

Three dimensional quality assurance protocol for thoracic and genitourinary radiation therapy

After cancer diagnosis one treatment option is the use of external radiation. As the radiation traverses the patient it deposits most of its energy in the tumor, which causes irreparable damage to the cancer cells. One type of external radiation therapy is the intensity modulated radiation therapy (IMRT). It is an advanced high-precision radiation therapy that delivers high dose of radiation to the tumor while sparing the surrounding normal tissue and organs. The radiation treatment plan is designed using a piece of software that computes what the radiation dose to the tumor and the normal anatomical organs will be. Before treating the patient, the treatment plan is measured and undergoes quality assurance (QA) process that evaluates how close the computed and measured radiation doses are. If the doses are not close enough the plan fails QA and needs to be reevaluated by a physician and/or a physicist.

Our work aimed at three goals. First, to define a set of statistical tests and anatomical organs that are to be included in a 3 dimensional pre-treatment quality assurance (QA) protocol. Second, to test if this protocol is sensitive and can detect certain clinical errors. The final goal was to compare the protocol performance to that of another two QA methods.

Measurements were performed on 13 prostate and 25 thoracic cancer patients. For each patient 8 anatomical organs were included in the QA protocol and three different statistical tests were applied to each organ. The tests included organ's average radiation dose difference, organ's absolute radiation dose and a gamma test. After performing and analyzing the measurements we quantified how close the two radiation doses have to be so the treatment plan would pass QA.

The error sensitivity and detectability of the 3D QA protocol, as well as that of two additional QA methods (1D and 2D) was tested by applying 18 clinically relevant errors to two prostate and two thoracic radiation treatment plans. The results showed that the 3D QA protocol is the most error sensitive out of the three investigated. This method detected most of the introduced errors and was followed by the 2D QA method. The worst performing method was the 1D. It conclusively detected 4 out of the 18 introduced errors.

Our research showed that the 3D QA method proposed is superior to the others already implemented in our clinic. It provides a comprehensive pre-treatment quality assurance by comparing how close are the computed patient radiation dose and the measured one.

Gueorgui Gueorguiev
Harvard Medical School,
Massachusetts General Hospital,
UMASS-Lowell

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Gueorguiev G, Cotter C, Turcotte JC, Crawford B, Sharp G, Mah'D M
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