

PROVISIONAL FINAL REPORT

- Project Title:** Development of a Simple Radioactive Marker System to Reduce Positioning Errors in Radiation Treatment
- Covering Period:** Grant Period: July 15, 2004 – December 21, 2006
- Date of Report:** March 19, 2007
- Recipient:** University of Missouri-Columbia
Columbia, MO 65211
- Award Number:** DE-FG07-04ID14588
- Subcontractors:** Dr. Jatinder Palta, University of Florida
- Other Partners:** None
- Contact(s):** William H. Miller
Nuclear Science and Engineering Institute
E2433 Lafferre Hall
University of Missouri
Columbia, MO 65211
573-882-9692
MillerW@missouri.edu
- Project Objective:** The objective of this research is to implement an inexpensive, quick and simple monitor that provides an accurate indication of proper patient position during the treatment of cancer by external beam X-ray radiation and also checks for any significant changes in patient anatomy. It is believed that this system will significantly reduce the treatment margin, provide an additional, independent quality assurance check of positioning accuracy prior to all treatments and reduce the probability of misadministration of therapeutic dose.
- Background:** The discipline of radiation therapy is reaching new levels of effectiveness with continued advancement in treatment planning, delivery, and treatment verification. Advances in imaging have enhanced our ability to create a complete anatomical and functional three-dimensional model of each patient, which facilitates the use of advanced-technology radiation therapy delivery tools. These new technologies can potentially have a significant impact on the future practice of radiation therapy because they make it possible to highly conform dose distributions to target volumes while sparing the surrounding critical structures, thus opening the doors for dose escalation and organ sparing treatment protocols.

The biggest challenge for the use of these advanced conformal radiation therapy delivery systems is the precise localization and positioning of patients for daily radiation treatment. Unfortunately, the necessary accuracy cannot be obtained due to imperfections in patient repositioning, changes in patient anatomy over the course of a treatment regime, and changes in tumor size and location during treatment. Due to these errors, a liberal treatment margin is often applied to insure that the total tumor volume is treated.

This grant is to design and implement an inexpensive, quick and simple monitor that provides an accurate indication of proper patient position and also a check for any significant changes in patient anatomy during the treatment regime. The system utilizes a small, radioactive implanted seed (similar to implanted markers currently used for X-ray films) in the tumor to be treated and a few (three to six) strategically placed radiation detectors around the patient on the treatment couch to identify the location of this radioactive seed. The system will check for the correct signal prior to each treatment and will indicate any errors in positioning or significant changes in patient anatomy. The exact source of error or change will not be identified, but the system will provide a quick go/no-go decision before proceeding with treatment. Should an error be noted, more sophisticated imaging systems can be called upon to determine the cause for the inaccuracy and necessary adjustments can be made. Analysis and experimental measurements indicate that patients can be positioned with sub-millimeter precision, thus providing the clinicians an opportunity to reduce the setup margin, spare more of the normal tissues and insure tumor doses.

Thus, a system will be designed and tested that will significantly reduce the treatment margin, provide an additional, independent quality assurance check of positioning accuracy prior to all treatments and reduce the probability of misadministration of therapeutic dose. Such a system will have significant positive impact in the delivery of high precision conformal radiation therapy and clinical outcomes.

Status:

Three students Y.W. Chang, A. Andreassen and N. Polasani, have already graduated based upon funding from this grant. Their progress was reported in the Y-2 Yearly Report and summarized in an abstract: Miller, W.H., A. Adovor, A. Andreassen, J. Berhorst, Y.W. Chang and N. Polasani, "Evaluation of a Simple System for Radiation Treatment Positioning," *Trans. Am. Nucl. Soc.*, **94**, 395-8 (June 6, 2006).

Two additional students (Jason Berhorst and Amenyeddu Adovor) are still working to refine the system. They were funded on the grant through

December 31, 2007 and are currently on other funds. Their work includes installation and testing of the positioning device on an actual, external beam therapy system and the testing of additional positional accuracy by using variable spaced detectors. Both are scheduled to complete their work and graduate in May 2007. At that time, a full journal article will be prepared for publication and will form the basis for a "final" Final Report.

The information contained here is to meet DOE reporting deadlines and supplemental information to fully complete Final Reporting requirements will be submitted during the summer 2007.

Plans for Next Year: We will continue to pursue possible commercialization of this system for use by the medical profession.

Patents: (Invention Disclosure submitted to University of Missouri)