Sung-Won Kim （金成原）1987.10.25,性别 ：男,学校名：北京大学 （Peking university ),学校地址 ：北京市海淀颐和园路5号，Peking University, Beijing 100871, P.R.China专业 ：临床医学（Medicine)

联系方式 ：Tel : +82 10 9378 9611,E-mail : wonni003@gmail.com.

**Analysis of independent risk factors of surgical site infection in neurosurgery and study on infection prediction**

Sung-Won Kim

（Medicine, Peking University, No. 5 Yiheyuan Road, Haidian District, Beijing, 100871, China）

**Abstract:** Surgical site infection (SSI) is a common postoperative complication. Once patients suffer from SSI, negative effects such as prolonged hospitalization time, higher hospitalization expenses, poor prognosis and even death, will develop. At the same time, SSI imposes a heavy burden on the medical system and consumes medical resources seriously. Therefore, effectively monitoring and actively preventing SSI are particularly important.

**Keywords:** Neurosurgery; Independent risk factors ;Analysis;

**1. Current situation of surgical site infection**

Surgical site infection (SSI) refers to infection that occurs at or near the surgical incision site within 30 days after surgery and 1 year after foreign body implantation, such as incision infection, brain abscess and peritonitis. Infection types include superficial surgical incision infection, deep surgical incision infection and organ (lacuna) infection.

SSI is an important nosocomial infection. The report from the World Health Organization shows that the nosocomial infection rate is 3%-21%, of which SSI accounts for 5%-34%. Incidence of SSI ranks the third in nosocomial infections, after respiratory tract and gastrointestinal tract infections. Different countries have slightly different SSI incidences and the proportions of all nosocomial infections that SSI accounts for. For example, in China they are ~15% and ~35%, while in the U.S. they are 14%-16% and 38%. Nosocomial infection control is an important measure for medical institutions to improve medical quality, while SSI prevention is the focus of nosocomial infection control.

Statistics at home and abroad indicate that the overall incidence of SSI among surgical patients is 4%-20%. Among them, the incidence of SSI of type I incision is the lowest, then comes type II. Type III and IV incisions can be exceeding 10%. The incidence of SSI varies greatly in surgical types according to literature reports: higher in craniocerebral operation and abdominal organ surgery, lower in obstetrics and gynecology.

In the United States, SSI occurs in 30.5 million operations every year, which accounts for 2%-5% of the total number of operations and causes a prolonged average hospitalization time (by 7 days) and an increased cost (by 3,000-50,000 US dollars). At the same time, the death rate of patients tripled and the readmission rate increased by 5 times. Broex *et al.* conducted a meta-analysis of literature about SSI published between 2004 and 2008, the results of which showed that compared with non-SSI patients, expenses of SSI patients increased by 34%-226%, and their hospitalization time prolonged by 48%-310%. Some domestic studies also showed that the hospitalization expenses of SSI patients were obviously higher and hospitalization time was longer than those of non-SSI patients. Early studies by British scholars indicated that 77% of surgical deaths were related to SSI. The burden of SSI on the country is considerable as well. The medical expenses provided by the British National Medical Center for SSI reached 1 billion pounds, which did not include indirect losses such as social care. Therefore, it is obvious that SSI not only causes heavy burden to the patients, but also consumes massive social resources.

**2. Etiology and epidemiology of surgical site infection**

The pathogenesis of SSI is based on the invasion of microorganisms to the surgical site. The type of pathogenic bacteria, virulence and immune function of patients are the key factors that determine whether SSI occurs or not. The risk of SSI can be expressed by the formula: SSI risk = bacterial contamination dose × virulence / patient’s immunity. When the microorganism per gram of tissue at the surgical site exceeds 10, the risk of SSI will significantly increase. However, if foreign bodies (such as silk sutures) exist at the surgical site, the amount of microorganism causing infection will be greatly reduced.

Pathogens causing SSI mostly originate from endogenous flora in patients' skin, mucosa or hollow organs. Common pathogens include both Gram-positive bacteria (e.g. *Staphylococcus aureus* and Coagulase-negative *Staphylococcus*) and Gram-negative bacteria (*e.g.* *Escherichia coli* and *Klebsiella pneumoniae*). Studies abroad have found that among SSI pathogens, *Escherichia coli* accounted for 23.9%, Coagulase-negative *Staphylococcus* for 22.8%, *Enterococcus* for 13.15%, and *Staphylococcus aureus* for 11.9%. The dominant pathogens varied from one surgical site to another. A study with large samples showed that *Staphylococcus aureus* and Coagulase-negative *staphylococcus* dominated sites of cardiac surgery, neurosurgery, breast surgery and vascular surgery, while Gram-negative bacteria and anaerobes dominated sites of abdominal surgery and urological surgery because these sites were close to perineum or groin. Investigations reveal that the proportion of SSI caused by fungi is also high, increasing with the incision depth. The detection rate of SSI resistant bacteria was relatively high, too. Common SSI resistant bacteria included *Staphylococcus aureus*, *Enterococcus*, *Escherichia coli* and *Pseudomonas*, among which the detection rate of Methicillin-resistant *Staphylococcus aureus* (MRSA) was as high as 44.9%. SSI resistant strains make the treatment of SSI patients face severe challenges and seriously threaten their lives. As shown in studies abroad, the death rate of SSI patients infected by MRSA was up to 74%. Therefore, there is positive significance for the treatment and recovery of SSI patients to implement active and effective measures to delay the development of drug resistance of SSI pathogens.

**3. Risk factors of surgical site infection**

As the research on SSI moves along, a series of risk factors have been discovered, which can be divided into two categories: patient factors and surgery-related factors.

**3.1 Patient factors**

**3.1.1 Age**

It is generally recognized that children and the elderly are susceptible to infection due to lower immunity. Domestic literature reported that incidence of SSI was relatively high when patients underwent abdominal surgery younger than 15 and older than 60. Studies abroad also supported that. In series of studies by Kaye *et al.*, for patients aged 17-65 years old, the incidence of SSI increased by 1.1% (P = 0.002) for every 1 year of age increase, but decreased by 1.2% (P = 0.008) for every 1 year of age increase for patients undergoing surgery aged >65 years old. However, studies abroad showed that there was no significant difference in the incidence of SSI at the age >70. Therefore, the relationship between age and the SSI incidence requires further research.

**3.1.2 Obesity**

Studies abroad revealed that obesity was another important risk factor. When body mass index (BMI) reached 30 kg/m2 or more, the incidence increased significantly (P = 0.03). Fat in incision of obese patients was prone to liquefy and form dead cavity after operation, which delayed incision healing.

**3.1.3 Malnutrition**

Preoperative malnutrition of patients will lead to poor incision healing after operation, quite easily causing infection. The incidence of SSI can reach as high as 22%-25% when severe malnutrition occurs.

**3.1.4 Preoperative hospitalization time**

Gong *et al.* found that the longer the preoperative hospitalization time, the higher the probability of contact with hospital pathogens, and the higher the incidence of SSI. The incidence was 0.05% when the preoperative hospitalization time was <3 days, while reached 3.08% when the preoperative hospitalization time was >8 days. Another investigation into cases of type I incision infection revealed that the length of preoperative hospitalization time was related to the occurrence of SSI.

**3.2 Surgery-related factors**

**3.2.1 Preoperative skin preparation**

Preoperative skin preparation can reduce the hair and the number of bacteria at the operation site, and reduce the occurrence of postoperative SSI. However, using razor to prepare the skin, compared with other methods e.g. cutting off, will significantly increase the incidence (RR: 2.09, 95% CI: 1.15-3.80). Using depilatory instead, can obviously reduce the occurrence (RR: 1.53, 95% CI: 0.73-3.21).

**3.2.2 Environment of the operation room**

Maintaining a sterile environment of the operating room such as surgical incisions, surgical instruments and surgical personnel can minimize the exposure to microorganisms, which is conductive to reducing the rate of surgical infection.

**3.2.3 Surgical instruments**

Surgical instruments like surgical clothing and sterile towel are in direct contact with the incision of patients. If they are not strictly sterilized, bacterial infection or even SSI may easily occur. The surgical clothing and sterile towel have separation effect, which can reduce the spread of microorganisms carried by the operator to the patient and reduce the chance of infection.

**4. Summary**

SSI is a common postoperative complication and one of the important types of nosocomial infection. To implement effective measures to prevent SSI has always been one of the focuses of nosocomial infection control. Patient factors and surgery-related factors in risk factors of SSI are mostly controllable, adjustment of which can reduce the incidence of SSI.

**References**

1. McGarry SA, Engemann JJ, Schmader K, *et al.* Surgical-site infection due to Staphylococcus aureus among elderly patients: Mortality, duration of hospitalization, and cost [J]. Infect Control Hasp Epidemiol 2004; 25: 461-467.

2. Yasunaga H, Ide H, Imamura T, *et al.* Accuracy of economic studies on surgical site infection [J]. Journal of nosocomial infection 2007; 65: 102-107.

3. Hong JL, Hao YT. Surgical site infections and their related factors [J]. Chinese Journal of Nosocomiology 2010; 20(5): 748-750.

4. Wu AH, Ren N, Wen XM, *et al.* One-day prevalence survey of nosocomial infection in 159 hospitals [J]. Chinese Journal of Infection Control 2005; 4(1): 12-16.

5. Bagnall NW, Vig S, Trivedi P. Surgical-site infection [J]. Surgery 2009; 27: 426-430.

6. Petrosill ON, Drapeau CM, Nicastri E, *et al.* Surgical site infections in Italian Hospitals: A prospective multicenter study [J]. BMC Infect Dis 2008; 8(34): 1-9.

7. Ding J, Zhang ZM, Pan Y, *et al.* Risk factors of surgical wound infection among patients in department of general surgery [J]. Chinese Journal of Nosocomiology 2009; 19(16): 2106-2109.

8. Fiorio M, Marvaso A, Vigano F, *et al.* Incidence of surgical site infections in general surgery in Italy [J]. Infection 2006; 34(6): 310-314.

9. Li JN, Wang NN, Liu FF, *et al.* Surveillance and analysis of risk factors for surgical site infection [J]. Chinese Journal of Nosocomiology 2011; 21(12): 2452-2454.

10. Gong RE, Wu AH, Feng L, *et al.* Targeted surveillance of surgical site infection [J]. Chinese Journal of General Surgery 2008; 17(7): 724-726.

11. Broex EC, van Asselt AD, Bruggeman CA, *et al.* Surgical site infections: How high are the costs? [J]. Journal of nosocomial infection 2009; 72: 193-01.

12. Shi N, Xu W, Shu XQ, *et al.* Direct economic costs of surgical-site infections: A case-control study [J]. Chinese Journal of Nosocomiology 2004; 14(6): 601-603.

13. Qin Y, Sun J. Direct economic cost of surgical site infection of post-thoracotomy incision [J]. Chinese Journal of Infection Control 2009; 8(6): 400-402.

14. Huang WY, Chen HL, Zhu L, *et al.* Economic evaluation of the loss resulted by operative site infection [J]. Journal of Clinical and Experimental Medicine 2010; 9(9): 655-657.

15. Kirkland KB, Briggs JP, Trivette SL, *et al.* The impact of surgical-site infections in the 1990s:
Attributable mortality, excess length of hospitalization, and extra costs [J]. Infect Control Hosp Epidemiol 1999; 20: 725-30.

16. Gaynes RP, Culver DH, Horam TC, *et al.* Surgical site infection (SSI) rates in the United States, 1992-1998: The National Nosocomial Infections Surveillance System basic SSI risk Index [J]. Clinical Infectious Diseases 2001; 33(suppl): 69-77.

17. Xu M, Nie SF, Liu AP, *et al.* Surveillance on surgical site infections in general hospital [J]. Chinese Journal Of Disease Control & Prevention 2005; (9)4: 358-359.

18. Yan B, Li MJ, Xu XP. The distribution and antimicrobial resistance of pathogenic organism in surgical site infection [J]. Acta Academiae Medicinae Jiangxi 2008; 48(3): 49-51.

19. Liu XM, Zhang CS. Drug resistance of pathogenic bacteria causing surgical site infections and intervention countermeasures [J]. Chinese Journal of Nosocomiology 2012; 22(19): 4385-4386.

20. Dohmen PM. Influence of skin flora and preventive measures on surgical site infection during cardiac surgery [J]. Surg Infect (Larchmt) 2006; 7(Suppl 1): S1-S17.

21. Guo ZC, Ye ZM, Huang ZS, *et al.* Risk factors of infection of incisional wound after abdominal operation [J]. Chinese Journal of Nosocomiology 2006; 16(7): 761-762.

22. Yoshida J, Shinohara M, Ishikawa M, *et al.* Surgical site infection in general and thoracic surgery: Surveillance of 2663 cases in a Japanese teaching hospital [J]. Surg Today 2006; 36: 114-118.

23. Kaye KS, Schmit K, Pieper C, *et al.* The effect of increasing age on the risk of surgical site infection [J]. J Infect Dis. 2005; 191: 1056-1062.

24. Minutolo M, Blandino G, Lanteri R, *et al.* Surgical site infection in elderly patients [J]. BMC Geriatrics 2011; 11(Suppl 1): A37.