Risk Factors for Neurosurgical Site Infections After A Neurosurgical Procedur: A Prospective Observational Study at Hospital Kuala Lumpur

S S Buang*, M S Haspani**

*Department of Neurosciences, Universiti Sains Malaysia, 16150 Kubang Kerian, Kelantan, **Department of Neurosurgery, Hospital Kuala Lumpur

SUMMARY

Introduction: Surgical site infection (SSI) after craniotomy even though rare, poses a real risk of surgery and represents a substantial burden of disease for both patients and healthcare services in terms of morbidity, mortality and economic cost. The knowledge of risk factor for surgical site infection after craniotomy will allow the authority to implement specific preventive measures to reduce the infection rate. Therefore, the objectives of this study are to determine the incidence and the risk factors of surgical site infection after craniotomy.

Material and methods: This study highlights an observational prospective study on adult patients who has undergone neurosurgical procedures in Hospital Kuala Lumpur (HKL) over a period of 2 years (June 2007 to June 2009). The neurosurgical procedures are craniectomy, craniotomy, cranioplasty and burrhole. A total of 390 cases fulfilled the requirements of inclusion and exclusion criteria were included in the study. Every patient in the study population was prospectively evaluated for development and risk factors for SSI. The follow-up cases were done by direct observation of the wound during their post-operative stay and ideally up to and including day 30 post-operatively, either as in-patients or through post discharge surveillance i.e. follow-up in the clinic 30 days post-operatively. SSIs were defined according to the Center for Disease Control definitions. Incidence was calculated per patient. Univariate Simple Logistic Regression analysis was used to analyse the association of the risk factors and SSI.

Results: A total of 30 post craniotomy surgical site infections (SSI) has been identified among 390 cases included in the study, resulting in an overall infection rate of 7.7%. This included 19 with superficial wound infection (63.3%), 9 with bone flap osteitis (30%) and 2 with organ/space infection (6.7%). Most of SSIs were detected during in patient cases accounting for 20 cases. The mean time between surgery and the onset of infection was 11.8 ± 21.8 days (median 10 days). The predominantly isolated organism in patients with SSIs were Staphylococcus aureus (11 or 36%) followed by MRSA (4 or 13%), and Acinetobacter spp (3 or 10%). Independent risk factors for SSI were surgeries that were performed by specialist (OR, 76.90 CI, 1.22-39.04.9; P 0.029) and senior medical officer (OR, 8.69 CI, 1.39-54.29.04.9; P 0.021) and surgery that was done for infective causes (OR, 4.44 CI, 1.33-14.81; P 0.015). ASA 2 and clean contaminated wound were independent predictive risk factors for SSI.

Conclusions: Post craniotomy surgical site infection remains an important problem in neurosurgery. Identification of risk factors for SSI should help us to improve patient care, reduce mortality, morbidity and economic burden of health care cost. Post surgical surveillance is important as well to identify the reliable risk factors for SSI.

KEY WORDS:
Surgical site infection (SSI), craniotomy, neurosurgical procedures, wound

Surgical site infections (SSI) has been recognized as one of the important complication of surgery and it is associated with significant morbidity and mortality. The effects to both human and financial costs are high [1]. They result in pain, discomfort, prolonged hospital stay and permanent disability hence increased cost [2]. In 1980, Cruse estimated that an SSI increased a patient's hospital stay by approximately 10 days and cost an additional $2,000[3]. A 1992 analysis by Martone W.J. *et al* showed that each SSI resulted in 7.3 additional postoperative hospital days, adding $3,152 in extra charges[4]. A studies conducted by Vegas (1993) and Albers (1994) also showed deep SSIs involving organs or spaces, as compared to SSIs confined to the incision, are associated with even greater increases in hospital stays and costs [5, 6].

Improvement in operating room ventilation, sterilization methods, barriers, surgical technique, and availability of antimicrobial prophylaxis showed advanced infection control, but complete eradication of infections in post surgical patients seems impossible to achieve. Yet, surgical site infection remains a cause for mortality and morbidity among hospitalized patient. This is partly due to increase emergence of antimicrobial-resistant pathogens and the increased numbers of surgical patients who are elderly and/or have a wide variety of chronic, debilitating, or immunocompromising underlying diseases.

Even though SSI in neurosurgical patient is rare, it has major consequences especially after a craniotomy. Since Hospital

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Corresponding Author: Siti Suriyati Buang, Hospital Universiti Sains Malaysia, Neuroscience, Jln Sultanah Zainab II, Kubang Kerian, Kelantan 16150, Malaysia Email: suriyati8@gmail.com

Kuala Lumpur in center of reference in our country, the knowledge of infection risk and identification of at-risk patients may allow specific preventive methods to be implemented in a unit level and for a particular patient. The indicators of SSI rates are one way of assessing the quality and effectiveness of our hospital care. By knowing the risk and preventive methods we can improve the patient care.

This study had 2 objectives: 1) to study the incidence of surgical site infection after a craniotomy; 2) to identify patients with high risk of SSI after undergoing a neurosurgical procedure.

PATIENTS AND METHODS

The aims of this study were to compare MVVSS outcomes between normal participants and subjects with peripheral vestibular disorder (PVD) and to measure the sensitivity and specificity of MVVSS in identifying PVD.

MATERIALS AND METHODS

This is an observational prospective study on the patients who have undergone neurosurgical procedure at Hospital Kuala Lumpur (HKL) over a period of 2 years (June 2007 to May 2009). The neurosurgical procedures concerned are craniectomy, craniotomy, cranioplasty and burrhole. Based on the inclusion criteria, patients who had undergone neurosurgical procedures were selected and monitored postoperatively for signs of any surgical site infection development.

Patients who were aged 18 years or older and underwent elective or emergency craniotomy and survived at least 7 days after surgery were included in the study. Patients with primary cerebrospinal fluid (CSF) shunt implantations, endoscopic surgery such as third ventriculostomy, patients highly suspicious of central nervous infection prior to the procedure including subdural empyema, cerebral abscess, or infected pathological disease such as Tuberculosis, Toxoplasmosis or Cryptococcal infection, patients with dirty wound and patients who underwent spinal surgery, patients who passed away within 48 hours after the operation, craniotomies performed for wound infection complication and patient underwent re-operation were excluded. The follow-up period was at least 30 postoperative days or until death for patients surviving less than 30 days if patient is still in the ward. For patient who was transferred to other hospitals, it was assumed that patients suffering a wound infection would be referred back to our unit. Patients who have been discharged will be reviewed again in neurosurgical clinic 30 days post-operatively for review whether there is post-operative surgical site infection or not.

Data collection was done using neurosurgical site infection form that is adapted from National Surveillance of Surgical Site Infection following Neurosurgical procedure in Scotland[7]. Data prospectively collected included age, sex, date of hospitalization, the ASA classification of physical status preoperatively, antibiotics prophylaxis and long term used of steroids (more than one week). Pertaining to surgical procedures, the following parameters will be noted: date of surgery, reason for surgery (tumor, vascular surgery, trauma, or functional), elective or emergency surgery, wound classification (clean, clean-contaminated, contaminated, and dirty-infected), length of surgery, intracranial pressure monitoring, type of cranioplasty, implant insertion, type of drain, and number of procedure done. A wound classification system was adapted for neurosurgery [8], as follows: dirty-infected surgery included brain abscess, subdural empyema, and osteitis surgical treatments, when sepsis was already present; contaminated surgery included mainly trauma patients with open compound cranial fractures or scalp lacerations older than 4 hours; clean-contaminated procedures included paranasal sinuses or mastoid entry, repair of cranial base fractures, or aseptic surgical technique breaches; clean surgery represented most of scheduled craniotomies. Duration of prophylactic antibiotics were noted. In the postoperative period, early subsequent operation, and wound infection (type, date, and responsible microorganisms) were noted. Early subsequent operations included emergency craniotomies, usually performed within the first 24 to 48 hours after the main surgical procedure for postoperative hematoma. SSIs were classified according to the guidelines of the Centers for Disease Control [7, 9] and diagnosis made by the surgeon or by attending practitioner of the patient. The classification was made as follows: scalp infection (purulent discharge from incision, a bacteria isolated from a serous drainage, or a clinical diagnosis by the attending neurosurgeon); bone flap osteitis (either a surgical diagnosis of osteitis, or fever with local signs and discharge, and a positive blood culture or a suggestive x-ray); meningitis-ventriculitis (either a Gram stain and/or CSF culture demonstrating a microorganism, or CSF leukocytosis with increased protein concentration and/or decreased glucose concentration, associated with fever and nuchal rigidity, with antibiotic treatment prescribed by the attending clinician); brain abscess and empyema (either a microorganism isolated from brain tissue or subdural space, or a surgical diagnosis of brain abscess, or fever, altered mental status, and/or focal neurological deficit and suggestive computed tomographic scan, with antibiotic treatment prescribed by the clinician). According to the criteria of the Centers for Disease Control, scalp wound infections defined as superficial incisional infection and bone flap osteitis and meningitis and abscess/empyema as organ/space infection [7, 9].

Statistical Analysis

Data were expressed as mean ± standard deviation and median. Contingency tables were used for categorical variables and, after categorization, for continuous variables. All P values were two-sided, and a P value of less than 0.05 was considered significant. Univariate and multivariate analyses were conducted with SPSS 16 software. The objective of the univariate analysis was to determine the risk factors linked to SSI, and then to conduct multivariate analysis. Thus, all variables that were found to be linked to SSI at a 25% level of significance were included in the multivariate analysis, and then the odds ratio and the 95% CIs were calculated.

RESULTS

Population

Over a period of two years from June 2007 until May 2009, a total of 390 cases fulfilled the inclusion criteria hence enrolled into the study, where 144 cases were elective and 246 cases were emergency. Men represented 69.5% of cases and 30.5% were female. The mean age of the patients was 42 years old. Most of the patients were in ASA 1, accounting for 288 cases (or 74%), followed by ASA 2 with 101 cases (or 26%) and only 1 patient with ASA 3. Preoperative antibiotics were administered in all patients.

Surgical procedures

Emergency operations accounted for most cases. There were 246 patients requiring emergency surgeries (63.1%); whereas the balance 144 patients were scheduled elective surgeries (36.9%). From a total of 390 surgeries, most of craniotomies were performed for trauma cases which comprised of 154 cases (40%), tumor 87 cases (22%), functional 82 cases (21%) and vascular cases 63 cases (16%). There were 4 cases that did not record the reason for surgery. Surgery classified as clean was 359 cases (or 92%), contaminated 10 cases (or 2.6%) and clean contaminated 8 cases (or 2.1%); 13 cases (or 3.3%) were not recorded. A total of 317 cases (or 81.3%) lasted more than 4 hours. Based on surgeon's grade, most cases were conducted by the senior medical officer that comprised 33% of all cases. Consultant did 89 cases, specialists 57 cases, and registrars 91 cases. Out of total 390 cases, only 70 cases (or 18%) using foreign body while the rest 320 cases (or 82%) did not. It was observed that the type of drain used after surgery was wound drain that constituted 85%, CSF drain of 9% and 6% of cases did not register any drain type.

Surgical Site Infection (SSI)

Out of 390 patients, 30 patients suffered from surgical site infection with a mean incidence of 7.7%. Scalp incision accounted for 63.3% (or 19 cases) and 30% (or 9 cases) with bone flap osteitis and 6.7% (or 2 cases) with organ/space infection. So, overall incidence of were 4.9% and 2.8% for incisional infection and deep wound infection, respectively. The mean time between surgery and the onset of infection was 11.8± 21.8 days postoperatively (median, 10 d). In actual situation postoperative Day 4 and postoperative day 10 have the highest frequency by 16.7%. It was followed by postoperative Day 7 (10%). Hence, it can be concluded that the length time to detect the surgical site infection was between postoperative Day 4 to Day 11.8. The positive physical finding to fulfill the criteria to determine the surgical site infection is mostly purulent drainage (median=8; mode=9; 30%), followed by redness accounting for 23.3% of the infected cases. Fever and heat was found in 26.6% cases, whereas localized pain and tenderness and localized swelling was found in 20% of infected cases. Most of the surgical site infection was detected during in patient stay (median=1; mode=20; 66.7%).

Table I: Analysis Showing Associated Risk Factors of Surgical Site Infection

Variable	(+)SSI n (%)	(-)SSI n (%)	ba	OR (95% CI)	p-value
Type of Surgery					
Elective	6 (20%)	138 (38.3%)		1	
Emergency	24 (80%)	222 (61.7%)	0.91	2.49	0.052
Reason of Surgery					
Trauma	12 (40%)	142 (39.4%)		1	
Vascular	5 (16.7%)	82 (22.8%)	-0.33	0.72 (0.25,2.12)	0.553
Infective	9 (30%)	73 (20.3%)	0.38	1.46 (0.59,3.62)	0.416
Functional	2 (6.7%)	61 (16.9%)	-0.95	0.39 (0.08,1.79)	0.224
Not Recorded	2 (6.7%)	2 (0.6%)	2.47	11.83 (1.53,91.61)	0.018
ASA Classification					
ASA1	17 (56.7%)	271 (75.3%)		1	
ASA2	13 (43.3%)	88 (24.4%)	0.86	2.35 (1.10,5.04)	0.027
ASA3	0 (0%)	1 (0.3%)	-18.43	0	1.000
Duration of Surgery					
Less than 4 hours	27 (90%	290 (80.6%)		1	
More than 4 hours	3 (10%)	70 (19.4%)	-0.78	0.46 (0.14,1.56)	0.213
Surgeon's Grade					
Consultant	4 (13.3%)	85 (23.6%)		1	
Specialist	5 (16.7%)	52 (14.4%)	0.72	2.04 (0.52,7.95)	0.303
Registrar	6 (20%)	85 (23.6%)	0.41	1.50 (0.41,5.51)	0.541
Senior Medical Officer	15 (50%)	138 (38.3%)	0.84	2.31 (0.74,0.72)	0.148
Type of Wound					
Clean	21 (70%)	338 (93.9%)		1	
Not Recorded	5 (16.7%)	8 (2.2%)	2.31	10.06 (3.03,33.44)	<0.001
Clean Contaminated	2 (6.7%)	6 (1.7%)	1.68	5.37 (1.02,28.21)	0.047
Dirty	2 (6.7%)	8 (2.2%)	1.39	4.02 (0.80,20.15)	0.090
Foreign Body					
No	26 (86.7%)	294 (81.7%)		1	
Yes	4 (13.3%)	66 (18.3%)	-0.38	0.68 (0.23,2.03)	0.495
Type of Drain					
None	24 (80%)	309 (85.8%)		1	
Wound	3 (10%)	32 (8.9%)	-0.71	0.49 (0.14,1.78)	0.280
CSF	3 (10%)	19 (5.3%)	-0.52	0.59 (0.11,3.24)	0.547

a. Simple logistic regression on surgical site infection as dependent variable.

Table II: Summary of Multiple Logistic Regressions on Risk Factors for Surgical Site Infection (SSI)

Variable	SSI(+) n (%)	SSI(-) n (%)	ba	Adjusted OR (95% CI)	p-value
Reason of Surgery					
Trauma	12 (40%)	142 (39.4%)		1	
Vascular	5 (16.7%)	82 (22.8%)	0.44	1.55 (0.32,7.53)	0.588
Infective	9 (30%)	73 (20.3%)	1.49	4.44 (1.33,14.81)	0.015
Functional	2 (6.7%)	61 (16.9%)	-0.32	0.73 (0.13,3.95)	0.727
Not Recorded	2 (6.7%)	2 (0.6%)	3.43	30.82 (3.26,290.71)	0.003
Surgeon's Grade					
Consultant	4 (13.3%)	85 (23.6%)		1	
Specialist	5 (16.7%)	52 (14.4%)	1.93	6.90 (1.22, 39.04)	0.029
Registrar	6 (20%)	85 (23.6%)	0.89	2.42 (0.43,13.67)	0.315
Senior Medical Officer	15 (50%)	138 (38.3%)	2.16	8.69 (1.39,54.29)	0.021
Type of Wound					
Clean	21 (70%)	338 (93.9%)		1	
Not Recorded	5 (16.7%)	8 (2.2%)	3.71	40.97 (8.337, 201.380)	<0.001
Clean Contaminated	2 (6.7%)	6 (1.7%)	1.69	5.43 (0.91, 32.36)	0.063
Dirty	2 (6.7%)	8 (2.2%)	1.69	5.41 (0.93, 31.32)	0.060

a. Multiple Logistic Regressions
Constant: -4.952

Table III: Micro-organisms identified in surgical site infection

Micro-organism	n(%)
Staphylococcus aureus	11(36.0)
MRSA	5(17.0)
Pseudomonas aeruginosa	4(13.0)
Acinetobacter spp.	3(10.0)
Others	2(8.0)
Total	25

Risk factor for surgical site infection (Table I and II)

According to univariate analysis, the significant risk factors for SSI were ASA score greater than 2 and clean contaminated wound. The other factors i.e. type of surgery, reason for surgery, duration of surgery, surgeon's grade, usage of foreign body and type of drain used did not show any significant relationship with SSI.

Forward Likelihood Ration was applied, the multicollinearity and clinically plausible are checked. The model accuracy was checked using Hosmer-Lameshow test (p-value: 0.699) Overall correctly percentage (91.8%) and ROC (87.8%)

Further analysis with multivariate analysis revealed three independent risk factors for SSI i.e. surgery that was done by specialist (OR, 76.90 CI, 1.22-39.04.9; P 0.029) and senior medical officer (OR, 8.69 CI, 1.39-54.29.04.9; P 0.021) and surgery that was done for infective causes (OR, 4.44 CI, 1.33-14.81; P 0.015).

The study showed out of 30 infected wound, 25 cases grew organisms (83%) whereas 5 cases did not grew any organism. Staphylococcus aureus was the main organism responsible for SSIs (11 cases out of 30 or 36%). Five cases grew MRSA (17%) followed by Pseudomonas aeruginosa 4 cases (13%) and Acinetobacter spp. 3 cases (10%). There were 2 cases of other isolated organisms.

DISCUSSION

The development of asepsis on the prevention of bacterial contamination by improvement in operating room ventilation, sterilization methods, barriers, surgical technique has made a significant reduction on postoperative wound infection. After the refinement and production of Alexander Fleming's Penicillium mold extract in 1940s, antibiotic prophylaxis served as a more advanced form of antisepsis with further advancement in infection control [10]. Despite all the efforts in controlling infection in surgery, complete eradication of infections in post surgical patients seems impossible to achieve and surgical site infection remains a cause for mortality and morbidity among postoperative patient regardless of the surgical specialties.

In this study, total of 390 cases of craniotomies that fulfilled the requirements of inclusion and exclusion criteria were recruited. Scheduled surgery accounted for 144 cases while emergency cases accounted for 246 cases. Most of the authors cited in literature reviews reported a large number of cases in their studies [11-13]. However, only a few studies reported a small number of cases [14-17].

From this study, the overall surgical site infection (SSI) rate in 390 patients was 7.7%. This result was similar, but slightly higher than the acceptable range that had been reported in the literature. The incidence of postoperative wound infection that had been documented in literature ranged as low as 1.25% to as high as 17% without prophylactic antibiotics, and 0.3% to 3.0% with prophylactic antibiotics [8, 10-13, 16, 18-33]. The wide variation of infection in different series was mainly due to wide variation of definition of postoperative wound infection. Some studies included all the infective complication within the definition of postoperative infection [16, 18]. Haines considered an infection rate less than 5% as acceptable [20]. Study finding of 7.7% of SSIs was within the range of reported incidence in the literature but slightly higher than the accepted range.

The superficial infection accounted for most of the SSI cases i.e. 63.3%, followed by bone flap osteitis (30%) and organ/space (6.7%). The overall superficial infection rate was 4.8%, close to a study done by R. Patir *et al* [16] but higher than the multicenter study by Korinek et al which was accounted for only 1% of SSIs [11]. For deep wound or organ/space infection, the overall infection rate was 2.9%. almost similar with a study by Korinek *et al*. Korinek *et al* in her study combined scalp infection and bone flap osteitis as incisional infections and gave a total incision infection rate of 1.5% and deep wound infection 2.5% [11]. Another study done by Korinek *et al* in 2006, showed an overall SSIs rate per patient at 6.1%. They reported 331 patients suffered incision infection (5.3%) and 95 meningitis (1.52%) [13]. Bloomstedt in his retrospective study on 1,143 patients showed a total of 8% infection rate [34]. His study also showed the following findings: the frequency of superficial wound infection was 1.9%; postoperative meningitis was 4%; sepsis was 0.4%; and intracranial abscess was 0.5% [34]. This study that was conducted more than 2 decade ago showed similar trend of infection rate. In fact, this indicated measures would be required to improve our infection rates.

Results from the analysis showed that on average, the length of time to detect the surgical site infection from date of surgery was 11.8 ± 22.8 days postoperatively with a mean 11.8 and median 10. Most of SSIs were detected when patients were in-patient (66.7%). This was the time when the patients were still monitored and kept for observation. The wound usually inspected postoperative Day 3. During this time, the wound dressing would be removed for inspection. That explained why the SSI could only be seen after postoperative Day 3. Some of our patients would be kept longer for any other complications such as prolonged ventilations, poor recovery or if there is non-central nervous system postoperative infections. Another way of detecting SSI was when the patients were reviewed in the clinic. If a patient was transferred to another hospital, the medical officer in-charge would refer them back to us if there is signs and symptoms of SSI present. Based on multicenter study done by Korinek *et al*, the mean time between the surgery and the onset of SSI was 18 ±25 days [11]. Another study by Korinek et al showed the mean time between surgery and the onset of meningitis was 14 ± 12 days [13].

The study showed gram positive cocci were the predominant organism isolated from the infected wound accounting for a total of 16 cases out of 30 SSIs. Staphylococcus aureus was the main organism responsible for SSIs (11 cases out of 30 or 36%) followed by MRSA (17%), Pseudomonas aeruginosa (13%) and Acinetobacter spp. (10%). This finding of gram positive cocci as the main organism responsible for SSI was similar to the findings from other series [8, 11, 12, 14, 28, 35-39]. From this study, 5 cases isolated MRSA which was reported as an emerging multi-resistant organism in the literature [11-14, 35-40].

There were varieties of risk factors for SSIs in neurosurgery that had been reported in literature. Balch [41] and Wright [42] identified certain factors for development of SSI. They found that multiple operations, CSF leak, duration of surgery, altered sensorium, age, use of corticosteroid and diabetes were believed to be associated with an increased risk of SSIs. Wright reported altered sensorium and multiple operations increased risk of SSI, but there was no correlation between duration of surgery, age, diabetes and use of corticosteroid with post-operative infection [42]. Balch in his study found that multiple operations and CSF leak increased risk of SSIs [41]. Mollman and Haines showed that cerebrospinal fluid (CSF) leak after surgery and operation in a patient with a concurrent, non-central nervous system infection increased the risk of SSI 6-fold [43]. Mollman and Haines also reported that there was no association between duration of surgery and infection risk [43]. Bloomstedt et al in his retrospective study also found that postoperative CSF leak to be the only highly significant risk factor for SSI [34]. Korinek et al in a large multicenter study reported that the presence of a CSF leak and subsequent operation were independent risk factors, while emergency surgery, clean contaminated and dirty surgery, an operative time more than 4 hours, and recent neurosurgery were independent predictive risk factors for SSIs. Our study showed ASA 2 and clean contaminated wound were significant risk factors for development of SSIs. This findings were similar with findings in a study by Kourbeti *et al* [17] and other study that was done by Korinek *et al* [11]. Narotam in his study had proposed a method of classifying surgical wound into dirty, contaminated, clean contaminated and clean with the predictive risk for development of SSIs. For clean contaminated wound, the predictive risk for development of SSI ranged 6-9% [8]. Multivariate analysis to isolate independent risk factors showed the surgeon's who performed the surgery and surgery for infective cases also play a role as risk factor for SSI. Surgeries that were done by specialist and senior medical officer and infective cases posed high OR. So, from this study we can see that surgeon grade is related to surgical experience and technique that directly related to SSI. The other factors that have been studied i.e. emergency surgery, reason for surgery, duration of surgery, presence of foreign body, surgeon's grade and type of drain did not show any significant association with development of SSIs. In terms of duration of surgery, this study agreed with the findings by Wright [42] and Mollman and Haines [43]. There had been other studies that showed longer duration of surgery increased the incidence of SSIs [11-13, 44]. Other factors of SSI i.e. patient's pre-morbid status, CSF leak, post-operative intracranial pressure monitoring or ventricular drain were not studied. The use of corticosteroid and prophylaxis antibiotic were not studied because the data that was collected showed almost 99% of cases received corticosteroid for less than one week and prophylaxis antibiotic prior to surgery.

CONCLUSION

Post craniotomy surgical site infection remains an important problem in neurosurgery. Identification of risk factors for SSI will help us to improve patient care, reduce mortality, morbidity and economic burden of health care cost. Post surgical surveillance is important to identify the reliable risk factors for SSI. In Hospital Kuala Lumpur, the incidence of surgical site infection was found to be 7.7%. Independent risk factors for SSI were surgeries that were performed by specialist and senior medical officer and surgery for infective cases. ASA 2 and clean contaminated wound were independent predictive risk factors.

LIMITATION OF THE STUDY

There were some limitations doing this prospective study. The main limitation was small sample size as compared with other studies. There is difficulty in monitoring the surgical site infection especially when the patient has been discharged home or transferred to other hospital. The detection of SSI in these patients depending on whether the patient knows presence of SSI or the respective doctors in others hospital review the patient's wound and this will delay the diagnosis.

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