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# Prediction of Significant Risk Factors for Surgical Site Infection at a Tertiary Care Center. A descriptive study

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## ABSTRACT

**Introduction:** Surgical site infection (SSI) is key to increased postoperative morbidity and costs. This study aimed to determine the significant risk factors for postoperative surgical site infections and wound healing.

**Methods:** This is an observational study conducted at Bir Hospital and Patan Hospital from March 2012 to January 2013 conducted among 136 patients undergoing open surgical procedures for 30 days post-operatively. Univariate and multivariate analyses were used to determine risk factors for SSI.

**Results:** The incidence of SSI was 14.7%. Superficial infection was found in 10% and deep infection in 20%. Patients' age, sex, time taken for surgery, ASA grade, and underlying disease had no impact on SSI. Multivariate analysis showed serum albumin < 3 gm/dL (p-value< 0.001), body mass index (BMI)> 25kg/m^2 (p-value <0.001), previous surgery (p-value <0.001) and hemoglobin level < 10 gm/dL (p-value 0.002) were a significant risk factor for SSI.

**Conclusion:** In this study, we found that low serum albumin, BMI, previous surgery, and low hemoglobin levels were independently associated with a significant risk of SSI. High levels of suspicion and close monitoring of patients with these risk factors may ensure more optimal patient outcomes.

## INTRODUCTION

Surgical site infections (SSIs) are infections occurring along the surgical tract postoperatively, affecting either superficial or deep tissue layers. They are the most common nosocomial infections among surgical patients, accounting for 38% of cases, and can develop within 30 days of surgery or up to a year if foreign material (e.g., mesh, graft, prosthesis) is implanted.[1] Incisional SSI, comprising 60–80% of cases, generally have a better prognosis than organ/space infections, which account for 93% of SSI-related deaths.[1]

SSI rates vary by procedure: 2% in inguinal hernia repairs, 26% in colectomies, and higher in emergency surgeries.[2,3] SSIs led to prolonged hospitalization, increased costs, and higher morbidity and mortality.[4] Surveillance systems with feedback to surgeons have effectively reduced infection rates.[5] Identifying modifiable risk factors is essential for prevention, and these fall into three categories

I. Bacterial factors,

II. Local wound factors, and

III. Patient factors

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Risk factors include age, diabetes, smoking, steroid use, malnutrition, obesity, distant infections, prolonged hospital stays, and nasal Staphylococcus aureus colonization.[1] The NNIS identifies ASA grade III/IV, contaminated wounds, and longer operative times as key predictors. Other factors include high BMI, emergency surgery, stoma creation, blood loss, glove change frequency, and subcuticular sutures.[6] However, few studies have examined the effect of preoperative nutritional status on SSI risk.[6,7] This study aims to identify significant risk factors for postoperative SSIs and wound healing complications.

## METHOD

A descriptive cross-sectional study was conducted on 136 patients who underwent various types of open general surgeries—both elective and emergency—at the National Academy of Medical Sciences and Patan Hospital, Kathmandu, Nepal, from March 1, 2012, to January 31, 2013. Ethical approval was obtained from the Institutional Review Committee (Reference No: 1284/081/82).

Patients aged 16 years and above admitted to the surgical unit were included through a convenient sampling method. Exclusion criteria comprised patients with pre-existing surgical site infections, those on prolonged antibiotics, individuals with diabetes mellitus, ASA classification ≥3, those receiving steroids or total parenteral nutrition, and patients lost to follow-up. Informed consent was obtained from all participants.

Preoperative data collection involved a structured proforma. Blood samples were collected to measure serum albumin, random blood sugar, and hemoglobin levels. BMI was calculated from weight and height measured at admission. For emergency surgeries conducted at night, serum albumin samples were stored in disposable syringes and sent for analysis the following morning. Albumin levels were determined using an automated analyzer.

All surgeries were performed by senior residents, registrars, or consultants. Prophylactic antibiotics were administered within 30 minutes prior to the skin incision. Postoperative follow-up was conducted for one month, either through outpatient visits or telephone interviews. Patients reporting wound discharge were asked to return to the surgical OPD for evaluation.

Data analysis was performed using IBM SPSS Statistics 21. Categorical variables were analyzed using the chi-square test, with a p-value < 0.05 considered statistically significant.

## RESULTS

In this study, a total of 136 patients who underwent open surgical procedures fulfilling the inclusion criteria in different surgical departments of Bir Hospital and Patan Hospital were studied.

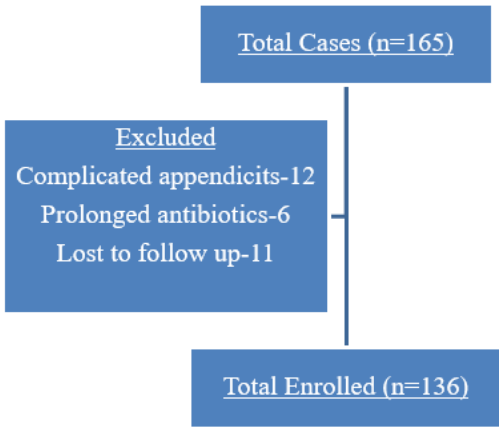



**Fig 1:** Consort chart

Among 165 cases initially, 29 cases were excluded. Among the excluded cases, 12 were cases of complicated Appendicitis with contaminated wounds requiring prolonged antibiotics, 6 cases required prolonged antibiotics depending on intra-operative findings, and 11 cases were lost to follow-up.

Patient demographics

**Table 1:** Demographic profile

| Variables | Number (Percentage) |
|---|---|
| **Age group** | |
| Mean age | 38.12 ±14.23 |
| <20 | 11 (8.1 %) |
| 20-40 | 71 (52.2 %) |
| 40-60 | 44 (32.4 %) |
| >60 | 10 (7.4 %) |
| **Gender** | |
| Male | 56 (41.2 %) |
| Female | 80 (58.8 %) |
| **System wise distribution** | |
| Hepatopancreatobiliary | 62(45.6 %) |
| Gastrointestinal | 41(30.1 %) |
| Urology | 13(9.6 %) |
| CTVS | 5(3.7 %) |
| Others | 15(11.0%) |
| **Elective/Emergency** | |
| Elective | 96 (70.6 %) |
| Emergency | 40 (29.4 %) |

A total of patients aged between 16 and 77 years were included in the study, with a mean age of 38.12 ± 14.23 years. The majority of patients (52.2%) belonged to the 20–40 years age group, followed by 41–60 years (32.4%), under 20 years (8.1%), and over 60 years (7.4%). In terms of gender distribution, 58.8% of the patients were female, while 41.2% were male.When classified according to the surgical system involved, the highest proportion of cases belonged to the Hepatopancreatobiliary (45.6%) and Gastrointestinal (30.1%) systems. The remaining cases involved Urologic (9.6%), Cardiothoracic and Vascular Surgery (CTVS) (3.7%), and other systems (11%). Elective open surgical procedures were performed in 70.6% of the cases, whereas 29.4% of patients underwent emergency open surgeries. (Table 1)

### SSI Incidence and Classification

**Table 2:** SSI incidence and classification

| SSI incidence | |
|---|---|
| Patients with SSI | 20 (14.7 %) |
| Patients without SSI | 116 (85.3 %) |
| **Mean day of presentation** | 7.80±2.14 |
| **SSI Classification** | **Number (Percentage)** |
| Superficial SSI | 18 (90 %) |
| Deep SSI | 2 (10%) |
| Organ space SSI | 0 |

The mean day at presentation of SSI was 7.80 days, earliest being the 4th post-operative day, and the delayed presentation was 13th post-operative day. Superficial SSI and deep SSI were observed in variable numbers. There were no cases of organ space-related SSI. 90% of cases of SSI were superficial SSI, and only 10% were deep SSI. (Table 2)

### Age and gender distribution and SSI

**Table 3:** Age and gender distribution and SSI

| Variables | SSI Number/(Percentage) |
|---|---|
| **Age group** | |
| <20 | 0 |
| 20-40 | 10/71 (7.1 %) |
| 40-60 | 8/44(18.2 %) |
| >60 | 2/10 (20 %) |
| **Gender** | |
| Male | 6/56 (10.71 %) |
| Female | 14/80 (17.5 %) |

No surgical site infections (SSIs) were observed in patients under 20 years of age. Among the age groups, SSIs occurred in 7.1% (10/71) of patients aged 20–40 years, 18.2% (8/44) in those aged 41–60 years, and 20% (2/10) in patients over 60 years. However, age was not found to be a statistically significant risk factor for SSI in this study (p = 0.464). Similarly, sex did not significantly predict SSI risk, with infection rates of 10.7% in males and 17.5% in females, and a p-value of 0.271. (Table 3)

SSI distribution with systems

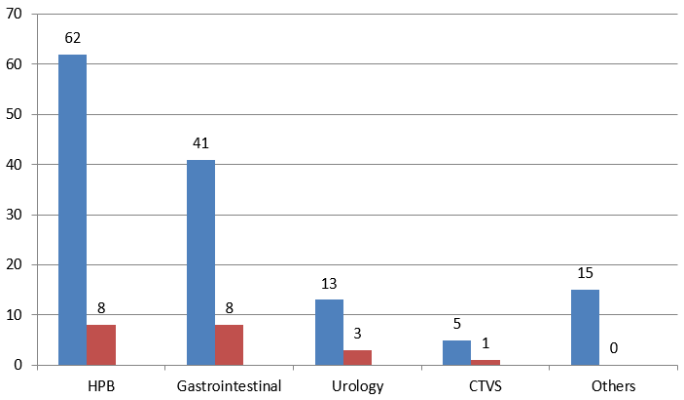



**Fig 2:** SSI distribution with the system ( red column shows SSI cases)

According to the systems, 8/62 (12.9%) SSI was seen in the Hepatopancreatobiliary group, 8/41 (19.5%) in the Gastrointestinal group, 3/13 (23.1%) in the Urology group, and 1/5 (20%) in the CTVS group. (Figure 2)

### SSI and Risk Factors

### Hemoglobin Levels and SSI

**Table 4:** Hemoglobin and Relation with SSI

| Hemoglobin g/L | Number (%) | SSI number (%) |
|---|---|---|
| <10 | 9 (6.6 %) | 5 (55.55 %) |
| 10-13 | 105 (77.2 %) | 13 (12.4 %) |
| >13 | 22 (16.2 %) | 2 (0.09 %) |

Most patients had hemoglobin levels above 10 g/dL. Only 6.6% of the study participants had hemoglobin below 10 g/dL, and none had levels under 8 g/dL. Among the 136 cases, 77.2% had hemoglobin between 10 and 13 g/dL, while 16.2% had levels greater than 13 g/dL. Of the 20 patients who developed surgical site infections (SSIs), a higher incidence was noted in those with low hemoglobin levels. Specifically, 5 out of 9 patients (55.56%) with hemoglobin <10 g/dL developed SSIs, whereas the incidence decreased significantly among patients with normal hemoglobin levels. Only 12.4% of patients with hemoglobin between 10 and 13 g/dL and 0.09%

with levels above 13 g/dL developed SSIs (Graph No. 6). This association was statistically significant, with a p-value of 0.002. (Table 4)

### 5.2 Serum Albumin and SSI

**Table 5:** Serum albumin and relation with SSI

| Serum albumin (mg/dl) | Number (%) | SSI number (%) |
|---|---|---|
| <3.0 | 6 (4.4 %) | 5 (83.3 %) |
| 3.0-3.5 | 43 (31.6 %) | 11(25.6 %) |
| >3.5 | 87 (64 %) | 4 (4.6 %) |

Hypoalbuminemia, defined as a serum albumin level below 3 g/dL, was observed in only 6 patients (4.4%) in this study. Additionally, 43 patients (31.6%) had albumin levels between 3 and 3.5 g/dL, while the majority (64%) had levels above 3.5 g/dL. Serum albumin was identified as a significant risk factor for surgical site infection (SSI), with a p-value less than 0.001. Among the 6 patients with albumin levels below 3 g/dL, 5 (83.33%) developed SSIs. In the group with albumin between 3 and 3.5 g/dL, 11 out of 43 patients (25.6%) developed SSIs, compared to only 4 out of 87 patients (4.6%) with albumin levels above 3.5 g/dL. (Table 5)

### 5.3 Body Mass Index and SSI

**Table 6:** BMI and its relation with SSI

| BMI (kg/m2) | Number (%) | SSI number (%) |
|---|---|---|
| 16-18.4 | 1 (0.74 %) | 0 |
| 18.5-24.9 | 123 (90.44 %) | 11(8.95 %) |
| 25-29.9 | 12 (8.82 %) | 9 (75 %) |
| >30 | 0 | 0 |

There were 123 (90.4%) patients out of the total having normal BMI, which was defined to be in the range of 18.5 to 24.9 kg/m2. BMI <18.5 kg/m² was considered underweight, and > 25 kg/m² was considered overweight. Only 1 (0.7%) case was underweighted, and 12 (8.8%) cases were overweight. Overweight was found to be another significant risk factor in this study. A P-value of less than 0.001 was a significant finding. Out of 12 patients who were overweight, 9 (75%) developed SSI. It was observed only in 11 (8.95%) of those patients who had normal BMI. (Table 6)

### 5.4 Wound type and SSI

**Table 7:** Wound type and its relation with SSI

| Wound type | Number (%) | SSI number (%) |
|---|---|---|
| Clean | 87 (64 %) | 11 (12.64 %) |
| Clean contaminated | 49 (36 %) | 9 (18.36 %) |

Patients were also classified based on the type of surgical wound. 87 out of 136 (64%) patients had clean wounds, and 49 (36%) had clean contaminated wounds. Only clean and clean-contaminated wounds were included in this study. There were 11 SSIs out of 87 clean wound groups (12.64%) and 9 SSIs. Out of 49 (18.36%) in the clean contaminated wound groups. There was an increase in SSI with clean contaminated wounds concerning clean wounds (18.36% vs 12.64%), but this was not statistically significant. The P-value was found to be 0.366.(Table 7)

### 5.5 ASA grade and SSI

**Table 8:** ASI grading with SSI

| ASA Grading | Number (%) | SSI number (%) |
|---|---|---|
| I | 127 (93.4 %) | 17 (13.39 %) |
| II | 9 (6.6 %) | 3 (33.33 %) |

Anesthetic evaluation charts were reviewed. Patients falling under ASA grade I were 127 (93.4%) and 9 (6.6%) under ASA grade II. Those patients who had ASA grade II had some sort of medical co-morbidities, including COPD and HTN. 17 out of 20 (85%) cases with SSI were with ASA grade I, and it was seen in 3/20 (15%) cases with ASA grade II. Amongst the ASA grade I patients, 17/127 (13.39%) developed SSI, whereas, in ASA grade II patients, 3/9(33.33%) cases developed SSI, which was not statistically significant. P-value was 0.103.(Table 8)

### 5.6 Surgery Duration and SSI

**Table 9:** Relation of duration of surgery and SSI

| Duration of surgery (Minutes) | Number (%) | SSI number (%) |
|---|---|---|
| < 60 minutes | 87 (64 %) | 12 (13.79 % ) |
| 60-90 minutes | 37 (27.2 %) | 6 (16.22 %) |
| >90 minutes | 12 (8.8 %) | 2 (16.67 %) |

Of the patients with a surgical duration of <60 minutes, 87 (64 %) and 12 (13.79 %) developed SSI among them. For those with 60-90 minutes, 6 (16.22 %) and with >90 minutes, 2 (16.67 %) developed SSI. However, the duration of surgery in this study as a predictor of risk factors was not significant, with a p-value found

to be 0.922. (Table 9)

**Risk factors and their P-value**

**Table 10** : P-value with risk factors

| Risk factors | p-Value |
|---|---|
| Serum albumin <3 mg/dl | <0.001 |
| BMI >25 kg/m$^2$ | <0.001 |
| Hemoglobin level | 0.002 |

Hence, the significant risk factors for SSI predicted in this study were serum albumin less than 3 gm/dL, body mass index more than 25 kg/m2, and hemoglobin level less than 10 gm% % (Table 10)

## DISCUSSION

This prospective longitudinal study, which included post-discharge surveillance, focused on patients primarily aged 20 to 40 years, with a predominance of females. The overall surgical site infection (SSI) rate observed was 14.7%, significantly higher than rates reported in developed countries such as the United Kingdom (3.1%) and the Netherlands (4.3%), as well as in developing countries like Mexico (9.7%) and Brazil (8.7%). Notably, a high incidence of SSI was found even following clean surgical procedures. Independent risk factors identified for SSI in this study were hypoalbuminemia, elevated body mass index (BMI), and low hemoglobin levels.

Hospital infection control programs are essential components of healthcare quality and utilize SSI surveillance data to evaluate hospital performance. SSIs rank among the second or third most common types of hospital-acquired infections, and the feedback from infection control programs has been associated with improvements in SSI rates.[5,6] Effective SSI surveillance is thus critical, especially in settings like this study's location, where such programs had not been implemented, which is common in many developing countries.

The risk of postoperative SSI is influenced by a combination of patient-specific intrinsic factors and procedural extrinsic factors. The National Nosocomial Infection Surveillance (NNIS) system classifies surgical risk based on ASA grade, wound contamination, and operative duration.[8] Other research, such as by Kaya et al., identified independent risk factors including advanced age, wound contamination, prolonged preoperative hospitalization, high ASA scores, blood transfusions, and coexistent infections.[9]

In contrast, this study found no statistically significant associations between SSI risk and factors such as ASA grade, age, sex, wound type, or operation time, differing from the findings of Fehr et al., who reported ASA classification ≥2, prolonged surgery duration, type of intervention, and dirty wounds as significant risk factors, but no patient-related factors like BMI or anemia.[10]

Hypoalbuminemia, defined as a serum albumin level below 3 g/dL, emerged as a significant predictor of SSI ($p < 0.001$). In this study, 83.33% of patients with hypoalbuminemia developed SSI, compared to lower rates in patients with higher albumin levels. Albumin's role in tissue healing, collagen synthesis, and immune function likely explains this relationship. Hypoalbuminemia impairs macrophage activation and increases wound edema by lowering plasma colloid osmotic pressure, fostering an environment favorable for bacterial growth.[11-15] Preoperative nutritional optimization to correct hypoalbuminemia has been shown to reduce postoperative complications and mortality .[12-14]

BMI was identified as a highly relevant patient-related risk factor, with a BMI over 25 kg/m² significantly associated with SSI ($p = 0.001$). Among overweight patients, 75% developed SSI, predominantly superficial incisional infections. Previous studies have linked increased BMI to altered immune responses, higher visceral fat, metabolic syndrome, and more complex surgical procedures. These factors can reduce adherence to aseptic techniques during surgery, contributing to higher SSI rates.[16-18]

Low hemoglobin level (<10 g/dL) was another significant risk factor for SSI in this study ($p = 0.002$), with over half of the anemic patients developing infections. Preoperative anemia and blood transfusions are known to correlate with poor surgical outcomes, including sepsis and increased postoperative morbidity.[19]

Limitations of this study include its single-center design, relatively small sample size, and lack of evaluation of bacterial etiology and cost analysis. These limitations suggest the need for further multicenter studies with larger cohorts to better elucidate specific SSI risk factors in clean and clean-contaminated surgeries.

## CONCLUSION

Low serum albumin, elevated body mass index (BMI), and decreased hemoglobin levels were independently linked to a significantly increased risk of surgical site infections (SSI). Maintaining a high level of vigilance and closely monitoring patients with these risk factors can lead to better clinical outcomes. While the NNIS index is a widely recognized and straightforward tool, conducting further studies with larger samples and active surveillance data may help uncover additional SSI risk factors.

## REFERENCES


1. Townsend CM, Beauchamp RD, Evers BM, Mattox KL. Sabiston Textbook of Surgery: The Biological Basis of Modern Surgical Practice. 19th ed. Philadelphia: Elsevier Saunders; 2012. p. 234-239. DOI: 10.1016/B978-1-4377-1601-6.00016-3

2. Sánchez-Manuel FJ, Seco-Gil JL. Antibiotic prophylaxis for hernia repair. Cochrane Database of Systematic Reviews. 2003;(2): CD003769. DOI: 10.1002/14651858.CD003769

3. Smith RL, Bohl JK, McElearney ST, Friel CM, Barclay MM, Sawyer RG, et al. Wound infection after elective colorectal resection. Ann Surg. 2004 May;239(5):599-605. DOI: 10.1097/01.sla.0000124292.21605.99 PMID: 15082963 PMCID: PMC1356267

4. Centers for Disease Control and Prevention. National Nosocomial Infections Surveillance (NNIS) report, data summary from October 1986-April 1996, issued May 1996. Am J Infect Control. 1996 Oct;24(5):380-8. DOI: 10.1016/S0196-6553(96)90026-7 PMID: 8902113

5. Haley RW, Culver DH, White JW, Morgan WM, Emori TG, Munn VP, et al. The efficacy of infection surveillance and control programs in preventing nosocomial infections in US hospitals. Am J Epidemiol. 1985 Feb;121(2):182-205. DOI: 10.1093/oxfordjournals.aje.a113990 PMID: 4014115

6. Williams NS, O'Connell PR. Bailey & Love's Short Practice of Surgery. 25th ed. London: Edward Arnold; 2008. p. 245-249. DOI: 10.1201/b13454

7. Sungurtekin H, Sungurtekin U, Balci C, Zencir M, Erdem E. The influence of nutritional status on complications after major intraabdominal surgery. J Am Coll Nutr. 2004 Jun;23(3):227-32. DOI: 10.1080/07315724.2004.10719365 PMID: 15190047

8. Baris PS. Surgical site infections: epidemiology and prevention. Surg Infect. 2002;3(1):9-21. DOI: 10.1089/10962960260496307

9. Kaya E, Yetim I, Dervişoğlu A, Sunbul M, Bek Y. Risk factors for and effect of a one-year surveillance program on surgical site infection at a university hospital in Turkey. Surg Infect (Larchmt). 2006 Dec;7(6):519-26. DOI: 10.1089/sur.2006.7.519 PMID: 17233569

10. Fehr J, Hatz C, Soka I, Kibatala P, Urassa H, Smith T, et al. Risk factors for surgical site infection in a Tanzanian district hospital: a challenge for the traditional National Nosocomial Infections Surveillance system index. Infect Control Hosp Epidemiol. 2006 Dec;27(12):1401-4. DOI: 10.1086/509855 PMID: 17152042

11. Paocharoen V, Mingphreudhi S, Lertsithichai P, Euanorasetr C. Preoperative serum albumin level and postoperative septic complications. Thai J Surg. 2003 Mar 31;24(1):29-32.

12. Hennessey DB, Burke JP, Ni-Dhonochu T, Shields C, Winter DC, Mealy K. Preoperative hypoalbuminemia is an independent risk factor for the development of surgical site infection following gastrointestinal surgery: a multi-institutional study. Ann Surg. 2010 Aug;252(2):325-9. DOI: 10.1097/SLA.0b013e3181e9819a PMID: 20647925

13. Ryan AM, Hearty A, Prichard RS, Cunningham A, Rowley SP, Reynolds JV. Association of hypoalbuminemia on the first postoperative day and complications following esophagectomy. J Gastrointest Surg. 2007 Oct;11(10):1355-60. DOI: 10.1007/s11605-007-0223-y PMID: 17682826

14. Haridas M, Malangoni MA. Predictive factors for surgical site infection in general surgery. Surgery. 2008 Oct;144(4):496-501. DOI: 10.1016/j.surg.2008.06.001 PMID: 18847631

15. Ward MW, Danzi M, Lewin MR, Rennie MJ, Clark CG. The effects of subclinical malnutrition and refeeding on the healing of experimental colonic anastomoses. Br J Surg. 1982 Jun;69(6):308-10. DOI: 10.1002/bjs.1800690604 PMID: 6805546

16. Kurmann A, Vorburger SA, Candinas D, Beldi G. Operation time and body mass index are significant risk factors for surgical site infection in laparoscopic sigmoid resection: a multicenter study. Surg Endosc. 2011 Nov;25(11):3531-4. DOI: 10.1007/s00464-011-1753-7
PMID: 21638185

17. Blumetti J, Luu M, Sarosi G, Hartless K, McFarlin J, Parker B, et al. Surgical site infections after colorectal surgery: do risk factors vary depending on the type of infection considered? Surgery. 2007 Nov;142(5):704-11.
DOI: 10.1016/j.surg.2007.05.012
PMID: 17981191

18. Nystrom PO, Jonstam A, Hojer H, Ling L. Incisional infection after colorectal surgery in obese patients. Acta Chir Scand. 1987 Mar;153(3):225-7.
DOI: 10.3109/00015458709129597

19. Bellantone R, Sites-Serra A, Bossola M, Doglietto GB, Malerba M, Franch G, et al. Transfusion timing and postoperative septic complications after gastric cancer surgery: a retrospective study of 179 consecutive patients. Arch Surg. 1998 Sep;133(9):988-92.
DOI: 10.1001/archsurg.133.9.988
PMID: 9749853