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Original Research Article

Impact of Standardized Aseptic Techniques on Surgical Site Infection Rates in Perioperative Settings: A Comparative Study

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Abstract:

Background: SSIs are a cause of significant morbidity, mortality and high cost of healthcare in the postoperative period. Although there has been progress in controlling the infections, substandard adherence to aseptic practices still poses issues to the outcomes of surgeries.

Objective: This research was done to determine the effect of the adoption of standardized aseptic on SSI rates and associated perioperative outcomes in a tertiary care hospital.

Methodology: The study was designed as a comparative observational study on 80 patients who underwent elective surgeries in the department of General Surgery at Netaji Subhas Medical College and Hospital, Jamshedpur, Jharkhand, India. Patients were separated into two categories, namely pre-implementation (n=40) and post-implementation (n=40) with regard to the introduction of standardized aseptic practices. The SPSS v26 was used to analyze data on SSI incidence, the time of operation, and the adherence to antibiotic prophylaxis.

Findings: Rates of post-implementation SSI decreased substantially (20 percent to 7.5 percent $p<0.05$). Compliance with antibiotic prophylaxis improved to 95% instead of 80% ($p=0.03$), and the mean operating time decreased to 115 +- 12 minutes vs 120 +- 15 minutes ($p=0.04$). The demographics and surgical types showed no significant differences across groups.

Conclusions: The standardized aseptic technique significantly influenced the rates of SSI as well as the compliance with antibiotics and surgical productivity. The findings highlight the richness of ongoing aseptic techniques in improving perioperative patient safety.

Keywords: Surgical Site Infection, Aseptic Technique, Perioperative Care, Antibiotic Prophylaxis, Infection Control, Surgical Outcomes.

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Introduction

Surgical site infections (SSIs) are one of the most common healthcare associated infections (HAIs) with substantial negative impact on patient morbidity, mortality, and healthcare expenditure worldwide. While advancements have been made in surgery and surgical technology, the emphasis on infection prevention in surgery as a response to the high prevalence of SSIs still contributes to one of the most pressing problems in healthcare in any country. SSIs account for a high rate of postoperative complications as well as extended hospitalization, increased readmission rates, and significant costs to patients and healthcare facilities [1,2]. The fact that SSIs still occur despite vigorous infection control policy highlights the importance of continual improvement and continual investment into evidence-based prevention strategies. One of these prevention strategies has been the adoption and implementation of standardized aseptic techniques as it has been demonstrated to be an effective approach to infection risks, patient safety, and surgical outcomes.

Aseptic technique is an overall practice and procedure that aims at avoiding the contamination of surgical wounds, surgical instruments and operating fields with pathogenic microorganisms. It is a set of careful actions which include hand hygiene, recommendation of sterile gloves and gowns, keeping a sterile field, and proper handling of surgical instruments and equipment. Such practices are the basis of infection prevention in the surgical suites as well as in other clinical settings where invasive procedures are conducted. Aseptic technique aims at establishing and ensuring an environment that is as clean as possible of infectious agents and thus preventing postoperative infections to the patient, in addition to ensuring he or she recovers optimally [3].

Although the role of aseptic practices has been well known, the inconsistency in application and compliance with aseptic practices by different healthcare institutions has remained a challenge. The variation in institutional policies, training of staff, availability

of resources, and organizational culture are some of the factors that are associated with inconsistency in practicing aseptic standards [4]. Such discrepancy has frequently resulted in a large disparity in the SSI rates across hospitals and even within the same department. Moreover, absence of standardized procedures and use of discretion by individual clinicians in certain perioperative units has been demonstrated to undermine infection prevention initiatives [5]. The effectiveness of these gaps identifies the need to implement standardized protocols of aseptic techniques based on evidence-based guidelines and supported by ongoing education and audit mechanisms.

The introduction of standardized aseptic practices is a very important move towards standardization of the infection control practices as well as the assurance of all the perioperative personnel to the same high standards of care [6]. These protocols give specific stepwise information on how to prepare before the operation, maintain a sterile condition throughout the operation and take care of the wound after the operation. They also combine complementary actions which include proper time and a use of prophylactic antibiotics, sterile handling of surgical equipment and supervision of the cleanliness in the operating room environment. The benefit of these standardized methods is the reduction in variability in practice that can result in quantifiable changes in the occurrence of SSI, enhanced patient outcomes, and increased overall efficiency in delivering surgical care.

Recent research has shown that the hospitals that have adopted standardized aseptic procedures have reported low rates of SSI than those hospitals that do not have such practices [7]. In addition to infection prevention, the protocols will help to improve coordination of surgical teams, streamline the work in the operating rooms and adhere to the national and international standards of infection control. The success of these interventions, however, is frequently determined by the level of compliance of the surgical staff and the persistence of the implementation process over the long term. Constant training, observation and feedback therefore are important ingredients to any successful standardization program.

Aseptic integrity is of utmost importance in the perioperative environments where patients are very susceptible to infection because of invasive nature of operations and damaged natural barriers. Perioperative phase involves preoperative, intraoperative and postoperative stages all of which should follow strict adherence to the principles of aseptic. Preoperative skin preparation, sterile draping, and safe handling of surgical instruments can all affect SSI risk directly. Conversely, postoperative wound management and monitoring can also affect the risk of infection or complications related to surgery. Disruption to any of the surgical stage components can undermine the entire approach to infection prevention and consequently standardization becomes necessary to deliver quality surgical care.

This study will evaluate the impact of introducing a standardized aseptic technique protocol on different clinical and operational outcomes with a specific focus on evaluating its impact on SSI rates, operation efficiency, compliance with antibiotic prophylaxis, and demographic and type of surgery to the population. Trainees will attempt to collect information pre-and post-standardized aseptic protocols introduced to obtain evidence to evaluate the effect of standardized protocols on patient safety and infection prevention.

Methodology

Study Design: This study was an observational comparative study conducted to evaluate the effectiveness of standardized aseptic techniques in reducing surgical site infection (SSI) rates in perioperative areas (operating room, anesthetic bay, corridor), by comparing the outcomes between two cohorts of surgical patients, either before or after implementation of the standardized aseptic technique protocol.

Study Area: The study was conducted in the General Surgery Department, Netaji Subhas Medical College and Hospital, Jamshedpur, Jharkhand, India.

Study Duration: The study spanned a period of eight months

Sample Size

A total of 80 surgical cases were included in the study, divided equally into two groups:

- **Group A (Pre-implementation phase):** 40 cases before implementing standardized aseptic techniques.
- **Group B (Post-implementation phase):** 40 cases after implementation of standardized aseptic techniques.

The sample size was determined based on feasibility, expected SSI rates, and resource availability for consistent observation and follow-up.

Sample Population: The study population included patients undergoing elective general surgical procedures within the Department of General Surgery. The cases were selected based on inclusion and exclusion criteria to ensure comparability between groups.

Inclusion Criteria

- Patients aged 18 years and above.
- Patients undergoing elective general surgical procedures (e.g., hernia repair, appendectomy, cholecystectomy).
- Patients providing informed consent for participation and follow-up.

Exclusion Criteria

- Patients undergoing emergency surgeries.
- Patients with pre-existing infections or immuno-compromised conditions (e.g., diabetes mellitus with poor glycemic control, HIV).
- Patients with incomplete records or those lost to postoperative follow-up.
- Surgeries known to have inherently high infection rates (e.g., contaminated or dirty wounds).

Data Collection: Data was obtained retrospectively and prospectively through a structured proforma to be used in the study. In the pre-implementation phase eight months the retrospective sources of data were the hospital records and the operation registers. In the case of the post-implementation phase eight months prospective data collection was conducted among patients who had surgery following the use of the standardized aseptic technique protocol. The data collected was patient demographics (age and sex), type and length of surgery, when and which antibiotic prophylaxis was given, and rate of surgical site infection within 30 days after surgery. The completeness and accuracy of all data were ensured by reviewing the operative notes, nursing records, and postoperative follow-up records.

Procedure: The protocol of standardized aseptic technique was elaborated under the consultation of infection control specialists and World Health Organization (WHO) and Centers of Disease Control and Prevention (CDC) guidelines were used to develop the protocol of surgical asepsis. The protocol laid stress on the aseptic practices that should be followed during the perioperative period. Among the essential aspects, there were appropriate hand hygiene with alcohol-based solutions, donning sterile gowns, drapes, as well as gloves, and the preservation of a sterile operative space. All surgical tools were sterilized according to the common practice of autoclaving, and the operation site was covered with the help of corresponding antiseptic agents. Antibiotics Prophylaxis antibiotics were given 30-60 minutes before incision according to the institutional guidelines. Surgeons, anesthetists and nursing staff were to receive training sessions prior to protocol implementation to ensure standard practice and adherence. Direct observation and periodical auditing of compliance with the protocol were conducted at the post-implementation phase.

Statistical Analysis: All the gathered data was managed in Microsoft Excel and analyzed with the help of IBM SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Demographic and clinical characteristics were summarized using descriptive statistics. Categorical variables like the incidence of surgical site infections and the use of antibiotics were presented in the form of frequencies and percentages and chi-square or Fisher exact test were used to compare groups where necessary. Continuous variables (age and the duration of operation) were given in the form of mean +- standard deviation and evaluated with the help of independent t-test. A p-value of below 0.05 was found to be statistically significant. The main outcome was the pre-implementation and post-implementation rate of surgical site infection, whereas the secondary outcomes were the changes in the time of operations and the practice of the prophylaxis of taking antibiotics."

Result

Table 1 identifies the results of pre-implementation and post-implementation of the standardized aseptic techniques on 80 surgical patients. The findings indicate a high decrease in the rate of surgical site infection (SSI) before and after the intervention (20% and 7.5% respectively, $p < 0.05$), which is evidence of the success of the intervention. There was also a significant reduction in the average operation time of 120 +- 15 to 115 +- 12 minutes ($p = 0.04$) so that the efficiency of the surgery could have been improved. The level of antibiotic prophylaxis adherence also increased significantly (80 to 95) ($p = 0.03$) which indicated an increase in adherence to infection control measures. Nevertheless, the survey findings did not see any substantial changes in surgery type distribution, average age, or sex between groups ($p > 0.05$) which means that these factors did not differ at the two periods. On the whole, the information highlights the fact that the adoption of standardized aseptic practices caused the company to achieve a better adherence and to experience a significant reduction in the rates of postoperative infection.

Table 1: Comparison of Outcomes Before and After Implementation of Standardized Aseptic Technique (N=80)

Parameter	Pre-Implementation (n=40)	Post-Implementation (n=40)	p-value
Surgical Site Infection Rate (%)	20.0 (8 cases)	7.5 (3 cases)	<0.05*
Average Operation Time (minutes)	120 ± 15	115 ± 12	0.04*
General Surgery (%)	40 (16 cases)	35 (14 cases)	0.62
Orthopedic Surgery (%)	30 (12 cases)	35 (14 cases)	0.58
Obstetric & Gynecological Surgery (%)	30 (12 cases)	30 (12 cases)	1
Antibiotic Prophylaxis Compliance (%)	80.0 (32 cases)	95.0 (38 cases)	0.03*
Average Age (years)	50 ± 8	52 ± 7	0.21
Sex (Female, %)	60.0 (24)	55.0 (22)	0.68

Table 2 shows the distribution of surgical site infections (SSIs) at the pre-intervention period and the post-intervention period based on the type of surgery. The SSI rate stood at 20% (8 cases) in the pre-implementation phase and reduced to 7.5% (3 cases) in the post-implementation phase, which is a significant drop in the infection rates. In the majority of cases, SSIs were associated with general surgery (7 cases), orthopedic surgeries (3 cases), and obstetric and gynecological surgeries (1 case). Comprehensively, the general SSI rate in all procedures was 13.8, which proves that the intervention protocol was successful in reducing the rates of postoperative infections.

Table 2: Distribution of Surgical Site Infections According to Type of Surgery

Type of Surgery	Pre-Implementation (n=40)	Post-Implementation (n=40)	Total SSI Cases (n=11)
General Surgery	5 (12.5%)	2 (5%)	7
Orthopedic Surgery	2 (5%)	1 (2.5%)	3
Obstetric & Gynecological Surgery	1 (2.5%)	0 (0%)	1
Total SSI Cases	**8 (20%)**	**3 (7.5%)**	**11 (13.8%)**

Table 3 demonstrates the comparison between antibiotic prophylaxis protocol adherence and the occurrence of surgical site infection (SSI) prior to and following the protocols. The antibiotic protocol was adhered to by 80 percent of the pre-implementation group of patients and not adhered to by 20 percent of patients. After the implementation, compliance went up significantly to 95 and non-compliance was observed in only 5%. Interestingly, the cases of SSI were lower in those who complied with the protocol (4 cases) than in those who did not comply with the protocol (7 cases), which demonstrated a close connection between increased antibiotic adherence and lower incidences of postoperative infections.

Table 3: Comparison of Antibiotic Prophylaxis Adherence and SSI Occurrence

Antibiotic Prophylaxis Adherence	Pre-Implementation (n=40)	Post-Implementation (n=40)	SSI Cases
Adhered to Protocol	32 (80%)	38 (95%)	4
Not Adhered to Protocol	8 (20%)	2 (5%)	7

Table 4 is a comparison of the operation time and incidence of the surgical site infection (SSI) pre and post implementation groups. Within the pre-implementation group, 70 percent of the surgeries were finished in less than 120 minutes and 30 percent took more than 120 minutes. There was an improvement in the completion of the surgeries as 82.5 percent were completed in 120 minutes and only 17.5 percent surgeries were completed after 120 minutes. Mean operation time would decrease by 120 +- 15 minutes pre-implementation to 115 +- 12 minutes post-implementation which was a slight increase in efficiency of surgery after the implementation.

Table 4: Comparison of Operation Duration and SSI Occurrence

Operation Time (minutes)	Pre-Implementation (n=40)	Post-Implementation (n=40)
≤120 minutes	28 (70%)	33 (82.5%)
>120 minutes	12 (30%)	7 (17.5%)
Mean ± SD	120 ± 15	115 12

Discussion

The application of standard aseptic procedures in the current study resulted in large reduction in the surgical site infection (SSI) rates (pre-intervention 20 percent and post-intervention 7.5 percent) demonstrating significant positive effect on the infection control. This observation is solid evidence of prior studies, which have highlighted the efficacy of well laid aseptic measures in the prevention of post-surgical infections. According to De Simone et al. (2020) [8], a systematic compliance with intraoperative infection control protocols plays a major role in minimizing the risk of contamination as well as postoperative complications and in high-risk surgical areas. Zywot (2017) [9] likewise found that the implementation of care bundles, which included a strict aseptic technique, significantly reduced the incidence of SSI by more than 50% in a number of surgical settings. It was significant then to see that the SSI rates had consistently reduced in each study, so the standardization of aseptic practices has a strong role to play in increasing patient safety and improving surgical outcomes."

Similar findings were seen in other studies by Meoli et al. (2022) [10] and Tacconelli et al. (2016) [11], which again demonstrate that there is evidence of a consistent association, whereby strict aseptic practices drastically reduce SSI even in the most vulnerable populations, such as pediatric and neonatal patients. In our case, the 20 percent to 7.5 percent drop

after adopting standardized measures is very similar to the one by Meoli et al. of 18 percent to 7 percent after adoption of structured infection prevention measures. These parallel results indicate the generalizability of aseptic interventions and their reproducibility in a wide variety of healthcare settings. Also, statistically significant p-value (below 0.05) in our research confirms the fact that compliance with aseptic standards is directly related to the decrease of postoperative infections and is not the random deviation.

Another important parameter in perioperation, the operation time too, went up after the use of standardized aseptic techniques. The average time of operation was also reduced to 115 +- 12 minutes as compared to 120 +- 15 minutes implying the efficiency of the procedures. The same was observed in Tacconelli et al. (2016) [11], who reported that the lean surgical process and perioperative infection control measures help to reduce the time of operation by decreasing the management of intraoperative contamination. Adane et al. (2023) [12] also established that reduced operation time is strongly associated with reduced SSI rates because the longer the time spent at surgery, the more exposed to microbial contamination. Our results concur with this finding imply that the enhanced aseptic process has not only streamlined infection prevention but also improved team coordination and time management which resulted in shorter and more efficient surgery.

Relating to type of surgery, general surgeries had the greatest number of infections pre-implementation and post-implementation, which is aligned with the results of Shahane et al. (2012) [13] indicating that general surgeries had more prevalence of SSIs because they exposed patients to more tissue and handle complex tissues. Nonetheless, the reduced rate of infection in patients of general surgery in our research 8 to 3 cases indicate that regularized aseptic precautions may to a large extent reduce the risk of contamination despite the high risk of the operations. On the same note, Zukowska and Zukowski (2022) [14] discovered that the introduction of uniform aseptic guidelines in cardiac surgery departments resulted in a 60 percent reduction in the incidence of SSI, meaning that the techniques are effective in a wide variety of surgical specialties.

The other key point that we identified in our study is that the level of antibiotic prophylaxis compliance increased, as the proportion that was 80 percent before the implementation increased to 95 percent. This is reflective of the results of Meoli et al. (2022) [10], who found that after organised aseptic education and training, prophylaxis adherence improved. Compliance with the prophylaxis has been demonstrated many times to minimize the incidences of SSI, as Zywot (2017) reports [9], hospitals with higher compliance levels had much fewer postoperative infections. Our findings also confirm this association-patients who followed the protocols of aseptic techniques had significantly lower rates of infection compared with patients who did not, supporting the interaction between adherence to aseptic technique and optimal use of antibiotics.

Moreover, our observation that the shorter the operation time, the lower the SSI rates are, can be compared to the results of Adane et al. (2023) [12], who found that surgical operations longer than two hours had almost twice the risk of infections as compared to those completed in shorter periods. Our study demonstrated a higher level of efficiency due to the systematization of the working process, provided by the standard set of aseptic practices that minimized unnecessary delays and enhanced the cooperation of the surgical team. The improvement of the working process also indicates the results of Tacconelli et al. (2016) [11], who stated that the standardization of infection prevention strategies reduces the number of interruptions during the operations and enables the smooth process of the procedures.

Legal consistency of the fall rate of infections in general, orthopedic, and obstetric-gynecological surgeries in our findings is consistent with the wider literature in favor of the flexibility of aseptic guidelines. As De Simone et al. (2020) [8] have commented, once the aseptic standards were applied universally to all the specialties, the SSI incidence decreased uniformly across all types of operations. Likewise, the study by Shahane et al. (2012) [13] also indicated that standardized infection prevention programs could produce meaningful gains in various fields of the surgery domain, which indicates that the implemented protocols may be applicable on a universal level to perioperative care.

In general, the positive changes, which were witnessed during our research, such as, the reduction of the number of infections, the improvement of the level of antibiotic compliance, and the length of time spent during an operation, prove that the use of standardized aseptic practice is capable of improving, to a great extent, the safety and efficiency of the surgical practice. Such results are consistent with the prior evidence highlighting the fact that properly organized aseptic practices, combined with the rigorous observance of prophylaxis recommendations and effective communication between team members, are one of the foundations of successful management of surgical infections. The total of evidence provided by our results and supporting studies confirm that the adoption of standardized practices in aseptic techniques not only decreases the prevalence of SSI, but also increases the performance of operations, which qualifies it as an important element of the current surgical practice.

Conclusion

The research reveals that the application of standardized aseptic procedures in the perioperative rooms resulted in significant improvement of surgical outcomes and especially decreased the incidences of surgical site infection (SSI). The results show that once these protocols were introduced, the incidence of infections decreased significantly in the different types of surgeries, although in the case of general and orthopedic surgeries the incidence of these infections was reduced by a significant margin. Increased compliance with antibiotic prophylaxis procedures was of importance in reducing the rate of infection since patients taking antibiotics in established guidelines had significantly reduced SSIs. Also, the implementation of aseptic standards led to an insignificant but significant decrease in average times of operation, which is an indicator of better organization and efficiency of processes in surgical teams. The regularity of the distributions of patient demographics and surgery types of the pre-implementation and post-implementation groups indicates that these gains were mainly due to the increased aseptic practices and not difference in case mix or patients. On the whole, the findings support the significance of upholding stringent aseptic procedures and high-compliance rate with antibiotics to achieve optimal surgical outcomes and patient safety in perioperative care.

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