Meningiomas are common tumors of the central nervous system,[1,2] and surgery is an effective treatment for meningiomas. Postoperative pneumonia (POP) is one of the common complications after meningioma resection. Even with the improvement of surgical techniques and postoperative care, the incidence of POP has still not been significantly improved. Exploring new predictive indicators can help to screen high-risk POP patients, intervene early, and improve patient prognosis.

The systemic inflammatory response index (SIRI) is an inflammatory response predictor based on the peripheral blood neutrophil, monocyte, and lymphocyte counts.[3] Some studies believe that SIRI can be used to characterize the underlying inflammatory response and predict the prognosis of patients. Therefore, it is reasonable to think that SIRI can be used to identify the potential inflammatory status of meningioma patients before surgery, screen out susceptible patients, and intervene early to improve the prognosis of patients. We retrospectively analyzed the POP situation and SIRI level of meningioma surgery patients in our center to study their relationship.

We collected the information of 282 patients who underwent meningioma resection from the First Affiliated Hospital of Fujian Medical University, Affiliated Hospital of Putian University, and the Zhengzhou University People’s Hospital between 2008 and 2019. These patients completed routine blood tests and obtained SIRI data within 1 week before the operation was used as preoperative baseline data and these tests were included in the scope of the routine preoperative examination. SIRI is based on peripheral blood neutrophil, monocyte, and lymphocyte counts, with the formula SIRI = N/N/MM/L, where N is neutrophil count, M is monocyte count, and L is lymphocyte count. The primary outcome indicator is POP. The diagnosis of POP was referred to the CDC and the National Healthcare Safety Network (NHSN) instructions for POP.[5]

Comprehensive data, including previous medical history, current medical history, general admission information, laboratory examination results, treatment received, and other data related to infection, were collected for each patient. The results of laboratory tests performed within 1 week before the operation was used as preoperative baseline data and these tests were included in the scope of the routine preoperative examination. SIRI is based on peripheral blood neutrophil, monocyte, and lymphocyte counts, with the formula SIRI = N/N/MM/L, where N is neutrophil count, M is monocyte count, and L is lymphocyte count. The primary outcome indicator is POP. The diagnosis of POP was referred to the CDC and the National Healthcare Safety Network (NHSN) instructions for POP.[5]
Data analyzed by R statistical software (R version 3.6.3, R Project, www.r-project.org). P value ≤ 0.05 was significant. A logistic regression model was established to evaluate the prognostic factors of POP. Delong method was used to test the performance of the area under the curve (AUC) model. Multivariate models were built. The initial pool of candidate prognostic factors variables included all available demographic, hospital admission, and meningioma-related variables that had a univariate P < 0.05 relationship with the outcome variable. The backward stepwise regression method was used to generate the final model, which in turn deleted the least essential variables until P < 0.05 for all remaining variables. All-important variables retained in the multivariable model were tested interactively. The Kaplan–Meier method was used to calculate the percentage of patients with POP within 30 days after surgery.

Data from 282 patients were collected, and patients excluded from the analysis were most likely to be transferred from other hospitals and lacked retrospective laboratory data. These excluded patients did not differ in disease severity compared with the population included in the study. A power analysis was conducted to determine the power to detect effects among SIRI count and POP. Fifty patients in this cohort were exposed to SIRI ≥ 1.85 (20% POP) and 232 patients were not exposed to SIRI ≥ 1.85 (3.4% POP) with power > 99%.

Univariate association between POP and preoperative examination parameters, including SIRI, was evaluated, and a multivariate model of POP was then created. In the multivariable model, all the selected univariate indicators were tested as potential prognostic factors. Only age, SIRI, and white blood cell (WBC) were still relevant. The results of the receiver operating characteristic (ROC) analysis showed that the optimal SIRI cutoff point of the cohort was 1.85 × 10^4. Therefore, in all subsequent studies, the SIRI score was classified as < 1.85 or ≥ 1.85. Besides, in this model, a significant interaction between age and SIRI was found. The predictive effect of SIRI on POP was limited to non-elderly patients with age < 60 years [Figure 1A]. In this cohort, 17.2% (34/198) of non-elderly patients had the SIRI ≥ 1.85. When ROC curve analysis was limited to non-elderly patients, it showed that the predictive power of SIRI (AUC: 0.874, 95% confidence interval [CI]: 0.772–0.975) was stronger than that of WBC (AUC: 0.794, 95% CI: 0.643–0.945; DeLong test, P = 0.025) and equivalent to that of neutrophil lymphocyte ratio (NLR, AUC: 0.767, 95% CI: 0.618–0.917; DeLong test, P = 0.188; Figure 1B).

In this study, we studied the predictive power of commonly used infection prognostic factors (WBC, NLR, etc.) and SIRI on POP following meningioma resection. We found that SIRI had good predictability for POP, but this was limited to non-elderly patients. SIRI predictive power was better than that of WBC and was comparable to NLR.

Qi et al.[3] proposed the concept of SIRI in 2016. Based on the counts of neutrophil, lymphocyte, and monocyte in peripheral blood, they constructed systemic inflammation indicators for the assessment of the occurrence of inflammation. SIRI has been used in the survival prognosis of cancer patients. However, its application in postoperative infectious diseases has not been reported. In the real world, the convenience of inspection needs to be considered when establishing predictive indicators. Through the combination of different parameters that are already available, it is possible to identify a high-risk population.
population that may have postoperative complications without screening additional items. The measurement of SIRI is simple, and clinicians have high acceptance of it. SIRI may be a simple way for the clinician to predict a patient’s risk of POP.

Therefore, SIRI has excellent potential for application. In response to infectious diseases, the human body initiates the anti-infective response through immune cells, increasing the peripheral blood cell count. Among them, the increase in neutrophil and monocyte is dominant in bacterial infections and the increase in a lymphocyte in viral infections. POP is mainly manifested as bacterial pneumonia. Therefore, the SIRI, containing cell count information of neutrophil, monocyte, and lymphocyte, can reflect the potential inflammatory state of the body before the symptoms appear and play a role in the early screening of susceptible patients.

Our research shows that SIRI may be a better indicator than WBC and NLR, with a better odds ratio (OR) value (SIRI OR: 1.500 (95% CI: 1.098–2.048); WBC OR: 1.139 (95% CI: 0.801–1.618); and NLR OR: 1.021 (95% CI: 0.840–1.242)), and it can be used to identify the occurrence of POP. At the same time, our data suggest that the predictive value of increased SIRI may be limited to non-elderly patients. The likely reason is that elderly patients often have immune dysfunction, which complicates the clinical course. Therefore, elderly patients are more likely to suffer from POP. It is more challenging to screen those with POP among aged patients with high potential POP risk. In our clinical data, we found that in non-elderly patients, SIRI has an excellent negative predictive value (NPV > 99%) comparing to WBC (positive predictive value [PPV]: 20.36%, NPV: 97.91%) and NLR (PPV: 14.11%, NPV: 98.68%), it is a more important prognostic factor of POP. Furthermore, it is relatively simple to acquire the SIRI, and the patient can be dynamically observed. Our results indicate that for non-elderly patients with non-elevated SIRI, continuous observation may not provide additional benefits. Thus, the monitoring time of these patients can reduce, and the allocation of medical resources can be improved while maintaining high standards of patient care.

Our research has many limitations, including observational design. Despite our methodological and statistical control, the effect observed between SIRI and POP may be confused with that of other factors (e.g., corticosteroid use and concomitant infections in other sites). In critically ill patients, multiple potential causes of elevated SIRI may coexist, making it difficult or impossible to identify the exact cause. SIRI is biased towards the prognosis of bacterial infections and may be insensitive to the prognosis of viral infections, requiring further analysis once pathogenetic information obtained, but pathogenetic data are not readily available. A final limitation to mention is the small number of centers involved in our study, and the selection bias in which the patients’ underlying condition and stage of the disease are affected by the economic level of the region in which the respective centers are located.

The increase in SIRI before meningioma surgery is related to the development of POP and may have unique clinical value for non-elderly patients. The predictive value of SIRI for POP is better than that of WBC and NRL in terms of OR and NPV. This result is incredibly valuable for non-elderly patients without an elevation in SIRI.

Conflicts of interest
None.

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