Purpose: To investigate a new approach and automated quality assurance (QA) tool for detecting radiotherapy errors using machine learning. The proposed datamining approach utilizes anomaly detection based on one-class estimation to overcome computational challenges of detecting rare events encountered in currently existing techniques.

Methods: The proposed anomaly detection approach captures regions in the input space of radiotherapy data where the safe class probability density lives and estimate errors as outliers that reside outside this support region. To model nonlinear support regions, we used a support vector machine (SVM) formalism, in which the QA data is mapped into higher dimensional space using kernel functions to achieve maximal separability and is denoted QA-SVM detector. We demonstrated our method using forty-three treatments plans from patients who received stereotactic body radiation therapy (SBRT) for lung cancer.

Results: Features related to monitor units, beam energies, number of beams, number of fractions, in addition to V20 were extracted from the DICOM files and used to train the QA-SVM detector. Using principle component analysis, 5 features were selected and used subsequently. For testing, we used a combination of cases that were considered “safe” with class label “+1” and simulated cases, which were considered “risky” with class label “-1”. A radial basis function was used as kernel and false positive limit was set at 10%. Our preliminary results indicate a training accuracy of 84% on cross-validation and testing accuracy of 80% with 100% positive predictive value and 80% negative predictive value.

Conclusions: We presented a new approach and tool based on machine learning to overcome the problem of direct modeling of QA errors and rare events in radiotherapy. The tool will be very valuable for automated QA and safety management for patients who undergo radiotherapy treatment.