GEORGIAN MEDICAL NEWS

ISSN 1512-0112

NO 6 (363) Июнь 2025

ТБИЛИСИ - NEW YORK

ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

Monthly Georgia-US joint scientific journal published both in electronic and paper formats of the Agency of Medical Information of the Georgian Association of Business Press. Published since 1994. Distributed in NIS, EU and USA.

GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman** (**Кириллица**), для текста на грузинском языке следует использовать **AcadNusx.** Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - http://www.spinesurgery.ru/files/publish.pdf и http://www.nlm.nih.gov/bsd/uniform_requirements.html
В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректура авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or compu-ter-printed on a single side of standard typing paper, with the left margin of **3** centimeters width, and **1.5** spacing between the lines, typeface - **Times New Roman** (**Cyrillic**), print size - **12** (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf
In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

Articles that Fail to Meet the Aforementioned Requirements are not Assigned to be Reviewed.

ავტორთა საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

GEORGIAN MEDICAL NEWS
No 6 (363) 2025

Содержание:

GEORGIAN MEDICAL NEWS
No 6 (363) 2025

TOXIC EFFECTS OF CHEMOTHERAPY ON THE VISUAL ORGAN IN MALIGNANT NEOPLASMS: A SYSTEMATIC REVIEW

Yesset Muratov[1], Yerbolat Iztleuov[2], Neilya Aldasheva[3], Vladimir Brzheskiy[4], Nauryzbay Imanbayev[5], Ruslan Irmekbayev[6], Maiya Taushanova[7].

[1]PhD student, Ophthalmologist Assistant Department, Department of Otorhinolaryngology and Ophthalmology, West Kazakhstan Marat Ospanov Medical University, Aktobe, Republic of Kazakhstan.

[2]PhD student, Ophthalmologist, PhD candidate in Public Health, Department of Otorhinolaryngology and Ophthalmology, West Kazakhstan Marat Ospanov Medical University, Aktobe, Republic of Kazakhstan.

[3]Doctor of Medical Sciences, General Director, Ophthalmic Surgeon, Physician of the Highest Qualification Category, Department of Ophthalmology, Kazakh Research Institute of Eye Diseases, Almaty, Kazakhstan.

[4]Doctor of Medical Sciences, Professor, Head of the Ophthalmology Department, Saint-Petersburg State Pediatric Medical University, St. Petersburg, Russian Federation.

[5]PhD, Surgical Oncologist, Joint Stock Company "Kazakh Research Institute of Oncology and Radiology", Almaty, Republic of Kazakhstan.

[6]PhD student, Ophthalmologist, PhD candidate in Public Health, Department of Otorhinolaryngology and Ophthalmology, West Kazakhstan Marat Ospanov Medical University, Aktobe, Republic of Kazakhstan.

[7]MD, PhD, Senior Lecturer, Department of Public Health and Healthcare, Non-profit Joint-Stock Company "West Kazakhstan Marat Ospanov Medical University", Aktobe, Republic of Kazakhstan.

Abstract.

Background: Cancer therapies such as chemotherapy enhance the survival rates but come with side effects such as ocular toxicity which reduces the QoL.

Objectives: To analyze the impact of chemotherapeutic agents on the visual system and the effects of visual loss on QoL.

Methods: An initial search in PubMed, Cochrane Library, Web of Science, and Scopus was done based on keywords and the search resulted in 909 articles. Criteria include chemotherapy-induced ocular toxicity and QoL; the type of articles included in the study included randomized controlled trials, cohorts, and case reports published within the past decade. The synthesis of findings was done through the extraction of data and quality assessment.

Results: The review pointed out different drugs that are known to cause ocular toxicity such as keratitis, conjunctivitis, retinopathy, optic neuropathy, and cataracts. Ocular complaints including visual changes, blurring of vision, and eye ache were frequently mentioned. These side effects, which developed several days to weeks after the treatment, affected the patient's functioning and quality of life. The ophthalmologic effects of sorafenib are best managed through early identification and a multiple-disciplinary approach with oncologists and ophthalmologists.

Conclusion: Chemotherapy-related ocular toxicity, often unnoticed, poses catastrophic threats to health-related quality of life. It is crucial to maintain early detection and follow-up to prevent severe effects and provide complete care for cancer patients. Future studies should focus on uncovering processes by which ocular toxicity occurs and identifying effective prevention methods.

Key words. Ocular toxicity, visual impairment, quality of life, cancer treatment, carboplatin, chemotherapeutic agents.

Introduction.

Chemotherapy which is a mainstay in the management of malignant neoplasms uses highly effective drugs to destroy cancer cells, inhibit their growth, and reduce the ability to spread to other parts of the body [1]. This systemic treatment is fundamental and useful for the different kinds of cancer, helping so many patients and increasing survival times and in many cases cure. Nevertheless, due to the toxicity associated with chemotherapeutic agents, several side effects are normally manifested affecting most body organs and systems, thus reducing the QoL of patients [1,2]. However, there is one crucial but frequently overlooked issue, which is the harm of chemotherapy to vision organs [3]. One of the most essential components of the human body that can be adversely impacted by these powerful compounds is the visual system, which plays a crucial role in people's daily lives and health. Conjunctival and corneal toxicity, especially keratitis, and retinopathy are ocular toxicities that are commonly reported [4]. These conditions not only affect vision but also quality of life, making cancer treatment and patient care even more challenging [5]. Quality of life (QoL) has a physical, psychological, and social aspect that defines the patient's welfare [6]. Evaluating QoL is important in cancer treatment since it indicates the patient's status in dealing with the disease and the therapeutic procedures [7,8]. Chemotherapy side effects where vision is impaired can reduce the patient's ability to carry out everyday tasks, and the extent of their independence, and can hurt their emotional well-being; thus, there should be a thorough assessment of this side effect [9]. This review focused on the following objectives: to review the adverse impacts of chemotherapy on the visual system, to exhibit the mechanisms through which ocular toxicity occurs, and to demonstrate the effect of vision loss on a patient's QoL. Thus, this review aims to provide an updated overview based on recent scientific and clinical investigations into the necessity of assessing and treating ocular disorders in cancer patients treated with chemotherapy.

Research Aim.

To examine and increase the knowledge of chemotherapy-induced ocular manifestations to better diagnose, treat, and help improve the lives of the patients.

Research Questions.

1. What are the mechanisms through which several of the chemotherapy agents are partly responsible for the several ocular adverse effects?

2. What is the current diagnosis and/or monitoring procedures for chemotherapy-induced ocular complications?

3. What is the efficiency of currently available interventions for ocular side effects prevention?

Research Focus.

The research problem is based on the investigation of the frequency, severity, and treatment approaches to the ocular manifestations resulting from chemotherapy for differing types of malignancy and treatment protocols. Unfortunately, it is hoping to make suggestions about enhancing clinical practice with respect to oncology and ophthalmological patient care.

Common Chemotherapeutic Agents.

Chemotherapy is a class of medication that is very vast and contains many subgroups of specific drugs that are aimed to tackle a particular type of cancer due to features of their actions. Some of the most commonly used chemotherapeutic agents include [10] Cisplatin, Carboplatin, and Oxaliplatin (and other platinum-containing compounds). These drugs interact with DNA and form cross-links with it; this causes DNA to be damaged and leads to the death of the cancerous cells [11]. Antimetabolites (e.g., Methotrexate, 5-Fluorouracil, and Cytarabine). These agents interfere with DNA and RNA synthesis by mimicking the normal substrates of nucleic acid synthesis, thereby inhibiting cell replication [12]. Anthraquinones (for example, Doxorubicin, Daunorubicin, and Epirubicin). These drugs become incorporated in the DNA, inhibit enzyme activity, and produce free radicals that lead to DNA strand scission. Alkylating Agents (e.g., Cyclophosphamide, Melphalan, Chlorambucil). It attaches alkyl groups to DNA and causes DNA strand breaks and cell lethality. Taxanes (for example, Paclitaxel and Docetaxel). These agents maintain microtubules and therefore halt cell division and result in apoptosis. Topoisomerase Inhibitors include: Irinotecan and Etoposide. It arrests the topoisomerase enzymes, which results in DNA strand breaks and the impossibility of DNA repair and replication processes (Figure 1).

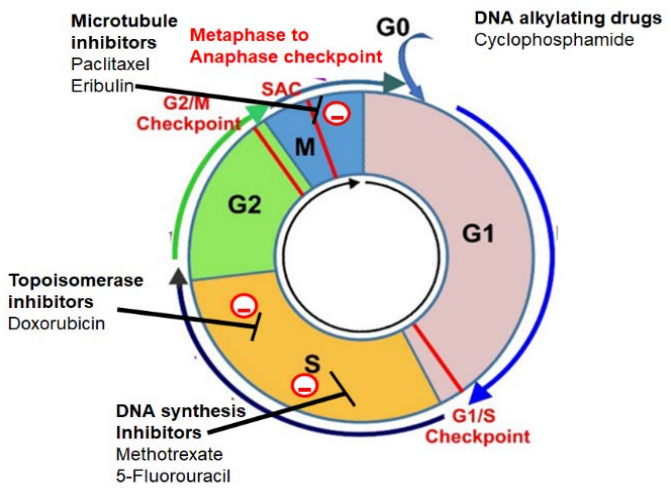

Figure 1. *Simplified diagram about the different effects of chemotherapeutic agents on the cell cycle.*
Source: *Compiled by the authors on the basis of analysis [11-13].*

Chemotherapy working on mechanisms and general side effects.

The chemotherapeutic agents in cancer treatment are cytotoxic and their modes of action are to preferentially affect the mitosis phases of cancerous cells by interposing with the necessary processes for DNA replication, RNA synthesis, and protein synthesis. They include DNA damage/repair inhibition, inhibition of mitosis, antimetabolite effects, and direct damage by the formation of free radicals, mostly by anthracycline, which causes oxidative stress. However, while fighting cancerous cells, chemotherapy is also toxic to the healthy cells especially those that reproduce quickly such as bone marrow cells, gastrointestinal tract cells and hair roots. That can lead to myelosuppression, gastrointestinal upsets, hair loss, fatigue, neurotoxicity, cardiotoxicity and ocular toxicity.

Chemotherapy and the Visual System: Biology and susceptibility.

The eye and its accessory structures, optic pathways, and visual cortex are part of the nervous system affected by cytotoxicity caused by chemotherapy. It comprises components like cornea, lens, retina, macula, optic nerve, and the vitreous body or humor. Other structures which are attachments include eyelids, eyelashes, and the lacrimal glands which are also essential. Optic charms, optic tracts as well as the visual cortex all in play a role in the transmission of visual info. These structures can be affected through direct toxicity on the tissues through inflammatory processes, microvascular damage, and neurotoxicity which result in ocular toxicity.

Pathophysiology of Chemotherapy-Induced Ocular Toxicity.

Several mechanisms have been identified as contributing to the pathophysiology of ocular toxicity resulting from chemotherapy. These include oxidative stress, apoptosis, disruption of cellular functions, immune-mediated damage, and vascular compromise. When activated, these mechanisms may lead to conditions such as keratitis, conjunctivitis, retinopathy, optic neuropathy, and cataract formation. These disorders can impair vision and cause ocular pain, discomfort, and a range of other symptoms, including photophobia, excessive or reduced lacrimation, conjunctival and scleral injection, and edema. Effective intervention requires early recognition and management of these side effects to prevent vision loss and preserve the patient's overall well-being.

Prophylactic and Treatment Measures for Chemotherapy-Induced Ocular Side Effects.

A comprehensive ophthalmic assessment, including documentation of baseline visual acuity, should be conducted prior to initiating chemotherapy. Post-treatment care must involve educating patients about potential ocular side effects and encouraging them to report any changes in vision promptly. Mild protective strategies may include the use of glasses or goggles to reduce light exposure, while more robust interventions involve pharmacologic approaches, such as topical eye drops to mitigate chemotherapy-induced ocular toxicity. Recommended interventions include topical treatments, systemic medications, surgical procedures, and supportive therapies. The management

of chemotherapy-induced ocular toxicity necessitates collaborative efforts between oncologists and ophthalmologists, with an integrated care model and a patient-centered approach being essential to optimize outcomes.

Quality of life (QoL) and Visual Impairment.

QoL on the other hand refers to physical, psychological and social well-being and is vital in the management of cancer patients. Chemotherapy-induced ocular toxicity negatively affects a patient's physical functioning, role limitations, social functioning, emotional well-being, and therefore, results in reduced QoL. Therefore, the patient's self-reported data, by using questionnaires including NEI VFQ-25, help to estimate the impact of visual impairment on QoL. The regular assessment of QoL, via long-term trials and standard questionnaires like EORTC QLQ-C30 and EORTC QLQ-OH25, enables the enhancement of interventions for improving patient well-being during cancer therapy.

Comprehensive Evaluations.

The integration of quality of life (QoL) measures with clinical examinations enables the collection of comprehensive data on a patient's overall health status. By implementing these management strategies and addressing QoL considerations, healthcare providers will be better equipped to manage patients undergoing chemotherapy who experience ocular toxicity, while also mitigating the associated side effects [14]. See Figure 2.

Methods.

General Background: This narrative review would seek to systematically analyse the extent and nature of chemotherapy-induced toxicity on the organ of vision in patients with malignant neoplasms and evaluate the dynamic influence of visual deterioration on QoL. The review of literature and clinical

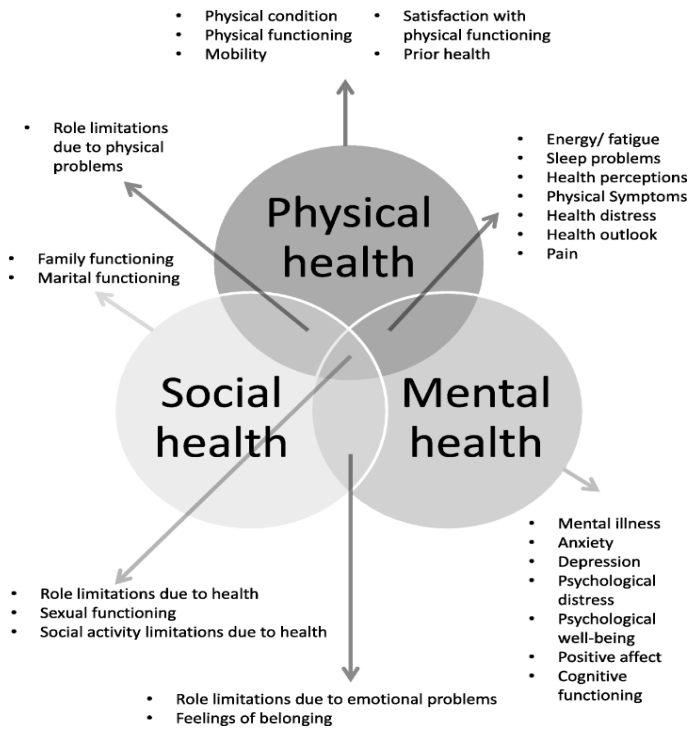

Figure 2. *Shows quality of life dimensions of cancer and chemotherapy [14].*

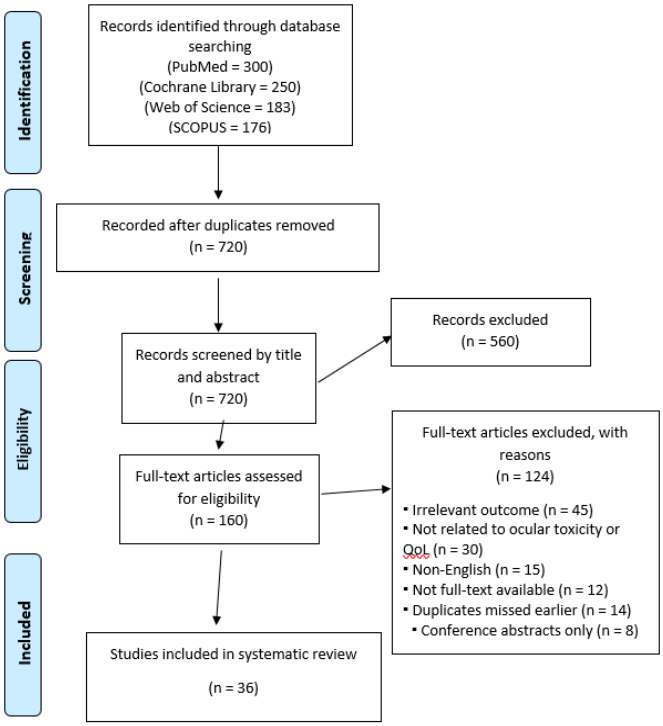

Figure 3. *Shows PRISMA flow chart of literature search. Source: authors' own development.*

information is brought forward to give details about these aspects and recommendations on how to handle or minimize them [14].

The total of 909 articles found with the help of the literature search in four large databases can be considered sufficient for the given review on chemotherapy-induced ocular toxicity and related QoL changes in cancer patients.

PubMed: The database provided 300 articles; PubMed was resourceful in its index of biomedical literature.

Cochrane Library: We identified 250 articles; it is considered to provide high-quality systematic reviews and meta-analyses.

Web of Science: This search returned 183 articles, which provided a rich array of multidisciplinary research.

Scopus: Thus, we secured 176 articles to make sure that the selection of the peer-reviewed literature is rather extensive. These databases made it possible to comprehensively and diversely identify and analyze various aspects related to the toxic effects of chemotherapy on the visual system and its influence on QoL

Inclusion Criteria:

The selection criteria for studies and reports in this review are as follows:

1. Population:

The review focuses on patients undergoing chemotherapy for malignant neoplasms. Both adult and pediatric populations are included.

2. Interventions:

The review encompasses studies investigating the ocular effects of various chemotherapeutic agents.

3. Outcomes:

The review targets studies that explore the impact of chemotherapy on the eye and its structures, such as corneal

abrasions, conjunctivitis, ocular chorioretinopathy, optic neuritis, and the formation of nuclear, cortical, or posterior subcapsular lens opacities.

4. Study Design:

The review includes a variety of study designs, such as randomized controlled trials (RCTs), observational studies, cross-sectional analyses, case-control studies, and case reports.

5. Time Frame:

To ensure relevance to current practices, only studies published within the last ten years are considered.

6. Language:

The review is restricted to articles published in English

Exclusion Criteria:

Studies were excluded from the review based on the following criteria:

Non-Chemotherapy: Papers related papers that are concerned with toxic effects on the eye related to treatment modalities excluding chemotherapy like radiation or immunotherapy.

Non-Malignant Conditions: Studies conducted on requirement for informed consent in patients with non-malignant disease or benign tumours.

Irrelevant Outcomes: Literatures not focused on ocular toxicity or on QoL concerning the deterioration or loss of vision.

Data Collection.

Data were systematically collected from the selected studies using a structured approach

Literature Search:

Exploratory searches in international literature relevant to PubMed, MEDLINE, and Scopus were made with key terms "chemotherapy," "ocular toxicity," "vision changes," and "quality of life."

Screening and Selection:

Title and abstracts were reviewed for eligibility and the full text of the potentially eligible papers was then looked at for further qualifications.

Data Extraction.

The details about the features of the study, the population that was involved, the chemotherapy regimen that was administered, the types of ocular toxicity, the methods used to assess the QoL and the results which were obtained were documented in a structured form.

Statistical Analysis.

While this narrative review does not involve primary data analysis, it includes a synthesis of findings from the selected studies:

Descriptive Analysis.

Charting of the frequency and the varieties of ocular toxicities related to the several chemotherapeutic agents.

Quality of life implication.

Quantitative and thematic analysis of the patients' quality of life comparing the findings of the included studies based on the patient-reported outcomes and the QoL measurement instruments used in the research.

Comparison of Findings.

Looking at the similarities and differences of the findings of different studies in order to know the trends, the disparities and the missing links in the existing literature.

Narrative Synthesis.

Integrating findings into a coherent narrative that has a focus on the mechanisms of chemotherapy-induced ocular toxicity, its clinical manifestations and then the effects.

Results.

Summary of Literature Search:

PRISMA flow chart shows the results of our literature search.

Summary of our studies included:

Carboplatin is another platinum-class anticancer agent that has been reported to exhibit a lesser degree of toxicity than cisplatin, but ocular toxicity is a problem [15]. This case involves a 70-year-old man, a smoker, with neuroendocrine bladder cancer diagnosed after the fifth chemotherapy cycle due to acute urinary retention He presented four weeks after his fourth chemotherapy cycle complaining of blurriness in his right eye; he presented four weeks after his third cycle complaining of the same blurriness in his left eye. The visual disturbances which we presumed to be carboplatin-induced ocular toxicity settled upon discontinuation of the chemotherapeutic agent. There is a lack of research on carboplatin-induced ocular side effects with the desired symptoms such as change in color perception, visual field loss, reduced visual acuity, and metamorphopsia described within a period of five days up to two weeks after treatment. This case highlights the sign that both ophthalmologists and oncologists need to closely observe wanted ocular side effects that may occur due to chemotherapy to minimize or avoid severe vision loss. Recent studies have shown an increased survival rate of patients with genitourinary (GU) cancer [16]. New modalities have appeared in the arsenal and some other protocols are still discussed in trials. Thus, this recent sprout of new agents has enhanced patient survival and, in particular, the quality of life of the patients, but at the same time, it has augmented the rate of several side effects. The current review will therefore target the possible ocular side effects of GU neoplastic interventions. Despite the logically plausible assumption that ocular toxicity's multiple manifestations reflect the organ's anatomic, physiological, and metabolic individuality. Usually, side effects do not endanger the patient's life and are not long-lasting, but there may be situations when they are severe, cause the inability to perform daily activities, and are permanent. Clinicians need to focus on vision-threatening complications with the potential to reduce the patient's quality of life. Therefore, the purpose of this review was to discuss the ocular toxicity of the antineoplastic regimens that are employed in GU malignancies in particular prostate, bladder, renal cell, testicular cancer, pheochromocytoma, adrenocortical carcinoma, and penile cancer.

Stoicescu et al. [17] reported that in diagnostic technology, chemotherapy has played a significant role in arresting the death rates. However, any intense chemotherapy regimen or combination therapies with target cancer cells, also affect the

normal cells and cause systemic as well as ocular side effects due to cytotoxicity inflammation, and neurotoxicity. Though the survival rates are relatively higher with the use of these drugs, these ocular side effects further deteriorate the quality of the lives of affected patients. Cytotoxic drug-induced ocular toxicity is not frequently recognized by the patient. Although this is not always possible, suitable management by an ophthalmologist is highly significant as the oncology team member. The ophthalmologic examination should be conducted before chemotherapy is initiated; the ophthalmologist also should check the patients more frequently for possible toxic effects during the chemotherapy. Table 1 shows a summary of the included studies.

Table 1 summarizes key findings from a case report and a review article concerning the ocular side effects of chemotherapy in patients with different types of cancer. The case report details a 70-year-old male smoker with neuroendocrine bladder cancer who developed blurred vision in both eyes after receiving Carboplatin. Fortunately, the blurriness resolved, indicating that the ocular side effects were temporary and manageable in this instance.

The review by Stoicescu et al. [17] provides a broader perspective on various genitourinary (GU) cancers treated with different chemotherapy agents. It highlights the range of potential ocular side effects, including cytotoxicity, inflammation, and neurotoxicity. However, the review does not specify patient details or whether the ocular side effects resolved, which underscores the variability in patient outcomes and the need for individualized monitoring and care during chemotherapy. The comparison between the specific case and the broader review emphasizes the importance of both individualized case reports and comprehensive reviews in understanding the spectrum of chemotherapy-induced ocular toxicities.

Table 2 provides a summary of studies that examined the ocular side effects of various chemotherapy agents across different cancer patient populations. Notably, Dulz et al. [18] identified significant retinal toxicity in 78.6% of patients treated with cisplatin, while Biswas et al. [19] reported retinal toxicity in 29% of epileptic patients receiving vigabatrin. Westall et al. [20] observed retinal toxicity in 13.3% of epileptic patients treated with vigabatrin, and Han et al. [21] reported ocular toxicity in 13.3% of cancer patients receiving mitogen-activated protein kinase (MEK) inhibitors, with an 8.7% increased risk of ocular adverse events. These findings highlight the diverse and potentially serious ocular risks associated with chemotherapy, emphasizing the need for vigilant monitoring and appropriate management.

Discussion.

Cancer remains a leading cause of death worldwide and imposes substantial social and economic burdens. Increased awareness, early diagnosis, and the development of novel chemotherapy regimens have significantly improved life expectancy. However, these advancements have occurred alongside a rise in adverse effects on the body, including the visual system [22]. Chemotherapy is a systemic treatment, meaning that it affects not only malignant cells but also normal cells, resulting in side effects such as cytotoxicity, inflammation, and neurotoxicity. This review highlights the importance of recognizing and addressing chemotherapy-induced ocular toxicity in order to improve patients' quality of life.

Chemotherapy-induced ocular toxicity is reported to be underdiagnosed, despite its potential to cause a clinically significant decrease in a patient's quality of life. Several chemotherapeutic agents, such as carboplatin, have been associated with ocular side effects, including color vision disturbances, scotomas, visual haziness, and metamorphopsia. These adverse effects may develop within days to weeks after the initiation of therapy, may become chronic, and can interfere with multiple aspects of daily functioning. A case report of a 70-year-old man with neuroendocrine bladder cancer illustrates that, although ocular toxicity is rare, continuous monitoring of ocular health is essential. His complaint of sequential bilateral visual blurriness, which resolved after discontinuation of carboplatin, exemplifies the clinical relevance of these side effects [23].

Thus, the management of chemotherapy-induced ocular toxicity requires close collaboration between oncologists and

Table 1. *Characteristics of Ocular Side Effects of Chemotherapy in Different Types of Cancer: A Review of Clinical Cases and Literature.*

Study	Patient Details	Cancer Type	Chemotherapy Agent	Ocular Side Effects	Resolution
Case Report	70-year-old male, smoker	Neuroendocrine bladder	Carboplatin	Blurriness in right and left eyes	Yes
Review (Stoicescu et al.) [17]	Not specified	Various GU cancers	Various chemotherapies	Cytotoxicity, inflammation, neurotoxicity	Not specified

Table 2. *Main Results of Studies on the Toxicity of drugs to the Organs of Vision.*

Study	Year	Chemotherapy Agent(s)	Study Population	Main Findings
Dulz et al. [18]	2017	Cisplatin	28 patients with various cancers	Significant retinal toxicity observed in 78.6% of patients.
Biswas et al. [19]	2020	vigabatrin	165 epileptic patients	Significant retinal toxicity observed in 29% of patients.
Westall et al. [20]	2014	vigabatrin	146 epileptic patients	Significant retinal toxicity observed in 13.3% of patients.
Han et al. [21]	2023	Mitogen-activated protein kinase (MEK) inhibitors	2235 patients with various cancers	Significant ocular toxicity observed in 13.3% of patients.

ophthalmologists. Ophthalmologists play a critical role in conducting pre-treatment evaluations and ongoing monitoring during chemotherapy. Early identification of ocular side effects allows for timely intervention, which can help mitigate the severity of these adverse effects. Given that ocular complications often remain irreversible, even when symptoms subside following discontinuation of chemotherapy, the duration during which patients experience these symptoms can significantly diminish their quality of life. Therefore, care management plans that include routine ophthalmologic examinations are essential to optimizing patient outcomes.

Ocular toxicities are increasingly recognized as significant concerns in patients receiving targeted anticancer therapies, as they represent some of the most common adverse effects. In response, the objective of Fu et al. [24] is to develop a management framework based on FDA data and comprehensive analysis of the existing literature.

This case review summarized sixteen oncologic drugs approved by the FDA up to March 14, 2015, concerning their recorded ocular toxicity profiles and included twelve small molecules and four monoclonal antibodies. Most people developed minor complaints like conjunctivitis and visual alterations; however, some patients experienced severe responses including blindness, retinal artery or vein thrombosis, and corneal ulcers. Due to the high prevalence and potentially lethal severity of both hepatic and renal toxicities, a combination of several specialties is advised inpatient treatment. The study also encourages the use of graduated systems in tracking exposed patients for a referral to specialized centers.

Antibody-drug conjugates include a monoclonal antibody, and a cytotoxic drug connected through a linker; this therapy type is far more effective when compared with the ordinary forms of treatment while having less adverse effects. They were introduced about two decades ago and offer sparing conventional treatments to patients with neoplasms that failed to respond to conventional treatment. Oral/ocular surface effects are frequent and probably constitute dose-related toxicity manifesting in different severities depending on the drug and the route of administration, the rates range from 20-90%. These effects can be due to receptor mediate events or non-specific phenomena such as macropinocytosis. It evidences that such events can heavily influence the comfort level of patients. This article seeks to review information available in the literature regarding such adverse effects in terms of pathophysiology, incidence and intervention. Optimization of identification and management leads to decreased rates of treatment termination, essential for patient survival.

Domínguez-Llamas [25] aimed to investigate adverse effects in terms of pathophysiology, incidence, and management strategies. Improved identification and intervention were shown to reduce the rate of treatment discontinuation, which is critical for patient survival. The study reported that antibody-drug conjugates consist of a monoclonal antibody linked to a cytotoxic drug via a chemical linker. This therapeutic approach is significantly more effective than conventional treatments and is associated with fewer adverse effects. Introduced approximately two decades ago, these therapies provide alternative options for patients with neoplasms unresponsive to standard treatments.

Oral and ocular surface effects are common and likely represent dose-dependent toxicity, with severity varying according to the specific drug and route of administration. Reported incidence rates range from 20% to 90%. These adverse effects may result from receptor-mediated mechanisms or non-specific processes such as macropinocytosis. These findings indicate that such events can substantially affect patient comfort and quality of life.

Case reports by Cho et al. [26] over the past 10 years examined uveoretinal adverse events associated with chemotherapy. More than 55 patients were included, with a predominance of female participants and a mean age of 51 years. The most frequently reported cancer type was breast cancer (36.4%), and noninfectious anterior uveitis was the most common uveoretinal disorder (21.8%). Approximately one-third of the patients experienced worsening of vision to less than 20/40, despite treatment with various chemotherapeutic agents, including cisplatin and daunorubicin. Most complications were reversible and responded well to conservative management. However, a few patients who discontinued chemotherapy experienced bilateral irreversible blindness.

Taushanova et al. [27] evaluated the effectiveness of educational interventions at the Glaucoma School in Aktobe, Kazakhstan, on improving medication adherence among glaucoma patients. The study demonstrated a significant improvement in adherence, with the proportion of patients properly administering their eye drops increasing from 63.9% to 72.1% ($p < 0.001$). These findings underscore the value of educational programs in enhancing compliance with glaucoma treatment regimens.

According to Jose et al. [28], the development of alternative ocular toxicity testing methods, such as in vitro organotypic models and assays like the Bovine Corneal Opacity and Permeability (BCOP) Assay, provides more ethically acceptable and regulatory-approved approaches for assessing the toxic effects of ophthalmic formulations on the visual system, thereby reducing the dependence on traditional animal testing methods.

As noted by Panchal and Batra [29], structured teaching programs are effective in enhancing the knowledge and attitudes of older individuals regarding the early detection and prevention of visual impairment, emphasizing the need for educational strategies to reduce the risk of vision loss among the elderly population.

The use of multisensor inversion voltammetry enables comprehensive analysis of the pharmacokinetics of ophthalmic drugs. It has been demonstrated that while the concentrations of Catachrom and Taufon decrease to minimal levels within four hours, Lanomax maintains its efficacy in the conjunctival cavity for up to twelve hours in patients with cataracts [30].

The integration of robotic surgeries in cancer treatment offers significant advantages, particularly in India, where economic factors and technological advancements are increasingly relevant. Studies have highlighted the efficiency and cost-effectiveness of robotic procedures compared to traditional surgeries across major urban centers [31].

The use of stem cells in cancer treatment, as reported in recent studies, presents promising potential for overcoming the

limitations of conventional therapies such as chemotherapy and radiation, which are often associated with adverse effects and drug resistance [32].

In the context of chemotherapy-induced toxicity affecting the visual system in malignant neoplasms, the exploration of alternative therapies such as stem cell-based treatments may offer new strategies for mitigating these adverse effects and improving overall treatment outcomes. Anticancer resistance, a key challenge in oncology, arises from various pharmacological mechanisms that reduce the efficacy of treatments such as chemotherapy [33]. Understanding these mechanisms, including altered drug metabolism and the activation of alternative signaling pathways, is essential for minimizing the ocular toxicity of chemotherapy and enhancing outcomes through the use of personalized medicine and novel drug delivery systems.

CAR T-cell therapy, an innovative form of immunotherapy, has shown significant potential in targeting malignant cells through the use of genetically engineered T cells capable of identifying and destroying cancerous tissue [34]. With respect to chemotherapy-induced ocular toxicity in malignant neoplasms, the integration of CAR T-cell therapy could serve as an alternative or adjunctive strategy, potentially reducing the need for high-toxicity chemotherapeutic regimens and limiting damage to the visual system.

Nanorobotics, a cutting-edge development in cancer treatment, offers promising capabilities for precision-targeted drug delivery, including the detection and elimination of cancer cells [35]. In the context of chemotherapy-related ocular toxicity, nanorobotic systems may represent a non-invasive, highly targeted alternative that minimizes ocular damage while enhancing therapeutic efficacy.

Immunotherapy has emerged as a promising modality in cancer treatment, improving survival rates and quality of life through various strategies, including T-cell transfer therapy, cancer vaccines, and cytokine-based therapies [36]. In the context of chemotherapy-induced toxicity affecting the visual system in malignant neoplasms, immunotherapy represents a potential alternative that may reduce reliance on cytotoxic agents and thereby minimize the risk of ocular complications.

Polymeric nanoparticles are increasingly recognized as a highly effective method for anticancer drug delivery due to their ability to enhance drug accumulation at tumor sites, reduce off-target effects, and increase bioavailability [36]. With regard to the toxic effects of chemotherapy on the visual organ in malignant neoplasms, the application of polymeric nanoparticles may enable more precise drug delivery, potentially reducing ocular toxicity and improving the overall safety and therapeutic efficacy of cancer treatment.

For these reasons, the present study underscores the importance of regular ophthalmological examinations during chemotherapy to identify and manage potential ocular complications in a timely manner.

Conclusion.

It can be stated that chemotherapy has significantly changed the cancer treatment and has a high impact on the survival rates of the patients, however, it is critical to acknowledge and treat the adverse effects on the vision. Ocular toxicity, despite its underappreciation, can greatly affect the patient's QoL and should be monitored closely by a specialized team. This team ideally includes oncologists, ophthalmologists, and oncology nurses who collaborate to identify early signs of ocular complications, conduct baseline and periodic ophthalmic assessments, and adjust chemotherapy regimens or initiate ophthalmic interventions when needed. Through emphasizing the role of timely diagnosis and treatment, it is anticipated that the insights provided by this review will support improved cancer management practices and help mitigate the adverse effects of chemotherapy on visual function and overall quality of life.

Recommendation and future research.

Further studies in impact and results of chemotherapy on eyes should also be redirected to increase the amount of knowledge and possible actions in the future. It requires the definition of protocols and guidelines on early diagnosis and treatment, increased cooperation between oncologists as well as ophthalmologists, and investigations on specific therapeutic approaches which may lead to negative effects on the eyes. More longitudinal studies are required to evaluate the ocular complications of the newer chemotherapy agents and the improvements in supportive care. From the findings, the early identification of genetic variations, particularly those affecting drug metabolism, ocular tissue sensitivity, and oxidative stress response, could play a pivotal role in predicting an individual's susceptibility to chemotherapy-induced ocular toxicity. By integrating pharmacogenomic screening into the initial stages of cancer care, clinicians could stratify patients based on their risk profiles and tailor chemotherapy regimens accordingly. This personalized approach would not only allow for the use of protective agents or dose adjustments when necessary but also support the development of surveillance protocols to detect ocular damage at its earliest stages.

REFERENCES

1. Mahmood U, Blake A, Rathee S, et al. Stratification to neoadjuvant radiotherapy in rectal cancer by regimen and transcriptional signatures. Cancer Res Commun. 2024;4:1765-76.

2. Rivera F, Longo F, Martín Richard M, et al. SEOM-GEMCAD-TTD clinical guideline for the diagnosis and treatment of gastric cancer (2023). Clin Transl Oncol. 2024;26:2826-40.

3. Yu C, Mao X, Zhou C. Influence of acupuncture and moxibustion on gastrointestinal function and adverse events in gastric cancer patients after surgery and chemotherapy: a meta-analysis. Support Care Cancer. 2024;32:524.

4. Goleij P, Pourali G, Raisi A, et al. Role of non-coding RNAs in the response of glioblastoma to temozolomide. Mol Neurobiol. 2025;62:1726-55.

5. Gong J, Reimers MA. A podcast on practical considerations in patients with advanced urothelial cancer receiving first-line cisplatin- or carboplatin-based chemotherapy followed by avelumab maintenance in a changing therapeutic landscape. Adv Ther. 2024;41:3441-51.

6. Witwaranukool P, Seedadard R, Krongthaeo S, et al. Quality of life and associated factors among cancer patients receiving chemotherapy during the COVID-19 pandemic in Thailand. Int J Environ Res Public Health. 2024;21:317.
7. Lewandowska A, Rudzki G, Lewandowski T, et al. Quality of life of cancer patients treated with chemotherapy. Int J Environ Res Public Health. 2020;17:6938.
8. Dehkordi A, Heydarnejad MS, Fatehi D. Quality of Life in Cancer Patients undergoing Chemotherapy. Oman Med J. 2009;24:202-7.
9. Fernandes SS, Saini JK. The impact of chemotherapy on quality of life in advanced-stage lung cancer patients. Indian J Cancer. 2023;60:310-5.
10. Tilsed CM, Fisher SA, Nowak AK, et al. Cancer chemotherapy: insights into cellular and tumor microenvironmental mechanisms of action. Front Oncol. 2022;12:960317.
11. Fang G, Zhang A, Zhu L, et al. Nanocarriers containing platinum compounds for combination chemotherapy. Front Pharmacol. 2022;13:1050928.
12. Agren R, Mardinoglu A, Asplund A, et al. Identification of anticancer drugs for hepatocellular carcinoma through personalized genome-scale metabolic modeling. Mol Syst Biol. 2014;10:721.
13. Yamada M, Iijima Y, Seo M, et al. Cancer chemotherapy-associated pigmentation of the oral mucosa. In Vivo. 2023;37:1880-5.
14. Mollaei M, Hassan ZM, Khorshidi F, et al. Chemotherapeutic drugs: Cell death- and resistance-related signaling pathways. Are they really as smart as the tumor cells? Transl Oncol. 2021;14:101056.
15. Bukowski K, Kciuk M, Kontek R. Mechanisms of multidrug resistance in cancer chemotherapy. Int J Mol Sci. 2020;21:3233.
16. Stoicescu EA, Iancu RC, Popa Cherecheanu A, et al. Ocular adverse effects of anti-cancer chemotherapy. J Med Life. 2023;16:818-821.
17. Dulz S, Asselborn NH, Dieckmann K-P, et al. Retinal toxicity after cisplatin-based chemotherapy in patients with germ cell cancer. J Cancer Res Clin Oncol. 2017;143:1319-25.
18. Biswas A, Yossofzai O, Vincent A, et al. Vigabatrin-related adverse events for the treatment of epileptic spasms: systematic review and meta-analysis. Expert Rev Neurother. 2020;20:1315-1324.
19. Westall CA, Wright T, Cortese F, et al. Vigabatrin retinal toxicity in children with infantile spasms: An observational cohort study. Neurology. 2014;83:2262-8.
20. Han J, Chen J, Zhou H, et al. Ocular toxicities of MEK inhibitors in patients with cancer: A systematic review and meta-analysis. Oncology (Williston Park). 2023;37:130-141.
21. Alhasan KA, Yepes-Nuñez JJ, Askandarani S, et al. Adapting clinical practice guidelines for chronic kidney disease: Blood pressure management and kidney replacement therapy in adults and children in the Saudi Arabian context using the Grading of Recommendations Assessment, Development, and Evaluation-ADOLOPMENT methodology. Saudi J Kidney Dis Transpl. 2023;34:S177-218.
22. Ogata FT, Verma S, Coulson-Thomas VJ, et al. TGF-β-based therapies for treating ocular surface disorders. Cells. 2024;13:1105.
23. Fu C, Gombos DS, Lee J, et al. Ocular toxicities associated with targeted anticancer agents: an analysis of clinical data with management suggestions. Oncotarget. 2017;8:58709-27.
24. Domínguez-Llamas S, Caro-Magdaleno M, Mataix-Albert B, et al. Adverse events of antibody-drug conjugates on the ocular surface in cancer therapy. Clin Transl Oncol. 2023;25:3086-100.
25. Cho AR, Yoon YH, Kim JG, et al. Uveoretinal adverse effects presented during systemic anticancer chemotherapy: A 10-year single center experience. J Korean Med Sci. 2018;33:e55.
26. Taushanova M, Yermukhanova L, Tazhbenova S, et al. Evaluating the impact of educational interventions on medication adherence among glaucoma patients in Kazakhstan: A public health perspective. Banglad J Med Sci. 2024;23:787-97.
27. Jose J, Deepthi S, Sandeep DS. Methods for Testing Ocular Toxicity: Current Status. Res J Pharm Technol. 2018;11:1499.
28. Panchal S, Batra N. Effectiveness of Structured Teaching Programme (STP) regarding early detection and prevention of visual impairment among older people. Asian J Nurs Educ Res. 2018;8:73.
29. Kolesnichenko I. Development of a method for multisensory stripping voltammetry in the analysis of medical preparations. ACS Omega. 2023;8:40229-41.
30. Patil P, Udasi S, Kumar Nrip N, et al. Study of robotic surgeries in India: Economical aspects and applications in cancer treatment. Res J Pharm Technol. 2023;429-34.
31. A. Masule A, M. Murari V. Utilization of stem cells for cancer treatment- A review. Asian J Pharm Res. 2023;269-276.
32. Khatri M, Dhar S, Ven P, et al. Understanding the pharmacological mechanisms of anticancer resistance: A multifaceted challenge in cancer treatment. Asian J Pharm Res. 2024;183-187.
33. Bajirao Suryawanshi S, D Khaire R. Review on car-T cell therapy for cancer treatment. Int J Technol. 2023;68-72.
34. Abrar M, Sheikh T, Mohammed S, et al. Nanorobotics in cancer treatment: A review. Res J Pharm Dos Forms Technol. 2019;11:43.
35. Mandlik YR. Immunotherapy, a type of cancer treatment. Res J Pharm Dos Forms Technol. 2020;12:282-284.
36. Jaitak D, Nacchammai K, Pavithra K, et al. Polymeric nanoparticles for Anti-cancer treatment-A review of its mechanisms. Res J Pharm Technol. 2021;14:1747-1754.