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Technology Forecast-Imaging Services

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Medical imaging plays a significant role in the diagnosis and management of disease. Technological developments have significant implications on how imaging equipment is used. Knowledge of the ongoing developments being made in medical imaging technology is essential for healthcare planning.

Computed Tomography

What are the technical limitations with a 16-slice scanner compared to one with 64-slices? The answer depends on what the application is. For non-cardiac applications, 16 slices is usually sufficient. Cardiac imaging has gained a lot of attention because it is the most technically challenging anatomy to image. Limitations such as high x-ray dose and high heart rates remain, so the push is for more speed. The latest commercially available development is the addition of a second x-ray tube. The second tube could have significant benefits, in terms of speed, dose and more clinical utility. Another development, though not yet commercially available, is the increase in slices to 256. While the issue of radiation dose is a growing concern, it seems inevitable that the use of CT will increase.

Magnetic Resonance Imaging

MR imaging has two advantages over CT; soft tissue contrast and absence of ionising radiation. However, it is associated with long exam times, significant patient discomfort and considerable complexity. Three developments in MR imaging are evident today: higher field strength, more open magnets, and simplified image acquisition. Higher field strengths enable faster and higher resolution imaging. This is particularly important in exams that attempt to detect small and transient changes. High field strength (3T) systems are becoming widely used despite additional costs. However, for routine patient exams there is little data to show concomitant benefits. As more clinical experience is gained 3T will continue to grow. Patient comfort was the main reason for the popularity of open MR systems. In Europe, open MR never found widespread use. Today, 1.5T MR systems are becoming increasingly "open", with shorter and wider bores coupled with acoustic noise reduction. MR is the most complex imaging tool in routine use. Manufacturers now provide a number of software packages that help the users acquire MR images more reliably. These packages can be expensive, so users need to carefully determine which tools they need.

Ultrasound

As digital signal processing becomes smaller and cheaper, the amount you can do with ultrasound is increasing.

Portable once meant the device could be wheeled around, now you can fit it in your pocket. With the development of small imaging devices healthcare facilities are being forced to reconsider how ultrasound is used. However, large, full feature ultrasound units remain important diagnostic tools. In particular, 3D imaging has proved to be more than a gimmick as it helps reduce variation between users.

Mammography

In 2005 the results of the long awaited ACRIN digital mammography study were released, showing that for women under the age of fifty, with radiographically denser breasts, digital mammography improved cancer detection. So, despite higher costs, there is now increased patient demand. A number of alternative technologies are either available or under development for breast cancer detection. None of them are promising to replace mammography as the primary screening tool. Instead, they are being developed to screen high-risk groups or reduce the number of breast biopsies. Breast MR imaging is probably the most widely used technology. However, until alternative technologies demonstrate sensitivities and specificities approaching that of minimally invasive biopsies, it is hard to justify their widespread adoption.

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Radiography

Now that digital image storage and review is indispensable, it is necessary for non-digital technologies to become integrated. Hence growing demand for digital radiography. The technology used in flat panel detectors (DR) appears to be mature now, with no recent technological developments as far as the detector is concerned. In contrast, the technology used in reusable phosphor plates (CR) is continuing to develop. Image quality is improving and image-processing times are reducing. The result is that what was once a clear distinction between DR and CR is not so clear-cut today. One interesting development for both CR and DR is the integration of both technologies into a portable x-ray unit that can be used around the hospital.

Fluoroscopy

The ubiquitous image intensifier is gradually being replaced by the smaller and more expensive flat panels (similar to DR). A significant amount of diagnostic work being done in radiology departments with fluoroscopy moved to CT. More recently flat panels are becoming more common on angiographic equipment and now are beginning to appear on general-purpose radiographic/fluorography equipment. The interesting aspect is what manufacturers can do with the technology to justify additional expense. Fluoroscopy equipment is now being used more for interventional procedures as CT becomes the predominant tool. Flat panel technology together with fast computing power is allowing CT-like images to be produced with fluoroscopic equipment. While images do not match those from CT they allow much improved guidance for interventional procedures.

Nuclear Medicine (SPECT and PET)

While gamma camera technology used in nuclear medicine has not really changed, the increasing interest in hybrid scanners has. The combination of PET and CT was one of the factors that dramatically affected growth of PET. Now, higher specification CT scanners are being combined with SPECT. While the clinical benefits are not clear compared to PET, it is likely that SPECT CT will become increasingly common. A lot depends on the development of radiotracers. The same is true for PET, the main issue being that new tracers being developed have very short half-lives, limiting availability and increasing costs. Perhaps the most significant development in PET imaging is not technology but the much stronger evidence being sought to demonstrate its effectiveness.

Computer Aided Detection

Historically computer aided detection has focused on the needs of mammography. Mammography CAD is generally accepted as improving detection, particularly when only one radiologist views images. As more users move to digital mammography it is likely that CAD will become a standard tool. Interest is moving to other areas that would benefit from CAD. Early results of CAD are promising. If such screening is to become common then it is very likely that CAD will be an essential part for the viability of such exams. In addition to pure CAD, i.e., detection, automated computer analysis of images is becoming increasingly important. Much of this is driven by the vast increase in the number of CT images being generated. The resulting 3D datasets cannot reasonably be reviewed by human observers. But computers can rapidly measure and analyse datasets, often with human interaction, to produce quantitative results. Problems include how to fit CAD into the workflow so that disparate systems and humans can work effectively together.

Most technological changes are the result of faster computer processors. Faster image acquisition, regardless of modality, means that diagnostic information is less dependent on patient's conformance. 3D data sets are becoming increasingly common. The most likely result of this is that more referring physicians and patients will demand more advanced imaging. Tempering this will be the growing demand from payers (i.e., governments) for evidence based research. These changes will require new equipment, different skill sets, and very different models for workflow within radiology departments.

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