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Computed Tomography Systems

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ECRI is a totally independent non-profit research agency designated as a Collaborating Centre of the World Health Organisation (WHO). Established as an Emergency Care Research Institute, ECRI opened its European Office in May 1995 with the goal of serving the particular needs of Europe and the UK. It is widely recognised as one of the world's leading independent organisations committed to advancing the quality of healthcare, with over 240 employees globally.

The comparative tables of computed tomography (CT) systems overleaf are extracted from ECRI's database. All of ECRI's products and services are available through the European Office, addressing the special requirements of Europe and the UK. For full information, please refer to ECRI. These data have additionally been reviewed and updated by the respective manufacturers.

Here, Jason Launders, MSc, of the ECRI US office, identifies the main factors to consider when choosing a CT system:

As recently as 1998 the majority of computed tomography (CT) systems acquired just one slice of data per rotation and each rotation taking at least a second. Since 1998 the pace of technological and clinical development has been rapid. First came 4-slice, then 8- followed by 16- and now 64-. Not only has the number of slices increased but also the rotation speed, with 3 rotations per second now possible. So, CT scanners have moved from 1 slice per second to almost 200. Hospitals that purchased a state of the art 4-slice system in 2002 are now left with 'obsolescent' technology. So what are the important factors to consider with CT?

Obsolescence

A review of ECRI's database reveals that the price paid for a 4-slice CT has almost halved since 2002. All CT systems offering 16 or less slices per rotation have fallen in cost significantly. So, the depreciation of CT equipment has followed a similar pattern compared to computer equipment rather than medical imaging equipment. For systems with more than 16 slices there is a noticeable price jump. This jump reflects some significant technological differences that were introduced when CT reached 16 slices. The result is that while it is possible to upgrade some systems, it is not always possible. Some systems are deliberately designed and sold with future upgrades in mind, particularly for buyers who are unable to afford the highest specification. So, buyers should always be aware what upgrade options are available for a system. Of course future developments are largely an unknown quantity and while manufacturers may indicate future developments, no one can be sure.

How Many Slices?

Perhaps the single biggest question people have when looking at CT today is: "Just how many slices do you need?" The only real difference afforded by more slices is the speed of information acquisition. The minimum slice thickness and spatial resolution is not usually affected. For

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example, a 64-slice scanner acquires 0.625 mm thick slices per rotation for a total coverage of 40 mm. A 16-slice scanner can also acquire 0.625 mm thick slices but only covers 10 mm per rotation. Therefore, all other factors being equal, the 64-slice system is 4 times faster. However, most clinical studies do not benefit from using 0.625 mm slice, instead 1 mm or even 2 mm are often adequate. If using 2 mm slices then the 64-slice scanner would only be really acquiring 20 slices per rotation (the total overall width is fixed at 40 mm), while the 16-slice scanner would acquire 12 slices per rotation (the overall width is fixed at 24 mm). In such a study the 64-slice scanner would only be ~2 times faster. (Note the slice thicknesses used in this example are specific to one manufacturer, not all 64-slice systems acquire a total of 40 mm per rotation).

Therefore, when moving from a 16-slice to 64-slice system, the clinical advantage is only significant if speed of acquisition is critical, for example in cardiac imaging. In general, as the number of slices is increased the law of diminishing returns holds. However, as clinicians gain more experience, particularly with 3D imaging, it is possible that 64-slice imaging will increase in value. Today, however, most routine clinical imaging does not benefit from 64 slices.

Comparing Technologies

With any imaging technology the image quality is an important consideration. While some well-known metrics for CT are available (and reported in ECRI's charts), a direct comparison is difficult due to the influence of image processing. Also, the standard measurement techniques usually used were designed when slice thicknesses were significantly wider than those used today, and the thicker slice thicknesses are still used to measure image quality. So, figures such as minimum detectable contrast and spatial resolution should be viewed with caution.

In addition, the competition between CT manufacturers has led to a number of innovative technologies that make comparison even harder. For example, one manufacturer uses a hardware technique to double the number of physical slices from 32 to produce 64 slices of data (i.e., not using interpolation). This technique has been shown to have some advantages, for example, the slice thickness is smaller and some artifacts are reduced. However, the overall coverage is less, so longer breath holds are required.

X-Ray Tubes

Modern CT scanners put considerable strain on the x-ray tube. As rotation times have decreased the forces on the tubes increase and the x-ray output must also increase to compensate. Any technology that extends the reliable life of the x-ray tube will decrease downtime and associated cost. Of course, the more advanced x-ray tubes also come with a premium price tag. What is more, reliability data is usually confidential. Whatever the choice of x-ray tube, it is recommended that x-ray tube replacement is covered by a contract so that costs can be budgeted.

Data Explosion

The volume of data produced by multislice CT scanners has increased dramatically. Therefore, faster computers are needed to reconstruct the data in a timely fashion, faster networks to transfer the data to PACS, and larger data storage archives. These costs must be factored in when considering the type of scanner.

Conclusion

CT technology is moving faster than clinical trials can keep up. It is true that 64-slice systems have clinical benefits, but for most routine CT exams, these benefits are limited. The only real benefit of 64 slices is when imaging rapidly moving anatomy. The costs of moving to high specification scanners can be considerable and should include higher xray tube costs and data management costs. Given the increase clinical utility it is likely that the most cost-effective strategy will be to have multiple scanners of differing specifications.

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