Microbial Etiology of Surgical Site Infections, Bacterial Isolates and their Antibiotic Susceptibility Patterns at Trauma University Hospital in Tirana, Albania

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Abstract

Hospital acquired infections in general and specifically surgical site infections increase significantly the morbidity and mortality of post-surgery patients. They are considered the most frequent postoperative complication worldwide, and a major public health burden especially in low income countries. The preventability and the high treatment costs of these complications, sets the focus towards identification of the most frequent etiological factors, in order to decrease the incidence of the phenomenon in different levels. This is a retrospective study carried out from January 1 to December 31, 2023. We analysed the microbiology and antibiotic susceptibility reports of specimens accepted and examined at the laboratory department of the Trauma University Hospital, Tirana. We reported standard operating procedure on direct microscopic examination with gram staining, and the susceptibility patterns reported by millimetre scaling the zone of inhibition of the examined antibiotics disks. We reported 40% negativity rate on the examined specimens. The most frequently isolated microorganisms within the positive results were Acinetobacter Baumannii (25.4%), Staphylococcus Aureus (13.5%), and Enterococcus faecalis (10.32%). The combination of cephalosporins together with aminoglycosides was found to be the most effective antibiotic prophylaxis formulation. Continuous surveillance of bacterial profiles through variable rich, statistically significant additional studies become crucial. The results will help toward better hospital acquired infection prevention and control.

Keywords: *Antibiogram, etiological factor, hospital acquired infection, surgical site infection, Trauma University Hospital*

1. Introduction

Surgical site infections (SSIs) are all the infections that occurs due to contamination at the site of surgery during or after the surgical procedure, (WHO, 2018; Horan et al., 2008) within the following 30 days after the procedure, or in the case of an added implant the duration is extended to 1 year (Horan et al., 2008; Ahmad et al., 2016). These infections increase significantly the morbidity and mortality of post-surgery patients, and are considered a major public health burden specially in low income countries and wherever resources are limited (Magill et al, 2014; Suetens et al., 2016). They are considered the most frequent postoperative complication worldwide (Magill et al). Due to the high cost of their treatment and the preventability of the phenomenon there exists a proven set of preventive measures that involve different levels starting with sound hygiene practices involving the patients, standardized preventive polities involving healthcare providing facilities and any involved parties ((Horan et al., 2008; Onyekwelu et al., 2017; Leaper et al., 2015).

Reported incidence rates of SSIs vary significantly, they peak in low income and developing countries. In 2016, among 44,814 elective surgery patients from low, middle and high income countries patients, the authors reported a 5% SSI incidence rate (Ahmad et al.2016). In China in 2019 the SSIs incidence after emergency abdominal surgery was reported to be 7.4%.10 Another multicentre study across 66 countries in 2018 reported the overall incidence of SSI to be 12.3% (ECDC, 2013). In sub-Saharan Africa in 2016 that the pooled incidence of SSI was reported to be 14.8%.9 climaxing in Ethiopia with 21.1% (Berrios-Torres et al., 2017).

The CDC surgical wound classification has been used since a long time as a predicting measure to determine SSIs risks.[6] Such risks differ significantly in-between procedures, and according to a European surveillance analysis the riskiest procedure resulted to be colorectal surgery (ECDC, 2013). Another study conducted in low- and middle-income countries relating to wound classification reported SSI rates ranging from 15.5 to 30% for dirty wounds, emphasizing again the significant burden of SSI in these countries, and in such areas and regions (Harrington P., 2014). The COVID-19 pandemics once again demonstrated that, even the simple everyday preventive measures like hand hygiene, social distancing and mask usage have a considerate impact on decreased the overall SSI rates (IHI, 2012; NICE, 2013). It has been demonstrated from many studies worldwide that the pathogens responsible for causing surgical site infections vary significantly in different locations, but still many studies conclude that the primary cause of such infections are Gram-negative pathogens (Berrios-Torres et al., 2017; Kirkland et al.,1999; HPS, 2015; Dellinger et al.,1994; Forbes et al.,2008). The most commonly isolated Gram- negative bacterial pathogens were found to be Escherichia coli, Klebsiella species, Pseudomonas species, and Proteus species (Berrios-Torres et al., 2017; Dellinger et al., 1994). On the other hand, Staphylococcus aureus, Streptococcus species and coagulase-negative Staphylococcus (CoNS) were the most commonly faced gram-positive pathogens. Generally these gram positive species showed a very high level of resistance (Belba et al., 2013; Jnaneshwara et al., 2015) against the tested antibiotics, and their pathologic effects on the affected individuals were found to be much more exacerbating than gram negative specimens (Berrios-Torres et al., 2017; Dellinger et al.,1994; Hedrick et al., 2007).

In Albania, a literature review revealed limited studies reporting risk factors of such infections, incidence and prevalence of nosocomial and hospital acquired infections, but very few papers reporting etiological factors. The first prevalence survey in Tirana University Hospital Center, in 2005, reported the overall nosocomial infection rate to be nearly 17% where the SSI prevalence occupied 24.3% of the burden or 4.1% of the total (Faria et al., 2007). Gjerazi et al in 2015 reported the SSIs infection rate to be 6%. Smoking, diabetes, hypertension, inadequate skin preparation, presence of drain and contaminated wounds were reported as the most important risk factors (Gjerazi et al., 2015).

Belba et al in 2013 reported the most frequently isolated microorganisms in the Burn Unit of Tirana to be Pseudomonas aeruginosa and Staphylococcus aureus, 67% and 24% respectively of the overall infected cases (Belba et al., 2013). The prevalence rate of SSI in the Burns Unit was reported to be 12%. Another study has reported the prevalence of HCV and HBsAg in haemodialysis patients with a high prevalence (Durro et al., 2019).

The scarcity of reports regarding the etiological pathogens responsible for SSIs leads to inefficient preventive strategies and defective antibiotic prophylaxis regimens. It is very important to prevent these infection as it will increase the health in our hospitals and the quality of service in patients (Kalaja R. and Krasniqi M., 2022).

This study aims to fill this research gap by determining the most frequent etiological pathogens and with the antibiotic resistance data delivered by the antibiogram analysis the professionals will be able to build better prophylaxis regimens and provide better therapeutical results.

The bacterial profile responsible for SSIs in the health facility, will provide a better perspective of the problem for the health facility's stakeholders and physicians in order to better control and efficiently prevent such devastating complications that have a significant administrative cost and seriously impair treatment outcomes. The result of the current study will hopefully rise awareness towards targeted CME events and antimicrobial stewardship activities in all health facilities.

2. Materials and Methods

2.1 Study area, period, and population

The study was conducted at Trauma University Hospital, Tirana. This the only tertiary facility for trauma cases in Tirana, Albania. The Trauma University Hospital offers services specialised in Traumatology, General Surgery, Orthopaedics, Neurosurgery, Ear Nose Throat Surgery, and Maxillofacial Surgery. Except a limited number of standardised surgical procedures that can be treated remotely in the regional hospitals the centre of the study virtually covers all the national trauma instances that require a certain level of expertise. On average 24 surgical procedures are performed per day.

Irrelevant of the emergent, expedited or elective status of the previous or current surgical procedure, the source population of the study were all the hospitalised patient from all the specified departments during the period of the study.

Disregarding the level of contamination of the initial trauma wound and/or surgical procedure as clean, clean-contaminated, contaminated, or infected we included in the study all the patients who were planned for surgery, underwent surgery before (within past 90 days) or during the current hospitalisation, whose tissue or biopsy materials were sent to the main laboratory unit for microbiological examination.

We have collected all the microbiology reports and the reported antibiotic susceptibility testing (antibiogram) examinations of the received wound swaps and/or samples taken of any biological material sent to the main laboratory department of the centre of study, beginning from January 1, 2023 till December 31, 2023. There were no excluded wound swaps, tissue samples and examined materials.

2.2 Specimen and data collection

All the samples were collected by the ward doctors or the experienced nurses with strict aseptic precautions. To avoid any possible contamination, the materials were collected from the depth of the wounds either with sterile cotton swaps for smear studies or through aspiration for aerobic and anaerobic culturing, which were sent to the laboratory department directly after the end of the procedure.

The data were collected directly from the report database of the laboratory department of the centre of study. A laboratory specialist responsible for data archiving was assigned for the data collection process, and all the reports were initially printed in A4 format.

2.3 Investigation technique and quality control

Direct microscopic examination with gram staining technique following standard operating procedure was performed. The classified results were than correlated with the culture growth after 24-48 hrs, and reported primarily as positive or negative. Susceptibility patterns were reported by millimetre scaling the zone of inhibition of the examined antibiotics disks with minimum inhibitory concentrations (MIC) range values interpreted as susceptible, intermediary susceptible, and resistant. Quality control was ensured by the continuous implementation of the quality control measures covered within the inter-institutional contractual rights between the hospital centre of the study and the central laboratory network.

2.4 Statistical analysis

The data were entered as Microsoft Excel Worksheet and analysed with SPSS version 19. Descriptive analysis was performed in order to obtain the distribution of data, and the results were explained in tables by frequency distribution

3. Results

A total of 219 examination reports were included in the study, the majority were males 154 (70.3%) and 65 (29.7%) were females. The age range was from 19 to 86 years old with a mean age of 58.45 years old. All the biological materials were reported to be obtained from wounds surgical or not. Most of the examinations 107 (49%) were sent and requested by the Plastic and Reconstructive Surgery Department followed by Orthopaedics and Neurosurgery Departments respectively

52 (24%) and 23 (11%) reports. The rest was spread through Internal Medicine Department, General Surgery and Intensive Care unit respectively 15 (7%), 14 (6%) and 8 (4%). See the data shown in table 1.

Table 1. Demographic data of the patients

Variables	No	%
Total examination cases	219	100
Gender		
Male	154	70.3
Female	65	29.7
Ward / Department		
General Surgery	15	7
Intensive Care Unit	14	6
Internal Medicine	8	4
Neurosurgery	23	11
Orthopaedics	52	24
Plastic and Reconstructive Surgery	107	49
Age in years		
Range	19-86 yrs	
Median	52.5 yrs	
Mean	58.45 yrs	

We faced a high examination negativity rate of more than 40% (88 cases) and within the positive cases 5 cases were reported contaminated. The contaminant in 4 of the cases was reported to be staphylococcus epidermidis, and in one case staphylococcus haemoliticus.

Among the positive cases the most frequently isolated microorganism was Acinetobacter Baumannii 32 out of 126, or 25.4% of the cases, followed by Staphylococcus Aureus in 13.5% of the cases or 17 out of 126.The subsequent most frequently isolated microorganisms were Enterococcus faecalis, Pseudomonas Aeruginosa and Escherichia Coli, respectively 13 (10.32%), 10 (7.94%) and 10 (7.94%) cases. Results shown in Table 2 and Figure 1.

Table 2. Bacterial aetiology of the specimens

Variables	No	%
Total examination cases	219	100
Negative Reports	88	40.18
Contaminated Reports	5	2.28
Positive Reports	126	57.54
Isolated microorganism		
Staphylococcus Aureus	17	7.76
Acinetobacter Baumannii	32	14.61
Klebsiela Pneumonia	9	4.11
Proteus Mirabilis	8	3.65
Pseudomonas Aeruginosa	10	4.57
Enterococcus Faecalis	13	5.94
Escherichia Coli	10	4.57
Enterococcus Faecium	8	3.65
Serratia Ficaria	1	0.46
Streptococcus Anginosus	1	0.46
Achromobacter Xylosoxidant	3	1.37
Streptococcus Constellatus	2	0.91
Candida Albicans	2	0.91
Enterobacter Cloacae	5	2.28
Citrobacter Amalonaticus	1	0.46
Actinomyces Europaeus	1	0.46
Arcanobacterium Haemoliticum	1	0.46
Citrobacter Braakii	2	0.91

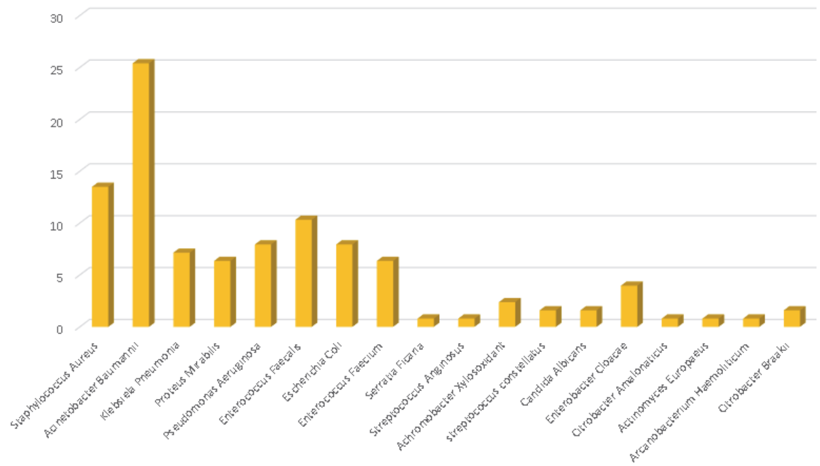

Figure 1. Bacterial aetiology of the specimens

Regarding the Antibiotic Susceptibility Examination, 56 out of 126 positive cases (44.4%) resulted resistant to all the panel antibiotics except Polymyxin E, 3 (2.4%) cases susceptible only to Polymyxin E and Trimethoprim-sulfamethoxazole, and 1 (0.8%) case only to Trimethoprim-sulfamethoxazole. 28 cases (22.2%) were reported to be susceptible by all the investigated panel antibiotics. The antibiotics with the highest susceptibility resulted to be Vancomycin-Teicoplanin, and Meropenem Imipenem groups, topping with Polymyxin E and Linezolid with virtually no reported resistance among any of the isolated superinfections. (Table 3)

The institutionally approved antibiotic prophylaxis is outlined as 1st or 3rd generation cephalosporin (cefazolin, ceftriaxone) used alone or in combination with an aminoglycoside (gentamycin, amikacin), and fluoroquinolone (ciprofloxacin) used alone or in combination with an aminoglycoside (gentamycin, amikacin). The cephalosporines altogether (including ceftazidime and cefepime) were reported to be efficient in 30 cases (23.8%) of the isolated microorganisms, aminoglycosides (including streptomycin) in 52 cases (41.3%) cases and fluoroquinolones (including levofloxacin and moxifloxacin) in 32 (25.4%) of the cases.

Table 3. Antibiotics Susceptibility Examinations Results

Variables	No	%
Positive cultures	126	100
Ampiciline	34	26.9
Amoxicilline, Acid clavulanik	34	26.9
Ceftaroline	30	23.8
Cefazoline, Ceftriaxone, Ceftazidime, Cefepime	30	23.8
Trimethoprim-Sulfamethoxazole	52	41.3
Piperacillin, Tazobaktam	37	29.4
Gentamycin, Streptomycin, Amikacin	52	41.3
Ciprofloxacin, Levofloxacin, Moxifloxacin	32	25.4
Clindamycin, Erythromycin	28	22.2
Vancomycin, Teicoplanin, Tigeciklin	51	40.5
Imipenem, Meropenem	51	40.5
Linezolid	54	43
Fusidic Acid, Mupirocin	28	22
Colistin (polymyxin E)	60	47.6
Nitrofurantoin	39	30.9
Fosfomycine	32	25.4

4. Discussion

Our study investigated all the reports of the tissue specimens sent for microbiological examination to the laboratory department of the center of study during the specified time interval. We focused on the identification of the bacterial isolate from the positive reports, and analyzed the antibiotic susceptibility pattern of the isolates. We are reporting a 57.54 % culture positivity rate.

Gram-negative isolates dominance has been reported in many African and Indian studies (Misha et al., 2021; Lakoh et al 2022; Dessalegn et al., 2014; Dessie et al., 2016; Birhanu et al., 2020), and we have reported 81.75% of the cases to be Gram-negative rods and 18.25% Gram-positive cocci.

Jnaneshwara et al. in 2015 described such Gram-negative rods predominance of the recent years to be justified by the increase in postoperative wound infections caused by such bacteria. Nevertheless, other regional similar studies reported Gram-positive cocci as a predominant isolate over Gram-negative rods (Pal et al., 2012; Kalayu et al., 2019; Ahmed et al., 2012).

The most frequently isolated microorganisms in our study was Acinetobacter baumannii (25.4%), a Gram negative rod. The other most frequent Gram-negative rod, and the third most frequent in our study was Enterococcus faecalis with 13 cases (10.32%), followed by Escherichia coli and Pseudomonas aeruginosa both with 10 cases respectively (7.94%).

Múñez et all reported Escherichia coli to be the most frequently isolated microorganism found in 28% of the cases (Múñez et al., 2011).

Other diverse papers report also Escherichia coli, Enterococcus faecalis, and Pseudomonas aeruginosa, to be among the most frequently isolated microorganisms (Sievert et al., 2009; Misha et al., 2021; Shakir et al., 2021).

In 2013 the Journal of Infection Control and Hospital Epidemiology reported that the most frequently isolated pathogen from 1029 facilities was Staphylococcus aureus (30.4%) followed by coagulase-negative staphylococci (Sievert et al., 2013). Staphylococcus aureus was the second most frequently isolated microorganism in our database with 17 reported cases or 13.49% of the overall positive cultures. We found no cases of coagulase-negative staphylococci.

In 2023 Candida albicans was found to be the predominant species among fungal infections of the chronic diabetic wounds, as an efficient contributor to biofilm production that generally leads to exacerbated polymicrobial wound infections (Ge et al, 2023). We are reporting 2 cases of Candida albicans with tissue specimens forwarded by the Plastic and Reconstructive Surgery Department. We lack the sufficient data to evaluate the linkage of diabetes mellitus contribution to our isolated cases.

A 2019 global meta-analysis reported Group B Streptococci to be a major cause of cesarean section infection worldwide.21 We identified 3 cases (2.38%) of streptococcus species but all of the cases were males and no correlating data was available (Collin et al., 2019).

The antibiotic susceptibility examination showed that cephalosporins and aminoglycosides independently were effective respectively in 23.8% and 41.3% of the isolated microorganisms. Taking into consideration that these microorganisms are hospital acquired infections, they derive and have evolved from a bacterial pool with a considerable level of antibiotic resistance, and among the currently accepted institutional protocols the combination of cephalosporins together with aminoglycosides is contemplated to be the most effective antibiotic prophylaxis regimen.

5. Conclusion

In our study the number and percentage of Gram-negative rod was reported to be relatively higher than Gram-positive isolates. The predominant Gram-negative isolate was Acinetobacter baumannii, and the most frequent Gram-positive isolates was Staphylococcus aureus. Although our result support structurally similar data reported by other comparable studies with akin population characteristics, they emphasize the need for continuous investigations and further papers focus on this subject. Periodic surveillance of the bacterial profiles, and antibiotic susceptibility testing, should be carried out, and the data should be communicated with the physicians, for the physicians to take appropriate action for better hospital acquired infection prevention and control, and overall better health management.

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