

## Impact of Cancer Treatment on Hematological Parameters in Patients with Bladder Cancer

Aliaa Mohammed Nama<sup>1</sup>, Mohsin Kazem Hassan<sup>2</sup>

<sup>12</sup> Department of Pathological Analyses, Faculty of Science, University of kufa, Kufa, Iraq.

### Article history

Received: 09/04/2026

Revised: 02/05/2026

Accepted: 12/05/20206

\*Corresponding Author: Aliaa Mohammed Nama, Department of Pathological Analyses, Faculty of science, University of Kufa, Iraq;  
Email: aliaam.alghafil@student.uokufa.edu.iq

**Abstract:** One of the most common urological cancers in the world, bladder cancer may affect a number of hematological parameters while being treated. The purpose of this research was to assess how various bladder cancer therapy approaches affected hematological markers.

**Methods:** 80 bladder cancer patients (30 pre-treatment and 50 post-treatment) and 30 healthy controls were selected from the Oncology Center at Imam Hussein Hospital in Karbala between October 2025 and March 2026, for a total of 110 Iraqi participants. EDTA-anticoagulated venous blood samples were used to test hematological parameters such as hemoglobin (Hb), red blood cells (RBCs), white blood cells (WBCs), differential WBC count, and platelet count. SPSS version 28 was used for the statistical analysis, which included independent t-tests ( $P < 0.05$ ) and one-way ANOVA. **Results:** Patients had considerably lower hemoglobin levels than controls, and after therapy, their RBC, WBC, and platelet counts decreased. Hemoglobin and platelet counts were considerably impacted by treatment duration, but there were no discernible changes between intravesical chemotherapy and immunotherapy. **Conclusion:** These results show that changes in hematological parameters are linked to bladder cancer and its intravesical treatments, underscoring the need for routine monitoring of complete blood count indices throughout therapy.

**Keywords:** Bladder cancer, hematological parameters, chemotherapy, immunotherapy, complete blood count

## 1. Introduction

The majority of cancer-related deaths worldwide are attributed to uncontrolled cell proliferation, localized tissue invasion, and the potential for metastasis to other organs. Cancer remains a significant global health burden. Due to its prevalence among men and its substantial contribution to annual cancer deaths, bladder cancer is one of the most common urological diseases and now ranks among the top ten most common cancers worldwide [1]. Transitional cell carcinoma is the most common histological type, and its development and course are influenced by several modifiable risk factors,

including obesity, chronic inflammation, tobacco smoking, and occupational exposure to aromatizing amines [2]. In clinical practice, bladder cancer is treated using a variety of approaches, ranging from radical cystectomy with preoperative and postoperative platinum-based chemotherapy in muscularly invasive and advanced stages, to organ-sparing techniques, such as transurethral resection with BCG injection into the bladder in non-muscularly invasive disease [3]. In addition to their effects on urothelial tumor cells, chemotherapy and systemic immunotherapies also affect hematological components and the immune system. This results in characteristic changes in complete blood count

indices, such as anemia, leukopenia or neutropenia, and thrombocytopenia, which are important indicators for monitoring bone marrow suppression, the risk of infection, and bleeding complications during treatment [4]. Simultaneously, in bladder cancer patients undergoing surgery, chemotherapy, or BCG-based immunotherapy, composite inflammatory indices derived from routine blood tests—such as the neutrophil-to-lymphocyte ratio, platelet-to-lymphocyte ratio, systemic inflammatory index, and lymphocyte-to-monocyte ratio—have emerged as readily accessible biomarkers associated with survival outcomes and the risk of disease recurrence [5]. Recent clinical and applied research indicates that bladder cancer therapies, by reprogramming hematopoietic stem cells and progenitor cells, modulating circulating myeloid and lymphoid cell counts, and enhancing robust T-cell responses, are also capable of reshaping systemic immunity. This links changes in hematological markers to treatment efficacy and side effects [6]. Therefore, systematic evaluation of the impact of cancer treatment on hematological markers in bladder cancer patients is crucial for improving patient selection, guiding dose adjustments, predicting side effects, and enhancing diagnostic classification in modern oncology practice and research [7]. The study aimed to evaluate the impact of different treatment modalities for bladder cancer on hematological parameters, including complete blood count (CBC) components such as hemoglobin (Hb), red blood cells (RBCs), white blood cells (WBCs), differential WBC count, and platelet count.

## 2. Methodology

This study was conducted at the Oncology center at Imam Hussein Hospital in Holy Karbala Governorate, where patients diagnosed with bladder cancer visited the center for diagnosis and treatment during this period. Samples were collected from these patients between October 2025 to March 2026 for the purpose of studying and analyzing the disease-related markers.

### *Experimental design*

This study involved a group of Iraqi patients, both male and female, who were diagnosed with bladder cancer and whose diagnosis was confirmed by pathology reports. The study included 80 bladder cancer patients who were divided into groups: thirty (30) pre-treatment, fifty (50)

post-treatment, and thirty (30) healthy individuals. The participants were fully informed about the details of the study, and their voluntary consent was obtained. The project was approved by the scientific ethics committee. Additionally, data were collected regarding several factors that may influence the study results, such as: gender, age, smoking.

### *Diagnosis of Bladder Cancer*

A specialized urologist examined and diagnosed all patients. In order to diagnose bladder cancer, doctors use various tests during a physical examination to confirm the presence of the disease. All patients were at the diagnostic stage. Therefore, this study approves medical reports based on various techniques such as blood tests, biochemical analysis, cystoscopy, biopsy, and imaging techniques like computed tomography (CT) scan and magnetic resonance imaging (MRI).

### *Collection of blood samples*

To perform hematological and biochemical analyses, both bladder cancer patients and healthy controls provided five milliliters of venous blood drawn from the antecubital vein using a sterile syringe. For the assessment of specific hematological parameters, one milliliter of each blood sample was transferred into a tube containing ethylenediaminetetraacetic acid as an anticoagulant. To measure the levels of various biochemical markers in the blood serum, four milliliters of blood were placed into plain glass tubes without anticoagulants and left at room temperature for one hour to allow clotting. After coagulation, the serum was separated through centrifugation and transferred into Eppendorf tubes using a micropipette. The samples were then stored at -20°C until further analysis.

### *Statistical Analysis*

Statistical Package of Social Sciences (SPSS) Version 28 software program (SPSS Inc., Chicago, Illinois, United States) was used to determine significant differences between the research variables. Two independent sample T test was used to determine the differences between variable of two groups. For a comparison of variable of more than two group, the one-way analysis of variance (ANOVA) is the appropriate method. Post paired comparisons were done by Multiple comparison (L.S.D)

to evaluate statistical differences between each two groups, mentioned that by small letters, means value with same small letter have no statistical differences, while means value with different small letters shows statistical differences.

The threshold for statistical significance was established at P less than 0.05, which indicates that differences with a probability of less than 5% were deemed to be statistically significant.

### 3. Results and discussion

#### *Distribution of Demographic Characteristics*

In this study, bladder cancer patients were examined and compared with a healthy control group. The patient cohort was further subdivided into two groups according to treatment status (before treatment and after treatment). Demographic characteristics were analyzed across the three groups, and the distribution of each variable was determined based on the statistical findings, as presented in the table 1.

#### *Hematological Parameters*

##### *Hemoglobin*

The figure compares the mean hemoglobin (Hb%) levels among the control (G1), pre-treatment (G2), and post-treatment (G3) groups, expressed as mean  $\pm$  SD. Hemoglobin was highest in the control group ( $12.67 \pm 1.62$ ) and decreased in the pre-treatment ( $11.19 \pm 1.51$ ) and post-treatment groups ( $10.84 \pm 1.87$ ). Statistical analysis indicated a significant difference between the control group and both treatment groups, while no significant difference was found between the pre- and post-treatment groups. Overall, hemoglobin levels were significantly lower in patients compared to controls, with no significant improvement after treatment.

Table 1: Distribution of Bladder cancer patients (Pre-and Post-Treatment) and Healthy Controls According to Demographic Characteristics

| Group      | Control |       | Pre-treatment |       | Post-treatment |      |
|------------|---------|-------|---------------|-------|----------------|------|
|            | No      | %     | No            | %     | No             | %    |
| Gender     |         |       |               |       |                |      |
| Male       | 23      | 76.7  | 21            | 70    | 39             | 78.0 |
| Female     | 7       | 23.3  | 9             | 30    | 11             | 22.0 |
| Age        |         |       |               |       |                |      |
| ≤40years   | 4       | 13.3  | 0             | 0     | 2              | 4.0  |
| 41-60years | 12      | 40.0  | 10            | 33.3  | 15             | 30.0 |
| ≥61years   | 14      | 46.7  | 20            | 66.7  | 33             | 66.0 |
| Smoking    |         |       |               |       |                |      |
| Yes        | 16      | 53.33 | 18            | 60.0  | 31             | 62   |
| No         | 14      | 46.67 | 12            | 40.0  | 19             | 38   |
| BMI        |         |       |               |       |                |      |
| ≤21        | 8       | 26.7  | 4             | 13.33 | 22             | 44.0 |
| 22-26      | 11      | 36.7  | 19            | 63.33 | 26             | 52.0 |
| 27-31      | 8       | 26.7  | 7             | 23.33 | 2              | 4.0  |
| ≥32        | 3       | 10.00 | 0             | 0.00  | 2              | 4.0  |

#### *Red Blood cells*

The figure compares the mean red blood cell count (RBC  $\times 10^{12}/L$ ) among the control (G1), pre-treatment (G2), and post-treatment (G3) groups, expressed as mean  $\pm$  SD. The control group showed the highest mean value ( $4.49 \pm 0.65$ ), followed by the pre-treatment group ( $4.28 \pm 0.59$ ), while the post-treatment group had the lowest count ( $3.85 \pm 0.79$ ). Statistical analysis revealed a significant difference between the control and post-treatment groups, whereas the pre-treatment group did not differ significantly from either. Overall, the results indicate a reduction in RBC count in the post-treatment group compared to controls.

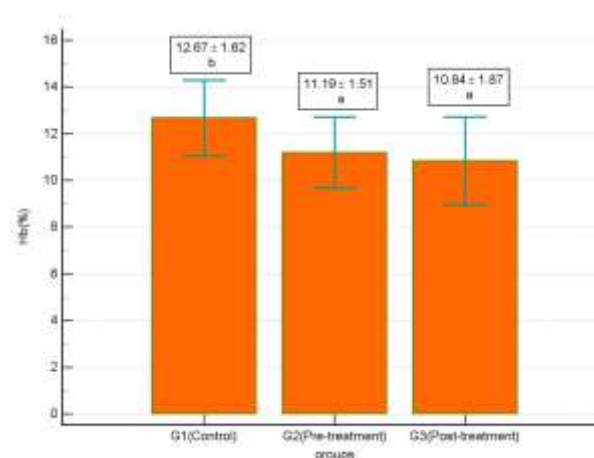
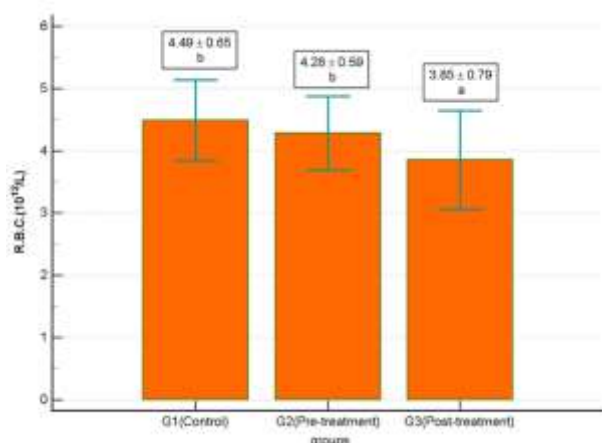
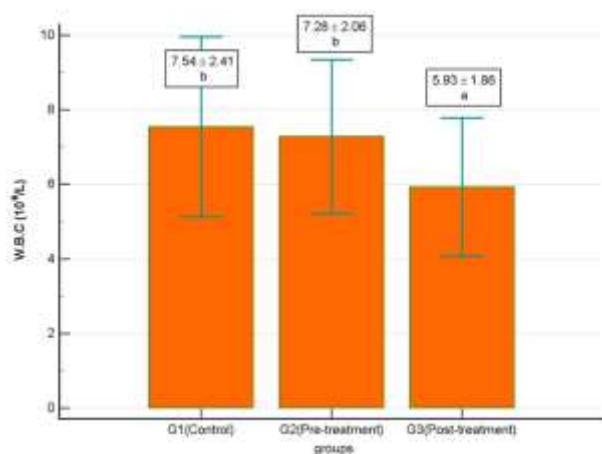


Fig.1: Hb level in study groups

**Fig.2:** RBC count in study groups

### White Blood Cells

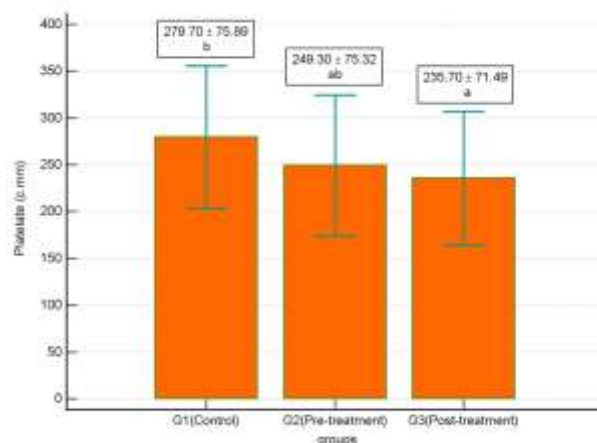
The figure presents the mean white blood cell (WBC) count ( $\times 10^9/L$ ) in the control (G1), pre-treatment (G2), and post-treatment (G3) groups. WBC counts were similar in the control ( $7.54 \pm 2.41$ ) and pre-treatment groups ( $7.28 \pm 2.06$ ), while a lower value was observed in the post-treatment group ( $5.93 \pm 1.86$ ). Statistical analysis ( $P \leq 0.05$ ) showed no significant difference between the control and pre-treatment groups, whereas the post-treatment group demonstrated a significant decrease compared to both. These findings indicate a significant reduction in WBC count following treatment.

**Fig. 3:** The W.B.Cs. counts in study groups

### Platelet

The figure shows the mean platelet count ( $\times 10^3/mm^3$ ) in the control (G1), pre-treatment (G2), and post-treatment

(G3) groups. The control group had the highest mean value ( $279.70 \pm 75.89$ ), followed by the pre-treatment group ( $249.30 \pm 75.32$ ), while the post-treatment group showed the lowest count ( $235.70 \pm 71.49$ ). Statistical analysis ( $P \leq 0.05$ ) revealed a significant difference between the control and post-treatment groups, whereas the pre-treatment group did not differ significantly from either. Overall, the results indicate a reduction in platelet count after treatment, with a significant decrease observed in the post-treatment group compared to controls.

**Fig.4:** Platelet counts in study groups

### Effect of Therapy Type

The table presents the effect of therapy type (chemotherapy versus immunotherapy) on hematological parameters (Hb, RBC, WBC, and platelets), with values expressed as mean  $\pm$  standard deviation.

No statistically significant differences were observed between the two treatment groups for any parameter (Hb:  $P = 0.804$ ; RBC:  $P = 0.524$ ; WBC:  $P = 0.088$ ; Platelet:  $P = 0.954$ ), as the values were comparable. These findings indicate that the type of therapy had no significant impact on hematological parameters during the study period.

**Table 2:** Effect Type of Therapy on Hematological Parameters

| Type of therapy | Hematological parameters |                   |                                   |                                      |
|-----------------|--------------------------|-------------------|-----------------------------------|--------------------------------------|
|                 | Hb                       | RBC               | WBC                               | Platelet                             |
| Chemotherapy    | 10.79( $\pm$ 2.03)       | 3.81( $\pm$ 0.79) | <b>5.82(<math>\pm</math>2.04)</b> | <b>235.31(<math>\pm</math>69.38)</b> |

|                   |                  |                 |                         |                            |
|-------------------|------------------|-----------------|-------------------------|----------------------------|
| Immunoth<br>erapy | 10.94(±<br>1.51) | 3.97(±0<br>.80) | <b>8.65(±9<br/>.21)</b> | <b>236.60(±7<br/>8.71)</b> |
| P value           | 0.804ns          | 0.524ns         | 0.088ns                 | 0.954ns                    |

Value represented as mean ± standard deviation, ns=non-significant differences

Table 3: Effect of therapy duration on hematological parameters

| Duration of<br>therapy | Hematological parameters |               |               |                   |
|------------------------|--------------------------|---------------|---------------|-------------------|
|                        | Hb                       | RBC           | WBC           | Platelet          |
| < 10 months            | 10.79±<br>1.82ab         | 3.84±0.<br>68 | 6.08±1.<br>85 | 250.88±69.<br>22b |
| 10-20<br>months        | 12.54±<br>1.68b          | 4.34±1.<br>37 | 5.92±1.<br>96 | 158.00±31.<br>25a |
| ≥21months              | 9.25±1<br>.14a           | 3.45±0.<br>99 | 4.38±1.<br>50 | 177.25±22.<br>75a |
| P<br>value             | 0.027*                   | 0.228ns       | 0.218ns       | 0.004*            |

Value represented as mean ± standard deviation, ns=non-significant differences

### *Effect of Therapy Duration on Hematological Parameters*

Table 2 and 3 shows the effect of therapy duration on hematological parameters. The results indicate significant differences in hemoglobin (Hb) and platelet counts at the significance level ( $P \leq 0.05$ ), where the P value for Hb was 0.027 and for platelets was 0.004. The 10–20 months therapy group recorded the highest mean Hb level (12.54±1.68), whereas the ≥21 months group showed the lowest value (9.25±1.14). Platelet counts were highest in patients with less than 10 months of therapy (250.88±69.22) and decreased in the other groups.

In contrast, RBC and WBC counts showed no significant differences among the different therapy durations, with P values of 0.228 and 0.218, respectively.

Overall, the findings suggest that therapy duration significantly affects hemoglobin levels and platelet counts, while no significant effect was observed on RBC and WBC counts.

The present study demonstrated that hemoglobin levels were significantly lower in bladder cancer patients compared with healthy controls, with no meaningful improvement after intravesical therapy. This finding is consistent with previous reports that described

cancer-related anemia as a common feature in urothelial carcinoma, driven by chronic inflammation, impaired erythropoiesis, and the metabolic burden of malignancy [10,11]. Moreover, even though most patients in the current cohort received local intravesical therapy rather than systemic chemotherapy, immune activation and treatment-related inflammatory responses may still contribute to subtle bone marrow suppression and persistent anemia [4,14].

A reduction in red blood cell count was observed in post-treatment patients compared with healthy controls, whereas the difference between pre-treatment patients and controls did not reach statistical significance. This pattern may reflect the combined effects of disease progression and cumulative treatment stress, which can interfere with normal erythropoiesis and shorten red cell survival [11,14]. Similar trends have been reported in urothelial carcinoma, where low RBC indices and anemia were associated with advanced disease and adverse prognosis, supporting the clinical relevance of monitoring RBC parameters in these patients [10].

In the current study, white blood cell counts were comparable between the control and pre-treatment groups but showed a significant decrease in the post-treatment group. This decline in WBC after therapy may be related to immune modulation induced by intravesical agents such as *Bacillus Calmette-Guérin* (BCG), which trigger strong local and systemic immune responses and can transiently alter circulating leukocyte populations [12]. Previous investigations have highlighted that changes in leukocyte counts and inflammation-based indices, including neutrophil-to-lymphocyte ratio and related markers, are associated with treatment response and outcomes in bladder cancer [5,7,9].

Platelet counts were highest in healthy controls and decreased progressively in pre- and post-treatment patients, with a significant reduction observed after therapy. Platelets are increasingly recognized as active players in tumor biology, contributing to cancer-associated inflammation, angiogenesis, and metastatic spread, and alterations in platelet count may mirror changes in tumor burden and systemic inflammatory status [13]. The observed post-treatment decrease in platelet count could therefore reflect both treatment-related effects on megakaryopoiesis and a modification of tumor-driven inflammatory pathways, in

line with previous studies that linked platelet dynamics to clinical outcomes in bladder cancer [5,13,15].

The comparison between intravesical chemotherapy and immunotherapy revealed no statistically significant differences in hemoglobin, RBC, WBC, or platelet counts, indicating that therapy type did not have a marked impact on routine hematological parameters in this cohort. This result is plausible because both regimens were delivered locally into the bladder, which generally limits systemic exposure and reduces the risk of profound bone marrow suppression compared with systemic platinum-based chemotherapy [3,4]. Previous reports on intravesical BCG and chemotherapy also suggest that, although these treatments can modulate systemic immunity, their effects on standard blood counts are usually modest and clinically manageable, especially when appropriate monitoring is performed [8,12,15].

In contrast to therapy type, treatment duration showed a significant influence on hemoglobin and platelet counts, with patients treated for 10–20 months having higher mean Hb but lower platelet levels than other groups. The relatively preserved hemoglobin in the intermediate-duration group may reflect better disease control and partial recovery of erythropoiesis, whereas the decline in Hb and fluctuating platelet counts in patients with the longest treatment duration ( $\geq 21$  months) could be related to cumulative physiological stress, ongoing inflammation, or subclinical bone marrow exhaustion [11,14]. Similar observations have been reported in longitudinal studies of bladder cancer, where prolonged exposure to anti-cancer therapies and chronic immune activation were associated with dynamic changes in hemogram parameters and with prognosis in patients receiving intravesical BCG [9,15].

## Conclusion

This research demonstrates that substantial changes in hematological parameters, including decreased hemoglobin, RBC, WBC, and platelet count in post-treatment patients compared with healthy controls, are linked to bladder cancer and its intravesical therapy. The influence of treatment length on hemoglobin and platelet counts, as well as the absence of substantial variations between intravesical chemotherapy and immunotherapy, indicates that these changes are mostly associated with cumulative treatment stress and disease burden rather

than a particular medication. Frequent monitoring of complete blood count indices may aid in the evaluation of a patient's general health, direct clinical judgment, and enable the early identification of issues associated with medication.

## Acknowledgement

The researchers commend the patients' families and all staff at the specialized hospitals for their assistance in the research through sample collection.

## Funding Information

The expenses for both research projects were at their own expense.

## Author's Contributions

The authors prepared and designed the study, wrote the research, collected and analyzed the data, and participated in the final review. All authors approved the final version.

## Ethics

This study was conducted with the approval of the Medical Research Ethics Committee at the University of Kufa (2026). Oral and written consent was obtained from the patients, and publication consent was obtained from both the participants and the researchers.

## References

1. Sung, H., Ferlay, J., Siegel, R. L., Laversanne, M., Soerjomataram, I., Jemal, A., & Bray, F. (2021). Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA: A Cancer Journal for Clinicians*, 71(3), 209–249. <https://doi.org/10.3320/caac.21660>
2. Richters, A., Aben, K. K., & Kiemeny, L. A. (2020). The global burden of urinary bladder cancer: An update.

- World Journal of Urology, 38(8), 1895–1904. <https://doi.org/10.1007/s00345-019-02984-4>
3. Lenis, A. T., Lec, P. M., Chamie, K., & Mshs, M. D. (2020). Bladder cancer: A review. *JAMA*, 324(19), 1980–1991. <https://doi.org/10.1001/jama.2020.17598>
4. Azam, F., Alharbi, H., Alshangiti, A., Gul, R. A., Bukhari, N., Ouda, M., Hussain, S. A., & Ibnshamsah, F. (2024). Eligibility criteria for different platinum-based chemotherapy regimens in metastatic urothelial carcinoma. *Cureus*, 16(8), Article e66504. <https://doi.org/10.7759/cureus.66504>
5. Wang, Q., Zhu, S. R., Huang, X. P., Liu, X. Q., Liu, J. B., & Tian, G. (2021). Prognostic value of systemic immune-inflammation index in patients with urinary system cancers: A meta-analysis. *European Review for Medical & Pharmacological Sciences*, 25(3), 1231–1241. [https://doi.org/10.26355/eurev\\_202102\\_24831](https://doi.org/10.26355/eurev_202102_24831)
6. Daman, A. W., Antonelli, A. C., Redelman-Sidi, G., Paddock, L., Khayat, S., Ketavarapu, M., Cheong, J. G., Jurado, L. F., Benjamin, A., Jiang, S., & Ahimovic, D. (2025). Microbial cancer immunotherapy reprograms hematopoiesis to enhance myeloid-driven anti-tumor immunity. *Cancer Cell*, 43(8), 1442–1459. <https://doi.org/10.1016/j.ccell.2025.07.0>
7. Hu, B., Yang, X. R., Xu, Y., Sun, Y. F., Sun, C., Guo, W., Zhang, X., Wang, W. M., Qiu, S. J., Zhou, J., & Fan, J. (2014). Systemic immune-inflammation index predicts prognosis of patients after curative resection for hepatocellular carcinoma. *Clinical Cancer Research*, 20(23), 6212–6222. <https://doi.org/10.1158/1078-0432.CCR-14-0396>
8. Griebsch, I., Shrestha, S., Lotan, Y., Ng, C. F., & Bottomley, A. (2025). The impact of intravesical instillations on quality of life in patients with non-muscle-invasive bladder cancer: A systematic review. *Oncology and Therapy*, 1–24. Advance online publication. <https://doi.org/10.1007/s40487-025-00326-w>
9. Celik, M., Polat, M. E., Karaaslan, M., Odabas, Ö., & Yilmaz, F. M. (2025). Prediction of recurrence using hematologic and urinary markers in intravesical Bacillus Calmette-Guérin treated bladder cancer. *Scientific Reports*, 15(1), Article 35415. <https://doi.org/10.1038/s41598-025-35415-w>
10. Warli, S. M., Andy, A., Prapiska, F. F., Siregar, G. P., & Sihombing, B. (2022). Poor prognosis of urothelial carcinoma in patients presented with persistent paraneoplastic leukocytosis with anemia. *Urology Annals*, 14(4), 328–

331.  
[https://doi.org/10.4103/ua.ua\\_169\\_21](https://doi.org/10.4103/ua.ua_169_21)
11. Vignjević Petrinović, S., Jauković, A., Milošević, M., Bugarski, D., & Budeč, M. (2022). Targeting stress erythropoiesis pathways in cancer. *Frontiers in Physiology*, 13, Article 844042.  
<https://doi.org/10.3389/fphys.2022.844042>
12. Rollin, P., Pluskwa, B., Artru, E., Le Vaslot, T., Kartasheva-Ebertz, D., Biron, D., Bossis, M., Onodi, F., LeMaoult, J., Rouas-Freiss, N., & Chevalier, M. F. (2026). BCG immunotherapy for bladder cancer triggers systemic and local BCG-specific CD4<sup>+</sup> Th1 responses. *iScience*, 29(2), Article 101234.  
<https://doi.org/10.1016/j.isci.2026.101234>
13. Morales-Pacheco, M., Valenzuela-Mayen, M., Gonzalez-Alatraste, A. M., Mendoza-Almanza, G., Cortés-Ramírez, S. A., Losada-García, A., Rodríguez-Martínez, G., González-Ramírez, I., Maldonado-Lagunas, V., Vazquez-Santillan, K., & González-Covarrubias, V. (2025). The role of platelets in cancer: From their influence on tumor progression to their potential use in liquid biopsy. *Biomarker Research*, 13(1), Article 27.  
<https://doi.org/10.1186/s40364-025-00027-z>
14. Bozzini, C., Busti, F., Marchi, G., Vianello, A., Cerchione, C., Martinelli, G., & Girelli, D. (2024). Anemia in patients receiving anticancer treatments: Focus on novel therapeutic approaches. *Frontiers in Oncology*, 14, Article 1380358.  
<https://doi.org/10.3389/fonc.2024.1380358>
15. Nebioğlu, A., Turhan, A., Başaranoğlu, M., Bozlu, M., & Akbay, E. (2025). Prognostic significance of hemogram parameters in non-muscle invasive bladder cancer: A comprehensive retrospective analysis. *Medicina*, 62(1), Article 51.  
<https://doi.org/10.3390/medicina62010051>