Annals of Medicine and Surgery 21 (2017) 25–29

Contents lists available at ScienceDirect

Annals of Medicine and Surgery

journal homepage: www.annalsjournal.com

A prospective randomised trial of isolated pathogens of surgical site infections (SSI)

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HIGHLIGHTS

- Seven main pathogens were isolated from patients with SSIs: *Escherichia coli, Klebsiella pneumoniae, Enterobacter cloacae, Pseudomonas aeruginosa, Bacteroides fragilis, Staphylococcus aureus* and *Enterococcus faecalis.*
- SSI incidence was 4,3% (31 patients out of a whole of 715 patients).
- Potentially contaminated are all scheduled operations of the GI tract and SSIs appear in this classification with an incidence of 7–8%.
- All patients participating in our study underwent scheduled operations of the upper or lower digestive system, considered potentially contaminated as stated.

ARTICLE INFO

Article history:
Received 2 March 2017
Received in revised form
16 July 2017
Accepted 17 July 2017

Keywords:
Surgical site infections (SSI)
Healthcare associated infections (HAIs)
Wound care
Infection control

ABSTRACT

Background: Every surgical wound is colonized by bacteria, but only a small percentage displays symptoms of infection. The distribution of pathogens isolated in surgical site infections has not significantly changed over the last decades. Staph. Aureus, Coag(-) Staphylococci, Enterococcus spp and *E. Coli* are the main strains appearing. In addition, a continuously rising proportion of surgical site infections caused by resistant bacterial species (MRSA, *C. Albicans*) has been reported.

Methods: This prospective and randomized clinical study was performed in the 1st Surgical Clinic of Sismanoglion General Hospital of Athens, from February 2009 to February 2015. Patients undergoing elective surgery in the upper or lower digestive system were randomized to receive antimicrobial treatment as chemoprophylaxis. Each patient filled a special monitoring form, recording epidemiological data, surgery related information, surgical site infections (deep and superficial), as well as postoperative morbidity (urinary and respiratory infections included).

The monitoring of patients was carried by multiple visits on a daily basis during their hospitalization and continued after they were discharged via phone to postoperative day 30.

Results: Our overall SSI incidence was 4,3% (31patients out of a whole of 715 patients). Specifically, the incidence of SSIs for scheduled surgery of the upper GI tract was 2,2% (11 out of 500 patients) and for the lower GI tract was 9,3% (20 out of 215 patients). Seven main pathogens were isolated from patients with SSIs: *Escherichia coli, Klebsiella pneumoniae, Enterobacter cloacae, Pseudomonas aeruginosa, Bacteroides fragilis, Staphylococcus aureus* and *Enterococcus faecalis*. Their growth rates were respectively: *S. Aureus* (17,3%), *E. faecalis* (19,5%), *P. aeruginosa* (10,5%), *B. Fragilis* (13,4%) *E. coli* (20,4%), *Enterobacter cloacae* (9,1%) and *K. Pneumoniae* (9,8%). In addition, all the SSIs were found to be multimicrobial. Several studies have already revealed that patient characteristics and coexisting morbidities such as obesity, smoking, heart or renal failure, pre-existing localized infections and patients' age (especially if age exceeds 65) seem to be independent prognostic factors for surgical field infections. Additionally, classification of the surgical wound, surgical operation complexity, preoperative hospitalization, prolongation of surgical time and need for transfusions have been proved to differentiate the incidence of SSIs.

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http://dx.doi.org/10.1016/j.amsu.2017.07.045

Conclusions: In conclusion, surgical site infections are important complications affecting the healthcare services, the cost of hospitalization and the patient himself. Future thorough studies are expected to reveal much more data, regarding predisposing and precautionary patient and hospital characteristics.

1. Introduction

Every surgical wound is colonized by bacteria, but only a small percentage displays symptoms of infection. When a wound is contaminated by more than 10^5 microorganisms per gram of tissue the risk of infection augments. Surgical site infection is the third most common hospital-acquired infection (HAI) with a quota reaching 14–16% and the first between surgical patients. Around two thirds of the SSIs are limited in the surgical wound area and only 30% regards organs and anatomical spaces that were accessed during the procedure.

The distribution of pathogens isolated in surgical site infections has not significantly changed over the last decades. Staph. Aureus, Coag (-) Staphylococci, Enterococcus spp and *E. Coli* are the main strains appearing [1]. In addition, a continuously rising proportion of surgical site infections caused by resistant bacterial species (MRSA, *C. Albicans*) has been reported. This ratio reflects the increase of immunosupressed and critically ill patients as well as antibiotics misuse [2,3].

In the majority of SSIs the source of pathogens is normal skin, mucosa and bowel microbiota. Prosthetic implants can also become sources of bacteria proliferation. Other external sources are the surgical staff, the surgical room and every machine and instrument used during the procedure.

Surgical site infections can also be caused by unusual pathogens such as Rhizopus Orizae, C. Perfrigens, Rhodococcus Bronchialis, Nocardia Farcinica, Legionella Pneumophilla, Legionella Dumoffil and Pseudomonas Multivorans. Whenever an unusual strain causes an SSI, it is mandatory that an extended research is carried, questing the source of the pathogen [4–6].

In particular types of interventions several factors may be associated with increased risk of surgical site infection colonization [7,8] diabetes [9], smoking [10,11], systemic use of steroids [12], obesity (>20% of ideal BW), age [13–15], malnutrition [16,17] perioperative blood transfusion and its derivatives [18,19].

Microorganisms may contain or produce toxins that improve their ability to cause damage to the host cells or tissues. For example, many gram (-) bacteria produce endotoxins which cause secretion of cytokines. These substances can trigger the syndrome of systemic inflammatory reaction and may in some cases lead to multiple organ dysfunction and failure [18,19]. A variety of microorganisms including gram (+) bacteria, such as coagulase negative staphylococci produce glycocalyx which provides natural protection from phagocytes and prevents binding or penetration of antimicrobial agents.

In order to reduce surgical site infections several researchers suggest the use of preoperative chemoprevention [20,21]. Preoperative antibiotic administration should be done closely to the skin incision time. The start of the antibiotic administration within 60 min before the incision is under consensus. The start 120 min before the incision affecting the rate of surgical field infections [20,21]. Especially the administration of cefuroxime 30–60 min before skin incision may minimize surgical infections [22,23].

According to literature higher percentages of SSIs are encountered in gastrointestinal procedures (5,3–10,6% for small intestine, 4,3–10,5% for colon, 2,8–12,3% for stomach and 2,8–10,2% for billiary system) [20–23].

The purpose of this study was to evaluate and record the surgical site infection (SSI) in elective procedures of the upper digestive such as laparoscopic cholecystectomy comparing the administration of single dose chemoprotection against three doses in surgical field infection rate.

2. Materials and methods

2.1. Study design

This prospective and randomized clinical study was performed in the 1st Surgical Clinic of Sismanoglion General Hospital of Athens, from February 2009 to February 2015. The study protocol was approved by the Scientific Council of the Sismanoglion Hospital and written consents were received from all patients included in this study.

Patients undergoing elective surgery in the upper or lower digestive system were randomized to receive antimicrobial treatment as chemoprophylaxis. The administration of antibiotics was performed preoperatively and within 60 min prior to the surgical incision. Repeated dose was administered intraoperatively whereas the procedure lasted more than 3 h and/or if blood loss exceeded 300 ml.

The study excluded patients with preoperative hospitalization longer than 15 days, patients undergoing urgent surgery because of obstruction, bleeding or inflammation of the gastrointestinal (GI) tract and patients with active infections and systemic antibiotic administration.

2.2. Antibiotic treatment

Cefuroxime (1,5 gr) was provided, in 1 or 3 doses depending on randomization, for upper GI interventions, while ticarcilline - clavulanate (5,2 gr) was selected for chemoprophylaxis of lower GI surgery. In addition, patients undergoing scheduled colectomy underwent mechanical bowel cleaning without oral antibiotics intake.

In case of known and certified beta-lactams hypersensitivity, aztreoname (2gr) was alternatively administered, combined with metronidazole (1gr) for lower GI tract, 1 or 3 doses on randomization basis. In cases of previous antibiotics intake, patients were randomized according to their medication with penicillin, ampicillin, amoxicillin-clavulanate, aminoglycosides, cephalosporins, cefaclor, cefprozil, cotrimoxazol or quinolones.

Each patient filled a special monitoring form, recording epidemiological data, surgery related information, surgical site infections (deep and superficial), as well as postoperative morbidity (urinary and respiratory infections included).

The monitoring of patients was carried by multiple visits on a daily basis during their hospitalization and continued after they were discharged via phone to postoperative day 30.

3. Results

In this study, seven main pathogens were isolated from patients