

The Role of Electrolyte Balance Disorders in the Formation of Aritmias in Patients Receiving Chemotherapy: Clinical-Diagnostic Assessment and Preventive Approaches

Ergashov B. B.

Bukhara State Medical Institute, Bukhara, Uzbekistan

Abstract During the study, the role of electrolyte imbalance in the development of arrhythmias in patients with oncological diseases receiving cardiotoxic chemotherapy was assessed. It has been established that hypokalemia and hypomagnesemia significantly increase the risk of supraventricular and ventricular rhythm disturbances, as well as prolongation of the QTc interval. Active electrolyte correction significantly reduced the frequency of arrhythmias, while combined prevention, including electrolyte correction and cardioprotective therapy, completely prevented the development of clinically significant arrhythmias. The obtained results confirm the necessity of mandatory monitoring and preventive management of electrolyte disorders to improve the safety of chemotherapy in cancer patients.

Keywords Heart arrhythmias, Chemotherapy, Cancer patients, Electrolyte balance, Hypokalemia, Hypomagnesemia, Cardiotoxicity, Prevention, Cardioprotection

1. Introduction

The development of cardiotoxic complications in patients with oncological diseases against the background of antitumor therapy remains one of the most significant problems of modern cardiology. In the structure of these complications, heart rhythm disturbances occupy a special place, the frequency of which significantly increases when using anthracyclines, platinum-containing compounds, tyrosine kinase inhibitors, and immuno-oncological drugs [1,2]. According to major studies, therapy-induced arrhythmias are associated with increased mortality, decreased chemotherapy tolerance, and longer hospital stays [3,4].

The main pathogenetic link in the formation of arrhythmias in this category of patients is the disruption of electrolyte balance, primarily the concentration of potassium, magnesium, and calcium. It is known that cisplatin and other platinum preparations cause pronounced hypomagnesemia and hypokalemia due to tubulopathy, and the frequency of hypomagnesemia can reach 70-90% with long courses of therapy [5,6]. Magnesium deficiency intensifies potassium loss, contributes to the prolongation of the QT interval, and significantly increases the risk of ventricular tachyarrhythmias,

including torsade de pointes [7,8].

The current recommendations of the European Society of Cardiologists emphasize the necessity of mandatory evaluation and timely correction of electrolytes in patients receiving cardiotoxic chemotherapy, especially when using drugs with the potential to prolong the QT interval [9]. It has been shown that maintaining potassium levels of >4.0 mmol/l and magnesium levels of >2.0 mg/dl significantly reduces the likelihood of developing serious arrhythmias and allows for safe continuation of antitumor treatment [10].

The purpose of the study is to comprehensively assess the role of electrolyte imbalance in the formation of arrhythmias in patients receiving chemotherapy, to determine clinical and diagnostic predictors, and to develop well-founded preventive approaches to reduce the risk of therapeutic-induced heart rhythm disturbances.

2. Materials and Methods of Research

The study included patients ≥ 18 years old with confirmed oncopathology receiving cardiotoxic chemotherapy. Patients were divided into three groups: 1st group - standard management without preventive electrolyte correction; 2nd group - active monitoring and correction of K^+ and Mg^{2+} levels before each cycle; 3rd group - combined prevention, including electrolyte correction and cardioprotective therapy

* Corresponding author:

bobir_ergashov@bsmi.uz (Ergashov B. B.)

Received: Nov. 19, 2025; Accepted: Dec. 22, 2025; Published: Dec. 25, 2025

Published online at <http://journal.sapub.org/ajmms>

(β -blockers, ACEI/ARB). All patients underwent clinical examination, ECG with QT/QTc monitoring, and, if necessary, Holter monitoring, echocardiography, and laboratory analysis of electrolyte levels. The main outcomes were the frequency of arrhythmias and the dynamics of electrolyte balance; statistical data processing was carried out using standard methods, with a significance level of $p < 0.05$.

3. Research Results

The study included 118 patients, distributed as follows: Group 1 (standard management) - 43 patients; Group 2 (active electrolyte correction) - 38 patients; Group 3 (combined prevention) - 37 patients.

The groups were comparable by age, sex, tumor localization, and chemotherapy types. The highest number of deviations was noted in the standard management group (Table 1).

Analysis of the frequency of electrolyte disturbances showed pronounced differences between the groups. In group 1 (standard management), hypokalemia was detected in 44.1% of patients, and hypomagnyemia in 53.4%, which indicates a high frequency of spontaneous electrolyte imbalance disorders without prevention. In 16.2% of patients in group 1, severe electrolyte disorders were diagnosed, requiring urgent correction.

In the 2nd group (active electrolyte correction), the frequency of hypokalemia decreased by more than 2 times (21.0%), and hypomagnesemia - by almost 2 times (28.9%) compared to the standard treatment. The proportion of severe disorders was also significantly lower (5.2%), which confirms the effectiveness of regular monitoring and targeted correction of K^+ and Mg^{2+} levels.

The most favorable indicators were noted in group 3 (combined prevention): hypokalemia was registered only in 10.8% of patients, hypomagnesia - in 13.5% of patients, and

no cases of severe electrolyte disorders were detected. The obtained differences are statistically significant ($p < 0.05$) and demonstrate the combined effect of electrolyte correction and cardioprotective therapy.

The results of the arrhythmia frequency are presented in Table 2.

Analysis of the frequency of arrhythmias revealed significant differences between the groups. In group 1 (standard management), supraventricular extrasystole was registered in 39.5% of patients, and ventricular extrasystole \geq Lown II - in 25.5%, which is the highest indicator among all groups. Elongation of the QTc interval was observed in 18.6% of patients, and clinically significant arrhythmias requiring changes in therapy or inpatient observation were recorded in 11.6% of patients.

In the 2nd group (active electrolyte correction), a significant decrease in the frequency of arrhythmias was noted: supraventricular extrasystole decreased to 23.7%, and ventricular extrasystole - to 13.1%. Elongation of QTc occurred in only 7.8% of patients. The proportion of clinically significant arrhythmias decreased to 5.2%. These data confirm that targeted correction of K^+ and Mg^{2+} reduces the severity of myocardial electrophysiological disorders.

The most favorable dynamics were noted in group 3 (combined prevention), where supraventricular rhythm disorders were detected in only 13.5% of patients, and ventricular rhythm disorders - in 5.4%. QTc prolongation was extremely rare (2.7%) and not a single case of clinically significant arrhythmias was recorded. This demonstrates the synergistic effect of electrolyte correction combined with cardioprotective drugs.

Statistical analysis confirmed the significance of differences between groups in the main types of arrhythmias, especially in ventricular extrasystole and prolongation of QTc ($p < 0.01$), which emphasizes the key role of preventive measures in reducing the risk of therapy-induced heart rhythm disorders.

Table 1. Electrolyte disorder frequency

Indicator	Group 1 (n=43)	Group 2 (n=38)	Group 3 (n=37)	p
Hypokalemia (<3.5 mmol/l)	44.1%	21.0%	10.8%	<0.01
Hypomagnyemia (<1.8 mg/dL)	53.4%	28.9%	13.5%	<0.01
Severe electrolyte disorders	16.2%	5.2%	0%	0.03

Table 2. Arrhythmia frequency results

Type of arrhythmia	Group 1 (n=43)	Group 2 (n=38)	Group 3 (n=37)	p
Supraventricular extrasystole	39.5%	23.7%	13.5%	0.02
Ventricular extrasystole (\geq Lown II)	25.5%	13.1%	5.4%	<0.01
Paroxysmal tachycardia	9.3%	5.2%	2.7%	0.24
QTc elongation (>470 ms)	18.6%	7.8%	2.7%	<0.01
Clinically significant arrhythmias	11.6%	5.2%	0%	0.03

4. Conclusions

The conducted study showed that electrolyte imbalance is a significant and modifiable risk factor for developing arrhythmias in patients receiving cardiotoxic chemotherapy. The highest frequency of hypokalemia, hypomagnesemia, and associated arrhythmias was detected in the standard management group. Active electrolyte correction significantly reduced the frequency of both electrolyte disorders and arrhythmias, including prolongation of QTc. The greatest prophylactic effect was noted in a combined approach, including electrolyte correction and cardioprotective therapy: in this group, clinically significant arrhythmias and severe electrolyte disorders were practically absent. Thus, the implementation of comprehensive prevention significantly reduces the risk of therapy-induced rhythm disturbances and increases the safety of chemotherapy in cancer patients.

REFERENCES

- [1] Buza V., Rajagopalan B., Curtis A.B. Cancer Treatment-Induced Arrhythmias: Focus on Chemotherapy and Targeted Therapies // *Circulation: Arrhythmia and Electrophysiology*. - 2017. - Vol. 10, No. 8. - e005443.
- [2] Herrmann J. Adverse cardiac effects of cancer therapy: cardiotoxicity and arrhythmia // *Nature Reviews Cardiology*. - 2020. - Vol. 17, No. 8. - P. 474-502.
- [3] Li H., et al. Incidence and predictors of arrhythmias in patients receiving cardiotoxic chemotherapy // *JACC: Cardio Oncology*. - 2024. - Vol. 6, No. 1. - P. 55-67.
- [4] Wright J.C., et al. Cardiac arrhythmias during immune checkpoint inhibitor therapy: clinical significance and outcomes // *European Heart Journal*. - 2025. - Vol. 46, No. 2. - P. 214-223.
- [5] Rosner M.H., et al. Cisplatin nephrotoxicity and electrolyte disorders // *Clinical Kidney Journal*. - 2014. - Vol. 7, No. 4. - P. 369-373.
- [6] Alrfaei B.M., et al. Electrolyte abnormalities associated with platinum-based chemotherapy // *Journal of Oncology Pharmacy Practice*. - 2023. - Vol. 29, No. 4. - P. 845-853.
- [7] Oronsky B., et al. Electrolyte disorders during chemotherapy: mechanisms and clinical implications // *Oncotarget*. - 2017. - Vol. 8, No. 30. - P. 51146-51159.
- [8] Goyal P., et al. QT prolongation and torsades de points in cancer patients receiving systemic therapy // *Journal of Clinical Oncology*. - 2022. - Vol. 40, No. 12. - P. 1345-1354.
- [9] Lyon A.R., et al. 2022 ESC Guidelines on Cardio-Oncology // *European Heart Journal*. - 2022. - Vol. 43, No. 41. - P. 4229-4361.
- [10] Giraud E.L., et al. Prevention of chemotherapy-induced arrhythmias: electrolyte management strategies // *Cardio-Oncology*. - 2022. - Vol. 8. Article 13.