

# Operating Room Traffic is a Major Concern During Total Joint Arthroplasty

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## Abstract

**Background** Periprosthetic joint infection (PJI) is a challenging complication associated with total joint arthroplasty (TJA). Traffic in the operating room (OR) increases bacterial counts in the OR, and may lead to increased rates of infection. **Question/purposes** Our purposes were to (1) define the incidence of door opening during primary and revision TJA, providing a comparison between the two types of procedures, and (2) identify the causes of door opening in order to develop a strategy to reduce traffic in the operating room. **Methods** An observer collected data during 80 primary and 36 revision TJAs. Surgeries were performed under vertical, laminar flow. Operating room personnel were unaware of the observer, thus removing bias from traffic. The observer documented the number, reason, and personnel involved in the event of a door opening from time of tray opening to closure of the surgical site.

**Results** The average operating time for primary and revision procedures was 92 and 161 minutes, respectively. Average door openings were 60 in primary cases and 135 in revisions, yielding per minute rates of 0.65 and 0.84, respectively. The circulating nurse and surgical implant representatives constituted the majority of OR traffic.

**Conclusions** Traffic in the OR is a major concern during TJA. Revision cases demonstrated a particularly high rate of traffic. Implementation of strategies, such as storage of instruments and components in the operating room and education of OR personnel, is required to reduce door openings in the OR.

## Introduction

Periprosthetic joint infection (PJI) has been regarded as one of the most challenging complications associated with total joint arthroplasty (TJA) [1, 2, 7, 10, 15]. The etiology of PJI is multifaceted; therefore, multiple strategies must be implemented to minimize the risk of PJI. The consequences of prosthetic infection have been grave, often resulting in additional morbidity [1, 2, 7]. Reducing the risk of PJI during TJA has been a major challenge that deserves continued exploration. Patient-related factors, such as BMI greater than 40 kg/m<sup>2</sup>, a compromised immune system, and medical comorbidities (American Society of Anesthesiologists [ASA] score greater than 2) reportedly affect surgical infection rates [3, 12, 14]. Perioperative care factors, including the operating room (OR) environment, have also been reported to contribute to the risk of PJI. Surgical time, perioperative antibiotic prophylaxis, preparation and draping techniques, ultraviolet light, and laminar airflow have all been investigated [4–6, 8, 14]. A systematic review by Evans [4] demonstrated the effectiveness of the

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laminar flow system; however, certain behavioral aspects in the operating room could contribute towards the risk of infection, and these deserve further investigation.

In addition to other studies [11, 13, 16], Young et al. [17] reported an increased trend of surgical site infections with an increased rate of OR traffic. In rooms equipped with laminar airflow, the opening and closing of the operating room door disrupts the airflow in close proximity to the patient. This disruption reportedly allows microbes to enter the airspace above the surgical site, possibly contributing to an increased risk of infection [4, 9, 11, 17]. It has been reported that increased OR traffic was one factor that adds to the increased incidence of PJI in revision as compared to primary TJA [12]. Previous studies have documented the flow of traffic through the OR during different types of surgical procedures, but these studies did not directly address OR traffic data associated with TJA or specifically identify discrepancies between primary and revision arthroplasty.

This study had two objectives: (1) define the incidence of door opening during primary and revision TJA at our institution, providing a comparison between the two types of procedures, and (2) identify the etiology of door opening in order to develop a strategy to reduce the incidence of traffic in the operating room.

## Materials and Methods

In this study, foot traffic (as determined by door opening) through the OR of a high-volume academic center was monitored during a series of primary and revision TJAs. Observers collected data during 116 primary and revision THAs and TKAs for door openings during a 7-month time period from May 2010 to November 2010. The observers recorded 59 THA cases (41 primaries and 18 revisions) and 57 TKA cases (39 primaries and 18 revisions). Six different adult reconstructive surgeons collected the data. The first 16 primary and 8 revision cases (hereafter referred to as early cases) were recorded from incision to closure, while the subsequent 64 primary cases and 28 revision cases (hereafter referred to as late cases) were recorded from the opening of the instrument packs to closure of the incision. Observers also recorded the time of incision in the late cases so that both sets of cases could be grouped together for data analysis. Any analysis conducted before incision only involved the 92 cases in the late cohort.

Four observers collected the data (PP, MS, DSC, RJ). One of the four observers was in the operating room recording door openings throughout the entire surgery and continued data collection until closure of the incision site. The data collected included: duration of procedure, total number of door openings during the procedure, reason for

opening, stage in surgery at which the door opening occurred (before or after incision), and personnel type entering and leaving the OR. They classified the personnel types entering and leaving the OR as the following: anesthesiologist, circulating nurse, equipment representative, nurse, observer, physician, primary assistant, and secondary assistant. They also categorized the reason for each door opening as one of the following: break/shift change, information, observation, paperwork, sample collection, scrubbing in or out, social, supplies, and through traffic.

The TJA operating rooms at our institution were equipped with vertical, fixed, laminar flow systems from two different manufacturers, Howorth Systems (Farmingdale, NY, USA) and Bio Air Systems (Greensboro, NC, USA). There were no walls associated with either of these systems. There were two doors through which the patient and staff gained access to the OR, with a sign on each stating "No Traffic - Implants In Use". The instrument packs were opened and the tables were set up prior to the patient entering the OR.

In order to reduce the chance of measurement bias, OR personnel were blinded as to the type of data being collected by the observer and the nature of the study being carried out. We conducted this study immediately following another study for which data collection had just concluded. The observers continued to follow the procedures for the prior study while recording this study's data, thereby masking the true purpose of the data collection. The observers did not contribute to any of the door openings.

The observers hand-recorded the data throughout the procedure and then transferred it onto a Microsoft® Excel spreadsheet (Redmond, WA, USA). We determined differences in OR traffic between revision and primary TJA using the Student's t-test.

## Results

The total number of door openings recorded during the 116 cases was 9657: 4803 during primary cases and 4854 during revision cases. The average number of openings for all cases from incision to closure was 83.2, and the average case length was 119.5 minutes; therefore, the mean rate of door openings was 0.69 openings per minute for all cases. The average number of openings for primary cases from incision to closure was 60, and the average case length was 92 minutes; therefore, the mean rate of door openings was 0.65 openings per minute for primary cases. The average number of openings for revision cases from incision to closure was 134, and the average case length was 160.7 minutes; therefore, the mean rate of door openings was 0.84 openings per minute for revision cases. The ratio of

door openings per minute was higher ( $p < 0.001$ ) in revision cases (0.84 openings per minute) as compared to primary cases (0.65 openings per minute) (Table 1). The highest percentage of the total traffic occurred after incision for both primary and revision TJAs (63% of door openings overall). Door opening after incision accounted for 61% of the total openings for primary TJAs and 69% for revision TJAs (Table 2). Despite the fact that door openings after incision accounted for a greater percentage of the total traffic, we noted that, on average, there was a higher rate of door openings (calculated as door openings per minute) during the period before incision.

The single largest identifiable reason by category for door opening was getting supplies, which constituted 23% of the openings. Collection and transfer of information, such as questions and comments about the case, comprised 12% of door openings. Scrubbing in and out during the procedure accounted for 8% of openings. It is important to note that for 47% of door openings the observer could not identify why the door had been opened (Table 3).

**Table 1.** Average duration and number of door openings recorded and ratio of door openings for all cases

Case type	Total number of cases	Average case length (minutes)	Average number of door openings	Average ratio of door openings (per minute)
Total	116	119.5	83.2	0.69
Primary	80	92.0	60.0	0.65
Revision	36	160.7	134.8	0.84

**Table 2.** Timing of door openings

Time period	Primary (%)	Revision (%)	All cases (%)
Before incision	39.5	31	36.9
After incision	60.5	69	63.1

**Table 3.** Occurrence and percentage of the categorised reasons

Category	Occurrence	Percentage (%)
Break/shift change	146	1.5
Collect sample	45	0.5
Information	1125	11.5
Observation	132	1.3
Paperwork	293	3.0
Scrub in/out	777	7.9
Social	103	1.0
Supplies	2291	23.3
Through traffic	261	2.7
Unknown	4640	47.3
Total	9813	100

The largest contributors of door openings were the circulating nurses, who were responsible for 26% of door openings. The next most frequent contributors were the equipment representatives (20% of door openings) and other nurses (19% of the door openings) (Table 4).

## Discussion

The opening of the operating room door disrupts the laminar airflow, allowing pathogens to enter the space surrounding the site of the operation [4, 9, 11, 17]. These pathogens have the potential to lead to increased rates of infection. Furthermore, increased OR traffic itself increases the risk of PJI [11, 13, 16, 17]. Our two main objectives were to (1) quantify operating room traffic during both primary and revision THA and TKA, providing a comparison between the two types of procedures, and (2) identify the causes of the traffic with the purpose of developing a strategy to reduce door opening during TJA.

There were several limitations to this study. First, because the study was blinded from the staff, the observer was not able to ask the staff the reasons for OR entry. Thus, the observer had to interpret the justification of each of the entries by different personnel. This led to a lack of identification in 47% of the door openings during the cases. However, we believed it was important to blind the staff from the reasons for the study since it might have influenced their behavior. Nonetheless, the fact that nearly half of the door openings were unexplained was alarming. Therefore, we were concerned that many openings occurred for reasons not essential to the case. An additional limitation due to the blinded nature of this study was that some of the justifications for door openings may have been misinterpreted, resulting in the possibility of artificially high or low reported values. We believed this limitation to be minimal because the observer labeled an opening where they were in doubt of the reason as unknown. Another limitation was the fact that we altered the protocol after the

**Table 4.** Occurrence and percentage of the total for each personnel type

Category	Occurrence	Percentage (%)
Anaesthesiologist	836	8.5
Circulating nurse	2548	26.0
Equipment representative	1991	20.3
Nurse	1861	19.0
Observer	626	6.4
Physician	666	6.8
Primary assistant	536	5.5
Secondary assistant	749	7.6
Total	9813	100

first 24 patients. This was done after the senior author realized that data was not being collected from the time the instrument packs were opened until the incision. This was a time period when a great amount of OR traffic occurred and needed to be included to maximize the value of the study. Lastly, the use of four observers could have introduced inter-observer bias. It was possible that the observers may have categorized certain personnel actions differently. We also thought this effect to be minimal due to the observers jointly monitoring the initial cases in order to determine discrepancies in classification.

The volume of observed traffic was alarmingly high, and the causes of such high level traffic were, to a large extent, modifiable. Only 8% of traffic was determined to be due to scrubbing in and out, demonstrating a high rate of unjustified traffic. The door was opened 0.69 times per minute, mostly while the skin was open. Young et al. [17] monitored the OR traffic for 46 consecutive cardiac surgeries. These cases produced a per-minute rate of traffic of 0.32, far less than in our orthopaedic procedures, although still described as alarmingly high by the authors. In our study, the period before incision corresponded to the highest rate of door openings per minute, largely due to room preparation and staff arrival. Revision TJA experienced the highest levels of operating room traffic (0.84 openings per minute). We postulated that this was due to the complexity of the procedure and the necessity of additional supplies and equipment. Those responsible for obtaining instruments, implants, and communicating information were most culpable for the high level of traffic. In a series of 28 cases, Lynch et al. [9] found that the circulating nurse and core staff generated 37% to 51% of door openings. Additionally, similar to our findings, the primary causes of these door openings were due to collection of information, checking on the case, and paperwork. Also comparable to Lynch et al, who determined that supply issues resulted in 11% to 22% of door openings, our cases demonstrated that 23% of door openings were attributed to equipment necessities. This indicated the importance of properly stocked rooms prior to the onset of procedures.

In order to mitigate the increased traffic during revisions, careful planning and anticipation of instrument and implant needs, as well as to the general measures delineated above, are essential. Many of the materials needed for a case are brought into the room from the time the equipment is opened to the time of incision, including paperwork and supplies. An obvious approach that could be implemented to alleviate this concern is to have all the necessary supplies in the operating room prior to opening the sterile instruments in the room. Furthermore, timing the opening of sterile instruments as close as possible to the time of incision would reduce their exposure to the increased traffic associated with equipment needs during the phase of the preoperative period. Another possible

strategy designed to lessen the traffic includes the storage of components and frequently used backup instruments in the OR in order to reduce the need to leave the room. Clear and advanced communication about the equipment needs (anticipated for the case) may also minimize the need to exit the room for instruments during the case. Also, shift changes could be timed so as to minimize traffic. Proper education for the operating room personnel regarding the function of the laminar airflow system and the relationship between traffic and infection may also increase awareness. Limiting the number of persons to those only active in the procedure, or having all observers enter prior to opening of the packs and leave after closure of the incision, may also decrease the traffic during revision procedures. Lastly, the implementation of video broadcast systems to monitor OR traffic may lead to a decrease in door openings. If OR personnel knew that their openings were being monitored, and that possible ramifications for high rates of traffic were in place, it is reasonable to conclude that traffic would decrease to only openings imperative to the case.

The findings of this study were alarming. We have instituted the perioperative protocol changes mentioned above and intend to collect data to assess the effectiveness of these modifications in reducing traffic. This issue is often overlooked and must be seriously considered by institutions. Measures to reduce OR traffic may decrease one etiology of PJI.

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