Modern Trends in Cancer Diagnosis and Treatment: Innovative Aspects

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Abstract: The study aims to analyse new methods in the treatment and diagnosis of cancer, as the prevalence of cancer has been growing rapidly over the past 10 years. This study examined and investigated the implementation of novel approaches in molecular diagnostics, precision medicine (focusing on the genetic and molecular characteristics of cancer), immunotherapy (including immune checkpoint inhibitors), radiation therapy (such as intensity-modulated radiation therapy, CyberKnife, brachytherapy, and proton therapy), nanotechnology, tissue engineering, and the application of artificial intelligence. According to the results of the study, it is worth noting that the use of these diagnostic and treatment methods has significant potential in the field of oncology. For example, molecular diagnostics can detect mutations in the cancer process and optimise treatment. Kosovo is actively considering the use of molecular biomarkers to inhibit cell growth, and Albania has introduced a new molecular classification that helps to predict the occurrence of complications. Genetic research in Kyrgyz Republic is studying the impact on the immune system of the tumour, apoptosis and treatment prognosis. Albania is also making parallels in the immune system of pregnancy and endometrial cancer to predict abnormal pregnancy and find new methods of cancer diagnosis and treatment. The problem of this study is the lack of empirical, clinical research and testing, and the toxicity of some diagnostic and treatment methods. Further research should focus on developing new methods of cancer treatment and diagnosis, as well as optimising and improving existing methods through empirical and clinical trials.

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Introduction

The prevalence of cancer in the world has been growing rapidly over the past 10 years. According to the World Health Organization (2024), 20 million new cases of cancer and 9.7 million cancer-related deaths were registered worldwide in 2022. Many researchers study this problem by analysing existing data and conducting experimental studies in the field of innovative methods related to cancer. The detection rate of cancer has been steadily increasing over the past decade. Lung cancer is the most common cancer worldwide, accounting for 12.4% of all newly diagnosed cases, and it is also the leading cause of cancer-related deaths, contributing to 18.7% of all cancer fatalities. Breast cancer follows closely as the second most common cancer, making up 11.6% of new cases (World Health Organization, 2024). These statistics underscore the relevance and urgency of the present study, highlighting the importance of identifying new methods for diagnosing and treating the most prevalent and deadly forms of cancer.

Chamberlin et al. (2024) faced the problem of limited access to mammography and ultrasound in breast cancer screening, and in preparation for surgery, the use of mammography leads to inaccuracies on the operating table due to different positions of the patient during the examination and surgery. In this regard, researchers have developed a new method of diagnosis and treatment that includes magnetic resonance imaging (MRI) lying on the back to more accurately determine the location of the tumour in the breast, which preserves healthy tissue and avoid radical mastectomy. Shala et al. (2023) studied the treatment of brain tumours in paediatrics and found that the methods include surgery, chemotherapy and radiotherapy, but these methods still lead to severe side effects, poor prognosis, and low survival rates. In this regard, an innovative method of treatment with the use of herbal preparations was considered. Such a drug is quercetin, which affects tumour cells and metastases, in the form of apoptosis and autophagy. Apoptosis or "programmed cell death" is a process that occurs under the control of certain molecules, the correct functioning of which has a positive effect on the development of the tumour, in the form of its reduction. Furthermore, this study found that quercetin affects cell proliferation by reducing the vital functions of tumour cells, which leads to a decrease in migration and invasion.

Given the high prevalence of gastric cancer, Bilyalov et al. (2023) studied the relationship between heredity and gastric cancer detection. The study was conducted with 113 patients who were diagnosed for the first time, and the analysis was based on the identification of mutated genes responsible for the onset of gastric cancer in the next generation. Among the results, it is worth highlighting that 6.2% of patients had a pathological or potentially pathological genetic set, 3.5% of patients had heterozygous variants of the genetic set in the form of pathogenic/possibly pathogenic genes, and 2.7% of patients had heterozygous mutations in autosomal recessive inheritance. Thus, this study found that the prevalence of genetic inheritance of gastric cancer is high and corresponds to global statistics (Assumpção et al., 2020). Furthermore, due to the increase in the detection and mortality rate from lung cancer, Khan et al. (2023) reviewed the use of exosomal nanovesicles in the diagnosis and treatment of this disease. The progression of lung cancer depends on the coordination of cancer cells and immune cells in the microenvironment of the cancer process. Exosomes are membrane vesicles that are released under the influence of various processes and cells for cell-cell interaction in normal and pathological conditions, however, tumour cell exosomes have an individual composition of molecules that determines the nature of the tumour and also contain neoantigens, ribonucleic acid (RNA), deoxyribonucleic acid (DNA) and proteins. Tumour exosomes can also control the suppression and stimulation of the immune response, which leads to an impact on acquired and innate immune factors. In addition, they are involved in signal transduction, tumour and metastasis growth, angiogenesis and epithelial-mesenchymal transition. This study showed that exosomes can be used as biomarkers in lung cancer immunotherapy, helping to suppress the tumour's immune response, and thereby reducing tumour growth. However, the lack of data and research in this area slows down the process of studying the topic.

Dell'Acqua et al. (2020) conducted an empirical study on the use of intensity-modulated radiation therapy (IMRT) in the treatment of anal cancer. During the year, 84 patients with squamous cell carcinoma who received IMRT were monitored. The study analysis addressed acute and early toxicity, time and intervals in treatment, life expectancy without colostomy removal and tumour response to the therapy used. The results of this study showed that the tumour response to treatment was positive with insignificant acute toxicity and justifies the use of IMRT as a standard of care for patients with anal cancer. Minervini et al. (2023) addressed the use of microRNAs as markers in the diagnosis of oral cancer at early stages. Previous studies have shown that microRNAs are significant biomarkers that help to detect smoking-related cancers at an early stage.

This study offers a unique contribution to the field of oncology by integrating a range of innovative diagnostic and treatment methods, including molecular diagnostics, precision medicine, immunotherapy, advanced radiation therapies, nanotechnology, tissue engineering, and artificial intelligence (AI). Unlike previous studies focusing on single approaches, this research highlights the synergy of these technologies to improve early cancer detection, personalized treatment, and patient outcomes. The study's novelty lies in its comprehensive application of genetic and molecular features for tailored therapies, with a focus on real-world settings in Kosovo, Albania, and the Kyrgyz Republic.

The study aims to explore innovative diagnostic and treatment methods for the early detection, effective treatment, and prevention of cancer, with a specific focus on improving patient outcomes, including survival rates and quality of life. The research seeks to assess how these advanced methods can enhance cancer care and contribute to better long-term health outcomes for patients.

Material and Methods

The scope of the study is defined by a focus on the most common and deadly cancers, such as stomach cancer, lung cancer, breast cancer, colorectal cancer, and endometrial cancer. The study pays special attention to patients with genetic predispositions to these cancers, as well as the application of innovative diagnostic and treatment methods in the context of different socioeconomic groups, in particular in developing countries such as Kyrgyzstan, Albania and Kosovo.

The main method of this theoretical research was a literature search in evidence-based databases and search engines such as PubMed, ScienceDirect, Scopus, and Google Scholar. The literature, in the form of empirical, theoretical, case studies and clinical cases, was selected for the period from 2020 to 2024. The following keywords were used to search for published studies: oncological diseases, cancer, diagnostics of malignant neoplasm, molecular diagnostics of cancer, genetic diagnostics of cancer, treatment of cancer, cancer immunotherapy, modulated radiation therapy of cancer, proton therapy of malignant process, brachytherapy of cancer, CyberKnife in the diagnosis and treatment of cancer, nanotechnology in the treatment of cancer, tissue engineering in the diagnosis and treatment of cancer AI in the diagnosis and treatment of cancer, Kyrgyz Republic, Albania, Kosovo. The literature search was conducted according to the selection criteria: relevance to the research topic, free access to reading, data published no later than 2020, and publications in English or Russian. The study selected 63 articles; however, if an article did not correspond to the topic, had unspecified data, was not published in English or Russian, or was not freely available, it was excluded from the lists for study. Upon completion of the selection, the list of references was narrowed down to 31 studies. This study examines innovative methods of cancer diagnosis and treatment in Kyrgyz Republic, Albania and Kosovo.

The study analyses the use of magnetic resonance imaging, immunotherapy, the study of genetic aspects of the immune system in the oncological process, and the use of passive radio wave radiometry in combination with AI in the diagnosis of breast cancer in Kyrgyz Republic. In addition, data on the introduction of genetic testing for hereditary gastric cancer, the use of immunotherapy for lung cancer, the use of molecular biomarkers for the treatment and diagnosis of cancer, and the ability of molecular diagnostics to detect malignant tumours in Kosovo were systematised. The use of intensity-modulated radiotherapy for the treatment of anal cancer, the identification of microRNAs for the early diagnosis of oral cancer, a comparative analysis of the immune system in pregnancy and endometrial cancer, and the introduction of a molecular classification for endometrial cancer in Albania were analysed.

The application of molecular diagnostics in the form of the ability to describe anatomical characteristics and determine the exact size, quantitative data, and composition at the cellular and molecular level is studied in detail. The use of liquid biopsies in genetic diagnostics, the use of combined immune systems, and the influence of inflammatory processes and cytokines in the treatment and diagnosis of cancer are reviewed and investigated. The comparison method was used to study intensity-modulated radiation therapy, magnetic resonance, proton, stereotactic, adapted radiation therapy, and the CyberKnife robotic radiation delivery system. Innovations in the use of nano/micromotors and magnetic nanoparticles for drug delivery and tumour destruction in the field of nanotechnology are considered. AI-assisted diagnostics were evaluated to speed up diagnostic processes (identifying mutations, the origin of tumours, adjusting the technical characteristics of diagnostic devices) and optimise treatment according to individual patient data.

Results and Discussion

The development of molecular diagnostics is improving the ability to detect cancer at an early stage and identify individual mutations, which helps to select

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the most effective treatment. The system for assessing tumour response to therapy may not accurately assess the effect of drugs due to poor tumour volume ratio, necrotic changes or tumour shrinkage, which may lead to a delay in detecting the effect. Molecular imaging can characterise a tumour not only anatomically, but also visualise its exact size, and quantitative data, and analyse it at the molecular, cellular, and subcellular levels. In addition, this method can be used to assess the response to treatment and clinical outcomes (Bai et al., 2023).

Molecular imaging is a method that visually outlines, characterises and measures the processes occurring in a tumour at the cellular and molecular level without resorting to invasive diagnostic methods. This method differs from the others in that it demonstrates the physiological process of molecules in a particular tissue or organ. Nuclear imaging is a type of molecular imaging used with radiotracers to assess the volume, number and biological appearance of a tumour. The advantages of this imaging method include high sensitivity and quantitative characteristics. For example, nuclear imaging and computed tomography, which can combine the anatomical structure and functioning of a tumour, can help correct cancer processes in the body more accurately. Photoacoustic imaging is one of the newer molecular imaging methods that generates an ultrasound signal based on photoacoustic action. When the laser pulses hit the tissue, they are partially absorbed and transformed into heat, which then creates an ultrasound signal and, consequently, an image. The method is highly accurate, making it clinically important for cancer diagnosis (Bai et al., 2023). Figure 1 shows the areas of application for molecular imaging. At the cellular level, probes bind to cell surface receptors, the nucleus, and targets in the cytoplasm. After the molecular probes are introduced into a living organism, the tumour response to therapy is assessed.

It is also worth noting a study on molecular imaging in gastric cancer. Scientists have studied the leucine-rich G-protein contained in the repeat receptor 5 and determined that it can be a marker of stem cells in gastric cancer. They also created a peptide probe that was used for molecular imaging of gastric cancer and found that the probe could be used to diagnose not only cancer but also metastases in the peritoneal zone (Kwak et al., 2021).

Histopathological factors and clinical presentation are the most common methods for determining the risks for the further management of a cancer patient. However, patients with stage II colorectal cancer need to optimise their treatment regimens, and in patients with stage III, the need for chemotherapy should be assessed to avoid unnecessary toxicity. In this regard, new genetic and epigenetic biomarkers were developed to help assess and plan the necessary therapy. New types of biopsy are also being developed, such as liquid biopsies, which are characterised by minimal intervention in the body and are based on the collection of blood or other human biological fluids and analysis of components derived from the cancerous tumour. However, there are some problems with this method, such as the small number of circulating cells, molecules or tumour DNA in the biological fluids. This way, a liquid biopsy will help analyse the tumour information in real-time, which will help to optimise treatment individually for each

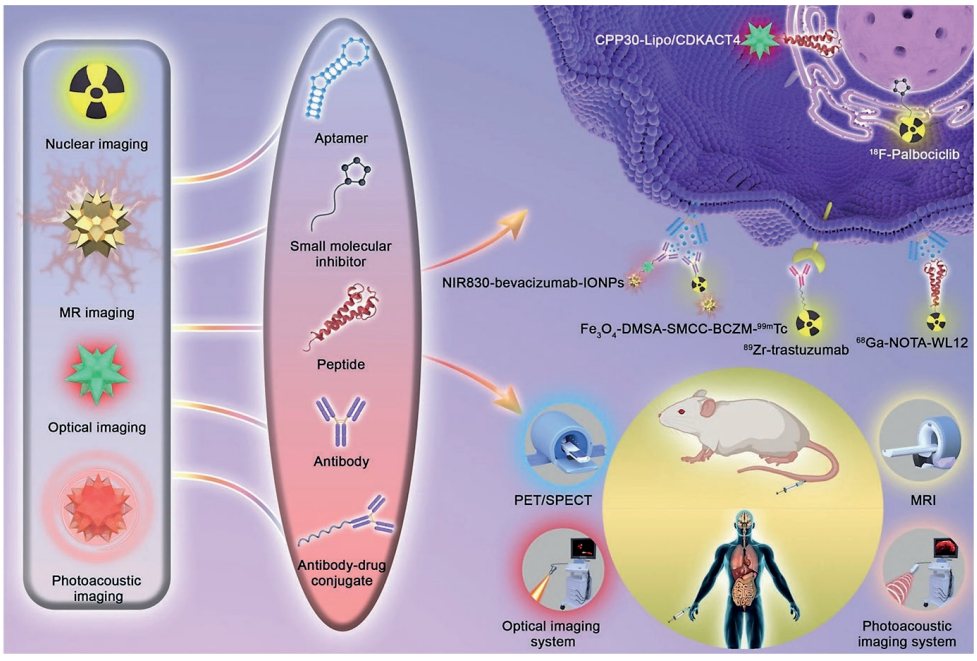

Figure 1: Areas of application for molecular imaging. Source: Bai et al. (2023).

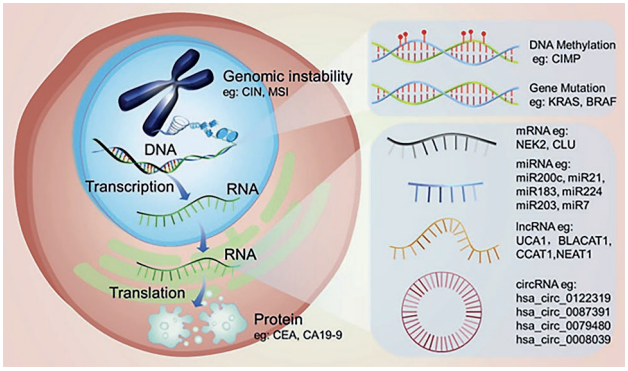

Figure 2: Types of epigenetic biomarkers. Source: Luo et al. (2021).

patient. Epigenetic biomarkers, which include DNA, microRNAs, lncRNAs and circRNAs, have been widely studied in oncology. Some of them have begun to be used in practice, such as a mutation in the proto-oncogene (KRAS), which is the only marker with the most proven effectiveness (Figure 2). However, the study of this topic is slowing down due to different types of samples, small sample size, selection of schemes with low efficiency and other reasons (Luo et al., 2021).

The development of immunotherapy in the field of oncology helps increase the body's immune response to tumours, which leads to an improvement in prognosis, outcomes, quality and duration of life. The use of immune cells to treat cancer is gaining momentum in this area. Combination therapies based on immune checkpoints, such as nivolumab and ipilimumab, have been used as first-line therapy for metastatic melanoma, with a nearly 60% improvement in progression-free survival rates of approximately 1 year. Furthermore, combinations of immune checkpoints with chemotherapy, antiangiogenics and other treatments were addressed (Yap et al., 2021). New small molecule agonists TLR7/8 can induce cytokines aimed at eliminating the inflammatory process, which contributes to increased cellular cytotoxicity. This method of treatment with small molecule agonists can increase the body's resistance to tumours, due to the effectiveness of monoclonal antibodies and the use of combining immunotherapy with other methods. In addition, the potential impact of inflammation and cytokines as markers for lung cancer in patients treated with immune checkpoint therapy, as well as their response to this treatment and prognosis, has been studied (Craig et al., 2024).

Radiotherapy has become more commonly used in the treatment of liver cancer, due to the good results achieved in this area. Radiation therapy includes optimised image guidance, treatment planning using precise methods, and motion control. These methods include intensity-modulated radiation therapy, magnetic resonance radiation therapy, proton radiation therapy, and stereotactic radiation therapy. Proton radiotherapy is based on reduced radiation exposure to normal tissues surrounding the tumour, which increases the dose to the tumour. Magnetic resonance radiotherapy delineates soft tissues more clearly than computed tomography.

In the regions of Kyrgyzstan, Albania and Kosovo, different methods of radiation therapy are used, each with its own characteristics and advantages. IMRT allows for more precise delivery of radiation to the tumour, reducing damage to surrounding healthy tissue due to the ability to control the shape and dose of the beam. This method is very effective in treating tumours in complex anatomical areas such as the head and neck, but has certain disadvantages, such as higher requirements for technical equipment and long treatment times. In Albania and Kosovo, IMRT is actively used to treat various types of cancer, such as prostate and breast cancer, but the limited availability of high-quality equipment may limit its use in some regions.

Proton therapy is the next stage in the development of radiation therapy, which reduces the dose of radiation to healthy tissues by using protons instead of X-rays. This method is especially useful in treating pediatric tumours and tumours located near important organs such as the brain or eyes. Proton therapy can also be used in the treatment of severe head and neck cancer, but it is expensive and technologically demanding, which limits its use in countries with limited access to appropriate equipment, such as Kyrgyzstan.

Stereotactic radiation therapy is another innovative technique that uses highly precise targeting of the tumour with multiple high doses of radiation, which allows for shorter treatment times and high efficacy in limited tumour areas. This method is particularly suitable for treating small tumours, such as those in the lung or liver, and is highly accurate when combined with computer and imaging technologies. However, its application requires expensive equipment and specialized knowledge, which limits its use in countries with low levels of medical funding, such as Kyrgyzstan.

As for AI tools in the diagnosis and treatment of oncology, their effectiveness varies in different regions depending on the level of technological equipment and data availability. In countries with advanced medical systems, such as Albania and Kosovo, AI is actively used for early cancer detection through the analysis of images such as mammograms, MRI, and computed tomography (CT) scans. AI can significantly improve diagnostic accuracy, reducing errors and improving early detection of tumours, which is critical for effective treatment. In Kosovo, for example, AI is

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also being used for personalized treatment planning, helping to develop optimal treatment regimens for each patient based on their genetic data.

In Kyrgyzstan, where medical technologies often have limited access, the use of AI in oncology is still in its infancy. However, in the future, with the development of technology and access to training programs, AI can become an important tool to support medical staff in diagnosing, planning treatment, and optimizing therapeutic processes, especially for early cancer detection, which is especially important in a country with limited resources for examinations.

Furthermore, in combination with online adaptive therapy, this method overcomes the problem of uncontrolled patient movements and reduces radiation doses to normal surrounding tissues (Zaki et al., 2023). In addition, adapted radiotherapy is used in oncology. Thus, the use of narrower fields significantly reduced the radiation dose by almost 60%. In this case, the doses directed to the tumour went beyond it to a lesser extent, which reduced the risks to the surrounding tissues (Nenoff et al., 2019). The use of CyberKnife, which is a robotic system for delivering radiation to the cancerous tumour zone, along with stereotactic image-guided radiation therapy, contributes to more accurate delivery of radiation doses to the required tumour zone. The use of such complex treatment improves target coverage, reduces risks to surrounding tissues, and improves the prognosis of the disease. In addition, CyberKnife has an advantage over brachytherapy, as patients complain of severe discomfort and have high risks associated with damage to other organs around the tumour (Gao et al., 2022; Posolenyk, 2024).

Nano/micromotors are created microscopic robots that convert energy into motion. In the field of oncology, such micro-robots can be used for drug delivery, tumour destruction or biomarker sensing (Figure 3). There are several types of micromotors: chemical, light, magnetic, and ultrasonic. However,

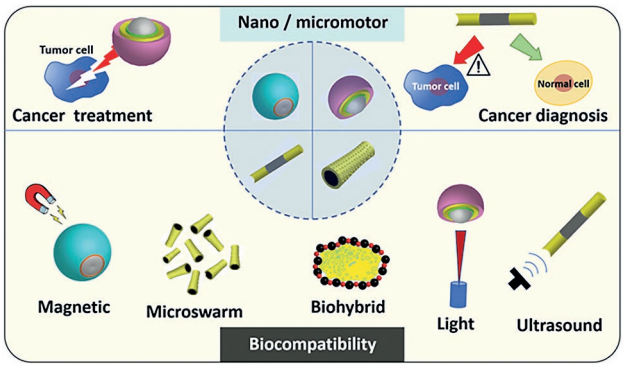

Figure 3: Micromotors used in oncology. Source: Zheng et al. (2024).

there are some problems in the study of this issue, which complicates the transition from laboratory to clinical trials. Micromotors are quite toxic, have harmful by-products, consume large amounts of toxic fuel and can cause an uncontrollable immune response from non-degradable components. Therefore, this method of diagnosis and treatment is still under development and animal testing, but has great potential (Zheng et al., 2024).

One of the primary concerns is the toxicity associated with these micromotors. Many of the materials used in their construction can be harmful, either due to their by-products or their degradation into toxic components. The fuel sources that power these micromotors can also be toxic, and the non-degradable components of these robots may trigger an uncontrolled immune response, further complicating their clinical use. Recent research is addressing these issues by focusing on reducing the toxicity of nano/micromotors. One avenue of improvement is the development of biocompatible materials that can minimize harmful interactions with the body. Chehelgerdi et al. (2023) highlight the importance of using biocompatible and biodegradable materials in the design of these micromotors. By employing such materials, the risk of an adverse immune response can be minimized, and the potential for the body to safely break down these robots after their use increases.

Research into the use of non-toxic fuels is being explored. Traditional fuels for nano/micromotors often involve chemical reactions that can produce harmful by-products, but alternative, safer fuels are being developed to mitigate these risks. Using non-toxic or minimally toxic fuels can significantly reduce the harmful effects associated with the operation of these micromotors, making them more suitable for clinical applications. Despite these advancements, the clinical implementation of nano/micromotors in oncology is still in the experimental phase. Most of the research is being conducted through animal testing, and many hurdles remain before these technologies can be safely used in humans. The progress in reducing toxicity and improving biocompatibility, as discussed by Chehelgerdi et al. (2023), provides a promising outlook for the future of nano/micromotors in cancer treatment. These innovations have the potential to revolutionize targeted therapy, offering a more precise, efficient, and less toxic treatment option for cancer patients.

Magnetic nanoparticles have garnered significant attention in the field of oncology due to their potential for targeted drug delivery and diagnostic applications. These nanoparticles are highly accessible and can be synthesized through various methods, including

thermal decomposition, polynomial synthesis, and hydrothermal synthesis. Magnetic nanoparticles offer several advantages, such as their ability to be controlled externally using magnetic fields, which makes them highly suitable for precise drug delivery to tumour sites and for enhancing diagnostic imaging. Liu et al. (2024), have highlighted the promising role of magnetic nanoparticles in improving the efficacy of anticancer treatments. Specifically, they have focused on their use in the delivery of autophagy-modulating compounds derived from Traditional Chinese Medicine. Autophagy, a process by which cells recycle damaged components, has been identified as a potential therapeutic target in cancer, as modulating this pathway can help induce cancer cell death and improve the effectiveness of anticancer treatments. Magnetic nanoparticles, when loaded with autophagy-modulating compounds, can be directed precisely to cancer cells, enhancing the localized effects of these compounds while minimizing off-target effects.

Authors provide insights into how magnetic nanoparticles can be designed to enhance the delivery of these compounds, ensuring that they reach the tumour site efficiently. The ability to control the nanoparticles using external magnetic fields allows for the fine-tuning of drug release, ensuring a more controlled and sustained therapeutic effect. This precision in targeting not only improves the effectiveness of the treatment but also reduces systemic toxicity, a significant challenge in traditional chemotherapy.

Challenges still remain in optimizing the use of magnetic nanoparticles for clinical applications. Issues such as biocompatibility, potential toxicity, and the stability of the nanoparticles within the body need to be addressed. Liu et al. (2024) emphasize the importance of using biocompatible materials for the synthesis of these nanoparticles, which can reduce the risk of adverse immune reactions. The development of more efficient synthesis methods that can scale up production while maintaining the nanoparticles' functionality is crucial for their future clinical use.

Developments in the field of tissue engineering make it possible to create artificial tissues and organs that can replace damaged tissue after cancer treatment. For example, using bone cancer as an example, tissue engineering methods are being developed to find biocompatible, tissue-specific and functional materials that will help restore bone and have an anti-cancer effect at the same time. Fourth-generation biomaterials have the properties of smart biomaterials, which have anti-infective and anti-tumour functions, which release active molecules and activate pathways necessary for fighting in the tumour microenvironment (Alromi et al., 2021; Ambrosio et al., 2021).

The use of nanomaterials, such as those described by Egwu et al. (2024), allows for better control over the drug release process and reduces the risk of harmful by-products. Nanomaterials can be designed to be biocompatible, biodegradable, and non-toxic, which significantly mitigates the risks of an immune response or tissue damage. These materials are often engineered to degrade in the body without releasing harmful substances, making them more suitable for clinical applications. Researchers are working on strategies to design these biomaterials with specific surface modifications that enable them to avoid immune system detection, thus reducing the likelihood of an immune response. This can be achieved through the use of hydrophilic coatings or by incorporating molecules that promote immune tolerance, further enhancing the safety profile of these materials.

As Egwu et al. (2024) discuss, the future of nanomaterials in drug delivery lies in their ability to combine effectiveness with minimal toxicity, allowing for a more targeted approach to treatment with fewer side effects. The ongoing advancements in fourth-generation biomaterials and nanomaterial-based drug delivery systems are set to play a crucial role in cancer therapy. By minimizing toxicity and providing controlled, localized delivery of therapeutic agents, these innovations hold the potential to significantly improve outcomes for cancer patients, particularly in the areas of tissue regeneration and tumour management.

In the clinical settings of Kyrgyzstan, Albania, and Kosovo, innovative cancer diagnostic and treatment methods have been increasingly integrated to enhance patient care. In Kyrgyzstan, for example, the use of passive microwave radiometry combined with AI has shown promise in diagnosing breast cancer. This approach, when combined with mammography and ultrasound, has improved the ability to identify pathological changes at early stages, thus enabling better prediction and prevention of malignancy. Additionally, AI assists in analysing microRNA biomarkers, contributing to the identification of conditions that could potentially develop into cancer.

In Albania, there is a significant focus on molecular diagnostics, especially in the area of endometrial cancer. The introduction of molecular classification systems has helped improve the selection of patients for specific treatments, enhancing both prognosis and treatment efficiency. Research into the immune system's response during pregnancy and its similarities with endometrial cancer has also paved the way for new therapeutic insights. Furthermore, the identification of microRNAs for early oral cancer detection is helping clinicians in Albania adopt more

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proactive screening methods, ensuring that cancer is caught at a more treatable stage.

Kosovo has seen the implementation of genetic testing for hereditary gastric cancer, which has allowed for more accurate risk assessments and tailored treatment plans. The use of immunotherapy for lung cancer, particularly with immune checkpoint inhibitors, has improved survival rates, and molecular biomarkers are increasingly used to guide diagnosis and treatment. The ability of molecular diagnostics to detect malignant tumours early in their development has significantly improved, providing clinicians with valuable tools to personalize cancer treatments and monitor therapy responses more effectively. These innovations have enabled oncologists in Kyrgyzstan, Albania, and Kosovo to move toward more personalized, precise treatment approaches, improving early detection, enhancing treatment outcomes, and reducing unnecessary toxicities. These advancements are making a critical difference in patient care by providing more effective, less invasive options for diagnosing and treating cancer.

Over the past ten years, the application of AI in the field of oncology has achieved great results. With the help of training and the availability of extensive information in the field of medical research, as well as unlimited possibilities in computing, AI has great potential in the diagnosis and treatment of cancer in patients. This method makes it possible to detect oncology more accurately at an early stage, determine the classification, and molecular structure of the tumour, prognosis of the disease and treatment, create individual treatment regimens, as well as automate the process of radiation therapy and be involved in the invention of new drugs (Chen et al., 2021). AI can be used to analyse histopathological data, as well as CT, MRI, mammography, or photographs of suspicious lesions. The genetic profile data can be used to determine the classification of tumours more accurately and quickly using AI. In addition, the detection of cancer mutations and the origin of tumour cells using liquid biopsy is also possible with proper training and settings of AI. Characterisation of the microenvironment of cancer formation, formation of design, and physicochemical properties of drugs is also possible using this method (Bhinder et al., 2021; Soyka et al., 2024).

Temaj et al. (2024) conducted a study, which examines changes in genetic information and their impact on the cancer process. When a mutation occurs in a gene responsible for creating a protein, it can lead to cells malfunctioning and turning into cancerous cells. Up-frameshift-1 (UPF1) has protective functions that help remove incorrect proteins from cells and prevent their accumulation. In addition, lncRNAs also affect the way cells divide and grow. In this regard, UPF1 can be a biomarker for the diagnosis and treatment of cancer, and the combination of UPF1 and lncRNA can affect cell growth processes and provide prognoses in this area. As for immune checkpoint inhibitors, they are one of the main methods of cancer treatment, both mono- and complex therapy. However, the problem with this method is that the effect is achieved in only one-third of all patients. Thus, the effectiveness of this method is influenced by individual cancer cell data, levels of immune checkpoint ligands, and the extracellular matrix, which is a crucial link. A study by Fejza et al. (2023) confirmed that optimisation of the extracellular matrix has an important interaction with the immune system of different tumour types. Many molecules derived from the extracellular matrix are used as a marker that can detect tumours and have a positive effect on treatment.

The use of immunotherapy in paediatric oncology is successful, as the survival rate for children is about 80–90%. Optimisation of supportive care and the use of therapy based on the genetic characteristics of tumour cells are important factors in this area. Among the improvements and innovations, it is worth noting the classification of certain subgroups based on genetic data in the form of aneuploidy or translocation, as well as their interaction and response to treatment. One of the problems that arise during treatment is the occurrence of toxicity with negative outcomes. Therefore, the use of immunotherapy has promising possibilities in cases of high risk, relapse and certain genetic changes. Signalling pathways can be targeted to slow down or stop small molecules by monoclonal antibodies that can recognise cell surface antigens. Inotuzumab ozogamicin, used in immunotherapy, can interact with leukaemia cells and release a toxin that leads to the destruction of the pathological cell, while blinatumumab activates T cells that have a genetic programme capable of detecting leukaemia cells. However, this area of oncology still requires additional study and research (Graiqevci-Uka et al., 2023).

Scientists in Albania Bruno et al. (2024) and Gupta et al. (2024) conducted a review to improve classifications and determine the risk of complications of endometrial cancer. The existing characteristics of risk predictors are not able to predict the response to treatment and the occurrence of relapse in the future. Biomolecular classification can help improve the system of selecting patients for a particular type of treatment, and it also improves the likelihood of complications in women with endometrial cancer. Among the disadvantages of this method, it is worth noting the unclear differences in the case of relapse, so in the future, efforts should be directed

at optimising the classification and using it in complex diagnostics. Zub et al. (2022) and Betti et al. (2023) studied the immune system of endometrial cancer by comparing it to pregnancy. As such, the immune systems of pregnancy and endometrial cancer are similar, however, those factors that have a positive effect on pregnancy can have a negative impact on the oncological process of the uterus. For example, studying the immune response during pregnancy complications can help determine the immune system response to cancer. The availability of existing research and machine learning can improve oncology research. These data can be used both for the management of complicated pregnancies and for the diagnosis and treatment of endometrial cancer.

A group of scientists from Kyrgyz Republic Fisher et al. (2023) conducted a study on the use of passive microwave radiometry for the diagnosis of breast cancer, and in the future, to identify microRNAs of this disease. As such, a study found that the combined use of mammography, ultrasound, passive microwave radiometry, and AI microRNAs can identify conditions and pathological changes in the body that may turn into cancer in the future. The use of these methods as mono-diagnostics shows only a low probability of cancer in a patient, while the combination of all methods determines reliable signs of the oncological process. This method identifies patients at risk of malignant disease and prevents precancerous conditions. In addition, a study by Hussain et al. (2024) on circular RNAs and KRAS found that circRNAs are a type of RNA that plays a significant role in the control of certain processes in cancer. Other types of RNA have also been studied that have an impact on the functioning and signalling pathway of the KRAS gene in cancerous tumours and can increase the activity of the KRAS pathway, thereby enhancing the growth and spread of cancer cells. Therefore, circular RNAs may influence the tumour's immune response to treatment, apoptosis programming, and drug sensitivity. This makes this method important in the diagnosis and treatment of cancer. However, there are also problems in this area: the complexity of KRAS gene mutations and the lack of research to clearly understand the processes.

Statistics and innovation perspectives

Begolli et al. (2023) studied molecular diagnostics and immunochemical tools, gene expression microarrays, immunoassays and immunostaining, and reviewed new trends in diagnostics and future applications of carbohydrate sulfotransferases. The latter accelerates the synthesis of proteoglycans, which are responsible for physical contact and signal transmission between neighbouring cells in normal and pathological conditions. The study found that carbohydrate sulfotransferases are used in most cases in the diagnosis of inflammatory conditions, cancer and connective tissue diseases. Low activity was detected in congenital connective tissue diseases, but an increased response was found in oncological processes. Mutation of the gene for carbohydrate sulfotransferase 3 causes bone dysplasia and multiple joint dislocations inherited by autosomal recessive type, on the other hand, increased activity of carbohydrate sulfotransferases 11, 12 and 15 is an unfavourable prognostic factor in ovarian cancer, glioblastoma and pancreatic malignancy. In addition, hyperactivity of carbohydrate sulfotransferases 11 and 15 in vascular smooth muscle cells has been associated with severe lung conditions in patients with COVID-19. This progress in molecular diagnostics is similar to the present study and confirms the importance of studying issues in this area.

In addition, Sadeghnejad Barkousaraie et al. (2020) addressed deep neural network training to improve beam orientation in prostate cancer using intensity-modulated radiation therapy. Manual or protocol selection of beam orientation is quite time-consuming and can produce incorrect results. Many algorithms were developed to improve the choice of beam orientation due to its impact on treatment outcome, but these calculations are quite slow. In the course of the study, a new method for fast beam orientation selection using deep neural network training was proposed, which can quickly produce a plan using state-of-the-art column generation. The innovation proposed by the researchers is based on the structure of training, observation control, the structure of the neural network training process, and the ability to learn from anatomical features to plan the required beam orientations without using dosimetric information from the candidate beams. AI studies the possibility of simulating column generation and selects the beam orientation by accurately calculating the beam suitability. This study involved 70 patients with prostate cancer who were divided into 3 groups: 50 patients for neural network training, 7 patients for validation, and 13 patients for testing – for model formation and testing. Six contours were created for each patient: the planned target volume, body, bladder, rectum and both femoral heads. Using neural networks and supervised column generation, two sets of plans were created for each subgroup in the test set. The method took about 1.5 s to create a set of 5 beam orientations 300 s to calculate the dose-effect matrices for the 5 beams, and about 20 s to improve the fluence map. However, it took about 15 hours to

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perform all the final calculations of the dose-effect matrices for all beams. The average dose received by the organs ranged from 1 to 6%. The bladder had the lowest dose – 1.18%, the rectum – 2.4%, left and right femoral heads – 5.8 and 5.5% respectively, and the body – 0.1% between the generated treatment plans. The study results show that the developed method of fast beam orientation selection based on neural network training can calculate the beam orientation in a matter of seconds, which makes it suitable for clinical procedures. The training of neural networks is similar to the present study and confirms the importance of introducing innovative methods in the field of oncology to improve treatment prognoses and speed up diagnosis.

Alkhathami et al. (2022) studied the issue of breast cancer and serum levels of lncRNA, which is usually abnormal in malignant tumours. This study involved 100 patients with histologically confirmed breast cancer and 100 healthy patients. Blood was drawn with serum separation and RNA extraction, followed by analysis of lncRNA expression (androgen receptor negatively induced [ANRIL], taurine-regulated gene 1 [TUG1], urothelial cancer 1 [UCA1] and HIT). Increased expression results were observed in patients with breast cancer compared to healthy controls. The relative expression of UCA1 lncRNA was significantly increased in patients with rapidly developing stages compared to patients at the initial stage. In addition, the expression of TUG1 lncRNA in patients with early-stage cancer was higher than in patients with advanced cancer, and ANRIL lncRNA was upregulated in patients with positive status. Furthermore, lncRNA-HIT had the greatest role in the potential use as a candidate biomarker in patients with breast cancer. The findings of this study suggest that changes in lncRNA expression may be a significant biomarker in the prognosis of cancer. The data from the biomarker panel determines the severity and progression of the cancer process. The study also contributed to the improvement of knowledge of the molecular mechanism in the field of breast cancer. Among the limitations of the study was the analysis based on the determination of lncRNA in serum, rather than working with patient tissue. This study has similar results and prospects in the study of the cancer process, its diagnosis and treatment.

Conclusion

According to statistics, about 10 million cases of cancer are detected worldwide per year, which means that every 5 people suffer from cancer. In this regard, scientists are striving to study and optimise new approaches to the diagnosis and treatment of cancer. In this theoretical study, some promising types of cancer diagnosis and treatment were considered.

This study examined the development of molecular diagnostic methods that help identify individual mutations, which allows us to select the most effective treatment. In Kosovo, research using molecular imaging and immune checkpoint inhibitors is being actively conducted. Albania is introducing molecular values in the classification of endometrial cancer, which helps determine the likelihood of complications. The study also established that precision medicine plays an important role: the use of genetics and bioinformatics allows us to tailor treatment individually to each patient, considering the genetic and molecular characteristics of the tumour and the patient's response. Kyrgyz Republic is actively researching the genetic aspects of cancer and the impact on their immune system, apoptosis and response to treatment. In addition, immunotherapy, which includes immune checkpoint inhibitors, contributes to a more robust resistance to the cancer process, which improves the quality and duration of patients' lives. In Albania, a comparative analysis between the immune systems of endometrial cancer and pregnancy was applied, which leads to the potential for the management of complicated pregnancies and endometrial cancer.

The present study confirms that the study of new radiotherapy methods includes intensity-modulated radiotherapy, CyberKnife, proton and brachytherapy. The development of nanotechnologies using microparticles to deliver drugs to tumour cells can improve the effect of treatment and reduce side effects, while tissue engineering can create artificial tissues and organs to visualise the cancer process or restore damaged organs after treatment. In addition, research is being carried out using AI, which is used in medicine to help predict the risk of cancer, speed up diagnosis, adapt treatment and monitor the results of therapy. Limitations in the introduction of the latest methods of diagnosis and treatment of cancer are the lack of research, accessibility, information and experimental studies in this area.

To implement the latest methods of cancer diagnosis and treatment, it is important for clinicians to use molecular diagnostics and molecular imaging. Nuclear imaging and photoacoustic imaging allow for accurate assessment of tumours at the molecular level, which ensures early detection and monitoring of treatment effectiveness. Liquid biopsies, which allow for real-time tumour monitoring with minimal intervention, should become the standard of practice, despite certain limitations of this technique.

It is important to integrate genetic and epigenetic biomarkers to individualize treatment, in particular

to assess mutations such as mutation in the proto-oncogene in patients with colorectal cancer. Immune therapy, in particular checkpoint inhibitors, is a promising area and requires precise selection for each patient. Advanced radiotherapy techniques, such as proton therapy and intensity-modulated radiation therapy, should be implemented to improve treatment accuracy and reduce damage to healthy tissue. The use of artificial intelligence to analyse medical images and predict responses to therapy can optimize diagnostic and treatment processes.

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