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Features to Consider When Selecting New Digital Radiology Systems

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With the introduction of proposed reimbursement changes starting in 2017 for film-screen and in 2018 for computed radiography [1], many practices are looking to upgrade radiographic equipment to what is known as digital radiography (DR). It may be challenging to sift through the marketing material and assess what truly best meets the needs of a practice.

An organized, thorough process for equipment evaluation can assist a practice in making the best of an investment and gathering support for a purchase. And although every practice may have individual needs assessments to balance with its budget, there may be a common list of considerations and features to weigh.

It is helpful to outline an assessment framework for understanding DR equipment specifications with practice needs. Both the assessment framework and evaluation are best done by a team that understands not only the technical specifications of the equipment but how it will be used and supported, including radiologists, technologists, medical physicists, engineers, and business operations staff members. A suggested framework for data gathering is provided in Table 1. A few of the highlighted topics are further described in detail, exploring some of the distinguishing features in DR offerings.

To gather data for evaluation, it is valuable to go beyond the data sheets and sample images. Visit a practice that uses the equipment in much the same way as your practice intends to use it. Look at their images. Spend time to explore features your practice will rely upon. Recognize that a different workflow or patient base (eg, sports medicine, general orthopedics, pediatrics) may have a different experience and challenges.

IMAGE PROCESSING

Many radiographic solutions offer similar detector properties (perhaps from the same detector original equipment manufacturer), or they may be able to obtain similar raw images through tailored technique selection. However, a primary distinguishing feature between what radiologists experience in image quality relies on the image-processing algorithm. The value a good image-processing algorithm brings cannot be understated.

Radiographic image processing algorithms have common elements, including image segmentation, spatial frequency-based processing, and histogram-based processing. However, there may be significant variability in how well these elements are implemented by different systems. Some image processing algorithms require a high level of refinement for different anatomy and views; this can indicate a lack of image processing robustness. Where algorithms lack robustness, more effort is required to achieve image quality consistency both with initial setup and regular use.

Assessment of a particular vendor's image-processing algorithm can be challenging. Image processing algorithms should not be judged solely based on their default settings for sample images. Default settings can be altered to a practice's preference, and the sample images do not demonstrate an algorithm's robustness with typical examination variability. A better assessment strategy is to work with a team including a radiologist, a technologist, and a physicist, to assess a system already in use in a similar practice.

DETECTOR

DR detectors for general radiography have largely consolidated to a flat-panel detector–based technology using a large-area amorphous silicon photodiode array and a cesium iodide or gadolinium oxysulfide scintillator.[1] The list of specifications and options for detectors can be confusing. In the end, it all boils down to how well the aspects work together, and a functional approach to evaluation is perhaps more pragmatic. A functional comparison is provided in Table 2 [3-6].

[1]Other detector types are on the market, though they are currently found primarily in systems designed for specialty rather than general application.

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Table 1. Suggested criteria for digital radiographic equipment evaluation

Image quality and dose	Image processing*
	Detector*
	Scatter control or compensation
	Exposure delivery control including exposure guidance for technologists (eg, EI, DI)
	Usability: how time-consuming or difficult it is for technologists to use the system, including workstation user interface and display viewing quality for technologists
Hardware configuration	Manual, fully automatic, or semiautomatic movements
	Table, wall-stand, and tube-mount options
	New room or retrofit*
Total cost of ownership	Baseline costs for equipment and installation
	Service contracts: quality and cost
	Workflow efficiency
	Durability and replacement costs, especially for wireless detectors
	Effort and downtime to implement, maintain operation, or optimize, including applications time
	Space or renovation needs
Advanced features	Stitching
	Tomosynthesis or cone-beam CT
	Dual-energy acquisition or simulation
Tools for quality control	Repeat-reject or other practice analytic tools*
	Quality control phantom and analysis software
Interoperability and security	Communication hardware and standards
	Meeting practice security standards, including access control, audit log, and patching in ways that can be implemented

Note: DI = deviation index; EI = exposure index.
*Discussed in further detail in the text.

NEW ROOM OR RETROFIT

One of first things to consider is whether your facility or budget is considering a full room upgrade or a retrofit. This distinction is possible because the systems that control the exposure (the generator, tube, and bucky) can be separated from the detector and image-processing components. Some radiographic room solutions are not that fundamentally different from a retrofit solution except that they are purchased under a single brand and service agreement and may exhibit a higher level of integration and related offerings.

A DR retrofit solution makes use of existing exposure delivery and

Table 2. Function-focused comparison table for digital detectors for general radiography

Wireless or fixed	Wireless cassette-style detectors are needed to accommodate nonbucky work. Fixed detectors can often accommodate the largest detector sizes.
Size	Ensure that the detector size meets the needs of your clinical application. Smaller detectors can make for easier positioning or handling with specific anatomy. Larger sizes can mean fewer repeated acquisitions for inability to fit all the desired anatomy on the detector.
DQE [2]	DQE helps quantify how efficiently a detector converts x-ray information into image information. Higher DQE means less exposure to patients for the same potential image quality.
Spatial resolution	Detector pixel sizes for general radiography currently range from 100-200 μm [3]. Look for smaller pixels for higher quality extremity imaging; larger pixels will hide fine bone detail, particularly in pediatric extremities, unless magnification is used [4].
Susceptibility to artifacts [5,6]	All detectors have the potential for artifacts. Check with practices that are currently using the detector to see if there any particular problems that plague a system you are considering.
Weight, handling, and durability	Weight can contribute to technologist stress injury. Good handling and durability can help prevent costly detector damage and replacement.
Battery life	Dead batteries cause examination disruption.

Note: DQE = detective quantum efficiency.

control equipment and replaces the detector and image workstation. This could be a cheaper means of moving to DR.

If you are considering a retrofit, consider the following issues:

- Ensure that your existing equipment that will not be replaced is in good repair and has the prospect of continued service support. You may have sacrificed a better overall choice if you end up having to replace all the room equipment in the near future.
- The options for a solution that integrates with your existing hardware may be limited. There are different levels of integration. Ask for references from customers who have used your specific combination. Poor integration can have less workflow efficiency than computed radiography [7].
- Retrofit solutions may not provide for advanced applications.

REPEAT-REJECT AND PRACTICE ANALYTICS TOOLS

Robust image quality, dose management, and practice efficiency are as much about how you use a tool as the tool itself. Although a good implementation plan and application training are essential when installing new equipment, ongoing quality control is also needed in radiography, in which there can be high variability in acquisition and processing [8]. After facing consumer challenges in utilization [9], many vendors are developing and implementing better, integrated tools for repeat-reject and practice analytics. In evaluating various vendor programs, look for tools that provide access to rejected images, as a lot of relevant information for quality improvement may be lost by looking only at examination data.

SUMMARY

Variability in digital radiographic equipment can result in variability in the total cost of ownership, ease of use, reliability, and quality of imaging. In undertaking an equipment evaluation, conducting a well-organized search and relying on expertise from medical physicists, engineers, radiologists, and technologists who have experience with the equipment under consideration can make a difference between adding value or headache to your radiology practice.

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