Open Access

# Fighting Nosocomial Infection Rates in the General Surgery Department of the Teaching Hospital Gabriel Toure in Bamako, Mali

Togo A.*[,1], Traore A.[1], Kante L.[1], Coulibaly Y.[1], Diango D.[2], Keita M.[1], Diallo S.[3], Dembele B.T.[1], Diakite I.[1], Diani N.[2], Samake B.[2], Traore B.A.[1] and Diallo G.[1]

[1]*Departments of general surgery and paediatric surgery CHU Gabriel Touré, PB 267 Bamako, Mali*

[2]*Department of anaesthesiology CHU Gabriel Touré, BP 267 Bamako Mali*

[3]*Laboratory CHU Gabriel Touré, BP 267 Bamako Mali*

**Abstract:** Nosocomial infections (NI) or hospital-acquired diseases are indicators of the quality of care. This study conducted in Mali aimed to determine the frequency of nosocomial infections, to recognize the risk factors, to identify the pathogens and their sensitivity to antibiotics and to determine the additional cost of care. The study lasted 6 months from January to June 2007, and the diagnosis of nosocomial infections was based on criteria from the USA C.D.C (Center for Disease Control). We identified 460 patients and 44 among them (9.6%) were affected by nosocomial infections, which included 31 cases of surgical site infections (57.4%), 9 cases of infections on burns (16.7%), 7 cases of lung infections (13%), and 7 cases of urinary tract infections (13%). The most frequently isolated bacteria were *Escherichia coli* (44%). All isolated bacteria were resistant to amoxicillin and 46% were sensitive to ciprofloxacin. The risk factors for infection were emergency surgery, ASA (American Society of Anaesthesiology) class and the type of surgery defined by Altemeir. The preoperative preparation of the patients, the strict respect of hygiene and asepsis to the operating room can reduce the frequency of NI in our country.

**Keywords:** Nosocomial infections, developing countries, risk factors.

## INTRODUCTION

Nosocomial infections (NI) are responsible for increased morbidity, mortality, hospital stay and costs of patient care [1]. The World Health Organization (WHO) estimates that among the 190 million patients who are hospitalized each year worldwide, an average of 9 million individuals are affected by nosocomial infections and approximately 1 million patients die each year because of these diseases [2]. There are only a few prevention programs in Africa and the rate of NI remains high [1, 3]. The reported NI rates in Algeria [4], Tunisia [5] and Gabon [6] are 16.2%, 9.4% and 11%, respectively. In Mali, earlier studies on nosocomial infections showed varying frequencies. The rate of NI found in the surgical and rehabilitation services of Gabriel Toure hospital and of the CHU Point G was 10.2% [7] and 13.8% [8], respectively.

### Objectives

Determine the rate of NI in our facility, identify the risk factors and define which bacteria are most responsible for the diseases and their sensitivity to antibiotics, then propose measures to reduce the rate of NI and finally evaluate the added costs derived from complications.

*Address correspondence to this author at the Centre Hospitalo-Universitaire Gabriel Toure, BP 267 Bamako, Mali, Maitre assistant en chirurgie générale, CHU Gabriel Touré, BP: 267 Bamako, France; Tel: 0022366903964; E-mail: ap.togo@yahoo.fr

## PATIENTS AND METHODS

This prospective study that examined two populations was conducted on all hospitalized patients (undergoing surgery or not) for at least 48 hours from January 1st to June 30th, 2007 in the service of general surgery. We excluded from this study all patients that were hospitalized for less than 48 hours and those who were not adequately tracked.

### Sampling

The sample size was calculated based on the Epi-Info 2000 for USA CDC (Center for Disease Control) with a required sample size of 128 cases. Each patient received a questionnaire to complete, and some consultation records, anesthesia forms and registration files were also used. The cases of nosocomial infections were identified according to the CDC criteria [9]. We used the ASA (American Society of Anaesthesiology) classification and Altemeir rating system as follows: Class ASA I= There is no organic, physiological, biochemical, or psychiatric disturbance; the pathological process for which the operation is to be performed is localized and is not a systemic disturbance.

Class ASA II= Mild to moderate systemic disturbance caused either by the condition to be treated or by other patho-physiological processes.

Class ASA III= Severe systemic disturbance or disease of any type of origin and for which it is not always possible to define the degree of disability.

Class ASA IV= Indicative of patients having a severe systemic disorder that is already life-threatening and that cannot be corrected by the operative procedure.

Class ASA V= the moribund patient who faces little chance to survive but is still brought for an operation in desperation.

Altemeir classification Class I= clean surgery, Class II= clean-contaminated surgery, Class III= contaminated surgery and Class VI= dirty surgery.

The NNISS scale (National Nosocomial Infection Surveillance System) developed by the "Center for Disease Control of Atlanta" is the sum of ratings of the three risk factors and varies from 0 to 3 points. ASA III, IV or V was rated 1 point.

Contaminated or dirty surgery was rated 1 point.

Longer than or equal to a time T was rated 1 point. Surveillance of surgical wound was made until the 30$^{th}$ postoperative days.

A medical sample was collected for each infection and bacteriological examination was conducted in 3 institutions of Bamako: the laboratory of bacteriology of the INRSP (Institut National de Recherche en Santé Publique), the bacteriology laboratory of the Mérieux Foundation, and the CVD (Center for Vaccine Development).

Data were recorded and analyzed on SPSS Inc 13.0 and Epi-Info 2000 - software tools from USA CDC. The statistical tests and Fisher khi2 were used to compare qualitative variables, while Kruskal Wallis (Mann-Whitney or Wilcoxon) and Anova were tested for quantitative variables. The threshold of significance was $P < 0.05$.

## RESULTS

The number of patients who met the inclusion criteria was of 460, with 363 operated individuals and 97 non-operated ones. Forty-four patients were affected by a nosocomial infection, yielding a NI rate of 9.56%. The number of patients who suffered a NI was 37 (10.19%) for the operated population (363 persons) and 7 (7.21%) for the non-operated group (97 persons). The age average was 40.3 years, with a standard deviation of 17.57; and the age extremes were 16 and 93. The age average was 40.22 ± 16.9 for individuals who underwent a surgery and it was 40.62 ± 19.9 for the non-operated patients. The infection rate was 24/258 for men and 20/202 for women. The sex ratio was 1.20 for the infectious diseases against 1.28 for the non-infectious diseases, which is not a statistically significant difference ($p = 0.82$). The sex ratios were 1.26 and 1.30 for the operated diseases and the non-operated ones, respectively; and therefore no statistically meaningful difference was found ($p=0.89$). The types of encountered NI included some surgical site infections (SSI) for 31 patients (57.4%), burn infections for 9 patients (16.6%), pulmonary infections for 7 patients (13%), and urinary tract infections for 7 patients (13%). The number of individuals who simultaneously presented with SSI, pulmonary and urinary tract infections was 4; and 2 burnt patients combined a lung and skin infection. Hence 54 infection cases were found in 44 patients.

When hospitalization conditions were sorted based on the number of beds per hospital ward, the breakdown of wound infection was the following: 4.54% of patients placed in single rooms (category I), 7.07% patients for rooms of 2 to 4 beds (category II) and 12.38% patients for rooms with more than 4 people (category III). The growth of infection rate from category I to III did not present a statistical difference, with chi2 = 4.2, ddl = 2 and $p = 0.119$. According to the ASA classification, NI cases were higher in the ASA I cluster, with 31 infections found in the ASA I population (411 cases), against 13 infections identified in the ASA II group (44 cases), at $p = 0.00001$.

Microorganisms were isolated and cultured in 28 cases, according to the following breakdown: *Escherichia coli* (39.29%), *Klebsiella pneumoniae* (14.26%), *Proteus mirabilis* (14.26%), *Pseudomonas aeruginosa* (10.72%), *Staphylococcus aureus* (3.57%), *Lactobacillus* (3.57%), *Citrobacter frundii* (3.57%), *Escherichia agglomerans* (3.57%), *Staphylococcus* not aureus (3.57%), and *Candida albicans* (3.57%). In 26 cases, the microorganisms were not isolated in culture. The main risk factors were the Altemeir

**Table 1. Risk Factor of NI**

| Risk Factors | Number | With Infection % | Without Infection % | P Value |
|---|---|---|---|---|
| Mean duration (mn) | | 99,25±33 | 51,25±34,17 | P<0,0001 |
| Altemeier I | 98 | 1,02 | 98,98 | Chi 2=22<br>DDl=3<br>P<0,0001 |
| Altemeier II | 119 | 7,75 | 92,25 | |
| Altemeier III | 73 | 17,80 | 22,2 | |
| Altemeier IV | 63 | 20,63 | 79,37 | |
| NNISS 0 | 122 | 2,2 | 97,8 | P<0,0001 |
| NNISS I | 195 | 6,15 | 83,85 | |
| NNISS II | 46 | 52,17 | 47,83 | |
| Emergency surgery | 172 | 18,02 | 81,98 | P<0,0001 |
| Programmed surgery | 191 | 3,14 | 96,86 | |

**Table 2. Sensitivity of Bacteria to Antibiotics**

| Antibiotic / Bacteria | Sensitivity to Ciprofloxacine | Sensitivity to Ceftriaxone Gentamycine | Sensitivity to Amoxicilline+ Acid clavulanique | Sensitivity to Gentamycine |
|---|---|---|---|---|
| *E. Coli* (n=11) | 5/11 | 4/11 | 3/11 | 4/11 |
| *S. Aureus* (n=1) | 0/1 | 1/1 | 1/1 | 0/1 |
| *K. Pneumoniae* (n=4) | 3/4 | 0/4 | 1/4 | 1/4 |
| *Proteus Mirabilis* (n=4) | 3/4 | 3/4 | 3/4 | 2/4 |
| *Ps. Aerusinosa* (n=3) | 2/3 | 3/3 | 2/3 | 0/3 |
| *Citrobacter frundii(n=1)* | 1/1 | 1/1 | 0/1 | 0/1 |
| *Lactobacillus (n=1)* | 0/1 | 1/1 | 1/1 | 1/1 |
| *Total (n=25)* | 14/25 | 13/25 | 11/25 | 8/25 |

class, NNISS scale, length of intervention and the type of surgery, as summarized in Table **1**. All tested bacteria were found to be resistant to amoxicillin and chloramphenicol; and the sensitivity of bacteria to other antibiotics is reported in Table **2**.

Infections were treated by a single antibiotic therapy in 10 patients, a bi-antibiotic therapy in 22 patients and a triple antibiotic therapy in 12 patients. A correlation between the length of hospitalization and infection was found. The infected patients stayed longer in the hospitals – i.e. 12.54 ± 7.2 days- compared to non-infected individuals who only stayed, 5.35±11.9 days (p = 0.00009). The number of recorded deaths was 5 (1.08%), which included 3 patients with a nosocomial infection. The average cost of care for infected patients was estimated at 210 ± 50.9 US Dollars *versus* 128 ± 34.99 US Dollars for the non-infected patients. This difference is considered to be statistically significant, with p <0.0005.

## DISCUSSION

The number of cases considered for this study exceeded the size of the minimum population cluster required for a reliable analysis. Indeed, 460 patients were included in this investigation, while a sample size of 128 was sufficient with the software Epi Info and by taking into consideration the NI rate of 9.1% [10] and the risk of error equal to 5%. This work has enabled us to assess the incidence of NI in our main hospitals, to identify the risk factors, to isolate the bacteria and to detect their sensitivity to antibiotics.

### Frequency

In Mali as in other African countries, there are no national data or programs for monitoring nosocomial infections, and the studies conducted on this subject are primarily research theses [11]. Mali nosocomial infection rate of 9.6 % is still high but it is not different from that determined by other African authors [5, 6, 12] (Table **3**). Nonetheless, this rate is worse to the one found in Turkey by Önen *et al.* [13] and in Canada by Nateghian *et al.* [14], with a value of 2.74% and 3.4%, respectively. We speculate that this difference is a result of better preparation of the skin and of the difference in the types of surgery that we carried out. Önen *et al.* [13] determined that the absence of skin preparation doubled the rate of postoperative infection from 3.1% to 6.3%. Surgical site infection (SSI) was the most commonly identified NI in our study, with a rate of 57.4%. This value is close to that reported by African researchers Samir *et al.* (60%) and Koumaré *et al.* (73.6%) [5, 12]. In another study conducted by Beaujean *et al.* [15], urinary tract infections were the most frequent cause of infection (29.7%). This difference may be linked to the nature of surgical interventions and to the smaller number of surveys used in our series. Hence, the fight against NI in African countries should focus on reducing the rate of SSI. The emergency surgery services, the scale of NNISS and the overcrowding of bed wards are the main risk factors of NI we have identified (Table **2**). These factors were reported by other Malian, Senegalese, Tunisian and Gabonese authors [5, 6, 11, 12]. The strengthening of hygiene measures in the operating room, the sterilization of instruments, the quality of peri-operative care and a good control of operating techniques should lead to a reduction in the rate of surgical site infections [11, 12]. The implementation of these measures and the design of a comprehensive monitoring program assisted by a feedback to healthcare professionals will likely reduce the rate of NI in Mali. *Escherichia coli* was the most frequent bacteria found in our series (44%) as well as in other studies [10, 14]. Different results were presented in a publication from Malaysia [16], which established that *P. aeruginosa* and *S. coagulase-negative* were the most dominant bacteria. Such discrepancy can be explained by the difference of surgical interventions among various services. The emergence of bacteria highly resistant to the cheapest and most common antibiotic drugs is a critical issue. The choice of antibiotics was determined accordingly with the sensitivity of the bacteria. In cases where several equally efficient drugs were available, the least expensive one was prescribed. The length of hospitalization was longer in presence of an infection, which also inflates the cost of healthcare, as shown in the literature [1, 2]. Based on this prospective study, we believe that the fight against NI in Mali should target three critical areas. The first area must focus on data collection by accurately gathering all NI cases identified in Malian hospitals and the largest healthcare community centers – *i.e.* number,

**Table 3. Nosocomial Infection Rates of Different Authors**

| Authors | Period of Study | Size of Sample | Nosocomial Infection % | P Value |
|---|---|---|---|---|
| Koumaré Mali [12] | 2004 | 1043 | 9.7 | 0.94 |
| Samir Tunisie [5] | 2000 | 643 | 9.4 | 0.89 |
| Njimenfeng Gabon [6] | 2003 | 5231 | 11 | 0.34 |
| Onen Turkey [13] | 2000 | 2842 | 2.7 | 0.000 |
| Nateghian Canada [14] | 2002 | 1117 | 3.4 | 0.000 |
| Our study Mali | 2007 | 460 | 9.56 | |

type and origin of NI on each site. The second critical area relates to the implementation of preventive measures which include a) the sterilization of the medical equipment and surgical rooms, b) the adoption of comprehensive hygiene programs by all Malian hospitals, c) a better preparation of the patient's skin prior surgery, and d) a greater knowledge about the operative techniques by the medical staff. Moreover, it is essential to reduce the number of patients per bed ward, which is often an issue in our country. If overcrowding cannot be avoided, we recommend to minimize the hospitalization stay whenever possible and to sterilize all bed sheets, mattresses, and textiles with bleach solutions. The use of cheap and efficient antimicrobial textile and clothing is an alternative, which should be explored as quickly as possible too. Another important matter relates to the availability of clean water or sterilized washing fluid for all medical staff. Water quality at the point of entry of Malian healthcare centers barely meet the World Health Organization clean water standards, particularly outside of Bamako. Serum solutions are used whenever possible but the stocks are quickly emptied due to a prohibitive cost. We believe that setting-up adequate point-of entry water filtration systems in all healthcare facilities will ease access to clean water supply at a more affordable cost. The third critical topic relates to a more rational use of antibiotic drugs based on their cost and efficacy to fight harmful bacteria. These antibiotics are used to fight NI cases and to efficiently prevent their expansion when a case of hospital-acquired infection is identified. Ultimately, the chosen preventive strategy must focus on priority issues that will improve the patient's protection at an affordable cost for Malian authorities.

## CONCLUSION

The high nosocomial infection rate leads to an increased hospitalization time and a greater cost of healthcare for the Malian government and for the patients. Surgical site infections are the most frequent risk factors in emergency surgery, and class of NNISS. It appears necessary to establish a reliable and efficient monitoring NI system (national program) for the implementation of preventive measures. Priority steps that are recommended include an improved knowledge of all technical procedures by the medical staff, the adoption of better hygiene practices in the healthcare facilities in general and most specifically in the surgical services where risk factors are more important.

## ACKNOWLEDGEMENTS

The authors gratefully acknowledge the laboratory of "Fondation Merieux Bamako Mali" and the laboratory of bacteriology of INRSP (Institut National de Recherche en Santé Publique).

## REFERENCES

[1] Raka L, Mulliqi G, Dedushaj I, Ahmeti S, Vishaj A. Prevalence of Nosocomial Infections in High-Risk Units in the University Clinical Center of Kosova. Infect Control Hosp Epidemiol 2006; 27: 421-3.

[2] Centre de coordination de la lutte contre les infections nosocomiales de l'inter région Paris et Nord. Guide de définition des infections nosocomiales. Paris: C-CLIN Paris-Nord, 1995. [updated 2002 March; cited 2009 Oct 30]. Available from: http://www.caducee.net/DossierSpecialises/infection/nosocomiales.asp

[3] National Nosocomial Infections surveillance (NNISS) System Report, data summary from January 1992 through June 2004. Am J Infect Control 2004; 32: 470-85.

[4] Bezzaoucha A, Makhlouf F, Dekkar N, Lamdjadani N. Prévalence des infections nosocomiales au centre hospitalo-universitaire de Bab El Oued-Alger. Médecine et maladies Infectieuses 1994; 2: 96-101.

[5] Samir E, Mokthar L, Ben A, *et al.* Etude de l'incidence et approche du surcoût des infections nosocomiales en chirurgie générale. Tunis Med 2000; 78: 628-33.

[6] Njimenten GL. Place des bactéries anaérobies Gram négatif dans les infections nosocomiales à l'Hôpital Paul IGAMBA de Port-Gentil Gabon de 1990-2000. Thèse de Pharmacie - Bamako 2003; N°27. [updated 2009 April 10; cited 2009 Oct 30]. Available from: indexmedicus.afro.who.int/iah/fulltext/Thesis_Bamako/05P79.PDF

[7] Timbiné LG. Etude bactériologique des I.N dans les services de chirurgie (chirurgie Générale, gynécologie, traumatologie) d'urgence et de réanimation de l'hôpital Gabriel Touré. Thèse de Pharmacie - Bamako 1998; N°6. [updated 2010 March 12; cited 2009 Oct 30]. Available from: à: http://indexmedicus.afro.who.int/iah/fulltext/Thesis_Bamako/05M49.PDF

[8] Dembélé S. Infections nosocomiales dans les services de chirurgie générale, de gynéco-obstétrique, d'urologie et de réanimation de l'hôpital national du Point G. Thèse de Médecine - Bamako 2002 ; N°70. [updated 2009 April 16; cited 2009 Oct 30]. Available from: http://www.keneya.net/fmpos/theses/2005/med/05M205.pdf

[9] Garner JS, Jarvis WR, Emori TG and coll. CDC definitions for nosocomial infections. Am J Infect Control 1998; 16: 128-40.

[10] Donigolo B. Infection nosocomiale dans le service de chirurgie « A » de l'hôpital national du Point G. Thèse de Médecine - Bamako 2005; N°59. [updated 2010 Marsh 30 ; cited 2009 Oct 30]. Available from: http://www.keneya.net/fmpos/theses/2005/med/05M59/pdf/05M59.pdf

[11] Farthouat M, Ogougbemy M, Millon A, *et al.* Infection du site opératoire (ISO) en chirurgie viscérale Etude prospective à l'hopital principal de Dakar. Medecine Afrique Noire 2009; 56: 143-8.

[12] Koumaré AK, Sissoko F, Diop AKT, *et al*. Facteurs influençant l'infection nosocomial en milieu chirurgical à l'hôpital du point G. Mali Médical 2008; 23: 44-6.

[13] Önen À, Geyik MF, Çigdem MK, Otçu S. Epidemiology and control of nosocomial infections in paediatric surgery 1. J Hosp Infect 2002; 52: 166-70.

[14] Nateghian A, Taylor G, Robinson JL. Risk factors for surgical site infections following open-heart surgery in a Canadian paediatric population. Am J Infect Control 2004; 32: 357-401.

[15] Baujean D, Veltkamp S, Blok H, *et al*. Comparison of two surveillance methods for detecting nosocomial infections in surgical patients. Eur J Clin Microbiol Infect Dis 2002; 21: 444-8.

[16] Hughes AJ, Ariffin N, Huat TL, *et al*. Prevalence of nosocomial infection and antibiotic use at a university medical center in Malaysia. Infect Control Hosp Epidemiol 2005; 26: 100-4.

Received: July 22, 2009 Revised: September 20, 2009 Accepted: September 24, 2009