Features to Consider When Selecting a New CT Scanner

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Question: Which imaging system (CT scanner) should I pick among the various manufacturers?

Answer: This is a common question often asked when selecting a new imaging system, for which the answer is not straightforward and simple because there are many factors to consider in the selection process. Generally, the selection process can be broadly classified into various phases, such as the needs assessment and specification phase, the data collection phase, and reviewing manufacturer data, before selecting a particular imaging system. Once the imaging system is chosen, the process continues with working out the details regarding the construction and installation phase, the acceptance testing phase, the clinical applications phase, and the beginning of routine use and establishment of service contracts. The selection process greatly benefits from discussions among radiologists, technologists, medical physicists, and administrators [1]. The team approach is optimal in selecting and identifying the best imaging system to match the need. The purpose of this article is to focus on the selection of a new CT scanner and the key features to consider during the selection process.

Identifying clearly the goals and needs for a CT scanner is important in the selection process. For example, is a **general-purpose** CT scanner or a **special-purpose** CT scanner needed? A general-purpose CT scanner is one that is used for routine imaging of all anatomic regions and accommodates all types of patients, acting as a workhorse in a radiology or an emergency department. Such CT scanners should require minimal downtime and accommodate all types of patients, and therefore such scanners need not necessarily be the latest and the greatest but rather stable scanners that have already demonstrated consistency for routine clinical use.

On the other hand, if a CT scanner is required for specific applications, such as pediatric radiology, neuroradiology (perfusion), cardiac imaging, and so on, the selection of a special-purpose scanner should focus on identifying not only the available scanners but also what resources manufacturers can provide for specific applications. One common theme applicable to both types of use is the capability of a CT scanner to deliver good image quality with the least amount of radiation dose.

It is often a challenge to pick the right CT scanner because most key features are similar among the various CT manufacturers. This is especially true of 16-slice or 64-slice multiple-row detector CT (MDCT) scanners, which are best suited for general-purpose use. Therefore, it is important to start off with a basic understanding of various features and the impacts they have on CT images [2]. Only certain salient features are distinguishable among the CT scanners, and therefore nontechnical issues such as the availability of service in the local area or other tangibles (research projects, beta testing site for future releases, and other options) provided by a particular manufacturer often loom large in the selection process. A good place to start is the latest product comparison charts [3], which provide information on key parameters among the various manufacturers. Medical physics consultations can be very useful in comparing various parameters and identifying the scanner that most closely matches the need.

KEY FEATURES TO CONSIDER IN THE SELECTION PROCESS

Tube Voltage

Even though 120 kVp has been the sweet spot among the tube voltages used in most CT protocols, it is key to ensure that a CT scanner is capable of being calibrated for all available voltage stations and can be used in any protocols. In the past, low tube voltages (80 and 100 kVp) were not used routinely, but recent studies have shown the advantage of using low tube voltages (eg, 80 kVp in CT perfusion protocols [4-6], 100 kVp for scanning pediatric and thin patients [4-6]) in not only reducing radiation dose but also improving image contrast. Therefore, it is important to ensure that a CT scanner has all available tube voltages and can be duly calibrated.

Tube Current

A CT scanner should have a broad range of tube current capability. This includes high-current ($\geq$600 mA) stations to accommodate obese patients and low-current stations (as low as 10 mA) that can be changed in smaller increments for scanning thin patients and pediatric patients [3]. Higher tube cur-

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rents require higher tube heating and cooling capacity. Because most CT manufacturers provide x-ray tubes with 5 to 8 million heat units, tube heating and cooling capability is no longer a distinguishing feature among CT scanners.

Pitch

All CT manufacturers are required to provide pitch information as defined by International Electrotechnical Commission standards [7]. This allows for easy and quick comparisons between the protocol settings and to understand the impact on radiation dose and image quality. Certain manufacturers are now providing variable pitch features, which allows scanning of contiguous regions (eg, scanning the chest, abdomen, and pelvis together) with variable pitch settings to match the clinical needs with a view toward lowering radiation dose.

Gantry Rotation Time

Gantry rotation time affects overall scan time and influences temporal resolution. Currently, scanners have rotation times ranging from 2 to 5 seconds per rotation to as fast as 0.4, 0.3, and even 0.28 seconds per rotation [3]. In fact, the demand for high temporal resolution in cardiac imaging has been at the forefront of technological development with faster gantry rotation including development of dual-source CT scanners.

Scan Volume

The numbers of detector channels available in MDCT scanners include 4, 16, 40, 64, 256, and 320 detectors and define the total scan volume coverage per gantry rotation. With 16-slice and 64-slice MDCT scanners, the maximum scan volume coverage per gantry rotation is 20 mm (16 × 1.25 mm) and 40 mm (64 × 0.625 mm), respectively, while 256-detector and 320-detector scanners cover 80 mm (128 × 0.625 mm) and 160 mm (320 × 0.5 mm) of scan volume per gantry rotation, respectively [2].

Dose Reduction and Optimization Strategies

Most MDCT scanners use several dose reduction strategies [2,8,9]. In fact, the availability of various radiation dose modulation tools and the implementation differ among manufacturers and is one of the key features that distinguish a scanner among the various manufacturers. Therefore, careful understanding and training on its correct use is key.

AFTER A SCANNER IS SELECTED

Once a CT scanner is selected, the coordination of site preparation, construction with radiation shielding to comply with local regulations, and installation of the scanner follow. After the completion of the installation process and before clinical use, it is important that the scanner undergo acceptance testing.

Acceptance Testing

Acceptance testing is performed to ensure that a CT scanner meets its manufacturer's specifications, to establish baseline measurements for later comparisons of the scanner's performance, and also to comply with regulatory requirements. Evaluation includes radiation dosimetry measurements, image quality evaluations including low-contrast and high-contrast resolution, and other parameters like those specified in the ACR technical standards [10]. This allows establishment of a quality assurance program for the scanner that benefits the site when it decides to apply for CT accreditation in the future [11]. Such accreditation is required beginning in 2012 [12] for all CT scanners located in outpatient and independent imaging centers, and it is highly possible that private insurers and other agencies may also demand accreditation for CT scanners located in hospitals as well. CT accreditation can be obtained by applying to the ACR's CT accreditation program [11], 1 of the 3 accrediting programs recognized by the US government [12].

CT Dose Reports

Current MDCT scanners such as 16 slice and higher do have the option to save dose information. In the absence of uniform standards, these reports vary among manufacturers. However, efforts are under way to develop uniform dose reports that can be displayed with CT images, archived and saved in patient health records, and recalled when the same patient arrives for additional CT scans. These efforts are in response to concerns about CT dose [13] and have led to policies [14] and initiatives [15].

Service

Irrespective of the type of CT scanner selected, the most critical element in the entire process of selection and utilization of a scanner depends on the availability of service in the local region and the type of service contracts. One must watch out for situations in which a manufacturer may lower the cost of its scanner to compete with other manufacturers but indirectly make up for the loss of the scanner cost by levying higher rates for service contracts [1]. Therefore, examining the type of service available in the region and the type of service agreement with a manufacturer is crucial at the time of selection.

ADDITIONAL FEATURES TO CONSIDER

Other upcoming features to watch out for are dual-energy capability; iterative reconstruction with the goal of reducing CT dose by an order of magnitude; CT dose reports that are easily stored, shared, archived, and interpreted; CT dose alerts (a system to warn when CT parameters are incorrectly set with the potential to deliver very high radiation dose); protocol standardization; and the capability to track and perform audits regarding any changes made in the clinical protocol settings.

CONCLUSIONS

Overall, the selection of a particular CT scanner fundamentally depends on the need. A 16-slice or 64-slice MDCT scanner can meet most requirements for general-purpose use. A team that includes radiologists, technologists, medical physicists, and administrators should all be involved in the process of selecting a CT scanner. When most factors are similar for a particular type of CT scanner, the availability of service that can result in minimal downtime is a key distinguishing feature in selecting a CT scanner from among the various manufacturers.

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