RESEARCH ARTICLE

Risk Factors for Wound Infectious Complications in Orthopedic Surgery Ward: A Case-control Study of Iran

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Introduction:

Surgical wound infections are a common cause of nosocomial infection. The United States Centers for Disease Control and Prevention (CDC) has developed criteria that define Surgical Site Infection (SSI) as infection related to an operative procedure that occurs at or near the surgical incision within 30 days of the procedure, or within 90 days if prosthetic material is implanted at surgery (Horan *et al.*, 1992). SSIs are often localized to the incision site but can also extend into deeper adjacent structures. However, the overall risk of SSI is low; it is estimated that SSIs develop in 2 to 5 percent while monitored in 30 million patients undergoing surgical procedures each year (Lewis *et al.*, 2013; Owens *et al.*, 2014).

The SSI rates in ambulatory surgical settings are relatively low; one study noted overall rates for 14 and 30 days were 3.1 and 4.8 per 1000 procedures (Boyce *et al.*, 1990) where antimicrobial prophylaxis and adjunctive measures for prevention of surgical site infection were discussed separately. Surgical site infections (SSIs) are associated with substantial morbidity/mortality, prolonged hospital stay, and increased cost (Poulsen *et al.*, 1994; Vegas *et al.*, 1993; Whitehouse *et al.*, 2002). Among

Abstract

Wound infections are among the most common reasons why people seek medical advice. In a case-control study, we compared 37 patients with postoperative wound infection in orthopedic-surgical site with 37 persons without infection. During the study we reviewed medical records of the patients who had orthopedic surgery, and collected data regarding the complete treatment and follow up process after discharge, mainly focusing on possible risk factors in the onset of SSIs (surgical site infection). We found the risk of SSI, pre and posterior surgical approach were independently associated with a higher risk of infections. The significant differences were seen between hospitalization period and SSI, hematoma at the site of surgery and types of surgeries done besides orthopedics. The finding showed that prevalence of SSI was 8.8% and it is influenced by the demographic characteristic of patients, injury characteristics, compliance with care protocols before, during and after surgery, factors related to hospitals and staff and types of wound and surgeries.

patients with SSI who died in the post-operative periods, deaths were seen to be directly related to SSI in more than 75% of cases. In one paired case-control study of SSI following orthopedic procedures, the occurrence of SSI accounted for a median increase in a hospital stay of 14 days, an increase in the rate of re-hospitalization was just double, and increased total costs of more than 300% (Perencevich *et al.*, 2003).

Wound infection which is defined as the infection of a wound caused by physical injury of the skin as a result of penetrating trauma from plants, animals, guns, knives or other objects is increasingly becoming a global concern with an increasing awareness of its cost burden (Horan *et al.*, 1992; Lewis *et al.* 2013). Wound infections are among the most common reasons why people seek medical advice and in more serious acute infections, may require hospitalization. These infections account for around 7% - 10% of hospitalized patients in the United States (Owens *et al.*, 2014). Wound infection related to surgical wounds are considered to be one of the most common nosocomial infections and are generally a high cause of morbidity and mortality (Lewis *et al.* 2013; Owens *et al.*, 2014; Boyce *et al.*, 1990; Poulsen *et al.*, 1994 & Vegas *et al.*, 1993).

A wide range of factors have been evidenced to

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influence wound infection. Some of such factors include pre-existing illness, wound class, wound contamination, age factor, malignancy, metabolic diseases, malnutrition, immunosuppression, cigarette smoking, remote site infection, length of surgical operation, emergency procedures and long duration of pre and postoperative hospitalization amongst others (Poulsen *et al.*, 1994; Vegas *et al.*, 1993; Whitehouse *et al.*, 2002 & Perencevich *et al.*, 2003). To reduce these complications, it is important to establish the risk factors that increase the chances of the incidence using multivariate analysis. Though the issue has already been addressed for orthopedic wound surgery (Owens *et al.*, 2014), but it has not been well studied for orthopedic wound surgery. However, the efficiency of antibiotic prophylaxis for reducing postoperative infectious complications has been demonstrated in the previous prospective, randomized studies (Vegas *et al.*, 1993; Whitehouse *et al.*, 2002 & Perencevich *et al.*, 2003), controversy still exists about which specific antibiotic agent to use (Lewis *et al.*, 2013). As per the current status, no studies yet consider postoperative global infectious complications including orthopedic infectious complications. The risk factors for SSI and for global infectious complications may differ. Our study estimated the risk factors for SSI and for global infectious complications in orthopedic surgery ward (in patients who received antibiotic prophylaxis). Identification of risk factors in the perioperative period may allow for a reduction in the rate of postoperative infectious complications.

Methodology:

This study was conducted in orthopedic surgery ward of a hospital affiliated to Jahrom University of Medical Sciences during 2010 March to 2011 March.

For the study, 50 patients were considered in each group. Inclusion criteria were Iranian nationality, having normal BMI, going through orthopedics surgery and not having other surgeries in past 6 months before initiation of our study. Exclusion criteria were not having compliance of the patients, not having access to patient medical record and death after surgery, need to intensive care pre or post operation.

Post-operative infection is defined as an infection occurring within 1 month after operation and infection of wound accompanying discharge (abnormal volume, color, and odor) and positive culture of the wound. At first, sampling method was done following the purpose of the study. The researcher filled out the questionnaire related to demographic variables in orthopedics surgery ward and then inclusion and exclusion criteria were given to nurses of the mentioned wards and the questionnaires were finally completed and collected. The face and content validity of the tool was obtained with the help of 10 faculty members at the university (IS: .89, CVI: .93, CVR: .85) and

the reliability was calculated using the test-retest method ($\alpha=.83$).

Both case and control groups were matched concerning age, gender, season of their admission and referred to the hospital, type of fracture, site of fracture and type of antibiotics administered. Total 13 patients were excluded finally, 3 patients due to incomplete medical documents, 3 of them were dead and 7 were not interested to participate in the study. Finally, assessment of possible causes of post-operative infection was done on 2 groups (case group: 37 Orthopedic patients suffered from SSI and control group: 37 Orthopedic patients without SSI). These 3 categories of cause of infection were mentioned as below:

- i) Cause related to patients' personal data (age, gender, occupation, accommodation place and previous infection).
- ii) Cause related to the trauma (type and site of fracture, hematoma, time of trauma, type of accident and trauma, size of fracture and wound)
- iii) Cause related to the hospital's management issues (preparation method before operating, ward in which patients admitted to it, type of palatine, time taken for transferring patient to the surgery ward, duration of hospitalization, frequency of changing dressing and antibiotic administration method).

Required documents were completed by interviewing with patients and some of the required remaining data were taken from the medical records of the patients. Data were analyzed through SPSS v 16 and 'k' square test (risk factors in groups), Mann-Whitney 'u' test, and 't' student (differences of the 2 group) were used.

Results:

In this study, a comparison between a group of 37 patients from orthopedic surgery ward and postoperative wound infection and 37 patients which were considered as the control group were selected from those who admitted in orthopedics ward having no postoperative wound infection. Obtained results are as follows:

a) Risk factors related to causes of trauma: results of the study showed significant difference in the case and control groups regarding hematoma ($p<0.05$). Total 81.1% of the case group and 97.3% of the control group had the hematoma. No statistically significant difference was found between 2 groups regarding bleeding amount and injury occurrence severity. About 78.4 % of the case group and 76.5% of the control group reported bleeding. It was demonstrated that most of the injuries occurred in both groups were considered as moderate and severe. Total 13.5% of the injuries of the case group were considered as necessary and 2.7% were life-threatening. Hematoma in wound decrease 88% Bleeding chance in patients (OR 0.119) (table 1).

b) Risk factors related to the patients: results of the

RESEARCH ARTICLE

study showed statistically no significant difference between both the groups concerning addiction, fracture and blood product transfusion ($p > 0.05$).

Total 75.5% of the case group and 86.5% of the control group used opium, whereas 89.2% of the case group and 91.2% of the control group were addicted. Further, 97.3% of the case group and 94.6% of the control group had a fracture. About 64.9% of the case group and 83.8% of the control group had blood product transfusion. (Table 2).

Complete 100% of the patients in both groups had a previous postoperative infection, urinary and fecal incontinence, urinary tract infection, respiratory tract infection and septicemia. In the case group, 56.8% of the patients used hoichi and 43.2% used packed cell. In the control group, 83.8% of the patients used hoichi and 16.2% used packed cell. Fractures increased the risk of bleeding double (OR 2.057).

Table-1: Significant Level of Risk Factor in Wound Infection

Risk Factors	Group		OR		p
	Infected N	Non-Infected %	Infected N	Non-Infected %	
Hematoma					
Positive	30	81.1	36	97.3	0.119 (0.014- < 0.025
Negative	7	18.9	1	2.7	1.23)
Bleeding					
Positive	29	78.4	32	86.5	0.566 (0.166 < 0.359
Negative	8	21.6	5	13.5	1.92)
The damage to the Body					
Mild	15	40.5	15	40.5	0.744 (0.482 < 0.112
Moderate	12	32.4	14	37.8	-1.147)
Sever	4	10.8	8	21.6	
Serious	1	2.7	0	0.0	
Critical	5	13.5	0	0.0	
Deadly	0	0.0	0	0.0	

Table-2: Risk Factors in Wound Infection

Risk Factors	Group		OR		p
	Infected N	Non-Infected %	Infected N	Non-Infected %	
Smoking					
Positive	28	75.7	32	86.5	0.486 (0.146 < 0.235
Negative	9	24.3	5	13.5	-1.62)
Addiction					
Positive	33	89.2	34	91.9	0.728 (0.151 < 0.691
Negative	4	10.8	3	8.1	-3.505)
Fractures					
Positive	36	97.3	35	94.6	2.057 (0.178 < 0.556
Negative	1	2.7	2	5.4	-23.72)
Blood Transfusions					
Positive	24	64.9	31	83.8	0.357 (0.118 < 0.062
Negative	13	35.1	6	16.2	1.078)

In the case group, WBC count before the operation was 10.41 ± 2.75 and 9.75 ± 3.45 was after the operation. In the control group, WBC count was 8.51 ± 3.08 before the operation and 8.19 ± 2.63 after the operation. It revealed a

statistically significant difference in WBC count before and after operation between the 2 groups (table-3).

Table-3: Risk Factors of Surgical Site Infection

Group	N	Mean	Std. Dev.	t	p-value
The last WBC Test of Injured before surgery					
Infected	28	10.3321	2.73781	2.379	0.021
Non-Infected	30	8.5067	3.07974		
The last WBC Test of Injured after surgery					
Infected	28	9.7893	3.45429	2.012	0.049
Non-Infected	31	8.1903	2.63000		

c) Risk factor related to the hospital: the results reveal that, in the case group accompanying person 86.5% and personnel 13.5% whereas in the control group, accompanying person 83.8% and personnel 13.5% and the patient 2.7% were having risk factors of infection. The education level of the shaver, in the case group, was 51.4% below diploma and 29.6% diploma. Total 92.2% of the case group were admitted to the emergency, surgery and ICU wards (table 4).

Table-4: Risk Factors of Orthopedics Wound Infection

Parameters	Group			
	Infected N	Non-Infected %	Non-Infected N	Infected %
One who is shaved				
Patient	0	0.0%	1	2.7%
Even with patient	32	86.5%	31	83.8%
Hospital Staff	5	13.5%	5	13.5%
Education of One who is shaved				
Uneducated	5	13.5%	4	11.1%
Below-diploma	19	51.4%	17	47.2%
Diploma	11	29.7%	12	33.3%
Bachelor	0	0.0%	2	5.6%
Master	2	5.4%	1	2.8%
Shift the way				
Morning	26	70.3%	24	64.9%
Evening	8	21.6%	11	29.7%
Night	3	8.1%	2	5.4%
Wards before surgery				
Emergency	12	32.4%	21	56.8%
Surgery	16	43.2%	4	10.8%
ICU	7	18.9%	8	21.6%
CCU	0	0.0%	3	8.1%
Internal ward	2	5.4%	1	2.7%

There is a statistically significant difference between 2 groups concerning the duration of time before the operation, but no significant difference between 2 groups concerning the duration of time after the operation has been revealed. However, there is a statistically significant difference exist between 2 groups concerning dosage of antibiotic before the operation. Similarly, there is also a statistically significant difference reveal between 2 groups concerning dosage of antibiotic after operation (table 5).

Table-5: Significant Level of Surgical Site Infection Risk Factors

Group	N	Mean±SD	Mann-Whitney	p
Duration of hospitalization before surgery				
Infected	37	2± 1	415.50	> 0.001
Non-Infected	37	1± 0		
Duration of hospitalization after surgery				
Infected	37	8± 7	567.5	> 0.200
Non-Infected	37	5± 3		
Dosage of Antibiotics before surgery				
Infected	37	6± 7	589.0	> 0.286
Non-Infected	37	5± 6		
Dosage of Antibiotics after surgery				
Infected	37	23± 22	488.0	> 0.032
Non-Infected	37	15± 12		

Invasive action in the case group was mentioned as 37.5% suction and 62.5% intubation. There was a statistically significant difference between 2 groups regarding duration of hospitalization, type of operation, duration of surgery (table 6).

Table-6: Risk Factors of Wound Infections

Group	N	Mean± SD	Mann-Whitney	p
A few hours before the procedure is performed Shaved				
Infected	37	7± 11	593.50	< 0.321
Non-Infected	37	13± 19		
Case after how many days/hours after admitted to hospital and.				
Infected	37	3± 2	555.5	< 0.153
Non-Infected	37	3± 2		
The patient was discharged a few days after surgery and				
Infected	37	8± 8	478.5	< 0.021
Non-Infected	37	4± 3		
In total, the patient was hospitalized for several days and				
Infected	37	11± 8	552.0	< 0.150
Non-Infected	37	7± 3		
How much duration in hours the surgery took and				
Infected	37	100± 50	439.5	< 0.006
Non-Infected	37	71± 25		
The number of operations carried out in the same shift in the operating room and				
Infected	37	11± 6	626.0	< 0.523
Non-Infected	37	12± 22		
The type of operation carried out in the same shift in the operating room, except for orthopedic surgery and....				
Infected	37	4± 3	372.0	< 0.001
Non-Infected	37	2± 2		
The patient had several operations on that day and....				
Infected	37	3± 2	389.5	< 0.001
Non-Infected	37	5± 3		
The average operating room personnel shifts in the same month				
Infected	37	211± 2	684.5	< 1.0
Non-Infected	37	211± 2		

There is statistically no significant difference regarding the frequency of changing dressing before the operation has been evidenced. On the other hand, a statistically significant difference was shown in the frequency of changing dressing after the operation. In the case group, total 91.9% and 59.5% in the control group, changing dressing at home was required (table 7).

Table-7: Nursing and Changing Dressing before operation

Risk Factors	Group		OR		p
	Infected	Non-Infected	(CI 95%)		
	N	%	N	%	
Frequency of dressing change on the day before surgery					
0	21	56.8	19	51.4	1.0
1	14	37.8	17	45.9	(0.014-1.23)
2	1	2.7	1	2.7	
3	1	2.7	0	0.0	
Frequency of dressing change after surgery a day					
0	0	0.0	1	2.7	-
1	29	78.4	36	97.3	< 0.008
2	8	21.6	0	0.0	

Discussion:

Surgical site infections are one of the most common nosocomial infections besides other systemic infections (Al-Mulhim *et al.*, 2014). According to the first national prevalence study of nosocomial infections, surgical site infections were the most prevalent infections and is one of the highest prevalence rates of nosocomial infections in the orthopedic wards (Al-Mulhim *et al.*, 2014). Maksimovic, *et al.* (2008) in their study revealed that a high incidence of surgical site infections in orthopedic patients and established risk factors related to surgical site infection. Smoking didn't reveal any significant difference in the above-mentioned study which is in agreement with our finding.

Further, open reduction fracture and hours between shaving and operation were seen as another factor which influences SSI. These factors were also considered in our study but no statistically significant differences were seen. Numbers of staff in the operating room and presence of drains were the other parameters evaluated in the mentioned study that they affected SSI significantly (Maksimovic *et al.*, 2008). In our study dosage of antibiotics before surgery did not reveal any statistically significant difference. Although Bratzler & Houck (2005) in their study established that dosage and duration of antibiotics before the surgery is effective.

Ercole *et al.* (2011) evaluated the SSI infection with evaluated risk factors and showed no significant difference between preoperative hospitalization time and SSI but got a significant difference between the duration of operation and SSI. On the other hand, according to a study by Ercole *et al.* (2011) duration of surgery and SSI are directly connected. Our results strengthened the above findings. Elongation of surgery might decrease infection and might increase fatigue of staff and which perhaps increase SSI. Statistically significant difference between hospitalization period and SSI somehow indicating the same.

Further, some other parameters were given interesting results in our study. Hematoma at the site of surgery and types of surgeries done besides orthopedics

RESEARCH ARTICLE

simultaneously and waiting times spent were effective. Hojat *et al.* (2013) in their study determined the risk factors of SSI in orthopedics wards and the results of their study strengthened our findings and they revealed that duration of hospitalization and existence of hematoma significantly affect SSI.

The finding showed that prevalence of SSI was 8.8% and it is influenced by the demographic characteristic of patients, injury characteristics, compliance with care protocols before, during and after surgery, factors related to hospitals and staff and types of wound and surgeries. These controversies in the results might be due to variation in operation rooms in developed and developing countries and personal differences. Thus, further studies are also required to support our findings and to evaluate the risk factors more precisely. Although the incidence of postoperative infection depends on the incidence of uncontrollable factors such as patient demographics, risk factors, and injury characteristics but compliance with care protocols before, during and after surgery, helps to prevent the incidence of even worst possible cases of infection.

Some more studies are required to support our findings and to consider other parameters such as usage of drains and numbers of staff.

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