Purpose:
The objective of this work is to develop an automated quality assurance (AQUA) system for linear accelerators, which will integrate multiple mechanical, dosimetric and imaging tests in a daily session of reasonable duration (30-45 min).

Methods:
AQUA is a web-based application with a centralized database containing a library of quality assurance (QA) tests defined in a user-scriptable language. AQUA communicates the test to the linear accelerator (and measuring devices) and analyzes the resulting data. The software supports concurrent testing of multiple linear accelerators. Five tests were implemented in the first AQUA prototype: Collimator and gantry rotation isocenter, radiation field-size (multileaf collimator (MLC) and jaws), gantry angle readout and kV-MV isocenter coincidence. Test results are obtained from the analysis of MV 2D images and cone-beam CT datasets of a phantom setup on the treatment couch. Tests were performed on a nightly basis on one linear accelerator and elapsed time was recorded. The field-size test reproducibility was extensively studied using simple multi-segment beams and its accuracy was assessed using films.

Results:
For the first AQUA prototype which is semi-automated, the elapsed time for the five AQUA tests was 45 min (setup, imaging and analysis). Results (n=17) for the different components tested were within institutional tolerances. The AQUA field size detection algorithm applied to 127 images of a static field showed a maximum variation in detected leaf position of ±0.15mm. AQUA was able to detect MLC positioning errors as small as 0.5mm. Field widths measured with AQUA were almost consistently smaller than with film with a maximum deviation of 0.34 mm (n=18).

Conclusions:
The AQUA system was developed and allows for semi-automated and quantitative daily testing of multiple machine parameters. Work is on-going to improve automation and efficiency and increase the number of available tests

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