Systematic Review

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Microbiology and Drug Sensitivity of Surgical Site Infections in Pakistan: A Systematic Review

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Author`s Contribution

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ABSTRACT

Various bacterial pathogens that are known to cause Surgical Site Infections (SSI) are becoming increasingly resistant to many antibiotics. The aim of this systematic review was to see various pathogens responsible to cause SSI in Pakistan and to see their drug sensitivity patterns according to culture and sensitivity reports during last five years. This systematic review was conducted according to the preferred reporting items for systematic reviews and met analysis (PRISMA) guidelines. Extensive search of medical databases Pubmed, Google Scholar and Pakmedinet was done. Four studies were selected from various cities of Pakistan. Most common bacterial pathogen isolated was staph aureus 49%, followed by Ecoli 18%, Enterococcus 8%, and Pseudomonas 7.4%. Methicillin resistant staph aureus (MRSA) was isolated as 5% and 18 % in two studies. Drug sensitivity pattern showed Vancomycin, Imipenem, Meropenem, Linezolid, Cefoperazone + Sulbactam to be the most sensitive drugs against all type of pathogens. Drugs found effective against staph aureus were Vancomycin, Linezolid, Meropenem and Fusidic acid. Drugs found sensitive against E coli were Cefoperazone Sulbactam combination, Linezolid and Meropenem. Ampicillin and Amoxicillin were found highly resistant against all pathogens. We concluded from our systematic review that most common bacterial pathogen responsible to cause SSI in Pakistan is staph aureus. Empirically Linezolid is found effective against all pathogens. Imipenem, Meropenem, sulbactam plus Cefoperazone combination, vancomycin, tazocin are effective drugs. Ampicillin, amoxicillin and ciprofloxacin are highly resistant in Pakistan.

Key words: Surgical Site Infections (SSI), Staph aureus, E Coli, Culture and Sensitivity

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Introduction

Infections occurring in surgical wounds, inside or around organs or spaces that are manipulated or handled during surgical procedures are known as surgical site infections (SSI).[1] SSI are the most common complication after surgery. The frequency of SSI varies in different type of surgeries and regions and depends on many factors but according to studies approximately 3-5 % of patients undergoing surgical procedures develop SSI.[1,2] Many factors influence the development of SSI and include immune system of patient, type of surgery, surgical technique, presence of foreign material, level of sterilization and prophylactic antiobiotics.[2,3] SSI are associated with significant morbidity and mortality. Patients with SSI have longer hospital stays than patients without and socioeconomic cost of treatment is high.[3,4] SSI are reported in every speciality of surgery with variable frequencies and different outcomes.[5,6,7] Various bacterial pathogens are reported to cause SSI[7]. The management of SSI is becoming a challenge due to increasing drug resistance of microorganisms.[7,8] Many cheaper drugs like penicillins, co trimaxazole and ciprofloxacin are mostly resistant and usually not prescribed to patients with complicated SSI. Many new drugs like Meropenem and Imipenem are effective against various pathogens but are expensive. This microbiological resistance is a challenge for poor resource countries[8,9]. The rising frequency of

Methicillin resistant staph aureus (MRSA) in swabs of SSI is alarming and, on the rise, as well.[7,10] As the treatment of SSI is becoming difficult, there is strong need and urge to focus on prevention of SSI.[11]

Pakistan is an underdeveloped, poor resource country which has a weak health care system. Inadequate sterilization measures especially at remote public sector hospitals and antibiotic resistance has caused rise in SSI.[11,12] Various studies are published before in which microbiology and drug sensitivity from swabs of SSI are tested. The aim of this systematic review is to gather recent information about microbiology and sensitivity of various antibiotics against the microorganisms isolated in cultures. We have limited this review to last 05 years to see recent trends. This review will establish the frequency of various bacterial pathogens responsible to cause SSI in Pakistan and will guide in drug treatment of these infections as well. Also the most effective drugs that may be used as empirical therapy in patients with SSI will be known.

Methodology

This systematic review was conducted as per PRISMA (preferred reporting items for systematic reviews and Meta analyses) guidelines.[13]

Pubmed, Google scholar and Pakmedinet databases were searched for each of the following terms i.e. surgical site infections, wound infections and microbiology SSI. All studies that were conducted during last 05 years in Pakistan where pus swabs were taken from patients of SSI and were tested for presence of microorganisms and drug sensitivity were included. Full texts of studies were retrieved, studied in detail and relevant information recorded and tabulated. Various microorganisms cultured were noted according to their frequencies. Only those studies were chosen which also tested various drug sensitivities as well. Chosen studies were not limited to elective or emergency surgeries, as well as not limited to general surgery.

Studies conducted in Pakistan during last five years on patients of SSI in which culture and sensitivity of pus swabs recorded were included. Studies more than five years old, published in journals not recognized in Pakistan were excluded. Studies in which infected patients were not separated before were also excluded. Studies where full text was not found were also excluded.

Throughout the research process, a total of 44,079 records were identified from various databases, including PubMed, Google Scholar, and PakMediNet. Among these, 2,129 records were removed due to duplicate entries and titles deemed irrelevant. The remaining 2,129 records underwent screening, where abstracts were scrutinized for relevance, resulting in the exclusion of 2,023 records.

Subsequently, 106 full-text articles were screened, and 102 studies were excluded as they did not meet the predefined inclusion criteria. Finally, after final evaluation, four studies were deemed eligible and included in the analysis. This sequential process highlights the meticulousness involved in filtering through vast amounts of data to identify relevant studies for further analysis and consideration.

Results

Four studies were included in review. Two studies were carried out in hospitals in Rawalpindi, one study in Swat and one study in Karachi. One study was conducted on plastic surgery patients, one emergency general surgery, one emergency pediatric surgery and one elective surgical procedure of various Specialties (table I). Total patients included in four studies were 535 (male=296, female= 239). A total of 472 Culture positive SSI were noted. Most common pathogen isolated from four studies collectively was Staph aureus 49% (n=235), followed by E coli 18% (n=87), Enterococcus 8% (n=38), Pseudomonas 7.4% (n=35). Other organisms isolated were Streptococcus, Klebsiella and Proteus. Mixed flora and rare atypical organisms were found in 6% samples. Fungal cultures were positive in 1.9% (n=9) samples collectively. MRSA was noted in 5% Staph positive samples in one study and 20% staph aureus positive samples in another study. Two studies did not report MRSA in cultures.

Drug sensitivity pattern showed Vancomycin, Imipenem, Meropenem, Linezolid, Cefoperazone + Sulbactam to be the most sensitive drugs against all type of pathogens. Drugs found effective against staph aureus were Vancomycin, Linezolid, Meropenem and Fusidic acid. Meropenem was found ineffective against MRSA in one study. Drugs found sensitive against E coli were Cefoperazone Sulbactam combination, Linezolid and Meropenem. Amikacin was found 45% resistant against Ecoli. Ampicillin and Amoxicillin were found highly resistant against all pathogens (table II).

Discussion

Surgical site infections (SSI) are frequently observed in surgical practice in Pakistan. Various bacterial pathogens are responsible to cause SSI. The most frequent organism reported to cause SSI is Staphylococcus aureus.[14] We

Table I: Microbiology of included studies

Reference	Year of publication	Type of surgeries	Number of SSI	Male: female ratio	Gram positive organisms	Gram negative organisms	MRSA	Fungal growth
Iqbal M et al[12]	June 2021 JRMC	Emergency general surgeries	237 cases	65.40:35.59	Staph aureus 61% Enterococcus 7.5% Streptococcus 4.6%	E .coli 16.45% Klebsiella 4.2% Pseudomonas 2.5%	5 % MRSA 1% VRSA Most effective drug Linezolid	Nil
Isthiaq S et al[14]	2021, JIIMC	Elective surgical procedures under GA all types	128 cases studied	17.2:82.8	Staph aureus21.09%, Enterococcus 5.4%, streptococcus 0.8%,	E coli 18.75%, Pseudomonas 14.06%, klebsiella3.9%, proteus mirabilis 0.78%	MRSA 20.03%	3.13%
Khan A et al[15]	2019, J Saidu med Col Swat	Plastic surgery procedures	70 cases studied	81.3:18.7	Staph aureus 33%, Enterococcus 1.35,	E coli 20%, pseudomonas 13.3%, proteus 10.7%,	NR	1.3%
Saleem AF et al[16]	2020 JPMA	Emergency Pediatric surgeries	98 children ,37 pathogens isolated	61:39	Enterococcus 13%	E coli 27%, Klebsiella 10%	NR	16% Candida

Table II: Drug sensitivity pattern

Drug sensitivity pattern	Iqbal M et al [12]	Isthiaq S et al[14]	Khan A et al [15]	Saleem AF et al [16]
Vancomycin	50% sensitive against MRSA	100% sensitive for staph, 92% sensitive to MRSA	100% sensitive against all pathogens isolated	-
Ceftazidime	-	96% sensitive against staph		-
Co trimaxazole	-	81% sensitive to staph		-
Cefoperazone plus sulbactam	19.40% sensitive against all pathogens	-	≥ 90% sensitive against pseudomonas, E coli effective against proteus	-
metronidazole	18.40% sensitive			Patients treated with combination of Metronidazole and Ampicillin with success
Linezolid	Highly effective against staph, 50% sensitive against MRSA	Not mentioned	100 sensitive to all pathogens isolated	-
Amikacin	8.86%	E coli 83% sensitive to Amikacin	25% resistance against proteus, 90% sensitive against pseudomonas	-
Piperacillin	8.43%			-
Amoxicillin	6.75%	High resistance 45%	Staph aureus and pseudomonas showed 100% resistant to amoxicillin,	Patients treated with combination of metronidazole and Ampicillin with success
Ciprofloxacin	3.79%	Highly resistant	E coli 60% sensitive	-
Ceftriaxone	3.79%	resistant		-
Imipenem & Meropenem	-	70% resistance for MRSA	No resistance against E coli, 90% sensitive against pseudomonas	-
Fusidic acid	-	-	84% sensitive against staph,	-

noted 472 positive cultures in our review in four studies in Pakistan. Staph aureus was found to be the most common pathogen. 49% (n=235) cultures were positive for staph aureus. The results in Pakistan are similar to studies conducted elsewhere in the world. The study conducted by PAL S et al[17] in INDIA also showed results similar to our review where staph aureus was found the most frequent pathogen causing SSI being positive in 45.3% samples.

Study conducted by Ali A et al[11] in Ethiopia on SSI showed 66.67% isolates of staph aureus. Even in the modern world staph aureus is the predominant cause of SSI. Study conducted by Dreyfus J[18] in US on 884 803 elective surgical patients showed staph aureus the most

common pathogen isolated from patients of SSI and found in 1.35% of infections. Majority of the traditionally used drugs are now resistant against staph aureus. This is also evident from our review. Study conducted by Khan A et al[15] al in swat showed amoxicillin to be 100% resistant against staph aureus while study conducted by Isthiaq A et al[14] showed 45% resistance of staph aureus against amoxicillin. The traditional use of amoxicillin as an empirical therapy in SSI is not further recommended. The study conducted by Saleem AF et[16] al in Karachi on pediatric population found amoxicillin to be effective against staph aureus. However other factors may be involved as well

The growing incidence and emergence of Methicillin resistance staph aureus (MRSA) in wounds of SSI is alarming and on the rise. Study conducted by Iqbal M et al[12] in Rawalpindi showed 5% of all staph aureus positive cultures were MRSA while 1 % were vancomycin resistant staph aureus (VRSA). This growing incidence is alarming. Study conducted by Isthiaq S et al[14] in Rawalpindi showed 20% MRSA positive cultures which is very high and alarming. The increase incidence of MRSA in SSI may be because of nasal colonization of staph aureus as determined by Ning J et al[19] in his meta-analysis. Drugs found effective in our review against staph aureus are vancomycin, linezolid, Meropenem and Imipenem. Study conducted by Isthiaq s et al[14] found ceftazidime to be 96% effective against staph aureus. Although majority of the cheaper, conventional drugs are now resistant against staph aureus Isthiaq et al found sensitivity of Cotrimaxazole as 86% against staph aureus. This drug is cheap and readily available as well. The incidence of steven johnson syndrome and other serious side effects are rare.[20] The treatment against staph aureus and particularly MRSA is very expensive and the focus should be on the prevention of SSI as depicted by Utzolino S[21] in his review.

After staph aureus most common pathogen found in our review was E coli, found in 18% cultures of SSI. All four studies showed almost similar results for E coli. Alkaki A[22] noted most common pathogen responsible to cause SSI as E coli. This is not contradiction to our review as Alkaki A only included abdominal surgeries and this is documented in literature that the most common pathogen causing SSI after abdominal surgeries is E coli. Maximum E coli was found in pediatric population in study conducted by Saleem AF et al[16] in Karachi where they isolated E coli in 27% cultures and treated every patient with amoxicillin or amoxicillin and clavulanic acid. The cause of this increase effectiveness of amoxicillin in pediatric population needs further evaluation as amoxicillin was found highly resistant in adults in rest of three studies. Most effective drugs found in our review against gram negative organisms and particularly E coli were Linezolid, combination of Cefoperazone and sulbactam, Amikacin, ceftazidime, Meropenem and Imipenem. Conventional drugs against gram negative flora like ciprofloxacin, ceftriaxone are found resistant against E coli. Isthiaq A et al[14] found ciprofloxacin as highly resistant while Amikacin 83% sensitive against E coli. Pseudomonas was found in 7.4% cultures of SSI and Cefoperazone sulbactam combination, Imipenem, Meropenem, linezolid and Amikacin were found sensitive. Mixed flora was also noted in few cultures in all studies and broad spectrum antibiotics like Imipenem, Meropenem, and sulphamethaxazole plus sulbactam were sensitive. We found 8% Enterococcus in cultures of SSI. Our results regarding Enterococcus are similar to the study conducted by Shah S[23] in India. Fungi are also known to cause SSI in literature[24]. S Saleem AF et al[16] also found 31% fungal positive cultures although rest of three studies did not have fungal growth.

Conclusion

SSI are serious post operative complication. In Pakistan majority of SSI are caused by staph aureus followed by E coli and Enterococcus. The commonly used drugs effective against all pathogens are Cotrimaxazole, linezolid, Imipenem and Meropenem. Approximately 5% staph positive cultures are MRSA against which linezolid and vancomycin are highly sensitive.

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