., 2010). Generally, it results to the contamination of a surgical wound with bacteria of skin or digestive tract. It is a complication which is often preventable and dreaded because it could compromise the benefit of the intervention, affect the functional and even vital life chances and generate additional costs (Gibbons et al., 2011; Ott et al., 2012).

The aim of this prospective study was to contribute to improving the safety of inpatients. The specific objectives consisted in isolating bacteria associated to SSIs in three hospitals of Yaoundé, evaluating the influence of various factors on these bacteria and invitro determining their
sensitivity profile to the commonly prescribed antibiotics in three hospitals.

MATERIALS AND METHODS

The study was conducted in three public hospitals in Yaoundé. Two were University Teaching Hospitals and one was a Community Hospital namely the Yaoundé Central Hospital (HCY), the Yaoundé University Teaching Hospital (CHU) and the Biyem Assi District Hospital (HDBA) respectively. The study took place between November 2011 and March 2012. The subjects recruited were male or female, any age group, who have developed an SSI within 30 days following surgery in one of the three hospitals, during the study period. They were recruited pursuant to strict ethical considerations.

Clinical considerations

All the SSIs were diagnosed by the surgeons responsible for the patients, using the Centers for Disease Control and Prevention (CDC) standardized criteria, (Horan et al., 1992). SSIs are classified as incisional or organ-space. Incisional SSIs are divided into those involving skin and subcutaneous tissue (superficial incisional) and those involving deeper soft tissue of surgical incision (deep incisional SSI). Organ space SSIs involve any part of the anatomy other than incised body wall layers that were opened or manipulated during an operation.

For each patient, various clinical data were recorded. These data include the status of the surgical procedure (elective or emergency), the American Society of Anaesthesiologists (ASA) physical status score, the type of the surgical procedure and the wound contamination class as described by Garner (1986) i.e. class I-clean; class II-clean contaminated; class III-contaminated; class IV-dirty.

Isolation and identification of bacteria

According to the type of lesion, the sampling was done swab or aspirate with the syringe. All samples were sent to the laboratory within a period of 2 h ± 1 min. Isolation and identification of the bacteria were performed by the conventional methods (Denis et al., 2007).

Determination of in vitro antibiotic sensitivity profile

Gentamycin (CN), ceftriaxone (CRO), ciprofloxacin (CIP), amoxicillin-clavulanic acid (AMC), cefuroxime (CXM), ampicillin (AMP) and netilmicin (NET) were the commonly prescribed antibiotics to patients undergoing surgery in the study. Oxacillin (OX) was added to this group for the Gram-positive cocci and imipenem (IMI) for the Gram-negative rods so that each isolated bacterial strain was submitted to the action of eight antibiotics. The determination of the bacterial sensitivity to antibiotics was carried out according to the method of disks (Denis et al., 2007). Thus, bacterial strains were classified into three groups: sensitive (S), intermediate (I) and resistant (R).

RESULTS

In the three hospitals, 1201 people underwent surgery during the study period. They were divided as follows: 126 (10.5%), 150 (12.5%) and 925 (77.0%) at the HDBA, the CHU and the HCY respectively. With regards to gender, 471 (39.2%) subjects were male while 730 (60.8%) were female. The subjects’ ages ranged from 2 to 85 years. The average age was 37. The modal class was 26 to 31 years. All the SSIs were incisional with 68.2% classified as superficial incisional SSIs whereas 31.8% were deep incisional SSIs. Concerning wound class contamination, 440 (36.6%), 125 (10.4%), 233 (19.4%) and 403 (33.6%) patients underwent classes I, II, III and IV respectively. Cesarean sections were the most common surgical procedure type (26.1%), followed by the osteosynthesis (20.9%) while laparotomies for prostate were less frequent (2.2%). All patients were placed under antibiotic treatment. Out of them, 12.7% participants did not take the prescribed drugs while 8.2% associated them with herbal medicine.

Isolated and identified bacteria

Bacteria were isolated in all samples. 62.35% of the isolates were Gram-negative rods (67.9% enteric bacteria and 32.1% non-enteric bacteria) while 37.65% were Gram-positive cocci (60.9% staphylococci and 39.1% streptococci). The overall distribution profile was as follow: Enterobacteriaceae (41.2%), S. aureus (15.3%), Pseudomonas spp. (14.1%), Enterococcus spp. (12.9%), CoNS (5.9%), Streptococcus spp. (1.8%), and others (8.8%). For further details, the isolates were belonging to 15 bacterial species, namely in descending frequency of isolation: S. aureus, Klebsiella sp., Pseudomonas spp., Enterococcus spp., Acinetobacter spp., Proteus sp., S. epidermidis, E. coli, Serratia spp., S. saprophyticus, Streptococcus sp., Providencia spp., Morganella morganii and Citrobacter spp.

Influence of various factors on the species and the isolation frequency of bacteria

The hospital

Most bacterial species cited above were present at the
HCY (93.3%) and the CHU (80%) while only 20% were present at the HDBA. *S. aureus*, *Pseudomonas* spp. and *Klebsiella* sp. were isolated in all three hospitals. *M. morganii*, *S. saprophyticus* and *Providencia* sp. were isolated only at the HCY while *Citrobacter* spp. was isolated only at the CHU (Figure 1).

**The type of surgical procedure**

The distribution profiles of the isolated bacteria and their isolation frequencies varied with the type of surgical procedure as seen in Figure 5. *Enterobacter* spp. was found in all types of surgical procedures.

**Antibiotic susceptibility of the isolates to the commonly prescribed antibiotics in the three hospitals**

Generally, the Gram-positive cocci were resistant to ampicillin, oxacillin, cefuroxime, and ceftriaxone, intermediate to gentamicin and amoxicillin/clavulanic acid and sensitive to the netilmicin and ciprofloxacin. Out of the four commonly prescribed antibiotics at CHU, these bacteria were sensitive to one, intermediate to another one and resistant to two. Out of the five antibiotics at HCY, Gram-positive cocci were sensitive to one, intermediate to two and resistant to two. Out of the three antibiotics prescribed at HDBA, the same bacteria were sensitive to one, resistant to another one and intermediate to one (Figure 6).

The Gram-negative rods were resistant to ampicillin, cefuroxime, and ceftriaxone. They were intermediate or resistant to amoxicillin/clavulanic acid and gentamicin; intermediate to netilmicin, sensitive to ciprofloxacin, and imipenem. Out of the four commonly prescribed antibiotics at CHU, these bacilli were resistant to two, intermediate to one and resistant to the last one. On the 3 common antibiotics at HDBA, Gram-negative rods were
Figure 2. Frequencies distribution of isolated bacteria as a function of the status of the surgical procedure.

Figure 3. Frequencies of isolated bacteria as a function of ASA score.
resistant to one, intermediate to one and sensitive to the last one while on the 5 regular antibiotics at HCY, they were resistant to 3 and intermediate or resistant to 2 (Figure 7).

**DISCUSSION**

In this study, the overall distribution profile of bacteria in SSIs was in descending frequency of isolation, as follow: Enterobacteriaceae, S. aureus, Pseudomonas spp., Enterococcus spp., CoNS, Streptococcus spp. and others. These bacteria could have come from the visceral flora or from the mucocutaneous coating as described by Dancer et al. (2012). They could have contaminated the surgical site during or after the surgery. The seven elements of the general profile were present at HCY, in the order described whereas at CHU, only six elements were present and in a different order. Enterobacteriaceae
retained the first place in these two hospitals. They were also dominated in the study of Shahane et al. (2012) whereas *Pseudomonas* was the commonest organism isolated by Mir et al. (2013).

In HDBA, only three elements of the profile were present and the first place was occupied by *Pseudomonas* spp. Hence, the distribution profile of the bacteria causative of SSIs would depend closely to the microbial ecology of the hospital and the concerned service as previously observed by Bercion et al. (2007). This profile also varied with the wound class contamination, the status of the surgical procedure and the type of the surgical procedure as described by Ercole et al. (2011), Namba et al. (2012). Thus, all seven elements of the bacterial distribution profile were present in dirty and contaminated surgeries while only six and two were isolated in clean and clean contaminated surgeries, respectively. Similarly, all these elements were cited in

Figure 6. Sensitivity to commonly prescribed antibiotics of Gram-positive cocci isolated in the three hospitals.

Figure 7. Sensitivity to commonly prescribed antibiotics of Gram-negative rods isolated in the three hospitals.
emergency surgery while the elective surgery had only six.

Fifteen bacterial species were isolated. The first three places were, in descending order of isolation frequency, occupied by *S. aureus*, *Klebsiella* spp. and *Pseudomonas* spp. These three bacteria were found in all hospitals and in all wound class contamination. This ubiquity could be justified by their nature. Indeed, these germs are commonly isolated in hospitals and their presence may be related to various factors (for example; virulence, immune status of the patients, inadequate use of prophylactic antibiotics, poor hospital hygiene). *S. aureus* was the predominant pathogen in many others studies (Kaye et al., 2009; Jido and Garba, 2012; Schimmel et al., 2010; Young et al., 2011).

The choice of commonly prescribed antibiotics turned out to be irrelevant. Thus, isolated bacteria were sensitive to only one of all antibiotics usually prescribed at CHU and HDBA. The same situation was observed at HCY, with the Gram-positive cocci while the Gram-negative rods, representing the majority of the isolates were sensitive to no commonly prescribed antibiotic. However, all the tested Gram-positive cocci were sensitive to netilmicin and to ciprofloxacin while all the Gram-negative rods were sensitive to ciprofloxacin and to imipenem. Jido and Garba (2012), Seguin et al. (2009) also found a good sensitivity of bacteria from SSIs to quinolone and cephalosporin. However, in our study, a strong resistance of the bacterial isolates to ceftriaxone and cefuroxime, the two cephalosporin of 2nd and 3rd generations commonly prescribed in the three hospitals was observed. Certainly, it is generally agreed that the terms of antibiotic use (practical prescribing and consumption) influence the effectiveness of antibiotics. It is all also generally common that hospital germs have increased resistance to antibiotics. No remains that these results, evidence of the increasing ineffectiveness of the available antibiotic molecules on the bacteria isolated in hospital are disturbing for a developing country, with usually limited access to drugs.

**Conclusion**

In this study, the overall distribution profile of the bacteria involved in SSIs was as follows: *Enterobacteriaceae* (41.2%), *S. aureus* (15.3%), *Pseudomonas* spp. (14.1%), *Enterococcus* spp. (12.9%), CoNS (5.9%), *Streptococcus* spp. (1.8%) and others (8.8%). These isolates were sensitive to fewer than 30% of the commonly prescribed antibiotics in the three hospitals participating to the study. These results are a concern for a developing country.

**REFERENCES**


