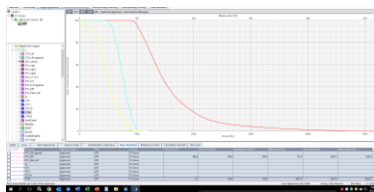
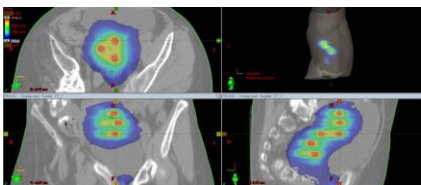


# Re-interpreting Biological Equivalent Uniform Dose for Lattice Radiotherapy

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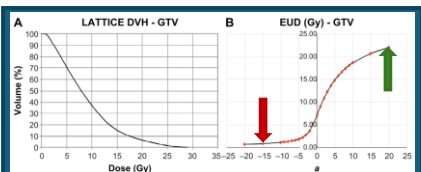


**Objective:** By creating a very heterogeneous, peak-valley dose distribution inside voluminous tumors, Lattice Radiotherapy (LRT) enhances tumor response without increasing patient's toxicity. LRT has been demonstrated to be safe and effective. However, so far, there has been no effective analysis to correlate between the Equivalent Uniform Dose (EUD) of LRT and the observed results of tumor control. The aim of this study is to find this correlation, specifically for the use of LRT in the treatment of advanced, bulky cervical cancer.



$$gEUD_a = \sqrt[a]{\sum (v_i d_i^a)}$$

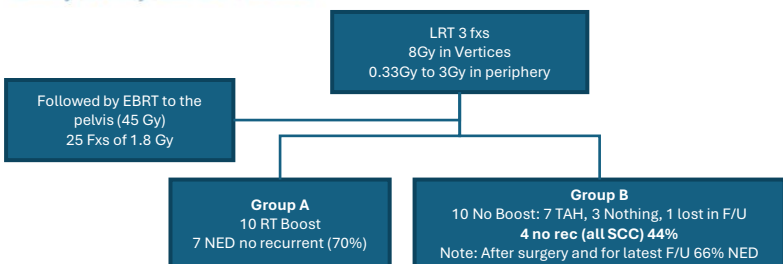
"For tumors, the parameter a is always negative and for normal tissues and organ it is always positive"  
 Niemerko, Chapter 5 Biological Optimization (II Advanced Image-Guided and Biologically Guided Techniques)



In evaluating the quality of a treatment plan, the concept of EUD has been frequently used to predict the effectiveness of tumor control and normal tissue toxicity. One form of EUD was suggested by Niemiako

## The Technical and Clinical Implementation of LATTICE Radiation Therapy (LRT)

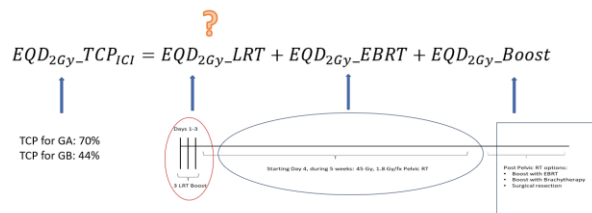
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## Materials and Methods:

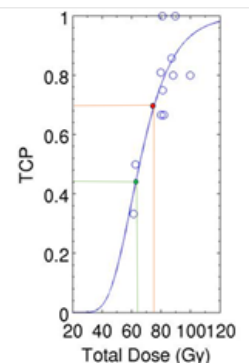
- The analysis is based on the Tumor Control Probability (TCP) obtained from a group of 20 patients with locally advanced cervical cancer (LACC) treated with LRT at Innovative Cancer Institute
- These results of TCP were correlated with the corresponding EQD2 values for LACC based on literature with focus on results of TCP vs EQD2 obtained by per Huang et al.(graph below)
- The value or EUD for a single lattice fraction in the series of patients was calculated.
- The generalized EUD formulism, using a single parameter 'a', proposed by Niemerko, was used to calculate the values of gEUD vs 'a' from the Dose Volume Histogram for each of the analyzed patients.
- The range of values for parameter 'a' corresponding to the EUD of LATTICE in the case of LACC was obtained.

## Total EQD2 from 3 phases of RT Course



## TCP vs EQD2 for the 20 patients

- GA: Boost
  - TCP = 70%
  - Total EQD2 = 76.5 Gy
- GB: No Boost
  - TCP = 44%
  - Total EQD2 = 63.0 Gy



Biology Contribution

## Onset Time of Tumor Repopulation for Cervical Cancer: First Evidence From Clinical Data<sup>1</sup>

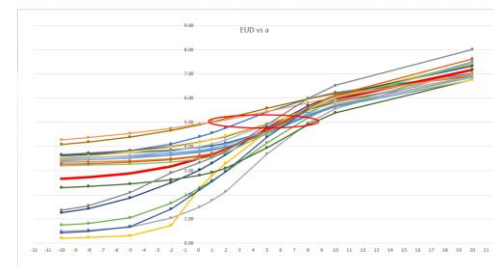
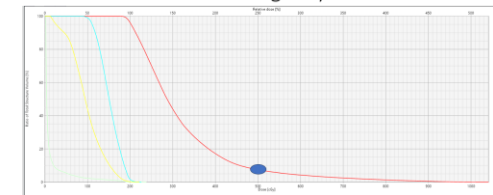
Zhibin Huang, Ph.D.,<sup>\*</sup> Nina A. Mayr, M.D.,<sup>1</sup> Mingcheng Gao, Ph.D.,<sup>1</sup> Simon S. Lo, M.D.,<sup>5</sup> Jian Z. Wang, Ph.D.,<sup>1</sup> Guang Jia, Ph.D.,<sup>1</sup> and William T.C. Yu, M.D., M.S.E.E.<sup>1</sup>

$$18 Gy = 3 * EUD_{LRT} \left[ \frac{EUD_{LRT} + \alpha/\beta}{2 + \alpha/\beta} \right]$$

Equivalent to 9 fractions of 2 Gy in tumor but maximum EQD2(3) in the OARs is 10.8 Gy

$$EUD_{LRT} \approx 5 Gy$$

Volume of GTV receiving 5 Gy or more = 8.5%



Positive "a" average 5.5 [2-8]

**Results:** A new and positive coefficient 'a' value in the EUD formulism, ranging between 2 and 8 (average 5.5), has been identified as more appropriately describing the biological effects observed in this series of patients.

**Discussion:** These results suggest that the traditional EUD needs re-interpretation in order to better correlate the technique with the clinical outcomes. Practically, the coefficient 'a' in the EUD as formulated by Niemerko would need to assume a different value to reflect the unique biological response of LRT. This value, very different from the traditional value of -10 that is used to project the tumor control when inhomogeneous doses are encountered in conventional radiotherapy, is more consistent with the hypothesized, unconventional, and advantageous biological effects when SFRT is used.