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Review Article

Factors Affecting Radiotherapy Treatment

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Abstract

Radiotherapy, an integral element in treating cancer, has experienced continuous advancements over the course of its historical evolution. The effectiveness of radiotherapy in achieving optimal tumor control and improving patient survival can be significantly influenced by a myriad of factors. This comprehensive literature review delves into the critical determinants shaping survival rates in radiation therapy. Key factors under scrutiny encompass tumor characteristics, patient-specific considerations, variabilities in therapeutic approaches, and the dynamic evolution of personalized treatment modalities. The interplay of these elements reflects the multifaceted nature of radiation therapy impact on cancer outcomes therefore improving the life quality for cancer patients.

Keywords: radiotherapy; factors affecting RT; survival rate; cancer curing

Introduction

Radiotherapy, a fundamental component in the fight against cancer, has seen consistent development throughout the course of its history [1]. Various elements could influence how effective it is in establishing tumor control and patient survival. This literature review investigates the aspects that are most important in determining radiation rates of survival. These factors include tumor features, patient-specific factors, therapeutic variables, and the ever-changing landscape of individualized treatment options.

1. Tumor Characteristics

1.1 Tumor Type

Treatment with radiation is successful in different forms of cancer. For instance, as cancer of the breast and prostate tend to respond positively to radiotherapy, the treatments are highly effective therein [2, 3]. Accordingly, cancers like glioblastoma resist radio sensitization and require innovative ways of treatment through radiation therapy [4–6]. In order to develop personalized treatment plans to cure cancer patients more effectively, it is vital to appreciate that cancers may respond differently to therapy due to these differences [7, 8].

1.2 Tumor Stage/size

Examining the stage at which a tumor has progressed is a pivotal factor in assessing prognosis and determining available treatment options. The level of tumor growth contributes significantly in regard to survival possibilities, since many patients with early-stage malignancies have better prognoses compared to those diagnosed with advanced tumors [2]. Early detection and treatment are crucial because they increase the probability that some malignant tumors can respond positively to therapeutic radiological procedures [9]. On the other hand, the late stage of cancer makes a huge challenge, and a combination of treatments have to be applied to get an upper hand on the disease [10]. Additionally, the size of the tumor is a determining factor in the outcome of radiation treatment. Reports indicate that tumors smaller than 3 cm are linked to a longer survival period compared to larger tumors [11], A prompt diagnosis and a precise grading are both essential components in developing the most efficient treatment methods and enhancing the long-term prognosis for cancer patients who are currently undergoing therapy.

1.3 Tumor Location

An important consideration in determining the effectiveness of radiotherapy is the tumor localization. The location of the tumor inside the body can influence the outcome of this intervention on the patient's condition. Accordingly, it may be difficult to administer radiation safely to tumors that are situated in important organs or delicate anatomical locations; therefore, treating these types of tumors presents a distinct set of obstacles [12, 13]. In situations like these, the therapeutic team must meticulously plan and manage the therapy in order to avoid harm to adjacent healthy tissues [13]. This emphasizes the necessity of accurate targeting and dose control in guaranteeing the patient's safety while also maximizing the effectiveness of the therapy [14, 15].

2. Patient-Specific Factors

2.1 Age and gender

Age is one of the most crucial determinants of an individual response to radiation therapy. Younger patients normally have healthier tissues

surrounding them with robust cell repair systems, thus they tend to tolerate radiation treatment better than their older counterparts [16]. This increased resistance helps in the recovery of their bodies from the damage caused by radiation and this can consequently improve their survival chances. However, old individuals can be at a higher risk due to reduced capacity for regeneration of tissues from radiation therapies [17]. For example, definitive therapy for soft tissue sarcoma of the extremities seems less commonly administered to older adults [18]. Understanding age-related disparities in radiosensitivity can enhance the effectiveness and secure the adaptation of therapeutic approaches for cancer patients.

Research by Siegel et al reveals a slight interval in mortality due to cancer between males and females. Males were 52.8%, while females totaled 47.2% [19]. Nonetheless, these implications show that there is a need for additional studies into gender disparities in cancer mortality trends. This holds significant importance as it enables building up of gender-specific focused healthcare programmers and tailored treatments for certain types of cancer among males and females.

2.2 Comorbidities and Overall Health

The presence of comorbid conditions has a significant impact on whether or not an intense radiation therapy plan is feasible. The overall health has an enormous influence on a patient's ability to tolerate radiation therapy [20]. Several comorbidities such as cardiovascular disease, diabetes, or respiratory disease could impede individual capacity to withstand the physical and physiologic toxicity of radiation therapy. Therefore, full examinations should be performed about wellness and disease profile so as to make a decision that will lead to successful radiotherapy [20]. This helps to make sure that wellness of the patient is the major objective of this management program.

2.3 Genetic Factors

Genetic factors are important in determining how individuals respond to radiation. Such genetic predispositions might play a significant role in determining how effective the radiation therapy will be as well as any risks posed by it [21]. The different patients' Deoxyribonucleic acid (DNA) repair systems might also be significant because it may also bring into an effect the sensitivity of different patients to radiation [22]. A few individuals have better DNA repair mechanisms, making them less susceptible to radioactive damage [23]. Nonetheless, some individuals could have weak healing organs leading to high sensitivity to radiation effects [24]. The knowledge of genetic variations becomes paramount as it allows for developing unique radiation therapy programs with improved efficacy and lowered toxicity thus ensuring individualized approach towards cancer therapy [25].

2.4 Immune System

The body reaction to radiation depends on the immune system, which is very important in that regard. An evolving approach, which seeks to maximize the immune-enhanced effects of these medications in order to boost survival rates among patients using their additive effects [26]. This novel strategy takes use of the complex interactions that take place inside our immune system [27]. As a result, it is able to not only attack cancer cells immediately but also improve the body's natural defenses against the illness [28]. The combination of these two therapies offers a great deal of promise in the effort to improve the prognosis of cancer patients in terms of making a full recovery, and it also marks a new front in the fight against this tough foe [29].

3. Treatment Parameters

3.1 Radiation Dose and Fractionation

In cancer therapy, achieving a balance between the overall radiation dosage and the strategy of dividing it is crucial. Accordingly, the fundamental objective is to achieve optimum management of the tumor while limiting the damage done to healthy tissues. High radiation dose can increase chances of eradicating cancer cells, but this is accompanied by a high probability of damage to normal tissue adjacent to tumor [30]. It is therefore crucial to strike the right balance for therapy maximization as well as the enhancement of the overall health and life quality of a patient post treatment [31]. Using experience in medical practice and sophisticated technical means, it is important to pay attention to these indications. Customizing the radiotherapy technique for each individual is essential to achieve the optimal outcome while minimizing effects on unaffected tissues.

3.2 Treatment Planning

The great strides that have gone into technology in such methods as, Intensity-modulated radiation therapy (IMRT), volumetric modulated arc therapy (VMAT), and stereotactic radiosurgery (SRS) have played a very significant role. The recent innovations in treating cancer through the use of imaging guided radiotherapy is very promising and has greatly transformed the ability to accurately target tumors which leads to minimized destruction of neighboring healthy tissues thus improving therapeutic ratio [32]. IMRT adjusts the radiation dosages to correspond with the contours and dimensions of the tumor, while SRS administers a single session of radiation that is both exact and of a high dose [33]. VMAT administers the radiation dose while the treatment machine undergoes rotation, shaping the radiation dose to target the tumor. Simultaneously, it diminishes the dose to the neighboring organs surrounding the tumor [34]. These cutting-edge approaches not only enhance the efficacy of therapy, but they also lessen the negative effects that treatment might have, giving cancer patients hope and improving their chances of survival.

3.3 Radiation Type

Treatment of medical conditions using different kinds of radiations such as Photon, Proton, and Heavy ion therapy possesses individual advantages. Photon therapy is one such technology that still plays an integral role as a cancer treatment because it can precisely target and kill tumor cells [35]. The majority of the energy from proton treatment is deposited inside the tumor, protecting the healthy tissue that is around it. This provides an additional level of accuracy [36]. The capacity of heavy ion therapy to provide a substantial dosage to malignant cells while maintaining normal tissue makes it particularly effective in the treatment of highly refractory malignancies, despite the fact that the therapy is less prevalent [37]. Medical practitioners have the ability to customize treatments which allows them to maximize the therapeutic advantages while limiting the damage to the patient's healthy organs and tissues [38].

4. Personalized Medicine

Individualized medicine has changed radically the way to cure cancer by customizing radiation for every patient based on their molecular signature and several other key things related to this diseaseand for their tumor. Through their specific approach, physicians can find a very effective treatment method with fewer adverse reactions [39]. There is hope in the form of forthcoming innovations like as radiogenomics, which offer the prospect of locating genetic markers that have the ability to forecast how patients will react to therapy [40]. Those who are facing cancer now have a new reason to have optimism because to recent developments in customized medicine, which offer the potential of more accurate and effective radiation treatment.

5. Treatment Response Assessment

Optimization of radiotherapy involves assessing the reaction of the patient to the treatment. The latest imaging modalities like positron emission tomography (PET), computed tomography (CT) scan and magnetic resonance imaging (MRI) need to be used in the determination of effectiveness of a therapy. They provide very helpful information into how the tumors are reacting to the treatment [41]. This procedure is further improved by adaptive radiotherapy, which makes it possible to make alterations to the therapy regimen in real time. Dynamic technique enables physicians to quickly respond to any alterations in the tumor shape, dimensions, and position while undergoing therapy [41, 42]. This makes sure that patients receive highest level of quality care by all means.

Future Directions

The future directions of this promising field should give us hope for better radical treatments for some cancers. One line of research aims at enhancing treatment efficiency through concomitant use of radiation with other therapies involving individual treatments or immune therapies that cooperate in the same process. The combination of several cancer therapies may change the way that we treat this disease completely [43]. Moreover, Artificial Intelligence (AI) and Machine learning (ML) is also a significant contributor on creation of better treatment methods [44]. These innovative tools help medical practitioners refine therapies, predict patient's reactions with very high precision, and thus lead to a better future in fighting cancer.

Conclusion

Finally, post-radiation survival is delicately shaped by many factors, reflecting the complexity of cancer care. For effective adaptation of the treatment methods, one must understand all those variables, tumor types including staging and site, and patient related factors like age, overall health, and genetics. Moreover, the dynamic world of personalized medicine keeps recreating radiology, especially as it adapts for high quality effects. The constant advancement of science and technology leads to exciting perspectives on how radiation might be further utilized to facilitate cancer treatment in the future. These developments may significantly improve the accuracy, safety, as well as efficacy of radiation; hence, the provision of enhanced survivorship as well as better quality of life for patients with cancers.

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Conflict of interest

The corresponding author states that there is no conflict of interest.

References

1. Baskar R, Lee KA, Yeo R, Yeoh KW (2012) Cancer and radiation therapy: Current advances and future directions. Int J Med Sci 9:193–199.
2. Balaji K, Subramanian B, Yadav P, Anu Radha C, Ramasubramanian V (2016) Radiation therapy for breast cancer: Literature review. Medical Dosimetry 41:253–257.
3. Martin NE, D'Amico A V. (2014) Progress and controversies: Radiation therapy for prostate cancer. CA Cancer J Clin 64:389–407.
4. Batin E, Depauw N, Jimenez RB, MacDonald S, Lu HM (2018) Reducing X-ray imaging for proton postmastectomy chest wall patients. Pract Radiat Oncol 8: e266–e274.
5. Baskar R, Lee KA, Yeo R, Yeoh KW (2012) Cancer and radiation therapy: Current advances and future directions. Int J Med Sci 9:193–199.
6. Ali MY, Oliva CR, Noman ASM, Allen BG, Goswami PC, Zakharia Y, Monga V, Spitz DR, Buatti JM, Griguer CE (2020) Radioresistance in glioblastoma and the development of radiosensitizers. Cancers (Basel) 12:1–29.
7. Krengli M, Loi G, Pisani C, Beldì D, Apicella G, Amisano V, Brambilla M (2016) Three-dimensional surface and ultrasound imaging for daily IGRT of prostate cancer. Radiation Oncology 11:159.
8. Peng G, Wang T, Yang KY, Zhang S, Zhang T, Li Q, Han J, Wu G (2012) A prospective, randomized study comparing outcomes and toxicities of intensity-modulated radiotherapy vs. conventional two-dimensional radiotherapy for the treatment of nasopharyngeal carcinoma. Radiotherapy and Oncology 104:286–293.
9. Zhang J, Lu CY, Chen CH, Chen HM, Wu SY (2020) Effect of pathologic stages on postmastectomy radiation therapy in breast cancer receiving neoadjuvant chemotherapy and total mastectomy: A Cancer Database Analysis. Breast 54:70–78.
10. Al-Hallaq HA, Salter BJ (2020) Safety and Quality Improvements with SGRT. In: Surface Guided Radiation Therapy. CRC Press, pp 25–49.
11. Ball D, Mitchell A, Giroux D, Rami-Porta R (2013) Effect of tumor size on prognosis in patients treated with radical radiotherapy or chemoradiotherapy for non-small cell lung cancer: An analysis of the staging project database of the international association for the study of lung cancer. Journal of Thoracic Oncology 8:315–321.
12. Chang AJ, Zhao H, Wahab SH, Moore K, Taylor M, Zoberi I, Powell SN, Klein EE (2012) Video surface image guidance for external beam partial breast irradiation. Pract Radiat Oncol 2:97–105.
13. Batista V, Meyer J, Kügele M, Al-Hallaq H (2020) Clinical paradigms and challenges in surface guided radiation therapy: Where do we go from here? Radiotherapy and Oncology 153:34–42.
14. Manger RP, Paxton AB, Pawlicki T, Kim GY (2015) Failure mode and effects analysis and fault tree analysis of surface image guided cranial radiosurgery. Med Phys 42:2449–246110.
15. Lau SKM, Patel K, Kim T, et al (2017) Clinical efficacy and safety of surface imaging guided radiosurgery (SIG-RS) in the treatment of benign skull base tumors. J Neurooncol 132:307–312.
16. Bry V, Licon AL, McCulloch J, Kirby N, Myers P, Saenz D, Stathakis S, Papanikolaou N, Rasmussen K (2021) Quantifying false positional corrections due to facial motion using SGRT with open-face Masks. J Appl Clin Med Phys 22:172–183.
17. Zhao B, Maquilan G, Jiang S, Schwartz DL (2018) Minimal mask immobilization with optical surface guidance for head and neck radiotherapy. J Appl Clin Med Phys 19:17–24.
18. Horton JK, Gleason JF, Klepin HD, Isom S, Fried DB, Geiger AM (2011) Age-related disparities in the use of radiotherapy for treatment of localized soft tissue sarcoma. Cancer 117:4033–4040.
19. Siegel RL, Miller KD, Wagle NS, Jemal A (2023) Cancer statistics, 2023. CA Cancer J Clin 73:17– 48.
20. Özkan EE, Erdemoğlu E, Raoufi J (2019) Impact of diabetes on gastrointestinal and urinary toxicity after radiotherapy for gynecologic malignancy. Turk J Obstet Gynecol 16:260–265.

21. Bert C, Metheany KG, Doppke KP, Taghian AG, Powell SN, Chen GTY (2006) Clinical experience with a 3D surface patient setup system for alignment of partial-breast irradiation patients. Int J Radiat Oncol Biol Phys 64:1265–1274.
22. Crop F, Pasquier D, Baczkiewic A, et al (2016) Surface imaging, laser positioning or volumetric imaging for breast cancer with nodal involvement treated by helical TomoTherapy. J Appl Clin Med Phys 17:200–211.
23. Gopan O, Wu Q (2012) Evaluation of the accuracy of a 3D surface imaging system for patient setup in head and neck cancer radiotherapy. Int J Radiat Oncol Biol Phys 84:547–552.
24. Kügele M, Mannerberg A, Nørring Bekke S, et al (2019) Surface guided radiotherapy (SGRT) improves breast cancer patient setup accuracy. J Appl Clin Med Phys 20:61–68.
25. Svoboda J, Bronstein MM, Drahansky M (2015) Contactless biometric hand geometry recognition using a low-cost 3D camera. In: Proceedings of 2015 International Conference on Biometrics, ICB 2015. Institute of Electrical and Electronics Engineers Inc., pp 452–457.
26. Luk SMH, Meyer J, Young LA, Cao N, Ford EC, Phillips MH, Kalet AM (2019) Characterization of a Bayesian network-based radiotherapy plan verification model. Med Phys 46:2006–2014.
27. Hughes S, McClelland J, Tarte S, Lawrence D, Ahmad S, Hawkes D, Landau D (2009) Assessment of two novel ventilatory surrogates for use in the delivery of gated/tracked radiotherapy for non-small cell lung cancer. Radiotherapy and Oncology 91:336–341.
28. Gierga DP, Riboldi M, Turcotte JC, Sharp GC, Jiang SB, Taghian AG, Chen GTY (2008) Comparison of Target Registration Errors for Multiple Image-Guided Techniques in Accelerated Partial Breast Irradiation. Int J Radiat Oncol Biol Phys 70:1239–1246.
29. Meyer J, Wilbert J, Baier K, Guckenberger M, Richter A, Sauer O, Flentje M (2007) Positioning accuracy of cone-beam computed tomography in combination with a HexaPOD robot treatment table. Int J Radiat Oncol Biol Phys 67:1220–122811.
30. Mayadev JS, Ke G, Mahantshetty U, Pereira MD, Tarnawski R, Toita T (2022) Global challenges of radiotherapy for the treatment of locally advanced cervical cancer. International Journal of Gynecological Cancer 32:436–445.
31. Flores-Martinez E, Cerviño LI, Pawlicki T, Kim G (2020) Assessment of the use of different imaging and delivery techniques for cranial treatments on the Halcyon linac. J Appl Clin Med Phys 21:53–61.
32. Freislederer P, Kügele M, Öllers M, Swinnen A, Sauer TO, Bert C, Giantsoudi D, Corradini S, Batista V (2020) Recent advanced in Surface Guided Radiation Therapy. Radiation Oncology 15:187.
33. Haraldsson A, Ceberg S, Ceberg C, Bäck S, Engelholm S, Engström PE (2020) Surface-guided tomotherapy improves positioning and reduces treatment time: A retrospective analysis of 16 835 treatment fractions. J Appl Clin Med Phys 21:139–148.
34. Sapkaroski D, Osborne C, Knight KA (2015) A review of stereotactic body radiotherapy - is volumetric modulated arc therapy the answer? J Med Radiat Sci 62:142–151
35. Jaffray DA, Langen KM, Mageras G, Dawson LA, Yan D, Edd RA, Mundt AJ, Fraass B (2013) Safety considerations for IGRT: Executive summary. Pract Radiat Oncol 3:167–170
36. Padilla L, Pearson EA, Pelizzari CA (2015) Collision prediction software for radiotherapy treatments. Med Phys 42:6448–6456
37. Pompos A, Durante M, Choy H (2016) Heavy ions in cancer therapy. JAMA Oncol 2:1539–1540
38. Huq MS, Fraass BA, Dunscombe PB, et al (2016) The report of Task Group 100 of the AAPM: Application of risk analysis methods to radiation therapy quality management. Med Phys 43:4209–4262
39. Malicki J, Bly R, Bulot M, et al (2014) Patient safety in external beam radiotherapy - Guidelines on risk assessment and analysis of adverse error-events and near misses: Introducing the ACCIRAD project. Radiotherapy and Oncology 112:194–198
40. Li S, Zhou B (2022) A review of radiomics and genomics applications in cancers: the way towards precision medicine. Radiation Oncology 17:217
41. Hattel SH, Andersen PA, Wahlstedt IH, Damkjær S, Saini A, Thomsen JB (2019) Evaluation of setup and intrafraction motion for surface guided whole-breast cancer radiotherapy. J ApplClin Med Phys 20:39–44
42. Laaksomaa M, Sarudis S, Rossi M, Lehtonen T, Pehkonen J, Remes J, Luukkanen H, Skyttä T, Kapanen M (2019) AlignRT ® and CatalystTM in whole-breast radiotherapy with DIBH: Is IGRT still needed? J Appl Clin Med Phys 20:97–104
43. Hoisak JDP, Pawlicki T (2018) The Role of Optical Surface Imaging Systems in Radiation Therapy. Semin Radiat Oncol 28:185–193
44. Shiraishi S, Grams MP, Fong de los Santos LE (2018) Image-guided radiotherapy quality control: Statistical process control using image similarity metrics. Med Phys 45:1811–1821.

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