First Time Implementation of a Physics Ultrasound (US) Testing Program: Analysis and New Lessons

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Background

Ultrasound (US) Imaging Annual Equipment Performance Evaluation is required for American College of Radiology® (ACR)-accredited facilities since 2015. Failure rates for US equipment have been previously evaluated for multi-year longitudinal trends, optimal frequency for testing in order to detect failures4-6, and for typical passing rates7.

Purpose

During the implementation of a new annual US Quality Control (QC) testing program by our healthcare system-wide in-house diagnostic medical physics team, an engineer made a comment that our failure rates were higher than other clients’. Our aim is to investigate our failure rates after the first year of physics testing, compare our results to published data, and determine any trends in tester performance.

Methods

The annual QC tests performed were: Physical and Mechanical Inspection, Image Uniformity and Artifact Survey, and scanners’ Electronic Image Display Performance. Per ACR, Image Uniformity assessment of transducers consists of three checks, verifying that:

(A) “The average brightness at the edge of the scan is the same as that in the middle.”

(B) “There are no vertically or radially oriented shadows from array element dropout.”

(C) “There are no brightness transitions between focal zones.”

These checks are graded on a scale from 1 to 3, meaning pass, conditional pass or fail, respectively. The other tests were based on pass/fail criteria. A summary of these tests is shown in Table 1.

Testing data was tracked not only in regards to failure rate but also by tester (Figure 1). Some of the physicists who tested were experienced in US scanner evaluation, while others were new and still building years of experience. Years of experience were defined by number of years testing at least 15 US units every 12 months.

Compared with literature, table 3 shows that the failure rates that we observed for our US equipment were much lower for Physical and Mechanical Inspection (11.3% vs. 25.1%) and similar or lower for the Image Uniformity and Artifact Survey tests (13.1% vs. 13.9% vs. 17.1%). No literature was found to compare with our results for the scanners’ Electronic Image Display Performance. More research is needed to determine whether the correlation is due to tester performance or equipment bias.

Results

The failure rate for the Physical & Mechanical Inspection test was 11%, with over 90% of the failures being attributed to mechanical faults of the unit. The failure rates for the Image Uniformity and Artifact Survey checks for A, B, and C were 0.7%, 13%, and 0.4%, respectively. Out of the total, 24.3% of units failed at least part of the Ultrasonic Electronic Image Display Performance test, with the vast majority of those failures attributed to the SMPTE Greyscale Calibration test. The breakdown of testing results is shown in Table 3.

Conclusions

The review of a new US QC annual physics testing program at our institution was performed. The engineer’s comment was investigated, and our failure rates were found to be on the lower end compared to literature. Further research is needed into tester bias and other confounding variables.

References

1. American College of Radiology®, Reston, VA, USA.