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Radiobiological Model-Based Plan Evaluation for Patients Undergoing Radiotherapy Treatment

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by

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About this Monograph

This monograph is a part of the dissertation submitted for the award of the degree of Doctor of Philosophy (Ph.D.), in the Department of Radiotherapy and Radiation Medicine, Institute of Medical Sciences, Banaras Hindu University (BHU), Varanasi, on the 30 August 2022 under the guidance of following supervisor-

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Synopsis

Radiotherapy treatment becoming essential in the treatment of most of the cancers. It is realised that technology is advancing rapidly which also impacted the advancement of radiotherapy techniques. With new modern techniques evolved with time, complexity as complementary attached to it. Modern techniques demand accuracy, knowledge of additional parameters and new approaches. Keeping in mind present thesis focused on efforts that how the radiotherapy treatment can be improved for the benefit of patients. Radiobiological models started to appear in 1980s since then it is continuously evolving. Medical physicist community is now understanding the importance of radiobiological models and many vendors started to incorporate radiobiological models with their treatment planning system. Still, most of the Medical physicist of the community hesitate to use radiobiological models because of uncertainty and complexity. Therefore, radiobiological models remained the topic of research. But with the efforts of researchers plenty of data have been produced with respect to biological models which is strengthening the reliability of these models. This work is motivated from the discussion during plan evaluation when one of the organ at risk (spinal cord) received dose beyond tolerance limit and it was impossible to achieve. The discussion moved from physical parameter based assessment to basic radiobiology of specific tissue of interest. It gives a kick, to study radiobiological models to handle complex scenarios during plan evaluation. Presently number of radiation oncologists are practicing altered fractionation depends on many clinical trials, changes in fractionation regimen drastically changes the treatment outcome. Therefore, if it is possible to understand the probability of outcome before it appears, it can lead in improvisation of treatment. There are number of biological models exist in literature and varies in terms of biological parameters. It is needed to choose appropriate biological model for better outcome and its validation before implementing in routine clinical practice. Present thesis work tried to answer doubts of radiobiological models and intended to bring in general practice.

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About the Author

The author, *Ganeshkumar Ramesh Patel* has been working as a Medical Physicist and Radiological Safety Officer in the Department of Radiotherapy at the Institute of Medical Sciences, Banaras Hindu University, since 2019. With approximately ten years of experience in radiotherapy cancer treatment, he holds a Master's degree in Physics from Nagpur University and a Postgraduate Diploma in Radiological Physics from the Bhabha Atomic Research Centre (BARC), Mumbai, which he completed in 2012. He is a certified Radiological Safety Officer accredited by the Atomic Energy Regulatory Board (AERB). The author is a life member of the Association of Medical Physicists of India (AMPI) and the Association of Radiation Oncologists of India (AROI). He has presented research papers at various national and international conferences. In addition to his professional responsibilities, he teaches Radiation Safety and Medical Physics to MD Radiotherapy students and Radiotherapy Technologist students in the department.

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Acronyms and Abbreviations

3D	*Three-dimensional*
2D	*Two-dimensional*
3D-CRT	*Thri-dimensional Conformal Radiation Therapy*
TCP	*Tumor Control Probability*
NTCP	*Normal Tissue Control Probability*
RB	*Radiobiological*
BED	*Biologically Effective Dose*
CBCT	*Cone-Beam Computed Tomography*
CT	*Computed Tomography*
CTCAE	*Common Terminology Criteria for Adverse Events*
CI	*Conformity Index*
HI	*Homogeneity Index*
GI	*Gradient Index*
IMRT	*Intensity Modulated Radiation Therapy*
DVH	*Dose Volume Histogram*
LQ	*Linear Quadratic*
LKB	*Lyman-Kutcher-Burman*
DVH	*Dose-Volume Histogram*
EORTC	*European Organization for Research and Treatment of Cancer*
OTT	*Overall treatment time*
GTV	*Gross Tumor Volume*
H&N	*Head And Neck*
ICRU	International Commission on Radiation Units and Measurements
VMAT	*Volumetric Modulate Modulated Arc Therapy*
QUANTEC	Quantitative Analysis of Normal Tissue Effects in Clinic
MLC	*Multi-leaf Collimator*
OAR	*Organs At Risk*
TPS	*Treatment Planning System*
EUD	*Equivalent Uniform Dose*
RTOG	*Radiotherapy Oncology Group*

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