**SERUM LEVELS OF TUMOR NECROSIS FACTOR-ALPHA, INTERLEUKIN-10 AND ALBUMIN CIRCULATING AMONG MALE PATIENTS WITH POST-SURGICAL WOUND INFECTION IN ASABA, DELTA STATE, NIGERIA**

**ABSTRACT**

Wound infections following surgery are common and significantly raise patient morbidity and treatment costs. Even in hospitals with the most up-to-date equipment and standard preoperative preparation and antibiotic prophylactic measures, surgical site infections (SSIs) remain the most frequent post-operative complications. The aim of this study was to evaluate the serum levels of circulating Tumor necrosis factor-alpha (TNF-α), Interleukin-10 (IL-10), and Albumin in male patients with post-surgical wound infections (PSWIs) in Asaba, Nigeria. Blood samples were taken from fifty (50) male participants who were enrolled voluntarily in the study (25 patients with PSWIs and 25 apparently healthy individuals (control group). TNF-α and IL-10 levels were determined using sandwich enzyme-linked immunosorbent assay while serum albumin was determined using Bromocresol green (BCG) method. The independent t-test and Pearson correlation were used to examine the data, and a p-value of <0.05 was considered statistically significant. The results showed that individuals with PSWIs had significantly higher mean serum levels of TNF-α (164.08±4.092 Vs 46.24±8.418; p=0.001) and IL-10 (32.36±9.367 Vs 16.80±5.874; p=0.001) but significantly lower mean serum albumin level (32.88±5.311 Vs 36.41±5.654; p=0.027) compared to the control group. These results highlight the possible roles that serum albumin and TNF-α/IL-10 dysregulation may play in the development and severity of surgical wound infections in male patients. The observed excessive inflammatory response may hinder infection resolution, which leads to poor treatment outcomes despite timely antibiotic treatment.

**KEY WORDS:** Post-surgical wound infection, Cytokine, Tumor necrosis factor alpha, Interleukin-10, Inflammatory response, Albumin, Hypoalbuminemia.

**INTRODUCTION**

Surgical site infections (SSIs) are infections that occur in the area of the body where surgery was performed (CDC, 2024). Bacteria enter surgical sites through incisions made during surgery, causing surgical site infections. Every year, they endanger the lives of millions of patients and fuel the development of antibiotic resistance (Word Health Organization (WHO), 2025). Surgery-related infections affect 11% of patients in low- and middle-income nations (WHO, 2025). According to Seidelman *et al*. (2023), between 0.5% and 3% of all surgical patients will experience a surgical site infection. In post-operative care, post-surgical wound infections (PSWI) continue to be a major issue because they can result in longer hospital stays, higher medical expenses, and worse patient outcomes (Ehiaghe *et al*., 2025).

These infections cause systemic and local responses, which are frequently mediated by cytokines (Geißler *et al*., 2017). At the location of the wound, different cell types produce cytokines in a cascade; in other words, a cytokine may cause its target cells to release more cytokines. These chemicals activate intracellular messengers that control gene transcription by binding to certain receptors (Souza *et al*., 2022). They control the synthesis and activity of other cytokines and have an impact on the activity, differentiation, proliferation, and survival of various cells, including immune system cells. Depending on the microenvironment in which they are found, certain cytokines may have proinflammatory (Th1 profile) or antiinflammatory (Th2 profile) effects (Souza *et al*., 2022). Tumor necrosis factor alpha (TNF-α) is regarded as pro-inflammatory, whilst interleukin-10 (IL-10) is regarded as anti-inflammatory cytokine (Uciechowski and Dempke, 2020; Jang *et al*., 2021; Carlini *et al*., 2023).

The pro-inflammatory cytokine TNF-α stimulates the synthesis of adhesion molecules, fibroblast growth factor, procoagulant factors, IL-1, and IL-6 (Jang *et al*., 2021). It is produced by activated macrophages, dendritic cells, neutrophils, eosinophils, mast cells, natural killer cells, and CD4+ lymphocytes. By encouraging the production of IL-1 and IL-6, increasing the expression of adhesion molecules, and starting the apoptotic and cytotoxic response, TNF-alpha carries out this function (Ozgur *et al*., 2023). Physiologically, TNF-alpha is necessary for a robust immune response. Although TNF-alpha can cause the immune system to regulate, excessive or inappropriate TNF-alpha production can be harmful and lead to disease (Jang *et al*., 2021) or failed wound healing and infection resolution in this respect.

On the other hand, IL-10 has strong anti-inflammatory qualities and is important in preventing or limiting an excessive inflammatory response (Ouyang and O'Garra, 2019). To protect the body and protect tissues from infection, the immune system depends on IL-10 to keep the immunological response in the right balance (Obasanmi *et al*., 2023).

Serum albumin (ALB), one of the most important proteins in human physiology, is primarily responsible for controlling plasma volume and oncotic pressure, transporting hormones, vitamins, oligominerals, and drugs, and serving as a strong anti-inflammatory and antioxidant (Gremese *et al*., 2023). A decrease in serum albumin levels leads to reduced oncotic pressure, which in turn causes interstitial oedema (Robert *et al*., 2003). Hypoalbuminemia is associated with mortality and postoperative complications such as SSI and reoperations (Liu *et al*., 2017). Research has also demonstrated that hypoalbuminemia plays a role in the severity of the disease, fracture union, and wound healing (Issangya *et al*., 2020; Gremese *et al*., 2023).

SSIs continue to be a major post-operative care issue because they can result in longer hospital stays, higher medical expenses, and worse patient outcomes. Following surgical procedures, post-operative wound infections are a common and critical therapeutic consequence. Research is also lacking in understanding the dynamic interaction between immune response indicators like TNF-alpha, IL-10 and albumin, particularly in male patients with post-operative infections. As a result of this, the current study investigated the serum levels of tumor necrosis factor-alpha, interleukin-10 and albumin circulating among male patients with post-surgical wound infection in Asaba, Nigeria.

MATERIALS AND METHODS

**Study site**

The study was carried out at Federal Medical Center Asaba, Delta State Nigeria.

**Study Design**

This was a cross-sectional study designed to evaluate the serum levels of tumor necrosis factor-alpha, interleukin-10 and albumin circulating among male patients with post-surgical wound infection in Asaba, Nigeria.

**Study population**

Fifty participants including twenty-five males with postsurgical wounds (test group) and twenty-five apparently healthy males (control group). were recruited by simple random sampling method clinical wound swab samples were collected from each patient.

**Sample size**

The sample size (N) was calculated using prevalence from previous studies on the prevalence of post-surgical wound infections globally which was found to be 2.5% (Mengistu *et al.*, 2023)according to the sample size calculation formula described by Daniel and Cross (1999).

**Inclusion criteria**

Male patients with confirmed cases of post-surgical wound infection and apparently healthy male participants who gave their informed consent were included for this study.

**Exclusion Criteria**

Male patients with post-surgical wound infection and apparently healthy male individuals without post-surgical wound infection who did not give their informed consent were excluded from this study.

**Ethical considerations**

Ethical approval was granted by the ethics committee of Federal Medical Centre, Asaba, Delta State, before the commencement of the study.

Informed consent of all the participating subjects were sought and obtained.

**Blood sample collection**

Five milliliters (5 ml) of venous blood sample was collected from each participant into plain container for determination of cytokine and albumin levels. Blood samples were allowed to clot, then retracted and centrifuged for 10mins at 4000 rpm. Serum samples were separated and stored at -200C until analyzed.

**Determination of Cytokine levels**

Tumor necrosis factor-alpha and interleukin-10 levels were determined using sandwich enzyme linked-immunosorbent assay technique.

**Albumin**

This was determined using the Bromocresol green method (BCG) described by Doumas and Watson (1971) and referenced by Okpogba *et al*. (2021).

**Statistical analysis**

The data obtained was analyzed using SPSS (Statistical Package for Social Sciences) 20.0 and expressed as Mean ± Standard deviation. Independent t-test and Pearson correlation was used to determine statistical difference and the association between variable. P value < 0.05 was considered statistically significant.

**RESULTS**

In Table 1, the mean values of serum TNF-α, IL-10 and Albumin of the Test group and the Control group are represented. There was a significant increase in the mean values of serum TNF-α and IL-10 in the male patients with post-surgical wound infection (test group) compared to the observed levels in the apparently healthy individuals (TNF-α=164.08±4.092 Vs 46.24±8.418; p=0.001; IL-10= 32.36±9.367 Vs 16.80±5.874; p=0.001), TABLE 1.

However, there was a statistically significant decrease in the mean value of serum Albumin present in the test group when compared to the observed values in the control group (32.88±5.311 Vs 36.41±5.654; p=0.027), TABLE 1.

There was no significant correlation observed in the parameters studied in the test group (p>0.05), Table 2.

A moderate significant negative correlation was observed between the parameters TNF-α vs Albumin (r=-0.498; p=0.011). However, a strongly significant positive correlation was observed between the parameters TNF-α vs IL-10 (r=0.728; P=0.001).

**Table 1: The mean values of Tumor necrosis factor alpha, Interleukin-10 and Albumin circulating among male patients with post-surgical wound infection and control group (Mean ±** **SD)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **PARAMETERS** | **GROUP** | **N** | **MEAN±SD** | **T-value** | **P-value** |
| TNF-α | TEST | 25 | 164.08±4.092 | 62.952 | 0.001\* |
|  | CONTROL | 25 | 46.24±8.418 |  |  |
| IL-10 | TEST | 25 | 32.36±9.367 | 7.037 | 0.001\* |
|  | CONTROL | 25 | 16.80±5.874 |  |  |
| Albumin | TEST | 25 | 32.88±5.311 | 2.274 | 0.027\* |
|  | CONTROL | 25 | 36.41±5.654 |  |  |

**\***Statistical significance at p<0.05

TNF-α = Tumor Necrosis Factor-alpha

IL-10 = Interleukin-10

**Table 2: Level of association between the parameters studied in the test group**

|  |  |  |
| --- | --- | --- |
| **Parameters** | **r-value** | **p-value** |
| TNF-α Vs Albumin | 0.365 | 0.073 |
| IL-10 Vs Albumin | 0.024 | 0.909 |
| TNF-α Vs IL-10 | 0.271 | 0.189 |

**\***Statistical significance at p<0.05

**Table 3: Level of association between the parameters studied in the control group**

|  |  |  |
| --- | --- | --- |
| **Parameters** | **r-value** | **p-value** |
| TNF-α Vs Albumin | -0.498 | 0.011\* |
| IL-10 Vs Albumin | 0.306 | 0.136 |
| TNF-α Vs IL-10 | 0.728\*\* | 0.001\* |

**\***Statistical significance at p<0.05

**DISCUSSION**

In the present study, the mean serum TNF-α and Il-10 levels were significantly higher in the patients with post-surgical wound infections compared with the control group. These findings imply that there is an elevated inflammatory response and altered cytokine environment in patients with post-surgical wound infection compared to apparently healthy controls. More so, the observed cytokine imbalances in this study may facilitate impaired wound healing process and resolution commonly seen in these patients. The current reports agree with findings of previous similar studies. Ehiaghe *et al*. (2024), Ehiaghe *et al*. (2025a) and Ehiaghe *et al*. (2025b), reported that the postsurgical wound infection patients in both Nnewi and Benin City Nigeria had significantly higher levels of tumor necrosis factor alpha, interferon-gamma, and interleukin-10 than in the control group noting that multidrug-resistant bacterial infections are more virulent, and that the observed excessive inflammatory response may impede infection resolution which may explain, in part, why patients with MDR infections do not respond well to treatment, even when they receive prompt antibiotics. Also, Olszewska *et al*. (2022) in line with the present findings demonstrated that both inflammatory markers, high sensitive C-reactive protein (hs-CRP) and TNF-α were higher in subjects with obstructive sleep apnea syndrome following surgery compared to the controls.

However, the current study noted a significantly lower mean serum albumin level in the patients with post-surgical wound infections compared to the control group. This report aligns with the results of several previous similar studies (Liu *et al*., 2017; Ge *et al*., 2017; Issangya *et al*., 2020; Hu *et al*., 2023). Albumin accounts for nearly three-quarters of serum's antioxidant capacity (Keller, 2019). Hepatic synthesis maintains circulating albumin, which can reach the interstitium and tissues and act as a free radical scavenger and antioxidant (Weaving *et al*., 2016). Albumin production and anti-inflammatory properties may be enhanced in response to the level of inflammation (Weaving *et al*., 2016). Inflammatory conditions lead to an increase in albumin breakdown in addition to increased albumin synthesis, which can lead to hypoalbuminemia (Weaving *et al*., 2016). Decrease in serum albumin level causes a fall in oncotic pressure which in turn leads to interstitial oedema and this can worsen the progression of wound healing and recovery. Studies also showed that hypoalbuminemia contributes in process of wound healing, fracture union and severity of disease (Robert *et al*., 2003). Serum albumin is frequently employed in clinical practice as a measure of nutritional status and has a strong correlation with clinical outcomes (Almasaudi *et al*., 2020).

The measures TNF-α vs. albumin also showed a moderately significant negative correlation in the control subjects. On the other hand, a highly significant positive association between TNF-α and IL-10 was found in the control group.

**CONCLUSION**

This study found that patients with post-surgical wound infections had significantly lower mean serum albumin levels and significantly higher mean serum levels of TNF-α and IL-10. The patient outcome may deteriorate as a result of the changes in cytokine levels and the ensuing hypoalbuminemia, which may promote a delay in wound healing and recovery.

**REFERENCES**

Almasaudi, A. S., Dolan, R. D., Edwards, C. A., & McMillan, D. C. (2020). Hypoalbuminemia Reflects Nutritional Risk, Body Composition and Systemic Inflammation and Is Independently Associated with Survival in Patients with Colorectal Cancer. *Cancers*, *12*(7), 1986. <https://doi.org/10.3390/cancers12071986>

Carlini, V., Noonan, D.M., Abdalalem, E., Goletti, D., Sansone, C., Calabrone, L., & Albini, A. (2023). The multifaceted nature of IL-10: regulation, role in immunological homeostasis and its relevance to cancer, COVID-19 and post-COVID conditions. *Frontiers in Immunology*, *14*, 1161067. https://doi.org/10.3389/fimmu.2023.1161067

Daniel, W.W., & Cross, C. L. (1999). Determination of Sample Size for Estimating Proportions. *Biostatistics: A Foundation for Analysis in the Health Sciences*, *8*, 189-190.

de Souza, J.N.R., de Castro, F.O.F., de Souza, C.L., El Cheikh, M.R., Ramos, H.V.L., da Fonseca, S.G., & Costa, C.C. (2021). Is There a Difference between the Preoperative and Postoperative Serum Levels of Interleukin-6 and Tumor Necrosis Factor-α in Children Submitted to Adenotonsillectomy?. *International Archives of Otorhinolaryngology*, *26*(2), e208–e212. https://doi.org/10.1055/s-0041-1730301

Doumas, B.T., Watson, W.A., & Biggs, H.G. (1971). Albumin standards and the measurement of serum albumin with bromcresol green. *Clinica Chimica Acta; International Journal of Clinical Chemistry*, *31*(1), 87–96. https://doi.org/10.1016/0009-8981(71)90365-2

Ehiaghe, F.A., Onyenekwe, C.C., Osakue, O.N., Ehiaghe, J.I., Chukwuanukwu, R.C., Okafoanyali, O.J., Onyenekwe, N.O., Igiebor, F.A., & Manafa, P.O. (2024). Patterns of Multidrug Bacterial Clinical Isolates and Cytokine Responses to AntibioticMisuse in Nnewi,

Anambra State, Nigeria. *Journal of Applied Science and Environmental Management, 28* (5), 1533-1538.

Ehiaghe, F.A., Ogonna, J., Ehiaghe, I.J., Erhunmwunse, R.U., Anyaegbu, I.H., Chukwuanukwu, R.C., Onyenekwe, C.C., Osakue, O.N., Okafoanyali, O., & Ogbodo, E.C. (2025a). Elevated Levels of Interferon Gamma, Interleukin-4, Neutrophil- Lymphocyte Ratio and Platelet-Lymphocyte Ratio As Biomarkers of Post-Surgical Wound Infections Amongst Female Patients in Nnewi, Nigeria. *Asian Journal of Medicine and Health*, *23*(4), 109-114.

<https://doi.org/10.9734/ajmah/2025/v23i41211>.

Ehiaghe, J.I., Ogbebor, A.O., Asiriuwa, I., Erhunmwunse, R.U., Ayanlere, KM., Amengialue, O.O, Ehiaghe F.A, Ogbodo, E.C. (2025b). Effect of Misuse of Antibiotics on Cytokine Patterns and Antibiogram of Bacteria Isolates from Surgical Site Infection in Benin City, Edo State, Nigeria. *Asian Journal of Medicine and Health*, 23(4), 153-162.

<https://doi.org/10.9734/ajmah/2025/v23i41216>.

Geißler, K., Markwart, R., Requardt, R. P., Weigel, C., Schubert, K., Scherag, A., Rubio, I., & Guntinas-Lichius, O. (2017). Functional characterization of T-cells from palatine tonsils in patients with chronic tonsillitis. *PloS one*, *12*(9), e0183214. <https://doi.org/10.1371/journal.pone.0183214>.

Ge, X., Dai, X., Ding, C., Tian, H., Yang, J., Gong, J., Zhu, W., Li, N., & Li, J. (2017). Early Postoperative Decrease of Serum Albumin Predicts Surgical Outcome in Patients Undergoing Colorectal Resection. *Diseases of the Colon and Rectum*, *60*(3), 326–334. https://doi.org/10.1097/DCR.0000000000000750

Gremese, E., Bruno, D., Varriano, V., Perniola, S., Petricca, L., & Ferraccioli, G. (2023). Serum Albumin Levels: A Biomarker to Be Repurposed in Different Disease Settings in Clinical Practice. *Journal of Clinical Medicine*, *12*(18), 6017. https://doi.org/10.3390/jcm12186017

Hu, K., Tan, K., Shang, Q., Li, C., Zhang, Z., Huang, B., Zhao, S., Li, F., Zhang, A., Li, C., Liu, B., Tong, W. (2023). Relative decline in serum albumin help to predict anastomotic leakage for female patients following sphincter‑preserving rectal surgery. *BMC Surgery, 23*, 38.

https://doi.org/10.1186/s12893-023-01923-w

Issangya, C. E., Msuya, D., Chilonga, K., Herman, A., Shao, E., Shirima, F., Naman, E., Mkumbi, H., Pyuza, J., Mtui, E., Sanga, L. A., Abdul, S., Leyaro, B.J., & Chugulu, S. (2020). Perioperative serum albumin as a predictor of adverse outcomes in abdominal surgery: prospective cohort hospital based study in Northern Tanzania. *BMC Surgery*, *20*(1), 155. https://doi.org/10.1186/s12893-020-00820-w

Jang, D.I., Lee, A.H., Shin, H.Y., Song, H.R., Park, J.H., Kang, T.B., Lee, S.R., & Yang, S.H. (2021). The Role of Tumor Necrosis Factor Alpha (TNF-α) in Autoimmune Disease and Current TNF-α Inhibitors in Therapeutics. *International Journal of Molecular Sciences*, *22*(5), 2719. https://doi.org/10.3390/ijms22052719

Keller, U. (2019). Nutritional Laboratory Markers in Malnutrition. *Journal of Clinical Medicine*, *8*, 775.

Liu, X., Wu, X., Zhou, C., Hu, T., Ke, J., Chen, Y., He, X., Zheng, X., He, X., Hu, J., Zhi, M., Gao, X., Hu, P., Wu, X., & Lan, P. (2017). Preoperative hypoalbuminemia is associated with an increased risk for intra-abdominal septic complications after primary anastomosis for Crohn's disease. *Gastroenterology Report*, *5*(4), 298–304. https://doi.org/10.1093/gastro/gox002

Liu, Z. J., Ge, X. L., Ai, S. C., Wang, H. K., Sun, F., Chen, L., & Guan, W. X. (2017). Postoperative decrease of serum albumin predicts short-term complications in patients undergoing gastric cancer resection. *World Journal of Gastroenterology*, *23*(27), 4978–4985. https://doi.org/10.3748/wjg.v23.i27.4978

Lohsiriwat, V., Chinswangwatanakul, V., Lohsiriwat, S., Akaraviputh, T., Boonnuch, W., Methasade, A., & Lohsiriwat, D. (2007). Hypoalbuminemia is a predictor of delayed postoperative bowel function and poor surgical outcomes in right-sided colon cancer patients. *Asia Pacific Journal of Clinical Nutrition*, *16*(2), 213–217.

Mengistu, D.A., Alemu, A., Abdukadir, A.A., Mohammed Husen, A., Ahmed, F., Mohammed, B., & Musa, I. (2023). Global Incidence of Surgical Site Infection Among Patients: Systematic Review and Meta-Analysis. *Inquiry: a journal of medical care organization, provision and financing*, *60*, 469580231162549. https://doi.org/10.1177/00469580231162549

Obasanmi, G., Lois, N., Armstrong, D., Hombrebueno, J.M.R., Lynch, A., Chen, M., & Xu, H. (2023). Peripheral Blood Mononuclear Cells from Patients with Type 1 Diabetes and Diabetic Retinopathy Produce Higher Levels of IL-17A, IL-10 and IL-6 and Lower Levels of IFN-γ-A Pilot Study. *Cells*, *12*(3), 467.

Okpogba, A.N., Odeghe, O.B., Ogbodo, E.C., Okwara, N.A., Izuchukwu, E.C.O., Ejovi, O., Gbodo, E.A., & Obi-Ezeani, C.N. (2021). Effect of occupational exposure to heavy metals on the liver functions in persons working in cable manufacturing factory in Nnewi. *IP International Journal of Forensic Medicine and* *Toxicological Science, 6*(1), 20-27.

 Olszewska, E., Pietrewicz, T.M., Świderska, M., Jamiołkowski, J., & Chabowski, A. (2022). A Case-Control Study on the Changes in High-Sensitivity C-Reactive Protein and Tumor Necrosis Factor-Alpha Levels with Surgical Treatment of OSAS. *International journal of molecular sciences*, *23*(22), 14116. <https://doi.org/10.3390/ijms232214116>

Ouyang, W., & O'Garra, A. (2019). IL-10 Family Cytokines IL-10 and IL-22: from Basic Science to Clinical Translation. *Immunity*, *50*(4), 871–891.

Ozgur, B.A., Cinar, S.A., Coskunpinar, E., Yilmaz, A., Altunkanat, D., Deniz, G., Gurol, A.O., & Yilmaz, M.T. (2023). The role of cytokines and T-bet, GATA3, ROR-γt, and FOXP3 transcription factors of T cell subsets in the natural clinical progression of Type 1 Diabetes. *Immunologic Research*, *71*(3), 451–462.

Robert, M., Daryl, G., Peter, M. R.V. (2003). Harper’s Illustrated Biochemistry. 26th Ed. Mc Graw-Hill Medical.

Seidelman, J.L., Mantyh, C.R., & Anderson, D.J. (2023). Surgical Site Infection Prevention: A Review. *Journal of American Medical Association*, *329*(3), 244–252.

Uciechowski, P., & Dempke, W.C.M. (2020). Interleukin-6: A Masterplayer in the Cytokine Network. Oncology. 2020;98(3):131-137. <https://doi.org/10.1159/000505099>.

U.S Center for Disease Control and Prevention CDC. (2024). Surgical Site Infections (SSI). Retrieved from: <https://www.cdc.gov/surgical-site-infections/about/index.html>

Weaving, G., Batstone, G.F., Jones, R.G. (2016). Age and sex variation in serum albumin concentration: An observational study. *Annals of Clinical Biochemistry*, 53 Pt 1, 106–111.

Word Health Organization (WHO). (2025). Infection perevent and control: surgical site infection.

Retrieved from: <https://www.who.int/teams/integrated-health-services/infection-prevention-control/surgical-site-infection>