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# Comparison of NNIS and SSIRS for Predicting Surgical Site Infection Following Exploratory Laparotomy: A Prospective Observational Study

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**Abstract:** ***Introduction*: Surgical site infections (SSIs) are a major cause of postoperative morbidity following exploratory laparotomy, particularly in contaminated and emergency settings. Accurate risk prediction tools are essential for identifying high-risk patients and guiding preventive strategies. While the National Nosocomial Infection Surveillance (NNIS) index is widely used, it may be limited by its focus on operative variables. The Surgical Site Infection Risk Score (SSIRS) incorporates patient-related factors and may offer improved predictive accuracy. *Aim*: To compare the predictive performance of NNIS and SSIRS in forecasting SSIs following exploratory laparotomy. *Materials and Methods*: This prospective observational study included 80 adult patients undergoing exploratory laparotomy over 18 months. NNIS and SSIRS were calculated for each patient. Associations were analysed using appropriate statistical tests, and predictive accuracy was assessed using ROC curve analysis. *Results*: SSI occurred in 20% of patients. Diabetes mellitus, tobacco use, hypoalbuminemia, anaemia, and contaminated wounds were significantly associated with SSI ($p<0.05$). NNIS demonstrated good predictive ability (AUC=0.800), while SSIRS showed superior discrimination (AUC=0.827). *Conclusion*: SSIRS outperformed NNIS in predicting SSI. Incorporation of multifactorial risk assessment may improve perioperative optimisation and surgical outcomes.***

**Keywords:** surgical site infection; exploratory laparotomy; NNIS score; SSIRS; risk prediction

## 1. Introduction

Surgical site infections (SSIs) represent one of the most frequent healthcare-associated infections and are associated with increased morbidity, prolonged hospitalisation, and higher healthcare costs [1]. Despite improvements in surgical techniques, antimicrobial prophylaxis, and perioperative care, the incidence of SSI remains substantial, particularly in low- and middle-income countries where delayed presentation and infection control challenges are prevalent [2].

Exploratory laparotomy is often performed in emergency conditions such as perforation peritonitis, intestinal obstruction, and abdominal trauma. These clinical scenarios are typically associated with contaminated operative fields, systemic inflammatory response, and compromised physiological reserve, thereby increasing susceptibility to postoperative infection. [3]

The development of SSI is multifactorial and influenced by microbial burden, host immunity, tissue perfusion, and operative factors. Patient-related variables such as diabetes mellitus, malnutrition, anaemia, and tobacco exposure play a critical role in impairing wound healing and increasing infection risk.

Accurate risk stratification is essential for early identification of high-risk individuals and implementation of targeted preventive measures. The NNIS risk index, although widely used, is limited by its dependence on operative variables. In contrast, the SSIRS incorporates both clinical and physiological patient factors, potentially improving predictive accuracy. [4,5]

The present study was undertaken to compare the effectiveness of NNIS and SSIRS in predicting SSI following exploratory laparotomy and to identify independent risk factors associated with its occurrence.

## 2. Materials & Methods

This prospective observational study was conducted over 18 months at a tertiary care teaching hospital in Navi Mumbai after obtaining approval from the Institutional Ethics Committee (IEC approval number: DHR-EC/SC/2022/06/07). Written informed consent was obtained from all participants.

A total of 80 adult patients (≥ 18 years) undergoing exploratory laparotomy (elective or emergency) were included. Patients undergoing re-laparotomy, those on long-term immunosuppressive therapy, and those lost to follow-up were excluded.

The sample size was calculated based on an expected SSI incidence of 20%, with a 95% confidence level and 10% absolute precision using the formula $\mathbf{n = Z^2pq/d^2}$, yielding a minimum sample size of 62. A total of 80 patients were included to enhance study power.

Data were collected using a structured proforma. Patient-related variables included age, sex, body mass index (BMI), diabetes mellitus, tobacco use, haemoglobin levels, and serum albumin levels. Operative variables included wound classification, duration of surgery, type of closure, and emergency versus elective status.

SSI was defined according to Center for Disease Control and Prevention (CDC) criteria and assessed within 30 days postoperatively [1].

NNIS score, based on ASA score, wound class, and duration of surgery and SSIRS, which incorporates patient-related variables including comorbidities and physiological parameters were calculated for all patients. Statistical analysis was performed using SPSS version 31.0.2.0. Categorical variables were analysed using the Chi-square test, while continuous variables were analysed using independent t-test

or Mann–Whitney U test as appropriate. Multivariate logistic regression was used to identify independent predictors of SSI.

Predictive performance was evaluated using ROC curve analysis, and results were expressed as AUC with 95% confidence intervals. A p-value <0.05 was considered statistically significant.

## 3. Results

A total of 80 patients undergoing exploratory laparotomy were included in the study, with a predominance of males (81.3%). The most common age group was 21–40 years (48.8%), and 46.3% of patients had a body mass index (BMI) between 25–30 kg/m². Overall, surgical site infection (SSI) was observed in 20% of patients, while seroma and wound gape occurred in 38.8% and 23.8% of cases, respectively.

Patients who developed SSI demonstrated significantly poorer physiological status compared to those without SSI. The mean NNIS score was significantly higher in the SSI group (2.0 ± 0.8) compared to the non-SSI group (1.0 ± 1.0; $p < 0.001$). Additionally, haemoglobin levels (9.8 ± 1.2 g/dL vs 11.4 ± 1.3 g/dL; $p < 0.001$) and serum albumin levels (2.7 ± 0.4 g/dL vs 3.6 ± 0.5 g/dL; $p < 0.001$) were significantly lower among patients who developed SSI.

On multivariate logistic regression analysis, diabetes mellitus (OR 3.4; 95% CI: 1.2–9.3; $p < 0.05$), tobacco use (OR 2.6; 95% CI: 1.1–6.4; $p = 0.019$), hypoalbuminemia (OR 4.1; 95% CI: 1.5–11.0; $p < 0.01$), anaemia (OR 2.9; 95% CI: 1.1–7.5; $p < 0.05$), and contaminated wound class (OR 3.2; 95% CI: 1.2–8.4; $p < 0.05$) were identified as significant independent predictors of SSI (**Table 1**). Age, BMI, and duration of surgery were not found to be statistically significant.

Receiver operating characteristic (ROC) curve analysis demonstrated good predictive performance of the NNIS score (AUC = 0.800; 95% CI: 0.68–0.90) and superior discriminatory ability of the SSIRS total score (AUC = 0.827; 95% CI: 0.72–0.92), whereas the SSIRS percentage score showed lower predictive value (AUC = 0.636; 95% CI: 0.50–0.77) (**Table 2**). The comparative ROC curves illustrating the predictive performance of NNIS and SSIRS are shown in **Figure 1**.

**Table 1:** Multivariate Logistic Regression Analysis of Risk Factors for SSI

| Risk Factor | OR | 95% CI | p-value |
|---|---|---|---|
| Diabetes mellitus | 3.4 | 1.2–9.3 | <0.05 |
| Tobacco use | 2.6 | 1.1–6.4 | 0.019 |
| Hypoalbuminemia | 4.1 | 1.5–11.0 | <0.01 |
| Anaemia | 2.9 | 1.1–7.5 | <0.05 |
| Contaminated wound | 3.2 | 1.2–8.4 | <0.05 |

**Table 2:** ROC Curve Analysis of Predictive Scores

| Score | AUC | 95% Confidence Interval | Interpretation |
|---|---|---|---|
| NNIS | 0.8 | 0.68–0.90 | Good |
| SSIRS Total | 0.827 | 0.72–0.92 | Superior |
| SSIRS % | 0.636 | 0.50–0.77 | Poor |

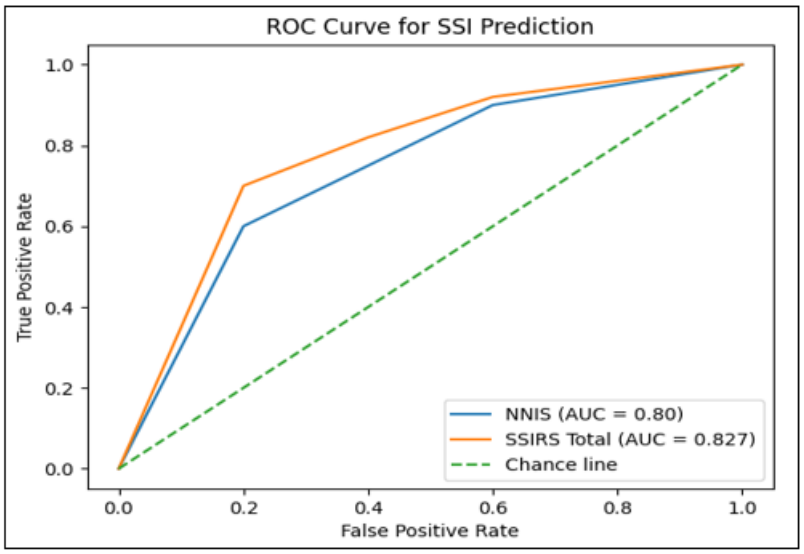


**Figure 1:** ROC Curve Comparing Predictive Performance of NNIS and SSIRS for SSI

## 4. Discussion

This study demonstrated an SSI incidence of 20% following exploratory laparotomy, which is consistent with reported rates in developing countries where emergency procedures and contaminated surgical fields are common [2,3]. The high burden of SSI in such settings reflects delayed presentation, intra-abdominal sepsis, and suboptimal physiological status at the time of surgery.

Diabetes mellitus emerged as a significant predictor of SSI in this study. Hyperglycaemia impairs neutrophil function, reduces host immune response, and compromises tissue perfusion, thereby increasing susceptibility to infection [1]. Similarly, tobacco use was significantly associated with SSI, likely due to its effects on vasoconstriction, reduced tissue oxygenation, and impaired collagen synthesis, which delay wound healing.

Hypoalbuminemia and anaemia were also identified as strong predictors of SSI, underscoring the importance of nutritional

and physiological optimisation. Serum albumin serves as a marker of nutritional status and immune competence, while anaemia reduces oxygen delivery to tissues, impairing wound healing and bacterial clearance [3]. These findings highlight the critical role of patient-related factors in determining postoperative outcomes.

The NNIS risk index demonstrated good predictive performance (AUC 0.800), consistent with its established role as a simple and practical risk stratification tool. However, the SSIRS model showed superior discriminatory ability (AUC 0.827), likely due to its incorporation of patient-specific variables in addition to operative factors [4,5]. This supports the growing evidence that multifactorial models provide more accurate and individualised risk prediction.

From a clinical perspective, improved risk stratification enables targeted interventions such as glycaemic control, nutritional optimisation, smoking cessation, and enhanced postoperative surveillance. Such strategies are essential in reducing SSI burden and improving surgical outcomes, particularly in high-risk populations.

## 5. Limitations

This study was conducted at a single centre with a relatively small sample size, which may limit generalisability. Additionally, variations in surgical technique and postoperative care were not fully standardised. Larger multicentric studies are required to validate these findings.

## 6. Conclusion

Surgical site infection remains a significant complication following exploratory laparotomy, particularly in contaminated and emergency settings. This study demonstrates that patient-related factors such as diabetes mellitus, hypoalbuminemia, anaemia, and tobacco use significantly contribute to infection risk.

While the NNIS risk index remains a simple and widely used tool, the SSIRS model demonstrated superior predictive performance, highlighting the importance of incorporating patient-specific physiological and nutritional parameters into risk assessment. Adoption of multifactorial risk stratification models such as SSIRS may facilitate early identification of high-risk patients, enable targeted perioperative optimisation, and improve postoperative outcomes.

Further multi-centric studies with larger sample sizes are recommended to validate these findings and strengthen evidence for routine clinical implementation.

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