A Harmonized Quality Control Program for Digital Mammography

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Abstract. Digital mammography is rapidly becoming a mature imaging modality. To maintain high quality in mammography, a routine quality control program is necessary to detect drifting or degradation of system performance over time. The American College of Radiology is developing a quality control program which will apply to all types of full-field digital mammography equipment, and provide effective and more efficient validation of performance. In the DMIST trial, there were no failures for many of the QC tests during the 24 months imaging was performed. When systems failed, they generally did so suddenly, rather than through gradual deterioration of performance. A recommended set of tests is presented, which can be used to ensure that full-field digital mammography (FFDM) systems are functioning correctly, and consistently producing mammograms of excellent image quality.

Keywords: Digital mammography, quality control, image quality.

1 Introduction

Digital mammography is an evolving imaging modality, quickly moving into regular clinical use with over 1300 full-field digital mammography (FFDM) units accredited in the US in March 2006, and the expectation of rapid acceptance of photostimulable phosphor systems. There are now a number of systems and technologies available on the market. Current US (MQSA) regulations [1] require that sites follow the quality control (QC) procedures described by the individual manufacturers of the FFDM systems, which has resulted in discordance among the various QC protocols. To ensure that image quality is optimal and to support an effective accreditation program; routine QC, standard physics evaluation methods and acceptance test practices that are independent of the manufacturer are required.

The American College of Radiology (ACR) has established a subcommittee to develop a harmonized QC program for digital mammography. The goals of this program are:

1) to provide as much as possible, a uniform set of tests that can be used across the range of commercial digital mammography systems that will be used clinically,
2) to effectively test those aspects of imaging performance that are relevant to diagnostic image quality and safety,

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3) to streamline the program to make it as efficient as possible, thereby eliminating unnecessary costs and labour, and
4) as much as possible to keep these tests similar or familiar to those currently performed by technologists and medical physicists who carry out QC in screen-film mammography (SFM) [2].

In the DMIST trial [3],[4] the QC program was designed to be as comprehensive as possible, with tests which could be applied generically among the different FFDM systems. Because little was known regarding the expected modes or frequencies of equipment failure, a test schedule was designed with more frequent evaluations than that required for SFM systems.

For a QC program to be practical and able to be followed by all facilities, some pragmatic decisions about the usefulness of individual tests and scope and extent of site survey testing must be made. In DMIST, the testing process was quite time consuming and while it generated information that was relevant to the characterization of digital systems, most of the information was of limited use for QC purposes. If one test can act as a surrogate for a number of others (offering high sensitivity, but possibly low selectivity), that test should be used in the QC program, and only if the system fails that test, should more selective diagnostic tests be performed outside of the QC program.

Historically, for SFM, x-ray generator technology was rather simple and fluctuations in the quantity or quality of X rays produced were not uncommon, and x-ray output was quite likely to drift over time, having an impact on image quality or radiation dose received by the breast. Modern x-ray generators used in digital systems, employ high frequency technology and extensive feedback and control systems, ensuring that their performance is stable and well regulated. Furthermore, modern radiographic equipment performs internal self-tests and has interlocks that prevent exposures being initiated when problems are detected.

The availability of image data in digital form provides opportunities for improvement of QC testing and allows for the introduction of objective and quantitative tests as well as more sophisticated measurements that are not practical for analogue systems. An additional benefit of harmonized tests is that cross-vendor validation of system compatibility is possible.

2 DMIST Recommendations for Testing

The tests used in DMIST were categorized into the evaluation of three areas: 1) the performance of the image acquisition system, 2) the dose and image quality, or 3) the image display system. For the ACR program, the physicist performs an annual equipment evaluation, which establishes that the equipment is performing at the expected level, and provides baseline target values that must be met by the technologist tests. The technologist performs routine tests to detect problems that may interfere with interpretation.

2.1 Tests Eliminated

DMIST results indicated that several tests currently required for SFM were of limited utility and should be eliminated from the program. These include: