The Effect of Traffic Patterns in the OR on Surgical Site Infections

Individuals are at risk of developing a number of postoperative complications after surgical intervention. Surgical site infections (SSIs), previously referred to in the literature as surgical wound infections (SWIs), are among the most serious adverse events that may result from surgical procedures. In addition to increasing the morbidity and mortality among the surgical patient population, SSIs result in extended hospitalization and more than $1 billion annually in excess medical costs.[1] Researchers reported that the average SSI prolongs a patient's hospital stay by 7.3 days and amounts in costs of approximately $3,152.[2] Other researchers indicated that these estimates are underrepresented because most SSIs occur after discharge and are associated with considerable resource use.[3]

Surgical site infections are among the four major types of hospital-acquired or nosocomial infections. Generally, infections that are not present (ie, clinically evident) nor incubating at the time of admission to an inpatient health care facility are classified as nosocomial infections. In contrast, community-acquired infections are those infections that are present or incubating at the time of hospital admission. In addition to SSIs, the Centers for Disease Control and Prevention's (CDC) national surveillance program continuously has monitored other leading nosocomial infections, including urinary tract infections, pneumonias, and bloodstream infections.

In 1992, the Surgical Wound Infection Task Force, composed of individuals representing the Society for Hospital Epidemiology of America (SHEA), the Association of Professionals in Infection Control and Epidemiology (APIC), the Surgical Infection Society (SIS), and the CDC, modified the definitions of SSIs and divided these into

- superficial incisional SSI,
- deep incisional SSI, and
- organ/space SSI.[4]

Using these revised SSI definitions, in 1995, the National Nosocomial Infections Surveillance (NNIS) System described the distribution of nosocomial infections among surgical patients by infection site for different types of surgical procedures.[5] The NNIS reported that the surgical site was the most common site of nosocomial infections in these patients.

Traditionally, ORs have welcomed observational experiences, particularly in large, academic medical centers. Consequently, at any given time during a surgical procedure, the number of people in the OR can become quite large—perhaps unnecessarily so—increasing the microbial burden. AORN always has recognized that microbial contamination of the surgical site is a

ABSTRACT

Perioperative nurses are situated uniquely to promote good traffic control practices in the OR. This study was conducted to explore the effect of traffic patterns, specifically the number of people in the OR, on the incidence of surgical site infections (SSIs). Researchers analyzed 2,864 clean surgical procedures performed in 1995 in an academic medical center. Duration of surgery and American Society of Anesthesiologists' physical assessment score were statistically significant risk factors for SSIs. A rising trend in SSIs was observed as the number of people in the OR increased; however, it was not statistically significant. Risk factors for SSIs must be better understood to develop more effective prevention programs. *AORN J* 68 (Oct 1998) 649-660.

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critical factor in the development of SSIs and has established standards and recommended practices designed to reduce the occurrence of such an event. With regard to traffic patterns in the perioperative practice setting, AORN recommendations include restrictions on excessive conversations and the number of people present during surgical procedures. The literature, however, reveals a lack of conclusive evidence to support restricting the number of people in the OR during surgery.

THE PROBLEM

The role of the perioperative nurse, as the facilitator of a safe OR environment, encompasses implementing nursing interventions that minimize the incidence of SSIs and other preventable postoperative complications. The controversial findings regarding the mode of transmission of microorganisms causing SSIs and the influence of the OR environment on such infections continue to be topics of ongoing debate. The lack of conclusive evidence has led some researchers to believe that environmental contamination as a source of wound infection has received unwarranted notoriety. Other researchers believe that the OR environment, including the people involved in a surgical procedure and the existing traffic patterns, is a major source of contamination that increases with both movement and talking.[6]

AORN's "Recommended practices for traffic patterns in the surgical suite," is designed to reduce the amount of airborne contamination during surgery. Specifically, AORN recommends that movement of staff members should be kept to a minimum while a surgical procedure is in progress.[7] This includes minimizing the number of people in the OR, movement, and talking during surgery and maintaining that OR doors be closed except during movement of staff members or equipment. AORN provides the following rationales for these guidelines.[8]

- Greater amounts of airborne contamination can be expected with increased movement.
- The mixing of OR air with corridor air increases the bacterial count in the room.
- Shedding increases with activity.

In addition to AORN recommendations, the Joint Commission on Accreditation of Healthcare Organizations' (JCAHO) *Accreditation Manual for Hospitals* and the CDC's guidelines for infection control emphasize the importance of traffic patterns in the surgical suite and limiting the number of personnel involved in the procedure.[9] The CDC guidelines state that airborne contamination decreases with increased ventilation that dilutes contaminated air with relatively clean filtered or outdoor air and with decreased numbers and activity of personnel.[10]

In accordance with AORN recommendations and CDC guidelines, this research project was based on the assumption that the OR environment is a major source of potential contamination that may result in postoperative SSI. Identifying risk factors that contribute to SSIs will allow surgical team members to implement specific prevention activities that result in improved patient and financial outcomes. The results of this study will provide research-based information for writing policies and guidelines for traffic control practices in the OR. Therefore, this study is vital to establish which perioperative nursing practices require modification to reduce the procedure-specific risk factors for SSIs.

PURPOSE

The purpose of this study was to explore the relationship between the number of people in the OR during surgery and the subsequent incidence of SSIs. Additionally, this study examined the effect of other variables such as age, sex, American Society of Anesthesiologists' (ASA) physical assessment score, length of preoperative stay, duration of surgery, and timely antibiotic prophylaxis on SSIs.

LITERATURE REVIEW

One researcher summarized the prevention and treatment of SSIs and described significant advances that were made in the area of surgical infections since the mid-1960s.[11] From the late 1950s, investigations focused on the number and nature of the microorganisms contaminating the wound. These studies led to the discovery that both aerobic and anaerobic endogenous bacteria frequently were the sources of surgical infections. Studies published in the late 1970s and early 1980s on the nature of human microbial flora in health and disease states led to major advancements in the use of prophylactic and therapeutic antibiotics in surgical patients. From the mid-1980s to the mid-1990s, the focus shifted to procedure-specific patient risk factors that influence the development of SSIs. Most recently, the emphasis has been placed on identifying host-related factors in high-risk surgical patients.

Antibiotic prophylaxis. The practice of administering prophylactic antibiotics before a surgical procedure has continued to evolve for the past 30 years. Researchers conducting some of the first studies in the late 1950s and early 1960s suggested that the efficacy of antibiotic prophylaxis was dependent on the timing of administration.[12] For clinicians, the timing of initial antibiotic administration, the agent of choice, and the duration of prophylaxis have continued to be controversial issues. In 1992, one researcher conducted an investigation on the timing of prophylactic administration of antibiotics and the risk of SWIs and prospectively monitored the timing of perioperative antibiotic administration in 2,847 patients undergoing elective clean or clean-contaminated surgical procedures at a large community hospital. This researcher found that, although there was considerable variation in the timing of administration of prophylactic antibiotics, antibiotics administered two hours preoperatively reduced the risk of wound infection. These findings suggest that the timely use of preoperative prophylactic antibiotics influence the incidence of postoperative wound infections.[13] In a prospective study using direct observation, another researcher demonstrated a favorable effect on SSI rates for lengthy surgery (ie, greater than four hours) when perioperative antimicrobial concentrations were maintained until wound closure.[14]

Despite research evidence and professional guidelines supporting timely administration of antibiotics preoperatively, some researchers have found that in clinical practice this is not always the case. For example, researchers from the New York State Peer Review Organization conducted a retrospective medical record review of 2,651 surgical patients to determine the proportion of patients who had documentation of receiving antibiotics and those who received preoperative antibiotics within two hours of the initial incision.[15] They found that antibiotic prophylaxis was performed in 81% to 94% of the cases; however, patients in 27% to 54% of all cases did not receive the antibiotics in a timely fashion. The researchers suggested delegating implementation of antibiotic prophylaxis to anesthesia team members to improve timing and reduce incidence of surgical infections.

Similarly, other researchers found that only 75 out of 92 patients (ie, 81.5%) studied received antibiotics within two hours before incision.[16] Nine patients (ie, 9.7%) received antibiotics more than two hours before incision; two patients (ie, 2.1%) received antibiotics within three hours after incision; and six patients (ie, 6.5%) received antibiotics more than three hours after incision. A one-week patient follow-up revealed no reported cases of postoperative surgical infections.

Another controversial issue regarding antibiotic prophylaxis in the surgical community involves the use of antibiotic prophylaxis in clean surgical procedures (Table 1). In one double-blind experimental trial in Canada, investigators stratified 775 surgical patients undergoing clean elective procedures into low- and high-risk categories using the NNIS criteria and randomly assigned them to receive 2 g of

Table 1

WOUND CLASSIFICATIONS[1]

Clean wounds

Uninfected surgical wounds in which there is no inflammation and the respiratory, alimentary, genital, or uninfected urinary tracts are not entered. Clean wounds generally are closed and drained with closed drainage if necessary. Surgical incision wounds after nonpenetrating (ie, blunt) trauma are included in this category if they meet the criteria.

Clean-contaminated wounds

Surgical wounds in which the respiratory, alimentary, genital, or urinary tract is entered under controlled conditions without unusual contamination. Surgical procedures involving the biliary tract, appendix, vagina, and oropharynx are included in this category if no evidence of infection or major break in technique is encountered.

Contaminated wounds

Open, fresh, accidental wounds, surgical procedures with major breaks in sterile technique or gross spillage from the gastrointestinal tract, and incisions in which acute, nonpurulent inflammation occurs.

Dirty or infected wounds

Old traumatic wounds with retained devitalized tissue and wounds that involve existing clinical infection or perforated viscera, suggesting that organisms causing postoperative infection were present in the surgical field before the procedure.

NOTE

1. J S Garner, *Guideline for Prevention of Surgical Wound Infections, 1985.* Available at http://www.cdc.gov/ncidod/hip/guide/surwound.htm. Accessed 25 Aug 1998.

It remains difficult to predict and measure the influence of risk factors for postoperative wound infection.

cefotaxime intravenously or placebo on call to the OR.[17] Surgical site infections developed in three patients receiving the antibiotic and in 16 patients given the placebo (ie, Mantel-Haenszel risk ratio 0.31; 95% confidence intervals 0.11 to 0.83; P = 0.013). Among the low-risk group, the benefit reached statistical significance (ie, 0.97% versus 3.9% SSI; P = 0.018). Only a trend was seen in the high-risk group (ie, 2.8% versus 6.1 % SSI).

Host-related and surgical procedure-related risk factors. Studies on procedure-specific patient risk factors for SSIs encompass those investigations focusing on host-related and surgical procedure-related risk factors. Researchers prospectively studied 62,939 surgical wounds and recommended 10 clinical practices to reduce the infection rate:

- short preoperative stays;
- hexachlorophene showers before surgical procedures;
- keeping shaving to a minimum;
- reducing further contamination;
- adhering to strict surgical technique;
- as expeditious a surgical procedure as is safe;
- scrupulous care in procedures on patients who are elderly, obese, malnourished, or have diabetes;
- no drains brought out through the surgical wound;
- meticulous coagulation technique using the electrosurgical unit; and
- feedback to each surgeon of their own clean wound infection rate as compared to their peers.[18]

Another researcher found that the inanimate environment, including floors, walls, and furnishings, is of little relevance in the transmission of infection in the OR.[19] Furthermore, the number of organisms in the air of the OR depends on various factors. Specifically, dispersal of bacteria varies with individuals—males tend to disperse more organisms than females. Also noted were parallel increases in the numbers of bacteria in ambient air in relation to increased activities and increased numbers of surgical team members.

In 1992, a Surgical Wound Infection Task Force comprised of members from SHEA, APIC, CDC, and SIS convened to evaluate surveillance programs for SWIs. The group authored a consensus paper, acknowledging that numerous risk factors for postoperative SSIs have been identified and verified by clinical trials. The relationship of risk factors and SSIs was classified as either

- definite,
- likely, or
- possible.[20]

Definite host-related risk factors included ASA score, disease severity index, prolonged preoperative stay, old age, morbid obesity, and infections at other sites. Host-related risk factors that were likely to influence SSIs included malnutrition and low albumin. Possible host-related risk factors included diabetes mellitus, cancer, and immunosuppression therapy.

Similarly, surgical procedure-related risk factors were divided into definite, likely, and possible in relationship to SSIs. Definite procedure-related risk factors reported included prolonged duration of surgical procedure, intraoperative microbial contamination, surgical wound class, razor shaves, specific type of surgical procedure, no prophylactic antibiotics, and low abdominal site. Procedure-related risk factors that were likely to influence SSIs included multiple procedures, tissue trauma, and prolonged hospital admission. Finally, possible surgical procedure-related risk factors included poor hemostasis, failure to obliterate dead space, unskilled surgeon, low procedure volume, inexperience, emergency surgery, drains, glove punctures, no preoperative shower or scrub, and the number of people in the OR. Clearly, it remains difficult to predict and measure the influence of risk factors for postoperative wound infection.

In a small prospective observational study of traffic control in total joint replacement procedures, a researcher found that the number of people in the OR ranged from five to 12.[21] At the time of discharge, there was no occurrence of SSIs in any of the 14 cases surveyed in this investigation.

Recent studies continue to focus on risk factors to identify patients at high risk for SSIs. One

Table 2

INFECTION RATES AND MEAN DURATION OF SURGERY BEFORE SERVICE

Service	Number of SSIs	Total number of cases	Duration of surgery (X)	Infection rate (%)
Neurosurgery	2	150	2:25	1.33%
Pacemaker	0	333	1:02	0.00%
Open heart	45	1134	3:04	3.96%
Orthopedic	10	734	1:21	1.36%
Vascular	11	513	1:48	2.14%

Table 3

PAIRED *T* TESTS FOR TOTAL NUMBER OF PEOPLE, LENGTH OF PREOPERATIVE STAY, AND DURATION OF SURGERY (TOTAL TIME)

	Paired differences							
				95% confidence internal of the difference				
	Mean	Standard deviation	Standard error mean	Lower	Upper	*t*	*df*	Significance two-tailed
Pair 1 Total number of people	-0.44	2.88	0.35	-1.14	0.26	-1.264	67	.211
Pair 2 Length of preoperative stay	0.42	5.02	0.61	-0.81	1.64	.682	66	.498
Pair 3 Total time (duration of surgery)	0:24	1:27	0:10	0:03	0:46	2.348	67	.022

Table 4

FREQUENCY DISTRIBUTION OF INFECTED CASES BY DURATION OF SURGERY AND SERVICE

	Duration of surgery (minutes)					
Service	≤ 59	60-119	120-179	180-239	≥ 240	Total
Neurosurgery (N = 150)	1 (4.3%) n = 23	0 n = 43	1 (2.2%) n = 45	0 n = 17	0 n = 22	1.33%
Pacemaker (N = 333)	0 n = 178	0 n = 138	0 n = 13	0 n = 3	0 n = 1	0%
Open heart (N = 1134)	0 n = 1	0 n = 36	21 (3.7%) n = 566	14 (3.7%) n = 378	10 (6.5%) n = 153	3.96%
Orthopedic (N = 734)	1 (0.3%) n = 330	3 (1.0%) n = 288	3 (4.1%) n = 74	1 (5.0%) n = 20	2 (9.1%) n = 22	1.36%
Vascular (N = 513)	2 (2.0%) n = 101	2 (0.8%) n = 242	4 (3.8%) n = 106	1 (2.6%) n = 39	2 (8.0%) n = 25	2.14%
Total (N = 2864)	4 (0.6%) n = 633	5 (0.7%) n = 747	29 (3.6%) n = 804	16 (3.5%) n = 457	14 (6.3%) n = 233	68 (2.4%) n = 2864

researcher contends that the greatest risk for postoperative infection appears to be the patients themselves and predicts that future studies will focus on identifying specific patient risk factors for each surgical procedure. This predictor index of high risk could be used to plan follow-up care with the intention of increasing the preventive and therapeutic interventions in high-risk patients and doing less for low-risk patients.[22] From the literature, it remains unclear if the number of people in the OR and their traffic patterns influence the development of postoperative SSIs. Further investigation may reveal if a correlation exists between these parameters.

METHODOLOGY

A retrospective medical record review of all clean surgical procedures in five surgical specialties was conducted to determine the influence of selected contributory variables on the incidence of SSIs. Members of the infection control committee at the medical center identified the surgical services to be studied. The elected surgical specialties included open heart, orthopedic, pacemaker, vascular, and neurosurgical services. These were selected specifically for their high volume of cases and the predominance of "clean" surgical procedures. Clean-contaminated and contaminated surgical procedures were excluded from the investigation.

Cases were identified from monthly infection control reports and reviewed by the appropriate directors of surgical services and infectious disease. A report of all cases with SSIs in the selected services was generated from the hospital infection surveillance program. Surgical site infections were diagnosed by infectious disease experts and surgeons in accordance with criteria established by the CDC.

Sample/setting. Out of a total of 3,259 surgical procedures performed from Jan 1, 1995, to Dec 31, 1995, at a large academic medical center in the south Florida region, 2,864 clean operations were analyzed; 396 cases were excluded because they did not meet inclusionary criteria (ie, procedures had to be classified as clean surgical procedures).

Data collection. Data were collected using a standardized data collection tool from individual medical records. The specific documents used to obtain pertinent information included the surgical procedure report, anesthesia record, preoperative assessment record, discharge summary, and medication administration record. The following information was collected:

- medical record number,
- date of surgery,
- date of admission,
- length of preoperative stay,
- age,
- sex,
- ASA score,
- urgency (ie, elective versus emergency),
- surgical service,
- OR,
- start time,
- end time,

Table 5
TOTAL NUMBER OF PEOPLE AND INFECTION RATES

Number of people	Uninfected	Infected	% Infected	Total
0 - 8	712	11	1.52	723
9 - 10	710	12	1.66	722
11 - 12	610	18	2.86	628
13 - 16	585	23	3.78	608
> 17	54	4	6.89	58
Total	2671	68	2.48	2739

Table 6
DURATION OF SURGERY AND INFECTION RATES

Duration of surgery (minutes)	Uninfected	Infected	% Infected	Total
≤ 59	629	4	0.63	633
60 - 119	742	5	0.66	747
120 - 179	775	29	3.59	804
180 - 239	441	16	3.50	457
≥ 240	209	14	6.27	223
Total	2796	68	2.43	2864

- duration of procedure,
- number of people in the OR, and
- use of prophylactic antibiotics.

Protection of human subjects. Cases were identified by medical record number only to ensure the protection of human subjects in this study. Additionally, patients' names and other personal information was not reviewed or recorded by the investigator during any phase of data collection and analysis.

RESULTS

The highest infection rate was found in open heart procedures followed by vascular, orthopedic, and neurosurgical procedures. The sample population consisted of 1,260 (ie, 44%) females and 1,604 (ie, 56%) males. The mean (± standard deviation [SD]) age was 68.2 ± 16.3 years and the ASA score was 3.2 ± 0.8. In a preliminary analysis, 68 out of the 69 reported SSI cases were matched with noninfected cases for age, sex, type of procedure, and ASA score. One case with a SSI was excluded from the analysis because it was a confirmed clean-contaminated case. Pacemaker procedures had no reported incidence of SSI in 1995 (Table 2). A paired *t* test revealed that there was a statistically significant difference between the groups with respect to duration of surgery (ie, $P = .022$) (Table 3); however, the total number of people in the OR and the length of preoperative stay did not reach statistical significance (ie, $P = .211$; $P = .498$, respectively). The frequency distribution of cases with SSIs by duration of surgery and service (Table 4) revealed a trend toward an increasing incidence of infection with longer surgeries in open heart and orthopedic procedures. Additionally, infection rate tended to increase as duration of surgical procedure increased.

Final analysis of the data included the creation of contingency tables for each independent variable with rate of infection and logistic regression analysis. Obvious trends can be seen with total number of people in the OR (Table 5) and with duration of surgical procedure (Table 6). As the number of people increased, there was a steady rise in infection rate. Similarly, as surgical procedures became longer, infection rates tended to increase. A less remarkable trend can be seen with ASA score and infection rate

Table 7

AMERICAN SOCIETY OF ANESTHESIOLOGISTS' SCORES AND INFECTION RATES

ASA Status	Uninfected	Infected	% Infected	Total
ASA (1)	83	0	0.00	83
ASA (2)	469	7	1.49	476
ASA (3)	1006	11	1.08	1017
ASA (4)	1237	50	3.88	1287
ASA (5)	1	0	0.00	1
Total	2796	68	2.43	2864

Table 8

INFECTION RATE BY GENDER

Sex	Uninfected	Infected	% Infected	Total
Female	1230	30	2.44	1260
Male	1566	38	2.36	1604
Total	2796	68	2.43	2864

Table 9

LENGTH OF PREOPERATIVE STAY AND INFECTION RATES

Preoperative stay (days)	Uninfected	Infected	% Infected	Total
0	717	13	1.78	730
1	944	19	1.97	963
2 - 4	601	23	3.68	624
5 - 15	362	12	3.20	374
16 - 30	40	1	2.43	41
> 31	8	0	0.00	8
Total	2672	68	2.48	2740

(Table 7). Gender (Table 8) and length of preoperative stay (Table 9) did not reveal any notable trending with rate of infection. The preoperative length of stay was measured as the number of days from date of admission to day of surgery. In some instances, this number became quite large, particularly for vascular procedures. For example, a patient in chronic renal failure admitted for the creation of an arteriovenous graft may require numerous surgical procedures to secure an adequate site for hemodialysis. As a result, the length of preoperative stay would be extended. Timely antibiotic prophylaxis was performed in 69% (ie, 1,599 out of 2,325) of the clean surgical procedures studied—this group had a slightly higher infection rate than the group that did not receive antibiotics in a timely fashion or received no antibiotic prophylaxis at all (Tables 10 and 11).

Forward stepwise logistic revealed duration of surgical procedure as the only risk factor to reach statistical significance (ie, $P < .0001$); however, using backward stepwise regression, both ASA score (ie, $P = .0097$) and duration of surgical procedure (ie, $P < .0001$) were statistically significant risk factors for SSIs.

Table 10

PROPHYLACTIC ANTIBIOTIC USE

Antibiotic given	Uninfected	Infected	% Infected	Total
120 minutes or greater preincision	251	10	3.83	261
60 to 90 minutes preincision	555	24	4.15	579
0 to 59 minutes preincision	997	23	2.25	1020
Given postincision	291	3	1.02	294
None given	169	2	1.17	171
Missing data	532	6	N/A	538
Total	2795	68	2.38	2863

Table 11

INFECTION RATES AND ANTIBIOTIC PROPHYLAXIS

Antibiotic prophylaxis	Uninfected	Infected	% Infected	Total
Received timely antibiotic prophylaxis within 2 hours preincision	1552	47	2.94	1599
Received antibiotics more than 2 hours preincision, postincision, or no prophylaxis	711	15	2.07	726
Total	2263	62	2.67	2325

Table 12

FREQUENCY DISTRIBUTION OF TOTAL NUMBER OF PEOPLE BY DURATION OF SURGERY

Duration of surgery (minutes)	(N = number of people) Valid	Missing	Mean	Median	Range	Minimum	Maximum
≤ 59	588	45	8.19	8.00	9	4	13
60 - 119	713	34	9.17	9.00	12	5	17
120 - 179	785	19	11.64	12.00	13	6	19
180 - 239	435	22	12.66	13.00	13	7	20
≥ 240	218	5	13.57	13.00	16	8	24

All other risk factors including age, sex, urgency, preoperative length of stay, and the number of people in the OR were not predictive of SSIs. Although the number of people in the OR did not reach statistical significance with logistic regression, further evaluation of the data revealed that longer surgical procedures were associated with a steady increase in the number of people in the OR (Table 12). Therefore, it is conceivable that the profuse microbial burden produced by the trafficking and escalating numbers of people in the OR may be a contributory factor in SSIs. From these results, we can predict that the probability of SSIs after clean procedures is higher as the duration of the procedure increases and with higher ASA physical assessment scores.

DISCUSSION

In this study, the duration of a given surgical procedure clearly was a significant procedure-related risk factor for SSI. Of the host-related risk factors, only ASA score reached statistical significance. A rising trend in infection rate was observed as the number of people in the OR increased; however, this factor did not reach statistical significance with regression analysis. The timely administration of prophylactic antibiotics did not reduce the rate of infection in the observed surgical procedures. This finding may reflect, in part, inconsistencies in the documentation of antibiotic administration times by nursing and anesthesia staff members as well as inaccurate or missing data. Finally, age, sex, urgency, and preoperative length of stay were not significant risk factors for SSI. These results do not support a previous study, in which 1,542 clean surgical procedures were analyzed and showed that age, use of antibiotics, and type of procedure were significant risk factors for SSI and length of hospital stay and duration of surgical procedure were not.[23]

It is generally assumed that longer surgical procedure time produces an increase in microbial contamination which may influence the incidence of postoperative wound infection. A prolonged surgical procedure may be an indicator of the complexity of the procedure, the expertise and skill of the surgeons, the extent of tissue trauma, or procedures that are not planned and coordinated among team members. The results of this study support this assumption. Additionally, ASA score has been shown to be a host-related risk factor for wound infection in previous investigations.[24] This study yielded a similar finding in that ASA score was a significant predictor of SSIs.

The purpose of this study was to examine the relationship between traffic patterns in the OR and SSIs, addressing the research question, "Does the number of people in the OR during surgical intervention influence the development of postoperative wound infection?" A thorough evaluation of the data did not yield a definitive answer. Perhaps a better way to evaluate the effect of this variable would be to prospectively measure the activity and conversational levels of staff members and to monitor the number of times OR doors are opened during surgery. For example, it has been observed that in collaborative seasoned surgical teams conducting a well-planned, long surgical procedure during which large numbers of people are present, limiting excessive trafficking is strictly enforced; therefore, conversations and movements of staff members remain at low levels. Likewise, it has been observed that in less cohesive surgical teams conducting a poorly planned, less organized surgical procedure involving fewer personnel, there may be more activity and talking and more trafficking due to the lack of preparation and foresight on the part of surgical team members. Consequently, simply accounting for the number of people in the OR may not be sufficient if these other components are not measured.

In this study, there was a rising infection rate associated with an increasing number of people in the OR, which provided some evidence that this variable may play a role in the incidence of SSIs. Interestingly, longer surgical procedures, which significantly increased the rate of infection, also had a corresponding increase in the number of people present during surgery. These findings suggest that traffic patterns, including the number and movements of surgical team members should be carefully monitored during surgery, especially as procedures become longer.

The overall infection rate for clean surgical procedures examined in this investigation was 2.4%, similar to rates found in other studies.[25] This supports the well-accepted conviction that infection rates for clean surgical procedures cannot be assumed to be low.[26]

Limitations. The literature cites that a sizable majority of, if not most, SSIs occur after hospital discharge and are not detectable by conventional surveillance.[27] Thus, because this was a retrospective chart review in the hospital, the possibility exists that the number of detected cases of SSIs in this study was lower than the actual number that occurred.

In addition, the retrospective, descriptive approach used in this investigation presented another limitation. For example, it was not possible to determine the number of times the OR doors were opened and closed during surgery. The activity and conversational levels of surgical staff members also were not measured. As mentioned previously, it may be important to evaluate these components of traffic patterns to determine the influence of the number of people in the OR on SSIs. Furthermore, the accuracy of documentation in medical records presented another limitation. It was not possible to verify that the number of people listed in the surgical report was the exact number present during any given surgical procedure.

CONCLUSION

It is critical that SSIs become better understood by health care practitioners to develop more effective prevention programs. Clearly, the OR is a good place to start because the period of greatest risk of microbial exposure occurs during surgery. Surgical procedure-related risk factors for wound infections (eg, traffic patterns of surgical team members) warrant further investigation. A prospective study should be conducted to examine the fundamental components of traffic patterns during surgery previously discussed in this report. Other risk factors (eg, surgical expertise, extent of tissue trauma, poor hemostasis, multiple procedures, prolonged hospital admission) also should be validated by more extensive research. Although numerous studies have provided a general description of these procedure-related risk factors, further investigations are needed to describe the nature of sentinel events occurring during surgery that predispose a patient to subsequent surgical infections.

Host-related risk factors that predetermine the classification of a surgical patient as either high risk or low risk also should be explored. Overall, experts in the field of wound infections agree that the general health status of the individual patient, together with the meticulous surgical techniques of surgical team members, are the most critical factors in the prevention of postoperative wound infection.[28] Procedure-specific patient risk factors must be validated through extended research efforts to reduce the surgical patient's risk of developing a wound infection. ▲

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