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RESEARCH

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Incidence and perioperative risk factors for surgical site infections in neurosurgery: prospective observational study

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Abstract

Background: Surgical site infections (SSI) represent a burden on the health care system especially in developing countries with significant morbidity and mortality. In Egypt, especially in our institution, there is no registry for the SSI rate or the contributing factors with no clear guidelines regarding the regimen of perioperative antibiotic prophylaxis. Our study was conducted to assess the local practice and to calculate the rate and risk factors of SSI.

Patients and methods: A prospective registry was established at the Neurosurgery Department, Demerdash teaching hospital Ain Shams University, Cairo, Egypt. All patients who underwent elective neurosurgical procedures were included in this study. Trauma patients were excluded. Patients were followed-up for incident SSI for 1 month postoperatively. SSIs were identified based on CDC criteria and a standardized data collection form predictor variables including patient characteristics, preoperative, intraoperative, and postoperative factors along with the pattern of antimicrobial prophylaxis.

Results: The study included 248 patients with 1-month postoperative follow-up. An SSI rate of 19% was recorded being mainly in patients below 10 years of age. Postoperative CSF leak was noticed to be the most significant risk factor of SSI in our study (p value < 0.01). Sixty five percent of culture results showed infection with gram-negative bacilli with the predominance of Acinetobacter.

Conclusion: Prolonged use of perioperative antibiotics does not seem to have an added benefit in SSI prevention. Tailoring of the used antibiotic regimen is highly recommended according to the latest antimicrobial prophylaxis guidelines and the local culture and sensitivity results.

Keywords: Surgical site, Nosocomial, Infection, Contamination, Risk factors, Clean surgery, Spinal surgery, Cranial surgery, Antibiotic prophylaxis

Introduction

Surgical site infections (SSIs) are infections related to surgical incision, organs, or space after surgery [1]. In 2010, a World Health Organization (WHO) report stated that up to one-third of patients who had surgeries in low- and middle-income countries developed surgery-related infections with a prevalence of up to twenty times greater than that of high-income countries [2]. This subsequently leads to high rates of morbidity, hospital readmission, reoperations, poorer outcomes in addition to increased healthcare costs [3, 4].

Within neurosurgical procedures, the reported incidence of surgical site infection in the last 10 years ranges from 0.8 to 6.6% [5].

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Many perioperative risk factors for SSI were reported. Old age, high BMI and prolonged duration of surgery increased the incidence of SSI [6]. Infection rates are lower when the surgery is elective, clean and with patients whose ASA score is lower. Suitable antimicrobial prophylaxis administration is considered one of the crucial factors [7]. According to CDC guidelines published in August 2017, there is no need for additional administration of prophylactic antibiotics after the closure of the incision in the operating room in case of clean and clean-contaminated wounds [1].

The conventional practice in many of the neurosurgical centers in Egypt is that of the extended use of broad-spectrum antimicrobial prophylaxis. Namely, a combination of intravenous (IV) Ceftriaxone plus Ampicillin/ Sulbactam before skin incision and throughout the patient's postoperative hospital stay and sometimes continued orally or parenterally after patient discharge (personal communication, unpublished data).

The aim of the present study was to construct a registry for SSI to objectively document the local practice, incidence of SSI, the patterns, risk factors of surgical site infections, local microbial prevalence and the pattern of antimicrobial resistance at El-Demerdash teaching hospital Ain Shams University in Cairo, Egypt, between 2016 and 2018.

Methodology

The study is a descriptive cohort study of a prospectively maintained data registry. All patients undergoing elective neurosurgical procedures (cranial, spine or peripheral nerve operations) were considered eligible, no specific age limitation, between the period of 2016 and 2018. Trauma patients were excluded.

Surgical site infections were defined according to the CDC (The Center for Disease Control and Prevention) criteria [1]. By using a standardized data collection form, predictor variables including patient characteristics, preoperative, intraoperative and postoperative data were obtained.

Study data included age, gender, wound class (clean, clean contaminated, contaminated, dirty), type of surgical site infection (superficial incisional, deep incisional, organ-space infection), incision site, type and duration of operation, type and duration of antimicrobial prophylaxis, use of wound drain, presence of postoperative CSF leak, preoperative anemia, use of implants, ICU admission, preoperative and postoperative hospital stay in addition to presence of other comorbidities like diabetes and hypertension.

One-month postoperative follow-up was done for incident SSI. All these data were collected using a paper-based checklist and saved in computer-based datasheets.

Ethical approval was obtained from the neurosurgery department to collect and analysis the data of the current practice to be include in the data registry.

Statistical analysis

Statistical analysis of all collected data was done using descriptive statistics. All data analysis was done using Excel software functions.

Results

A total number of 248 patients were included in the study with 13.7% attrition (34 patients lost follow-up) and 214 patients remaining (114 females and 100 males). Mean age was 34 years (R 4 days–70 years). The majority, 122 (57%) patients underwent cranial surgery; 86 (40%) patients underwent spinal surgery; 3% underwent other procedures. The reported attrition was attributed to difficult communication with the patients after discharge.

SSI infection rate was 19% (41 patients). The majority (54%) have had spinal surgeries, 39% have had cranial surgeries, and 5% of cases underwent other surgeries. Type of SSI was identified in 26 patients with predominance of superficial incisional SSI.

Highest infection rate occurred in the age below 10 years followed by 31–40 years age range. However, age did not show a statistically significant association with the occurrence of SSI (p value > 0.05, Mann–Whitney test used).

The most significant risk factor for SSI was postoperative CSF leak, and this occurred in 34% of cases with SSI (p value < 0.01, Chi-square test used).

Other factors like prolonged duration of surgery (more than 100 min), presence of breach in sterile techniques, postoperative ICU admission, preoperative anemia, diabetes mellitus, and surgical implants showed no statistically significant influence on the SSI outcome among the included patients (p value > 0.05, Chi-square and fisher exact tests used). Additionally, there was no statistically significant difference between infected and non-infected cases regarding patient's gender (p value > 0.05, Chi-square test used), length of preoperative hospital stay or intraoperative estimated blood loss (p value > 0.05, Mann–Whitney test used).

A total of 34 culture results were available for analysis, 13 showed no growth after 48 h incubation (38%), 6 cultures revealed infection with gram-positive organisms (18%) and 22 cultures showed infection with gram-negative organisms (65%).

The predominant organism in cultures was Acinetobacter (33%) followed by E- Coli, and Klebsiella (29% for each) (Fig. 1). Amikacin showed the highest sensitivity rates, while Ceftriaxone and Ampicillin/ Sulbactam

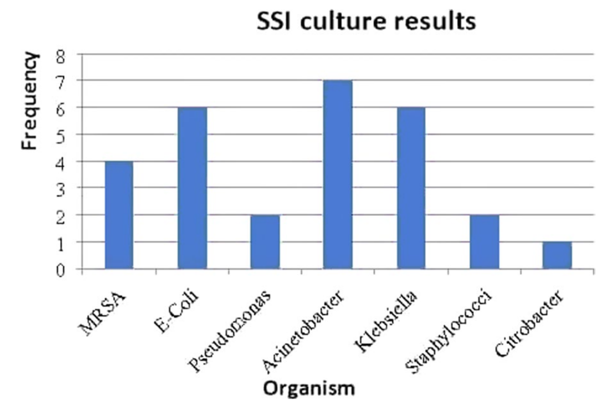

Fig. 1 SSI culture results

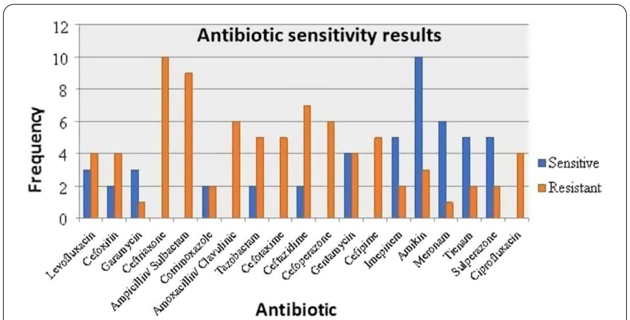

Fig. 2 Antibiotic sensitivity results

showed the highest resistance rates (Fig. 2 shows an antibiogram for the antimicrobial sensitivity patterns).

Discussion

Multiple risk factors for SSIs exist, and the perioperative use of antimicrobial prophylaxis has been long in use as an attempt to reduce SSI risk. The chosen antimicrobial agent should be effective against the most common surgical-site pathogens. The predominant organisms causing SSIs after clean procedures (i.e., most of the neurosurgical procedures) are skin flora including Staphylococcus Aureus and coagulase-negative Staphylococci (e.g., Staphylococcus Epidermidis) [8–10].

The administration of antibiotics is not intended to sterilize tissues, but to act as an adjunct to decrease the intraoperative microbial load to a level that can be managed by the patient's immunity [11, 12]. To achieve this goal, it is crucial for antibiotic therapy to reach sufficient tissue levels at the time of the expected microbial contamination [9] and the optimal agent should preferably be long-acting, inexpensive, and has a low side effect profile [11].

According to NICE guidelines, single dose of antibiotic prophylaxis should be given on starting anesthesia and repeated dose is given if the duration of surgery is longer than the half-life of the drug used. The aim is to establish adequate tissue levels throughout surgery from the time of incision until closure [13, 14]. The same notion was advocated by the CDC guidelines published in August 2017 [1]. The excessive fear from the devastating complications of SSI after neurosurgical procedure may lead to prolonged antimicrobial prophylaxis practices. The abuse of antibiotics leads to increased drug resistance and bacterial spectral changes [15].

Throughout the conducted study in our university hospital, a local protocol of antimicrobial prophylaxis was used. This included the simultaneous administration of a third-generation cephalosporin, mostly ceftriaxone combined with ampicillin/sulbactam for long durations throughout the hospital stay, and mostly until sutures are removed.

It is possible that this practice contributed to the relatively high infection rate and the presence of predominately gram-negative infections. Additionally, culture results are affected, where about 1/3 of the cultures did not grow organisms. This can be partially explained by the effect of antibiotics in the pre-infection period or attributed to the empirical antibiotics given on suspicion of SSI. The predominance of gram-negative infections (65%) indicates a switch from the conventional gram-positive wound infections. This can be mainly attributed to the overuse of broad-spectrum prophylaxis giving opportunity for otherwise weaker strains to flourish [16, 17]. In support of this, the gram-negative organisms in the current results show multi-drug resistance, especially to the commonly used agents. We regard this as a serious turn of events because the appropriate drug management would entail the use of other more complex agents that have both higher side effects and a higher cost.

Three important results stand out in our study: a relatively high SSI rate of 19%; the most common infective organism being Acinetobacter and CSF leak as the only significant risk factor for SSI. The association of a postoperative CSF leak as the most significant risk factor for SSI indicates the absolute need for its prevention through meticulous surgical technique. It also reinforces the imperative for early and definitive management of a CSF leak in order to prevent serious sequelae.

The failure of our study to find statistical significance with respect to the other risk factors could be attributed to the small sample size relative to the expected incidence of variation in such factors. Thereby, the study might not be sufficiently powered to detect differences in those risk factors. The relatively small total number resulted in smaller numbers available for subgroup analysis and comparisons.

Breach of sterile techniques was recorded in all surgeries as well. This invokes cautionary measures in considering the results of the current study as it increases the number of confounding steps and variables that may have contributed to the outcome. It also emphasizes the role of good infection control practice and its impact on SSI risk.

The setting of the current study could be viewed as a limitation of its own, namely the peculiar pre-study environment and specific antimicrobial prophylaxis regimen. Nevertheless, similar practices are still out there in many developing countries and in some centers in the developed world. Subsequently, any derivations will be considered input to help shape a local corrective practice. In other words, the pattern of predominantly gram-negative microbial prevalence in our SSI sites is peculiar and as such is considered essential to tailor a local antibiotic prophylaxis protocol.

We are aware of the downsides of the current study, being a single-center study with a small number of subjects is on the top of the list, and some data were lost about subtype of SSI despite being a prospective study in addition to a 13.7% attrition which is within the acceptable range and do not undermine the internal validity of the results.

Conclusions

Prolonged use of perioperative broad-spectrum antibiotics did not decrease the rate of SSI as it was intended and believed. Conversely, this practice was associated with the emergence of multi-drug resistant strains of pathogens. Postoperative CSF leakage should be diagnosed early and managed with caution to decrease infection rates. Taking into consideration the local patient factors and patterns of microbial prevalence and antimicrobial resistance will help in adaptation of the recommendations of international guidelines and results in a more tailored approach of antimicrobial prophylaxis. Such approach might require validation through randomized clinical trials.

Abbreviations

SSI: Surgical site infections; CDC: The center for disease control and prevention; ASA: American society of anesthesia; WHO: World health organization.

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Authors' contributions

AAM, AH both were involved in writing the manuscript especially the discussion. NIG, OMS designed the methodology of the study, methodology section writing. SGA, GAA contributed to data collection and results formulation. AI, AMAL contributed to concept, study design, final revision and approval of manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

Available upon request.

Declarations

Ethics approval and consent to participate

It was obtained by the Research Ethics committee, Faculty of medicine, Ain Shams University, Cairo, Egypt. The reference number of the committee FWA 000017585. The unique ID number approval for out study: FMASU R119/2020.

Consent for publication

Not applicable, no individual personal data were included.

Competing interests

The used and/or analyzed during the current study is available from the corresponding author on reasonable request.

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