OPEN ACCESS
World Journal of Applied Medical Sciences
ISSN (Online): 3049-0200 | Vol. 2, No. 11, 2025
Website: https://wasrpublication.com/index.php/wjams

Current Developments in Cyclophosphamide for Lymphoma: Immunomodulation, Metronomic Approaches, and Toxicity Control

A. Mohamed Sikkander[1*], C. Hazarathaiah Yadav[2], Narendra Revanuri[2]

[*1]Department of Chemistry, Velammal Engineering College, Chennai-600066 INDIA

[2]Department of Chemistry, Vel Tech Rangarajan Dr. Sakunthala R & D Institute of science & Technology, Avadi, Chennai, India.

Received: 14/08/2025 | Accepted: 01/10/2025 | Published: 21/11/2025

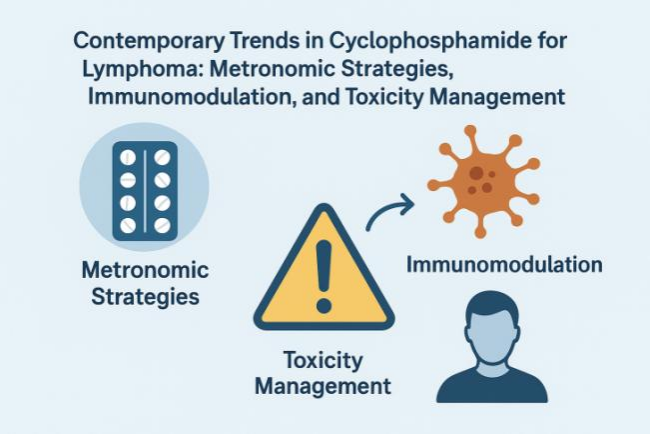
Abstract: Cyclophosphamide is a medication that is mostly used to treat tumours, including multiple myeloma, cancer, and bone cancer. Nitrogen mustard, or cyclophosphamide, has anti-neoplastic properties through end-to-end alkylation. An interdisciplinary collaboration examines the recommendations, contraindications, mode of action, and other important aspects of cyclophosphamide as a valuable agent in the therapy and management of neoplastic diseases. The use of cyclophosphamide in the treatment of severe multiple sclerosis is also discussed. Determine the cyclophosphamide's mode of action and administration. Describe cyclophosphamide's side effects and contraindications. Examine the relevant cyclophosphamide toxin and monitoring. In order to improve cyclophosphamide and alleviate problems, summarise interprofessional platoon techniques for improving care collaboration and communication. One kind of nitrogen mustard medication that works by alkylating DNA is cyclophosphamide. The medication metabolises into an active form that can prevent protein conflation through DNA and RNA crosslinking, and it is not cell-cycle phase-specific. The phosphoramide mustard produced by the drug's metabolism by liver enzymes such cytochrome P-450 is responsible for the maturity of cyclophosphamide's antineoplastic products. Cyclophosphamide is initially converted by hepatic enzymes to hydroxycyclophosphamide, which is subsequently metabolised to aldophosphamide. Phosphoramide mustard and acrolein, the primary alkylating agent, bind to aldophosphamide. At the guanine N-7 site, the phosphoramide metabolite creates cross-links both within and between conterminous DNA strands.The result of these infinite variations is programmed cell death. Although acrolein has no anticancer activity, it is the primary cause of hemorrhagic cystitis. Cyclophosphamide possesses immunosuppressive properties and T cell selectivity in addition to its antimitotic and antineoplastic properties.

Keywords: haematopoietic cells, polatuzumab, bendamustine, rituximab, lenalidomide, antimitotic, antineoplastic products.

Cite this article:

Sikkander, A. M., Yadav, C. H., Revanuri, N., (2025). Current Developments in Cyclophosphamide for Lymphoma: Immunomodulation, Metronomic Approaches, and Toxicity Control. *World Journal of Applied Medical Sciences*, *2*(11), 4-6.

Graphical Abstract:



Highlights:

#With its continuous anti-tumor pressure and significantly lower toxicity, metronomic cyclophosphamide is revolutionising low-intensity therapy.

#Low-dose cyclophosphamide's immunomodulatory effects are driving its integration into contemporary immuno-oncology techniques

#Metronomic cyclophosphamide combination regimens are emerging as a low-cost but clinically significant option for situations with difficult-to-treat lymphoma. The safety profile of cyclophosphamide is being updated by developments in toxicity mitigation, especially for myelosuppression, urotoxicity, and fertility preservation.

#The future trajectory of cyclophosphamide research centers on biomarker-guided personalization and integration within immunotherapy-dominant treatment landscapes

***Corresponding Author**
A. Mohamed Sikkander*
Email: ams240868@gmail.com.

Introduction:

While smaller tablets have demonstrated potential for usage in selective immunomodulation of nonsupervisory T cells, high cure cyclophosphamide is used in the abolition therapy of spiteful haematopoietic cells. The medication increases the stashing of Th2 cytokines like IL-4 and IL-10 in the CSF and additional blood while decreasing the stashing of interferon-gamma and IL-12. Because of these factors, a significant therapeutic problem is the background and management of elderly or frail patients with verbose large B-cell cancer (DLBCL)(1). I evaluate first-line treatment alternatives, such as druthers to R-CHOP, the operation of regressed or refractory DLBCL, frailty assessments, and the possibility of new treatments for older DLBCL cases. According to available data, problems similar to those of youngish cases are experienced by elderly patients who are able to tolerate typical frontline curatives for DLBCL with guidelines similar to R-CHOP (2). This emphasises how important it is to distinguish campaigners for standard therapy and those who are better treated with reduced, adapted, or completely altered treatment regimes using individual frailty evaluation. There is no conventional treatment for regressed or refractory complaints, although excellent antigen receptor T (Auto-T) cell therapy, polatuzumab with bendamustine and rituximab, and lenalidomide alone or in combination are all viable choices(3).

Treatment problems and toxin levels in this group may be improved by novel curatives under discussion, whether they are utilised in conjunction with conventional curatives, as a lead-heft or conservation remedy, or as stage-alone remedies (4). Cyclophosphamide is regarded as a valuable supplement to immunisation protocols against excrescence, post-transplant all reactivity operations, and the treatment of some types of vasculitis and vulnerable-mediated diseases (5). Although it's unclear exactly how cyclophosphamide produces its immunomodulatory effects, a number of studies have proposed numerous plausible mechanisms of action (6). These include preconditioning host cells for patron T cells, which reduces all reactivity, inducing T cell growth factors such type I interferons, and eliminating nonsupervisory T cells in naïve or bad host cells(7).Hodgkin's melanoma is treated with cyclophosphamide either by alone or in conjunction with other medications. Adnoun-Hodgkin's melanoma (cancers that start in a type of white blood cell that typically fights infection); multiple myeloma (a type of cancer of the bone gist); coetaneous T-cell melanoma (CTCL, a group of cancers of the vulnerable system that first appear as skin rashes); and some types of leukaemia (cancers of the white blood cells), such as habitual lymphocytic leukaemia (CLL), habitual myelogenous leukaemia (CML, ANLL), and acute lymphoblastic leukaemia (ALL) (9).Additionally, it is used to treat ovarian cancer (cancer that starts in the female reproductive organs where eggs are created), bone cancer, retinoblastoma (cancer of the eye), and neuroblastoma (a cancer that starts in vagrancy-whams cells and primarily occurs in children). Cyclophosphamide is also used to treat youngsters with nephrotic pattern, a condition brought on by damage to the feathers, whose condition has not improved, has become worse, or has returned after taking other particular, or who have experienced unbearable side effects with other specifications (10). Cyclophosphamide belongs to a group of substances known as alkylating agents. Cyclophosphamide is used to treat cancer by preventing or slowing the growth of cancer cells within your body. Cyclophosphamide suppresses your body's susceptible system in order to treat nephrotic pattern. Ask your croaker or pharmacist to clarify any parts you do not understand, and carefully follow the instructions on your traditional marker (11). Cyclophosphamide should be taken precisely as prescribed. Don't take more or less of it, or take it more frequently than your doctor recommends. Do not resolve, suck, or crush the tablets; instead, swallow them whole(12).

Depending on how you respond to treatment and any adverse effects you report, your doctor may need to postpone or modify your cyclophosphamide regimen (13). During your treatment, discuss your feelings with your croaker. Don't stop taking cyclophosphamide without consulting your doctor. Ask your croaker or pharmacist to clarify any parts you do not understand, and carefully follow the instructions on your traditional marker (14). Cyclophosphamide should be taken precisely as prescribed. Don't take more or less of it, or take it more frequently than your doctor recommends (15).Do not resolve, suck, or crush the tablets; instead, swallow them whole. Depending on how you respond to treatment and any adverse effects you report, your doctor may need to postpone or modify your cyclophosphamide regimen. During your treatment, discuss your feelings with your croaker (16–24).

Conclusion:

It has been demonstrated that the capacity of interprofessional health care providers to function as a cohesive team improves patient care quality and increases favourable prognostic concerns in the development of professional health care delivery. Integrated case-centered care, communication, sharing of values, and a clear explanation of interprofessional obligations are all necessary to establish this paradigm. Effective collaboration among a battalion of medical specialists is crucial in today's ultramodern healthcare environment. Primary care physicians, oncologists, speciality care nurses, and oncologic druggists should all be part of this approach. Implicit negative occurrences and crimes are reduced when there is effective communication. Tuckman's phases of group formation have been validated by vibrant research on platoon development and effective leadership. A platoon passes through four stages in this model: forming, storming, norming, and performing.To establish an efficient platoon, it is both necessary and inevitable to go through each of these stages. After this procedure, the platoon members are better equipped to evaluate their own and other members' positions within the unit. Higher case care is made possible by each member's reciprocal technical expertise and experience. This cooperation is essential for the appropriate use of cyclophosphamide. The healthcare platoon is more suited to evaluate the appropriate operation of cyclophosphamide usage by adhering to the Team-Grounded capabilities outlined by the Interprofessional Education Collaborative, which include honesty, discipline, and collective pretensions. From an organisational standpoint, improved collaboration can result in fewer hospital stays and associated expenses, fewer unexpected admissions, and easier access to services. Effective collaboration improves prognosis, lowers medical error, and increases patient satisfaction with care. When it comes to implicit medication relationships, appropriate dosage, and continuing case monitoring, a board-certified cancer druggist should be consulted. Oncology speciality nurses should be involved in covering treatment progress and adverse medication reactions. They can also contact the oncologist or the oncology druggist as needed. These interprofessional examples will improve cyclophosphamide-related problems.

References

1. Viallard JF, Pellegrin JL, Ranchin V, Schaeverbeke T, Dehais J, Longy-Boursier M, Ragnaud JM, Leng B, Moreau JF. Th1 (IL-2, interferon-gamma (IFN-gamma)) and Th2 (IL-10, IL-4) cytokine production by peripheral blood mononuclear cells (PBMC) from patients with systemic lupus erythematosus (SLE). Clin Exp Immunol. 1999 Jan;115(1):189-95. doi: 10.1046/j.1365-2249.1999.00766.x.
2. Lugtenburg PJ, Mutsaers PGNJ. How I treat Elderly Patients with DLBCL in the frontline setting. Blood. 2022 Nov 22:blood.2020008239. doi: 10.1182/blood.2020008239.
3. Abbasi M, Rolfson D, Khera AS, Dabravolskaj J, Dent E, Xia L. Identification and management of frailty in the primary care setting. CMAJ. 2018 Sep 24;190(38):E1134-E1140. doi: 10.1503/cmaj.171509.
4. Bajracharya R, Song JG, Patil BR, Lee SH, Noh HM, Kim DH, Kim GL, Seo SH, Park JW, Jeong SH, Lee CH, Han HK. Functional ligands for improving anticancer drug therapy: current status and applications to drug delivery systems. Drug Deliv. 2022 Dec;29(1):1959-1970. doi: 10.1080/10717544.2022.2089296.
5. Nagler A, Labopin M, Arat M, Reményi P, Koc Y, Blaise D, Angelucci E, Vydra J, Kulagin A, Socié G, Rovira M, Sica S, Aljurf M, Gülbas Z, Kröger N, Brissot E, Peric Z, Giebel S, Ciceri F, Mohty M. Posttransplant cyclophosphamide-based anti-graft-vs-host disease prophylaxis in patients with acute lymphoblastic leukemia treated in complete remission with allogeneic hematopoietic cell transplantation from human leukocyte antigen-mismatched unrelated donors versus haploidentical donors: A study on behalf of the ALWP of the EBMT. Cancer. 2022 Nov 15;128(22):3959-3968. doi: 10.1002/cncr.34452.
6. Nuzzo, G.; Senese, G.; Gallo, C.; Albiani, F.; Romano, L.; d'Ippolito, G.; Manzo, E.; Fontana, A. Antitumor Potential of Immunomodulatory Natural Products. *Mar. Drugs* **2022**, *20*, 386. https://doi.org/10.3390/md20060386
7. Yunis J, Short KR, Yu D. Severe respiratory viral infections: T-cell functions diverging from immunity to inflammation. Trends Microbiol. 2023 Jan 10:S0966-842X (22)00342-0. doi: 10.1016/j.tim.2022.12.008. Epub ahead of print. PMID: 36635162; PMCID: PMC9829516.
8. IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. Pharmaceuticals. Lyon (FR): International Agency for Research on Cancer; 2012. (IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, No. 100A.) CYCLOPHOSPHAMIDE. https://www.ncbi.nlm.nih.gov/books/NBK304336/
9. Miriyala LKV, Avasthi D. Cutaneous Multiple Myeloma. Cureus. 2021 Sep 6;13(9):e17779. doi: 10.7759/cureus.17779.
10. Cucer F, Miron I, Müller R, Iliescu Halitchi C, Mihaila D. Treatment with Cyclophosphamide for steroid-resistant nephrotic syndrome in children. Maedica (Bucur). 2010 Jul;5(3):167-70.
11. Tapia C, Bashir K. Nephrotic Syndrome. [Updated 2022 Jun 5]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing;2023Jan. https://www.ncbi.nlm.nih.gov/books/NBK470444/
12. https://www.childrensmn.org/educationmaterials/childrensmn/article/15662/cyclophosphamide-cytoxan/
13. https://www.webmd.com/drugs/2/drug-6093/cyclophosphamide-oral/details
14. https://www.mayoclinic.org/drugs-supplements/cyclophosphamide-oral-route-intravenous-route/precautions/drg-20063307?p=1
15. https://www.mayoclinic.org/drugs-supplements/cyclophosphamide-oral-route-intravenous-route/proper-use/drg-20063307
16. https://www.oncolink.org/cancer-treatment/oncolink-rx/cyclophosphamide-oral-formulation-cytoxan-r-neosar-r-endoxan-r
17. Sikkander, A. M. (2022). Duct cancer evaluation in situ–review. In Acta Biology Forum (pp. 01-04).
18. Sikkander, M., Vedhi, C., & Manisankar, P. (2012). Cyclic voltammetric determination of 1, 4-Dihydro pyridine drugs using MWCNTs modified glassy carbon electrode. Der Chem. Sin, 3, 413-420.
19. A. Mohamed Sikkander (2022). Intrathecal Chemotherapy for Blood Cancer Treatment. Acta Biology Forum.V01i01, 14-17. DOI: https://doi.org/10.5281/zenodo.7008901
20. Sikkander, M., & Nasri, N. S. (2013). Review on Inorganic Nano crystals unique benchmark of Nanotechnology. Moroccan Journal of Chemistry, 1(2), J-Chem.
21. Yadav, C. H., Revanuri, N., & Sikkander, A. R. M. (2025). Tungsten-based compounds: A new frontier in cancer diagnosis and therapy. Journal of Applied Organometallic Chemistry, 5, 149-167.
22. Sikkander, A. R. M. (2025). RUTHENIUM ORGANOMETALLIC COMPOUNDS IN CANCER TREATMENT. Biomedical Engineering: Applications, Basis and Communications, 37(01), 2430003.
23. Yadav,H,C., Revanuri,N., Sikkander,A.R.M, 2025. Organometallic Compounds phototoxicityagaint cancer cells. Biomedical Engineering Applications Basis and Communications, 2550020. http://dx.doi.org/10.4015/S1016237225500206
24. Sikkander, A. R. M., Meena, M., Yadav, H., Wahi, N., & Lakshmi, V. V. (2024). Appraisal of the impact of applying organometallic compounds in cancer therapy. Journal of Applied Organometallic Chemistry, 4, 145-166.

"Conflict of Interest"

"Dr A.Mohamed Sikkander has no conflict of interest to report".

"Acknowledgment"

"The author has no acknowledgment".