academicJournals

Vol. 8(15), pp. 1620-1626, 9 April, 2014
DOI: 10.5897/AJMR2013.6438
Article Number: F25046443842
ISSN 1996-0808

http://www.academicjournals.org/AJMR

African Journal of Microbiology Research

Full Length Research paper

Environmental impact on postoperative wound infections in a privately owned hospital in Ghana

Feglo, P.[1]* and Afriyie-Asante, A.[2]

[1]School of Medical Sciences, College of health Sciences, KNUST, Kumasi, Ghana.
[2]Department of Laboratory Technology, Faculty of Allied Health Sciences, KNUST, Kumasi, Ghana.

Received 20 October, 2013; Accepted 27 December, 2013

Edwin Cade Hospital of Anglogold, Ashanti, had been experiencing high levels of surgical site infections, but the causes of these were unknown. This study aimed to investigate environmental contamination and postoperative wound infections in the hospital. Wound samples were collected from infected surgical sites and also environments of operating theatre and the surgical wards and cultured for bacteria. Growths on culture media were identified. Antimicrobial susceptibility of the isolates was tested. Culture results indicated bacterial infections of 86% of the surgical site wounds sampled. Wounds in female surgical ward had 92%, male surgical ward had 84.2% and the maternity ward had 81.4% wounds infected with various bacterial types. The most occurring isolate was *Staphylococcus aureus* (54.3%) followed by *Escherichia coli (*16.3%), Coagulase-negative *Staphylococcus* (15.5%), *Proteus mirabilis* (7.8%) and *Pseudomonas aeruginosa* (6.2%). Similar isolates were obtained from the environmental samples with *Bacillus sp.* (43.9%) dominating followed by *S. aureus* (24.9%). There was strong correlation between wounds isolates and environmental isolates (OR=.678, P>0.05). Post-operative wound infection in the hospital was high recording 86% probably due to environmental contaminants. Stronger infection control measures are advocated for the hospital.

Key words: Surgical site, postoperative wound infection, surgical wound, environmental contamination.

INTRODUCTION

There are many diseases that affect humans, which require surgical interventions to correct, but surgical site infections are also common creating serious post-operative complications (de Lissovoy et al., 2009). In the developing world, surgical site infections affect up to two-thirds of patients who undergo operations (Bernstein, 2013) and account for about 20% of all hospital-associated infections (Nasser Abdulsalam et al., 2013). These surgical site infections are common and easily noticeable at Ghana, but data describing the situation in Ghana is scarce. This study therefore aimed at determining bacterial types infection post-operative wounds at Edwin Cade Memorial Hospital, AngloGold Ashanti, Obuasi. It was also to determine whether environmental isolates were responsible for the surgical site infections.

MATERIALS AND METHODS

The study site

The study site was Edwin Cade Memorial Hospital, Obuasi where the study was conducted between July to September, 2011. The study was performed after permission was obtained from the hospital authorities and after ethical clearance was obtained from the Committee on Human Research and Publication of Kwame Nkrumah University of Science and Technology, Kumasi. This study was performed after the informed consent of the patients was obtained. Patients who refused participation were excluded. This is

*Corresponding author. E-mail: pfeglo.sms@knust.edu.gh.

Table 1. Characteristics of the patients and the prevalence of surgical site infection.

Sex	Male: n=57	Female: n=93	Total: N=150
Mean age	42.5 ± 14.5	35.4 ± 10.4	35.4 ± 10.4
Number (%)of wounds contaminated	52 (91.2)	77 (88.2)	129 (86)

a prospective on patients of all sexes aged 14 years and above and who had surgery at the Edwin Cade Hospital.

Post-operative wound sampling

After surgery, the dressings were removed and the wounds inspected after 72 h for signs of the presence of pus and malodors. When pus and malodors were present, the wound was considered infected. Infected wounds were sampled with a cotton-tipped swab to collect pus from the infected wound. The swab was placed in Stuarts transport medium and then transported to the bacteriology laboratory for processing. In the laboratory, the specimens were inoculated onto Blood agar and MacConkey agar and incubated aerobically at 37°C overnight. Blood agar and or MacConkey plates which grew less than five (5) colonies for a wound were considered to have mere contamination but not an infection. Dry wound without pus were not sampled and therefore were not included in the study.

Sampling surgical theatre environment

Fomites

Two sample were taken from the fomites. One set of samples was taken before the theatre was cleaned and disinfected and another set was taken just hour after the theatre was cleaned and disinfected. Samples were collected using sterile swabs moistened with sterile saline and used to collect samples from door handles, bedstead, water-taps, and trolleys in the surgical theatre. Each of the samples was placed into a tube containing peptone water. The tubes were labeled appropriately and then taken to the laboratory for analysis.

In the laboratory, the specimens were incubated aerobically at 37°C for 3 h to resuscitate stressed bacteria. After resuscitation, the specimens were sub-cultured onto Blood agar and MacConkey agar and then incubated aerobically at 37°C for overnight and inspected for growth. If no growth occurred, the agar plates were re-incubated for another 24 h. If a culture failed to grow the agar plates were discarded.

Air sampling

Petri dishes containing plate count agar (PCA) were left open for 1 h in the surgical theatre, maternity ward and also the male and female surgical wards. There were five Petri dishes in each of the locations mentioned. The Petri dishes were then taken directly to the laboratory and incubated aerobically at 37°C for 24-48 h. After incubation, growths which occurred on the five plates in each room were counted and the mean count was taken as the count for that site and the organisms were idenfied.

Bacterial identification

After incubation, growths that occurred on the MacConkey and Blood agar plates were identified using, lactose fermentation, formation of mucoid colony forms and other colony forms. Bacterial colonies of similar characteristics were picked and subcultured onto nutrient agar to obtain pure cultures. Bacterial identification was done using the pure cultures on the nutrient agar using conventional methods involving Gram staining and appropriate biochemical tests (catalase, coagulase, oxidase, indole, citrate utilization, urease production, motility test sugar fermentation tests on Triple sugar iron agar tests) and following previously described standard protocols (Cheesebrough, 2000; Gilchrist, 1993).

Antimicrobial susceptibility testing of the isolates

Antimicrobial susceptibility of the isolates was determined by the modified disk diffusion Kirby-Bauer method (CLSI, 2010) on Muller-Hinton agar using the following antibiotic discs: ampicillin (10 µg), co-trimoxazole (25 µg), gentamicin (10 µg), cefuroxime (30 µg), cefotaxime (30 µg), ceftriaxone (30 µg), Chloramphenicol, penicillin (10 µg), flucloxacillin (5 µg), erythromycin (5 µg), and tetracycline (10 µg). The test was performed by preparing 0.5 McFarland suspension of the test. The suspension was seeded onto Muller-Hinton agar and the antibiotic discs were applied. The set-up was incubated at 37°C overnight. The zone of inhibition around each disc was then measured and compared to a standard chart to determine whether it was susceptible or resistant.

Statistical analysis

The Pearson's χ^2 test, Fisher's exact test, or linear-by-linear association were used to compare categorical variables, as needed. To determine independent risk factors for mortality, a multiple logistic regression model was used to determine the effects of confounding variables. The results of logistic regression analyses were reported as adjusted ORs with 95% CIs. All *P*- values were 2-tailed, and $P < .05$ was considered to indicate statistical significance.

RESULTS

General characteristics of the study population

There were 150 patients (57 males and 93 females) who had surgical procedures to correct various medical conditions at the Edwin Cade Memorial Hospital, AngloGold Ashanti, Obuasi within the period under study. The patients had ages ranging from 16 to 76 years with a mean age 38.1±12.4 years. The majority (91.3%) of the patients were young adults with modal age group of 12-25 years had their wounds contaminated. The mean age males had 42.5 ±14.5 years, which was statistically significant (p=0.001) as compared with female age of 35.4±10.4 years. Of the 150 wounds sampled, 129 grew bacteria, indicating postoperative wound contamination prevalence of 86% (Table 1).

Table 2. Bacteria types isolated from surgical wounds in the ward of admission.

Parameter	Female Surgical	Male Surgical	Maternity	Total
Number of wounds sampled	**50**	**57**	**43**	**150**
Wound isolates	n=46 (%)	n=48 (%)	n=35 (%)	n=129 (%)
Staphylococcus aureus	24 (34.3)	28 (40.0)	18 (25.7)	70 (54.2)
Escherichia coli	9 (42.8.0)	8 (38.1)	4 (19.1)	21 (16.2)
CNS	7 (35.0)	6 (30.0)	7 (35.0)	20 (15.5)
Pseudomonas aeruginosa	4 (50.0%)	2 (25.0)	2 (25.0	8 (6.2)
Proteus mirabilis	2 (20.0)	4 (40.0)	4 (40.0)	10 (7.8)
Total	46 (92.0)	48 (84.2)	35 (81.4)	129 (100)

n (%)= number (frequency) of times a bacterial type was isolated; CNS=coagulase negative staphylococci.

Table 3. Surgical procedure type and prevalence of surgical site infection.

Type of surgical procedure	Number of surgeries performed	Number (%) contaminated
Caesarian section	43	35 (81.4)
Myomectomy	20	19 (95.0)
Total hysterectomy	19	19 (100.0)
Inguinal Hernia Repair	17	15 (88.2)
Hydrocelectomy	14	13 (92.9)
Limb Amputation	13	10 (76.9)
Appendectomy	8	7 (87.5)
Cholecystectomy	7	6 (85.7)
Thyroidectomy	6	2 (33.3)
Colectomy	3	3 (100.0)
Total	150	129 (86)

Surgical wound isolates in relation to ward of admission

Different types of bacteria were isolated from the patients and from all the wards. The most common occurring bacterium was *S. aureus* (54.3%), followed by *E. coli* (16.3%) and Coagulase-negative staphylococcus (15.5%). Other organisms isolated were *P. mirabilis* and *P. aeruginosa* with their respective occurrences of 7.8 and 6.2%. These isolates occurred at high prevalence levels across all the surgical wards from which samples were collected as presented in Table 2.

Surgical procedure in relation to postoperative wound infection

There were 43 caesarian births, being the most frequent surgeries performed in the hospital, out of which number 43/35 (81.3%) had infections. Out of the 20 myomectomy cases, 19 (95%) were infected but all the 19 patients who had total hysterectomy had their wounds contaminated with various bacterial types. Other surgical procedures that had infections have been presented in descending order of frequency as shown in Table 3.

Environmental contamination in relation to surgical wound infection

Various microorganisms were isolated from the fomites in the wards with *Bacillus sp.* having the most common prevalence levels of 50, 38.1, 42.1 and 48.5% in the male surgical ward, female surgical ward, maternity ward and theatre respectively (Table 4). *S. aureus* was the second most common isolate in the wards, registering 27.8, 14.3, 26.3 and 38.8% respectively in the male surgical ward, female surgical ward, maternity ward and theatre. Tables 5 and 6 indicate levels of bacterial contamination at the various parts of the surgical ward and the theatre. The bacteria types were more frequently isolated on the ward than from the theatre. Comparing level of contamination of fomites at the two sites (Surgical wards and the Operating theatre) Bacillus sp. and *S. aureus* and *E. coli* were again the most common isolates. Other isolates and their frequency of isolation are indicated in Tables 5 and 6.

Prediction that a bacterial type isolated from a wound is an environmental contaminant

Prediction that an isolate was obtained from the wound

Table 4. Distribution of bacteria isolated in wards using exposed plates for 1 h.

Isolates	Male ward	Female ward	Maternity ward	Operating theatre	Total
	N (%)	N (%)	N (%)	N (%)	N (%)
Bacillus sp	9 (50)	8 (38.1)	8 (42.1)	5 (48.5)	30 (43.9)
S. aureus	5 (27.8)	3 (14.3)	5 (26.3)	4 (38.8)	17 (24.9)
E. coli	2 (11.1)	5 (23.8)	2 (10.5)	0	9 (13.2)
Klebsiella pneumoniae	2 (11.1)	5 (23.8)	2 (10.5)	0	9 (13.2)
P. aeruginosa	0	0	2 (10.5)	0	2 (2.6)
CNS	0	0	0	1 (9.5)	1 (1.5)
P. mirabilis	0	0	0	1 (9.5)	0.3 (0.4)
Total	18 (100)	21(100)	19 (100)	11 (9.5)	69 (100)

N, mean viable count (%); CNS-Coagulase Negative S*taphylococcus, E. coli*, *S. aureus, P. aeruginosa.*

Table 5. Bacteria isolated from fomites in the surgical wards using swabs.

Organisms	Main door handle N/ (%)	Bathroom door handle N/ (%)	Lavatory door handle N/ (%)	Ward Tap N/ (%)	Bath Tap N/ (%)	Bed N/ (%)
S. aureus	7 (38.9)	7 (38.9)	9 (42.9)	3 (16.7)	2 (12.5)	9 (15)
Bacillus sp.	7 (38.9)	7 (38.9)	9 (42.9)	7 (38.9)	5 (31.3)	34 (56.7)
K. pneumoniae	3 (16.7)	1 (5.6)	1 (4.8)	4 (22.2)	5 (31.3)	6 (10)
E. coli	1 (5.6)	3 (16.7)	2 (9.5)	4 (22.2)	4 (25)	11 (18.3)

was environment gave Odds Ratio (OR) and P values suggesting strong correlation. Results obtained in the χ^2 test predictions for predicting *S. aureus* isolated from the environment and wounds from male patients gave OR= 0.942, and p=.023 for *S. aureus* indicating strong correlation. There was a similarly strong correlation between male patient *E. coli* isolates and that of male ward environment (OR= 0.896, P= .012). Isolates obtained from female wounds were compared with theatre environment isolates *S. aureus* (OR= 0.746, P= .012); wound *P. mirabilis* (OR= 0 .996, P= .023) had a correlation suggesting that postoperative wound infection might be as a result of contamination in the theatre. Maternity ward environmental isolates were compared with postoperative wound isolates from the maternity patients with respect to *P. aeruginosa* and *S. aureus* and there were strong correlations (OR .996, P= .002); (OR .811, P= .042) respectively. These results and other comparisons are presented in Table 7.

Antimicrobial susceptibility of isolates

Antimicrobial susceptibility patterns of the isolates obtained in the study are varied and are presented in Table 8.

K. pneumoniae

K. pneumoniae isolated from the environmental samples had resistant strains to almost all the antibiotics tested while all the *K. pneumoniae* isolates (100%) were resistant to ampicillin and tetracycline; proportion to resistant to cotrimoxazole and cefotaxime were 90.5 and 75.0% respectively. The resistance levels to antimicrobials chloramphenicol and ceftriaxone was 60%, and were 40% to gentamycin and 30% to cefuroxime.

E. coli

E. coli strains isolated from the post-operative wounds had resistant strains to eight antibiotics tested. While all (100%) of the *E. coli* isolates were resistant to tetracycline and ampicillin, resistance level to cefuroxime was 81% and cotrimoxazole was 66.7%. The resistance levels to other antimicrobials were much lower as shown in Table 8.

P. mirabilis

No *P. mirabilis* isolate was susceptible to tetracycline and cotrimoxazole, but their resistant proportion to ampicillin and cefotaxime were both 90%. Proportions resistant to other antimicrobials were 80% to cefotaxime, 60% to cefuroxime, 50% to gentamycin and chloramphenicol, 50%.

Coagulase negative staphylococci

Ampicillin and flucoxacillin had all the coagulase negative *staphylococcus* isolates to them (100%) while resistance

Table 6. Bacteria isolated from fomites in the operating theatre.

Organism	Main door handle n/ (%)	Theatre tap n/ (%)	Theatre bed n/ (%)	Trawley n/ (%)	Reagent Bench n/ (%)	Total N/ (%)
S. aureus	4 (66.7)	1 (16.7)	1 (33.3)	1 (16.7)	3 (50)	6 (100)
CNS	0	0	0	1 (16.7)	0	0
Bacillus sp	2 (33.3)	5 (83.3)	1 (33.3)	4 (66.7)	3 (50)	0
Proteus mirabilis	0	0	1 (33.3)	0	0	0

CNS, Coagulase Negative *Staphylococci.*

Table 7. Prediction that a wound isolate is an environmental contaminant.

Parameters compared	Isolates			
	S. aureus	***E. coli***	***Proteus***	***Pseudomonas***
Location versus the environment	OR (P)	OR (P)	OR (P)	OR (P)
Male wound vrs theatre environment	0.942 (0.023)	--	.996 (.003)	--
Male wound vrs male ward environment	0.746 (0.012)	.896 (.012)		--
Female wound vrs theatre environment	968 (0.023)	--	.426 (.120)	--
Female wound vrs female environment	0.689 (0.011)	.742 (.016)		--
Maternity wounds vrs theatre environment	0.824 (0.005	--	.862 (.015)	--
Maternity wounds vrs maternity ward environment	0.811 (0.042)	.234 (.342)	--	.996 (.002)

(-) = no correlation; OR=Odds ratio; P=p value. Close to (1) indicates correlation, Close to (-1) indicates correlation. ≤0.05 indicates significance.

proportion to erythromycin was 94.7%, but was 89.5% to tetracycline and penicillin. Resistant proportions to other antimicrobials were cefuroxime 78.9%, cotrimoxazole 73.7%, and gentamicin 21.10%. Resistance levels of other antibiotics are indicated in Table 8.

DISCUSSION

Surgical procedures have improved worldwide and deaths occurring from them have reduced considerably. Despite these advances, surgical site infections continue to be a major cause of morbidity and long hospital stay among these patients (de Lissovoy et al., 2009). This study was conducted with the aim of identifying the different types of bacteria contaminating post-operative wounds at the Edwin Cade Memorial Hospital, AngloGold Ashanti, Obuasi. Bacterial isolates from the wounds were compared with environmental contaminants isolated in the operating theatre and the surgical wards so as to determine whether the wound isolates were from the environment.

The study results indicate a high level of bacterial contamination of surgical wounds, with eight different bacterial types isolated. The theatre and surgical ward environments were found to be contaminated with bacteria similar to those isolated from the surgical wounds. The bacteria isolates from the wounds were probably from the environment since isolates from both sites (wounds and environments) were very much similar. The prevalence of bacterial infection of post-operative wounds in this study was 86%, a value considered high compared to 45% reported from India (Lilani et al., 2005), 34% reporded from Yemen (Nasser et al., 2013) and 57.4% reported from Mali (Togo et al., 2010) and 10,9% in Ethiopia (Wondimagegn et al., 2012). Bacteria types that contaminate surgical wounds vary with *S. aureus* and coagulase negative staphylococci which are frequently reported as the most common isolates (Anderson and Kaye, 2009; Anguzu and Olila, 2007). In the present study, Gram negative rods such as *E. coli* (16.3%), *P. mirabilis* (7.8%) and *P. aeruginosa* (6.2%) were also isolated. The degree of wound contamination has been linked to the kind of surgery performed. The kind of surgery has been classified variously to include: clean, clean- contaminated, contaminated and dirty, depending on the bacterial burden at the surgery site (Wassef et al., 2012). This classification scheme is used to predict surgical wound infection (Nguyen et al., 2001). The degree of contamination of clean surgery contamination is also influenced as described by Yi et al. (2011). Infections of Clean surgery site are determined by level of contamination of the theatre environment and the duration of the surgery (Pokrywka and Byers, 2013). The durations of the surgeries performed were not determined in this present study, but the environment was sampled

Table 8. Isolate proportions resistant to antibiotics (%).

Isolate	Tetracycline	Co-trimoxazole	Ampicillin	Gentamicin	Cefuroxime	Flucloxacillin	Erythromicin	Penicillin	Chloramphenicol	Cefotaxime	Ceftriaxone
S. aureus	90	94	100	84	100	92	48	100			
CNS	100	100	100	100	100	100	75	100			
K. pneumoniae	100	95	100	40	70		-		60	75	60
E. coli	92	71	100	54	73		-		67	63	58
P. mirabilis	75	100	100	100	100		-		100	100	100
P. aeruginosa	100	100	100	100	100		-		100	100	100

or bacteria. It was found that bacterial contamination was found in all the surgically related units, which are the surgical theatre and the surgical wards. These units have bacteria contaminants isolated from the air, door handles and bedsteads (Tables 5 and 6). Wound infections on females on the surgical ward recorded 92% wound infections and 81.4% on the maternity ward as compared to the 84.2% on the male surgical ward. This finding is in support of other findings that there is a higher risk of post-operative wound infections among females than males (Brandt et al., 2006; Manilich et al., 2013; Nasser et al., 2013).

S. aureus recording prevalence 57.9% was the most common isolate obtained from the surgical wounds and gain was the most common isolate obtained from almost all the surgical procedures performed. Furthermore, *Staphylococcus aureus* was found on many of the fomite types sampled from the environment. It is known that many healthy people carry *S. aureus* in their nostrils, skin, axilla and hairlines (Crawford et al., 2012) such carriers might shed the organism in the environment. The surgical wounds might have got infected from such contaminated environmental fomites or from such endogenous sources (Gottrup, 2005). It is for this reason that prophylactic antibiotic is given to reduce bacterial load at such sites prior to surgery (Crawford et al., 2012). Endogenous organisms such as *S. aureus* may not be cleared completely from the patient during the prophylactic cover prior to surgery and may re-colonize the surgical site soon after surgery (Anderson and Kaye, 2009). They therefore can cause nosocomial infection (Hawn, 2010), even if the patients are adequately given antibiotic prophylaxis before the surgery (Hirsch et al., 2010). Surgical site infections have been linked to environmental contamination in the surgical theatre and surgical wards (Adamina et al., 2013) as it was found in this present study that fomites sampled in the theatre had virtually no reduction in bacterial numbers after the theatre was cleaned and disinfected.

Organisms isolated from hospital environment might have had contact with several antibiotics (Aykan et al., 2013), so they are often multidrug resistant as a result of the production of antibiotic hydrolyzing enzymes such as the β-lactamases (Wasnik, 2013). Bacillus species remain unaffected by disinfectants and antimicrobials (Hirsch et al. 2010), because *Bacillus spp.* often survive in the environment in the form of spores which are unaffected by disinfectants. The door handles were frequently handled by patients, hospital workers and other people who enter the hospital facility making the ward door handles highly contaminated (Hota, 2004). In this study all the *S. aureus* isolated from contaminated surgical wounds were resistant to Penicillin and Ampicillin while over 50% were resistant to Erythromycin (Table 7). This observation is consistent with many other studies (Anderson and Kaye, 2009; Anguzu and Olila, 2007; Crawford et al., 2012) that *S. aureus* and enteric gram negative microbes have very high proportions being resistant to the commonly prescribed antimicrobials and tend to cause nosocomial infections.

The roles of organisms in the surgical theatre environment in contaminating surgical sites have been recognized in relation to failure of disinfectants and antibiotic prophylaxis. Attempts have therefore been made to reduce contamination of the surgical theatre by the use of laminar airflow in the theatre, but this gave no benefit and was associated with higher risk for severe post surgery wound infection (Brandt et al., 2008). There are many other factors that influence post surgery complications such as operative time, Body Mass Index (BMI), age, level of experience of the surgeon and the type of surgery performed (Manilich et al., 2013). Other factors that influence surgical site infection are preventive, and these involve skin preparation, wound closure technique adopted by the surgeon and the most significant among them is the degree of microbial contamination of the surgical environment (Bode et al., 2010). These factors interplay with level of environmental contamination to determine frequency of surgical site infection (Brandt et al., 2008). In the light of these factors, extensive infection control practices are necessary to prevent pathogens invading surgical wounds to cause infection. The hospital is a place that keeps patients who are ill, and many of them are severly immunocompromised. A patient's immunity is breached by surgery so such a surgery patient needs to be protected, especially from surgical site infection. In conclusion, the results from this study at the Edwin Cade Memorial Hospital, AngloGold Ashanti, Obuasi showed that the prevalence of bacterial post-operative wounds infection was very high with a variety of microorganisms.

The organisms isolated from the wounds were similar to those isolated from theatre and surgical ward environments and they had similar antibiotic susceptibility patterns suggesting that the environmental isolates might be responsible for infecting the wound. Infection control measures in such critical areas such as the surgical theatre and surgical wards of the hospital need to be reviewed and strengthened.

REFERENCES

Adamina M, Gié O, Demartines N, Ris F (2013). Contemporary perioperative care strategies. Br. J. Surgery 100(1):38-54.

Anderson DJ, Kaye KS (2009). Staphylococcal surgical site infections. Infect. Dis. Clin. North Am. 23(1):53-72.

Anguzu J, Olila D (2007). Drug Sensitivity patterns of bacterial isolates from septic postoperative wounds in a regional referred hospital. Uganda Afr. Health Sci. 7(3):148-154.

Aykan SB, Engin E, Caglar K, Sipah IA, Sultan N, Yalinay ÇM (2013). Investigation of the Presence of Disinfectant Resistance Genes qacA/B in Nosocomial Methicillin-Resistant Staphylococcus aureus Isolates and Evaluation of Their In Vitro Disinfectant Susceptibilities. Mikrobiyol Bul 47, 1-10.

Bernstein J (2013). The Silent Epidemic. etrieved from http://www.huffingtonpost.com/james-bernstein-md/the-silent-epidemic_b_3006709.html.

Bode LGM, Kluytmans JAJW, Wertheim HFL, Bogaers D, Vandenbroucke-Grauls CMJE, Roosendaal R, Troelstra A, Box ATA, Voss A, van der Tweel I (2010). Preventing Surgical-Site Infections in Nasal Carriers of Staphylococcus aureus. New England J. Med. 362(1):9-17.

Brandt C, Hott U, Sohr D, Daschner F, Gastmeier P, Rüden H (2008). Operating Room Ventilation With Laminar Airflow Shows No Protective Effect on the Surgical Site Infection Rate in Orthopedic and Abdominal Surgery. Ann. Surgery 248(5):695-700 610.1097/SLA.1090b1013e31818b31757d.

Brandt C, Sohr D, Behnke M, Daschner F, Rüden H, and Gastmeier P (2006). Reduction of Surgical Site Infection Rates Associated With Active Surveillance. Infect. Control Hosp. Epidemiol. 27(12):1347-1351.

Cheesebrough M (2000). District laboratory practice in Tropical countries. Cambridge University Press, UK, 370-387.

CLSI (2010). Clinical Laboratory Standards Institute, Performance standards for antimicrobial susceptibility testing. Twentieth informational supplemented. CLSI document Wayne, PA, USA M100-S20.

Crawford T, Rodvold KA, Solomkin JS (2012). Vancomycin for Surgical Prophylaxis? Clinical Infectious Diseases 54(10):1474-1479.

de Lissovoy G, Fraeman K, Hutchins V, Murphy D, Song D, Vaughn BB (2009). Surgical site infection: Incidence and impact on hospital utilization and treatment costs. Am. J. Infect. control 37(5):387-397.

Gilchrist FA (1993). Basic laboratory procedures in clinical laboratory, Geneva World Health Organization 52-193.

Hawn MT (2010). Surgical care improvement: Should performance measures have performance measures. JAMA 303(24):2527-2528.

Hirsch T, Seipp HM, Jacobsen F, Goertz O, Steinau HU, Steinstraesser L (2010). Antiseptics in surgery. Eplasty 10:e39.

Hota B (2004). Contamination, Disinfection, and Cross-colonization: Are Hospital Surfaces Reservoirs for Nosocomial Infections. Clin. Infect. Diseases 39:1182-1189.

Lilani SP, Jangale N, Chwdhary A, Daver GB (2005). Surgical site infection in clean and clean-contaminated cases. 249-252.

Manilich E, Vogel JD, Kiran RP, Church JM, Seyidova-Khoshknabi D, Remzi FH (2013). Key Factors Associated With Postoperative Complications in Patients Undergoing Colorectal Surgery. Diseases of the Colon & Rectum 56(1):64-71 10.1097/DCR.1090b1013e31827175f31827176.

Nasser Abdulsalam MA, Zhang X, Yang L, Sawafta FJ, Salah B (2013). Assessment of Surgical Site Infections from Signs, Symptoms of the Wound and Associated Factors in Public Hospitals of Hodeidah City, Yemen Int. J. Appl. Sci. Tech. 3(3):101-110.

Nguyen D, Bruce- MacLeod W, Phun DC, and Cong QT (2001). Incidence and Predictors of Surgical Site Infections in Vietnam. Infection Control Hosp. Epidemiol 22(8):485-492.

Pokrywka M, Byers K (2013). Traffic in the Operating Room: A Review of Factors Influencing Air Flow and Surgical Wound Contamination. Infectious Disorders - Drug Targets (Formerly Current Drug Targets - Infectious Disorders) 13(Number): (156):156-161.

Togo A, Traore A, Kante L, Coulibaly Y, Diango D, Keita M, Diallo S, Dembele BT, Diakite I, Diani N (2010). Fighting Nosocomial Infection Rates in the General Surgery Department of the Teaching Hospital Gabriel Toure in Bamako, Mali. Open Biol. J. 3:87-91.

Wasnik BD (2013). Occurrence of Extended Spectrum Beta - Lactamase Producing Enterobacteriaceae Causing Wound Infections. Asian J. Biomed. Pharm. Sci. 3(20):201-112.

Wassef MA, Hussein A, Abdul Rahman E, El-Sherif RH (2012). A prospective surveillance of surgical site infections: Study for efficacy of preoperative antibiotic prophylaxis. Afr. J. Microbiol. Res. 6(12):3072-3078.

Wondimagegn M, Kibru G, Beyene G, Damtie M (2012). Postoperative Nosocomial Infections and Antimicrobial Resistance Pattern of Bacteria Isolates among Patients Admitted at Felege Hiwot Referral Hospital, Bahirdar, Ethiopia. Ethiopian J. Health Sci. 22(1):1-18.

Yi M, Edwards JR, Horan CT, Fridkin SK (2011). Improving risk-Adjusted Measures of Surgical Site Infecction for National Health care safety Network Infect Control and Hospt Epid 32(10):970-986.