Association Between the Systemic Inflammatory-Immunity Index and Acute Postoperative Pain Severity Following Traumatic Hip Fracture Surgery in Elderly Patients with Rheumatoid Arthritis

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Abstract:

Background and Objective: Traumatic hip fractures in elderly patients with rheumatoid arthritis are associated with significant postoperative pain, which adversely affects recovery and overall quality of life. Identifying reliable biomarkers, such as the systemic inflammatory-immunity index, may improve the prediction of pain severity and optimize pain management strategies. This study aims to investigate the role of the systemic inflammatory-immunity index in predicting postoperative pain outcomes, ultimately improving care for this vulnerable population through personalized, evidence-based approaches.

Materials & Methods: This descriptive cross-sectional study was conducted in the winter of 2024 at Shahid and Imam Reza Hospitals, affiliated with Tabriz University of Medical Sciences. A total of 112 elderly patients with rheumatoid arthritis were recruited via convenience sampling. Demographic characteristics, clinical factors, and biomarkers (neutrophil, lymphocyte, and platelet counts) were collected to calculate the systemic inflammatory-immunity index. Postoperative pain severity, opioid consumption, and hemodynamic parameters were assessed for their correlation with the systemic inflammatory-immunity index using Pearson correlation coefficients.

Results: Correlation analyses revealed a significant positive relationship between the systemic inflammatory-immunity index during hospitalization and acute postoperative pain severity, as measured by the pain intensity scale, within the first four hours after surgery. The strongest correlation with the Visual Analog Scale (VAS) score was obsereved at the second postoperative hour (R=0.658, P=0.009). Additionally, significant correlations were identified at the first hour (R = 0.596, P = 0.014), third hour (R = 0.488, P = 0.026), and fourth hour (R = 0.452, P = 0.036); however, these correlations progressively weakened and became non-significant in subsequent hours.

Conclusion: The systemic inflammatory-immune index is a valuable predictor of postoperative pain severity, hemodynamic instability, and prolonged hospital stays in elderly patients with rheumatoid arthritis.

Keywords: Systemic inflammatory-immunity index, postoperative pain, Hip fractures, length of stay

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Background and Objective

Acute postoperative pain presents a significant challenge in clinical care, particullarly for elderly patients with rheumatoid arthritis who frequently undergo complex surgeries, such as hip fracture repairs. effective pain management in this population is crucial for improving quality of life and reducing the risk of postoperative complications, including delayed recovery, decreased mobility, and the development of chronic pain[1]. Despite advancements in anesthesia and pain management techniques, accurately predicting the severity of acute postoperative pain remains difficult due to the complex interplay of numerous physiological, psychological, and biochemical factors influencing the patient's pain experience[2].

An emerging area of focus in postoperative care is the impact of systemic inflammation on pain levels following surgery. Surgical trauma associated with hip fractures triggers a substantial inflammatory response characterized by immune cell activation, cytokine release, and alterations in the systemic inflammatory profile[3]. While inflammation plays a crucial role in tissue healing, excessive or dysregulated inflammatory processes can amplify nociceptive signals, leading to increased pain sensitivity. Therefore, identifying reliable biomarkers that can predict pain severity and clarify the underlying inflammatory mechanisms is vital for improving clinical practices[4].

The systemic inflammatory-immunity index (SII) has emerged as a significant biomarker reflecting the balance between immune and inflammatory responses. It is calculated using peripheral blood cell counts, including neutrophils, lymphocytes, and platelets, thereby providing a composite measure of systemic inflammation and immune function.[5,6] The SII comprises three critical components: neutrophils, which indicate the inflammatory response; lymphocytes, which are essential for immune regulation; and platelets, which are involved in inflammatory processes and tissue repair[7]. This index offers a more comprehensive evaluation compared to traditional single-component indices, such as the neutrophil-to-lymphocyte ratio or platelet-to-lymphocyte ratio[8].

Recent research has established a correlation between elevated SII levels and adverse outcomes across various diseases, including cancer, cardiovascular conditions, and critical illnesses. In surgical contexts, higher SII values are associated with an increased incidence of postoperative complications, prolonged hospital stay, and delayed recovery. However, the specific association between the SII and acute postoperative pain—particularly in elderly patients with rheumatoid arthritis undergoing major trauma-related surgeries—remains underexplored[9].

Elderly patients with rheumatoid arthritis constitute a unique cohort due to their distinct immune response profiles, increased comorbidities, and increased risk of adverse outcomes. The aging process is often accompanied by "inflammaging," a state characterized by chronic low-grade inflammation and immune dysfunction[10]. This persistent inflammation, combined with the acute inflammatory response triggered by surgical trauma, can significantly affect pain perception and recovery. Therefore, understanding the role of the SII in this population may offer clinically vlauable insights to improve postoperative care[11].

Acute postoperative pain following pelvic fractures in elderly patients with rheumatoid arthritis is multifactorial and can be particularly severe. This pain is influenced by several factors, including the extent of soft tissue damage, the duration of surgery, and individual variability in immune and inflammatory responses[12].

The multifaceted nature of the SII positions it as a potentially valuable predictive tool for pain severity, aiding in the development of effective pain management strategies and identifying individuals at risk of developing pain-related complications[13].

Despite its potential, the utility of SII as a predictive biomarker for acute postoperative pain has not been thoroughly investigated[14].

Existing studies indicate that inflammatory markers, such as neutrophil and lymphocyte counts, correlate with pain intensity; however, the integration of these markers into a composite index like the SII remains largely unexplored. Furthermore, the impact of the SII on pain outcomes in elderly patients with trauma-induced rheumatoid arthritis—who present unique physiological and clinical challenges—has yet to be systematically evaluated[15,16].

The present study aims to address this crucial research gap by exploring the relationship between the SII and acute postoperative pain intensity in elderly patients with rheumatoid arthritis who have undergone surgical intervention for traumatic pelvic fractures. The primary objective is to elucidate the correlation between the SII and the severity of acute postoperative pain in this vulnerable population.

Materials and Methods

Study Design

This descriptive cross-sectional study was conducted over six months in late 2023 at Shahid and Imam Reza Hospitals, affiliated with Tabriz University of Medical Sciences. The study strictly adhered to predefined inclusion and exclusion criteria to ensure rigorous data collection and analysis.

Sampling Method

An exploratory approach to sample size determination was employed, aiming for a statistical power of 80% and a significance level of 0.05. After accounting for an anticipated 10% dropout rate, a final sample size of 112 patients was obtained using convenience sampling methods.

Inclusion and Exclusion Criteria

Inclusion Criteria: This study included adult participants aged 65 to 80 years who were scheduled for hip fracture surgery and classified as ASA Class I or II according to the American Society of Anesthesiologists' guidelines. Participants were required to provide informed consent. Surgical procedures were performed within 24 hours post-trauma to minimize potential confounding effects on inflammatory biomarkers. All surgeries were performed by a standardized surgical team to ensure methodological consistency throughout the study.

Exclusion Criteria: Patients were excluded from the study if they had a history of alcohol or drug dependence, were taking psychiatric medications, or had medical conditions likely to elevate inflammatory markers. This included individuals with advanced cardiovascular disease, cancer, or those who had undergone chemotherapy or radiotherapy. Additional exclusion criteria included the presence of infectious diseases, use of anti-inflammatory medications, recent blood transfusions, pathological or multiple fractures, fractures located near prosthetic devices or open fractures, and prior conservative treatment for fractures. Furthermore, patients undergoing corrective or repeat surgeries, those receiving long-term immunosuppressive therapy (e.g., glucocorticoids), and surgeries lasting longer than four hours were also excluded.

Methodology

To systematically collect relevant data, a structured data collection form was used for each participant. This form recorded essential demographic and clinical information, including age, gender, body mass index, smoking history, and a detailed medical history encompassing hypertension, diabetes, chronic obstructive pulmonary disease, stroke, chronic liver disease, and chronic kidney disease. Hip fracture classified as femoral neck, intertrochanteric, or subtrochanteric. Additionally, the ASA classification and the surgical approach (total hip replacement, hemiarthroplasty, or intramedullary nailing) were carefully documented.

Venous blood samples were collected from the cubital vein by a qualified nursing professional and subsequently sent to the central laboratory for analysis. Upon hospital admission, key biomarkers- specifically neutrophil, lymphocyte, and platelet counts- were measured. The systemic immune-inflammation index (SII) was calculated using the following formula:

Lymphocyte count / (Neutrophil count * Platelet)

Pain intensity was assessed using the Visual Analog Scale (VAS), a validated instrument that has been widely employed for over five decades. Pain scores were recorded at 1, 2, 3, 4, 6, 12, 18, and 24 hours post-operatively to examine the correlation between pain intensity and the systemic immune-inflammation index, which was measured preoperatively and upon admission. Additionally, the dosage of opioids administered (measured in milligrams of pethidine) was correlated with the systemic immune-inflammation index. Hemodynamic parameters, including heart rate and mean arterial pressure, were monitored at corresponding time intervals to explore their relationship with the systemic immune-inflammation index. All patients received spinal anesthesia in a seated position at the L4–L5 or L5–S1 intervertebral space using a 22-gauge needle, along with an injection of 20 mg of Marcaine.

Data Analysis

The data collected were analyzed using SPSS software (version 25). Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize baseline characteristics. The Pearson correlation coefficient assessed the relationship between pain intensity and the systemic immune-inflammation index, with a significance level set at $p < 0.05$.

Ethical Considerations

This study received ethical approval from the Ethics Committee of Tabriz University of Medical Sciences (Approval Number: IR.TBZMED.REC.1403.154). No additional financial burden was imposed on participants, and immediate measures were taken to address any adverse events that occurred.

Findings

The study included 112 elderly patients diagnosed with rheumatoid arthritis who underwent surgical intervention for traumatic hip fractures. The mean age of the participants was 56.74 ± 5.34 years, with a predominance of males representation (71.42%). Femoral neck fractures were the most common type identified, and most patients were classified as ASA Class I. Comprehensive demographic and clinical characteristics of the study cohort are detailed in Table 1.

Laboratory assessments revealed a mean systemic immune-inflammation index (SII) of 11.329 ± 0.956 among participants. Blood cell counts, including neutrophils, lymphocytes, and platelets, were consistent with expected values for this demographic. A summary of additional hematological and inflammatory parameters is provided in Table 2.

Correlation analyses revealed a significant positive association between SII values during hospitalization and the severity of acute postoperative pain, as measured by the pain intensity scale within the first four hours after the surgery. The strongest correlation was observed at the second hour post-operatively ($r = 0.658$, $p = 0.009$). Significant correlations were also found at the first hour ($r = 0.596$, $p = 0.014$), third hour ($r = 0.488$, $p = 0.026$), and fourth hour ($r = 0.452$, $p = 0.036$), although the strength of the correlations decreased in subsequent hours. Based on prior research, an optimal SII threshold of 805.86 was established, categorizing patients into normal (values < 805.86) and abnormal (values > 805.86) groups.

Table 1- Basic information about participants

Variable		Mean ± standard deviation/frequency (percentage)
Age (years)		74.5 ± 56.34
Gender	Male	80 (%.71.42)
	Female	32 (%.28.75)
Body Mass Index		27/89± 3.28
Smoking	Yes	28(%25.00)
	No	(84%.75.00)
High Blood Pressure	Yes	51(%.45..54)
	No	61(%.54.46)
Diabetes Mellitus	Yes	34(%.30.36)
	No	78(%.69.64)
Lung Disease	Yes	13(%.11.61)
	No	99(%.88.39)
Stroke	Yes	7(%66.25)
	No	105(%.93.75)
Liver Disease	Yes	4(%.3.57)
	No	105(%.69.43)
Kidney Disease	Yes	10(%.8.93)
	No	(102%.91.07)
Hip Fracture Type	Femoral Neck	50(%.44.64)
	Intertrochanteric	39(%.34.82)
	Subtrochanteric	(23%.20.54)
ASA Class	Class I	68(%.60.71)
	Class II	44(%.39.29)
Surgical Procedure	Total Hip	56(%.50.00)
	Hemiarthroplasty	34(%.30.36)
	Intermedullary	22(%.19.64)

Table 2- Summary of the results of biochemical tests of study participants

Variable	Mean±SD
White blood cells ($\times 10^9$/L)	744.7 ± 1.74
Red blood cells ($\times 10^{12}$/L)	85.4 ± 0.51
Platelets ($\times 10^9$/L)	33.299 ± 99.35
Neutrophils ($\times 10^9$/L)	36.4 ± 1.41
Lymphocytes ($\times 10^9$/L)	32.2 ± 0.66
Monocytes ($\times 10^9$/L)	62.0 ± 0.23
Eosinophils ($\times 10^9$/L)	0.21 ± 0.11
Basophils ($\times 10^9$/L)	0.12 ± 0.21
Hemoglobin (g/dL)	14.25 ± 2.63
Systemic immune-inflammatory index	956.02±329.11

Significant differences were observed between the two groups in terms of neutrophil, platelet, white blood cell, and lymphocyte counts, as well as in the duration of hospital stay. Patients with a high SII exhibited significantly elevated neutrophil, platelet, and white blood cell counts ($P < 0.001$ for all), along with significantly lower lymphocyte counts ($P < 0.001$). Furthermore, the high SII group had a longer average hospital stay of 22 days compared to 17 days in the low SII group ($P = 0.006$).

Discussion

The primary aim of this study was to investigate the relationship between the systemic immune-inflammatory index (SII) and postoperative pain intensity in patients with rheumatoid arthritis. The findings indicate a significant association between elevated SII and increased postoperative

pain, greater analgesic requirements, notable hemodynamic changes, and prolonged hospital stays, including potential time spent in intensive care. These results suggest that SII may serve as a valuable prognostic marker for assessing postoperative recovery in this patient population.

The measurement of pain severity in the early postoperative phase, assessed using the Visual Analog Scale (VAS), demonstrated a significant correlation with SII values. Specifically, patients with elevated SII levels reported increased pain during the initial hours following surgery. This finding aligns with existing literature emphasizing the role of systemic inflammation in the onset and exacerbation of pain. In patients with rheumatoid arthritis, chronic inflammation can lead to the overactivation of immune pathways and the subsequent release of inflammatory mediators, which intensify postoperative pain by sensitization both peripheral and central pain pathways[17,18].

The present study highlights a significant association between elevated systemic immune-inflammatory index (SII) values and increased postoperative pain severity in patients with rheumatoid arthritis. Furthermore, patients with higher SII levels required greater amounts of opioid analgesics. This correlation underscores the profound influence of inflammatory status on patients' responses to analgesic treatment. Specifically, the active inflammation characteristic of rheumatoid arthritis appears to lower pain thresholds and reduce the effectiveness of analgesics, necessitating more intensive pharmacological intervention to achieve adequate pain control. Therefore, it is crucial to incorporate assessments of immune-inflammatory status into the development of postoperative pain management strategies[3].

In addition to pain intensity, a significant correlation was observed between SII and hemodynamic changes during the early postoperative phase. Patients with elevated SII levels tended to exhibit increased arterial pressure, likely reflecting the systemic effects of inflammation on vascular tone and endothelial function. Pro-inflammatory cytokines, which are prevalent in rheumatoid arthritis, can increase peripheral vascular resistance, potentially leading to hemodynamic instability. Consequently, SII may serve as a valuable indirect indicator for assessing hemodynamic status in the postoperative context[19,20].

The observed hemodynamic changes in patients with elevated SII values indicate a significant inflammatory response that requires close monitoring. Careful observation during the postoperative period is critical, as these patients may be more susceptible to physiological instability[21].

Another key outcome of this study was the evaluation of hospital stay duration. The results indicated that an elevated SII correlates with prolonged hospitalization, likely due to delayed healing, impaired tissue repair, and an increased risk of postoperative complications. Persistent inflammation can disrupt repair processes and impede the immune system's return to homeostasis, ultimately extending the duration of hospital care[22,23].

Moreover, patients with elevated SII values showed a higher likelihood of requiring admission to the intensive care unit and advanced medical interventions. This finding suggests that systemic inflammation significantly influences the postoperative clinical course. Given the persistent inflammation and multi-system involvement characteristics of rheumatoid arthritis, indices like the SII are essential for the early identification of high-risk patients[24].

Further analysis revealed that SII functions as an independent predictor of prolonged hospital stays, consistent with existing literature on the adverse effects of systemic inflammation on postoperative recovery. Inflammation is known to compromise immune function, impair wound healing, and disrupt metabolic homeostasis, thereby extending the recovery timeline and increasing the demand for hospital resources[25].

Other clinical and laboratory parameters also demonstrated a relationship with the length of hospital stay, notably body mass

index (BMI). A higher BMI correlates with prolonged hospitalization, potentially due to exacerbated systemic inflammation, impaired healing, and an increased risk of postoperative complications in patients with rheumatoid arthritis[26]. Furthermore, the overall health status of patients, assessed using the ASA classification, significantly influenced the duration of hospitalization, with individuals presenting higher comorbidities and surgical risks being more prone to extended stays[27].

Additionally, increased platelet counts, indicative of inflammatory activity, were associated with longer hospital stays, while decreased hemoglobin levels correlated with poorer postoperative outcomes[28]. Anemia, which is particularly common among patients with rheumatoid arthritis, can hinder recovery by reducing oxygen delivery and impairing tissue repair mechanisms[19].

The clinical implications of these findings are significant. The SII serves as a simple, accessible, and cost-effective tool for identifying rheumatoid arthritis patients at increased risk of severe pain, greater analgesic requirements, hemodynamic instability, and prolonged hospitalization. Early identification of these patients enables the development of tailored care strategies that optimize pain management and reduce postoperative complications[29]. Furthermore, monitoring inflammatory status supports personalized management approaches, enhancing safety and overall quality of postoperative care while reducing reliance on opioids[30,31].

conclusion

In conclusion, the systemic immune-inflammatory index emerges as a valuable prognostic tool for assessing postoperative pain, analgesic requirements, and critical clinical outcomes in patients with rheumatoid arthritis. Elevated SII values are associated with increased pain intensity, higher analgesic consumption, and prolonged durations of both hospital and intensive care unit stays. Additionally, factors such as body mass index, overall health status, platelet counts, and hemoglobin levels significantly infleunce postoperative recovery. By integrating the SII with other clinical parameters, healthcare professionals can improve risk prediction, guide treatment decisions, and optimize postoperative care for patients with rheumatoid arthritis. Further research is needed to clarify the role of the systemic immune-inflammatory index in clinical practice.

References:

1. Bobian M, Gupta A, Graboyes EM. Acute Pain Management Following Head and Neck Surgery. Otolaryngologic clinics of North America. 2020;53(5):753-64. Epub 2020/07/20. doi: 10.1016/j.otc.2020.05.005. PubMed PMID: 32682530.
2. Di Saverio S, Podda M, De Simone B, Ceresoli M, Augustin G, Gori A, et al. Diagnosis and treatment of acute appendicitis: 2020 update of the WSES Jerusalem guidelines. World journal of emergency surgery: WJES. 2020; 15(1): 27. Epub 2020/04/17. doi: 10.1186/s13017-020-00306-3. PubMed PMID: 32295644; PubMed Central PMCID: PMCPMC7386163.
3. Lundberg IE, Sharma A, Turesson C, Mohammad AJ. An update on polymyalgia rheumatica. Journal of internal medicine. 2022; 292(5): 717-32. Epub 2022/05/26. doi: 10.1111/joim.13525. PubMed PMID: 35612524; PubMed Central PMCID: PMCPMC9796644.
4. Patel JM. Multisystem Inflammatory Syndrome in Children (MIS-C). Current allergy and asthma reports. 2022; 22(5):53-60. Epub 2022/03/23. doi: 10.1007/s11882-022-01031-4. PubMed PMID: 35314921; PubMed Central PMCID: PMCPMC8938222.
5. Liu B, Wang J, Li YY, Li KP, Zhang Q. The association between systemic immune-inflammation index and rheumatoid arthritis: evidence from NHANES 1999-2018. Arthritis Res Ther. 2023; 25(1): 34. Epub 2023/03/05. doi: 10.1186/s 13075-023-03018-6. PubMed PMID: 36871051; PubMed Central PMCID: PMCPMC9985219.
6. Song Y, Guo W, Li Z, Guo D, Li Z, Li Y. Systemic immune-inflammation index is associated with hepatic steatosis: Evidence from NHANES 2015-2018. Front Immunol. 2022;13:1058779. Epub 2022/12/06. doi: 10.3389/fimmu.2022.1058779. PubMed PMID: 36466832; PubMed Central PMCID: PMCPMC9718528.
7. Sahin MF, Eseoglu E, Akgul M, Malak A, Dogan C, Yazici CM. Use of the Systemic Immune-Inflammation Index to Predict Treatment Efficacy in Patients with Bladder Pain Syndrome. Journal of the College of Physicians and Surgeons-Pakistan : JCPSP. 2024;34(5):556-60. Epub 2024/05/09. doi: 10.29271/jcpsp.2024.05.556. PubMed PMID: 38720216.
8. Canikli Adıgüzel Ş, Akyurt D, Bahadır Altun H, Tulgar S, Ültan Özgen G. Can Neutrophil-Lymphocyte Ratio, Platelet-Lymphocyte Ratio, or Systemic Immune Inflammation Index Be an Indicator of Postoperative Pain in Patients Undergoing Laparoscopic Cholecystectomy? Cureus. 2023; 15(1): e33955. Epub 2023/02/24. doi: 10.7759/cureus.33955. PubMed PMID: 36820108; PubMed Central PMCID: PMCPMC9938425.
9. Wang H, Nie H, Bu G, Tong X, Bai X. Systemic immune-inflammation index (SII) and the risk of all-cause, cardiovascular, and cardio-cerebrovascular mortality in the general population. European journal of medical research. 2023;28(1):575. Epub 2023/12/09. doi: 10.1186/s40001-023-01529-1. PubMed PMID: 38066657; PubMed Central PMCID: PMCPMC10709886.
10. Candemir M, Kiziltunç E, Nurkoç S, Şahinarslan A. Relationship Between Systemic Immune-Inflammation Index (SII) and the Severity of Stable Coronary Artery Disease. Angiology. 2021;72(6):575-81. Epub 2021/03/10. doi: 10.1177/0003319720987743. PubMed PMID: 33685239.
11. Peng F, Xia J, Niu H, Feng X, Zheng T, He X, et al. Systemic immune-inflammation index is associated with aneurysmal wall enhancement in unruptured intracranial fusiform aneurysms. Front Immunol. 2023;14:1106459. Epub 2023/02/14. doi: 10.3389/fimmu.2023.1106459. PubMed PMID: 36776878; PubMed Central PMCID: PMCPMC9911448.
12. Tutan D, Doğan AG. Pan-Immune-Inflammation Index as a Biomarker for Rheumatoid Arthritis Progression and Diagnosis. Cureus. 2023;15(10):e46609. Epub 2023/10/09. doi: 10.7759/cureus.46609. PubMed PMID: 37808603; PubMed Central PMCID: PMCPMC10558813.
13. Tian SY. Systemic Immune-Inflammation Index Predicts Restenosis after Interventions for Lower Extremity Arteriosclerosis Obliterans. The heart surgery forum. 2023;26(3):E225-e33. Epub 2023/07/04. doi: 10.1532/hsf.5303. PubMed PMID: 37401437.
14. Liu J, Li S, Zhang S, Liu Y, Ma L, Zhu J, et al. Systemic immune-inflammation index, neutrophil-to-lymphocyte ratio, platelet-to-lymphocyte ratio can predict clinical outcomes in patients with metastatic non-small-cell lung cancer treated with nivolumab. Journal of clinical laboratory analysis. 2019;33(8):e22964. Epub 2019/07/10. doi: 10.1002/jcla.22964. PubMed PMID: 31282096; PubMed Central PMCID: PMCPMC6805305.
15. Tort M, Sevil FC, Sevil H, Becit N. Evaluation of systemic immune-inflammation index in acute deep vein thrombosis: A propensity-matched. Journal of vascular surgery Venous and lymphatic disorders. 2023;11(5):972-7.e1. Epub 2023/04/02. doi: 10.1016/j.jvsv.2023.02.008. PubMed PMID: 37003462.

16. Ryvlin J, Kim SW, Hamad MK, Fourman MS, Eleswarapu A, Murthy SG, et al. The prognostic role of neutrophil-to-lymphocyte ratio, platelet-to-lymphocyte ratio, and systemic immune-inflammation index on short- and long-term outcome following surgery for spinal metastases. Journal of neurosurgery Spine. 2024;40(4):475-84. Epub 2024/01/02. doi: 10.3171/2023.10.spine23851. PubMed PMID: 38157531.
17. Zhang J, Ma Q, Li W, Li X, Chen X. S-Ketamine attenuates inflammatory effect and modulates the immune response in patients undergoing modified radical mastectomy: A prospective randomized controlled trial. Front Pharmacol. 2023;14:1128924. Epub 2023/03/07. doi: 10.3389/fphar.2023.1128924. PubMed PMID: 36873990; PubMed Central PMCID: PMCPMC9977820.
18. Wang C, Fan S, Gu D, Deng J, Ma B, Xie L, et al. Effect of ultrasound-guided transverse abdominal plane block on neutrophil-to-lymphocyte ratio, platelet-to-lymphocyte ratio, and systemic immune inflammation index in patients undergoing radical resection of endometrial carcinoma. PLoS One. 2024;19(12):e0315175. Epub 2024/12/05. doi: 10.1371/journal.pone.0315175. PubMed PMID: 39637188.
19. Karakayali M, Omar T, Artac I, Rencuzogullari İ, Karabag Y, Demir O. The relationship between the systemic immune-inflammation index and reverse-dipper circadian pattern in newly diagnosed hypertensive patients. Journal of clinical hypertension (Greenwich, Conn). 2023;25(8):700-7. Epub 2023/07/19. doi: 10.1111/jch.14688. PubMed PMID: 37464585; PubMed Central PMCID: PMCPMC10423764.
20. Dey S, Kashav R, Kohli JK, Magoon R, ItiShri, Walian A, et al. Systemic Immune-Inflammation Index Predicts Poor Outcome After Elective Off-Pump CABG: A Retrospective, Single-Center Study. J Cardiothorac Vasc Anesth. 2021; 35(8): 2397-404. Epub 2020/10/14. doi: 10.1053/j.jvca.2020.09.092. PubMed PMID: 33046365.
21. Aydin C, Alpsoy Ş, Akyüz A, Özkaramanli Gür D, Emlek N, Şahin A, et al. Could the systemic immune-inflammation index be a predictor to estimate cerebrovascular events in hypertensive patients? Blood pressure monitoring. 2022; 27(1): 33-8. Epub 2022/01/08. doi: 10.1097/mbp.0000000000000560. PubMed PMID: 34992205.
22. Topal D, Korkmaz UTK, Velioglu Y, Yuksel A, Donmez I, Uçaroğlu ER, et al. Systemic immune-inflammation index as a novel predictor of atrial fibrillation after off-pump coronary artery bypass grafting. Revista da Associacao Medica Brasileira (1992). 2022;68(9):1240-6. Epub 2022/10/14. doi: 10.1590/1806-9282.20220295. PubMed PMID: 36228255; PubMed Central PMCID: PMCPMC9575030.
23. Güneylioğlu MM, Güngör A, Göktuğ A, Üner Ç, Bodur İ, Yaradılmış RM, et al. Evaluation of the efficiency of the systemic immune-inflammation index in differentiating parapneumonic effusion from empyema. Pediatric pulmonology. 2022; 57(7): 1625-30. Epub 2022/04/15. doi: 10.1002/ppul.25926. PubMed PMID: 35420252.
24. Mangalesh S, Dudani S, Malik A. The systemic immune-inflammation index in predicting sepsis mortality. Postgraduate medicine. 2023; 135(4): 345-51. Epub 2022/10/27. doi: 10.1080/00325481.2022.2140535. PubMed PMID: 36287784.
25. Güngör A, Göktuğ A, Yaradılmış RM, Güneylioğlu MM, Öztürk B, Bodur İ, et al. Utility of the systemic immune-inflammation index to predict serious bacterial infections in infants with fever without a source. Postgraduate medicine. 2022; 134(7): 698-702. Epub 2022/06/16. doi: 10.1080/00325481.2022.2091373. PubMed PMID: 35705191.
26. Riekert M, Rempel V, Keilwerth S, Zöller JE, Kreppel M, Schick VC. Airway-Associated Complications With and Without Primary Tracheotomy in Oral Squamous Cell Carcinoma Surgery. The Journal of craniofacial surgery. 2023;34(1):279-83. Epub 2022/08/12. doi: 10.1097/scs.0000000000008881. PubMed PMID: 35949029.
27. Badger-Emeka L, Al Rashed AS, Aljindan RY, Emeka PM, Quadri SA, Almutairi HH. Incidence of Drug-Resistant Hospital-Associated Gram-Negative Bacterial Infections, the Accompanying Risk Factors, and Clinical Outcomes with Treatment. Antibiotics (Basel, Switzerland). 2023;12(9). Epub 2023/09/28. doi: 10.3390/antibiotics12091425. PubMed PMID: 37760721; PubMed Central PMCID: PMCPMC10525819.
28. Dotan I, Shochat T, Shimon I, Akirov A. The Association Between BMI and Mortality in Surgical Patients. World J Surg. 2021;45(5):1390-9. Epub 2021/01/23. doi: 10.1007/s00268-021-05961-4. PubMed PMID: 33481082.
29. Wang RH, Wen WX, Jiang ZP, Du ZP, Ma ZH, Lu AL, et al. The clinical value of neutrophil-to-lymphocyte ratio (NLR), systemic immune-inflammation index (SII), platelet-to-lymphocyte ratio (PLR) and systemic inflammation response index (SIRI) for predicting the occurrence and severity of pneumonia in patients with intracerebral hemorrhage. Front Immunol. 2023;14:1115031. Epub 2023/03/03. doi: 10.3389/fimmu.2023.1115031. PubMed PMID: 36860868; PubMed Central PMCID: PMCPMC9969881.

30. Wang J, Zhou D, Dai Z, Li X. Association between Systemic Immune-Inflammation Index and Diabetic Depression. Clin Interv Aging. 2021;16:97-105. Epub 2021/01/21. doi: 10.2147/cia.s285000. PubMed PMID: 33469277; PubMed Central PMCID: PMCPMC7810592.
31. Nie Y, Zhou H, Wang J, Kan H. Association between systemic immune-inflammation index and diabetes: a population-based study from the NHANES. Front Endocrinol (Lausanne). 2023;14:1245199. Epub 2023/11/29. doi: 10.3389/fendo.2023.1245199. PubMed PMID: 38027115; PubMed Central PMCID: PMCPMC10644783.