Effectiveness of structured teaching programme on knowledge regarding surgical site infection and its prevention among staff nurses

Shivank Maheshwari[*1], Dr. Anitha Martin[2], L. Priyalata Devi[3]
*[*1]NPCC Final Year, Rohilkhand College of Nursing, Bareilly, (U.P.)*
[2]Professor Cum Vice Principal, Rohilkhand College of Nursing, Bareilly, (U.P.)
[3]Assistant Professor, Rohilkhand College of Nursing, Bareilly, (U.P.)

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Abstract:

Surgical site infection (SSI) is one of the most common healthcare-associated infections (HAIs) worldwide, contributing significantly to increased patient morbidity, prolonged hospital stays, escalating healthcare costs, and, in severe cases, mortality. Global estimates indicate that the pooled cumulative incidence of SSI among general surgical patients is approximately 11%, meaning that roughly one in every nine to ten patients undergoing surgery may develop an infection at the operative site within thirty days of the procedure. In India, reported SSI rates vary widely from 4.2% to 38% depending on the type of surgery, hospital setting, and surveillance methodology used. Staff nurses, being present at every stage of the perioperative continuum, play a pivotal role in preventing surgical site infections through consistent adherence to evidence-based infection prevention and control practices. Objectives: To evaluate the effectiveness of a structured teaching programme (STP) on knowledge regarding surgical site infection and its prevention among staff nurses, and to determine the association between pre-test knowledge scores and selected socio-demographic variables. Materials and Methods: A quantitative, pre-experimental, one-group pre-test–post-test research design was adopted. The study was conducted among 50 staff nurses at Rohilkhand Medical College & Hospital, Bareilly, Uttar Pradesh, selected through non-probability convenience sampling. Data were collected using a self-structured, validated knowledge questionnaire and analyzed using the Statistical Package for Social Sciences (SPSS), version 20. Results: The findings revealed a statistically significant improvement in the knowledge of staff nurses regarding surgical site infection and its prevention following the structured teaching programme, with the mean knowledge score rising from 14.06 ± 4.492 in the pre-test to 22.89 ± 2.674 in the post-test (paired $t = 24.255$, $p = 0.0001$), an absolute gain of 8.83 points and a relative improvement of approximately 62.8%. A statistically significant association was also found between pre-test knowledge scores and selected socio-demographic variables, including age, gender, professional qualification, area of working, years of experience, and source of information. Conclusion: The structured teaching programme was highly effective in improving the knowledge of staff nurses regarding surgical site infection and its prevention. These findings are consistent with the broader international literature, which similarly reports meaningful knowledge gains following structured educational interventions among nursing personnel. Enhancing nurses' knowledge through regular, structured educational programmes can strengthen infection prevention practices at the bedside and in the operation theatre, thereby contributing to a measurable reduction in the incidence of surgical site infections and an overall improvement in the quality and safety of patient care.

Keywords:

Effectiveness, Structured Teaching Programme, Knowledge, Surgical Site Infection, Prevention, Staff Nurses, Infection Control, Nursing Education, Hospital-Acquired Infection.

1. Introduction:

Surgical Site Infections (SSIs) are defined by the Centers for Disease Control and Prevention (CDC) as infections that occur at or near a surgical incision within thirty days of the procedure, or within ninety days to one year if prosthetic material or an implant has been placed (CDC, 2010). SSIs are conventionally classified into three categories: superficial incisional SSI, involving only the skin and subcutaneous tissue; deep incisional SSI, involving the deeper soft tissue such as fascia and muscle layers; and organ/space SSI, involving any part of the anatomy other than the incision that was opened or manipulated during the operative procedure (CDC, 2010; Gillespie et al., 2021). SSIs remain among the most common healthcare-associated infections and continue to be a major cause of postoperative morbidity, prolonged hospital stays, increased healthcare costs, and, in a proportion of cases, mortality (Karami et al., 2022; Maraş & Sürme, 2023).

The global burden of SSI is substantial. A systematic review and meta-analysis pooling data from 488,594 patients across 57 studies reported a 30-day cumulative incidence of 11% (95% CI 10–13%), indicating that approximately one in every nine surgical patients develops an infection at the operative site (Gillespie et al., 2021). Other meta-analyses report a somewhat lower pooled global incidence of around 2.5%, with marked regional variation — infection rates are considerably higher in the African region (7.2%) and in other low- and middle-income countries (LMICs) compared with high-income settings (Mengistu et al., 2023). SSIs are estimated to account for approximately 20–38% of all healthcare-associated infections and are frequently ranked as the second or third most commonly reported nosocomial infection in hospitalized surgical patients (Mengistu et al., 2023; Meena et al., 2023). In LMICs specifically, up to 40% of patients undergoing "dirty" or heavily contaminated surgery may develop an SSI, reflecting the disproportionate burden carried by resource-constrained health systems (LMIC SSI Burden Review, 2025).

Within India, the reported incidence of SSI varies considerably across studies, hospital types, and surveillance definitions used. The multicentre International Nosocomial Infection Control Consortium (INICC) surveillance study, conducted across ten hospitals in six Indian cities, documented an overall SSI rate of 4.2% among more than 28,000 surgical procedures (Rosenthal et al., 2014). In contrast, single-centre studies from tertiary care hospitals report considerably higher rates — 16% in a western Indian tertiary hospital (Patel et al., 2011), 22% (8.8%) in a Chennai-based prospective cohort following open elective and emergency surgeries, and rates ranging from 23% to 38% in a broader review of Indian hospital-based studies that lacked standardized post-discharge surveillance (India SSI Prevention Review, 2018). A study from central India similarly reported that SSI rates in Indian hospital settings commonly range between 4% and 30%, with clean-contaminated and contaminated wounds showing substantially higher infection rates than clean surgical wounds (Central India SSI Risk Factor Study, 2025). This wide variability underscores both the absence of a uniform national SSI surveillance system in India and the urgent need for standardized, evidence-based infection prevention practices across all levels of surgical care (India SSI Prevention Review, 2018).

Beyond the clinical burden, SSIs impose a significant economic cost on both patients and healthcare systems. A systematic review of the economic burden of SSI in low- and middle-income countries found that infected patients experience substantially prolonged hospital stays and higher direct treatment costs compared with uninfected patients, a burden that is magnified in resource-limited settings with fewer buffers for unplanned care (Monahan et al., 2020). Earlier European estimates placed the annual economic cost of SSIs between €1.47 and €19.1 billion, a figure that has almost certainly grown given the rising incidence of antimicrobial-resistant surgical pathogens (Maraş & Sürme, 2023).

Evidence consistently shows that a substantial proportion of SSIs — estimated at approximately 50% — are preventable through strict adherence to evidence-based infection prevention practices, including surgical hand hygiene, appropriate skin antisepsis, correctly timed antimicrobial prophylaxis, maintenance of a sterile field, appropriate hair removal techniques, normothermia, glycaemic control, and vigilant postoperative wound assessment and dressing technique (Sadaf et al., 2018; WHO, 2016; Allegranzi et al., 2016). The World Health Organization's Global Guidelines for the Prevention of Surgical Site Infection provide a comprehensive, evidence-graded set of pre-, intra-, and postoperative recommendations intended to standardize SSI prevention practice across both high-income and resource-limited settings (WHO, 2016; Allegranzi et al., 2016).

Staff nurses occupy a uniquely central position across this entire perioperative continuum. From preoperative patient preparation and skin antisepsis, through intraoperative asepsis and instrument handling, to postoperative wound monitoring, dressing changes, and patient education at discharge, nurses are directly responsible for implementing — or failing to implement — the majority of evidence-based SSI prevention measures (Karami et al., 2022; Kaur et al., 2021). Consequently, the depth and accuracy of nurses' knowledge regarding SSI and its prevention have a direct bearing on clinical outcomes. However, multiple studies from India and elsewhere suggest that nurses' knowledge in this domain is frequently inadequate or only moderately adequate. A recent global systematic review and meta-analysis of seventeen studies found that only 62% of nurses, pooled across settings, demonstrated "good" knowledge of SSI prevention, with substantial heterogeneity attributable to educational qualification, in-service training exposure, and clinical experience

(Habtie et al., 2025). A comparable Indian study conducted among staff nurses at a tertiary hospital in Bengaluru found that 67.5% had only "moderately adequate" knowledge, with no significant association between knowledge scores and demographic variables such as age, gender, or years of experience — a finding that itself underscores the need for universal, structured, and repeated in-service education rather than reliance on informal or experiential learning alone (Ramaiah Medical College Study, 2024).

Regular educational interventions and structured teaching programmes (STPs) have repeatedly been shown to produce significant, measurable improvements in nurses' knowledge, to promote evidence-based practice, and to enhance compliance with infection control protocols (Patel & Shah, 2022; Raj & Singh, 2022; Horgan et al., 2024; Abdelbayen & Suriadi, 2022). Given the persistent knowledge gaps documented in the literature, the substantial and largely preventable burden of SSI, and the pivotal role of nursing personnel in infection prevention, the present study was undertaken to evaluate the effectiveness of a structured teaching programme on knowledge regarding surgical site infection and its prevention among staff nurses at Rohilkhand Medical College & Hospital, Bareilly. It is anticipated that the findings of this study will help strengthen the evidence base supporting continuing nursing education in infection control, and will contribute, in the wider sense, to improved infection prevention practices and better patient outcomes.

2. Review of literature:

A structured review of the available literature was undertaken under three broad heads: (A) studies related to the prevalence and burden of surgical site infection; (B) studies related to the knowledge and practice of nurses regarding SSI prevention; and (C) studies related to the effectiveness of structured teaching programmes and other educational interventions in improving nurses' knowledge.

2.1. Literature related to the prevalence and burden of surgical site infection:

Mengistu et al. (2023) conducted a systematic review and meta-analysis of the global incidence of surgical site infection and found an overall pooled incidence of 2.5%, with the highest regional burden observed in the African region at 7.2%; the review also noted that the global incidence of SSI decreased only marginally, from 2.9% in 1996 to 2.8% in 2022, despite decades of infection-control advances. A separate, larger meta-analysis of 488,594 general surgical patients across 57 studies reported a considerably higher pooled 30-day cumulative incidence of 11% and found that SSI risk was significantly associated with the duration of surgery (Gillespie et al., 2021). Maraş and Sürme (2023) reviewed the epidemiological and microbiological profile of SSI and reiterated that Staphylococcus aureus remains the most frequently isolated causative organism, followed by coagulase-negative staphylococci, Escherichia coli, Pseudomonas aeruginosa, and various Enterobacter and Klebsiella species, and estimated that approximately half of all SSIs are preventable through the consistent application of evidence-based perioperative practice (Sadaf et al., 2018).

Within the Indian context, Rosenthal et al. (2014), reporting on behalf of the International Nosocomial Infection Control Consortium (INICC), documented an SSI rate of 4.2% (95% CI 4.0–4.4%) across 28,340 surgical procedures performed in ten hospitals across six Indian cities, noting that rates in most surgical categories were higher than those reported by the CDC's National Healthcare Safety Network but broadly comparable with other INICC member countries. Patel and colleagues, in a study conducted at a tertiary care hospital in western India (Gujarat), reported a considerably higher SSI rate of 16% among 200 surveyed patients, with E. coli identified as the predominant causative organism (Patel et al., 2011). A more recent review focused on Indian hospital settings found that reported SSI rates ranged from 23% to 38%, considerably higher than global estimates of 0.5–15%, and attributed this discrepancy to inconsistent perioperative care standards, variable theatre environments, and the absence of standardized, evidence-backed national SSI prevention guidelines in India (India SSI Prevention Review, 2018). Jatoliya et al. (2023), in a prospective study of abdominal surgeries at a government tertiary hospital in Jodhpur, Rajasthan, reported an overall SSI incidence of 17%, with markedly higher rates following emergency surgery (26%) compared with elective/planned surgery (8%), and identified diabetes mellitus, prolonged operative duration, and anaemia as significant contributing risk factors. Similarly, a study of risk factors in central India found that SSI rates in Indian hospitals commonly range from 4% to 30%, rising sharply with wound contamination class — from 2–5% in clean wounds to over 30% in contaminated or dirty wounds (Central India SSI Risk Factor Study, 2025). Pathak et al. (2017), studying obstetric and gynaecological surgical patients in a rural Indian teaching hospital, found a cumulative SSI incidence of 7.84%, with patients who developed SSI experiencing a mean postoperative stay 3.6 days longer than those who did not. Skender et al. (2022), examining orthopaedic surgical patients in Madhya Pradesh, reported an SSI incidence of 7.6% over a three-year surveillance period, with S. aureus again identified as the predominant pathogen. Collectively, this body of literature illustrates both the substantial and highly variable burden of SSI across Indian healthcare settings, and the consistent

finding that emergency surgery, wound contamination class, and patient comorbidities such as diabetes are recurrent, modifiable or partially modifiable risk factors.

2.2. Literature related to nurse's knowledge and practice regarding SSI prevention:

Habtie et al. (2025) conducted a comprehensive systematic review and meta-analysis of seventeen observational studies assessing nurses' knowledge of SSI prevention across multiple countries and found a pooled proportion of only 62% of nurses demonstrating "good" knowledge, with knowledge levels significantly determined by educational qualification, in-service infection-control training, and years of clinical experience. A comparable Indian study conducted among staff nurses at Ramaiah Medical College Hospital, Bengaluru, found that 67.5% of participating nurses had only moderately adequate knowledge of SSI prevention (mean score 15.83), and reported no statistically significant association between knowledge and demographic variables such as age, gender, marital status, or years of experience — a finding the authors attributed to a persistent theory–practice gap among nurses transitioning into clinical roles (Ramaiah Medical College Study, 2024). Kaur et al. (2021), assessing infection-prevention knowledge and practice among nurses at a tertiary care hospital in India, similarly reported gaps between theoretical knowledge and its consistent application at the bedside. Sadaf et al. (2018), studying nurses at Allied Hospital, Faisalabad, Pakistan, found that while a majority of nurses possessed adequate theoretical knowledge of SSI prevention, actual practice scores were considerably lower, again pointing to a knowledge–practice gap that structured, hands-on educational interventions are well positioned to address. Naz et al. (2023), in tertiary hospitals in Peshawar, Pakistan, reported similarly moderate knowledge and practice scores among nurses, with significant associations between knowledge and professional qualification. Dönmez and Sarı (2019), studying Turkish nurses, found that while general awareness of SSI existed, specific knowledge regarding evidence-based practices such as appropriate hair removal technique, normothermia maintenance, and correct antiseptic skin preparation was frequently deficient. Shaheen and Hawash (2021), assessing Egyptian nurses, reported comparable gaps between knowledge and practice, recommending mandatory, recurring in-service training. A large cross-sectional study of 999 operating-room nurses across 124 hospitals in Guizhou, China, found that nurses' knowledge, attitude, and practice scores were interrelated, and that knowledge scores differed significantly according to nurses' professional qualification and prior specialty training (Patel et al., 2011). Horgan et al. (2024), evaluating a complex quasi-experimental intervention among multidisciplinary healthcare professionals in a university hospital, found that a structured intervention combining education with surveillance-system training significantly improved participants' knowledge and attitudes toward SSI prevention and surveillance, reinforcing the broader evidence that structured, systematic approaches outperform ad hoc or informal learning.

2.3. Literature related to the effectiveness of structured teaching programmes:

Patel and Shah (2022) evaluated the effectiveness of a structured teaching programme on infection-control practices among nurses in an Indian hospital and reported a statistically significant improvement in post-test knowledge and practice scores compared with pre-test scores, concluding that short, well-designed STPs are an efficient and cost-effective method for updating nurses' infection-control knowledge. Raj and Singh (2022), studying the effectiveness of a structured teaching programme on knowledge regarding the prevention of hospital-acquired infection among student nurses in Meerut, similarly found a highly significant gain in post-test knowledge scores following the intervention, along with significant associations between pre-test knowledge and selected demographic variables. Gupta and Kumar (2017), assessing infection-control practice in Indian surgical wards, found that nurses who had received recent, structured in-service training demonstrated significantly better adherence to infection-control protocols than those without such training, supporting the practical value of periodic structured education. Sharma and Malik (2018) reported comparable findings among Indian hospital nurses, with structured teaching interventions producing significant gains in both knowledge and self-reported practice regarding SSI prevention. Abdelbayen and Suriadi (2022), evaluating an educational programme among nurses in Khartoum State, Sudan, found significant post-intervention improvements in both knowledge and observed practice scores related to SSI prevention, reinforcing the cross-cultural generalizability of structured, competency-based nursing education as an effective strategy for closing knowledge gaps. Taken together, this body of literature strongly and consistently supports the central hypothesis of the present study: that a well-designed, structured teaching programme, delivered through a combination of lecture, interactive discussion, and audiovisual aids, can produce a statistically and clinically significant improvement in nurses' knowledge regarding surgical site infection and its prevention.

2.4. Need and significance of the study:

Surgical site infection remains one of the most preventable, yet most persistent, sources of postoperative morbidity worldwide. With global incidence estimates ranging from 2.5% to 11% and Indian hospital-based estimates ranging considerably higher, from roughly 4% to 38% depending on the setting and surveillance methodology, SSI continues to impose a substantial and largely avoidable burden on patients and health systems alike (Mengistu et al., 2023; India SSI Prevention Review, 2018; Gillespie et al., 2021). Each episode of SSI is associated, on average, with several additional days of hospitalization, increased antibiotic exposure — with attendant implications for antimicrobial resistance — and a measurably higher risk of postoperative mortality, which has been estimated to increase two- to eleven-fold in patients who develop an SSI compared with those who do not (Mojtahedi et al., 2023).

Staff nurses are present at every point of contact across the surgical patient's journey and are therefore uniquely positioned to prevent, detect, and manage the early signs of surgical site infection. Yet, as the reviewed literature makes clear, nurses' knowledge of SSI prevention is frequently only moderate, with pooled international estimates suggesting that little more than three in five nurses demonstrate "good" knowledge on standardized assessment (Habtie et al., 2025), and Indian data pointing to comparable or even lower levels of adequate knowledge (Ramaiah Medical College Study, 2024). This gap is particularly concerning given that up to half of all SSIs are considered preventable through consistent, correct application of relatively simple, low-cost, evidence-based nursing measures such as hand hygiene, aseptic technique, appropriate skin preparation, and vigilant wound monitoring (Sadaf et al., 2018; WHO, 2016).

Continuing nursing education is widely recognized as one of the most cost-effective and scalable strategies available to healthcare institutions for closing such knowledge gaps, particularly in resource-constrained settings such as many Indian district and medical-college hospitals, where formal infection-control training may not be a routine or mandatory part of ongoing professional development. Unlike systemic infrastructure investments, a structured teaching programme requires comparatively modest resources — trained facilitators, audiovisual material, and protected staff time — yet has repeatedly been shown, across the reviewed literature, to produce large, statistically significant, and durable improvements in nursing knowledge (Patel & Shah, 2022; Raj & Singh, 2022; Horgan et al., 2024; Abdelbayen & Suriadi, 2022). From an institutional perspective, investing in structured, in-service SSI education is therefore likely to be a highly cost-effective intervention relative to the downstream costs — clinical, financial, and reputational — associated with even a modest reduction in SSI incidence (Monahan et al., 2020).

The investigator, during clinical postings and interactions with staff nurses working in medical, surgical, and intensive care areas, observed considerable variability in nurses' awareness of specific, evidence-based SSI prevention measures, as well as inconsistency in practices such as surgical hand antisepsis technique, dressing change protocol, and the timing of antimicrobial prophylaxis administration. This informal observation, combined with the consistent gaps documented in the wider published literature, provided the motivation and rationale for undertaking the present study. It is anticipated that the findings will not only demonstrate the immediate effectiveness of the structured teaching programme employed, but will also generate institution-specific evidence to support the case for regular, mandatory, structured infection-control education as a standing component of nursing in-service training at Rohilkhand Medical College & Hospital and in comparable healthcare settings across India.

3. Statement of the problem:

"A study to assess the effectiveness of a structured teaching programme on knowledge regarding surgical site infection and its prevention among staff nurses working at Rohilkhand Medical College & Hospital, Bareilly, Uttar Pradesh."

3.1. Objectives:

1. To assess the pre-test and post-test level of knowledge of staff nurses regarding surgical site infection and its prevention.
2. To evaluate the effectiveness of the structured teaching programme regarding knowledge on surgical site infection and its prevention among staff nurses, by comparing pre-test and post-test knowledge scores.
3. To determine the association between pre-test knowledge scores on surgical site infection and its prevention and selected socio-demographic variables of staff nurses.

3.2. Hypotheses:

H1: There will be a significant difference between the mean pre-test and post-test knowledge scores of staff nurses regarding surgical site infection and its prevention, following the structured teaching programme.

H2: There will be a significant association between pre-test knowledge scores on surgical site infection and its prevention and selected socio-demographic variables of staff nurses (age, gender, professional qualification, area of working, years of experience, and source of information).
All hypotheses were tested at the 0.05 level of significance.

4. Operational definitions:

Effectiveness: The extent to which the structured teaching programme achieves a statistically significant, measurable improvement in the knowledge scores of staff nurses regarding surgical site infection and its prevention, as evidenced by the difference between pre-test and post-test scores on the structured knowledge questionnaire.
Structured Teaching Programme (STP): A systematically planned and organized educational intervention, delivered through lecture-cum-discussion and audiovisual aids over approximately 45–60 minutes, designed to enhance staff nurses' knowledge regarding the definition, epidemiology, risk factors, classification, clinical manifestations, and evidence-based preventive strategies for surgical site infection.
Knowledge: The correct information and understanding possessed by staff nurses regarding surgical site infection and its prevention, as measured through responses to a self-structured, 30-item multiple-choice knowledge questionnaire.
Surgical Site Infection (SSI): An infection occurring at or near a surgical incision within thirty days of the operative procedure, or within one year if an implant was placed, as defined by the Centers for Disease Control and Prevention (CDC, 2010).
Staff Nurses: Registered nursing personnel, holding ANM, GNM, B.Sc. Nursing, or higher qualification, currently employed and providing direct patient care at Rohilkhand Medical College & Hospital, Bareilly.

4.1. Assumptions:

The study assumed that: staff nurses possess varying levels of baseline knowledge regarding surgical site infection and its prevention; a structured teaching programme, delivered through appropriate audiovisual and interactive methods, is capable of enhancing nurses' knowledge; and knowledge gained through structured education can be reliably measured using a validated, self-structured knowledge questionnaire administered before and after the intervention.

4.2. Delimitations:

The study was delimited to fifty staff nurses working at Rohilkhand Medical College & Hospital, Bareilly, Uttar Pradesh, who were available and willing to participate at the time of data collection. The study assessed only the cognitive knowledge domain regarding SSI and its prevention and did not assess nurses' clinical practice, skill performance, or attitudes. The post-test was administered only once, seven days after the intervention, and long-term knowledge retention beyond this period was not assessed.

4.3. Conceptual framework:

The present study was guided by a modified version of the General System Theory, originally proposed by Ludwig von Bertalanffy, which conceptualizes any process as comprising interrelated input, process, output, and feedback components. In the context of this study, the **input** component comprised the socio-demographic characteristics of staff nurses (age, gender, professional qualification, area of working, years of experience, and source of information) together with their baseline (pre-test) knowledge regarding surgical site infection and its prevention. The **process** component comprised the structured teaching programme itself — the planned educational intervention delivered through lecture, interactive discussion, and audiovisual presentation covering the definition, epidemiology, risk factors, classification, clinical manifestations, and evidence-based preventive strategies for SSI. The **output** component comprised the measurable change in staff nurses' knowledge, assessed through the post-test administered seven days after the intervention. Finally, the **feedback** component comprised the statistical comparison between pre-test and post-test knowledge scores, which informs judgments about the effectiveness of the structured teaching programme and identifies areas warranting further reinforcement in future educational cycles. This system-based framework provided a coherent conceptual structure linking the study's demographic and baseline knowledge data, its educational intervention, and its outcome measures.

5. Materials and methods:

5.1. Research approach:

A quantitative research approach was adopted for the present study, as the primary objective was to measure the effectiveness of a structured teaching programme in producing a numerically expressible, statistically testable change in staff nurses' knowledge scores.

5.2. Research design:
A pre-experimental, one-group pre-test–post-test research design was employed. This design was considered appropriate given the exploratory and evaluative nature of the study, the practical constraints of the clinical setting, and the absence of a comparable control group of staff nurses who could ethically be denied access to infection-control education.

5.3. Variables:
The **independent variable** in this study was the structured teaching programme on surgical site infection and its prevention. The **dependent variable** was the level of knowledge of staff nurses regarding surgical site infection and its prevention, as measured by scores on the structured knowledge questionnaire. The selected **socio-demographic variables** — age, gender, professional qualification, area of working, years of clinical experience, and source of information — were treated as attribute variables for the purpose of testing the second hypothesis.

5.4. Setting of the study:
The study was conducted at Rohilkhand Medical College & Hospital, Bareilly, Uttar Pradesh, a tertiary care teaching hospital that provides a range of medical, surgical, obstetric, and critical care services and serves as a clinical training site for undergraduate and postgraduate nursing and medical students.

5.5. Population:
The **target population** comprised all staff nurses working in hospitals providing surgical services in Bareilly district. The **accessible population** comprised staff nurses working in the medical, surgical, and critical care areas of Rohilkhand Medical College & Hospital, Bareilly, at the time of the study, who met the predefined inclusion criteria.

5.6. Sample and sample size:
The sample comprised 50 staff nurses selected from the accessible population. The sample size was determined based on feasibility considerations typical of a pre-experimental design conducted within the time and resource constraints of an undergraduate/postgraduate nursing research project, and is broadly consistent with sample sizes employed in comparable published STP-effectiveness studies in the Indian nursing literature (Patel & Shah, 2022; Raj & Singh, 2022).

5.7. Sampling technique:
A non-probability convenience sampling technique was used to select participants, based on their availability, accessibility, and willingness to participate at the time of data collection.

5.8. Sampling criteria:
Inclusion criteria: Staff nurses who were (a) currently working in medical, surgical, or critical care areas of the selected hospital; (b) available at the time of data collection; and (c) willing to provide written informed consent to participate.
Exclusion criteria: Staff nurses who were (a) on leave or otherwise unavailable during the study period; (b) had received formal, structured training specifically on SSI prevention within the preceding six months; or (c) were unwilling to participate.

5.9. Description of the tool:
The data collection instrument was a self-structured questionnaire developed by the investigator in two sections:
Section A: Socio-Demographic Proforma. This section elicited information on age, gender, professional qualification (ANM, GNM, B.Sc. Nursing and above), area of working (medical ward, surgical ward, ICU, others), years of clinical experience, and source of prior information regarding SSI (books and journals, mass media, study centre/health-team members, or no previous source of information).
Section B: Structured Knowledge Questionnaire. This section comprised 30 multiple-choice items covering the definition, epidemiology, risk factors, classification, clinical manifestations, and evidence-based

preventive strategies for surgical site infection, including hand hygiene, aseptic technique, skin preparation, antimicrobial prophylaxis, and postoperative wound care. Each correct response was awarded one mark and each incorrect response zero marks, yielding a maximum possible score of 30. Based on the distribution of scores, the level of knowledge was categorized as **Good** (21–30), **Average** (11–20), or **Poor** (1–10).

6. Content validity:

Content validity of the tool was established by submitting the instrument to a panel of experts in nursing (medical–surgical nursing and community health nursing specialists) and infection-control practice, who reviewed the items for relevance, clarity, and comprehensiveness. Modifications were incorporated based on expert recommendations prior to finalizing the tool.

6.1. Reliability:

The reliability of the structured knowledge questionnaire was established using the split-half method, which yielded a correlation coefficient of r = 0.90, indicating a high degree of internal consistency and confirming the tool's suitability for the study.

6.2. Pilot study:

A pilot study was conducted on a small group of staff nurses, comparable to but excluded from the final study sample, to assess the feasibility of the study, the clarity and comprehensibility of the tool, and the approximate time required for data collection and administration of the structured teaching programme. Findings from the pilot study confirmed that the study was feasible and did not necessitate substantial modification of the tool or procedure.

6.3. Development and description of the structured teaching programme:

The structured teaching programme (STP) was developed by the investigator based on a review of current evidence-based guidelines, including the WHO Global Guidelines for the Prevention of Surgical Site Infection (WHO, 2016; Allegranzi et al., 2016) and the CDC's SSI prevention recommendations (CDC, 2010). The content was organized into the following broad areas: the definition and classification of SSI; epidemiology and burden of SSI, including global and Indian data; identifiable risk factors (patient-related, procedure-related, and organizational); clinical manifestations and early warning signs; standard infection-control precautions; surgical hand hygiene and aseptic technique; appropriate preoperative skin preparation and hair removal; correct timing and administration of antimicrobial prophylaxis; intraoperative measures, including maintenance of normothermia and glycaemic control; postoperative wound assessment, dressing technique, and patient education; and the specific role of the staff nurse across each phase of the perioperative period. The programme was delivered by the investigator to small groups of staff nurses through a combination of structured lecture, PowerPoint presentation, interactive discussion, and audiovisual aids, over a period of approximately 45–60 minutes, with opportunities for participants to ask questions and actively engage with the content throughout the session.

7. Data collection procedure:

Data collection was carried out following approval from the Institutional Ethics Committee of Rohilkhand College of Nursing and administrative permission from Rohilkhand Medical College & Hospital, Bareilly. Eligible staff nurses meeting the inclusion criteria were recruited through non-probability convenience sampling. The investigator explained the purpose, objectives, and procedure of the study to all potential participants, and written informed consent was obtained prior to enrolment. Baseline (pre-test) data were collected using the structured socio-demographic proforma and the 30-item knowledge questionnaire. Immediately following the pre-test, participants received the structured teaching programme, delivered by the investigator in small groups. A post-test, using the identical knowledge questionnaire, was administered seven days after the intervention to evaluate the change in knowledge. All completed questionnaires were reviewed for completeness, coded, and entered into the statistical database for analysis, with participant confidentiality maintained throughout.

8. Plan for data analysis:

Data were analyzed using the Statistical Package for Social Sciences (SPSS), version 20, employing both descriptive and inferential statistics. Descriptive statistics (frequency, percentage, mean, and standard deviation) were used to describe the socio-demographic characteristics of the sample and the distribution of pre-test and post-test knowledge scores. The paired (dependent) t-test was used to compare mean pre-test and

post-test knowledge scores and to test Hypothesis H1. The chi-square test of association was used to determine the relationship between pre-test knowledge scores and selected socio-demographic variables, in order to test Hypothesis H2. Statistical significance was set at $p < 0.05$ for all inferential tests.

8.1. Ethical considerations:

Ethical approval for the study was obtained from the Institutional Ethics Committee of Rohilkhand College of Nursing. Administrative permission was obtained from the authorities of Rohilkhand Medical College & Hospital, Bareilly. Written informed consent was obtained from all participants after explaining the purpose, procedure, potential benefits, and voluntary nature of participation, including the right to withdraw at any stage without any adverse consequence. Confidentiality and anonymity of participant data were maintained throughout data collection, analysis, and reporting.

8.2. Analysis and interpretation:

Data collected from the 50 staff nurses were organized, tabulated, and analyzed using descriptive and inferential statistics, and are presented under the following heads; frequency and percentage distribution of pre-test and post-test levels of knowledge; comparison of mean pre-test and post-test knowledge scores; and association between pre-test knowledge and selected socio-demographic variables.

Table. 1: Frequency and percentage distribution of pre-test and post-test level of knowledge regarding surgical site infection and its prevention among staff nurses

(N = 50)

Level of Knowledge	Scores	Pretest		Posttest	
		Frequency	%	Frequency	%
Good	21-30	28	56%	40	80%
Average	11-20	15	30%	10	20%
Poor	01-10	07	14%	00	00%

Table. 1 shows the frequency and percentage distribution of the pre-test and post-test levels of knowledge regarding surgical site infection and its prevention among staff nurses. The findings revealed that, in the pre-test, the majority of staff nurses, 28 (56%), had good knowledge, 15 (30%) had average knowledge, and only 7 (14%) had poor knowledge regarding surgical site infection and its prevention. In the post-test, the majority of staff nurses, 40 (80%), had good knowledge, while 10 (20%) had average knowledge. None of the staff nurses had poor knowledge in the post-test, indicating a marked improvement in the level of knowledge following the intervention. This pattern of improvement is broadly consistent with the findings reported by Patel and Shah (Patel & Shah, 2022) and Raj and Singh (Raj & Singh, 2022), both of whom documented a substantial post-intervention shift away from "poor" and "average" knowledge categories toward "good" knowledge following structured teaching interventions among Indian nursing personnel.

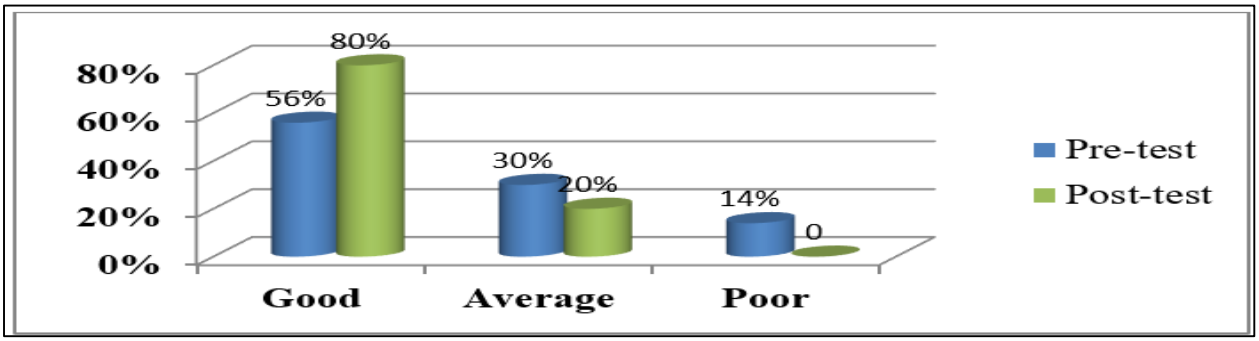

Figure. 1: Cylindrical diagram showing the percentage distribution of pre-test and post-test level of knowledge regarding surgical site infection and its prevention.

Table. 2: Comparison of mean and standard deviation of pre-test and post-test knowledge scores of staff nurses regarding surgical site infection and its prevention

(N = 50)

Level of Knowledge	Mean	SD	df	Paired 't' value	p-value
Pretest	14.06	4.492	49	24.255	0.0001*
Post test	22.89	2.674			

Dependent (paired) t-test, T49 = 1.676 at p < 0.05 level of significance, significant*

Tab. 2 presents the comparison of pre-test and post-test knowledge scores of staff nurses regarding surgical site infection and its prevention. The mean knowledge score in the pre-test was 14.06 ± 4.492, which increased to 22.89 ± 2.674 in the post-test — an absolute mean gain of 8.83 points, corresponding to a relative improvement of approximately 62.8% over baseline. The obtained standard deviation was also considerably narrower in the post-test (2.674) than in the pre-test (4.492), indicating that the structured teaching programme not only raised the average level of knowledge but also reduced the spread of scores across participants, suggesting a more uniform level of understanding across the sample following the intervention. A paired (dependent) t-test was performed to compare pre-test and post-test scores, yielding t = 24.255 (df = 49) and p = 0.0001, which is well below the critical table value of t49 = 1.676 at the 0.05 level of significance. This indicates a highly statistically significant difference between the pre-test and post-test knowledge scores. The null hypothesis (H0) was therefore rejected, and the research hypothesis (H1) — that there would be a significant difference between pre-test and post-test knowledge scores following the structured teaching programme — was accepted. These findings closely mirror those reported in comparable studies: Patel and Shah (Patel & Shah, 2022) reported a highly significant post-test gain in infection-control knowledge among Indian nurses following a structured teaching programme; Raj and Singh (Raj & Singh, 2022) similarly reported a highly significant improvement in knowledge scores among student nurses following an STP on hospital-acquired infection prevention; and Abdelbayen and Suriadi (Abdelbayen & Suriadi, 2022), working in a different national context, reported comparable significant post-intervention gains in both knowledge and practice scores. The consistency of this effect across multiple, methodologically similar studies conducted in different countries and clinical settings lends strong external validity to the conclusion that structured, audiovisual-supported teaching programmes are an effective and reliably reproducible method of improving nurses' knowledge regarding SSI prevention.

Table. 3: Association between pre-test knowledge and socio-demographic variables among staff nurses regarding surgical site infection and its prevention

(N = 50)

S. No	Demographic Variables	Good	Average	Poor	Chi-square	df	p-value
1	**AGE (in years)**				40.737	6	12.59*
	a) 20-25	08	03	08			
	b) 26-30	06	05	00			
	c) 31-35	02	06	01			
	d) 36 & above	03	03	03			
2	**GENDER**				43.308	2	5.99*
	a) Male	04	05	03			
	b) Female	24	12	02			
3	**PROFESSIONAL EDUCATION**				41.188	4	9.48*
	a) ANM	05	10	02			
	b) GNM	15	02	00			
	c) B.Sc. Nursing & above	09	01	03			
4	**AREA OF WORKING**				40.623	6	12.59*
	a) Medical Ward	08	03	01			
	b) Surgical Ward	07	06	00			
	c) ICU	03	04	05			
	d) Others	02	04	04			
5	**YEARS OF EXPERIENCE**				40.684	6	12.59*
	a) 0-3	04	03	05			
	b) 4-6	06	04	00			
	c) 7-9	06	04	02			
	d) 10 & above	03	08	02			
6	**SOURCE OF INFORMATION**				40.546	6	12.59*

	a) Books & Journal	05	08	06			
	b) Mass media	02	03	00			
	c) Study centre & Health team member	01	05	05			
	d) No previous knowledge	03	04	04			

df2 = 5.99, df4 = 9.48, df6 = 12.59 at p < 0.05 level of significance, Significant*

Table. 3 depicts the association between the pre-test level of knowledge and the selected socio-demographic variables of staff nurses regarding surgical site infection and its prevention. The findings revealed a statistically significant association between pre-test knowledge scores and age (χ^2 = 40.737), gender (χ^2 = 43.308), professional qualification (χ^2 = 41.188), area of working (χ^2 = 40.623), years of experience (χ^2 = 40.684), and source of information (χ^2 = 40.546), as the calculated χ^2 values exceeded the respective table values at the 0.05 level of significance for their corresponding degrees of freedom. The research hypothesis (H2) was therefore accepted, indicating that the pre-test level of knowledge among staff nurses was significantly influenced by these socio-demographic characteristics. This finding is notable when contrasted against the Bengaluru-based study of Ramaiah Medical College Hospital staff nurses, which found no significant association between pre-test knowledge and demographic variables (Ramaiah Medical College Study, 2024). The divergence between the two sets of findings suggests that the strength and pattern of association between demographic characteristics and baseline SSI knowledge may vary across institutional and regional nursing populations, reinforcing the value of institution-specific needs assessment prior to designing continuing education interventions, rather than relying solely on findings generalized from other settings.

9. Discussion:

The findings of the present study demonstrate that a structured teaching programme was highly effective in improving the knowledge of staff nurses regarding surgical site infection and its prevention. The majority of participants were female, aged 26–30 years, GNM qualified, working in medical wards, with 4–6 years of clinical experience, and reported books and journals as their primary source of prior information — a demographic profile broadly typical of the Indian staff-nurse workforce reported in comparable studies (Kaur et al., 2021; Ramaiah Medical College Study, 2024). The post-test mean knowledge score (22.89 ± 2.674) was significantly higher than the pre-test mean score (14.06 ± 4.492), with a highly significant paired t-value (t = 24.255, p = 0.0001), confirming the effectiveness of the educational intervention.

These findings align closely with the wider body of national and international literature reviewed for this study. Patel and Shah (Patel & Shah, 2022) and Raj and Singh (Raj & Singh, 2022), both working within Indian nursing populations, reported comparable, highly significant post-intervention gains in knowledge following structured teaching programmes addressing infection prevention and hospital-acquired infection, respectively. Internationally, Abdelbayen and Suriadi (Abdelbayen & Suriadi, 2022), studying nurses in Khartoum State, Sudan, similarly documented significant improvements in both knowledge and observed clinical practice following a structured educational programme, while Horgan et al. (Horgan et al., 2024), evaluating a more complex, multi-component quasi-experimental intervention in a university hospital setting, likewise found significant gains in knowledge and attitudes toward SSI prevention and surveillance. Taken together, this consistency across geographically and culturally diverse settings — India, Sudan, and a Western European teaching hospital — provides strong triangulated support for the conclusion that structured, well-organized nursing education, whether delivered through lecture-based STPs or more complex blended interventions, is a reliably effective strategy for closing knowledge gaps in SSI prevention.

At the same time, the magnitude of the pre-test knowledge deficit observed in this study — with 44% of participants classified as having only average or poor knowledge prior to the intervention — is consistent with, and indeed somewhat less severe than, the gaps documented elsewhere in the literature. Habtie et al.'s global meta-analysis found that only 62% of nurses, pooled across seventeen studies, demonstrated "good" knowledge of SSI prevention (Habtie et al., 2025), while the Bengaluru-based study found that fully two-thirds (67.5%) of nurses had only moderately adequate knowledge (Ramaiah Medical College Study, 2024). Given that the present study's pre-test "good" knowledge proportion (56%) falls within this same general range, it appears that the baseline knowledge deficit observed here is neither an isolated nor an anomalous institutional finding, but rather reflects a broader, systemic gap in structured infection-control education across nursing cadres — a gap that appears to be reliably addressable through relatively brief (45–60 minute), well-designed educational interventions.

The significant association found between pre-test knowledge and socio-demographic variables such as professional qualification, years of experience, and source of information also merits discussion. This finding is broadly consistent with Habtie et al.'s meta-analytic observation that educational qualification and prior in-service training are significant determinants of nurses' baseline SSI knowledge (Habtie et al., 2025), and with Naz et al.'s finding of a significant relationship between professional qualification and knowledge scores among Pakistani nurses (Naz et al., 2023). It stands, however, in contrast to the Bengaluru study, which found no significant demographic associations (Ramaiah Medical College Study, 2024). This divergence may reflect differences in sample composition, institutional training exposure, or regional variation in nursing curricula, and suggests that demographic predictors of baseline SSI knowledge should not be assumed to generalize uniformly across all nursing populations without local verification.

Overall, the discussion of these findings against the wider literature reinforces two key conclusions. First, those structured teaching programmes — regardless of the specific national or institutional context in which they are delivered — represent a consistently effective, low-cost, and readily scalable method for improving nurses' knowledge regarding SSI prevention. Second, given the persistent and internationally documented gap between nurses' knowledge and their observed clinical practice (Sadaf et al., 2018; Naz et al., 2023; Shaheen & Hawash, 2021), future institutional efforts should consider extending beyond knowledge-focused STPs to incorporate structured practice assessment, direct clinical observation, and periodic reinforcement, in order to ensure that measurable gains in knowledge are reliably translated into sustained improvements in bedside and perioperative infection-prevention practice.

10. Nursing implications:

The findings of this study carry implications across the four traditional domains of professional nursing: practice, education, administration, and research.

Nursing practice: The demonstrated effectiveness of the structured teaching programme underscores the value of incorporating brief, focused, evidence-based educational sessions into routine ward-level and departmental nursing practice. Staff nurses equipped with accurate, up-to-date knowledge of SSI risk factors and prevention strategies are better positioned to consistently apply correct hand hygiene, aseptic technique, and wound-care practices at the bedside, potentially contributing to a measurable reduction in institutional SSI rates over time.

Nursing education: Nurse educators and hospital in-service education departments should consider incorporating structured, competency-based teaching modules on SSI prevention into both pre-service (undergraduate and diploma) nursing curricula and mandatory continuing nursing education (CNE) programmes for practicing staff. Given the significant post-test gains observed even after a single 45–60-minute session, periodic "booster" sessions — perhaps scheduled every six to twelve months — may help sustain knowledge gains over time and address the natural decay of knowledge that typically follows any single educational exposure.

Nursing administration: Nursing administrators and infection-control committees should consider institutionalizing regular, mandatory SSI-prevention training as a standing component of staff orientation and annual in-service education calendars, particularly for nurses working in surgical, orthopaedic, obstetric, and critical care areas where SSI risk is highest. Administrators may also wish to link structured education initiatives with institutional SSI-surveillance data, using observed infection trends to identify departments or nurse cohorts most in need of targeted re-training.

Nursing research: Further research is warranted to extend the present pre-experimental design into a true experimental design incorporating a control group, in order to more rigorously isolate the effect of the structured teaching programme from other potential confounding influences on knowledge scores. Additional research is also needed to examine the durability of knowledge gains over longer follow-up periods (e.g., three, six, and twelve months post-intervention), to correlate knowledge scores with directly observed clinical practice rather than self-report, and to explore the comparative effectiveness of alternative teaching modalities — such as simulation-based training, e-learning modules, or peer-led education — relative to the traditional lecture-cum-discussion format employed in this study.

11. Limitations of the study:

The present study is subject to several limitations that should be considered when interpreting its findings. The pre-experimental, one-group design, in the absence of a control group, limits the extent to which the observed knowledge gain can be attributed exclusively to the structured teaching programme, as opposed to other factors such as test familiarity or maturation effects between the pre-test and post-test. The sample was relatively small (N = 50) and was drawn from a single institution using non-probability convenience sampling, which may

limit the generalizability of the findings to staff nurses in other hospitals or regions. The study assessed only cognitive knowledge and did not directly measure nurses' clinical practice or behavioural change, meaning that the translation of improved knowledge into actual bedside practice remains an assumption rather than a directly demonstrated outcome. Finally, the post-test was administered only once, seven days after the intervention, and the study therefore cannot speak to the longer-term retention of the knowledge gained.

12. Recommendations:

Based on the findings of this study and the wider literature reviewed, the following recommendations are proposed:

1. Structured teaching programmes on surgical site infection and its prevention should be incorporated as a mandatory, recurring component of nursing in-service education across medical, surgical, obstetric, and critical care departments.
2. A similar study may be replicated with a larger, multi-institutional sample and a true experimental design, including a comparable control group, to strengthen the internal validity of the observed effect.
3. Future studies should incorporate follow-up assessments at multiple time points (e.g., one, three, and six months post-intervention) to evaluate the durability of knowledge retention.
4. Studies correlating nurses' knowledge scores with directly observed clinical practice, rather than self-reported behaviour, are recommended to clarify the extent to which improved knowledge translates into improved bedside infection-prevention practice.
5. Hospital infection-control committees should consider linking structured educational interventions with institutional SSI-surveillance data to evaluate the programme's downstream impact on actual infection rates, not solely on knowledge scores.
6. Alternative and blended teaching modalities — including simulation-based learning, e-learning modules, and peer-led education — should be explored and compared against traditional lecture-based STPs for their relative effectiveness and cost-efficiency.
7. Nursing curricula at the diploma and undergraduate level should ensure adequate, competency-based coverage of evidence-based SSI prevention practices, consistent with current WHO and CDC guidelines.

13. Conclusion:

The present study concluded that the structured teaching programme was highly effective in improving the knowledge of staff nurses regarding surgical site infection and its prevention, with the mean knowledge score rising from 14.06 ± 4.492 in the pre-test to 22.89 ± 2.674 in the post-test, a statistically highly significant improvement ($t = 24.255$, $p = 0.0001$). A statistically significant association was also found between pre-test knowledge scores and selected socio-demographic variables, including age, gender, professional qualification, area of working, years of experience, and source of information. These findings, considered alongside the substantial body of national and international literature reviewed in this study, reinforce the conclusion that structured, evidence-based educational interventions represent a reliable, low-cost, and readily replicable method for closing persistent knowledge gaps among nursing personnel regarding surgical site infection prevention. Therefore, regular continuing nursing education and structured, mandatory in-service training programmes are strongly recommended to enhance nurses' knowledge and to promote effective, evidence-based prevention of surgical site infections in clinical practice. Further research, incorporating larger samples, control groups, longer follow-up periods, and direct observation of clinical practice, is needed to more fully establish the role of staff nurses in the prevention of surgical site infections across all areas of hospital-based surgical care.

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