Association Between Surgical Site Infection Rates and Operating Room Traffic Including Frequency of Door Openings

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ABSTRACT

Background: Surgical site infections (SSIs) continue to pose a significant challenge in surgical care, particularly in resource-constrained settings. Although patient and procedural factors are well documented, the impact of operating room (OR) traffic and frequent door openings on SSI risk remains underexplored in Indian hospitals.

Methods: This prospective observational study was conducted at Parul Sevashram Hospital, Vadodara. Two hundred adult patients undergoing surgery across Orthopedic, Cardiac, Obstetrics & Gynaecology, Urology, and General Surgery theaters were included. Door opening events were recorded in real time throughout each procedure. Patient demographics, surgical details, wound class, and OR environmental factors were documented. SSIs were prospectively monitored for 30 days using CDC/NHSN criteria. Data were analysed using descriptive statistics, chi-square tests, and binary logistic regression.

Results: The overall SSI incidence was 6.0% (12/200), with superficial infections accounting for 75% of cases. Forty percent of procedures had more than 50 door openings, with the highest activity occurring during the intraoperative phase. A strong dose-dependent association was found between door-opening frequency and SSI ($p < 0.001$). Binary logistic regression identified door openings >50 as the strongest independent predictor (adjusted odds ratio 4.78, 95% CI 2.01–11.34, $p < 0.001$), followed by poor traffic compliance (AOR 3.37), surgery duration >2 hours (AOR 2.94), and clean-contaminated wounds (AOR 2.16).

Conclusion: Frequent door openings and poor OR traffic control are important modifiable risk factors for postoperative SSI, even in theatres with adequate ventilation infrastructure. Simple measures to minimise unnecessary door openings and improve team discipline may significantly reduce SSI rates in similar Indian hospital settings.

Keywords: Surgical site infection, Operating room traffic, Door openings, Infection prevention.

CHAPTER ONE: INTRODUCTION

Background of the Study

Surgical site infections (SSIs) continue to represent one of the most common and burdensome complications following operative procedures worldwide. These infections not only prolong hospital stays and increase healthcare costs but also contribute to patient suffering, delayed recovery, and, in severe cases, life-threatening sequelae. In many low- and middle-income settings, including India, the challenge is compounded by variable infrastructure, high surgical volumes, and resource constraints that make consistent adherence to infection prevention practices difficult [2].

Globally, the pooled incidence of SSIs has been estimated around 2.5%, yet rates vary dramatically by region and healthcare context. In India, hospital-based studies have reported figures ranging from approximately 5% to as high as 18–30% in certain settings, with higher burdens often observed in emergency procedures, contaminated wounds, or prolonged operations. For example, multi-center surveillance efforts across Indian tertiary centers have documented an overall SSI rate of around 5.2%, with notable variation between institutions and surgical specialties. Obstetric, orthopedic, and abdominal procedures frequently show elevated risks, reflecting the interplay of patient factors, procedural complexity, and environmental influences [3, 4].

While traditional risk factors such as patient comorbidities (diabetes, malnutrition), prolonged preoperative hospital stays, and wound contamination class have long been recognized, attention has increasingly turned toward modifiable elements within the operating room (OR) environment itself. Among these, operating room traffic particularly the frequency of door openings has emerged as a potentially significant contributor. Each time a door opens, the carefully balanced positive-pressure airflow can be disrupted, allowing airborne particles and microorganisms to enter the sterile field. Over the course of a procedure, these seemingly minor interruptions accumulate, potentially elevating bacterial loads on surfaces and in the air.

One such factor is the operating room (OR) environment, which is designed to maintain strict sterility through controlled airflow systems, positive pressure ventilation, and high-efficiency particulate air (HEPA) filtration. However, these systems can be compromised by human activity, particularly frequent movement of personnel and repeated door openings during surgical procedures [5, 6, 7].

Operating Room Environment and Traffic

The operating room is intended to function as a highly controlled environment to minimize microbial contamination. Advanced ventilation systems, including laminar airflow (LAF) and HEPA filtration, are designed to reduce airborne pathogens and maintain a sterile surgical field. Positive pressure systems further ensure that contaminated air from adjacent areas does not enter the operating room [8, 9].

Despite these measures, the operating room is inherently dynamic. Healthcare personnel frequently enter and exit for various reasons, including retrieving equipment, coordinating care, educational activities, and communication. This movement, collectively referred to as operating room traffic, can disrupt airflow patterns and compromise environmental sterility.

Each door-opening event results in temporary loss of positive pressure and mixing of clean and contaminated air, increasing the risk of airborne microbial contamination [10]. Studies have consistently demonstrated that increased traffic and higher numbers of personnel are associated with elevated levels of airborne particles and colony-forming units (CFUs) [11]

Recent guidelines from international bodies such as the International Society for Infectious Diseases (ISID) and the SHEA/IDSA/APIC compendium emphasize minimizing unnecessary movement and maintaining closed doors as essential infection control practices. However, in routine clinical practice, operating room traffic is often poorly monitored and rarely incorporated into quality assessment frameworks.

Door Openings and Risk of Surgical Site Infection

Emerging evidence suggests a growing link between the frequency of door openings and the risk of surgical site infections. A recent meta-analysis involving over 4,000 patients demonstrated that each additional door opening per hour was associated with a measurable increase in SSI risk, although the effect size for individual events was small [11]. However, the cumulative effect during long or complex surgeries may be clinically significant.

Similarly, systematic reviews have highlighted that frequent door openings and increased personnel movement contribute to higher airborne contamination, particularly in procedures such as orthopedic and abdominal surgeries [12]. While earlier studies reported inconsistent findings, more recent evidence indicates a consistent trend linking higher traffic levels with increased infection risk [13].

Interventional studies have also shown that reducing operating room traffic through simple strategies such as improved preoperative planning, staff education, and restricted access can lead to a significant reduction in both door-opening frequency and SSI rates [14]

Nevertheless, some variability in findings persists, likely due to differences in study design, ventilation systems, and surgical complexity. Despite this, minimizing unnecessary door openings remains a practical and cost-effective strategy for infection prevention.

Impact in LMICs and the Indian Context

The burden of SSIs is particularly high in LMICs, including India, where healthcare systems often face challenges such as limited resources, overcrowding, and inconsistent adherence to infection control practices (WHO, 2023). The increasing volume of surgical procedures further intensifies pressure on operating room infrastructure, potentially leading to higher traffic levels.

Studies conducted in Indian healthcare settings have reported SSI rates ranging from 5% to 15%, even in clean and clean-contaminated surgeries [15, 16, 17]. Behavioral factors, including frequent movement of staff and inadequate traffic control, may contribute to these rates.

Despite this, there is a notable lack of locally generated evidence linking operating room traffic particularly door opening frequency to SSI outcomes. This gap is especially evident in Western India, including Gujarat. Without such data, it becomes difficult for hospital administrators and infection control committees to implement targeted interventions.

Problem Statement

In many Indian hospitals, including midsized facilities like Parul Sevashram Hospital, operating theatres handle a high volume of mixed surgical cases under varying levels of staffing and logistical support. Staff frequently move in and out to retrieve supplies, consult colleagues, or respond to immediate needs, resulting in door openings that can exceed 50–100 per case in some procedures. Such patterns raise legitimate concerns about increased environmental contamination and subsequent SSI risk.

Although infrastructure such as positive-pressure ventilation and laminar airflow systems provides a foundational layer of protection, behavioral and workflow factors often undermine these safeguards. Previous observational work has linked higher door-opening frequencies to measurable increases in airborne bacterial counts and, in some studies, elevated SSI rates. However, granular data from Indian hospital settings that combine direct observation of real-time traffic with prospective SSI surveillance remain relatively limited. This gap leaves hospital teams and infection control committees without clear, locally relevant evidence on which to base practical traffic-control policies [12].

The present study therefore sought to examine the relationship between OR door-opening frequency and the occurrence of postoperative SSIs in a cohort of 200 surgical procedures, while also exploring associated factors such as surgery duration, wound class, and adherence to traffic protocols.

Rationale and Significance of the Study

Understanding the contribution of OR traffic is especially important because it represents a modifiable risk factor. Unlike patient age, comorbidities, or emergency status, door openings and staff movement can be influenced through relatively low-cost interventions: better preoperative planning, improved supply organization, team huddles, visual reminders, and simple monitoring tools. In resource conscious Indian hospitals, where every percentage-point reduction in SSI can translate into meaningful savings in antibiotics, extended stays, and re-interventions, targeting behavioural patterns offers a practical pathway to safer surgery [13].

Moreover, the predominance of superficial SSIs in many local reports suggests that environmental contamination during the procedure rather than solely endogenous flora plays a notable role. By quantifying the association between traffic and infection in a real-world multi-specialty setting, this study aims to provide actionable insights that can inform hospital policy, staff training, and quality improvement initiatives [18].

RESEARCH OBJECTIVES

General Objective:

To investigate the Association between surgical site infection rates and operating room traffic including frequency of door opening.in patients undergoing various surgical procedures at Parul Sevashram Hospital.

Specific Objectives

To determine the overall incidence and pattern (superficial, deep, organ/space) of SSIs in the study population.

To describe the frequency and distribution of door-opening events across different phases of surgery (pre-incision, intraoperative, closure).

To examine the relationship between categories of door-opening frequency and SSI occurrence using appropriate statistical methods.

To assess adherence to operating room traffic control practices and its correlation with infection outcomes.

Research Questions

What is the incidence and distribution of surgical site infections following the observed procedures?

How frequently do doors open during different phases of surgery, and what patterns emerge across specialties?

Is there a statistically significant association between higher door-opening counts and increased SSI risk?

How does observed adherence to traffic protocols influence infection outcomes in this setting?

HYPOTHESIS

Null Hypothesis (H_0): There is no significant association between the frequency of operating room door openings and the occurrence of postoperative surgical site infections.

Alternative Hypothesis (H_1): Higher frequencies of door openings in the operating room are significantly associated with an increased risk of postoperative surgical site infections.

Scope of the study

The study was conducted in a single hospital with 200 observed procedures across general, orthopaedic, obstetric/gynaecological, urological, and cardiac specialties. While this provides a focused, real-world snapshot of traffic patterns and outcomes, findings may not be fully generalizable to smaller district hospitals or large corporate centres with different staffing models and infrastructure. As an observational study, it can establish associations but cannot prove definitive causation. Some potential confounders (e.g., exact timing of antibiotic prophylaxis or subtle variations in sterile technique) were not exhaustively measured.

Definition of Key Terms

Surgical Site Infection (SSI): Infection occurring at the surgical incision site within 30 days after surgery (or within one year if an implant is involved), classified as superficial incisional, deep incisional, or organ/space according to standard criteria.

Door-Opening Events: Any instance in which an operating room door is opened during the surgical procedure, regardless of duration or personnel movement.

Operating Room Traffic: Collective movement of personnel, equipment, and supplies into and out of the OR, reflected primarily by door openings and the number of individuals present.

Wound Class: Categorization of surgical wounds as clean, clean-contaminated, contaminated, or dirty/infected based on the degree of microbial contamination at the time of surgery (CDC classification) [6].

CHAPTER TWO: REVIEW OF LITERATURE

Overview

Surgical site infections (SSIs) represent a persistent and significant challenge in modern surgical practice, contributing substantially to patient morbidity, extended hospital stays, elevated healthcare expenditures, and occasionally severe long-term consequences. Over the period from a growing body of research has examined the multifaceted nature of SSIs, with particular emphasis on incidence patterns in diverse healthcare settings, traditional and emerging risk factors, the debated utility of advanced ventilation systems, and the increasingly recognized role of intraoperative environmental factors such as operating room (OR) traffic and door openings. This chapter provides a comprehensive synthesis of key studies published and conducted during this timeframe, drawing from both Indian and international literature. It highlights consistencies in findings while noting contextual variations, especially in low- and middle-income country (LMIC) environments like India, where high surgical volumes, variable infrastructure, and resource constraints often amplify risks. By reviewing these developments, the chapter identifies important gaps that the present observational study at Parul Sevashram Hospital seeks to address through direct, prospective data collection on door-opening frequency and its association with postoperative SSIs.

Global and Indian Incidence of Surgical Site Infections

Recent epidemiological work underscores the variable but clinically meaningful burden of SSIs. Globally, pooled estimates for cesarean sections, for example, stand around 7.0% (95% CI 6.0–8.0%), with higher figures in LMICs (8.0%) compared to high-income countries (HICs, 5.0%). In India, hospital-based studies conducted between 2020 and 2026 report SSI rates ranging from approximately 2.6% in well-resourced tertiary centers to as high as 18.6% in specific abdominal surgery cohorts, with most figures clustering between 5% and 13% [19, 17, 20].

A large prospective study involving 2,076 patients across various surgical procedures documented an overall SSI prevalence of 5.6%, with abdominal surgeries accounting for the majority (61.2%) of cases. Younger patients (16–24 years), males, those undergoing emergency procedures, individuals with diabetes, and those with prolonged hospital stays emerged as higher-risk groups. Another multi-centric surveillance effort across trauma and orthopedic cases reported a 5.2% SSI incidence among 3,090 patients, with significant inter-center variation (1.5% to 13.5%) and notably elevated rates in debridement procedures (54.2%) [19, 21].

Cesarean section studies provide additional granularity. One analysis of 2,024 cases found a 5.63% incisional SSI rate, associated with nearly triple the treatment costs and ten extra hospital days compared to uninfected controls. A 2025 study in Central India reported a 13.7% SSI rate following cesarean deliveries, linking higher risk to rural location, low socioeconomic status, multiparity, obesity, emergency status, prolonged rupture of membranes, extended labor, and increased preoperative stay. In rural and semi-urban Indian hospitals, an overall 7.0% SSI rate was observed, with dirty wounds carrying approximately six times the risk of clean cases [22, 23, 20].

Emergency surgeries consistently show elevated rates. A 2025 comparison of abdominal procedures documented 41.46% SSI in emergency versus 14.63% in planned cases. An abdominal surgery series from Western Rajasthan reported an 18.6% incidence, comparable to other Indian studies but markedly higher than Western benchmarks, with Pseudomonas as the predominant isolate and older age, diabetes, respiratory or urinary tract infections, emergency status, and higher BMI as key contributors [23].

An ICMR multi-centric report highlighted approximately 15 lakh annual SSI cases in India, with orthopedic procedures showing a particularly high contribution (54.2% in certain sub-analyses). Superficial SSIs predominate in most series, followed by deep and organ/space infections, reflecting common pathways of environmental or skin-flora contamination. These patterns emphasize that while some Indian centers achieve rates approaching HIC levels through structured protocols, emergency cases, contaminated wounds, and comorbidities continue to drive substantial burden [23].

Recent Indian studies report SSI rates that vary considerably by hospital type, surgical specialty, and wound classification. In a 2022 prospective study of 413 patients undergoing various procedures, the overall SSI incidence reached 11.1%, with higher rates linked to contaminated wounds and inadequate surgical antibiotic prophylaxis (SAP). A 2025 observational study comparing emergency and planned abdominal surgeries found markedly higher infection rates in emergency cases (41.46%) versus planned procedures (14.63%), underscoring the added risks of limited preoperative optimization and contaminated fields [26]. Cesarean sections have received particular attention. A 2022 analysis of over 2,000 cesarean deliveries documented a 5.63% incisional SSI rate, with infected patients experiencing nearly three times higher treatment costs and ten additional hospital days on average. Another large prospective cohort of 2,015 cesarean patients using single-dose prophylaxis per WHO guidelines reported a lower 4.6% SSI rate, predominantly superficial infections, suggesting that standardized antibiotic practices can help moderate risk. In contrast, a 2025 multi-center surveillance effort across Indian trauma and orthopedic cases recorded an overall SSI incidence of 5.2%, with notable variation between centers (1.5% to 13.5%) [20, 27].

Broader abdominal and general surgery cohorts have shown rates between 2.8% and 17.1%, with superficial infections consistently predominating. Rural and semi-urban Indian hospitals reported an overall 7.0% SSI rate in 2023, influenced strongly by wound class dirty wounds carried roughly six times the risk of clean cases. These figures align with pooled LMIC estimates around 8.0% for cesarean sections and highlight that, while rates in well-resourced Indian centers can approach high-income country levels, emergency procedures and contaminated wounds continue to drive higher burdens [28, 29, 30].

Patient and Procedural Risk Factors

Contemporary literature from 2020–2026 categorizes SSI risk factors into patient-related, procedural, and environmental domains. Patient factors repeatedly identified include diabetes (especially uncontrolled), obesity (BMI >25), anaemia or low hemoglobin, smoking, hypoproteinemia, malnutrition, older age (>50–55 years in many cohorts), and low socioeconomic status [19, 22].

Procedural risks feature prominently. Emergency surgery often carries 2–4 times higher odds than elective procedures. Prolonged operative duration (>2 hours) consistently correlates with increased risk, likely due to extended tissue exposure and cumulative contamination. Higher wound contamination class (clean-contaminated, contaminated, or dirty) remains one of the strongest predictors, with dirty wounds showing markedly elevated rates [21].

Additional factors include prolonged preoperative hospital stay (>7 days), American Society of Anesthesiologists (ASA) class III or higher, presence of drains, blood transfusion, and inappropriate or delayed surgical antibiotic prophylaxis (SAP). In pediatric abdominal surgery cohorts, similar patterns emerge, with emergency status, contaminated wounds, prolonged surgery, malnutrition, and immunosuppression standing out [32].

Multivariate analyses frequently confirm these associations. For instance, one 2025 general surgery study using regression modeling highlighted emergency procedures, contaminated wounds, and conventional (non-optimized) OR environments as independent contributors. Behavioral elements, such as adherence to protocols, often mediate or amplify baseline risks [33].

Operating Room Environment and Ventilation system

The effectiveness of laminar airflow (LAF) or unidirectional airflow (UDAF) systems has been rigorously scrutinized from 2020 onward. Several systematic reviews and meta-analyses, including those focused on orthopedic and cardiac procedures, found no consistent protective benefit against SSIs compared with conventional turbulent ventilation. One orthopedic meta-analysis reported pooled odds ratios and risk ratios suggesting LAF might even be associated with neutral or slightly higher SSI risk in some contexts [33].

The value of laminar airflow (LAF) or unidirectional airflow systems has been actively debated. Several 2023–2025 reviews and meta-analyses, including one focused on orthopedic surgery, found no clear protective effect of LAF against SSI and, in some analyses, even suggested a possible increase in risk. A 2025 study of general surgeries identified conventional (non-laminar) OR environments as carrying roughly double the adjusted odds of SSI compared with optimized setups, though behavioral factors appeared to mediate much of this difference. Positive pressure maintenance remains important, but evidence increasingly suggests that ventilation hardware works best when supported by disciplined staff practices rather than serving as a standalone solution [33, 11, 34].

Early research demonstrated that laminar airflow could reduce contamination levels by approximately 30–40%, while increased personnel movement and door openings were associated with higher airborne particle counts [35]. Subsequent studies have reinforced these findings, showing that both the number of individuals present and the frequency of movement significantly influence air quality in operating rooms; More recent investigations have provided additional insight into the relationship between environmental conditions and microbial contamination [10]. For example, factors such as door opening frequency, staff density, and cleaning practices directly affected airborne colony-forming units (CFUs) in operating theatres [9].

Similarly, Della Camera et al. (2022) demonstrated that door-opening events, particularly in turbulent airflow environments, led to measurable increases in particulate matter. Although laminar airflow systems can mitigate these effects, they do not completely eliminate the impact of repeated door openings[10].

Advancements in air management technologies, such as high-efficiency air recirculation systems, have shown promise in improving air quality and reducing SSI rates [35]. However, these technologies are often costly and may not be feasible in resource-limited settings. Consequently, behavioral interventions aimed at reducing unnecessary movement remain a practical and cost-effective alternative.

Operating Room Traffic and Door Openings

Studies have paid growing attention to intraoperative traffic as a modifiable environmental risk. Door openings disrupt positive-pressure airflow, increase airborne particle counts, and elevate bacterial load on surfaces and in the air. A 2021 simulation study demonstrated that high numbers of door openings produced significantly more airborne bacteria and viable colonies on OR surfaces compared with control conditions [36].

Clinical data reinforce these laboratory observations. An individual-patient data meta-analysis published in 2025, pooling 4,412 patients from eight observational studies, found that each additional door opening per hour was associated with a small but statistically detectable increase in SSI odds (OR 1.012, 95% CI 1.005–1.019), with very low certainty of evidence overall. The cumulative effect appeared more pronounced in patients already at higher baseline risk. An umbrella review from the same year synthesized evidence showing that rooms with more than ten personnel present faced roughly threefold higher SSI risk in some cohorts, while every five additional door openings per procedure correlated with increased hazard [11].

Observational work has documented average door openings ranging from 18 to over 100 per case, with substantial activity occurring even in the pre-incision phase. Quality improvement initiatives targeting traffic reduction through better supply planning, staff education, visual signage, and preference-card updates have achieved 40–50% reductions in door openings, sometimes accompanied by measurable drops in SSI rates or standardized infection ratios [38, 39].

Not all studies, however, find a strong independent link after full adjustment for confounders such as operative duration and case complexity. Some authors caution that while traffic clearly increases contamination, its translation into clinical infection depends on the overall infection prevention bundle and baseline microbial pressure [40].

Prevention Bundles and Quality Improvement Initiatives

Multicomponent bundles addressing multiple risk points have shown promising results. Indian quality improvement projects focused on cesarean sections have reduced SSI rates from as high as 30% to below 5% through standardized prophylaxis, skin preparation, traffic awareness, and surveillance with feedback. Similar bundle approaches in gynaecological and general surgeries have produced substantial reductions when implemented with stakeholder engagement. Common bundle elements include timely single-dose antibiotics, appropriate hair removal (clipping rather than shaving), chlorhexidine skin preparation, normothermia, and conscious limitation of OR traffic [40].

Door-Opening Frequency and Clinical SSI Outcomes

While the relationship between door openings and environmental contamination is well established, evidence linking door-opening frequency directly to SSI outcomes has emerged more recently.

A meta-analysis by Groenen et al. (2025), involving over 4,400 patients, reported that each additional door opening per hour was associated with a small but statistically significant increase in SSI risk. Although the effect size per event was modest, the cumulative impact during prolonged or high-traffic procedures was considered clinically meaningful [11].

Similarly, found that surgical procedures involving more than 100 door openings were significantly associated with higher SSI rates, particularly in abdominal surgeries. These findings support the concept of a dose response relationship between traffic exposure and infection risk [7].

However, not all studies have reported consistent results. Some researchers have highlighted the influence of confounding factors such as case complexity, ventilation systems, and staffing patterns. Despite this variability, the overall trend in the literature suggests that minimizing unnecessary door openings is a prudent and potentially effective strategy for reducing SSI risk [1, 41]

Strategies for Reducing Operating Room Traffic

Given the growing evidence linking operating room traffic to contamination and SSI risk, several studies have explored interventions aimed at reducing unnecessary movement.

Behavioral and organizational strategies have been shown to be particularly effective. These include preoperative planning to ensure availability of supplies, staff education, restricted access policies, and the use of visual reminders such as signage [13]

Interventional studies have reported significant reductions in door opening frequency following the implementation of such measures. For instance, demonstrated a 30–40% reduction in door openings, accompanied by a decrease in SSI rates [1].

Similarly, quality improvement initiatives focusing on staff training and workflow optimization have successfully reduced operating room traffic, particularly in orthopedic settings (T. Khan et al., 2023). Studies have also identified circulating nurses and pre-incision activities as major contributors to traffic, suggesting targeted opportunities for intervention [38]

Although technological solutions such as automated monitoring systems and advanced ventilation technologies can enhance infection control, their cost may limit widespread adoption. Therefore, lowcost behavioral interventions remain highly relevant, especially in LMIC settings.

Gaps in the Existing Literature

Despite valuable contributions, notable gaps persist. Many studies rely on retrospective designs or selfreported traffic data rather than prospective direct observation combined with standardized 30-day SSI surveillance. Granular, multi-specialty data from midsized Indian hospitals quantifying door openings across surgical phases (pre-incision, intraoperative, closure) and linking them directly to infection outcomes remain limited. The relative contribution of behavioral factors (traffic compliance, signage presence) versus infrastructure (laminar flow, positive pressure) needs clearer characterization in realworld Indian contexts. Low-cost, sustainable interventional studies testing traffic-reduction strategies in busy, shared operating suites are still relatively scarce. Qualitative insights into staff perceptions of barriers and facilitators to traffic discipline could also inform more acceptable implementation strategies.

Conceptual Framework

This study draws on the understanding that SSIs arise from the dynamic interaction of endogenous patient flora, procedural complexity, and the OR microenvironment. Operating room traffic serves as a behavioral bridge that can either safeguard or undermine environmental controls such as positive pressure and airflow stability. By directly observing door-opening events alongside prospective SSI surveillance, the present work aims to generate locally relevant, actionable evidence on this modifiable factor [1].

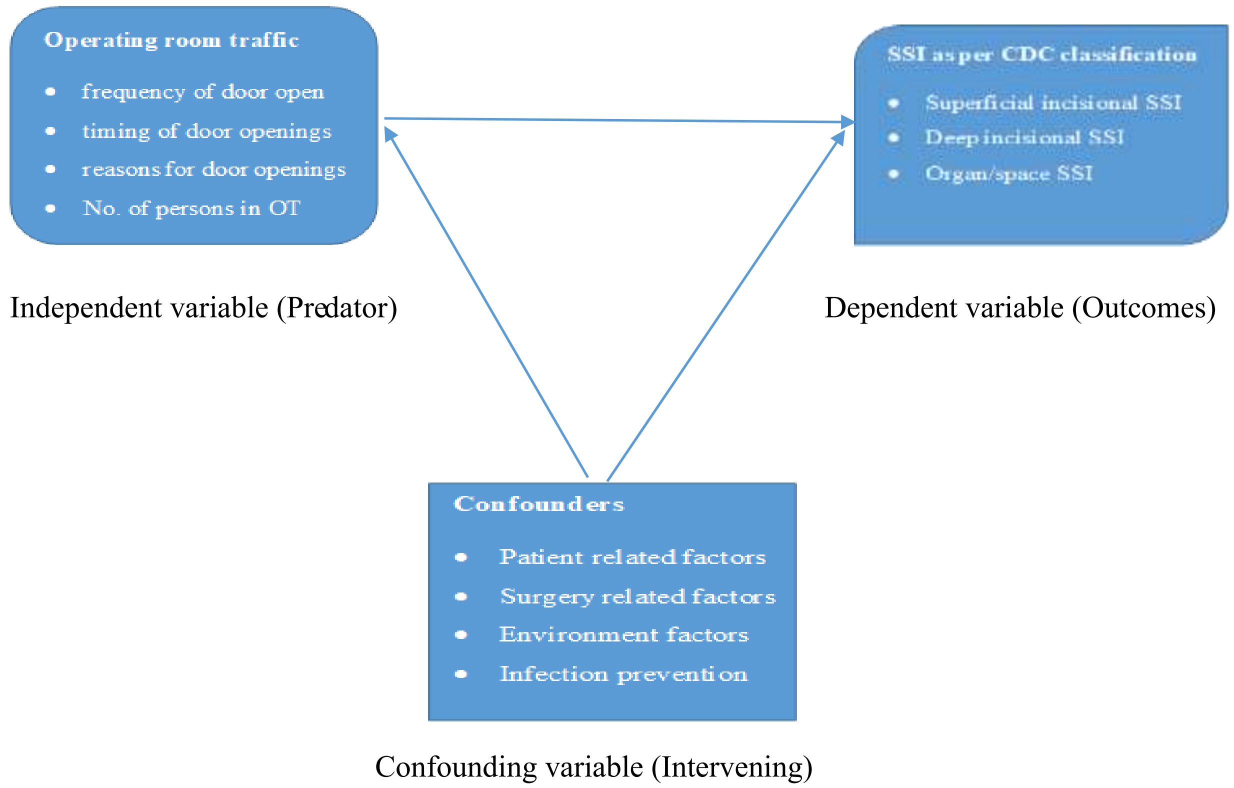

Figure 1: Conceptual framework on surgical site infection

(*sketch showing SSIs arise from the dynamic interaction of endogenous patient flora, procedural complexity, and the OR microenvironment)*

CHAPTER THREE: MATERIALS AND METHODS

Introduction

This chapter outlines the methodological framework adopted for the present study, which aimed to explore the potential association between operating room (OR) traffic particularly the frequency of door openings and the occurrence of postoperative surgical site infections (SSIs) in patients undergoing various surgical procedures at Parul Sevashram Hospital, Vadodara, Gujarat. An observational design was chosen because it allowed for direct, real-time documentation of actual traffic patterns during routine surgical procedures without interfering with clinical workflows or introducing artificial controls that might not reflect everyday practice. The approach combined structured observation during surgery with prospective follow-up for infection outcomes over 30 days, providing a balanced view of both environmental behaviors and clinical results. This methodology aligns with several recent observational studies that have examined OR traffic dynamics in real-world settings, where controlled experiments are often impractical due to patient safety and ethical considerations.

The study was conducted between September 2025 to March 2026, covering multiple surgical specialties to capture a representative mix of cases commonly performed in Parul Sevashram hospital Gujarat-India. By focusing on five major departments Orthopedic, Cardiac, Gynaecological, Urology, and General Surgery the design sought to enhance the applicability of findings across different procedural complexities and risk profiles.

Study Design

A prospective observational study design was employed. This approach enabled researcher to observe and record door-opening events and other traffic-related variables in real time while simultaneously tracking postoperative outcomes through standardized surveillance. Unlike retrospective chart reviews, which often suffer from incomplete documentation of intraoperative behaviors, prospective observation provided more accurate and granular data on actual movements inside the operating theater. The design also incorporated elements of a cohort study, in that all included patients were followed forward in time from the index surgery to assess SSI development.

No randomization or intervention was introduced, as the primary goal was to document existing practices and their natural associations with infection outcomes rather than to test a specific trafficreduction strategy. This non-interventional stance helped minimize the Hawthorne effect, where staff might alter behavior simply because they know they are being observed. Observers were trained to remain as unobtrusive as possible, positioning themselves discreetly within the OR and limiting interactions to essential clarifications with the circulating nurse when needed.

Study Setting

The study was carried out in the operating theatres of Parul Sevashram Hospital, a multi-specialty tertiary care teaching hospital affiliated with Parul University in Vadodara, Gujarat, India. The hospital maintains several well-equipped operating suites serving a mixed patient population from urban, semiurban, and rural areas of Gujarat and neighboring regions. The selected theaters included those dedicated to or shared by Orthopedic, Cardiac, Obstetrics & Gynaecology, Urology, and General Surgery departments. These specialties were chosen deliberately because they represent a broad spectrum of elective and emergency procedures with varying baseline SSI risks and different patterns of intraoperative activity.

Most theaters in the hospital are equipped with positive-pressure ventilation systems, and a subset features laminar airflow capabilities. However, behavioral aspects such as traffic control signage and supply management practices vary across rooms and teams. Conducting the study in this real-world environment allowed for observation of typical workflows, including occasional supply shortages, staff handovers, and multidisciplinary coordination, which are common in busy Indian hospital settings.

Study Population and Sampling

The target population consisted of adult patients (aged 18 years and above) undergoing elective or emergency surgical procedures in the selected operating theaters during the study period. A consecutive sampling technique was used, wherein all eligible patients scheduled for surgery in the participating theaters were approached sequentially until the target sample size of 200 procedures was reached. This approach helped reduce selection bias while remaining feasible within the hospital’s operational constraints.

Inclusion Criteria

- Patients aged 18 years or older.
- Undergoing surgical procedures in Orthopedic, Cardiac, Gynaecological, Urology, or General

Surgery theaters.

- Willing to provide written informed consent (or surrogate consent where appropriate) for participation and 30-day follow-up.
- Procedures classified as clean or clean-contaminated wounds (to focus on cases where environmental contamination could play a clearer role).

Exclusion Criteria

- Patients with pre-existing active infections at the surgical site or systemic infections requiring ongoing treatment.
- Immunocompromised individuals (e.g., known HIV/AIDS with low CD4 count, patients on high dose corticosteroids or chemotherapy).
- Procedures involving dirty or infected wounds, as endogenous contamination would predominate.
- Patients undergoing revisional or implant-related procedures with anticipated prolonged antibiotic courses that might confound SSI assessment.
- Cases where the observer could not be present for the entire duration due to logistical reasons.

A total of 200 procedures were ultimately included after applying these criteria and obtaining consent. This sample size was determined based on practical considerations, expected SSI incidence (around 5–10% from local and national data), and the need for adequate events in each door-opening category to support chi-square and logistic regression analyses.

Sample Size Determination

The sample size of 200 was guided by both statistical power considerations and feasibility within the hospital’s case volume. For the primary association between door-opening frequency (categorized into four levels) and SSI occurrence (binary outcome), calculations using standard power analysis for chi square tests suggested that approximately 180–220 cases would provide reasonable power (around 80%) to detect a medium effect size at a 5% significance level, assuming an overall SSI rate of 6–8%. This estimate aligned with similar observational studies examining OR traffic. For the logistic regression component involving multiple predictors (door openings, surgery duration, wound class, and traffic compliance), the rule of thumb of at least 10–15 events per predictor variable was also considered, given the anticipated low number of SSI events. The final figure of 200 balanced statistical needs with the practical realities of observer availability and theater scheduling.

Data Collection Tools and Procedures

Data were collected using three main structured tools developed and pilot-tested for the study:

Intraoperative Observation Checklist: This tool recorded real-time door-opening events, including the exact count, timing (pre-incision, intraoperative, closure phases), reason for opening (supply retrieval, personnel change, consultation, etc.), and number of personnel entering/exiting. Additional notes captured overall traffic compliance (excellent, satisfactory, unsatisfactory) based on predefined criteria such as unnecessary openings or failure to minimize movement during critical phases. A single trained observer (a postgraduate researcher or infection control nurse not involved in direct patient care) was present for each case to ensure consistency.

Patient and Surgical Characteristics Form: This captured demographic details (age, sex), surgical variables (type of surgery, wound class according to CDC criteria, duration of procedure), and environmental factors (presence of positive air pressure, laminar airflow, and traffic control signage in the theater).

SSI Surveillance Form: Postoperative monitoring followed CDC/NHSN definitions for superficial incisional, deep incisional, and organ/space SSIs. Patients were assessed daily during hospital stay and contacted via telephone or outpatient visit at 30 days post-surgery. Wound examination, culture reports (when available), and clinical signs (pain, redness, discharge, fever) were documented. Follow-up completion rate was 100% for the 30-day period.

All tools were pre-tested on 10 non-study cases to refine wording, timing, and observer training. Interobserver reliability was checked during the pilot phase, yielding good agreement (kappa > 0.80 for key variables).

Data Collection Procedure

After obtaining institutional ethics approval and written informed consent from patients (or surrogates), the observer arrived in the designated theater well before the scheduled start time. Observation began from the moment the first sterile instruments were opened and continued until final wound dressing and patient transfer out of the room. Door openings were counted only when the door physically opened sufficiently for personnel or equipment movement. Subtle entries (e.g., passing notes through a small gap) were noted separately if relevant.

Environmental parameters (air pressure status, laminar flow presence, signage) were verified at the start of each session through direct check or consultation with theater staff. Postoperative follow-up was coordinated with the respective surgical teams and the hospital's infection control department to ensure systematic surveillance without overburdening clinical staff.

To maintain objectivity, observers were instructed not to comment on traffic patterns during cases and to record data discreetly. Any ambiguities (e.g., whether a brief door crack counted as an opening) were resolved through predefined operational definitions established during training.

Data Management and Statistical Analysis

Completed data forms were double-entered into Microsoft Excel for initial cleaning, followed by transfer to IBM SPSS Statistics (version 26) for formal analysis. Missing data were minimal (<2%) and handled using pairwise deletion, as they appeared random and unrelated to key outcomes.

Descriptive Analysis: Frequencies, percentages, means, and standard deviations (means ± SD) were calculated for demographic, surgical, and environmental variables. Door-opening counts were categorized into four groups (<25, 25–50, 51–100, >100) for ease of interpretation and to identify dose response patterns.

Pearson's chi-square test assessed associations between door-opening categories and SSI occurrence. Binary logistic regression identified independent predictors (door openings >50, surgery duration >2 hours, clean-contaminated wounds, poor traffic compliance), reporting adjusted odds ratios with 95% confidence intervals. Phase-specific means were compared descriptively. Analyses used IBM SPSS, with $p < 0.05$ considered significant. Results were presented in tables and figures for clarity.

Inferential Analysis: The association between door-opening categories and SSI occurrence was examined using Pearson's chi-square test, with $p < 0.05$ considered statistically significant.

Binary logistic regression was performed to identify independent predictors of SSI, adjusting for potential confounders such as surgery duration, wound class, and traffic compliance. Adjusted odds ratios (AOR) with 95% confidence intervals were reported.

Phase-specific door-opening means (pre-incision, intraoperative, closure) were compared descriptively.

All analyses were two-tailed, and results were presented in tabular and graphical formats for clarity.

Assumptions for each test (e.g., expected cell frequencies for chi-square) were checked beforehand.

Ethical Considerations

The study protocol received approval from the Institutional Ethics Committee of Parul University and Parul Sevashram Hospital (PU-IECHR) with approval number PUIECHR/PIMSR/00/081734/9109. The research adhered strictly to the principles outlined in the Declaration. Written informed consent was obtained from all participants after providing a clear explanation of the study's purpose, procedures, potential risks (minimal, primarily related to follow-up contact), and the voluntary nature of participation. Patients were assured that refusal or withdrawal would not affect their standard medical care. Confidentiality was maintained by using unique study codes instead of names or hospital registration numbers. Data were stored securely on password-protected devices accessible only to the principal investigator and designated research team members. No identifiable information was shared in reports or publications.

Since the study involved only observation of routine practices and standard SSI surveillance, no additional risks beyond everyday surgical care were introduced. Benefits included potential contribution to hospital quality improvement efforts through aggregated findings shared with the infection control committee.

Pre surveillance Study

A pilot phase involving 10 procedures was conducted prior to full-scale data collection. This helped refine observation protocols, test data collection tools for clarity and completeness, and train the observer on consistent recording of door events and traffic compliance. Minor adjustments were made, such as adding specific codes for common reasons for door openings and clarifying SSI surveillance timelines. Feedback from the pilot confirmed the feasibility of the methodology within the hospital's workflow.

CHAPTER FOUR: ANALYSIS AND INTERPRETATION OF DATA

Introduction

This chapter reports the findings from a prospective observational study involving 200 surgical procedures performed in the operating theaters of Parul Sevashram Hospital, Vadodara. The primary objective was to investigate the association between operating room (OR) traffic, particularly the frequency of door openings, and the occurrence of postoperative surgical site infections (SSIs) monitored over 30 days. Data were collected through direct, real-time observation across five surgical specialties: Orthopedic, Cardiac, Obstetrics & Gynaecology, Urology, and General Surgery. Descriptive statistics provided an overview of patient, surgical, and environmental characteristics, while inferential analyses examined relationships and identified independent predictors of SSI. Results are presented in tables and figures, accompanied by interpretations grounded in the study context and existing literature on SSI risk factors.

Data Quality and Preparation

All data collection forms underwent thorough review for completeness and accuracy. A double-entry verification process was implemented to reduce recording errors. Missing data were minimal (<2%) and randomly distributed, permitting pairwise deletion. Postoperative SSI surveillance achieved 100% follow-up at 30 days, strengthening confidence in the outcome measures.

Demographic Profile

The study population consisted of 200 adult patients. The largest age group was 31–50 years (45.5%), followed by 18–30 years (29.0%), 51–70 years (20.5%), and >70 years (5.0%). Males accounted for 56.0% and females for 44.0% of the sample.

Table 1: Demographic profile of the participant (N=200)

Variable	Category	Frequency Percentage (%)	
Age	18–30 yrs.	58	29.0
	31–50 yrs.	91	45.5
	51–70 yrs.	41	20.5

	>70 yrs.	10	5.0
Sex	Male	112	56.0
	Female	88	44.0

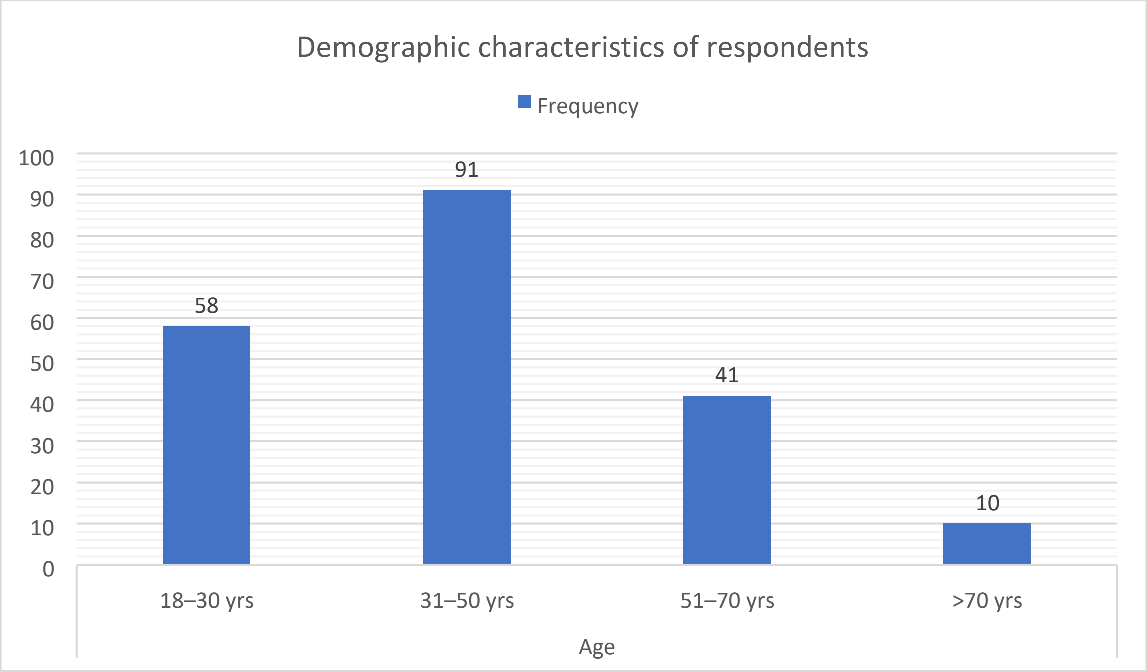

Figure 2: Demographic characteristics of respondents (*Bar charts illustrating age distribution)*

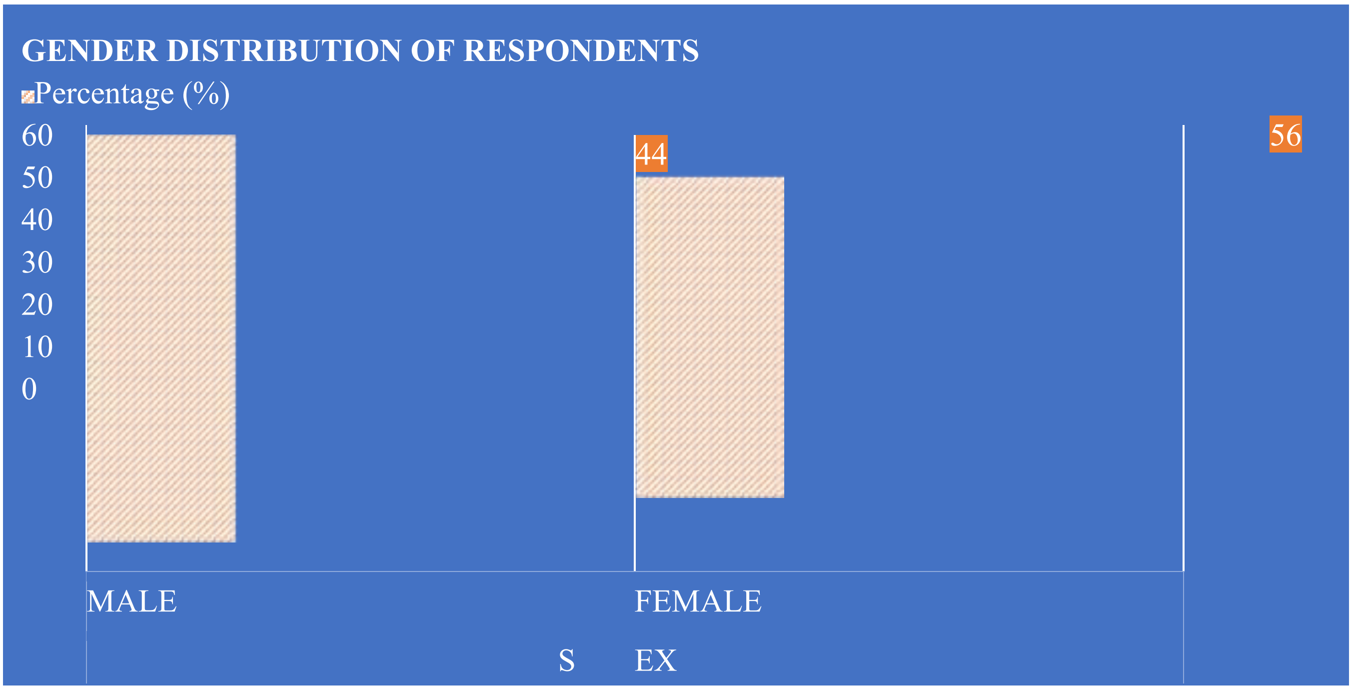

Figure 3: Demographic profile *(Bar charts illustrating gender proportionate of respondents)*

This demographic profile mirrors common surgical caseloads in Indian teaching hospitals, where middle-aged adults, particularly men, frequently undergo orthopedic and general surgical procedures. While age and sex are not direct modifiable risk factors, they often correlate with comorbidities such as diabetes or trauma that can interact with environmental influences like OR traffic to elevate SSI risk.

Surgical Characteristics

General surgery comprised the largest share (41.0%), followed by orthopedic (31.5%), obstetrics & gynaecology (16.5%), and urology (11.0%). Clean wounds predominated (64.0%), with clean contaminated wounds accounting for 36.0%. Procedure duration exceeded 2 hours in 33.5% of cases.

Table 2: Surgical details

Variable	Category	Frequency	Percentage (%)
Surgery type	General	82	41.0
	Orthopedic	63	31.5
	Obstetrics & Gynaecology	33	16.5
	Urology	22	11.0
Wound class	Clean	128	64.0
	Clean-contaminated	72	36.0
Duration	<1 hr	46	23.0
	1–2 hr	87	43.5
	>2 hr	67	33.5

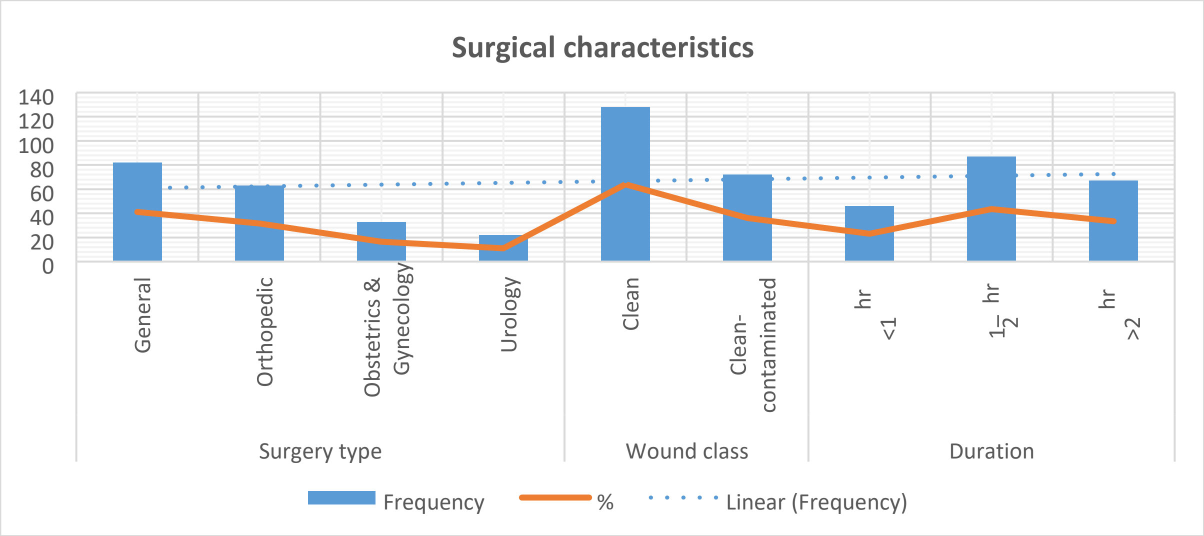

Figure 4: Surgical ***characteristics (grouped bar charts showing surgery type, wound class and duration category).***

The distribution of surgery types and wound classes reflects typical hospital activity. Prolonged operations (>2 hours) and clean-contaminated wounds are well-documented global risk factors for SSI, as they increase tissue exposure time and endogenous microbial load. In this cohort, these procedural elements provided an important baseline against which the additional contribution of OR traffic could be evaluated.

Operating Room Environment

Positive air pressure was maintained in 92.0% of procedures, and laminar airflow was available in 76.0%. Traffic control signage was present in only 48.5% of theaters.

Table 3: Operating room environment

Variable	Category	Frequency	%
Air pressure maintained	Yes	184	92.0
	No	16	8.0
Laminar airflow present	Yes	152	76.0
	No	48	24.0
Signage on traffic control	Present	97	48.5
	Absent	103	51.5

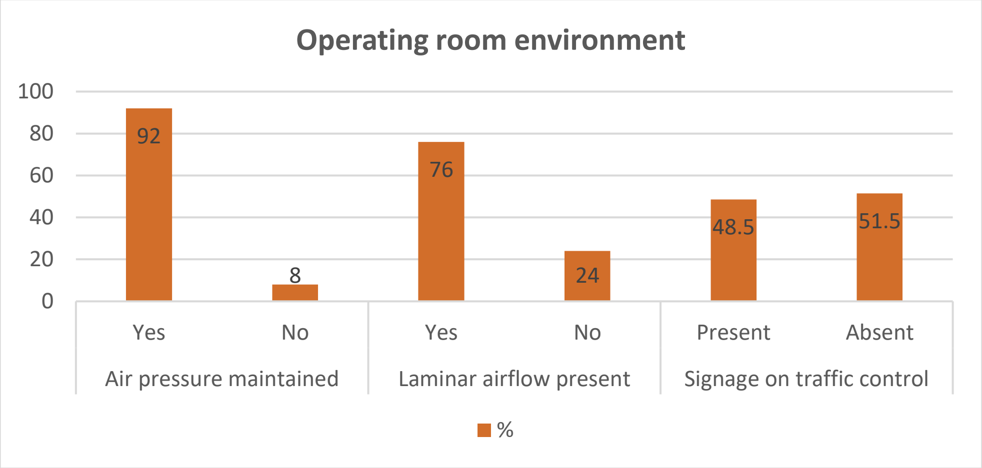

Figure 5: Operating room environment profile

(Bar charts depicting air pressure, lamina air flow, and signage status)

Strong ventilation infrastructure was evident in most cases. However, the inconsistent presence of signage highlights a potential weakness in behavioral reinforcement. Effective infection prevention relies on both technical systems and consistent human practices; visible reminders can play a modest but meaningful role in sustaining disciplined traffic control.

Operating Room Traffic Patterns

Door openings per case ranged widely, with 40% of procedures recording 50 or more events. Mean counts were highest during the intraoperative phase (32.4 ± 11.2), followed by pre-incision (18.7 ± 6.4) and closure (10.2 ± 4.8).

Table 4: Operating room traffic patterns

Phase	Mean events (SD)
Pre-incision	18.7 (±6.4)
Intraoperative	32.4 (±11.2)
Closure	10.2 (±4.8)

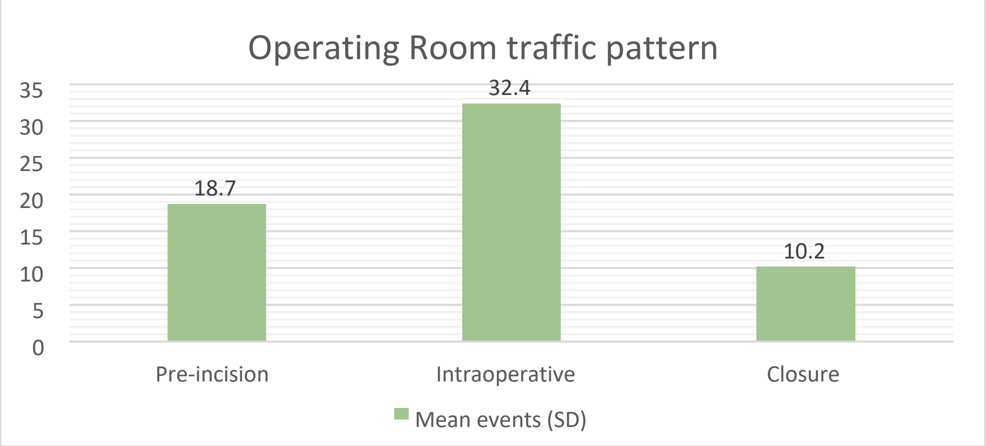

Figure 6: Phase-based distribution of OR movement

(*Bar graph comparing mean events across surgical phases with standard deviations***)**

Substantial traffic, particularly before and during the main operative period, indicates opportunities for workflow optimization. Frequent door openings can disrupt positive-pressure airflow, increase airborne particle counts, and elevate microbial contamination risk. The pre-incision phase is especially critical, as early environmental disturbances may compromise air quality before the surgical wound is created. These patterns align with recent international observations linking cumulative door movements to higher SSI odds.

Table 5: Frequency distribution of door opening events

Door open count per case	Frequency	%
<25 events	54	27.0
25–50 events	66	33.0
51–100 events	52	26.0
>100 events	28	14.0

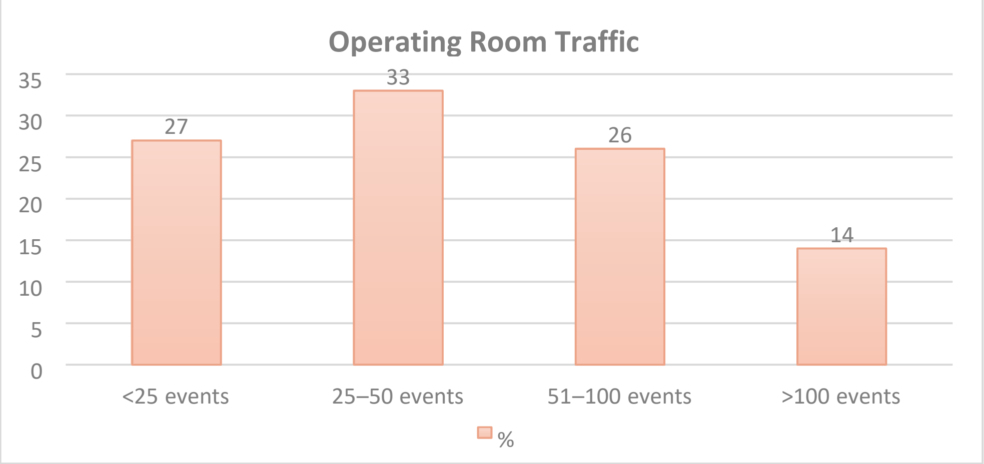

Figure 7: Frequency distribution of door opening events

(*Bar chart showing four categories of door openings*)

Interpretation: High traffic levels, especially before and during surgery, indicate opportunities for improved supply management and team coordination.

SSI Incidence and Pattern

SSIs developed in 12 patients (6.0%). Among these, superficial infections were most common (75.0%), followed by deep (16.7%) and organ/space (8.3%) infections. The remaining 188 patients (94.0%) remained infection-free.

Table 6: SSI Incidence (N=200)

Outcome	Frequency	Percentage (%)
No SSI	188	94.0
SSI	12	6.0
- Superficial	9	75.0
- Deep	2	16.7
- Organ/Space	1	8.3

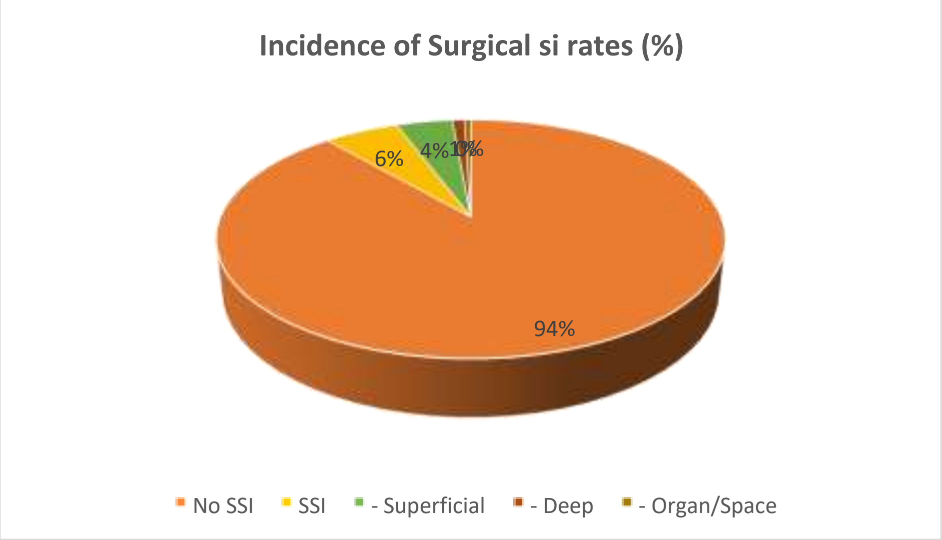

Figure 8: Surgical site infection outcomes

(*Pie chart showing overall SSI rate and subtype distribution among positive cases*)

Interpretation and Global Context:

The observed 6% SSI rate is consistent with recent Indian hospital-based studies (typically 5–12%) and falls within the broader range reported from low- and middle-income countries. Globally, high-income settings often report rates below 3%, while LMIC estimates frequently exceed 5–10%, particularly when prolonged procedures and clean-contaminated wounds are common. The predominance of superficial infections in this series suggests that environmental and skin-flora contamination during surgery played a more prominent role than deep endogenous seeding, reinforcing the potential importance of OR traffic control.

Association Between OR Traffic and SSI

Pearson's chi-square analysis demonstrated a statistically significant association between door-opening frequency and SSI occurrence (p < 0.001), with a clear dose-response relationship.

Table 7: Door opening category and SSI occurrence

Door-opening category	SSI Present	SSI Absent	p-value
<25	1	53	
25–50	2	64	0.001
51–100	4	44	
>100	5	27	

Overall Chi-square p< 0.001

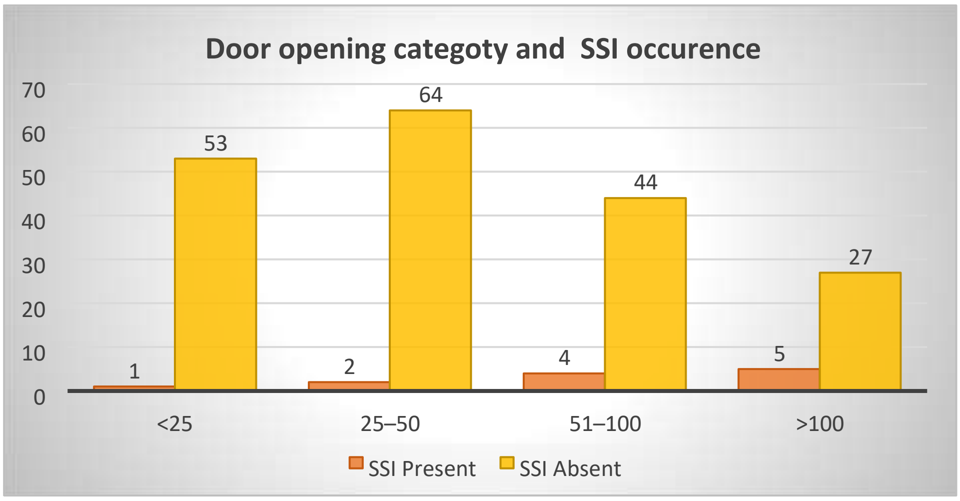

Figure 9: Association between door openings and SSI

(*Bar plot illustrating SSI rates across door opening categories)*

A statistically significant association was observed between door-opening frequency and SSI occurrence (**p < 0.001**). A clear dose response relationship is evident: Minimal risk at <50 openings, Increasing risk beyond 50 openings and highest risk at >100 openings. This pattern strongly supports the hypothesis that increased OR traffic contributes to infection risk.

Binary logistic regression, adjusting for potential confounders, identified four independent predictors of SSI.

Observer assessed traffic compliance was rated excellent in 21%, satisfactory in 41.5%, and unsatisfactory in 37.5% of cases. Poor compliance was strongly associated with SSI (p < 0.01). Traffic during pre-incision and intraoperative phases exerted significant influence on risk, whereas closurephase movement showed little independent effect.

Table 8: Binary logistic regression independent predictors of SSI

Predictor	Adjusted OR	95% CI	P-value
Door openings (>50)	4.78	2.01 - 11.34	<0.001
Surgery duration >2HRS	2.94	1.22 - 7.03	0.014

Clean-contaminated Wounds	2.16	1.03 - 5.11	0.041
Poor traffic complience	3.37	1.44 - 7.24	0.003

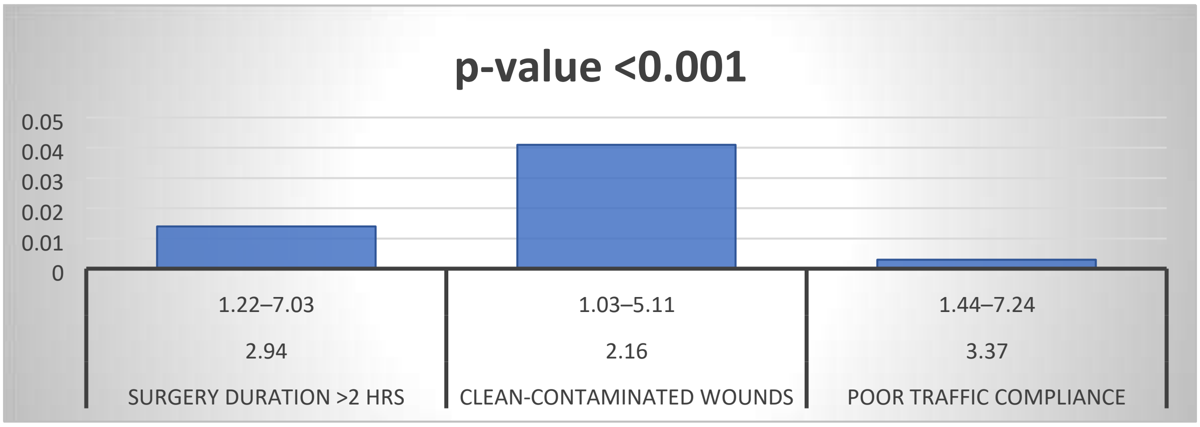

Figure 10: Regression analysis of SSI predictors

(*plot displaying adjusted odds ratios and 95% confidence intervals for each predictor)*

Door openings exceeding 50 per case emerged as the strongest independent predictor, increasing the adjusted odds of SSI nearly fivefold. This finding underscores the cumulative impact of repeated airflow disruption in a real-world setting. Poor traffic compliance amplified risk almost as strongly as prolonged operative time, highlighting that behavioral factors can outweigh some traditional procedural risks. In comparison with global literature, these results support the growing recognition that OR traffic is a modifiable environmental determinant of SSI, particularly when combined with longer surgery or higher wound contamination class. The hospital's generally reliable ventilation infrastructure could not fully compensate for excessive movement, suggesting that technical measures work best when paired with disciplined team behavior.

Hypothesis Testing The null hypothesis (no significant association between door-opening frequency and SSI) was rejected based on chi-square ($p < 0.001$) and regression results, confirming that higher frequencies of door openings are linked to increased SSI risk.

Therefore, analysis revealed a 6% SSI incidence, with superficial infections predominating. A strong, dose-dependent relationship was observed between OR door-opening frequency and SSI occurrence. Independent predictors included excessive door openings (>50), poor traffic compliance, surgery duration exceeding 2 hours, and clean-contaminated wound class. These findings emphasize that behavioral and environmental factors within the operating room represent high-yield, modifiable targets for reducing SSI in similar hospital settings. The next chapter discusses these results in relation to broader literature and explores their practical implications.

CHAPTER FIVE: DISCUSSION OF FINDINGS

Introduction

This chapter interprets the results from an observational study of 200 surgical procedures performed across multiple specialties at Parul Sevashram Hospital. The main emphasis lies on the relationship between operating room movement measured chiefly by the frequency of door openings and the development of postoperative surgical site infections (SSIs). By situating these findings within the wider body of research from both Indian and international settings, the discussion explores underlying patterns, potential mechanisms, and practical implications for improving surgical safety in everyday hospital environments [11].

Incidence and Pattern of Surgical Site Infections

The overall SSI incidence in the present study was 6.0%, with 94% of patients remaining infection-free during the 30-day surveillance period. This rate falls within the range commonly reported in Indian hospital studies, where SSI incidence often varies from approximately 5% to 12% or higher, depending on the healthcare setting, case mix, and infection control practices. Similar figures have been documented in multi-center Indian observations, with rates around 5.2% in some tertiary settings and up to 7–11% in others [2, 3, 15].

Most infections observed were superficial (75%), while deep and organ/space SSIs were less frequent (16.6% and 8.3%, respectively). This predominance of superficial infections is consistent with patterns described in the literature, where such cases are often linked to environmental or skin flora contamination during the procedure rather than deeper seeding. Although superficial SSIs may appear less severe, they still contribute to patient discomfort, delayed wound healing, additional healthcare costs, and prolonged hospital stays issues that are particularly relevant in resource-aware Indian hospital contexts [43].

The hospital’s ventilation infrastructure likely offered some protection, as positive air pressure was maintained in 92% of theaters and laminar airflow was available in 76%. However, the occurrence of 12 infections despite these measures suggests that technical infrastructure must be complemented by consistent behavioral and workflow practices.

Operating Room Traffic and Its Link to SSI Risk

A prominent finding was the statistically significant association between higher frequencies of door openings and increased SSI occurrence ($p < 0.001$), with a clear dose-response trend procedures exceeding 50 or 100 openings showed proportionally more infections. Each door opening can briefly disrupt the positive-pressure airflow, allowing potential airborne contaminants to enter the sterile field. In busy multi-specialty Indian operating suites, such interruptions often accumulate due to supply retrieval, staff consultations, or logistical needs [8, 36].

Our data indicated substantial movement even in the pre-incision phase (mean 18.7 events), which is especially concerning because it may compromise air quality before the wound is created. International observational studies have similarly reported that frequent door openings elevate bacterial counts and particle loads in the OR, with effects sometimes more pronounced outside laminar airflow zones. While some meta-analyses describe the per-opening risk increment as relatively modest on its own, the cumulative impact across an entire case particularly in longer procedures appears clinically relevant [9,11].

Independent Predictors Identified Through Regression Analysis

Binary logistic regression highlighted four independent predictors of SSI: door openings >50 (adjusted odds ratio 4.78), poor traffic compliance (AOR 3.37), surgery duration >2 hours (AOR 2.94), and cleancontaminated wound class (AOR 2.16). Traffic-related factors demonstrated stronger effect sizes than wound classification alone, underscoring their modifiable nature.

These results align with established understanding that prolonged operative time increases cumulative exposure to potential contaminants, while clean-contaminated wounds carry inherently higher endogenous microbial risk according to standard CDC wound classification systems. Behavioral elements, such as adherence to traffic protocols, can either amplify or mitigate these baseline risks through better planning and team coordination [4].

Contextualizing the Results with Existing Literature

The observed associations resonate with broader evidence. Multiple studies have linked increased door openings to higher microbial contamination and elevated SSI risk, with some reporting average openings ranging from 20 to over 100 per case in orthopedic and general surgery. Indian research has repeatedly identified prolonged surgery duration and wound contamination class as key risk factors, findings echoed in our regression models [5].

Recent individual-patient data meta-analyses suggest a small but detectable increase in SSI odds with each additional door opening per hour, with stronger cumulative effects in higher-baseline-risk patients. Our work contributes by providing direct observational traffic data paired with prospective SSI surveillance in an Indian mid-sized hospital setting, where such granular studies remain relatively uncommon [11].

Clinical, Operational, and Public Health Implications

These findings point to practical, relatively low-cost opportunities for improvement. Measures such as preoperative team huddles to anticipate supply needs, clearer internal communication, and visual reminders about traffic discipline could reduce unnecessary movements without major workflow disruption. In the Indian context, where SSIs contribute to antibiotic overuse and resistance pressure, addressing modifiable environmental and behavioral factors offers a sustainable route to lowering infection burden [44].

Limitations in Interpretation

As a single-center observational study, the exact percentages may vary across different hospital types or regions. While key variables were accounted for, unmeasured factors (e.g., precise antibiotic timing or subtle technique differences) could influence outcomes. Observer presence might also have subtly affected staff behavior, though efforts were made to minimize this.

Concluding Remarks for the Discussion

Overall, the evidence indicates that operating room traffic, particularly frequent door openings, functions as a meaningful and modifiable determinant of SSI risk. Combining sound infrastructure with disciplined movement practices presents a realistic opportunity to further safeguard patients.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

Overview

This observational study investigated the relationship between operating room traffic (primarily dooropening frequency) and postoperative SSI incidence in 200 procedures at Parul Sevashram Hospital. Direct observation during surgery was combined with 30-day prospective surveillance. Descriptive findings showed a mixed surgical case load, with notable traffic levels (40% of cases ≥50 door openings) and an overall SSI rate of 6%, mostly superficial. Statistical analyses confirmed a strong link between higher door-opening categories and infection risk, with regression identifying traffic-related factors as prominent independent predictors [11].

Major Conclusions

The study concludes that frequent door openings and uncontrolled OR traffic are important modifiable contributors to SSI risk, even in settings with reasonable ventilation support. Door openings exceeding 50 per case emerged as the strongest predictor in adjusted models. The results emphasize the value of intentional planning and team discipline rather than unattainable zero-movement ideals [36,13].

Recommendations:

For Hospital Administration and Leadership

Develop practical traffic control policies, consider simple monitoring tools, and integrate traffic metrics into quality audits. Support preoperative preparation protocols to reduce mid-case movements.

For Operating Room Teams and Clinical Staff

Adopt a mindful approach to movement, use team huddles for supply planning, and foster a culture where traffic discipline is viewed as shared patient protection.

For Infection Prevention and Control Committees

Incorporate door-opening frequency or traffic compliance as process indicators in SSI surveillance. Provide regular feedback from observational audits and include traffic topics in multidisciplinary training.

For Future Research Directions

Multi-center studies across varied Indian hospital settings would improve generalizability. Interventional trials testing traffic-reduction bundles (e.g., checklists combined with feedback) could quantify impact on both door openings and SSI rates [1].

Strengths of the Present Study

Objective direct observation of traffic, complete 30-day follow-up, and combined statistical approaches strengthen the findings. The focus on actionable behavioral and environmental factors adds practical value.

Limitations and Areas for Caution

Single-center design and observational nature limit definitive causality claims. Some confounders may remain unmeasured, and subtle observer effects cannot be entirely ruled out.

Final Reflections

Surgical site infections continue to challenge surgical care, yet many contributing factors are within the team's influence. By attending thoughtfully to movement patterns and building disciplined habits, operating rooms can become calmer, safer environments ultimately benefiting patient recovery one procedure at a time.

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