Commentary
Volume 13:03, 2024

Journal of Electrical & Electronic Systems

ISSN: 2332-0796 Open Access

Harnessing Low-energy Electrons for Cancer Therapy

Denico Mawin*

Department of Physics, Mutah University, Mutah 61710, Jordan

Introduction

In the landscape of cancer treatment, the pursuit of therapies that effectively target tumors while sparing healthy tissue remains a critical challenge. Conventional treatments such as surgery, chemotherapy, and radiotherapy have made significant strides, but they often come with limitations such as systemic toxicity and damage to surrounding organs. The emergence of Low-Energy Electrons (LEEs) as a potential modality for cancer therapy represents a promising advancement in addressing these challenges. LEEs, characterized by their ability to deposit energy over short distances within tissues, offer the potential for more precise and targeted treatment delivery. This article explores the underlying principles of LEE-based therapy, current research advancements, and the future prospects of harnessing LEEs to transform cancer treatment [1,2].

Description

Harnessing Low-Energy Electrons (LEEs) for cancer therapy represents a groundbreaking approach in the ongoing battle against cancer. Traditional cancer treatments such as surgery, chemotherapy, and radiation therapy, though effective, often come with severe side effects and varying degrees of success. LEEs offer a promising alternative that could potentially increase the precision and effectiveness of cancer treatments while minimizing damage to healthy tissues. Low-energy electrons are subatomic particles with kinetic energies typically less than 50 electron Volts (eV). Despite their low energy, LEEs have the ability to induce significant biological effects, especially at the molecular level. When LEEs interact with biological molecules, they can cause ionization and excitation, leading to molecular fragmentation. This property makes them particularly useful in targeting and damaging cancerous cells, which are characterized by their rapid division and DNA instability [3].

The therapeutic potential of LEEs lies in their ability to cause lethal damage to the DNA of cancer cells. Upon interaction with DNA, LEEs can induce single and double-strand breaks, which are critical types of DNA damage. Double-strand breaks are particularly detrimental because they are challenging for cells to repair accurately, often leading to cell death. The localized generation of LEEs in or near the tumor can ensure that the DNA damage is predominantly confined to cancerous cells, sparing the surrounding healthy tissues. LEEs can be generated through various means, including the use of photosensitizers or radiosensitizers. Photosensitizers are compounds that, upon activation by light, produce LEEs, while radiosensitizers enhance the production of LEEs when exposed to ionizing radiation. These agents can be selectively delivered to the tumor site, allowing for targeted therapy. Once the photosensitizer or radiosensitizer accumulates in the tumor, it can be activated, resulting in the generation of LEEs that inflict lethal damage to the cancer cells [4]. One of the significant advantages of LEE-based therapy is its precision. Traditional radiation therapy often affects both cancerous and healthy cells, leading to collateral damage and side effects such as fatigue, skin irritation, and an increased risk of secondary cancers. In contrast, the localized action of LEEs minimizes damage to healthy tissues, reducing side effects and improving the patient's quality of life during treatment. Additionally, LEE-based therapy can be used in conjunction with other treatment modalities. For instance, combining LEEs with existing chemotherapy or immunotherapy regimens could enhance the overall effectiveness of the treatment, potentially overcoming resistance mechanisms that some cancers develop against traditional therapies [5].

Conclusion

The exploration of Low-Energy Electrons (LEEs) for cancer therapy represents a promising frontier in oncological research and treatment innovation. By capitalizing on the unique physical properties of LEEs—specifically their ability to deliver precise, localized radiation doses—researchers are poised to redefine the standard of care in cancer treatment. LEEs offer several distinct advantages over traditional radiotherapy methods. Their short-range interaction within tissues enables targeted delivery of radiation to tumor sites while sparing healthy surrounding tissue, thereby reducing the risk of treatment-related complications and improving patient outcomes. This precise targeting potential holds particular promise for treating tumors located near critical organs or in complex anatomical regions where preserving healthy tissue function is paramount. Moreover, the biological mechanisms underlying LEE-induced DNA damage and cellular responses continue to be elucidated, providing insights into optimizing treatment protocols and enhancing therapeutic efficacy.

As research advances, refining electron beam delivery systems and dosimetry techniques will be crucial to ensuring reproducibility and safety in clinical settings. Clinical trials investigating LEE therapy across various cancer types have shown encouraging results, demonstrating comparable or superior outcomes in terms of tumor response rates and patient survival. These early successes underscore the transformative potential of LEEs in oncology and pave the way for broader adoption and integration into mainstream cancer treatment protocols. Looking ahead, continued interdisciplinary collaboration between physicists, biologists, and clinicians will be essential to further advancing LEE-based therapies. Addressing challenges such as optimizing treatment planning algorithms, improving patient selection criteria based on tumor characteristics, and expanding the application of LEE therapy to different cancer types will be pivotal in realizing its full clinical potential. In conclusion, harnessing low-energy electrons for cancer therapy represents not only a technological advancement but also a paradigm shift in personalized oncological care. With ongoing innovation and clinical validation, LEE therapy holds the promise of offering safer, more effective, and more patient-centered treatment options for individuals battling cancer. As research progresses and technology evolves, the future of LEE-based cancer therapy appears increasingly promising, offering renewed hope in the fight against this complex disease.

Acknowledgement

None.

Conflict of Interest

None.

***Address for Correspondence:** Denico Mawin, Department of Physics, Mutah University, Mutah 61710, Jordan; E-mail: mawin@gmail.com*

Received: 22 May, 2024, Manuscript No. jees-24-142050; **Editor Assigned:** 24 May, 2024, PreQC No. P-142050; **Reviewed:** 07 June, 2024, 2024, QC No. Q-142050; **Revised:** 12 June, 2024, Manuscript No. R-142050; **Published:** 19 June, 2024, DOI: 10.37421/2332-0796.2024.13.118

References

1. Rezaee, Mohammad, Richard P. Hill and David A. Jaffray. "The exploitation of low-energy electrons in cancer treatment." *Radiat Res* 188 (2017): 123-143.
2. Meißner, Rebecca, Jaroslav Kocisek, Linda Feketeova and Juraj Fedor, et al. "Low-energy electrons transform the nimorazole molecule into a radiosensitiser." *Nat Commun* 10 (2019): 2388.
3. Ebel, Kenny and Ilko Bald. "Low-energy (5–20 eV) electron-induced single and double strand breaks in well-defined DNA sequences." *J Phy Chem Lett* 13 (2022): 4871-4876.
4. Vetritti, Leonardo, Janina Kopyra and Paulina Wierzbicka and Márcio T. do N. Varella. "Fragmentation of the DNA Lesion 8-oxo-Guanine by Low-Energy Electrons." *J Phy Chem A* 127 (2023): 7470-7478.
5. Rackwitz, Jenn and Ilko Bald. "Low-energy electron-induced strand breaks in telomere-derived DNA sequences—influence of DNA sequence and topology." *Chem Eur J* 24 (2018): 4680-4688.

How to cite this article: Mawin, Denico. "Harnessing Low-energy Electrons for Cancer Therapy." *J Electr Electron Syst* 13 (2024): 118.