Increasing Awareness of the Impact of High Volumes of Foot Traffic in Operating Rooms on Patient Outcomes among Clinicians and Support Staff

By Meneka Bansal & Laura Hackenberger
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ABSTRACT

Increasing Awareness of the Impact of High Volumes of Foot Traffic in Operating Rooms on Patient Outcomes among clinicians and Support Staff

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Background: The Hospital of the University of Pennsylvania’s perioperative leadership took upon an initiative to understand and measure foot traffic during surgical cases and its relation to patient outcomes. Theoretically, higher traffic could lead to an increased risk of surgical site infections (SSI). This study aims to collect and analyze Operating Room (OR) traffic using a door counter and to understand clinicians’ participation and perceptions of heavy OR traffic.

Objectives: To understand how OR traffic can affect surgical outcomes; to measure and analyze OR traffic; highlight reasons why there is heavy OR traffic; and provide recommendations to reduce OR Traffic.

Methods: Quantitative data was collected to measure how often clinicians pass through the door during a case. Additionally, OR environmental conditions were measured and compared with the door counter data. Interviews were conducted to understand the environmental and cultural conditions of the OR. Surveys with clinicians were also administered to assess perceptions of OR traffic.

Results: Researchers analyzed 108 surgical cases. An average of 33 passages occurred per hour during a case. Supplies, equipment and communication were determined as the main causes of traffic.

Conclusions: Researchers were unable to find one major source of excessive OR traffic. Several behavioral factors contribute to high rates of traffic and these influences vary with OR role. Without the ability to correlate SSI’s with OR traffic, the recommended method to reduce unnecessary traffic in the OR involves increasing awareness through educational efforts.
Introduction

The historic Hospital of the University of Pennsylvania (HUP) opened as the first teaching hospital in the United States in 1874. Today, the U.S. News & World Report nationally ranks HUP as the 10th best hospital in the United States. Only through dedication to its mission, to “create the future of medicine,” has HUP continued to be such a prominent and respected institution. Targeting service excellence, educational pre-eminence, new knowledge, innovation, and national and international leadership allow clinicians and administrators to continue to excel. Together, they strive to deliver excellent care and services to their patients and community. HUP also seeks to develop educational programs for future leaders by continually impacting research for discoveries of new diagnoses, treatments and prevention of diseases. The HUP community provides an example of Embracing core values of excellence, integrity, diversity, professionalism, individual opportunity, collaboration and tradition.

In an effort to continue to provide high quality care to patients, the leadership in the hospital is always searching for ways to improve. Observing what appeared to be excessive traffic in the operating suites, the leadership of Peri-Operative Services became interested in investigating the potential impact of excessive foot traffic. Consequently, if high traffic could lead to an increased risk of infection, processes should be improved to reduce traffic and improve patient outcomes. The leadership elicited the services of the Process Improvement Specialists on staff at the hospital and recruited the authors of this paper to design and conduct the study initiated by the surgical leadership.

The threat of infection during a surgical procedure is a very serious one. Surgical Site Infections (SSIs), those that result from an operation and involve skin and subcutaneous tissue,
deep soft tissue, or any part of the anatomy,\textsuperscript{1} have been identified as a major cause of morbidity and mortality in healthcare.\textsuperscript{2} In 2002, an estimated 8,205 individuals died as a result of an SSI which falls into a broader category of Healthcare Associated Infections (HAIs).\textsuperscript{3} HAIs occur when a patient acquires an infection while receiving care in a healthcare institution and are the most common complication of hospital care. These are among the leading causes of preventable death in the US and contribute to a considerable portion of healthcare spending.\textsuperscript{4} The Department of Health and Human Services (DHHS) has identified HAIs as a necessary point of improvement in healthcare. Healthy People 2010 includes the goals to “Prevent, reduce, and ultimately eliminate healthcare-associated infections.” While this goal has been targeted mainly to address CLABSI and MRSA infections, HHS identifies SSIs as an emerging issue and plans to increase surveillance and implement prevention programs in the future.\textsuperscript{4} Because SSIs are preventable and are followed by substantial negative repercussions, including prolonged hospital stays and increased economic burden on patient and health care systems, there has been increased interest placed on reporting and prevention of SSIs.\textsuperscript{5}

Surgical Site Infections remain a significant cause of postoperative complications. An estimated 20\% of HAIs are derived from surgical site infections.\textsuperscript{3} Other factors that influence the risk of acquiring an infection include individual health status and co-morbidities, details and complexity of procedure, administered antibiotic prophylaxis, as well as the physical environment of the operating room.\textsuperscript{6,7,2} Many studies have shown the efficacy of infection control procedures in operative environments, but infections in surgical sites remain prevalent. The premise of this project is that the uncontrolled and potentially excessive amount of foot traffic in the OR during procedures may contribute to increased risk of surgical site infections.
Background

Process Improvement/Six Sigma

To achieve improvement in patient health outcomes and satisfaction, healthcare institutions attempt to improve performance and processes. These institutions select and implement programs that provide a framework for improving processes. The framework utilized at HUP is one that includes principles from Six Sigma, Lean, and IHI Improvement Models, all components of a larger program designed by Healthcare Performance Partners, a MedAssets Company.

The process improvement framework provides a step-by-step method that emphasizes the importance of understanding all components of a process before implementing any changes or improvements. Therefore, process improvement in the OR begins with understanding the physical attributes of the OR, surgical process, and infection prevention. Reviewing and assessing the relevant literature and disseminating the findings to the clinicians is also a crucial step in this process. By integrating the knowledge gained regarding environmental infection control procedures with a measurement of foot traffic in the HUP Dulles OR suites, this project hopes to improve outcomes for surgical patients. Also, detailing the magnitude and the sources of the problem through quantitative and qualitative research will help in building awareness and creating solutions. These improvements will be brought about through culture and behavior change only, not by altering the physical environment.

Physical and Environmental Conditions

By design, there are many precautions in place to protect patients from infections acquired during surgery. Hand washing behaviors and surgical attire are well known measures
for preventing infection transmission. Less known are the components of the built environment that contribute to infection control. All surgical areas, including those in Dulles, are divided into zones. The outermost area, the Unrestricted Area, serves as the entry way to the surgical suite. Here, entrance is not restricted and individuals are permitted to be dressed in street clothes. Once an individual enters the Semi-Restricted area, they must wear surgical attire and cover all head and facial hair. This zone only allows limited personnel and includes storage areas for surgical supplies, scrub sinks, and the entryways to the Restricted Area. Operating rooms and the sterile core comprise the Restricted Area. Personnel in this area must be appropriately scrubbed and wear a face mask at all times. Circulating nurses, who frequently travel throughout the surgical corridors, must wear proper attire in the Restricted Area but are not fully scrubbed in as they do not assist in the surgical procedure directly. Sterile supplies are opened in this area as well. The layout of surgical floors intends to reduce transmission of infection.

Many of the efforts to reduce infection during surgery, including the use of sterile surgical equipment and the sterile field, have been in use for decades. Since the 1950’s, when it was discovered that many SSIs were a result of contaminated air from surrounding areas within the hospital, more attention has been paid to the environmental air. Surgical suites are now commonly equipped with Heating Ventilating and Air Conditioning (HVAC) systems that provide optimal conditions for surgery. The introduction of filtered air and positive pressure have greatly reduced the incidences of these infections. The functions of the HVAC for perioperative spaces include the maintenance of appropriate levels of air filtration, temperature, humidity, pressurization, and outside air. The design phase of the construction of such spaces and systems is guided by recommendations from the American National Standards Institute (ANSI) and the American Society of Heating, Refrigerating, and Air-Conditioning (ASHRAE) which give
requirements for exhaust and recirculation, total air exchanges per hour and minimum outside air, and pressure relationships. Recommendations laid out here specify airflow, temperature and humidity and are adopted from ASHRAE Standard 170. ASHRAE recommends that operating rooms are maintained between 68°F-73°F and humidity is maintained between 30-60% relative humidity to maintain sterility of supplies. Architects of the Dulles OR rooms followed these guidelines for the design of operative spaces.

As a measure for infection control, HVAC systems supply laminar airflow in operating rooms. In most operating rooms, air vents and diffusers allow air to mix and circulate around the room. With laminar flow, the air is distributed downward only, usually directly above the patient, and is collected through return vents near the floor. Therefore, there is little opportunity for infectious material to circulate in the environmental air. For ideally clean rooms, laminar flow diffusing vents cover the entire ceiling; however, because other equipment and lights must be fastened to the ceiling, this is not possible in most ORs.

The supply air to the system is filtered by High Efficiency Particulate Air (HEPA) filters before distribution. For most operative spaces, the return ducts supply the majority of the volume of air, while outside air contributes a smaller portion. While outside air is preferable to the return, several rounds of filtration occur before the air is vented into the room. This is considered sufficient as HEPA filters have been proven very effective in removing 99.7% of contaminants.

Similar to laminar flow, maintenance of positive pressure within an operating room is important for controlling airflow. Positive pressure is achieved by distributing more air than is returned through the floor vents. With positive pressure in place, air will be forced out of the
room at all times (including under doors and through cracks). This ensures that when a door is opened, air flows out into the corridor, an area with lower air pressure relative to the inside. Without positive pressure, air may enter the OR from the semi-restricted areas which does not have all of these infection control procedures in place.\textsuperscript{11,14}

\textit{Surgical Process}

Surgical preparation is a deliberate process that limits contamination to reduce infection. Supplies needed for surgery are selected and sterilized throughout the day prior to surgery. Once sterilized and packaged, supplies are placed in the operating room and unwrapped by the scrub nurse who will handle the sterilized equipment throughout the procedure. The circulating nurse, who is not scrubbed in, leaves the OR to retrieve any additional supplies needed during the case. Once the room is prepped, the patient is transported to the OR before induction by the resident anesthesiologist. The anesthesiologist attending may stop in during the procedure to check in with their resident. After the patient is anesthetized, the surgeon arrives and the incision begins the case. The surgeon completes the procedure and closes the patient. The patient is then dressed and leaves the OR. Soon after, the room is thoroughly cleaned and the cycle begins again.

\textit{Professional organizations guidelines}

The Association of PeriOperative Registered Nurses (AORN) included in “Recommended Practices for Traffic Patterns in the PeriOperative Practice Setting” a recommendation for the movement of personnel, “Movement of personnel should be kept to a minimum while invasive and noninvasive procedures are in progress.” It states that the door to the operating or procedures rooms should be closed except during movement of patients, personnel, supplies and equipment, and talking and the number of people present should be
minimized during procedures. Additionally, the CDC’s guidelines for infection control state “airborne contamination decreases with increased ventilation that dilutes contaminated air with relatively clean-filtered or outdoor air with decreased numbers and activity of personnel. Such recommendations acknowledge the importance of reduced foot traffic as well as suggestions to do so.

Aims:

The purpose of this study is to understand, observe and measure foot traffic in the surgical environment and identify literature that proposes a link between OR traffic and infection control. The hope is that by understanding the effects of their behavior, clinicians will reduce foot traffic in the PeriOperative space. Specific aims of the project include:

- Conduct a literature review to identify previously conducted studies that can inform methods and hypotheses.
- Collect data to:
  - Measure passages of clinicians entering and exiting the OR and determine patterns and causes.
  - Investigate why clinicians enter/exit the OR during a case.
  - Measure particulate air counts and compare to rates of OR traffic over time.
- Use research findings to recommend initiatives that will reduce OR traffic in the future.
Literature Review

A review of the literature shows that OR traffic is considered high by most researchers. Others have shown that door openings and human activity can impact various risk factors for infection. Additionally, some studies give recommendations for traffic reducing measures and indications that they may be effective in reducing SSIs. Information analyzed from previously conducted studies was useful in both understanding OR foot traffic and in designing the procedure for data collection in this project.

Nearly thirty years ago, researchers at a large healthcare institution in Missouri undertook a study of SSIs by implementing intraoperative surveillance during orthopedic surgeries. The researchers, infection control nurses, observed procedures and later presented findings and recommendations to the surgeons in the institution. After a year of observations, they identified several problem areas. They indicated that the doors were opened and closed too frequently (25-50 times during procedures that lasted less than 90 minutes), too many people were present in the operating rooms (between 5 and 9 individuals), and excessive conversation. Several other problem areas were identified, most of which related to antibiotic prophylaxis and aseptic procedures. After presenting their findings to the clinicians, there was a statistically significant drop in SSIs in their institution. Unfortunately, because the recommendations were comprehensive, it is unclear how much behavior change occurred related to OR traffic or how much that reduced the risk of infection. However, changes in these behaviors may have had an impact. 17

Acknowledging the potential effects of high traffic, Lynch et al. (2009) conducted an observational study of foot traffic in the operating rooms of a large academic medical center. A total of 28 operative procedures were observed over the course of two months from various
surgical services. The researchers observed traffic inside the operating room and did not disclose the purpose of the study to personnel. A total 3,071 door openings were found in the 28 observed cases. The researchers observed higher than expected traffic across all specialties, counting 19 to 50 events per hour. The door counter data ranged from 13 to 316 per case and 5 to 87 per hour, both varying by specialty. The average rate of 40 door openings occurred each hour. However, because it took the door approximately 20 seconds to close, the researchers calculated that the door was open for 15-20 minutes every hour. Therefore, if a procedure is one hour, the door is open for one third of the duration of the case.

Lynch et al. (2009) were particularly interested in determining the categorical purposes for entry and exit. They found that the majority of the traffic occurred for information purposes—activities that could have been accomplished through other means including information technology, phone calls, or peering through windows. The other most common reasons for transit were the retrieval of supplies and shift changes which showed little variation by case length. The researchers determined that the circulating nurse and core staff together contributed to 37%-51% of door openings. While the surgeons contributed to 9%-17% of door openings, followed closely by the anesthesia team of 10%-20%. Scrub nurses, technicians, observers, visitors contributed the least amount of traffic in the cases observed. In addition, they found that majority of door openings occurred before incision.

Considering these findings, the investigators brought about initiatives in their institution to reduce traffic in a number of ways. Because they found that staff breaks contributed to traffic, even during short cases, they suggested changing staffing policies. Openings for supply retrieval also frustrated the researchers because even simple cases with little variety in supply choices had as many as eight traffic events for supply retrieval. Again, intending to reduce traffic, the
researchers emphasized the importance of supply policies and up-to-date pick lists and began
debriefing after surgeries to review which equipment was missing or incorrect. This project
hopes to find similar conclusions at HUP so that processes can be improved and foot traffic
reduced.

Recently, few researchers have shown interest in the impact of foot traffic on these
infection control measures. Researchers stated that door openings in operating theatres may
cause distractions which can be a contributory factor for surgical mistakes. A multi-center study
conducted in the UK measured frequency and rate of door opening in cardiac surgery services
using an digital door counter. Data was collected over a three month period and a total of 46
cases were observed in two operating rooms. A total 4,273 door openings were found in 46
cases. An average of 92.9 door openings occurred per a case. Researchers calculated that on
average it takes 20 seconds for the door to close. Therefore, for each case, the door was open for
an average of 31 minutes.

Ayliffe (1991) found that both rates of infection and mean airborne bacterial counts were
lower in the presence of an ultraclean air system—showing the importance of HVAC systems.
The study listed high amounts of airborne organisms as a primary cause of SSI, which increases
with the number of individuals in the operating room and foot traffic. Because clinicians are
necessarily active within the OR environment, airflow measures are not maintained perfectly
during procedures. Using computational fluid dynamics, Brohus et al (2006) showed that the
movement of persons in the OR disrupts the engineered airflow and introduces contaminants to
the clean area around the surgical incision.

Similarly, other researchers have sought to understand the influences of personnel
activity on HVAC infection control in the OR. Tang et al (2005) showed that despite isolation
conditions, infectious air could escape a negative pressure room. Isolation rooms maintain
negative pressure to increase airflow into a room and prevent airborne infectious agents’ escape.
The researchers modeled how opening a door can disrupt the pressure differential and airflow, underminging this important infection control measure in operating theatres.¹⁹

Scaltriti et al (2007) conducted a study of risk factors for particulate and microbial contamination of air in operating theatres by measuring the microbial count of the air compared to the frequency of door opening. They found that dust and fine particulate counts decreased with higher rates of door opening. They considered this to be likely attributed to the negative pressure of the OR forcing air out of the room. In contrast, they found a positive relationship between door openings and bacterial counts—the more frequently the doors were opened, the higher the bacterial count rose. Their conclusions suggest that human movement is the major source of microbial contamination in the OR, but also acknowledge that a linkage between microbial counts, particulate counts, and OR traffic has not been thoroughly established.²⁰

Stocks et al (2010) performed a similar study in which they attempted to use airborne particulates measurements to predict the prevalence of airborne contaminants in surgical theatres. Their data indicated that the number of colony forming units (CFUs), was associated with the number of staff in the operating room and high particulate counts. This lead to the conclusion that a positive relationship exists between the number of personnel in the OR and CFUs at the surgical site. During their data collection, an average of 7.9 clinicians were in the OR and they suggested that practices that limit the number of individuals in the OR during surgeries may be indicated. Additionally, they concluded that airborne particle counters may be an appropriate means of monitoring airborne bacterial contamination during surgeries. ²²
Methods and Procedures

Overview of the Study design

The approach to this study was informed by the Six Sigma Process Improvement framework. There are five component phases; define, measure, analyze, design and verify. The define phase consists of mapping out the project while using a number of process improvement tools. In the measure stage, data collection occurs. In this project, door counters that quantify the amount of traffic in and out of the OR and particulate counters that quantify the amount of particulates in the air will collect quantitative data. Qualitative data will be collected by surveys and in-depth interviews with key stakeholders. During the analyze stage, analysis of the quantitative and qualitative data will point to the problems in the process. The design stage will consist of planning for countermeasures and action plans based on the problems identified in the analysis stage to implement the recommendations to be made. Lastly, recommendations will be created and be given to HUP to implement. When recommendations are implemented, HUP will be able to enter the verify stage and observe the impact measuring counts of foot traffic using a door counter.

This study will focus on two operating rooms located on the fourth floor of the Dulles building at the Hospital of the University of Pennsylvania, Philadelphia PA operating rooms 29 & 30. While there are many other surgical spaces in this institution, these were selected due to the number and type of procedures that occur there each day and the physical construction of the rooms. Additionally, the study provides the opportunity to develop education tools for administration to implement in order to increase awareness of effects traffic has on a patient.
Project Charter

The process improvement procedure at HUP begins with the completion of a charter that both enlists the support of members within the institution and maps out the steps for its completion. The charter becomes the groundwork for the process improvement tools to be implemented. The tools are provided as part of the process improvement framework and provide methods for both qualitative and quantitative data collection and analysis. As described in the charter, following data collection, results will be analyzed, and methods for improvement will be identified and implemented. (Appendix A)

Stakeholder Analysis

Once the charter had been completed, a stakeholder analysis was conducted to identify who will be affected by this project. It provided an educated estimate of the extent to which the key players are currently invested in this initiative as well as what level of investment will be needed for them to participate in the desired behavior change. These stakeholders include administration, surgeons, anesthesiologists, residents, charge nurses, circulating nurses, patient transport, and environmental services. (Appendix B)

Value Stream Mapping

Value Stream Mapping is a valuable tool from the Six Sigma Program. This tool was used to outline and map out our perceptions of the current process at hand. It was done specifically for the two Dulles ORs, that are the subject of study. This tool highlighted how long the surgical process takes from developing the pick list to closing the patient, who is involved,
what are the steps, the lead time from one step to another and how often the steps in the process occur correctly and pointed out any potential wastes. (Appendix C)

Voice of the Customer

To learn the perspectives of the clinicians and other stakeholders, a Voice of the Customer tool was utilized. A survey was administrated to nurses, service partners, residents and various clinicians that highlighted four questions: “Do you feel there is excessive foot traffic passing in and out of the OR during surgical cases?”, “Do you think excessive foot traffic has an impact on infection control?”, “What is the most common reason you enter or exit the OR during a case? Equipment? Clinical or Personal Communication? Supplies? Exiting/Entering to begin and end case? Other?”, “What do you feel is the most common reason for the majority of staff entering or exiting the OR during a case? Supplies? Equipment? Clinical or Personal Communication? Exiting/Entering to begin and end case? Other?.” Each respondent was asked to answer all questions and only select one answer to each question. Responses to these questions determined the current attitudes and awareness of this issue, as well as identified possible problems with the current process. The surveys were distributed using an online service called “Redcap” and on two occasions in two locations. The first took place during a weekly nurse in-service. All of the participants on this day were registered nurses. The second survey distribution attempted to gather data from a larger variety of service roles. To do this, the researchers approached potential participants in the “SNACU” during lunch time. Although other roles were represented in this sampling, most of the respondents were nurses. The composition of the roles of the survey respondents is represented in table four in Appendix K. Appendix D specifically states questions asked.
**Interviews**

Additionally, in-depth interviews shed light on infection control practices in the OR. Interviews with individuals trained and experienced in the areas of architecture and infectious disease contributed to understanding how the physical environment of the OR complements other infection control measures. An architect specializing in HVAC systems described the contributions of laminar flow, air filtration, and temperature to infection control. Questions asked of the architect are shown in Appendix E. The Director of Infection Prevention and Control from the infectious disease department at HUP gave her point of view on the potential effect of excessive OR traffic flow. An attending anesthesiologist provided an important point of view of the process because anesthesiologists are involved in heavy OR traffic. Additionally, brief and small focus groups with the Quality Council and support staff provided an in depth perspectives of OR traffic. Appendix F shows the questions asked of these clinicians.

**Spaghetti Diagram**

A spaghetti diagram, a tool that maps out where clinicians go, was completed by shadowing various clinicians in OR 29 and 30 during cases. This tool provided information on how long clinicians leave the OR, where they go, and if any unexpected occurrences delay them from going back to the operating room efficiently. (Appendix G)

**OR Observations**

Direct observations of the operating rooms during procedures allowed a greater understanding of the surgical process. At this time, hand counts of door passages were taken to compare to the door counter for verification and to observe the various causes of OR traffic.
Door Counter

To quantify the amount of foot traffic in the Dulles OR, two door counters were purchased and installed at the entrances to OR 29 and OR 30. These door counters provided a count of how many people enter and exit the OR over time and are recorded by the hour. The counts provided were matched to the NaviCare system. This system records the details of each case and includes timestamps for when the patient enters the room, time of incision, and time of close. Other data is recorded including the room number, surgical service, and surgeon. For the purposes of this project, the focus was how many passages occurred during a case. The time of a case was defined as from incision to close as listed in the NaviCare system. The door counts the corresponded to timestamps “incision” and “close” in the NaviCare system were selected as traffic that occurred during a case.

Particulate Air Monitor

To investigate and quantify particulate count in the Dulles OR, a TSI P-Trak ® was placed near the doors in OR 29. The monitor provided continuous measurement of particulates per cubic cm (pt/cc) in the OR throughout the day. The data was compared to the door counter data to find a relationship between the amount of passages during a surgical case and particulates in the air. Additionally, the TSI Q-Ttrak ® provided continuous measurement of percent humidity (% h), temperature (°F) and CO2 concentration (parts per million) in the OR throughout the day. The data was compared to the door counter data to look for a correlation with amount of door passages.
Data Analysis

Door counts taken from OR29 and OR30 were analyzed by calculating descriptive statistics of door passages. T-Tests tested the difference between the rates of traffic in the two rooms. In depth analyses compared traffic by case order, length of case, and surgical service in both rooms. Traffic was graphically presented and compared to the particulate counts, humidity, temperature, ad carbon dioxide over time.

Recommendations

The final intent of the project was to provide recommendations for the hospital based on information collected in the literature review, interaction with hospital personal, and analysis of data from door counter and particulate air monitor. The aim of the campaign will be to create awareness to clinicians and personnel of the impact excessive OR traffic has on patient outcomes.

Results

Door counter data was collected for five weeks beginning in February and ending in early-April 2012. Not counting weekends and days the counters were malfunctioning, a total of 70 days of data were available for analysis. Room 29 provided 37 days of data, and 33 days of data were available for room 30. A total of 42,198 door passages were recorded over 1,680 hours in both rooms combined, and 25 passes per hour on average over 24 hours a day. A total of 24,437 passages occurred in room 29 and 17,761 occurred in rooms 30. While there is an observable pattern in which the counters in room 30 consistently measured more passages than
the counter in room 29, there was no statistically significant difference determined by a two-tailed t-test (p=0.2052).

At the end of each week, door counts were pulled and matched with NaviCare data to determine during which hours cases were in progress. A total of 108 cases spanning 411 hours were available for analysis. In room 29, there were 226 hours of available data spanning over 57 cases. Cases in room 30 totaled 185 hours over 51 cases. The number of passages during cases was significantly different between the two rooms (p< 0.001). The average number of passages per hour in room 29 was 37.8 during cases, and the median was 32 per hour. In room 30, the average number of passages was 26 per hour and the median was 24. Together, the average number of passes per hour was 33 and the median was 28 passes per hour.

*Daily Hourly Trends*

To discover patterns that were associated with heavy traffic throughout the day, means and medians were calculated by room and hour of day which are shown in figures 1 and 2.

![Figure 1 Comparison of average passages in OR 29 & 30](image)
Because the door counters collected data 24 hours a day, closer consideration was taken for data that was considered to be during peak hours, 7:00am to 4:00pm. Of the total door passages, 25,048 took place during peak hours. Door passages during peak hours for the two rooms combined accounted for 60% of the total passages. The average number of passages was 40 per hour during peak hours and the median was 38.5 passages per hour.

Surgical Service

A variety of surgical services were represented in both of the rooms. The surgical service from the NaviCare list was matched to the door counter data. The number of cases in each
service as well as the measured passages per case and passages per hour are represented in the following table 1.

**Table 1: Number of cases and passages by surgical service**

<table>
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<tr>
<th>Surgical Service</th>
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<td>398</td>
<td>13170</td>
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**Case Length**

Initial hypotheses and previous studies both suggested that OR traffic would increase with case length. Case length was measured using NaviCare data, and then matched to the door counter to quantify the traffic during the time period indicated. Most cases were 3-4 hours long as described in figure 3.
When studying only the first three hours of the cases, the data shows that the most traffic occurs during the first hour of the procedure, about 30%. Although there are differences between the rooms, both show a decrease over the three-hour period.

**Case Order**

Another hypothesized explanation for high OR traffic was related to the time of day the case was performed. Cases that occurred earlier in the day were thought to have different amounts of traffic than those that took place later. Case order was identified using NaviCare and matched to door counter data. An average of 35 passages per hour with a median of 30 was found during 94 first cases analyzed. 39 second cases were analyzed. An average of 29 passages per hour and a median of 26.5 was found. Total of 4 third cases were analyzed and an average of 32 passages per hour with a median of 28 was found. Therefore, more traffic was observed
during the first case of the day. Please See Table 2 in Appendix H and figure 4 below for more detail.

![Average and Median passages per hour by case order](image)

**Figure 4** Average and Median passages per hour by case order

**Particulate Data**

The particulate counts were collected over two days in OR 29. Specific details of the procedure are available in Table 3 in Appendix I. The data output from the particulate monitory gave a reading of particulate concentration every minute. The fluctuating concentrations were graphed along with door traffic throughout the day and no relationship was apparent between the traffic and air particle concentration.
Figure 5 Frequency of particulates compared with door passages per hour on day one

Figure 6 Frequency of particulates compared with door passages per hour on day two
Qualitative Results

Qualitative research was conducted to understand the opinions, roles, interest, and participation in OR traffic among staff. One of the methods employed was the distribution of a four question, multiple-choice survey (Appendix D). The survey was completed by 128 individuals, the majority of whom were surgical residents, RN’s and service partners. The survey was distributed online and during the nursing in-service as described in table four in Appendix K.

Figure 7 Frequency of temperature, humidity, CO2 levels compared with door passages
Perceptions of the current rates of OR traffic varied little by surgical role. The majority of respondents, about two-thirds, felt there was excessive foot traffic during surgical cases, as indicated by the first question.

<table>
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<th>Q1: &quot;Do you feel there is excessive foot traffic passing in and out of the OR during a surgical case?&quot;</th>
<th>Yes</th>
<th>No</th>
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<td>Residents</td>
<td>68%</td>
<td>32%</td>
</tr>
<tr>
<td>RN and Support Staff</td>
<td>64%</td>
<td>34%</td>
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</table>

Surprisingly, there was much more variation by surgical role for question two. Most nurses and support staff, 81%, felt that excessive foot traffic has an impact on infection control, compared to the minority of surgical residents, 43% that agreed.

<table>
<thead>
<tr>
<th>Q2: &quot;Do you think excessive foot traffic has an impact on infection control?&quot;</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residents</td>
<td>43%</td>
<td>57%</td>
</tr>
<tr>
<td>RN and Support Staff</td>
<td>81%</td>
<td>18%</td>
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</tbody>
</table>

In question three, participants described the reasons they entered and exited the OR during a case. These responses differed by OR role when grouping RNs with support staff compared to surgical residents. The variations among RNs and support staff were fewer (see Appendix K for more detailed representation of survey responses by OR role). As expected, the most commonly cited reasons for entrance or exit during a case were “supplies” and “clinical communication” among nurses and support staff. No residents reported “supplies” or “equipment” as reasons for transit and most commonly enter or exit at the beginning or end of
the case or for clinical communication. A small percentage of respondents selected “Other” and listed reasons not available for selection: “checking on students”, “scrub tech”, “working”. A more detailed description of all selected responses for each of the responses is available in Appendix L.

Question four asked participants what they feel is the reason for others entering and exiting the OR during a case. Interestingly, these responses varied from question three in some cases. Similarly, a few participants selected “Other” and provided responses: “pass through”, “clinical communication: attending entering/exiting who are managing multiple rooms, change in staff, breaks for lunch or short breaks during a case,” personal communication: techs talking to
each other NOT necessary, very disruptive,” “working,” “staff breaks,” “attending anesthesiologist,” “surgical residents with questions or patient info.”

Figure 9 Residents vs. RN & Support staff compared answers to question four

**Student Observations and Spaghetti Diagram**

In an effort to observe the causes for OR traffic, the researchers observed the operating rooms during procedures. During this time, the reason and destination of an individual entering or exiting the OR was identified, as well as their role in the staff. The total number of door passages was tallied to verify the validity of the door counter data which was found to be consistent with the number of passages recorded by the observation.
Researchers recorded the destination and purpose of transit when possible. Speaking on the phone (4), scrubbing into surgery (5), bathroom breaks (3), nurse bringing supplies (3), circulating nurse to sterile core (3), and deliverance of supplies from support staff (8) were the most common reasons for traffic. Other results are recorded and available in Appendix J.

During observations, researchers completed a spaghetti diagram. The diagram shows Anesthesiologist tech, anesthesiologist attending, surgeon, nurse and medical student travel paths after leaving the OR during a surgical procedure. Checking in on other procedures and leaving the surgical ward were reasons for traffic caused by the anesthesiologist attending. Please see Appendix G for more detail.

Discussion

In this study, foot traffic in two surgical theaters was quantified. Seemingly high rates of passages were found in both rooms. While there are no suggested numbered limits for traffic, AORN has recommended that unnecessary traffic be kept to a minimum. The surveys and observations in this study suggest that many of the passages that occurred during the cases in Dulles could be reduced. The data shows that on average 33 passages occur per hour during a case. Meaning every 1.8 minutes, a person is either leaving or entering the operating room. By modifying this practice, the chances of poor patient outcome may be reduced. Specialists have stated that increased rates of traffic may be a determinant of SSI. Additionally, that increase in traffic can contribute to surgical mistakes. Qualitative research also suggests that many of the passages that occurred during cases could be reduced.

The daily patterns indicated by the door counter data reflected what had been expected. There were higher passages during the peak hours of the day, when most surgical procedures are
scheduled to take place. The traffic that takes place in the early morning hours represents the
activities that occur to prepare a room for the first cases of the day. The traffic during the peak
hours varied, and while the difference between the two rooms was not found to be significantly
different between the two rooms, there was an observable pattern. When only considering traffic
that occurred while cases were in progress, there was a statistically significant difference
between the two rooms. This is most likely explained by the presence of the second door in OR
30. The second door that leads to a semi-sterile core should not be used by staff for passage, but
rather for access to necessary supplies. The consistently lower rate of traffic in OR 30 suggests
that staff is, in fact, using this door for exit and entry into the operating room throughout the
procedure. This may have implications for infection control.

The researchers had not hypothesized a relationship between surgical service and traffic;
other studies had shown that all services have high rates of traffic. However, logically, it could
be suggested that services that perform more complicated procedures, e.g. cardiovascular
surgery, could have more traffic. Analysis of the traffic recorded in this study did not consider
the complexity of each case, but rather the surgical service. Additionally, some services were
underrepresented and because a limited number of cases analyzed, this analysis is incomplete.
For instance, some surgical services had only one case analyzed therefore an accurate
comparison could not be made for those services and those that had a higher number of cases.

With the data analyzed by the researchers, each of the surgical services’ average passages per
hour ranged from 22-45 and a median average of passages per hour ranged from 20-39. The
intent of comparison among surgical services was not to identify which services should be
targeted with the highest rates of traffic, but rather to suggest that clinicians from all specialties
likely contribute to excessive OR traffic to a relatively equal extent.
The door counter data was also analyzed by case order. The hypothesis had been that the first case of the day should have the least amount of door passages because it would have the most time to be prepared for surgery. Fewer passages would be needed for reasons related to supplies and equipment. Surprisingly, analysis of the data did not show this correlation. On average, the first case had more passages per hour than the later cases. However, there were 64 first cases and 39 second cases analyzed, while there were only 4 third cases in each room. When comparing only the first and second cases, there were more passages per hour in the first case. When presenting the data to clinicians, one physician suggested that his colleagues may be mindful of their later cases while the first case is in progress. The second cases may then be better prepared because they are on site and communicating with those who prepare the rooms. With this input, the support staff can more efficiently prepare the room for the second case.

One model study conducted by Lynch, et al (2009) had found a positive correlation with case length and door openings per hour. The door counter data in this study did not increase proportionally with case length as suggested. The data showed that shorter cases had more average passages per hour than the longer cases. One underlying assumption for a comparison of case length and traffic is that longer cases are more complex than others. While this may be the case, as noted previously, this study did not include a measure of case complexity. A study that compares complexity with OR traffic may have more compelling results. If a case is relatively simple, regardless of the length, one might suggest that the amount of traffic should be lower. This was not captured through the measure of case length. On the other hand, researchers in the Lynch, et al (2009) study found that there were high rates of traffic related to staff breaks, even during shorter cases. If much of the traffic that occurs during shorter cases is related to breaks, traffic could be reduced by altering the breaking policies.
Studies have suggested that increased passages in the OR limit the effectiveness of the ventilation systems that are meant to reduce infection because levels of contaminants and particulates increase each time a passage is made. Unfortunately, the data from this research was unable to show such a relationship. The highest count of particulates in the air occurred during periods of fewer door passages. The limitations of the study have not allowed an accurate conclusion.

The particulate counts were potentially confounded by a number of other factors. It is possible that the entrance and presence of additional personnel in the operating room leads to higher particulate counts, but other surgical activities, such as cauterization, may lead to higher readings on the particulate counter, masking the appearance of particulates that resulted from traffic. Unfortunately, there is no way to distinguish between foreign particulates that entered the OR via traffic and those that are derived from the surgical process. Similarly, high particulate counts are not inherently dangerous. The composition of the air particulates is unknown--it cannot be assumed that all fine particulates are virulent. Finally, only two days of particulate counts were collected. High particulates cannot be directly related to OR traffic or surgical infections, however, this technology may be useful in further studies that seek to understand how these two variables are related to OR traffic.

Even if the amount of traffic could not be tied to particulate counts in the air, traffic could indirectly impact infection by altering the operating environment. Measures of humidity, carbon monoxide, carbon dioxide, and temperature tracked throughout the day were compared to the rates of door traffic. Both the measures of humidity and temperature fluctuated throughout the day, but not outside of the parameters recommended by ASHRAE. None of the measures seemed to be strongly influenced by traffic patterns, even when it was particularly high. Again, the
amount of data available was limited to one day, in one room. Further studies may illuminate relationships that this data was unable to capture.

Qualitative data was collected to understand clinicians’ behaviors and perceptions surrounding traffic in operating rooms. As expected, both varied by surgical role. Observations in the OR indicated that the amount of traffic as well as the reasons for passage varied by position. Similarly, the surveys showed variation in both opinions about OR traffic and self-reported participation among different types of clinicians. This notion is paramount in understanding OR traffic and for the development of programs to reduce OR traffic in the future.

One fascinating outcome of the survey results was the differences in perceptions of OR traffic. The first two questions of the survey asked clinicians if they felt there was excessive traffic in the OR and if they felt there was an impact on infection control. 80% of nurses felt that excessive OR traffic has an impact on infection control. These results suggest that nurses may be more inclined to participate in traffic reducing behaviors because they feel there is an impact. An initiative to reduce their contribution to traffic would be most effective if it focused on how to change behaviors and improve systems. In stark contrast, less than half of the residents surveyed, 43%, felt that infection control was impacted by OR traffic. Without evidence that links traffic with infections or poor outcomes, these clinicians are less likely to engage in traffic reducing behaviors. Unfortunately, there is no conclusive data available proving that heavy OR traffic causes infections. This has been a major limitation of this study, and will continue to inhibit traffic reducing measures until the relationship is better understood.

The third and fourth questions in the survey were intended to find the major reasons for passages into and out of the OR. Previous studies have collected observational data measuring
reasons of excess traffic in operating rooms. Lynch et al (2009) found that 27%-54% of traffic was related to communication, 11%-22% due to supplies, and 20%-26% was due to breaks. The survey data found similar results. When clinicians’ were asked why they leave the operating rooms 46% of clinicians stated it was due to supplies, 26% due to clinical communication and 23% due to simply entering or exiting to begin or end a case. However, when asked why they believe staff leaves the OR, 43% said due to supplies, 28% due to clinical communication and 21% stated due to equipment.

Once again, to understand the purposes for transit, consideration must be given to individual OR roles. For example, residents stated the main reason they enter or exit the OR was for clinical communication (46%), and none of the residents stated that they leave the OR due to supplies and equipment. Retrieving supplies and equipment is not under their job description, but were major reasons for transit among nurses and support staff. Political and procedural initiatives that seek to reduce OR traffic will need to be considerate of this. Some suggestions to reduce traffic have included updating pick-lists and debriefing after a case to review equipment use and status. This may be a helpful tool to reduce traffic in which supplies and equipment are major reasons for transit. However, this will not reduce the traffic contribution of residents and attendings; their major reasons for entrance are categorically communication. In fact, in response to the reviewing the data, a surgeon mentioned that residents are encouraged to enter the OR to speak to their attending physician rather than call them on the phone, even if they are not participating in the case. Therefore, improvements and tools for communicating with attendings inside the OR and stricter policies for who should be in an OR during a case could reduce communication related traffic among residents.
The spaghetti diagram and the researcher’s observations validated the findings found in the qualitative research. Supplies, equipment, communication and breaks were main reasons clinicians left or entered the OR. However, bathroom breaks and scrubbing in were other reasons clinicians exited or entered the OR. Defining which activities constitute necessary traffic (scrubbing in/out, beginning and end of case) and excessive traffic (personal phone calls and unnecessary communication) is difficult to document as an observer, and complicates the design of traffic reducing interventions.

Many interviewees indicated that political or cultural interventions would likely require buy-in from upper management based on evidence that OR traffic is related to infection. However, there are good reasons to believe that high OR traffic can compromise infection control. Several of the environmental measures are related to controlling the ambient air, and because of the devastating effects of SSIs, precautions should be taken. Additionally, the researchers’ observations and survey results indicate that some of the traffic can be avoided.

Due to time and availability, the number and range of surgeries observed was limited. The study is also limited to only inpatient surgeries and only those that take place in the identified operating rooms. The door counter measures passages rather than door openings, which is both a strength and weakness of the study. Other studies used door openings as a proxy for the number of individuals who passed. Counting individuals gave a better measure of the actual traffic in our study. On the other hand, because a major component of the argument to reduce traffic is predicated on the idea that opening the door undermines the efforts of the HVAC systems, counting the number of individuals who enter and exit does not capture the extent to which the door is opened and the efficacy of those measures reduced.
Other analyses were impaired by data collection restraints. The door counters time stamp by hour which became difficult when matched with the NaviCare if time of incision or close was during the hour. Therefore, use of total door counts for the whole hour skewed the validity of our data. Also, the analysis of OR 30 was altered by the back door which contributed to passages not included in collection and analysis. A door counter had been installed but was not operational. In the future, OR traffic could be monitored through this passageway.

The traffic that is observed in these rooms may be higher for teaching purposes than it would in a non-academic institution. Additionally, some OR traffic is necessary, for instance shift changes, surgical attending coming into OR to check on residents, emergencies, etc. Not all traffic recorded will have an attributed purpose because we are not always able to interact with the clinicians. Additionally, the particulate data was only collected for one day and one room. Also, because we were only able to match one surgical case using the particulate data, an accurate conclusion cannot be made regarding relationship with particulate and number of passages. The most important limitation to the study was that the researchers were blinded to patient information and outcomes. Therefore, they were unable to show that high foot traffic leads to SSIs in the cases that were observed.

Recommendations

In the absence of hard evidence that shows that high traffic leads to surgical site infections and without the ability to distinguish absolutely what constitutes excessive traffic, it is difficult to reduce traffic. Therefore, awareness campaigns through education and continuous monitoring and enforcement from upper leadership may be the best strategy to change the current traffic behaviors. Signs placed in the PeriOperative space and memos sent to clinicians
will increase awareness and educate those regarding potential negative consequences of traffic. Enforcement from upper management will exemplify new behavior changes that need to be made and showcase the importance of reducing traffic. Presentation of the door counts has been relatively shocking to PeriOperative quality council. Simply learning that more than half of the time, over 30 people enters a room during a case may discourage someone from entering a room if not entirely necessary.

Appendix M provides examples of signs that could be placed throughout the OR halls and on doors. The first two signs are based on the premise that people are currently unaware of how much traffic happens each day and hour. Additionally, knowing that their actions are being monitored and counted, clinicians are likely to be more conscious of their actions. When clinicians noticed observers in the surgical suite, they assumed hand washing behaviors were being documented and became consciously compliant. Knowing door traffic is being monitored may influence them in the same way. The other signs suggest clinicians find alternative methods or wait until after a surgery. With increased awareness of how much traffic is currently occurring, clinicians will be more informed to make better decisions. Even if they are unsure of the impacts and do not fully buy-in on the idea that high rates of traffic are related to infection control, these signs may influence their behaviors without greatly impeding their work.

As suggested by other studies, updating current picklists to fit individual surgeons at HUP will reduce traffic needs for supplies and equipment purposes. Also, the infectious disease specialist stated that there are other behavioral factors that may contribute to SSI’s including, surgical attire and inanimate objects that make it more difficult to draw a direct relationship with OR traffic and SSI’s.
Conclusions

The purpose of this study was to measure and understand foot traffic in two operating rooms at HUP. Additionally, a literature review to document the link between traffic and SSI was conducted, but a causal relationship has not yet been found. Given the ambiguity of the relationship between these two variables, the researchers recommended that voluntary participation in traffic calming measures is indicated. An awareness campaign that targets the problem areas identified by the surveys and interviews may be the best method until more research is completed to understand the impact of foot traffic in ORs. Future studies are needed, and monitoring of OR traffic should continue in hopes of improving patient safety and outcomes.
LIST OF REFERENCES


11 P. Shapiro, personal communication, November 17, 2011.


15 Simmons. CDC guidelines on infection control. 187-196.


Young, R.S., & O'Regan, D.J. (2009). Cardiac surgical theatre traffic: time for traffic calming measures?. *Interactive Cardiovascular and Thoracic Surgery, 10*, 526-529.

Appendix A- Project Charter

**Charter Title:** Increase Awareness of the Impact of High Volumes of Foot Traffic in Dulles Operating Rooms on Patient Outcomes Among Clinicians and Support Staff

### 1. Issue/Problem/Purpose
The traffic of individuals entering and exiting the OR during procedures introduces risk to the surgical procedures by increasing sources of airborne infectious agents and decreasing the effects of infection control measures of the OR.

**Customer name:** Patients, Nurses, OR Staff

**Characteristic to improve:** Traffic flow

### 2. Product/Unit
Validate traffic flow

### 3. Defect
Doors to the OR are opened frequently and remain open for extended periods of time during procedures, personelle enter and exit through doors excessively to communicate with other staff and/or prepare for procedures by retrieving supplies

### 4. Metric(s) to Improve
- **Current**: TBD in measure phase
- **Goal (S.M.A.R.T.):** TBD in research phase
- **Date to Achieve**: TBD from day one of training

**Process Owner(s):** Responsible for the design, continuous improvement and sustaining the process.

**Project Leader:** Meneka Bansal and Laura Hackenberger

**Description:** Leads the team and execution of the methodology. Shares prime responsibility with Champion for success.

### 5. Financial Impact Metrics:

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<td>$ Annualized Amount</td>
<td>Signature</td>
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</table>

### 6. Scope
- **6. Scope:** What must be included or excluded is...

- **Patient in room from induction to patient exit**

- **Dulles Operating Rooms 29-32**

- **Excluded:** all other OR at HUP and Surgi Center

**Team Members**
- Laura Hackenberger
- Meneka Bansal

### High Level Project Plan:

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## Appendix B-Stakeholder Analysis

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<th>Process Owner</th>
<th>Decision-maker Approver</th>
<th>Target of the change</th>
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<th>Current level of Buy-In to change Rate 0-10 with 0 being no need</th>
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Appendix C - Value Stream Mapping
Appendix D-OR Traffic Survey Questions

Please complete and return to the Drexel student team after completion

PerioOp Quality Council has engaged this graduate student team to study OR traffic patterns during cases and as part of this study we need to understand the habits/culture of the OR. Your feedback in addition to direct observations of traffic will help us determine how traffic in and out of the OR should be managed during cases.

1. Do you feel there is excessive foot traffic passing in and out of the OR during a surgical case?
   A. Yes
   B. No

2. Do you think excessive foot traffic has an impact on infection control?
   A. Yes
   B. No

3. What is the most common reason you enter or exit the OR during a case?
   A. Supplies
   B. Equipment
   C. Clinical Communication
   D. Personal Communication
   E. Exiting/Entering to begin and end case
   F. Other____________________

4. What do you feel is the most common reason for the majority of staff entering or exiting the OR during a case?
   A. Supplies
   B. Equipment
   C. Clinical Communication
   D. Personal Communication
   E. Exiting/Entering to begin the end case
   F. Other____________________
Appendix E - Voice of the Customer (In depth Interview Questions)

1. Who is entering and leaving the OR?

2. What are the reasons others are entering and exiting during procedures?

3. Why do you enter or leave the OR during a case?

4. Do you ever choose not to enter the room? If so, why?

5. Do you believe your colleagues enter and exit the room during procedures excessively?

6. Do you the number of people entering and exiting the OR has an impact? If so, please explain?

7. What could be done differently to achieve these goals without entering or exiting the OR?

8. How do you think we can reduce the foot traffic?
Appendix F-HVAC Questions

1. What is laminar flow?

2. What is positive pressure? And how is that achieved through an HVAC system?

3. What is sterile/non-sterile air?

4. How might these be affected by door opening?

If so, does the proximity of the patient to the door change the affects of these airflow measures?

5. What systems were installed in the Dulles rooms to achieve appropriate levels for surgery in the following areas:
   - Air Filtration
     - HEPA filter
     - UV filter
     - Return system
   - Temperature
   - Humidity
   - Pressurization
     - Positive pressure
   - Airflow
     - Laminar flow

6. How many air exchanges per minute does the system provide?
Appendix G-Spaghetti Diagram
## Appendix H-Case Order Details

### Table 2

<table>
<thead>
<tr>
<th></th>
<th>First cases</th>
<th>Second cases</th>
<th>Third cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>64</td>
<td>39</td>
<td>4</td>
</tr>
<tr>
<td>#hours</td>
<td>261</td>
<td>128</td>
<td>9</td>
</tr>
<tr>
<td>Mean passes per hour</td>
<td>35</td>
<td>29</td>
<td>32</td>
</tr>
<tr>
<td>Median passes per hour</td>
<td>30</td>
<td>26.5</td>
<td>28</td>
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</table>
## Appendix I-Particulate Counter Case Data

### Table 3

<table>
<thead>
<tr>
<th>Particulate concentration (pt/cc)</th>
<th>Day 1</th>
<th>Day 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>317</td>
<td>296</td>
</tr>
<tr>
<td>Minimum</td>
<td>7</td>
<td>18</td>
</tr>
<tr>
<td>Time of Minimum</td>
<td>8:50:46</td>
<td>7:48:19</td>
</tr>
<tr>
<td>Maximum</td>
<td>3814</td>
<td>18598</td>
</tr>
<tr>
<td>Time of Maximum</td>
<td>9:28:46</td>
<td>14:18:19</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>Service</th>
<th>GYN</th>
<th>UROLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Case</td>
<td>PT in room</td>
<td>7:27</td>
<td>7:21</td>
</tr>
<tr>
<td></td>
<td>Incision</td>
<td>8:25</td>
<td>7:53</td>
</tr>
<tr>
<td></td>
<td>Close</td>
<td>12:30</td>
<td>10:56</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Service</th>
<th>GYN</th>
<th>UROLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second Case</td>
<td>PT in room</td>
<td>14:02</td>
<td>12:22</td>
</tr>
<tr>
<td></td>
<td>Incision</td>
<td>14:53</td>
<td>12:58</td>
</tr>
<tr>
<td></td>
<td>Close</td>
<td>16:10</td>
<td>15:41</td>
</tr>
</tbody>
</table>
Appendix J-Student Observations

Door counts

<table>
<thead>
<tr>
<th>Time frame</th>
<th>Passages</th>
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<tbody>
<tr>
<td>8:00-8:30</td>
<td>23</td>
</tr>
<tr>
<td>8:30-9:00</td>
<td>10</td>
</tr>
<tr>
<td>9:00-9:30</td>
<td>8</td>
</tr>
<tr>
<td>9:30-10:00</td>
<td>9</td>
</tr>
<tr>
<td>10:00-10:30</td>
<td>32</td>
</tr>
</tbody>
</table>

Details of the case

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:21</td>
<td>Patient in Room</td>
</tr>
<tr>
<td>7:36</td>
<td>Induction</td>
</tr>
<tr>
<td>7:41</td>
<td>Ready for Surgeon</td>
</tr>
<tr>
<td>8:10</td>
<td>Incision</td>
</tr>
<tr>
<td>10:31</td>
<td>Closing</td>
</tr>
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</table>
Appendix J (cont)

Recorded reasons for transit

<table>
<thead>
<tr>
<th>Event</th>
<th># Occurrences</th>
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<tbody>
<tr>
<td>Speak on phone</td>
<td>4</td>
</tr>
<tr>
<td>Speak to another person</td>
<td>2</td>
</tr>
<tr>
<td>Scrub in</td>
<td>5</td>
</tr>
<tr>
<td>Use the bathroom</td>
<td>3</td>
</tr>
<tr>
<td>Surgeon Finished</td>
<td>1</td>
</tr>
<tr>
<td>Going on break</td>
<td>1</td>
</tr>
<tr>
<td>Nurse bringing supplies</td>
<td>3</td>
</tr>
<tr>
<td>Vender</td>
<td>1</td>
</tr>
<tr>
<td>Returning from break</td>
<td>1</td>
</tr>
<tr>
<td>Circulating nurse trip to core</td>
<td>3</td>
</tr>
<tr>
<td>Support staff delivering supplies</td>
<td>8</td>
</tr>
<tr>
<td>Attending Anesthesiologist</td>
<td>3</td>
</tr>
</tbody>
</table>
## Appendix K-Survey Respondent Profile

### Table 4

<table>
<thead>
<tr>
<th>Survey distribution</th>
<th>OR Role of Respondent</th>
<th>n=</th>
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<tbody>
<tr>
<td>RedCap Online</td>
<td>Residents</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Attending Physician</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>2</td>
</tr>
<tr>
<td>Nurse In-Service</td>
<td>RN</td>
<td>68</td>
</tr>
<tr>
<td>SNACU</td>
<td>Service Partners</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Instrument Processing</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Anesthesia Tech</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>X-Ray Tech</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Perfusionist</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>OR Tech</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>RN</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>128</strong></td>
</tr>
</tbody>
</table>
Appendix L - Questions 3 & 4 survey responses

Q3: "What is the most common reason you enter or exit the OR during a case? (CIRCLE ONE)"

- Supplies: 39%
- Equipment: 22%
- Clinical Communication: 20%
- Personal Communication: 12%
- Exiting/Entering to begin and end case: 4%
- Other: 2%

Q4: "What do you feel is the most common reason for the majority of staff entering or exiting the OR during a case? (CIRCLE ONE)"

- Supplies: 37%
- Equipment: 24%
- Clinical Communication: 18%
- Personal Communication: 8%
- Exiting/Entering to begin and end case: 6%
- Other: 6%
Appendix M- Sample materials for awareness campaign

600 People will go through these doors today . . .

. . . don’t just follow the crowd. Help reduce traffic in our ORs.
Did you know...  

On average, people go through this door PER HOUR?!
HELP REDUCE OR TRAFFIC

**DO NOT ENTER** if you do not have an urgent purpose

**LIMIT** unnecessary trips by ensuring you have all of the proper materials before the start of the case.

**DELAY** personal communications for another time.

**DO** use other means of communicating with individuals within the OR during cases. **BE MINDFUL** of your contribution to the traffic.
PLEASE LIMIT TRAFFIC AND ENTER ONLY IF NECESSARY

PLEASE KEEP ALL OR DOORS CLOSED
STOP and THINK Before Entering

Is it NECESSARY?
Can it WAIT until after the case?
Can I call on the phone?

PLEASE LIMIT UNECESSARY TRAFFIC

Please keep all OR doors close