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RESEARCH ARTICLE
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"EFFECT OF INTEGRATED SURGICAL SITE INFECTION (SSI) BUNDLE AND ANTIMICROBIAL STEWARDSHIP ON SSI RATES IN A TERTIARY-CARE TEACHING HOSPITAL: A PRE–POST INTERVENTION STUDY"

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ABSTRACT

Introduction: Surgical Site Infection (SSI) is one of the most common preventable postoperative complications, contributing significantly to morbidity, prolonged hospital stays, and increased antimicrobial use. LMICs, including India, report higher SSI rates due to limited adherence to Infection Prevention and Control (IPC) practices, inconsistent aseptic technique, and rising antimicrobial resistance. Evidence suggests that structured SSI-prevention bundles and Antimicrobial Stewardship (AMS) interventions can significantly reduce SSI burden when implemented effectively. This study evaluates the impact of an integrated SSI bundle and AMS program on SSI rates in a tertiary-care teaching hospital.

Material and Methods: A pre–post intervention study was conducted in surgical units over 18 months. A total of 600 patients undergoing clean and clean-contaminated surgeries were included (300 pre-intervention and 300 post-intervention). The SSI bundle consisted of preoperative CHG bathing, timely antibiotic prophylaxis, optimal skin preparation, normothermia maintenance, glycemic control, and sterile surgical practices. AMS interventions included optimizing prophylactic antibiotic choice, timing, and duration aligned with WHO and CDC guidelines. SSI surveillance was conducted using CDC/NHSN criteria up to 30 days post-surgery. Rates were calculated per 100 surgeries.

Results: SSI rates decreased from 9.6% in the pre-intervention phase to 4.3% in the post-intervention phase (55% reduction; p=0.032). Timely antibiotic prophylaxis improved from 61% to 88%, and inappropriate prolonged antibiotic use decreased from 47% to 19%. CHG-based skin preparation compliance improved from 54% to 87%. Clean surgeries showed the most significant decline in SSI. Gram-negative organisms, including Klebsiella and Pseudomonas, were predominant in pre-intervention cultures, whereas post-intervention isolates decreased significantly.

Conclusion: Implementation of an integrated SSI-prevention bundle combined with AMS interventions resulted in a substantial reduction in SSI rates. The study demonstrates that simple, evidence-based, low-cost practices—supported by antimicrobial governance—can significantly improve surgical outcomes in resource-limited settings. Sustained adherence and surveillance are essential for long-term success.

Keywords: Surgical Site Infection; SSI Bundle; Antimicrobial Stewardship; Prophylaxis; IPC; Surgical Safety; CHG preparation; Antibiotic Timing

INTRODUCTION

Surgical Site Infection (SSI) remains one of the most common postoperative complications worldwide, accounting for nearly 20% of all healthcare-associated infections. The burden is especially high in low- and middle-income countries, where SSI rates may be two to five times higher than those reported in high-income regions. Factors contributing to high SSI incidence include limited adherence to aseptic surgical techniques, suboptimal perioperative antibiotic practices, inadequate operating room sterility, and rising antimicrobial resistance (AMR).[1–3]

International guidelines by WHO, CDC, and NICE recommend evidence-based SSI-prevention bundles that include preoperative bathing, appropriate surgical prophylaxis, optimal skin preparation, glycemic control, temperature management, and sterile handling protocols. When implemented consistently, these bundles have been shown to reduce SSI rates by 40–70%.[4–6] However, compliance in LMICs remains inconsistent due to infrastructural limitations, variable staff training, and lack of continuous monitoring.[7]

Antimicrobial Stewardship (AMS) forms a crucial component of SSI prevention. Rational antibiotic prophylaxis—administered within 60 minutes before incision and discontinued within 24 hours—has been shown to reduce postoperative infections and prevent antimicrobial overuse.[8–9] In many Indian hospitals, prolonged and inappropriate postoperative antibiotic use remains a common issue, contributing to AMR and unnecessary costs.

Despite the availability of guidelines, SSI rates remain a challenge in many surgical units due to fragmented practices, lack of audits, and insufficient coordination between surgeons, anesthesiologists, microbiologists, and nursing staff. There is a need for practical, scalable, and evidence-based SSI prevention models that integrate both IPC bundles and AMS principles.

The present study evaluates the effect of an integrated SSI-prevention bundle and AMS interventions on reducing SSI rates in a tertiary-care teaching hospital. The objective is to demonstrate measurable improvement achievable through standardized, low-cost interventions.

STATISTICAL ANALYSIS

- Data analyzed using **SPSS v26**.
- Continuous variables → mean ± SD.
- Categorical variables → percentages.
- Comparison of SSI rates:
  - **Chi-square test**
  - **Fisher's exact test** (if cell count <5)
- Compliance improvement compared using:
  - **Z-test for proportions**
- **p-value <0.05** considered statistically significant.
- Relative Risk (RR) and Attributable Risk (AR) calculated.

RESULTS

1. Demographic Profile

Variable	Pre (n=300)	Post (n=300)
Mean age (years)	46.8 ± 12.3	47.1 ± 11.8
Male (%)	54%	57%
Female (%)	46%	43%
Clean surgeries	190	188
Clean-contaminated	110	112

2. Compliance to SSI Bundle

Bundle Element	Pre (%)	Post (%)	Improvement
CHG Bathing	52%	86%	+34%
Prophylaxis within 60 min	61%	88%	+27%
CHG–Alcohol Skin Prep	54%	87%	+33%
Glycemic control	69%	84%	+15%
Normothermia	72%	89%	+17%

3. Use of Antibiotics (AMS Indicators)

Indicator	Pre (%)	Post (%)	Change
Wrong choice of prophylactic antibiotic	41%	18%	↓ 23%
Prolonged prophylaxis (>24h)	47%	19%	↓ 28%
De-escalation based on culture	22%	46%	↑ 24%

4. SSI RATE REDUCTION

Outcome	Pre (n=300)	Post (n=300)	p-value
SSI cases	29 (9.6%)	13 (4.3%)	**0.032**
Clean surgeries	7.3%	2.8%	—
Clean-contaminated	13.7%	6.9%	—

Relative Risk (RR) = 0.45
Reduction = 55%

5. Microbiological Profile
Pre-intervention isolates
- **Klebsiella pneumoniae** – 34%
- **E. coli** – 29%
- **Pseudomonas aeruginosa** – 18%
- **S. aureus (MRSA)** – 14%
- **Acinetobacter spp.** – 5%

Post-intervention isolates
- Significant overall reduction
- Higher reduction seen in Gram-negatives
- MRSA decreased from 14% → 8%

DISCUSSION

The present study evaluated the impact of an integrated SSI-prevention bundle combined with AMS interventions on reducing postoperative infections in a tertiary-care teaching hospital. The findings indicate a significant reduction in SSI rates, improved compliance with evidence-based practices, and rationalization of antimicrobial use after implementation of the intervention.

The reduction in SSI rates from **9.6% to 4.3% (p = 0.032)** represents a substantial improvement and aligns with global evidence that structured SSI bundles can reduce infections by **40–70%** when implemented with fidelity. These results are consistent with studies from WHO-SEAR countries, which highlight that basic perioperative measures—such as chlorhexidine skin preparation, correct prophylactic antibiotic timing, and strict aseptic technique—have the largest effect on SSI prevention.

One of the strongest contributors to improvement in this study was the enhanced compliance with **timely surgical antibiotic prophylaxis**, which increased from **61% to 88%**. This mirrors the observations from international systematic reviews showing that prophylaxis administered within 60 minutes of incision reduces SSI risk significantly compared with delayed administration. Additionally, the introduction of the hospital antibiogram and AMS-guided selection of prophylactic antibiotics prevented unnecessary use of broad-spectrum agents.

The improved compliance with **chlorhexidine (CHG) bathing** and **CHG–alcohol skin preparation** further strengthened infection control outcomes. CHG-based preparation has been shown to reduce microbial burden more effectively than povidone-iodine, especially against Gram-negative organisms commonly isolated in Indian surgical settings. Our pre-intervention culture profile—dominated by **Klebsiella, E. coli, and Pseudomonas**—is consistent with trends reported from many Indian tertiary hospitals. The significant decline in these organisms in the post-intervention phase reinforces the effectiveness of standardized preparation methods.

The AMS component contributed meaningfully by reducing prolonged postoperative antibiotic use (47% to 19%) and improving culture-based de-escalation practices. These changes reduce drug resistance pressure and align with CDC, WHO, and Indian AMS guidelines, which emphasize short-duration prophylaxis and early narrowing of therapy.

This study is particularly important because it demonstrates that **simple, low-cost, workflow-based interventions** can achieve measurable reductions in SSI even without advanced technology such as automated surveillance systems or digital OR monitoring. This makes the model scalable for other resource-limited hospitals.

Additionally, surveillance quality improved during the intervention period, enhancing the accuracy of SSI detection. Daily wound rounds, SICU–OT communication, and feedback loops strengthened reporting and ensured early detection of postoperative complications.

Overall, the integrated approach—IPC bundles + AMS + surveillance—proved crucial for sustained improvement. These results strongly support the continued expansion of such programs at IMCHRC and similar institutions.

CONCLUSION

Implementation of a structured Surgical Site Infection (SSI) prevention bundle combined with a strengthened Antimicrobial Stewardship Programme significantly reduced SSI rates in this tertiary-care hospital. The intervention led to measurable improvements in preoperative preparation, intraoperative asepsis, postoperative care, and rational antibiotic usage.

A 55% reduction in overall SSI rates, improved compliance with critical bundle components, and a marked decrease in inappropriate antimicrobial use demonstrate that standardized preventive measures are both feasible and effective in resource-limited healthcare settings.

This study confirms that consistent adherence to SSI bundle components, supported by AMS governance and continuous surveillance, can substantially improve patient outcomes. The findings provide a practical and scalable framework for hospitals seeking to reduce surgical infections, improve antimicrobial use, and strengthen perioperative safety culture.

Declaration by Authors

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