Original Article

Study of Surgical Site Infections in Abdominal Surgeries

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ABSTRACT

Background: Surgical site infections (SSI) have been responsible for the increasing cost, morbidity and mortality related to surgical operations and continue to be a major problem even in hospitals with most modern facilities and standard protocols of pre-operative preparation and antibiotic prophylaxis.

Aims: This study aimed to determine the incidence of SSI in the abdominal surgeries and to identify risk factors associated with the development of SSI.

Settings and Design: This retrospective observational study included patients who had undergone surgeries (abdominal) in the Department of General Surgery and Department of Obstetrics and Gynacology. It was conducted over a period of 18 months.

Materials and Methods: All surgeries (1000 cases) where abdominal wall was opened were considered for the study. Wound class was considered as clean, clean contaminated, contaminated and dirty based on the extent of intraoperative contamination. The data collected includes details of timing of antimicrobial prophylaxis, surgical wound infection, types of surgeries (emergency and elective surgeries), the wound classes, apart from demographic profile of the patient.

Results: The overall surgical wound infection rate was 13.7%. The infection rate was more with emergency surgery (25.2%) when compared to elective surgery (7.6%). The surgical site infection rate increased as the risk index score increased from 0 to 3. SSI was more with early operative and post operative prophylaxis. There was definite correlation between the wound infection rate and the timing of prophylaxis.

Statistical Analysis: Chi-square test was applied and the level of significance was set at 5%.

Conclusion: A pre-existing medical illness, prolonged operating time, the wound class, emergency surgeries and wound contamination strongly predispose to wound infection. Antimicrobial prophylaxis is effective in reducing the incidence of post-operative wound infections for a number of different operative procedures but, timing of administration is critical.

Key Words: Surgical site infection, National Nosocomial Infections Surveillance (NNIS) risk index, Antibiotic prophylaxis

KEY MESSAGE

- SSIs remains as one of the most important causes of morbidity and mortality in surgically treated patients.
- Antimicrobial prophylaxis is effective in reducing the incidence of post-operative wound infections for a number of different operative procedures but, timing of administration is critical.
- An organised system of wound surveillance and reporting are the most effective means to reduce the wound infection rate to an attainable minimum

INTRODUCTION

Despite the advances made in asepsis, antimicrobial drugs, sterilization and operative techniques, surgical site infections (SSI) continue to be a major problem in all branches of surgery in the hospitals [1]. They have been responsible for the increasing cost, morbidity and mortality related to surgical operations and continue to be a major problem even in hospitals with most modern facilities and standard protocols of preoperative preparation and antibiotic prophylaxis. A major 30%-50% of antimicrobials prescribed in hospital practice are for surgical prophylaxis to prevent post-operative wound infection. A reduction in the infection rate to a minimal level could have significant benefits in terms of both patient comfort and medical resources used [2]. This study aimed to determine the incidence of SSI in the abdominal surgeries and to identify risk factors associated with the development of SSI.

MATERIALS AND METHODS

This retrospective observational study was done in tertiary care centre Rajarajeshwari medical college hospital. All the 1000 abdominal surgeries conducted in the Department of General Surgery and in the Department of Obstetrics and Gynacology over a period of 18 months i e., from March 2010 to Aug 2011 were considered for the study. A sample size of 1000 cases was chosen for statistical purpose. Ethical clearance was obtained from the Ethical Committee of our Institution before the start of the study. All surgeries where abdominal wall was opened including caesarean section, abdominal hysterectomy and tubectomy were considered for the study. Those patients who were receiving antimicrobials for therapeutic purpose were excluded from the study.

Wound infection was diagnosed if any one of the following criteria were fulfilled: serous or non-purulent discharge from the wound, pus discharge from the wound, serous or non-purulent discharge from the wound with signs of inflammation (oedema, redness, warmth, raised local temperature, fever > 38°C, tenderness, induration) and wound deliberately opened up by the surgeon due to localized collection (serous/purulent). Stitch abscesses were excluded from this study[3]. Wound class was considered as clean, clean contaminated, contaminated and dirty as per National Research Council classification criteria (Table/Fig-1), This classification is based on the extent of intraoperative contamination [4].

Timing of administration of prophylactic antimicrobial was considered *early operative* if it was given more than 2 hours before incision, *pre-operative* if it was given less than 2 hours before incision, *peri-operative* if it was during surgery and post-operative if it was given after the completion of surgery. The National Nosocomial Infections Surveillance (NNIS) risk index was calculated for which, the three independent risk factors considered, namely, poor clinical condition of the patient [corresponding to levels 3, 4 or 5 of the ASA classification [Table/Fig-2] [4], a contaminated/ infected surgical wound, and surgery longer than 2 hr or longer than the cut-off point (the 75th percentile) prescribed for the type of procedure performed, are all allocated to a score of 1. By summation of the scores, patients are classified into four groups with scores from 0 to 3 [Table/Fig-3] [4].

Class/classification	Potential for contamination
Class I/clean	Surgical wounds that exhibit no infection or inflammation; operations not involving the entry of the uninfected respiratory, digestive, genital or urinary tracts. Operations in which aseptic conditions are fully maintained: surgical wounds are primarily closed and, if necessary, drained using a closed system. Surgical wounds after non-penetrating trauma injuries are included in this class if they fulfill the above criteria.
Class II/potentially contaminated	Surgeries involving opening of the respiratory, digestive, genital or urinary tracts under controlled contaminated conditions and without abnormal contamination. Operations involving biliary tract, appendix, vagina and oropharynx that exhibit no evidence of infection and where aseptic conditions are fully maintained are included in this class.
Class III/ contaminated	Fresh (within 7 h of causal event), open trauma injuries. Surgical procedures with a major in sterile technique (open heart surgery), or with significant contamination from the gastrointestinal tract. Wounds with acute, non-purulent inflammation are included in this class.
Class IV/ infected/dirty	Old (more than 7 h after causal event) trauma injuries with devitalized tissue and with pre-existing clinical infection or perforated viscera. This definition suggests that organisms giving rise to postoperative infection were present in the surgical area prior to the surgery.

[Table/Fig-1]: Classification of surgical site according to the National Research Council [4]

Classification	Physical condition of the patient
1	Normally healthy.
2	Discrete systemic disease.
3	Serious, non-incapacitating, systemic disease.
4	Life-threatening, incapacitating systemic disease.
5	Moribund with death expected within 24 hrs.

[Table/Fig 2]: Risk index classification of the American Society of Anaesthesiology (ASA) [4]

The data collected includes details of timing of antimicrobial prophylaxis, surgical wound infection, types of surgeries (emergency and elective surgeries), the wound classes, Haemoglobin percentage, apart from demographic profile of the patient. The results were analyzed as per the following indicators:

1. Timing of administration of antimicrobial prophylaxis as early operative, pre-operative, peri-operative and post-operative.
2. Surgical site infection rate as per wound class, type of surgeries, timing of prophylaxis and NNIS risk index.

Statistical Analysis: Chi-square test was applied to detect the statistical significance between the variables and the level of significance was set at 5%.

RESULTS

The present study included one thousand various types of abdominal surgical procedures performed [Table/Fig-4]. A total of 17 types of abdominal procedures were performed out of which appendicectomy, caesarean section, abdominal hysterectomy and herniorraphy accounted for 61.2% of the total surgical procedures. The overall surgical wound infection rate was 13.7%. Out of 137 wound infections, appendicectomy, caesarean section, abdominal hysterectomy and small bowel surgeries themselves accounted for

Risk factor	Score ascribed	
	0	1
Physical condition of patient according to the ASA classification	< 3	= 3
Class of contamination of surgical wound according to the NRC classification	Clean or potentially contaminated	Contaminated or infected
Length of surgery (in terms of the 75 percentile for the procedure)	≤75	> 75

[Table/Fig-3]: The National Nosocomial Infections Surveillance (NNIS) risk index classification for predicting surgical site infection [4]

Surgical Procedure	No. of patients (n = 1000)	No. of wound infections (n = 137)	Percentage (%)
Appendicectomy	173	25	14.5
LSCS	168	19	11.3
Abdominal Hystrectomy	149	19	12.8
Herniorraphy	122	3	2.5
Small Bowel Surgeries	77	44	57.1
Abdominal Tubectomy	70	0	0
Herniotomy	65	1	1.5
Gastric Surgery	44	2	4.6
Laparotomy	29	9	31
Surgeries on Ovaries and Tubes	23	1	4.4
Incisional Hernia repair	19	5	26.3
Suprapubic Cystolithotomy	19	1	5.3
Colorectal Surgery	12	2	16.7
Cholecyctectomy	10	3	30
Trans Vesical Prostectomy	10	2	20
Bladder Surgery	6	1	16.7
Splenectomy	4	0	0

[Table/Fig-4]: Surgical site Infections according to surgical procedure

107 infections (78.1%). The surgical site infections with there rate according to wound class were recorded [Table/Fig-5]. Infection rate is 3.9% in clean wounds where as it was 56.7% in dirty wounds. Thus there was clear correlation between the wound infection rate and the contamination of the wound.

The surgeries were grouped as emergency and elective surgery [Table/Fig-6]. The infection rate was more with emergency surgery {87/345(25.2%)} when compared to elective surgery [50/655(7.6%)] which was statistically significant {P<0.001(χ^2 = 59.08)}. The hamoglobin percentage of the patients undergone surgery was taken into account. It was observed that patients having hamoglobin level below 9 gm% accounted for 5.5%. The wound infection rate was 21.8% (12/55) in these patients compared to 13.2% (125/945) in normal individuals (p> 0.05 χ^2 = 3.53) which was statistically not significant.

The surgical site infection rate increased as the risk index score increased from 0 to 3 (Table/Fig 6). Patients with risk index of 0 and 1 were considered as low risk and with 2 and 3 were considered as high risk. In high risk patients, infection rate was 33.2% (71/214) compared to 8.4% (66/786) in low risk patients (P < 0.001, χ^2 = 87.39). It was observed that in 81.8% (818) of patients prophylaxis was started post-operatively i.e. prophylaxis was started soon after the operation was completed, while only 10.2% of patients received prophylaxis pre-operatively i.e. within two hours before surgical incision. SSI was more with early operative and post-operative prophylaxis (Table/Fig-7). The surgical prophylaxis was given for ≤ 3days in 12.7% (127/1000), ≤ 7 days in 56.6% in (566/1000) and >7 days in 30.7% of cases.

Wound Class	No. of patients (n = 1000)	No. of Wound infections (n = 137)	Percentage of wound infections*
Clean	282	11	3.9
Clean contaminated	463	58	12.5
Contaminated	188	30	16.0
Dirty	67	38	56.7

[Table/Fig-5]: Surgical site infection according to wound class [4]
* p < 0.001 highly significant (χ^2 = 129.06)

Composite risk index	No. of patients (n= 1000)	No. of wound infections (n= 137)	Percentage of wound infections*
0	354	16	4.5
1	432	50	11.6
2	173	46	26.6
3	41	25	61.0

[Table/Fig 6]: Surgical site infection according to composite risk index [4]
* p < 0.001 highly significant (χ^2 = 128.67)

Timing	No. of patients (n = 1000)	No. of wound infections (n = 137)	Percentage of wound infections*
Early operative	80	21	26.25
Pre-operative	102	10	9.80
Peri-operative	nil	nil	nil
Post-operative	818	106	12.95

[Table/Fig-7]: Surgical site infection according to timing of prophylaxis
* p < 0.01 highly significant (χ^2 = 12.33)

DISCUSSION

The etiology of surgical site infections is dependent on the location of the surgery, the bacterial load in the tissue or blood peri-operatively and the integrity of host defences [5]. The overall infection rate is around 2-5% for extra abdominal surgeries and about 20% for intra abdominal injuries but varies from surgeon to surgeon, hospital to hospital, one procedure to another and even from one patient to another patient [5]. In our study, the overall surgical wound infection rate was 13.7%. Many studies from India at different places have shown the SSI rate to vary from 6.09% to 38.7% [1, 3, 6, 7]. In some surgical procedures for example in cholecystectomy, transvesical prostectomy, the high infection rate is reflected because of inadequate sample size in the respective surgical procedures. The infection rate in Indian hospitals is much higher than that in other countries; for instance in the USA, it is 2.8% and it is 2-5% in European countries [1]. The higher infection rate in Indian hospitals may be due to the poor set up of our hospitals and also due to the lack of attention towards the basic infection control measures. Surgical site infection rate increased from clean to dirty wound. Similar results were observed in other studies also [2, 8, 9]. Garibaldi et al [10] found that 30 or more colony-forming units (CFU) of bacteria cultured from a wound are predictive of wound infection regardless of wound class. In addition, a prospective study of 190 colorectal surgery patients has shown that a concentration of 5 CFU per millilitre or higher of bacteria in the peritoneal fluid are predictive of wound infection [2].

The infection rate was more with emergency surgery (25.2%) when compared to elective surgery (7.6%). The high rates of infection in emergency surgeries can be attributed to inadequate pre-operative preparation, the underlying conditions which predisposed to the emergency surgery and the more frequency of contaminated or dirty wounds in emergency surgeries [1].

A statistically significant association was observed between the rate of SSIs, the order of the operation (number of the particular operation in the OT list on that day) and the duration of the operation. As the order and the duration of the operation increased, the rate of SSIs also increased. The factors which were incriminated were the onset of fatigue, resulting in a decline of aseptic measures and an increase in pollution in the operation theatre with the lapse of time [3,11]. The wound infection rate was 21.8% (12/55) in those patients with hamoglobin <9% compared to 13.2% (125/945) in normal individuals. Similar results were observed by Awan MS [12]. However, Anamia itself is not an established factor for SSI [12].

The surgical wound infection rate increased as the risk index score increased. Similar results were observed by Raka L et al [13], where the SSI rate was low with risk index 0 and increased with index of 2 and 3. We found a good correlation between the NNIS System risk index and the development of SSI.

The administration of prophylaxis longer than 2 hours prior to surgery or post-operatively was confirmed to be associated with a higher SSI rate (Table/Fig-7). Similar observations were made by study done by Platon E M et al [14]. Antibiotic prophylaxis reduced the microbial burden of the intra-operative contamination to a level that could not overwhelm the host defences. The pre operative antibiotic prophylaxis could decrease post-operative morbidity, shorten the hospital stay and it could also reduce the overall costs which were attributable to the infection [15]. Timing of administration is critical. The drug should be administered ideally within 30 minutes and certainly within two hours of the time of incision [16]. The first dose should always be given before the skin incision is performed. For longer procedures, readministration of the drug is indicated at intervals of one or two times the half-life of the drug (using the same dose) [17]. This ensures adequate tissue levels throughout the duration of the procedure. The duration of an adequate tissue level of the antibiotic need not exceed the operative period.

The duration of administration is extended only in special circumstances, such as gross contamination secondary to a ruptured viscus or severe trauma. The available data provide no evidence for the efficacy of extending coverage to 24 to 48 hours in such contexts [18]. The disadvantages in continuing prophylaxis for long duration are (1) cost of prophylaxis, (2) stay in hospital and more importantly (3) the development of drug resistant organisms.

Post-operative prophylaxis accounts for 81.8% which could probably be due to more of clean wound surgeries [Table/Fig-5]. Preoperative prophylaxis are usually strictly planned and followed in cases of dirty wounds which are less in number in our study. Prophylaxis is recommended for most gastrointestinal procedures. The number of organisms and proportion of anaerobic organisms progressively increase along the gastrointestinal tract, so the recommendation depends on the segment of gastrointestinal tract entered during the procedure [19]. The intrinsic risk of infection associated with procedures entering the stomach, duodenum and proximal small bowel is quite low and does not support a routine recommendation for prophylaxis. However, the predominance of clinical practice involves special circumstances that alter this recommendation. Any context associated with decreased gastric acidity is associated with a marked increase in the number of bacteria and the risk of wound infection [19]. Therefore, previous use of antacids, histamine blockers or a proton pump inhibitor qualifies the patient for prophylaxis. Prophylaxis is also indicated for procedures treating upper gastrointestinal bleeding. Stasis also leads to an increase in bacterial counts, so prophylaxis is warranted in procedures to correct obstruction. In addition, the intrinsic risk of infection in patients with morbid obesity and advanced malignancy is sufficiently high to warrant prophylaxis in these cases. Although the local flora is altered in these patients, cefazolin provides adequate prophylaxis and is the recommended agent. Colorectal procedures have a very high intrinsic risk of infection and warrant a strong recommendation for prophylaxis. Antibiotic spectrum should be directed at gram-negative aerobes and anaerobic bacteria.

Since our study was retrospective study, certain parameters like blood glucose level at the time of surgery were not included. Another limitation of our study was that it included SSIs which occurred within the hospital and cases which may have developed SSI after discharge within 30 days were not included as post discharge surveillance of wound infection was not done in our hospital. So a prospective study with post discharge surveillance upto 30 days would yield more information.

Prophylactic antibiotic therapy seems indicated whenever (1) the consequences of wound infection are uniformly disastrous, even though the occurrence of this sepsis is uncommon. (2) the incidence of wound infection is great, yet seldom does it ever threaten life. (3) the patient has such an extreme impairment in host defence mechanisms that any infection, no matter how minor has a propensity for becoming systemic and there by fatal [5]. Incidences of SSI that originate primarily from the care procedures provided during hospitalization, which is about 30% cases, can be avoided if appropriate precautions are taken [4]. A sound antibiotic policy, reduction of length of procedures through adequate training of the staff on proper surgical techniques, proper intra-operative infection control measures and feedback of appropriate data to surgeons regarding SSIs would be desirable to reduce the surgical site infection rate [1, 3, 13]. The benefits to be gained from a preventive antibiotic program includes reduction in both morbidity and mortality. Additional and certainly the other advantages are a conservation of hospital bed space and the potential for great savings in money to be expanded for individual patient care [5].

In most of the western hospitals, a wound surveillance cell is present where the wound infection nurse is the data manager gathering facts from charts and tabulates the wound infection rate according to surgical speciality. The observation period for such surveillance is 30 days. Various solutions have been proposed for improving capture of late wounds infections including telephone calls to patients or mailed follow up questionnaires in such hospitals [21, 22]. In India wound surveillance method is still in infantry stage and such a surveillance system is very much needed in every hospital.

CONCLUSION

Surgical site infection is increasingly recognized as a measure of the quality of patient care by surgeons, infection control practitioners, health planners and public. Although surgical site infections cannot be completely eliminated, a reduction in the infection rate to a minimal level could have significant benefits, by reducing post-operative morbidity and mortality, and wastage of health care resources. A pre-existing medical illness, prolonged operating time, the wound class, and wound contamination strongly predispose to wound infection. Antimicrobial prophylaxis is effective in reducing the incidence of post-operative wound infections for a number of different operative procedures but, timing of administration is critical. The drug should be administered ideally within 30 minutes and certainly within two hours of the time of incision. The judicious use of antibiotic prophylaxis and the use of an organised system of wound surveillance and reporting are the most effective means to reduce the wound infection rate to an attainable minimum [2].

REFERENCES

[1] Mahesh C B, Shivakumar S, Suresh BS, Chidanand SP, Vishwanath Y. A prospective study of surgical site infections in a teaching hospital. *Journal of Clinical and Diagnostic Research* 2010 October; 4:3114-9.

[2] Nandi PL, Rajan SS, Mak KC, Chan SC, So YP. Surgical wound infection. *HKMJ* 1999; 5: 82-6.

[3] Lilani SP, Jangale N, Chowdhary A, Daver GB. Surgical site infection in clean and clean-contaminated cases. *Indian J Med Microbiol* 2005; 23:249-52.

[4] Ercole FF, Starling CEF, Chianca TCM, Carneiro M. Applicability of the National Nosocomial Infections Surveillance System Risk Index for the Prediction of Surgical Site Infections: A Review. *The Brazilian Journal of Infectious Diseases* 2007; 11(1):134-41.

[5] Yohannes Y, Mengesha Y, Tewelde Y. Timing, choice and duration of peri-operative prophylactic antibiotic use in surgery: A teaching hospital based experience from Eritrea, in 2009. *Journal of Eritrean Medical Association* 2009;65-7.

[6] Anvikar AR, Deshmukh AB, Karyakarte RP, Damle AS, Patwardhan NS, Malik AK, *et al* . A one year prospective study of 3,280 surgical wounds. *Indian J Med Microbiol* 1999; 17:129-32.

[7] Ganguly. PS, Khan Y. Malik A. Nosocomial infection and hospital procedures. *Indian J. common Med*.2000; 990-1014.

[8] Krukowski Z H, Stewart M P M, Alsayer H M, Matheson N A. Infection after abdominal surgery: Five year prospective study. *British Medical Journal* 1984; 288:278-80.

[9] Kamat US, Fereirra AMA, Kulkarni MS, Motghare DD. A prospective study of surgical site infections in a teaching hospital in Goa. *Indian J Surg* 2008; 70:120-4.

[10] Garibaldi RA, Cushing D, Lerer T. Risk factors for post-operative infection. *Am J Med* 1991; 91(Suppl 3B):158S-163S.

[11] Tripathy BS, Roy N. Post –operative wound sepsis. *Indian. J sur* 1984; 285-8.

[12] Awan MS, Dhari FJ, Laghari AA, Bilal F, Khaskheli NM. Surgical Site infection in Elective Surgery. *Journal of surgery Pakistan* 2011; 16(1):33-7.

[13] Raka L, Krasniqi A, Hoxha F, Musa R, Mulliqi G, Krasniqi S et al. Surgical site infections in an abdominal surgical ward at Kosovo Teaching Hospital. *J Infect Developing Countries* 2007; 1(3):337-41.

[14] Platon E M, Antolin JAJ, Zubiqaray S, Garcia PB. The effect of surgical antibiotic prophylaxis and the timing of its administration on the risk of surgical wound infection. *Rev Clin Esp*.1995 Oct; 195(10):669-73.

[15] Haley RW, Schaberg DR, Crossley KB, Von Allmen SD, Mac Gowan JE. Extra charges and prolongation of stay attributable to nosocomial infections; a prospective inter hospital comparision. *Am J Med* 1981; 70:51-8.

[16] Classen DC, Evans RS, Pestotnik SL, Horn SD, Menlove RL, Burke JP, *et al*. The timing of prophylactic administration of antibiotics and the risk of surgical-wound infection. *N Engl J Med* 1992; 326: 281-6.

[17] Nichols RL. Surgical antibiotic prophylaxis. *Med Clin North Am* 1995; 79:509-22.

[18] Dellinger EP. Antibiotic prophylaxis in trauma: penetrating abdominal injuries and open fractures. *Rev Infect Dis* 1991;13(Suppl 10): S847-57.

[19] Dellinger EP, Gross PA, Barrett TL, Krause PJ, Martone WJ, McGowan JE Jr, et al. Quality standard for antimicrobial prophylaxis in surgical procedures. *Clin Infect Dis* 1994; 18:422-7.

[20] Humphreys H. Preventing surgical site infection, where now?. *J Hospital infection* 2009; 73: 316-22.

[21] Olson MM, Lee JT. Continuous 10 year wound infection surveillance results, advantages and unanswered questions. *Arch Surg* 1990; 125:794.

[22] Mangram AJ, Horan TC, Pearson MI, Silver LC, Jarvis WR, The Hospital Control Practices Advisory Committee. Guideline for prevention of Surgical Site Infection 1999. *Infection Control and Hospital Epidemiology*. 1999; 20(4): 265-7.

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