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Microbiology Section

Risk Factors and Bacterial Profile of Abdominal Surgical Incisions-Changing Trends

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ABSTRACT

Introduction: Surgical Site Infections (SSIs) remain a significant postoperative complication after abdominal surgeries, even with the advancement of infection control practices. The emergence of drug resistance to routine antibiotics was a challenge to infected wound management.

Aim: To analyse the host risk factors and bacterial flora associated with abdominal surgical site infections and to evaluate the changes in the prevalence and antibiotic susceptibility pattern over the years.

Materials and Methods: A hospital-based cross-sectional study was done among 150 abdominal surgery cases admitted to a Government Medical College Thrissur, (referral hospital) in Kerala, India for one year, from September 2010 to August 2011. Host risk factors were analysed by clinical details and preoperative investigations. Samples were collected from the wound site on the third day of surgery using sterile swabs for bacteriological analysis. Repeated samples were taken in case of suspected wound infection to identify the types of pathogen, if any. Statistical analysis was done using Microsoft excel and open Epi software. The results were compared with the similar studies conducted in this institution during 2015-2016 and 2016-2017 to know the changes in prevalence and antimicrobial sensitivity.

Result: Out of 150 cases higher infection rate was found in patients >60 years 5 (17.2%), emergency surgeries 16 (21.6%), large intestinal surgeries 4 (44.4%), with diabetes 5 (26.32%), patients on steroids and obese 3 (37.5%). Colonisers were present in 34.7% abdominal surgical wounds. Infection rate of 14.7% in abdominal surgeries was reduced to 11.2% and 10% between the years 2015-16 and 2016-17 respectively. Higher infection rate was noticed in patients with premorbid risk factors. When compared with the similar studies conducted in the same institute, *Pseudomonas* and *Acinetobacter* with *E. coli* and *S. aureus* were found to be most common wound pathogens and resistance to ciprofloxacin and ceftriaxone were increased. Amikacin, piperacillin tazobactam and imipenem were useful but decrease in sensitivity were noticed.

Conclusion: Bacterial colonisation with endogenous flora was the primary source of SSIs. Good infection control practices, early identification of the pathogen and treatment with an appropriate antibiotics can reduce the development of resistant organisms and cross infection. The use of antimicrobials for prophylaxis and treatment needed to be modified according to the antimicrobial sensitivity report and local susceptibility pattern.

Keywords: Antimicrobial susceptibility, Colonisation, Cross infection, Endogenous flora, Infection control, Wound infections

INTRODUCTION

The Surgical Site Infections (SSIs) accounts for 20% of all Hospital Acquired Infections (HAIs) [1]. Depending on the type of operations and underlying patient status, infection rates vary from 2.5-41.9% [2]. The risk of infection is generally based on the susceptibility of a wound to microbial contamination. Gram negative bacteria like *E. coli*, *Klebsiella*, *Pseudomonas* and *Enterococci* are predominant after intestinal surgeries [3,4]. *Enterococci* cause infections of the biliary tract and contribute intra abdominal infections and bacteremia [3,5]. Multiple factors are involved in the development of wound infections. Patient related factors are age, smoking, diabetes, anaemia, obesity, jaundice, uremia, steroid use, hospitalisation and bacterial colonisation [3,6-8]. Prolonged operative time, wound contamination status, prophylactic antibiotics, site of surgery, size and depth of the incision, emergency nature of surgery, instruments and suture material being used and wound closure techniques are the most common procedure related risk factors [3,9]. The infection rate could be reduced by correcting the risk factors and reducing the microbial load of the wound site through good infection control practices and better surgical skills [9-11]. Recent studies highlighted the use of feedback data as a key element in improving strategies of infection control and antibiotic usage [10,12].

Effective surveillance includes analysis of SSI rates according to the risk factors and antibiotic usage [6-8,10-13]. The selection of antimicrobials based on the local susceptibility pattern has a vital role in infection control. A similar study was not conducted earlier in this institution, and inappropriate antibiotic usage was prevalent among surgeons. This study was aimed to determine the infection rate, identify the coloniser/pathogen and the changing trends in antibiotic sensitivity which will help the surgeon reduce SSIs.

MATERIALS AND METHODS

A hospital-based cross-sectional study was conducted to evaluate the host risk factors associated with surgical incisions infections and to find out the bacteria on the wound surface after abdominal surgeries. The study was conducted in the General Surgery Wards of Government Medical College Thrissur, Kerala, India for one year from September 2010 to August 2011.

Total 150 patients were selected for the study after getting the informed consent and Ethical Committee Clearance (08/IEC/MCTCR/2010dt 06.08.2010). The results were compared with similar studies on abdominal surgeries conducted in the same institution in General Surgery units (2015-2016) and in Gynaecology units (2016-2017). Over the years changing trends in the SSI prevalence and sensitivity pattern were analysed.

Inclusion criteria: The 166 patients between 18-80 years old who underwent abdominal surgeries were included in the study.

Exclusion criteria: Severely ill patients with laproscopic surgeries, stitch abscess, patients unwilling to give consent were excluded from the study. Total 16 cases were excluded from the study.

Study Procedure

Data was collected in a proforma, including demographic variables and patient related risk factors like diabetes, hypertension, Chronic Obstructive Pulmonary Disease (COPD), use of steroids, obesity, haemoglobin percentage and type of surgery.

On the third postoperative day, samples were collected from the wound surface using two sterile swabs after cleaning with sterile normal saline. Gram staining was done with one swab to detect any inflammatory cells or bacteria. Another swab was inoculated in blood agar, chocolate agar and MacConkey agar and incubated at 37°C for 24-48 hours. Bacteria were identified based on colony morphology, gram staining and biochemical tests.

Isolate was considered as a pathogen correlating with gram stain findings. The isolates were considered as colonisers when gram stain showed absence or scanty pus cells and the wound showed no signs of infection [6,13,14]. Antibiotic sensitivity of the pathogens was done by the Kirby-bauer disc diffusion method under Clinical and Laboratory Standards Institute (CLSI) guidelines [15]. Methicillin resistance among *Staphylococcus* was identified using cefoxitin 30 mcg disc. The patient was followed-up for one week. If the wound was infected, repeated swabs were taken for bacteriological analysis.

STATISTICAL ANALYSIS

Statistical analysis was done using Microsoft excel and open Epi software. Results were expressed in proportions, Chi-square test and odds ratio with a 95% confidence interval. The association between the variables was found using Chi-square test. The p-value<0.05 was considered to be statistically significant.

RESULTS

The 150 patients were studied, including 74 (49.3%) males and 76 (50.7%) females. The data was categorised based on demographic details, surgical interventions and premorbid risk factor as given in [Table/Fig-1,2]. Total number of cases were 150, in which non infected were 128 (85.3%) and infected cases were 22 (14.7%).

Factors affecting infection rate		No.of cases N=150	Non infected (128)	Infected (22)	p-value from Chi-square test
Age group (Years); n (%)	≤40	66 (44%)	56 (84.8%)	10 (15.2%)	χ^2=20.06; p-value<0.001
	41-60	55 (36.7%)	48 (87.3%)	7 (12.7%)	
	>60	29 (19.3%)	24 (82.8%)	5 (17.2%)	
Gender; n (%)	Males	74 (49.33%)	63 (85.14%)	11 (14.86%)	χ^2=0.0045; p-value=0.946
	Females	76 (50.67%)	65 (85.53%)	11 (14.47%)	
Type of surgery; n (%)	Elective	76 (50.7%)	70 (92.1%)	6 (7.9%)	χ^2=5.644; p-value=0.0175
	Emergency	74 (49.3%)	58 (78.4%)	16 (21.6%)	
Wound class; n (%)	Clean and clean-contaminated	114 (76%)	108 (94.7%)	6 (5.3%)	χ^2=33.56; p-value=0.001
	Contaminated	36 (24%)	20 (55.6%)	16 (44.4%)	
Closed drain; n (%)	Drain not used	62 (41.3%)	55 (88.7%)	7 (11.3%)	χ^2=0.962; p-value=0.32
	Drain used	88 (58.7%)	73 (83%)	15 (17%)	
Surgical sites; n (%)	Stomach duodenum and small intestine	47 (31.2%)	42 (89.4%)	5 (10.6%)	χ^2=10.9664; p-value=0.026
	Appendix	38 (25.4%)	30 (78.9%)	8 (21.1%)	
	Large intestine	9 (6%)	5 (55.6%)	4 (44.4%)	
	Hepatobiliary	18 (12%)	15 (83.3%)	3 (16.7%)	
	Abdominal wall and renal	38 (25.4%)	36 (94.7%)	2 (5.3%)	

[Table/Fig-1]: Surgical interventions and infections (2010-2011).

Age above 60 years (p-value <0.001), emergency procedures (p value=0.0175) contaminated wound class (p-value=0.001) and large intestinal surgeries (p-value=0.026) increased the risk of SSIs. Association of other premorbid ailments and infection rate was found out statistically with no risk factor as the reference category [Table/Fig-2].

Premorbid factors	No. of cases* (N=150); n (%)	Non infected; n (%)	Infected; n (%)	Odds Ratio (OR); (95% CI)	p-value from Chi-square test
No premorbid illness (reference); n (%)	78 (52%)	71 (91%)	7 (9%)	0	-
Anaemia (Hb <10 mg/dL)	22 (14.67%)	17 (77.27%)	5 (22.73%)	2.32 (0.68-7.81)	0.16
Diabetes	19 (12.67%)	14 (73.68%)	5 (26.32%)	3.62 (1.0-13.06)	0.019
Hypertension	8 (5.33%)	7 (87.5%)	1 (12.5%)	1.449 (0.15-13.53)	0.75
Blood transfusion	40 (26.66%)	33 (82.5%)	7 (17.5%)	2.152 (0.69-6.63)	0.29
Others (steroid drugs, obesity)	8 (5.33%)	5 (62.5%)	3 (37.5%)	6.33 (1.626-24.71)	0.003

[Table/Fig-2]: Association of premorbid factors and SSIs (2010-2011) (N=150).
*Some patients had multiple premorbid variables as risk factors

Diabetes and steroid usage or obesity were associated with SSIs with 5 (26.32%), Odds Ratio (OR) 3.62 (1.0-13.06), p=0.019 and 3 (37.5%), OR 6.33 (1.626-24.71), p=0.003 respectively.

No bacterial growth on the wound surface was obtained from 98 cases. Bacterial growth of colonisers was noticed in 52 (34.7%) patients on the third postoperative day, which yielded 62 isolates [Table/Fig-3].

Isolates on 3rd postoperative day	Number of isolates; n (%)
S. aureus	29 (46.8%)
E. coli	10 (16.1%)
Klebsiella spp	8 (12.9%)
Enterococci faecalis	7 (11.3%)
Acinetobacter spp.	5 (8.1%)
Pseudomonas	3 (4.8%)

[Table/Fig-3]: Frequency of bacterial isolates on third postoperative day (2010-2011) (n=62).

In 14 (9.33%) cases the incision site showed signs of inflammation within 48 hours. Within one week, wound infection was noticed in 22 (14.7%) cases. Eight cases had no bacterial growth by the third day but developed wound dehiscence later within one week. Repeated swabs were taken from the infected wounds. The isolates were compared with the results of the first swab [Table/Fig-4].

According to 2010-2011, 25 isolates were yielded from 22 infected cases with a frequency of *E. coli* 14 (56%), *S. aureus* 7 (28%), *Klebsiella* 2 (8%) and *Enterococcus* 2 (8%). Cefotaxime was used in 77.15% of patients preoperatively, and combination of cephalosporin with beta lactamase in 21.9% of cases.

Enterobacteriaceae 15 (93.7%) isolates were resistant to cefotaxime. Three of the seven isolates of (42.85%) *S. aureus* showed methicillin resistance on the cefoxitin 30 mcg disc diffusion test. One of the two *Enterococci* 50% was resistant to ampicillin, and all were sensitive to high level gentamicin.

The authors have compared the data of isolates and their antibiotic sensitivity pattern in the present study with the data on file in the same Department in this institution during 2015-16 and 2016-17 in which total 124 samples from the General Surgery Unit and 270 samples from the Gynaecology unit were obtained, and antibiotic sensitivity was calculated respectively. Isolates were listed in [Table/Fig-5].

Among the *S. aureus*, MRSA constituted 2 (20%) in 2015-16 and 6 (40%) in 2016-17 studies. Vancomycin resistance was not seen in gram positive isolates of either study. The 75% of the *Pseudomonas* were resistant to ceftazidime and ciprofloxacin. *Acinetobacter* was resistant to gentamicin, cotrimoxazole, ciprofloxacin. Antibiotic sensitivity pattern of the *Enterobacteriaceae* isolates was compared against the common drugs in [Table/Fig-6].

Surgical sites	Swab 1 (3rd day of surgery)		Swab 2 (after wound infection)	
	Isolated organisms	No. of cases	Pathogenic isolates	No. of infected cases (n=22)
Appendicectomy (n=8)	No growth	3	*E. coli*	3
	E. coli	4	*E. coli*	4
	S. aureus	1	*S. aureus*	1
Small intestine (n=4)	No growth	2	*E. coli*	2
	Klebsiella spp	1	*Klebsiella spp*	1
	S. aureus	1	*S. aureus*	1
Large intestine (n=4)	No growth	1	*E. coli*	1
	E. coli+ Enterococcus	2	*E. coli+ Enterococcus*	2
	E. coli	1	*E. coli + S. aureus*	1
Stomach and duodenum (n=1)	*S. aureus*	1	*S. aureus*	1
Hepatobiliary (n=3)	No growth	2	*E. coli*	1
			S. aureus	1
	Klebsiella spp	1	*Klebsiella spp*	1
Abdominal wall surgeries (n=2)	*S. aureus*	2	*S. aureus*	2

[Table/Fig-4]: Comparison of bacterial isolates in infected wounds .

Isolates	2010-2011 (N=150); n (%)	2015-2016 (General surgery unit) (N=124); n (%)	2016-2017 (Gynaecology unit) N=(270); n (%)
Infected cases	22 (14.7%)	124 (11.2%)*	27 (10%)
No. of isolates; (n)	25	96	27
E. coli	14 (56%)	55 (57.29%)	6 (22.2%)
Klebsiella spp	2 (8%)	20 (20.84%)	5 (18.5%)
S. aureus	7 (28%)	10 (10.42%)	15 (55.6%)
Pseudomonas aeruginosa	0	4 (4.16%)	0
Enterococcus faecalis	2 (8%)	6 (6.25%)	1 (3.7%)
Acinetobacter baumanni	0	1 (1.04%)	0

[Table/Fig-5]: Comparison of bacterial isolates from abdominal SSIs in different time period.
*1108 abdominal surgeries were done during study period

Antibiotics	2010-11		2015-16		2016-17	
	E. coli (n=14)	*Klebsiella* (n=2)	*E. coli* (n=55)	*Klebsiella* (n=20)	*E. coli* (n=6)	*Klebsiella* (n=5)
Ampicillin	1 (7.1%)	0	7 (12.7%)	0	0	0
Ceftriaxone/ cefotaxime	1 (7.1%)	0	1 (1.8%)	4 (20%)	2 (33.33%)	0
Ciprofloxacin	3 (21.4%)	1 (50%)	15 (27.27%)	5 (25%)	0	0
Gentamicin	5 (35.7%)	1 (50%)	37 (67.27%)	11 (55%)	4 (66.67%)	2 (40%)
Amikacin	14 (100%)	2 (100%)	51 (92.7%)	16 (80%)	6 (100%)	4 (80%)
Cotrimoxazole	6 (42.8%)	1 (50%)	21 (38.18%)	10 (50%)	2 (33.33%)	2 (40%)
Piperacillin tazobactam	14 (100%)	2 (100%)	21 (38.18%)	11 (55%)	5 (83.33%)	3 (60%)
Imipenem	14 (100%)	2 (100%)	55 (100%)	20 (100%)	6 (100%)	4 (80%)

[Table/Fig-6]: Antibiotic sensitivity pattern of major isolates during 2011-2017.
(S: Sensitivity %)

DISCUSSION

The Infection rates in abdominal surgeries is higher compared to extra abdominal surgeries. Surveillance of SSI rates according to the risk factors and antibiotic usage was established in the institution after the study done in 2011. A similar study was conducted after five years about the SSIs in postoperative wards of different surgical specialties.

A reduction of SSI rate (14.7% to 11.2% and 10%) was noticed after five years in different surgical wards of the hospital. Infection rates of abdominal surgeries from other hospitals were reported as Malappuram (13%) [16], Pune (19.3%) [7], Karad (14%) [17], Bihar (20%) [13] and Canada (16.3%) [14].

On analysing the demographic variables, age above 60 years significantly persisted as a risk factor for SSI (χ^2=20.06, p-value <0.001) and correlated with other studies [17-19]. A higher infection rate in males 14.9% was not significant (p=0.946). Women had a lower infection rate due to the anti-inflammatory effect of estrogen on wounds [20].

A significant association (χ^2=5.644, p-value=0.0175) was seen with infections in emergency surgeries 21.6% as found in other studies[11,13,17,20]. The emergency laparotomy cases were done with inadequate bowel preparation. The infection rate was significantly higher in contaminated wounds compared to clean and clean contaminated classes (χ^2=33.56, p-value=0.001) and other studies support this [13,21]. The infection rate was higher 17% when closed drains were used but not statistically significant (χ^2=0.962, p-value=0.32). An infection rate of 72.7%, 12% and 14%, respectively was reported by Mekhla and Borle FR [8], Khan AQ and Mahesh Kodalkar [22] and Fuji T et al., [23] with the usage of drains.

Large intestinal tract surgeries carried higher infection rate, 44.4% and found statistically significant (χ^2=10.966, p-value=0.026) as in other studies [20,24].

In contrary to other studies, [17,25,26] anaemia was not found associated to SSIs (OR: 2.32; 95%CI: 0.68-7.81; p-value=0.16). Diabetic patients had 3.62 times increased odds of developing infection 5 (26.32%); OR: 3.62; 95%CI: 1.0-13.06; p-value=0.019, which remained unchanged 23.39% in the 2015-16 study. According to Ata A et al., New York, the incidence of SSI was higher in people with diabetes 15.4% than non diabetic people 11.0% [27]. Multivariate analysis revealed that factors like steroids and obesity OR: 6.33; 95%CI: 1.626-24.71; p-value=0.003 were predictors for SSIs. Hypertension OR: 1.449; 95%CI: 0.15-13.53; p-value=0.75 and blood transfusion (OR: 2.152; 95%CI: 0.69-6.63; p-value=0.29 were not found associated with wound infections which was not supported by other studies [20,28]. A higher infection rate 20.83% in patients with premorbid risk factors was seen unchanged. Association of SSIs with various risk factors highlighted the precautions to be taken in surgical techniques, sterilisation methods, correction of diabetes or anaemia and selection of appropriate prophylactic antibiotics.

S. aureus 46.8% and *E. coli* 16.1% were the major wound colonisers indicating the normal flora causing endogenous contamination. The bacterial profile described in studies supports the role endogenous floras role in surgical infections [4,29].

The gut flora contaminates the surgical sites during abdominal surgeries leading to infection. *E. coli* and *S. aureus* were the major pathogens in this study and in other studies [9,11, 14,19-21,30-34]. An upward trend in the prevalence of *Klebsiella* infection was noticed (8%-20.84% and 18.5%) in different wards of our hospital within five years. Given the awareness created by the study reports of 2011, contact precautions were insisted in surgical units resulting a decrease of MRSA to 20%. The higher prevalence of MRSA in gynaecology units 40% indicated to enforcement of strict infection control measures in all specialties. The prevalence of MRSA in other

Place	Kerala					Other states			International		
	Present study, *Thrissur			Sasikumari O et al., Kottayam [30]	Mannarakkal R et al., Malappuram [16]	Negi V et al., Uttarakhand [31]	Anilkumar MS and Deepakraj KR et al., Mysuru [19]	Singh P et al., Haryana [32]	George M et al., Uganda [33]	Lutfor AB et al., Bangladesh [34]	Kameran MA et al., Iraq [35]
Year of publication and study period	*2011	*2015-2016	*2016-2017	(2016) 2011-12	(2018) 2016-17	(2015) 2013	(2019) 2018-2019	(2021) 2018-2019	(2018) 2015	(2018) 2016	(2021) 2018-2019
Methicillin resistance among *S. aureus* isolates (MRSA/*S. aureus*)	3/7 (42.85%)	2/10 (20%)	6/15 (40%)	20/50 (40%)	3/4 (75%)	11/70 (15.7%)	-	17/17 (100%)	27/41 (65.9%)	78/117 (66.7%)	-
E. coli	n=14	n=55	n=6	n=48	n=9	n=32	n=41	n=67	n=22	n=53	n=14
Ampicillin	1 (7.1%)	7 (12.7%)	0	0	0	6 (18.7%)	-	-	-	2 (3.8%)	-
Cetftriaxone/cefotaxime	1 (7.1%)	1 (1.8%)	2 (33.3%)	8 (16.6%)	0	18 (56.2%)	2 (4.8%)	34 (50.7%)	4 (18.2%)	29 (54.7%)	3(21.4%)
Ciprofloxacin	3 (21.4%)	15 (27.27%)	0	12 (25%)	2 (22.2%)	19 (59.4%)	0	19 (28.5%)	-	21 (39.6%)	2 (14.3%)
Cotrimoxazole	6 (42.8%)	21 (38.18%)	2 (33.3%)	-	2 (22.2%)	18 (56.2%)	1 (2.4%)	14 (20.8%)	3 (13.6%)	28 (52.8%)	5 (35.7%)
Gentamicin	5 (35.7%)	37 (67.27%)	4 (66.6%)	19 (39.5%)	7 (77.7%)	17 (53.1%)	13 (31.7%)	57 (85.7%)	7 (31.1%)	34 (64.1%)	4 (28.6%)
Amikacin	14 (100%)	51 (92.7%)	6 (100%)	40 (83.3%)	7 (77.7%)	27 (84.4%)	-	48 (71.6%)	-	42 (79.2%)	11 (78.6%)
Piperacillin tazobactam	14 (100%)	21 (38.18%)	5 (83.3%)	33 (68.75%)	**7 (100%)	28 (87.5%)	-	42 (62.8%)	-	35 (66%)	-
Imipenem meropenem	14 (100%)	55 (100%)	6 (100%)	48 (100%)	**7 (100%)	-	6 (14.6%)	62 (92.5%)	21 (95.5%)	49 (92.5%)	13 (92.9%)

[Table/Fig-7]: Comparison of sensitivity pattern of major isolates to inuse antibiotics; n (%) [16,19,30-35].
*Current study groups; ** only 7 were tested and all were sensitive

centres were displayed in [Table/Fig-7]. The emergence of drug resistant *Pseudomonas* 4.16% and *Acinetobacter* 1.04% during 2015-16 was an alarming sign of rising drug resistant nosocomial pathogens calling for prompt transmission based precautions and antimicrobial surveillance.

Antibiotic sensitivity pattern of the significant isolate *E. coli* to commonly used antibiotics was compared with other recent studies and described in [Table/Fig-7] [16,19,30-35].

Decreased sensitivity 1.8%-33.3% was observed for cefotaxime/ceftriaxone in the present study. Declined sensitivity (0-21.4%) for the drug was noticed in other studies also [16,19,30,33,35]. Lowered sensitivity for Ciprofloxacin (21.4%, 27.7% and 0%) was seen in our hospital and similar reports were published from other centres [16,19,30,35]. Ceftriaxone/cefotaxime and ciprofloxacin were effective agents against gram negative bacteria and used most widely in hospitals. The increased resistance to these drugs highlights the importance of periodic surveillance of antibiotic usage and its sensitivity pattern. Prolonged and appropriate prescription of the drugs leads to the production of Extended Spectrum Beta Lactamase (ESBL) and the development of resistance to a higher degree. Usage of the resistant drugs must be curtailed for a period and can be included in the drug list for future use.

Cotrimoxazole showed more activity for *Klebsiella* 50% than *E. coli* 42.8% in the present study groups. The decreased activity of cotrimoxazole 2.4%-35.7% against gram negative bacteria was documented in other studies [16,19,32,33,35]. Gentamicin revealed increased sensitivity from 35.7-67.3% during 2011-2017. The reason may be limited use of gentamicin when piperacillin tazobactam or cefaperazone sulbactam were added to the hospital supply. A good response to amikacin was noticed in reports of all studies [16,19,30-35]. The development of resistance observed to piperacillin tazobactam after five years (sensitivity 100% to <40%) in the General Surgery Wards was an early warning sign of antibiotic over use in our hospital, but 83.3% sensitivity was observed in Gynaecology units where the drug was rarely used. Over the past few decades, the appearance of Multidrug Resistant (MDR) strains has been regarded as an inevitable genetic response to the strong selective pressure imposed by antimicrobial chemotherapy [31,34]. Imipenem showed a good response for *E. coli* 100%, but a decreasing trend of sensitivity to *Klebsiella* was noticed after 2017 (80%).

Recent trends in antibiotic susceptibility could not be studied in the wake of the COVID-19 pandemic when surgery was done exclusively for emergency cases. On analysing the results of SSI samples received in the laboratory for the previous few months, authors have observed an increased isolation of *Klebsiella, Pseudomonas* and *Acinetobacter* as pathogens in abdominal SSIs. The trend of nosocomial pathogens replacing the endogenous flora as the source of infections strongly suspects the spread of drug resistant pathogens due to injudicious use of antibiotics. Further studies are needed to detect the genetic and epidemiological pattern of drug resistance in frequently isolated pathogens.

Limitation(s)

Patients, follow-up could not be done beyond one week, and SSIs developed after that were not known. Variations in infection control practices and antibiotic usage is observed among surgeons. A molecular study of drug resistant isolates could not be performed.

CONCLUSION(S)

Postoperative infections are increased with host risk factors. Bacterial colonisation with endogenous flora was the primary source of SSIs. A preoperative bath using carbolic acid soap can reduce the microbial load on the skin surface. Antimicrobial resistance is an essential challenge for nosocomial infections. Reduced activity for ciprofloxacin and cefotaxime/cefrtriaxone were observed. Amikacin, piperacillin tazobactam and imipenem are still effective. Transmission based precautions, particularly hand hygiene recommendations, must be strengthened in hospitals to prevent cross infections. Data feedback to the surgical team is required based on the SSIs, preoperative risk factors and resistance pattern of common in use antibiotics.

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REFERENCES

[1] Ban KA, Minei JP, Laronga C, Harbrecht BG, Jensen EH, Fry DE et al. American College of Surgeons and Surgical Infection Society: Surgical Site Infection Guidelines, 2016 Update. J Am Coll Surg. 2017;224(1):59-74.

[2] Malik S, Gupta A, Singh KP, Agarwal J, Singh M. Antibiogram of Aerobic Bacterial Isolates from Post-operative Wound Infections at a Tertiary Care Hospital in India. J Infect Dis Antimicrob Agents 2011;28(1):45-51.

[3] Liau KH, Tarchini G, Solomkin JS. Fischer's Mastery of Surgery. 7th ed. Chapter 7, Perioperative antimicrobial prophylaxis and treatment of surgical site infection. Philadelphia: Wolters Kluwer; 2018;pp.414-60.

[4] Sonawane J, Kamath N, Swaminathan R, Dosani K. Bacterial Profile of surgical site infections and their antibiograms in a tertiary care hospital in Navi Mumbai. Bombay Hospital Journal. 2010;52(3):358-61.

[5] Suragul W, Rungsakulkij N, Vassanasiri W, Tangtawee P, Muangkaew P, Mingphruedhi S et al. Predictors of surgical site infection after pancreatico-duodenectomy. BMC Gastroenterol. 2020;20(1):201. https://doi.org/10.1186/s12876-020-01350-8.

[6] De Simone B, Sartelli M, Coccolini F, Ball CG, Brambillasca P, Chiarugi M, et al. Intraoperative surgical site infection control and prevention: a position paper and future addendum to WSES intra-abdominal infections guidelines. World J Emerg Surg. 2020;15(1):10. https://doi.org/10.1186/s13017-020-0288-4 (2020) 15:10.

[7] Save M, Khadilkar R, Shah P, R. Shiva. A study of incidence and factors determining the occurrence of surgical site infection in abdominal surgeries Int Surg J. 2020;7(2):520-25.

[8] Mekhla, Borle FR. Determinants of superficial surgical site infections in abdominal surgeries at a Rural Teaching Hospital in Central India: A prospective study. J Family Med Prim Care. 2019;8(7):2258-63.

[9] Sharma AC, Singla M, Shuaib M, Kumar S. Evaluation of Wound Complications in Elective Abdominal Surgery. Int J Contemporary Medical Research 2016;3(10):3095-98.

[10] CDC, Surgical Site Infection Event (Internet) Published January 2022, available from: https://www.cdc.gov/nhsn/pdfs/pscmanual/9pscssicurrent.pdf

[11] Sahu S, Shergill J, Sachan P, Gupta P. Superficial Incisional Surgical Site Infection In Elective Abdominal Surgeries - A Prospective Study. The Internet Journal of Surgery. 2009; 26:(1)1-7.

[12] Ahuja S, Smadja NP, Peven K, White M, Leather AJM, Singh S, et al. Use of feedback data to reduce surgical site infections and optimize antibiotic use in Surgery: A Systematic Scoping Review. Ann Surg. 2022;275(2):e345-e352.

[13] Singh AK, Nath U. Surgical Site Infection in Abdominal Surgeries in a Tertiary Centre. Ind J applied research. 2016;6(3):617-18.

[14] Alkaaki A, Al-Radi O Khoja A, Alnawawi A, Alnawawi A, Maghrabi A et al. Surgical site infection following abdominal surgery: a prospective cohort study. Can J Surg 2019;62(2):111-17.

[15] Wayne PA. CLSI document M100-S21: Clinical and Laboratory Standards Institute; 2011. Twenty-First Informational Supplement 2011.

[16] Mannarakkal R, Suaib M, Karatparambil A, Das N A. Factors predicting surgical site infection after clean contaminated surgery. Int Surg J. 2018;5(1):300-304.

[17] Nangare N, Tewani V. Abdominal surgical site infection occurrence and risk factors. Ind J Applied Res. 2020;10(1):46-48. DOI:10.36106/ijar.

[18] Ariho SB, Lule H, Agwu E,Shaban A. Abdominal surgical site infection incidence, risk factors, and antibiotic susceptibility at a university teaching hospital in western Uganda: A cross-sectional study. East and Central African Journal of Surgery. 2020. DOI:10.4314/ecajs.v25i4.##

[19] Anilkumar MS, Deepakraj KR. A study of pattern of pathogen and their sensitivity isolated from surgical site infections in abdominal surgeries. Int Surg J. 2020;7(1):267-70. DOI: http://dx.doi.org/10.18203/2349-2902.isj20195982.

[20] Garcia CG, Flores-Barrientos OI, Juárez-Rojop IE, Robledo-Pascual JC, Baños-González MA, Tovilla-Záratee CA, et al. Abdominal Surgical Site Infection Incidence and Risk Factors in a Mexican Population. Adv Skin Wound Care. 2019;32(6):1-6.

[21] Papadopoulos A, Machairas N, Tsourouflis G, Chouliaras C, Manioti E, Broutas D et al. Risk Factors for Surgical Site Infections in Patients Undergoing Emergency Surgery: A Single-centre Experience. In vivo. 2021;35(6):3569-3574. doi:10.21873/invivo.12660.

[22] Khan AQ, Mahesh Kodalkar. Role of negative suction drain in subcutaneous plane in reducing laprotomy wound infection. Int J of Science and Research 2016;5(1):692-94.

[23] Fujii T, Tabe Y, Yajima R, Yamaguchi S, Tsutsumi S, Asao T. et.al. Effect of subcutaneous drain for prevention of incisional SSI in high risk patients undergoing colorectal disease. Int j of colorectal surgery. 2011;26(9):1151-55.

[24] Satyanarayana V, Prashanth H.V, Basavaraj Bhandare, Kavyashree AN. Study of Surgical Site Infections in Abdominal Surgeries. J Clin and Diagn Research 2011;5(5):935-39.

[25] White MC, Longstaff L, Lai PS. Effect of preoperative anaemia on postoperative complications in low resource settings. World J Surg. 2017;41(3):644-49. doi:10.1007/s00268-016-3785-6.

[26] Surbhi A, Peerzada M and Aanieq M. To determine the association between anemia and occurrence of surgical site infection in a tertiary hospital. Int J Curr Adv Research. 2020;9(8):22929-931.

[27] Ata A, Valerian BT, Lee EC, Bestle SL, Elmendorf SL, Stain SC. The effect of diabetes mellitus on surgical site infections after colorectal and non-colorectal general surgical operations. Am Surg. 2010;76(7):697-702.

[28] Alexander W, Solomkin JS, Edwards MJ. Updated recommendations for Control of Surgical Site Infections: Ann Surg. 2011;253(6):1082-93.

[29] Anusha S, Vijaya LD, Pallavi K, Manna PK, Mohanta GP, Manavalan R. An epidemiological study of surgical wound infections in a surgical unit of tertiary care teaching hospital. Ind J Pharm Prac. 2010;3(4):8-13.

[30] Sasikumari O, Sreekumary PK, Jayalekha B. The bacterial profile of surgical site infection occurring within one week after surgery in a tertiary care centre. J Acad Clin Microbiol. 2016;18:86-90.

[31] Negi V, Pal S , Juya D, Sharma M K , Sharma N. Bacteriological Profile of Surgical Site Infections and Their Antibiogram: A Study From Resource Constrained Rural Setting of Uttarakhand State, India. J Clin Diagn Res. 2015;9(10):DC17-20. DOI: 10.7860/JCDR/2015/15342.6698.

[32] Singh P, Garg R, Kumar H, Rinku. Isolation and antimicrobial susceptibility pattern of microorganisms causing intra-abdominal infections at tertiary care hospital of northern India. Asian J Pharm Clin Res. 2021;14(10):37-40.

[33] George M, Iramiot JS, Muhindo R, Olupot-Olupot P, Nanteza A. Bacterial Aetiology and Antibiotic Susceptibility Profile of PostOperative Sepsis among Surgical Patients in a Tertiary Hospital in Rural Eastern Uganda. Microbiol Res J Int. 2018;24(2):MRJL.41690. doi:10.9734/MRJI/2018/41690.

[34] Lutfor AB, Saha R , Akter M , Deb A, Mahmud AM , Khan SA. Changes in five years among pathogens in wound infection and their susceptibility to antimicrobials. American Journal of Infectious Diseases and Microbiology. 2018;6(1):1-8. doi: 10.12691/ajidm-6-1-1.

[35] Kameran MA, Bahrouz MA, Al-Jaff. Source and antibiotic susceptibility of gram-negative bacteria causing superficial incisional surgical site infections. International Journal of Surgery Open. Open. 2021;100318. https://doi.org/10.1016/j.ijso.2021.01.007.

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