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Innovative Technologies Changing Cancer Treatment

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ABSTRACT

One in every six fatalities worldwide is caused by the global health issue of cancer. The procedure of treating cancer has been quite difficult. Aside from recent significant advancements in stem cell therapy, targeted therapy, ablation therapy, nanoparticles, natural antioxidants, radionics, chemodynamic therapy, sonodynamic therapy, and ferroptosis-based therapy, traditional treatment modalities like surgery, chemotherapy, and radiotherapy are still in use. Oncology practises today concentrate on creating effective and secure cancer nanomedicines. Targeting both primary and metastatic cancer foci, stem cell therapy has shown encouraging results in regenerating and repairing sick or damaged tissues, and nanoparticles have introduced novel diagnostic and therapeutic alternatives. The growth and spread of particular cancer cells can be prevented by targeted therapy, which also protects good cells from harm. Ablation therapy has become a minimally invasive method for freezing or burning tumours without performing open surgery. Natural antioxidants have shown promise in locating free radicals and counteracting their damaging effects, perhaps treating or preventing cancer. Clinical trials are being conducted on a number of innovative technologies, some of which have already received approval. An update on recent developments and discoveries in cancer therapy was provided in this review.

Keywords- *1 Definition of Cancer, 2 Advanced and innovative cancer therapies ,3 types of cancer treatment*

1. Introduction

The transformative impact of technological advances on cancer research featured prominently at the 54th annual meeting of the Irish Association for Cancer Research (IACR). Translational research is advancing its enormous potential at breakneck speed, as mature applied technologies meet with the innovations of multi-disciplinary research groups. High-throughput omics studies (e.g., genomics, proteomics, metabolomics, transcriptomics) utilize new technologies to generate enormous datasets that are being mined with ever-more specificity and value [1]. The potential of routine diagnostic technologies, including magnetic resonance imaging (MRI), computed tomography (CT), positron emission tomography (PET) imaging, and immunohistochemical analysis of tissues is being fully understood through the development of the fields of radiomics and pathomics [2,3]. Nanomedicine is harnessing the power of nanotechnology to improve drug delivery, pharmaceutical properties, imaging, and diagnosis, establishing the area of theranostics [4,5]. The ability to isolate, characterise, and functionally phenotype nanometer-scale extracellular vesicles is opening up new possibilities for the therapeutic and diagnostic use of these intercellular RNA, DNA, and protein carriers [6]. Tissue processing and high-throughput fluorimetry underpins novel tools like BH3 profiling to predict cellular response to chemotherapeutic agents [7]. The concept of sensitizing cancer cells to radiotherapy has been investigated for close to 50 years but new advances are seeing more effective small molecule (oxygen/oxygen mimics), macromolecule (miRNA, siRNA, peptide), and engineered nanomaterial-based radiosensitisers emerge [8]. Here we discuss novel studies presented at the 2018 IACR Annual Meeting, which showcased these cutting-edge technologies and their applications in the cancer research arena.

2. What Is Cancer?

The Definition of Cancer

Cancer is a disease in which some of the body's cells grow uncontrollably and spread to other parts of the body. [9]

Cancer can start almost anywhere in the human body, which is made up of trillions of cells. Normally, human cells grow and multiply (through a process called cell division) to form new cells as the body needs them. When cells grow old or become damaged, they die, and new cells take their place.[10]

Sometimes this orderly process breaks down, and abnormal or damaged cells grow and multiply when they shouldn't. These cells may form tumors, which are lumps of tissue. Tumors can be cancerous or not cancerous (benign). [11]

Cancerous tumors spread into, or invade, nearby tissues and can travel to distant places in the body to form new tumors (a process called metastasis). Cancerous tumors may also be called malignant tumors. Many cancers form solid tumors,[11]

3. Differences between Cancer Cells and Normal Cells

Cancer cells differ from normal cells in many ways. For instance, cancer cells:grow in the absence of signals telling them to grow. Normal cells only grow when they receive such signals, ignore signals that normally tell cells to stop dividing or to die (a process known as programmed cell death, or apoptosis).[12]

invade into nearby areas and spread to other areas of the body. Normal cells stop growing when they encounter other cells, and most normal cells do not move around the body,tell blood vessels to grow toward tumors. These blood vessels supply tumors with oxygen and nutrients and remove waste products from tumors.[13]

hide from the immune system. The immune system normally eliminates damaged or abnormal cells,trick the immune system into helping cancer cells stay alive and grow. For instance, some cancer cells convince immune cells to protect the tumor instead of attacking it.[14]

4. Advanced and innovative cancer therapies

Among the obstacles of cancer, drug resistance and its delivery systems are the most problem in cancer cure and decreasing signs and symptoms; but currently, there are many approved treatment approaches and drugs. The efficiency of conventional cancer is reduced due to tumor pathology and architectural abnormality of tumor tissue blood vessels.[15] The following are the advanced and innovative cancer therapy types with their benefits and challenges.[15]

4.1 Stem cells therapy

Stem cells are undifferentiated cells present in the bone marrow (BM) with an ability to differentiate into any type of body cell. Stem cell therapeutic strategy is also one of the treatment options for cancer which are considered to be safe and effective. Application of stem cell is yet in the experimental clinical trial; for example, their use in the regeneration of other damaged tissue is being explored. Mesenchymal stem cells (MSCs) are currently being used in trials that are delivered from the BM, fat tissues, and connective tissues.[16]

4.2 Pluripotent stem cells

Embryonic stem cells (ESCs) isolated from the uniform inner mass cells of the embryo possess the flexibility to administer rise to any or all kinds of cells except those within the placenta. In 2006, the invention of Yamanaka factors to induce pluripotent stem cells (iPSCs) from physical cells in a culture marked a breakthrough in cell biology.[17] Avoiding ethical issues from embryo destruction, iPSCs and ESCs have the same characteristics. Hematopoietic embryonic stem cells (hESCs) and iPSCs are currently used for the induction of effector T cells and natural killer (NK) cells.and anti-tumor vaccine preparation.[18]

4.3 Adult stem cells

Adult stem cells (ASCs) groups often used in tumor therapy include hematopoietic stem cells (HSCs), MSCs, and neural stem cells (NSCs). HSCs, located in BM, can form all mature blood cells in the body. Currently, only approved by the Food and Drug Administration (FDA) is the infusion of HSCs derived from cord blood to treat multiple myeloma and leukemia. [19] MSCs are found in many tissues and organs, playing important roles in tissue repair and regeneration into cells, such as osteocytes, adipocytes, and chondrocytes. MSCs have special biological characteristics and are used as complimentary with other approaches in treating tumors.NSCs can self-renew and generate new neurons and glial cells and are used for treating both primary and metastatic breast and other tumors[20]

4.4 Targeted drug therapy

Targeted cancer therapies are drugs or other substances which are sometimes interchangeably used as “molecularly targeted drugs,” “molecularly targeted therapies,” and “precision medicines.” Those drugs’ mechanism of action is by interfering with growth molecules which leads to blocking the growth and spreading of cancer. Tumor initiation and progression are determined by the TM of an atypical tumor which comprises endothelial cells, pericytes, smooth muscle cells, fibroblasts, various inflammatory cells, dendritic cells, and CSCs. There are various signaling mechanisms and pathways that TM-forming cells dynamically interact with the cancerous cells which are suitable for sustaining a reasonably high cellular proliferation. So, it is the area of research interest using TM conditions to mediate effective targeting measures for cancer therapy.[21]

- Selectively treating cancer cells with conventional chemotherapy is difficult since it is similar to normal cells. So those problems are intervened by cellular mechanisms, such as cell cycle arrest, apoptosis induction, proliferation prevention, and interfering with metabolic reprogramming by targeted drug therapy agents.Modifying TM and targeting TM for drug delivery for effective treatment are two strategies that can be used for the treatment of cancer .[22] Targeted therapy drugs do work in different ways from standard chemotherapy drugs treatment like attacking cancer cells while doing less damage to normal cells which is a programming that sets them apart from normal, healthy cells.Using targeted therapy markedly increased the survival rate for some diseases, for example, from 17% to 24% in patients with advanced pancreatic cancer, the addition of erlotinib

to standard chemotherapy. Imatinib has had a dramatic effect on chronic myeloid leukemia, and rituximab, sunitinib, and trastuzumab have revolutionized the treatment of renal cell carcinoma and breast cancer, respectively.[23,24]

- These agents stop the tumors from making new blood vessels which helps cut off the tumors' blood supply so that tumors cannot grow. In addition, they arrest tumor growth that involves by curtailing blood supply to the tumor by inhibiting angiogenic factors, such as vascular endothelial growth factor (VEGF) or its receptors. The study showed the survival of patients with advanced colorectal carcinoma extended by months after the use of Avastin (bevacizumab) in combination with 5-fluorouracil-based chemotherapy.[25]

5. Types of Cancer Treatment

There are many types of cancer treatment. The types of treatment that you receive will depend on the type of cancer you have and how advanced it is.[26]

5.1 Biomarker Testing for Cancer Treatment

Biomarker testing is a way to look for genes, proteins, and other substances (called biomarkers or tumor markers) that can provide information about cancer. Each person's cancer has a unique pattern of biomarkers. Some biomarkers affect how certain cancer treatments work. Biomarker testing may help you and your doctor choose a cancer treaThere are also other kinds of biomarkers that can help doctors diagnose and monitor cancer during and after treatment. To learn more, visit the Tumor Markers fact sheet.[27]

5.2 Chemotherapy to Treat Cancer

Chemotherapy works by stopping or slowing the growth of cancer cells, which grow and divide quickly. Chemotherapy is used for two reasons Chemotherapy is used to treat many types of cancer. For some people, chemotherapy may be the only treatment you receive. But most often, you will have chemotherapy with other cancer treatments. The types of treatment that you need depend on the type of cancer you have, if it has spread and where, and if you have other health problems. [28]

5.3 Hormone Therapy to Treat Cancer

Hormone therapy is a cancer treatment that slows or stops the growth of cancer that uses hormones to grow. Hormone therapy is also called hormonal therapy, hormone treatment, or endocrine therapy. Hormone therapy can stop or slow cancer's growth and reduce the chance it will return.

Hormone therapy is used to treat prostate and breast cancers that use hormones to grow. Hormone therapy is most often used along with other cancer treatments. The types of treatment that you need depend on the type of cancer, if it has spread and how far, if it uses hormones to grow, and if you have other health problems

5.4 Hyperthermia to Treat Cancer

Hyperthermia is almost always used with other forms of cancer treatment. Many clinical trials have shown that hyperthermia, when used with treatments such as radiation therapy and chemotherapy, helps shrink tumors and may make it easier for them to kill cancer cells. Hyperthermia is a type of treatment in which body tissue is heated to as high as 113 °F to help damage and kill cancer cells with little or no harm to normal tissue. Hyperthermia to treat cancer is also called thermal therapy, thermal ablation, or thermotherapy.[29]

5.5 Immunotherapy to Treat Cancer

Immunotherapy is a type of cancer treatment that helps your immune system fight cancer. The immune system helps your body fight infections and other diseases. It is made up of white blood cells and organs and tissues of the lymph system. Immunotherapy is a type of biological therapy. [30]Biological therapy is a type of treatment that uses substances made from living organisms to treat cancer .the immune system detects and destroys abnormal cells and most likely prevents or curbs the growth of many cancers. For instance, immune cells are sometimes found in and around tumors. These cells, called tumor-infiltrating lymphocytes or TILs, are a sign that the immune system is responding to the tumor. People whose tumors contain TILs often do better than people whose tumors don't contain them.[31]

5.6 Cancer Treatment Vaccines

Cancer treatment vaccines are a type of immunotherapy that treats cancer by strengthening the body's natural defenses against the cancer. Unlike cancer prevention vaccines, cancer treatment vaccines are designed to be used in people who already have cancer—they work against cancer cells, not against something that causes cancer.The idea behind treatment vaccines is that cancer cells contain substances, called tumor-associated antigens, that are not present in normal cells or, if present, are at lower levels. Treatment vaccines can help the immune system learn to recognize and react to these antigens and destroy cancer cells that contain them.[32]

5.7 Radiation Therapy to Treat Cancer

Radiation therapy (also called radiotherapy) is a cancer treatment that uses high doses of radiation to kill cancer cells and shrink tumors. At low doses, radiation is used in x-rays to see inside your body, as with x-rays of your teeth or broken bones.[33]

Radiation therapy is used to treat cancer and ease cancer symptoms.When used to treat cancer, radiation therapy can cure cancer, prevent it from returning, or stop or slow its growth.When treatments are used to ease symptoms, they are known as palliative treatments. External beam radiation may shrink tumors to treat pain and other problems caused by the tumor, such as trouble breathing or loss of bowel and bladder control. Pain from cancer that has spread to the bone can be treated with systemic radiation therapy drugs called radiopharmaceuticals.[34]

5.8 Surgery to Treat Cancer

Surgery, when used to treat cancer, is a procedure in which a surgeon removes cancer from your body. Surgeons are medical doctors with special training in surgery.[35]

5.9 Lasers to Treat Cancer

Laser therapy uses an intense, narrow beam of light to remove or destroy cancer and abnormal cells that can turn into cancer. Tumor cells absorb light of different wavelengths (or colors) than normal cells do. So, tumor cells can be targeted by selecting the proper wavelength of the laser. Laser therapy is a type of local treatment, which means it treats a specific part of your body.

Lasers can also be used in other types of local treatment, including photodynamic therapy and a treatment that is like hyperthermia, called laser interstitial thermal therapy, or LITT.[36]

5.10 Targeted Therapy to Treat Cancer

Targeted therapy is a type of cancer treatment that targets proteins that control how cancer cells grow, divide, and spread. It is the foundation of precision medicine. As researchers learn more about the DNA changes and proteins that drive cancer, they are better able to design treatments that target these proteins. [37]

5.11 Hyperthermia to Treat Cancer

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5.12 Photodynamic Therapy to Treat Cancer

Photodynamic therapy uses a drug that is activated by light, called a photosensitizer or photosensitizing agent, to kill cancer cells. The light can come from a laser or other source, such as LEDs. Photodynamic therapy is also called PDT.[39]

- **How photodynamic therapy treats cancer**

When cells that have absorbed photosensitizers are exposed to a specific wavelength of light, the photosensitizer produces a form of oxygen, called an oxygen radical, that kills them.

Photodynamic therapy may also damage blood vessels in the tumor, which prevents it from receiving the blood it needs to keep growing. And, it may trigger the immune system to attack tumor cells, even in other areas of the body[40]

6. Conclusion

The concept of sensitizing cancer cells to radiotherapy has been investigated for close to 50 years but new advances are seeing more effective small molecule (oxygen/oxygen mimics), macromolecule (miRNA, siRNA, peptide), and engineered nanomaterial-based radiosensitisers emerge. Cancerous tumors may also be called malignant tumors. Many cancers form solid tumors,9 Differences between Cancer Cells and Normal Cells Cancer cells differ from normal cells in many ways. For instance, cancer cells: grow in the absence of signals telling them to grow. ignore signals that normally tell cells to stop dividing or to die (a process known as programmed cell death, or apoptosis). hide from the immune system.

Each person's cancer has a unique pattern of biomarkers. Chemotherapy to Treat Cancer Chemotherapy works by stopping or slowing the growth of cancer cells, which grow and divide quickly. Hormone therapy is also called hormonal therapy, hormone treatment, or endocrine therapy. Hormone therapy is used to treat prostate and breast cancers that use hormones to grow. Hyperthermia to Treat Cancer Hyperthermia is almost always used with other forms of cancer treatment. It is made up of white blood cells and organs and tissues of the lymph system. For instance, immune cells are sometimes found in and around tumors. Unlike cancer prevention vaccines, cancer treatment vaccines are designed to be used in people who already have cancer—

they work against cancer cells, not against something that causes cancer. External beam radiation may shrink tumors to treat pain and other problems caused by the tumor, such as trouble breathing or loss of bowel and bladder control. As researchers learn more

References

1. Hasin, Yehudit, et al. "Multi-Omics Approaches to Disease." *Genome Biology*, vol. 18, May 2017, p. 83. *PubMed Central*, https://doi.org/10.1186/s13059-017-1215-1
2. Gillies, Robert J., et al. "Radiomics: Images Are More than Pictures, They Are Data." *Radiology*, vol. 278, no. 2, Feb. 2016, pp. 563–77. *PubMed Central*, https://doi.org/10.1148/radiol.2015151169
3. Saltz, Joel, et al. "Towards Generation, Management, and Exploration of Combined Radiomics and Pathomics Datasets for Cancer Research." *AMIA Summits on Translational Science Proceedings*, vol. 2017, July 2017, pp. 85–94. *PubMed Central*, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5543366
4. Shi, Jinjun, et al. "Cancer Nanomedicine: Progress, Challenges and Opportunities." *Nature Reviews. Cancer*, vol. 17, no. 1, Jan. 2017, pp. 20–37. *PubMed Central*, https://doi.org/10.1038/nrc.2016.108
5. Yordanova, Anna, et al. "Theranostics in Nuclear Medicine Practice." *OncoTargets and Therapy*, vol. 10, Oct. 2017, pp. 4821–28. *PubMed Central*, https://doi.org/10.2147/OTT.S140671.
6. Maas, Sybren L. N., et al. "Extracellular Vesicles: Unique Intercellular Delivery Vehicles." *Trends in Cell Biology*, vol. 27, no. 3, Mar. 2017, pp. 172–88. *PubMed Central*, https://doi.org/10.1016/j.tcb.2016.11.003.
7. Montero, Joan, et al. "Drug-Induced Death Signaling Strategy Rapidly Predicts Cancer Response to Chemotherapy." *Cell*, vol. 160, no. 5, Feb. 2015, pp. 977–89. *PubMed Central*, https://doi.org/10.1016/j.cell.2015.01.042
8. Wang, Hao, et al. "Cancer Radiosensitizers." *Trends in Pharmacological Sciences*, vol. 39, no. 1, Jan. 2018, pp. 24–48. *PubMed*, https://doi.org/10.1016/j.tips.2017.11.003.
9. *Cancer Statistics - NCI*. 2 Apr. 2015, https://www.cancer.gov/about-"cancer/understanding/statistics.
10. What Is Cancer?" *Cancer Research UK*, 16 Dec. 2014, https://www.cancerresearchuk.org/about-cancer/what-is-cancer
11. What Is Cancer?" *Cancer.Net*, 1 Aug. 2012, https://www.cancer.net/navigating-cancer-care/cancer-basics/what-c%C3%A1ncer.
12. https://www.google.com/search?q=difference+between+cancer+cells+and+normal+cell&oq=diifernance+between+cancer+cell+&aqs=chrome.1.69i57j0i10i13i512j0i13i512l2j0i13i15i30j0i15i22i30j0i22i30j0i5i13i15i30j0i8i13i30l2.19796j0j7&sourceid=chrome&ie=UTF-8
13. "Cancer Cells vs. Normal Cells: How Are They Different?" *Verywell Health*, https://www.verywellhealth.com/cancer-cells-vs-normal-cells-2248794. Accessed 20 Mar. 2023
14. *The Difference between Normal and Cancer Cells*. https://www.mymed.com/diseases-conditions/cancer/the-difference-between-normal-and-cancer-cells. Accessed 20 Mar. 2023.
15. *Google Scholar*. https://scholar.google.com/scholar_lookup?journal=J+Nanomater&title=Cancer+nanomedicine:+a+new+era+of+successful+targeted+therapy&author=MZ+El-Readi&author=MA+Althubiti&volume=2019&publication_year=2019&pages=4927312&. Accessed 20 Mar. 2023.
16. Takahashi, Kazutoshi, and Shinya Yamanaka. "Induction of Pluripotent Stem Cells from Mouse Embryonic and Adult Fibroblast Cultures by Defined Factors." *Cell*, vol. 126, no. 4, Aug. 2006, pp. 663–76
17. Romito, Antonio, and Gilda Cobellis. "Pluripotent Stem Cells: Current Understanding and Future Directions." *Stem Cells International*, vol. 2016, Dec. 2015, p. e9451492
18. *Pluripotent Stem Cells - Latest Research and News | Nature*. https://www.nature.com/subjects/pluripotent-stem-cells. Accessed 20 Mar. 2023
19. *Adult Stem Cell - an Overview | ScienceDirect Topics*. https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/adult-stem-cell. Accessed 20 Mar. 2023.
20. Prentice, David A. "Adult Stem Cells: Successful Standard for Regenerative Medicine." *Circulation Research*, vol. 124, no. 6, Mar. 2019, pp. 837–39. *DOI.org (Crossref)*
21. *Targeted Therapy for Cancer - NCI*. 15 Aug. 2014, https://www.cancer.gov/about-cancer/treatment/types/targeted-therapies
22. Adjei, Isaac M., and Sharma Blanka. "Modulation of the Tumor Microenvironment for Cancer Treatment: A Biomaterials Approach." *Journal of Functional Biomaterials*, vol. 6, no. 1, Feb. 2015, pp. 81–103. *PubMed Central*.

23. *Google Scholar*. https://scholar.google.com/scholar_lookup?journal=J+Clin+Oncol&title=Positron+emission+tomography+as+an+imaging+biomarker&autho r=WA+Weber&volume=24&publication_year=2006&pages=3282-3292&pmid=16829652&. Accessed 21 Mar. 2023.
24. Weber, Wolfgang A. "Positron Emission Tomography as an Imaging Biomarker." *Journal of Clinical Oncology: Official Journal of the American Society of Clinical Oncology*, vol. 24, no. 20, July 2006, pp. 3282–92.
25. Hurwitz, Herbert, et al. "Bevacizumab plus Irinotecan, Fluorouracil, and Leucovorin for Metastatic Colorectal Cancer." *The New England Journal of Medicine*, vol. 350, no. 23, June 2004, pp. 2335–42. *PubMed*, https://doi.org/10.1056/NEJMoa032691
26. *Types of Cancer Treatment - NCI*. 31 July 2017, https://www.cancer.gov/about-cancer/treatment/types.
27. *Biomarker Testing for Cancer Treatment - NCI*. 5 Oct. 2017, https://www.cancer.gov/about-cancer/treatment/types/biomarker-testing-cancer-treatment.
28. *Chemotherapy to Treat Cancer - NCI*. 29 Apr. 2015, https://www.cancer.gov/about-cancer/treatment/types/chemotherapy.
29. *Hormone Therapy for Cancer - NCI*. 29 Apr. 2015, https://www.cancer.gov/about-cancer/treatment/types/hormone-therapy.
30. *Immunotherapy for Cancer - NCI*. 29 Apr. 2015, https://www.cancer.gov/about-cancer/treatment/types/immunotherapy
31. "How Immunotherapy Works To Treat Cancer." *Cleveland Clinic*, https://my.clevelandclinic.org/health/treatments/11582-immunotherapy. Accessed 21 Mar. 2023.
32. *Cancer Treatment Vaccines - Immunotherapy - NCI*. 24 Sept. 2019, https://www.cancer.gov/about-cancer/treatment/types/immunotherapy/cancer-treatment-vaccines
33. *Radiation Therapy for Cancer - NCI*. 29 Apr. 2015, https://www.cancer.gov/about-cancer/treatment/types/radiation-therapy.
34. "What Is Radiation Therapy?" *Cancer.Net*, 22 Mar. 2013, https://www.cancer.net/navigating-cancer-care/how-cancer-treated/radiation-therapy/what-radiation-therapy
35. *Surgery for Cancer - NCI*. 29 Apr. 2015, https://www.cancer.gov/about-cancer/treatment/types/surgery .
36. *Lasers to Treat Cancer - NCI*. 13 Sept. 2011, https://www.cancer.gov/about-cancer/treatment/types/surgery/lasers .
37. *Targeted Therapy for Cancer - NCI*. 15 Aug. 2014, https://www.cancer.gov/about-cancer/treatment/types/targeted-therapies .
38. *Hyperthermia to Treat Cancer - NCI*. 9 Sept. 2011, https://www.cancer.gov/about-cancer/treatment/types/hyperthermia .
39. Agostinis, Patrizia, et al. "PHOTODYNAMIC THERAPY OF CANCER: AN UPDATE." *CA: A Cancer Journal for Clinicians*, vol. 61, no. 4, 2011, pp. 250–81. *PubMed Central*.
40. *Photodynamic Therapy to Treat Cancer - NCI*. 6 Sept. 2011, https://www.cancer.gov/about-cancer/treatment/types/photodynamic-therapy