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Incidence of and risk factors for abdominal surgical site infection in a Nigerian tertiary care centre

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Abstract
This study aims to determine the incidence of and identify the risk factors responsible for surgical site infection (SSI) following laparotomies in adult patients in a Nigerian tertiary care facility. This is a prospective study carried out between January and December 2012. Wound assessment was done using standardized criteria stipulated by the Centres for Disease Control and Prevention. There were 291 patients during the study period, out of which 223 met the inclusion criteria: 157 (70.4%) males and 66 (29.6%) females. Surgical site infection was diagnosed in 85 patients giving an incidence rate of 38.1%. Identified risk factors for SSI include anaemia, contaminated and dirty wounds, retroviral disease status, physiological status (ASA scores IV and V), prolonged surgery time, cadre of surgeon, emergency surgeries and use of drains. The high incidence of SSI observed in this study was found more in patients that presented with septic abdomen and those that had large bowel procedures. Paying close attention to identified risk factors will reduce the burden of SSI.

Keywords: Cross infection; Surgical wound infection, risk factors; Incidence

Introduction
Surgical site infection (SSI) is the second most common nosocomial infection and its effect on both the patients and healthcare providers cannot be overemphasized.[1] The occurrence of SSI depends largely on the interplay between the virulence of the organism, the inoculum, and the host immune response.[2] Environmental factors as well have been identified as culprits in the development of SSI.[3] In the developed world, efforts have been directed at these variables in order to reduce the occurrence of SSI.

Background
In our environment, the occurrence of SSI has posed a lot of stress on healthcare providers as well as patients, and much still needs to be done in order to achieve a reduction in the rate of SSI. To this end, this study was conducted to examine the incidence of SSI following

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laparotomies and compare the findings with those from other climes. This is expected to identify the gaps in our infection control protocols and therefore identify areas of focus to reduce the burden of SSIs.

Methods

This was a prospective study carried out between January and December 2012 on patients that had elective and emergency laparotomies at Federal Medical Centre, Gombe, Nigeria. All patients who had laparotomies either as elective or emergency procedures within the stipulated duration of this study and who met the inclusion criteria for the study were recruited, counseled on the purpose of the study and had a written consent signed. All adult patients (18 years and above) who had either emergency or elective laparotomy in the General Surgery unit were included. Exclusion criteria included patients who had laparotomy outside Federal Medical Centre and were referred because of complications, and patients who had laparotomies done for gynaecological reasons.
Ethical clearance was obtained from the Ethics and Research Committee. Written and verbal consents were obtained from each patient before they were included in the study. The study was carried out on hospitalized patients who had either elective or emergency laparotomy.

Prior to surgical intervention, all patients were optimized to ensure haemodynamic stability. This was achieved by giving intravenous fluids to attain an hourly urine output of 0.5ml/kg/hour in each patient. Also, patients that were clinically pale and anaemic were transfused with blood appropriately. Adequate analgesia was also given where indicated. Blood samples were taken for relevant investigations like full blood count, erythrocyte sedimentation rate, electrolytes and urea, and blood grouping and cross-matching. Patients had their height and weight measured pre-operatively. These parameters were used to calculate the body mass index (BMI). All patients were pre-oxygenated with 100% oxygen for five minutes before anaesthesia. A prophylactic dose of intravenous ciprofloxacin (200mg) was given 120 minutes prior to skin incision while intravenous metronidazole (500mg) was given 60 minutes prior to skin incision; the dose was repeated at 12 hours for ciprofloxacin and at 8 hour intervals for metronidazole. However, this did not go beyond 24 hours. Patients with established infection had their antibiotics discontinued 3-5 days after signs of inflammation have subsided. Hair at the operative site was shaved preoperatively in the operating room using a razor blade, after which chlorhexidine and 70% alcohol solutions were used sequentially in skin preparation of all patients. All patients had their wounds closed primarily after surgery with nylon sutures.

Surveillance for SSI was done within 30 days of surgery. Patients' wounds were inspected under aseptic conditions on post-operative days 3, 5 and 7 for local evidence of wound infection. Days 3, 5 and 7 were chosen for wound inspection because the acute inflammatory reactions that accompany wound healing in the inflammatory period are expected to have subsided by 48 hours. However, if these inflammatory features persist beyond 48 hours, then wound infection is likely to be present.[4] Swabs for microscopy, culture and sensitivity were obtained from patients with wound discharge. Cleansing of the infected or suspected infected wounds with sterile gauze soaked in normal saline was done, followed by parting of the wound edges and dipping the swab stick to the floor of the wound without touching the surrounding wound skin and edges.

The diagnostic criteria used for clinical diagnosis of incisional SSI were extrapolations from the Centres for Disease Control and Prevention's criteria and included the presence of at least two of the following.[5] erythema (in light complexioned patients), swelling/oedema at the wound margins, discharge of pus/serous effluent from the wound, presence of abnormal odour, presence of tender, inflamed skin and subcutaneous tissue (cellulitis) around the operative wound and the presence of systemic response like fever, tachycardia or tachypnoea in the absence of other possible causes like malaria, blood transfusion reactions.

A Gram stain from each specimen was made on a clean, grease-free microscope glass slide and allowed to dry.[6] Culture was carried out as described by Koneman.[7] The samples collected were inoculated on blood agar, chocolate agar (Oxoid, Basingstoke, UK) and MacConkey agar (Fluka Medica) plates using a sterile platinum wire loop. MacConkey and blood agar

plates were incubated aerobically at a temperature of 35-37°C for 24 – 48 hours, while chocolate agar plates were incubated in a candle jar to facilitate the growth of fastidious organisms. Growth on the culture plates was examined macroscopically for colonial morphology and reactions on the media (e.g. β- haemolysis seen in group B β-haemolytic streptococcus, lactose fermentation for *Escherichia coli* and *Klebsiella* spp.). The colonies were subjected to appropriate biochemical tests such as carbohydrate fermentation, oxidase production, catalase utilization, coagulase production, indole production, citrate utilization and ability to produce urease, for identification and classification.

Pathogens were identified as follows.[8] *Klebsiella spp* were identified as gram-negative bacilli, non-motile, lactose fermenting, indole negative with a positive citrate utilization reaction. *Staphylococcus aureus* was identified as gram-positive cocci with positive catalase and coagulase reactions. *Escherichia coli* was identified as gram-negative bacilli, motile, lactose fermenting, positive indole and negative citrate reaction. *Proteus spp* were identified as gram- negative bacilli, non-lactose fermenting with positive urease and negative oxidase reactions, swarming and motile.

Antibiotic susceptibilities were determined on Mueller-Hinton agar (Oxoid, Basingstoke, UK) by standard disk diffusion procedures. The test organisms were inoculated into peptone water and incubated for 2-3 hours. The inoculum in each peptone water broth was standardized by McFarland's 0.5 barium sulphate standard. Sterile cotton swabs were used to inoculate the plates by dipping the swab into the peptone water test inoculums; pressing and rotating the swab firmly against the side of the bottle and streaking on the surface of the medium uniformly. The antibiotic discs were applied on two different 90 mm petri dishes, allowed to pre-diffuse for about 20 minutes and incubated at 37°C overnight: penicillin (10 units), ciprofloxacin (10µg), gentamicin (10µg), ceftazidime (30µg), ceftriaxone (30µg), cefuroxime (30µg), sparfloxacin (30µg), amoxicillin-clavulanic acid (30µg). Control strains were run simultaneously with the test organisms. Positive antibiotic response was interpreted by the presence of zone of inhibition around the test organism. [9]

Data analysis was done using Epi info version 3.5.1. Quantitative data were presented in frequencies and percentages. Mean and standard deviation for quantitative variables were calculated. Multivariate logistic regression analysis was used to test for significance of association between patients' parameters that serve as independent risk factors for development of SSI. The strength of association was expressed as the odds ratio. A p-value of ≤ 0.05 with confidence interval of 95% was considered statistically significant.

Results

There were 291 patients out of which 223 met the inclusion criteria. One hundred and fifty seven (70.4%) were males and 66 (29.6%) were females (M: F = 2.4: 1). Their ages were between 18 and 80 years with a mean age of 33.89 ± 12.57 years. The pre-operative full blood count of the patients with SSI revealed a total white cell count of 3,000-12,500 cells/mm^3 (mean 8,703 ± 1,122.41 cells/mm^3) with a differential neutrophil count of 45-75% (mean 59.10 ± 6.07%). Sixty (68.9%) patients with SSI had neutrophilia while 27 (31.0%) had normal neutrophil count prior to surgery. The pre-operative haemoglobin concentration of the patients was 5.67-14.33g/dl (mean 10.29±1.71 g/dl). A total of 98 (43.9%) patients had pre-operative anaemia with haemoglobin concentration less than 10g/dl.

Incisional SSI was clinically diagnosed in 85 patients giving an incidence rate of 38.1%. Sixty-three (74.1%) were superficial SSI while 22 (25.9%) were deep SSI. Fifty-four (63.5%) of the 85 patients were diagnosed on post-operative day 3, 31(36.5%) on post-operative day 5 while none was noticed on day 7. Eleven (12.9%) of these infections resolved by the ninth day, while the remaining resolved by the 17th day. Resolution was achieved by wound dressings and use of antibiotics.
All wounds were closed primarily with nylon suture however; secondary wound closure was done for 16 (45.7%) patients who had SSI with residual wound dehiscence with healthy granulation tissue in whom spontaneous closure did not occur. Thirty five (17.5%) patients had re-do procedures which included colostomy reversal (16), drainage of intra-abdominal abscesses (3), secondary wound closure of dehisced wounds (16) and definitive procedures of intestinal

Table I. Relationship between clinical parameters and incidence of SSI

Parameter	SSI Present Frequency (%)	SSI Absent Frequency (%)	Total	X^2	df	P value
Age						
< 20	6 (25.0)	18 (75.0)	24 (100.0)			
21-30	27 (43.6)	35 (56.4)	62 (100.0)			
31-40	22 (43.1)	29 (56.9)	51 (100.0)	6.346	5	0.274
41-50	16 (41.0)	23 (58.9)	39 (100.0)			
51-60	9 (31.0)	20 (69.0)	29 (100.0)			
61-70	3 (20.0)	12 (80.0)	15 (100.0			
71-80	2 (66.7)	1 (33.3)	3 (100.0)			
Sex						
Male	59 (37.6)	98 (62.4)	157 (100.0)	0.065	1	0.799
Female	26 (39.4)	40 (60.6)	66 (100.00			
Type of surgery						
Elective	17 (25.4)	48 (71.6)	67 (100.0)	3.867	1	0.049
Emergency	68 (43.6)	90 (57.7)	156 (100.0)			
ASA status of patients						
I	4 (14.8)	23 (85.2)	27 (100.0)			
II	9 (12.2)	65 (87.8)	74 (100.0)			
III	49 (51.6)	46 (48.4)	95 (100.0)	62.472	4	< 0.001
IV	21 (91.3)	2 (8.7)	23 (100.0)			
V	2 (50.0)	2 (50.0)	4 (100.0)			
Class of wounds						
Clean	3 (13.6)	19 (86.4)	22 (100.0)			
Clean contaminated	12 (27.3)	32 (72.7)	44 (100.0)			
Contaminated	37 (35.6)	67 (64.4)	104 (100.0)	56.190	3	< 0.001
Dirty	41 (77.4)	12 (22.6)	53 (100.0)			
Duration of surgery						
< 1 hour	2 (10.0)	18 (90.0)	20 (100.0)			
1-2 hours	47 (33.3)	94 (66.7)	141 (100.0)			
2-3 hours	36 (59.0)	25 (41.0)	61 (100.0)	19.331	2	< 0.001
Cadre of surgeon						
Registrar	11(64.7)	6 (35.3)	17 (100.0)			
Senior Registrar	66 (39.5)	101 (60.5)	167 (100.0)			
Consultant	8 (20.5)	31 (79.5)	39 (100.0)	10.359	2	0.006
Co-morbid factors						
Diabetes	1(16.7)	5 (83.3)	6 (100.0)			
Anaemia	17 (38.6)	27 (61.4)	44 (100.0)			
Smoking	15 (48.4)	16 (51.6)	31 (100.0)			
RVD	11 (68.8)	5 (31.2)	16 (100.0)	9.274	6	0.099
Obesity	27 (100.0)	0 (0.0)	27 (100.0)			
CLD	3 (60.0)	2 (40.0)	5 (100.0)			

Key: CLD-chronic liver disease, RVD-retroviral disease

resection and anastomoses (4).The average duration of hospital stay for these patients in this study was 16.69 ± 8.50 days.

Table I shows the relationship between patients' characteristics and incidence of SSI. The various indications for emergency and elective laparotomies are illustrated in Tables II and III respectively. One hundred and fifty six (70%) patients presented as emergencies; patients presenting with peritonitis had the highest cumulative frequency of SSI (Table 2). Table IV illustrates the isolated organisms according to different classes of wound encountered in the study. Single microbial isolates as well as mixed microbial isolates from the laparotomy wounds are shown in Tables V and VI respectively. Table VII depicts the various independent

Table II: Indications for emergency laparotomy and attendant SSI rates in 156 patients

Indication	Procedure done	Number	SSI Present n (%)	Cum (%)
Intestinal obstruction (without peritonitis)				
1. Colonic tumour	Biopsy +colostomy	9	1 (1.9)	1.4
	Resection + end-to-end anastomosis	8	3 (5.9)	4.4
2. Rectal tumours	Biopsy + colostomy	11	2 (3.9)	2.9
3. Gangrenous sigmoid volvulus	Resection + colostomy	6	5 (9.8)	7.4
4. Obstructed sigmoid volvulus	Resection + anastomosis	5	3 (5.9)	4.4
5. Adhesive intestinal obstruction	Adhesiolysis	8	1(1.9)	1.4
	Adhesiolysis + resection + anastomosis	4	2 (3.9)	2.9
Sub-total		**51**	**17 (33.3)**	**(25.0)**
Oesophageal pathologies				
1. Corrosive oesophageal stricture	Feeding Gastrostomy	2	1 (16.67)	1.4
2. Oesophageal carcinoma	Feeding Gastrostomy	4	1 (16.67)	1.4
Sub-total		**6**	**2 (33.33)**	**(2.9)**
Peritonitis				
1. Typhoid ileal perforation	Right hemicolectomy + ileo-transverse anastomosis	9	7 (13.2)	10.3
	Segmental resection + ileo-ileal anastomosis	10	10 (18.9)	14.7
2. Duodenal (peptic) ulcer perforation	Simple closure	4	2 (3.8)	2.9
3. Gastric (peptic) ulcer perforation	Closure of perforation + omental patch	11	7 (13.2)	10.3
4. Small bowel perforation (Blunt abdominal injury)	Biopsy + closure of perforation + omental patch	10	4 (7.6)	5.9
	Closure of perforations	9	4 (7.6)	5.9
Sub-total		**53**	**34 (64.2)**	**(50.0)**

Penetrating Abdominal injuries				
1. Traumatic gastric perforation	Closure of perforation	6	1 (3.2)	1.4
2. Traumatic small bowel perforations	Resection + anastomosis	4	1 (3.2)	1.4
3. Left colonic perforation + splenic injury	Colostomy + splenectomy	9	4 (13.0)	5.9
4. Left colonic perforation	Colostomy	6	3 (9.7)	4.4
5. Transverse colon perforation	Colostomy	3	1 (3.2)	1.4
6. Liver laceration + splenic laceration	Suturing + Splenectomy	3	0 (0.0)	0.0
Sub-total		**31**	**10 (32.3)**	**(14.7)**
Blunt abdominal injuries				
1. Small bowel contusions + mesenteric contusion	Resection + anastomosis	5	0 (0.0)	0 (0.0)
2. Isolated liver laceration	Omental patch	2	0 (0.0)	0 (0.0)
Sub-total		**7**	**0**	**0**
Enterocutaneous fistula (High output)	Right hemicolectomy + ileo	6	4 (50.0)	5.9
[Ileal =6, Jejunal=2]	transverse anastomosis	2	1 (12.5)	1.5
	Resection + jejuno-jejunal anastomosis			
Sub-total		**8**	**5 (62.5)**	**(7.4)**

Key: Cum (%)-cumulative number and percentage with respect to total patients in the study group.

risk factors for the development of SSI in this study. These include: emergency surgery (p=0.01), operative time > 2hours (p=0.02), presence of contaminated and dirty wounds (p=0.05 and < 0.01 respectively), pre-operative physiological status of patients [ASA IV and V] ($p \leq 0.01$), retroviral disease [RVD] ($p \leq 0.01$) and the use of peritoneal drains ($p \leq 0.01$).

Discussion

Surgical site infection is the most common hospital acquired infection worldwide,[10] accounting for 14-16% of nosocomial infections.[11] The occurrence of SSI in the study centre has been taking its toll on our patients in terms of morbidity and mortality, prolonged hospital stay and increase in the cost (out of pocket payment) incurred by the patient.[12] A pilot study conducted over a period of three months in this centre revealed that half of the patients who underwent laparotomies eventually developed SSI. This was worrisome and efforts have been on-going in order to define the magnitude of this burden. This now prompted this study to look at the gaps in our surgical and infection control protocols which will enable policy formulation that will foster a reduction in wound infection rate.

Nigeria, like other African countries, has been battling with the burden of SSI in surgical patients.[12] It is an established fact that most third world countries have similar health care problems that have been identified to contribute to the high incidence of SSI. These conditions include poor operating room environment, lack of infection surveillance and control strategies as well as patient-related factors which include late presentation to hospital and poor pre-operative physiological status.[13, 14] On the contrary, lower infection rates have been reported from the western world and these have been credited to active infection surveillance protocols which are lacking in many developing countries.[15, 16]

Table III: Indications and occurrence of surgical site infection in elective laparotomies

			SSI present	
Indication	**Procedure done**	**Number**	**n (%)**	**Cum %**
Oesophageal tumour	Gastrostomy	4	1(5.88)	5.9
Sub-total		**4**	**1 (25.0)**	**5.9**
Gastro-intestinal pathologies				
1. Gastric tumours	Gastro-jejunostomy	9	1 (5.88)	5.9
2. Colonic tumours	Resection + anastomosis	12	2 (11.76)	11.76
	Biopsy + colostomy	4	1 (5.88)	5.9
3. Recto-anal tumours	Biopsy + colostomy	5	1 (5.88)	5.9
Sub-total		**30**	**5 (16.67)**	**35.4**
Hepato-biliary pathologies				
1. Obstructive jaundice	Double by-pass	4	1 (5.88)	5.9
	Triple by-pass	9	2 (11.76)	11.76
2. Calculous cholecystitis	Cholecystectomy	16	2 (11.76)	11.76
Sub-total		**29**	**5 (17.24)**	**29.4**
Enterocutaneous fistula (ileal) [Failed conservative management]	Right hemicolectomy+ ileo-transverse anastomosis	3	2 (66.67)	11.76
Sub-total		**3**	**2 (66.67)**	**11.76**
Superficial wound dehiscence*	Secondary wound closure	16	0 (0.0)	0.0
Sub-total		**16**	**0**	**0**
Intra-peritoneal abscess (Blunt abdominal injury)*	Drainage of intraperitoneal abscess	3	2(66.67)	11.76
Sub-total		**3**	**2 (66.67)**	**11.76**
Colostomy reversal*				
Colonic tumour	Resection + colostomy reversal	14	2 (12.5)	11.76
Sigmoid volvulus	Colostomy reversal	2	0 (0.0)	0
Sub-total		**16**	**2 (12.5)**	**11.76**

KEY: * Re-do procedure; Cum % - Cumulative percentage of SSI with respect to total number of patients with SSI in the group.

In our study, SSI was observed to be present in 85 patients, giving an incidence rate of 38.1%. The observed rate from our study is similar to that reported from Ghana (39%)[17] but is at variance with reports from other centres in Nigeria. Two separate studies from Nnewi, southeast Nigeria, reported 13.79%[18] and 15.5%[19] respectively; Mofikoya *et al* from Lagos reported a rate of 17.4%[20] from a prospective study that was carried out on patients that had abdominal surgeries. From Jos, North-central Nigeria, an incidence rate of 22.6%[21] was reported by Ihezue and his colleagues while 13.7%[22] was reported by

Table IV. Isolated microorganisms according to classes of wounds.

Class of wound	Isolated organisms
Clean	*Staphylococcus aureus*
Clean contaminted	*Staphylococcus aureus, Klebsiella* spp.
Contaminated	*Klebsiella* spp., *Providencia* spp.
Dirty	*Klebsiella* spp., *Providencia* spp., *Escherichia coli.*

Ukwenya *et al.* from Zaria. Surprisingly, our incidence rate (38.1%) in this study was much lower when compared with Oladeinde's report from Benin, South-south Nigeria (70.1%).[23] The reported infection rates emanating from various studies in Nigeria (13.79%-22.6%),[18-22] however, are comparable with those reported from other third world nations like Tanzania (15.6%),[24] Pakistan (13.5%)[25] and Vietnam (14.9%).[26] The seemingly high incidence rates from Nigeria and other developing nations may be attributed to factors discussed earlier, most importantly the lack of institutional infection surveillance measures which appears to be a common denominator in the developing nations.[13,14] This fact is evident and substantiated by the lower incidence rates reported from North America (4.7%),[15] Thailand (4.7%)[16] and Europe (2.5%)[27] where guided policies and infection surveillance protocols are in place and effective.

The reason for the SSI rate from our study may be connected with contamination of the wound margins during laparotomies for obstructing colo-rectal pathologies, both as emergency and elective procedures. More than 70% of the surgeries in this study were carried out as emergencies, and about 50% of the total number of wound infections developed among patients that had laparotomies for peritonitis on emergency basis. Therefore, we can say that laparotomies for sepsis are a significant reason for the high incidence of SSI. This was not surprising as peritoneal inflammation with an already established infection in those patients could not be reversed before surgical intervention, with contamination of the wound margins by purulent exudates during surgical procedures leading to established post-operative infection.

Table V. Single isolates from the laparotomy wounds

Single isolates (n=56)	Frequency	Percentage
Klebsiella spp.	19	34.0
Staphylococcus aureus	17	30.4
Proteus spp.	11	19.6
Providencia spp.	7	12.5
Escherichia coli	2	3.6

Patients with mechanical bowel obstruction (without peritonitis) accounted for another 25% of the total patients in the emergency category who subsequently developed SSI. In such patients, timely intervention was crucial in relieving the obstruction in order to avert disastrous complications like gangrene setting in. As such, routine mechanical bowel preparation to reduce faecal load was not feasible as time was of essence in relieving the obstruction. However, prophylactic doses of peri-operative antibiotics were given to cover for both aerobes and anaerobes. Generally, prophylactic antibiotics are given 60 minutes prior to skin incision except for drugs like ciprofloxacin and vancomycin which are given not less than 120 minutes before skin incision due to their delayed onset of action.[28] (A single dose of prophylactic antibiotics is usually sufficient intra-operatively. However, if the duration of the surgery is prolonged, or the patient has lost blood or fluid in excess of 1,500ml, then it becomes necessary to repeat the dose of prophylactic antibiotics intra-operatively. The dose may need to be repeated during the procedure, but prophylactic use

Table VI. Mixed isolated from the laparotomy wounds

Mixed isolates (n=21)	Frequency	Percentage
Staph. aureus + *Klebsiella* spp. + *Proteus* spp.	7	33
Staph. aureus +*Proteus* spp.	6	29
Staph. aureus + *Klebsiella* spp.+ *E. coli*	4	19
Klebsiella spp. + *Providencia* spp.	4	19

of antibiotics should not exceed 24 hours).[28] Opening unprepared large bowel as the case was in this study either to resect a segment of the diseased bowel and/or fashion a colostomy (in patients with gangrenous segments) may have led to the contamination of the wound edges with subsequent development of SSI.

Generally speaking, most emergency surgeries are carried out late at night by the surgeon (more often than not, the junior registrar). Although most of the surgeries in this study were carried out by the Senior Registrars, those that were done by the Junior Registrars were associated with more wound infections (P=0.003, OR= 2.15). Operations undertaken by Junior Residents may also be unduly prolonged due to technical delays related to level of competence. This prolongation in operation time exposes the tissues to atmosphere causing desiccation and contamination which makes the wound susceptible to developing post-operative infection. This prolonged operation time coupled with the poor physiological condition of the patients (ASA IV and V) eventually makes the occurrence of SSI inevitable. Other workers have also acknowledged the fact that SSI occurs more after prolonged and emergency surgeries as observed in this study.[29-31]

Contaminated and dirty wounds accounted for 70% of the total wounds encountered in our study. The attendant infection rates of 35.6% in contaminated wounds (P=<0.05, OR= 4.3) and 77.4% in dirty wounds (P= <0.001, OR= 41) were therefore not unexpected when compared with the defining parameters stipulated by CDC.[5] Reports from other studies are in agreement with our findings.[29,30,32]

The overwhelming effect of sepsis could be the reason for the pre-operative anaemia seen in some of our patients (P=<0.01, OR=2.59). Anaemia as a predisposing factor could cause a reduced tissue oxygen level; resulting in a hypoxic and nutritionally depleted wound micro-environment that favours bacterial multiplication. Other workers have corroborated the fact that anaemia is a risk factor for development of SSI.[25,33]

The occurrence of SSI in patients with RVD was found to be significant (P=<0.001, OR=3.01). This may be related to the immune suppression (both humoral and cellular) that has been observed to be present in such patients. This impairment may become significant when the viral load is high (>1500 copies/mL) and/or the CD4 count is less than 200 cells/μL.[34,35]

Our drains were improvised using fenestrated fluid giving sets connected to a receiving (infusion) bag. The mechanism here may not completely exclude the peritoneal cavity from the exterior, hence retrograde ascent of microorganisms may be unhindered. Patients who had drains inserted had a higher incidence of SSI and this observation agrees with earlier reports from India.[36] The age of the patients, sex of the patients, presence of obesity, diabetes mellitus and cigarette smoking were not contributory to the development of SSI.

In order to reduce the high rate of SSIs observed in this study, efforts must be directed at events that directly lead to such. It was observed that 50% of the total patients with SSI presented with peritonitis; therefore efforts should be geared towards preventing/or promptly treating diseases that could be complicated with peritonitis such as typhoid enteritis, abdominal traumas and peptic ulcer disease. For abdominal injuries, timely intervention is crucial as this will truncate the pathological progression of faecal peritonitis.

Table VII. Multivariate logistic regression analysis of risk factors responsible for wound infection.

Factor	Odd's ratio	95% CI	Coefficient	Standard error	Z statistics	P-value
Age						
< 20	1	-	-	-	-	-
21-30	0.415	0.1315- 1.3099	-0.8794	0.5864	-1.4996	0.134
31-40	0.3064	0.0965-0.972	-1.1829	0.5897	-2.0059	0.449
41-50	0.067	0.0118-0.3809	-2.7033	0.8868	-3.0484	0.231
51-60	0.2545	0.0383-1.6916	-1.3683	0.9663	-1.1960	0.157
61-70	0.4498	0.1608-1.2582	-0.7989	0.5248	-1.5223	0.128
71-80	1.101	0.897-1.123	1.443	0.056	1.501	0.119
Sex						
Male	1	-	-	-	-	-
Female	1.1814	0.6147-2.2707	0.1667	0.3334	0.500	0.617
Type of surgery						
Elective	1	-	-	-	-	-
Emergency	3.1098	1.2985-7.448	1.1346	0.4456	2.5461	0.011
Duration of surgery						
< 1 hour	1	-	-	-	-	-
1-2 hours	2.0882	0.4085-10.6755	0.7363	0.8325	0.8844	0.376
2-3 hours	15.8296	2.776-90.2528	2.7619	0.881	3.1097	0.002
Class of wounds						
Clean	1	-	-	-	-	-
C/ contaminated	1.033	0.1807-5.938	0.0352	0.8909	0.00395	0.969
Contaminated	4.2793	1.006-18.2036	1.4538	0.7387	1.968	0.049
Dirty	41.345	8.002-213.63	3.722	0.8379	4.4419	0.000
ASA status						
I	1	-	-	-	-	-
II	0.7501	0.3694-1.5232	-0.2875	0.3614	-0.7956	0.426
III	1.1144	0.976-1.2724	0.1083	0.0676	1.6014	0.109
IV	3.0117	1.04-8.6473	1.1025	0.5381	2.0488	0.004
V	2.5917	1.4603-4.599	0.9523	0.2927	3.2536	0.001
Cadre of surgeon						
Consultant	1	-	-	-	-	-
Sen. Registrar	0.456	0.3942-1.4563	1.1893	0.5834	1.1123	0.051
Registrar	2.153	1.14-5.854	0.9453	0.5567	2.1023	0.003
Cigarette smoking						
No	1	- -	-	-	-	
Yes	0.7501	0.3694-1.5232	0.2875	0.3614	- 0.7956	0.426

Diabetes						
Absent	1	-	-	-	-	-
Present	0.4699	0.0478-4.6226	0.7552	1.1664	-0.6475	0.517
Obesity						
Absent	1	-	-	-	-	-
Present	1.3708	0.7150-2.6281	0.3154	0.3321	0.9497	0.342
Anaemia						
Absent	1	-	-	-	-	-
Present	2.5917	1.4603-4.599	0.9523	0.2927	3.2536	0.001
Retroviral disease						
Absent	1	-	-	-	-	-
Present	3.0117	1.04-8.647	1.1025	0.5381	2.0488	0.004
Use of drain						
No	1	-	-	-	-	-
Yes	2.5917	1.4603-4.599	0.9523	0.2927	3.2536	0.001

Mechanical bowel obstruction caused by tumours could be relieved by resection and establishment of primary colonic anastomosis in uncomplicated cases.[37] Using an antegrade on-table lavage may not only reduce the faecal load but enhances better bowel handling with minimal risk of wound contamination. In septic abdomen, the use of an active peritoneal drain (Redivac) is advised when desired. This has been found to prevent retrograde ascent of organisms, keeps the patient tidy and also helps to quantify the effluent.[38]

Conclusions

The incidence of SSI in our environment is still high when compared to the developed world. Concerted efforts are paramount in order to reduce the burden. Public health measures with respect to prevention of waterborne disease, and the early diagnosis and treatment of ailments can pave way in achieving a significant reduction in the incidence of cases that could present with septic abdomen to the surgeon.

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