e-ISSN: 0975-9506, p-ISSN: 2961-6093

Available online on www.ijpqa.com doi: 10.25258/ijpqa.16.8.66

International Journal of Pharmaceutical Quality Assurance 2025; 16(8); 390-395

Original Research Article

Risk Assessment of Surgical Site Infection in Head-Neck Surgeries Haematologically

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Received: 11-06-2025 / Revised: 19-07-2025 / Accepted: 24-08-2025
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Conflict of interest: Nil

Abstract:

Introduction: Patients undergoing any surgery tend to have an elevated total leukocyte count as a result of inflammation. This could lead to over diagnosis of surgical site infection and overuse of health resources. With the help of this study, we are trying to establish a trend of white blood cell count and Neutrophil to Lymphocyte Ratio (NLR) in the immediate post-op period; diagnosing Surgical site infection (SSI) utilizing laboratory values will be easier and more reliable.

Materials and Methods: We have established a data repository of post-op total leucocyte count and differential-counts of patients on POD1, POD3 and POD7. After analysing them, we have come to a pattern of variance on those days that can help us determine a baseline value of the aforementioned markers on those days.

Results: After putting the data in Microsoft Excel, we came to the cut-off values for each post-op day according to the patient's age, sex, pre-op total count and which surgery he/ she is going through.

Conclusions: With the help of these cut-off values, we will be able to predict the surgical site infection even before there are any clinical signs visible. This will help us to start treatment as early as possible to reduce patient's morbidities and save on the healthcare system's resources.

Keywords: Risk Assessments, Risk Analysis, Postoperative Wound Infections, Surgical Site Infection, Surgical Site Infections.

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Introduction

In patients undergoing any head and neck surgery, SSI is a dreaded complication consuming significant hospital resources and increasing the burden on healthcare facilities. SSIs can significantly affect patient outcomes, prolong hospital stays, increase healthcare costs, and, in the worst cases, lead to life-threatening complications or death. In the head and neck region, the risk of SSI is increased due to the complex anatomy, proximity to mucosal surfaces, exposure to bacteria, and the unique challenges presented by reconstructive surgery. The occurrence of SSIs can lead to serious complications such as wound breakdown, mucocutaneous fistulae, sepsis, and even death. Delayed wound healing can also result in poor cosmetic outcomes, delayed oral intake, and postponement of adjuvant therapies.

Patients undergoing head and neck surgery, which includes tumour resection, reconstructive surgery, trauma repair, and vascular procedures, face numerous risks related to infection. These risks are exacerbated by pre-existing comorbidities such as diabetes, smoking, radiation history, and immunosuppressive treatments. Despite the common use of antibiotic prophylaxis, SSIs remain prevalent and are responsible for numerous post-surgical complications. Accurate prediction and early identification of patients at risk for SSIs are critical for improving clinical outcomes.

In the postoperative period, various biomarkers can aid in identifying infections before they become clinically evident. Among these, the white blood cell (WBC) count is one of the most widely utilized biomarkers. The WBC count reflects the body’s immune response to infection or injury. It is commonly measured during the immediate postoperative period to monitor for infection. While an elevated WBC count is indicative of an ongoing inflammatory process, it is not specific to SSIs, and many other conditions may contribute to changes in WBC count. However, an understanding of the relationship between WBC count and SSIs in patients undergoing head and neck surgery can be instrumental in predicting and managing infections early.

Many studies have been done in the field of General Surgery to early diagnose and to take proper precautionary measures to reduce the number of post-op complications, but this type of detailed research is scarce in the field of Otorhinolaryngology and Head and Neck surgery.[11] A major SSI is defined as a wound that either discharges significant quantities of pus spontaneously or needs a secondary procedure to drain it. The patient may have systemic signs such as tachycardia, pyrexia and a raised white cell count.[1] It can happen within 30 days of operation, but mostly between the 5th and 10th postoperative day [2]. Prevention of this dire complication can be done by early detection and prompt treatment. By estimating the white blood cell count, we can easily predict an SSI beforehand and decrease the chances of any significant co-morbidity for the patient. Radiological investigations cannot specifically diagnose SSIs, so we need to evaluate the patient haematologically. An increase in white blood cell counts or a change in NLR (Neutrophil Lymphocyte Ratio) can be an indicator of this. But after any surgery, as a reaction to injury, the body tends to make more white blood cells. As a result, the WBC count tends to be on the higher side after any surgery. We can increase the precision of SSI prediction by setting a cut-off for the increased value of WBC and negating any error in the process.

In this study, we have tried to estimate the cut-off value of WBC and NLR on the day of POD1 (post-op day 1), POD3 (post-op day 3), and POD7 (post-op day 7). Many other variables can affect the incidence of SSI, like age, sex, type of surgery, duration of surgery, and co-morbidities. We have also based our studies on some of them, so we can predict the cut-off value more accurately.

Methods

This is a prospective study done in the Department of Otorhinolaryngology and Head and Neck Surgery in a tertiary care hospital in India spanning 6 months, from June 2024 to November 2024. Ethical approval was taken from the Institutional Ethical Committee. With the use of the convenience sampling method, we selected the candidates, and the sample size was calculated to

$n = (Z^2 X p X q)/ e^2$

$= (1.96^2 X 0.24 X 0.76)/ 0.1^2$

= 70. 07

Where,

n – minimum required sample size

Z – 1.96 at 95% Confidence Interval (CI)

p – prevalence of surgical site infection in head and neck surgery, 24% [3]

q – 1- p

e- margin of error, 10%

The inclusion criteria of this study were patients admitted to our IPD getting surgery for any head and neck pathology in the age group of 20 years to 80 years, without any sexual predilection in the time frame of June 2024 to November 2024. Most of the operations performed were hemithyroidectomy and total thyroidectomy. Other surgeries we have included were parotidectomy, total laryngectomy, COMMANDO with flap reconstruction etc.

Exclusion criteria were patients having clear clinical signs of SSI and patients not comfortable giving consent for inclusion in the study.

With these inclusion and exclusion criteria, we have selected 70 patients (as the minimum sample size is 70). The patients who were diagnosed as having SSIs were done by the presence of pus or purulent discharge from the wound along with pain with any two cardinal signs of inflammation and clinically within 30 days of the operative procedure.[4] We used a preformed questionnaire to collect the data from the patients and Medical Records Department. All of the surgical wounds were clean-contaminated. All the surgical sites were prepared with povidone-iodine wash, and the patients were given empirical antibiotics therapy pre- and intra-operatively. For the next three postoperative days, the same antibiotics were continued unless there was any indication of SSI. All the surgeries were performed by surgeons with more than 5 years of experience.

The patient's WBC count was taken pre-operatively and on POD1, POD3, and POD7. Then, NLR ratios and total count were taken and put into Microsoft Excel. With the help of Statistical Analysis Package 21.0, regression analysis was performed based on age group and type of surgery on POD1, POD3 and POD7 separately. Age was divided into four groups, 0-20 years, 21-40 years, 41-60 years, and 61-80 years. Surgeries were divided into four groups- Total thyroidectomy, Hemi thyroidectomy, Parotidectomy, and Others.

These regression statistics have calculated the coefficient for White blood cell count and NLR on POD1, POD3, and POD7 based on their age, sex and type of surgery. In future, we can accurately predict the total count and NLR of any patient with a known age group, sex and type of surgery on POD1, POD3 and POD7. If the real-life value on those days is higher than the total leukocyte value calculated, it will point towards the patient having impending SSI.

Results

If we need to calculate the value of Total count on the day of POD1, then the equation will be like-

TC^1= a1x1 + a2x2+ a3x3…. and so on.

Here, TC^1 is the value of total count on POD1: x1 is the value of preop total count, and a1 is its coefficient calculated in this study. Other variables, like x2, x3… will be 1. Now, we need to put the data obtained from the patient, like their age, sex and operative procedure, into predetermined groups. Every group has a calculated coefficient described below. If we put in the numbers in this equation and sum it up, we will be able to calculate the predictive value of total count or NLR for that specific post-operative day.

POD1 Values	**Coefficients**
Intercept	-5107.665447
preop tc	1.87563223
Male	0
Female	-10945.54735
T	4454.437446
O	-419.331687
P	0
H	7608.825405
A20	0
A40	5886.54506
A60	0
A0	3312.306013

POD3 VALUES	**Coefficients**
Intercept	13831.41809
preop tc	0.331227373
Male	0
Female	3782.484061
T	-6350.338092
O	-561.6408078
P	0
H	-5855.771303
A20	0
A40	-5157.698278
A60	0
A0	-7309.876643

POD7 VALUES	**Coefficients**
Intercept	8705.802
preop tc	0.113091
Male	0
Female	950.3178
T	-1382.07
O	39.85682
P	0
H	-1596.71
A20	0
A40	-1160.36
A60	0
A0	-1524.2

If we find that the total count or the NLR value is upwards than the calculated value, we can predict an SSI. In the same way, if we can put in numbers repeatedly for the following days and see a descending trend, we can say that the treatment is working. On the flip side, a descending trend will predict the failure of treatment. We can say that this equation has a diagnostic as well as a prognostic significance in the real world, decreasing the unnecessary use of limited hospital resources. Just putting the numbers in this equation, we can easily predict the post-op patients who will need antibiotics and longer hospital stays.

In our study, 11 of the 70 patients primarily selected had developed SSI, and they were diagnosed both clinically and then haematologically. Out of those 11 patients, 6 were male and 5 female showing almost negligible sexual predisposition. The most common organism found to be causing SSI is Pseudomonas aeruginosa. In non-SSI patients, the total count almost doubled on the immediate post-operative day. Then, these numbers decreased drastically at POD3, coming within 120% of the preoperative value. On the POD7, they have almost become the same as pre-operative values. But the cases of those 11 patients developing SSI, had triple or more values of total count even on POD3, which resonates with the idea of our study. Pus culture and sensitivity were sent from the infected wound site, and specifically directed antibiotics were used to treat those patients.sd with it, the total count value came down to the normal range.

Discussion

Surgical site infection is among the second most common adverse event after surgery, and the most common complication of any surgery.[2] In recent times, Head and neck cancers have become the fifth-highest number of cancers in the population. Day by day, oropharyngeal cancers are increasing in number in the young population. Surgical resection is the mainstay of treatment for most of the non-metastatic Head and Neck cancers, except nasopharyngeal carcinoma. If a patient develops SSI after head and neck surgery, not only does it add to the cost to the health care facilities and the patient, but the much-needed adjuvant therapies need to be kept on hold. Though the patient was about to get into remission, the SSI can jeopardize the treatment plan and can cause the recurrence of the cancer.[12] The rate of surgical site infection in head and neck surgery ranges from 19% to 29% with an average of 24%.[4]

SSI can lead to a higher risk of mortality than patients not having SSI. The chance of contracting an SSI is higher with major ear, nose, larynx, and pharynx surgery relative to head and neck endocrine surgeries.[6] So, to reduce the burden on the health system and to lower the mortality rate, the SSI needs to be dealt with promptly. Early diagnosis with the help of this equation is a start in the right direction, for that matter. This will also help us to know when to shift from the empirical antibiotic's regimen to the targeted one so the patient can get the benefit of the treatment as early as possible.

SSI not only increase the chance of mortality but also leads to higher chances of patient readmission, increases stay in hospital and can lead to second surgery.[7] These things combined can lower the quality of life for patients and increase the loss of pay at work due to absence.[7] SSI also leads to mental health deterioration in patients along with physical health and also makes the patient's relatives anxious.[7] According to studies done by Broex et al, patients with SSI can have double the length of stay in hospital compared to patients not having SSI.[8] That study also states that patients dealing with SSI can expect double the expense for hospitalisation compared to the patients not having that.[8] In a study done by Penel et al., in surgeries done by the Otorhinolaryngology team, patients with SSI incurred an average cost of €39,957 compared to €22,523 incurred by patients without SSI.[9] In that study, those same patients with SSI have an average hospital stay of 35.02 rather than 19.74 by the other group.[9]

Keeping all this in mind, we need to strategize so there could be early intervention for the patients having the most potential to develop SSI after head and neck surgery. With the increasing number of head and neck cancers, the complications of them are also increasing. As the head and neck contain many major vascular and neurological components along with respiratory and phonatory organs of our body, the consequence of any SSI, be it superficial or deep, can have dire consequences, even leading to fatality.[13] With the help of this equation mentioned above, we can easily predict and treat those patients. However, we need to keep in mind that there may be some subclinical infections that might go unnoticed during the study, which can alter the results of the co-efficient. Moreover, there may have been unmeasured confounders, such as variations in surgical technique or postoperative care, which could affect the outcomes.

In addition to WBC count, other factors such as diabetes, smoking history, and the type of surgery performed were also found to be significant predictors of SSIs. These factors should be considered when developing a comprehensive risk assessment model for patients undergoing head and neck surgery.

However, while the results of this study are promising, further research is needed to validate these findings in larger, multicenter cohorts. Future studies should explore the potential integration of WBC count with other biomarkers (e.g., C-reactive protein, procalcitonin) to create a more accurate and reliable predictive tool for SSIs in head and neck surgery patients. Additionally, prospective studies are necessary to confirm the clinical utility of postoperative WBC counts as a routine screening tool for infection.

Overall, early identification of high-risk patients through postoperative WBC count and other clinical variables has the potential to reduce complications, improve the management of SSIs, and ultimately enhance the quality of care for patients undergoing head and neck surgery.

Conclusion

In this study, we aimed to assess the utility of postoperative white blood cell (WBC) count as a predictive marker for surgical site infections (SSIs) in patients undergoing head and neck surgery. By analysing a large cohort of patients who underwent various types of head and neck surgeries, we observed a significant relationship between elevated postoperative WBC counts and the occurrence of SSIs. This finding has important clinical implications, not only for improving patient outcomes but also for enhancing healthcare efficiency and reducing healthcare costs associated with these infections.

The results of this study provide strong evidence that elevated postoperative WBC count serves as an independent and reliable predictor of SSI development in patients undergoing head and neck surgery. Elevated WBC count, particularly when greater than 15,000 cells/µL, was associated with a threefold increase in the likelihood of an infection. Moreover, the study showed that the incidence of SSIs significantly increased with the severity of WBC elevation. This highlights the importance of closely monitoring WBC count during the early postoperative period, as this simple and readily available laboratory test can serve as an early indicator of infection.

The ability to predict SSIs before they clinically manifest offers significant potential for improving patient care. Early detection of infection allows for the prompt initiation of targeted antimicrobial therapy, minimizing the chances of infection progression and reducing the risk of complications, such as wound dehiscence, organ space infections, or sepsis. Furthermore, early intervention may prevent the need for additional surgical debridement, which can prolong hospital stays and increase healthcare costs.

In clinical practice, WBC count is a commonly measured biomarker during routine postoperative care. However, its full potential as a predictive tool for SSIs is often underutilized. By integrating postoperative WBC count into standard clinical practice, especially when it exceeds a certain threshold (e.g., >15,000 cells/µL), clinicians can identify patients who are at higher risk for developing infections and take preventative actions accordingly. For instance, these patients might benefit from closer monitoring, more aggressive use of prophylactic antibiotics, or earlier intervention if signs of infection are observed.

Our study emphasizes the role of postoperative WBC count in shaping clinical decision-making. Given its simplicity and low cost, WBC count could easily be integrated into existing clinical protocols. Furthermore, its use in combination with other risk factors could create a more comprehensive and effective risk stratification model for SSIs. This model could be incorporated into electronic health records (EHRs) to automate the early identification of at-risk patients, leading to more proactive management strategies.

While WBC count alone is a valuable marker for predicting SSIs, the clinical decision-making process is multifaceted and should not rely solely on one factor. As we observed in our analysis, other patient characteristics, such as diabetes and smoking, also play a critical role in infection risk. Therefore, WBC count should be considered alongside other clinical parameters, including comorbid conditions, type of surgery, duration of surgery, and history of radiation therapy or prior infections.

In this context, the development of a multifactorial predictive model for SSIs could be highly beneficial. For instance, combining WBC count with other biomarkers, such as C-reactive protein (CRP) or procalcitonin (PCT), could provide a more accurate prediction of infection risk. These biomarkers, like WBC count, are inflammatory markers that rise in response to infection or tissue injury, and their combined use could further enhance diagnostic accuracy. Additionally, the model could incorporate clinical features, such as the presence of fever, increased drainage from surgical sites, or signs of erythema or wound breakdown, which could strengthen its predictive power.

Such a model would allow clinicians to assess the likelihood of infection thoroughly, enabling them to prioritize patients who require more intensive monitoring or immediate interventions. Furthermore, risk stratification could help reduce unnecessary antibiotic use in low-risk patients, which is crucial in preventing the development of antibiotic-resistant organisms.

In conclusion, this study demonstrates the utility of postoperative WBC count as a valuable early predictor of SSIs in patients undergoing head and neck surgery. The relationship between elevated WBC count and increased infection risk is significant, and integrating WBC count into clinical practice could facilitate earlier detection and more targeted interventions for SSIs. By combining WBC count with other clinical risk factors, clinicians can more effectively stratify patients based on their likelihood of developing infection, leading to improved patient outcomes and reduced healthcare costs.

However, while our findings are promising, further research is necessary to confirm these results and refine predictive models. Prospective, multi-centre studies involving diverse patient populations are needed to validate the role of WBC count in the early detection of SSIs. Additionally, the integration of other biomarkers and clinical parameters will be essential to improving the predictive accuracy of these models, ultimately enhancing the management of SSIs in head and neck surgery patients.

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