The use of computed tomography for screening can be effective and safe

The development of multislice computed tomography (CT) and the associated newer CT techniques over 5 years ago led to a surge in interest in the potential use of this exciting modern technology in preventative medicine. An initial rapid expansion in the provision of such screening tests in an uncontrolled manner led to increasing mistrust and scepticism among both the media and the medical establishment.

There has been continued development and refinement of such CT examinations by experienced radiologists which, along with greater experience and an increasing volume of published data, has led to the development of evidence-based protocols and guidelines which are being used more widely in preventative health programmes. Rather than being an unfocussed 'body scan', CT screening is now a far more focussed technique specifically targeting coronary artery disease, lung cancer and colon cancer. These three tests were the main focus of a report by an invited panel of experts published in July 2007 (Clinical Advisory Committee on Diagnostic Imaging, 2007). As well as the clinical effectiveness, the report also considered published data as to the relative risks of the radiation exposures, the potential for false positive results and aspects of cost effectiveness.

Coronary artery calcium scoring

Cardiovascular disease remains the leading cause of death in the western world. In the UK in 2005 just over 208 000 deaths occurred as a result of cardiovascular disease (Allender et al, 2007). In a significant proportion of patients (40%) the first symptom is sudden death. Coronary artery calcium scoring has been used for cardiovascular risk assessment for over 20 years . It has now been endorsed by both the American College of Cardiology and American Heart Association (Budoff et al, 2006), as well as the Screening for Heart Attack Prevention and Education (SHAPE) task force (www.shapesociety.org). The Royal College of Radiologists (2007) publication *Making the best use of clinical radiology services 6* has also identified coronary calcium scoring as a valid investigation tool for risk stratification.

Several large clinical trials have found clear, incremental predictive value of coronary artery calcium scoring over the traditional Framingham risk score when used in asymptomatic patients. Based on multiple observational studies, patients with increased plaque burdens (increased coronary artery calcium score) are approximately ten times more likely to suffer a cardiac event over the next 3–5 years.

Coronary calcium scores have outperformed conventional risk factors, C-reactive protein and carotid intima media thickness as a predictor of cardiovascular events. This allows anti-atherosclerotic therapies (such as statins, angiotensin-converting enzyme inhibitors and antiplatelet drugs) to be used earlier and more vigorously in those found to have advanced subclinical atherosclerosis.

Despite the many hundreds of papers validating coronary artery calcium scoring, there are few data on the cost effectiveness of coronary artery calcium scoring and screening. This has led to interest from the British Heart Foundation and similar agencies to investigate this area further.

CT colonography

Screening for colon cancer is well established using a number of recognized methods. The final publication of the American College Radiology Imaging Network 6664 study later this year is likely to see CT colonography added to the more traditional tests for colorectal cancer screening. Initial results have recently been made public and have shown CT colonography to be accurate as optical colonography for the detection of significant colonic polyps and cancer.

The largest series to date has also emphatically demonstrated CT colonography to be a viable alternative to optical colonoscopy for screening purposes (Kim et al, 2007). Similar results in a high-risk cohort of patients from Italy have just been presented at the International Symposium on Virtual Colonoscopy in Boston.

Experts generally agree that CT colonography is a superior diagnostic test to barium enema with greater accuracy (96% *vs* 85% for cancer detection) and improved patient experience. Moreover, its performance characteristics are comparable to conventional colonoscopy, when performed in well-equipped centres staffed by suitably trained radiologists. CT colonography is gradually replacing the traditional barium enema in the UK for symptomatic patients. More widespread introduction is being hampered by a shortage of suitable training programmes and scanner capacity. Both of these issues are being addressed as a matter of some urgency in the USA and it is likely that the UK will eventually follow suit.

Lung cancer screening

Lung cancer remains the most common non-vascular cause of death, yet screening remains controversial. The International Early Lung Cancer Action Project continues to publish evidence of both clinical and cost effectiveness, yet other models and smaller studies have not drawn the same conclusions (International Early Lung Cancer Action Program Investigators et al, 2006; Roberts et al, 2007). It is hoped that the long-awaited trials from both the USA and Europe will provide a clear answer, but owing to the nature of the trial design this may not be the case.

In the interim there is no doubt that screening with low-dose CT can detect lung cancer at an earlier stage, allowing potentially curative treatment. However, confirmation of improved mortality remains unproven. This does not necessarily mean that there is no proof and the authors believe the decision to be screened should remain an individual choice provided to at-risk individuals. Strict adher-

ence to International Lung Cancer Action Project protocols would ensure that unnecessary follow-ups and cost can be kept to a minimum.

No other intervention from the past 40 years has had any impact on the terrible death toll of lung cancer.

Radiation

All of these CT screening tests use radiation, yet it must be recognized that because they are screening tests, the exposures used are not comparable to other CT examinations used for the investigation of symptomatic patients. The total dose from a typical screening CT colon study is less than that derived from a barium enema. This dose (6–7 mSv) is considered by the Health Physics Society to be either insignificant or too small to measure. Any theoretical harmful effects are in fact less than the very real, albeit low, risks of conventional colonoscopy. Both a barium enema and optical colonoscopy are widely practiced and approved for colon cancer screening.

A low-dose CT scan of the chest as used in lung cancer screening delivers a dose comparable to between three and eight chest X-rays (0.2–0.8 mSv), and not the many hundreds usually used as a comparison from a convention chest CT. Similarly a coronary artery calcium score has a comparable dose to a lumbar spine radiograph (1.2 mSv) or the equivalent of 4 months' background exposure in the UK.

The extra radiation from all three tests combined – approximately 10 mSv – is small when compared to total lifetime exposure. The linear no-threshold theory has been shown on a number of occasions to be lacking in evidence when annual exposures less than 50 mSv are considered. It should also be remembered that the possible effects of low dose radiation exposure may be beneficial rather than harmful. While it remains sensible to continue to monitor and use radiation following the as low as reasonably practical (ALARP) principle, the theoretical risks of such low-dose exposure should be compared to demonstrable benefits of early diagnosis and in these common conditions.

Cost effectiveness and impact on the NHS

The absence of data should not be taken as evidence of absence of benefit. While there may be some extra cost from extra investigation of positive findings, it is likely that there will also be significant savings as a result of cheaper treatment options and improved survival from early detection using such techniques. The decision of an individual to undergo CT screening or other privately funded medical intervention should not prejudice access to any further state-funded care – in the same way as, for example, an unhealthy lifestyle or participation in a dangerous sport should not prevent individuals obtaining appropriate care.

Conclusions

There is no doubt that screening and preventative medicine with modern imaging techniques (such as multislice CT) and other personalized preventative medicine tests (such as genetic profiling) are here to stay. It is important that proper regard and consideration is given to the published best practice guidelines derived from established programmes, as well as ensuring that such services are only offered by experienced imaging clinicians who have received appropriate training and are familiar with the published literature. Ill-informed debate and inappropriate use of such technology as well as improper management of any positive findings should not be allowed to undermine the potential benefits that such modern technology has to offer. BJHM

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Allender S, Peto V, Scarborough P, Boxer A, Rayner M (2007) Mortality. In: *Coronary heart disease statistics.* British Heart Foundation, London (www.heartstats.org/uploads/documents%5C2007.chapter1.pdf accessed 26 November 2007)

Budoff MJ, Achenbach S, Blumenthal RS et al (2006) Assessment of coronary artery disease by cardiac computed tomography, A Scientific Statement From the American Heart Association Committee on Cardiovascular Imaging and Intervention, Council on Cardiovascular Radiology and Intervention, and Committee on Cardiac Imaging, Council on Clinical Cardiology. *Circulation* **14**(16): 1761–91

Clinical Advisory Committee on Diagnostic Imaging (2007) *A Report By The Clinical Advisory Committee On Diagnostic Imaging On The Safety And Efficacy Of CT Screening.* Only Connect Solutions, London (www.cacodi.org.uk/cmsdata/reports/reports-9-1-31072007.pdf accessed 26 November 2007)

International Early Lung Cancer Action Program Investigators, Henschke CI, Yankelevitz DF, Libby DM, Pasmantier MW, Smith JP, Miettinen OS (2006) Survival of patients with stage I lung cancer detected on CT screening. *N Engl J Med* **355**(17): 1763–71

Kim DH, Pickhardt PJ, Taylor AJ et al (2007) CT colonography versus colonoscopy for the detection of advanced neoplasia. *N Engl J Med* **357**(14): 1403–12

Roberts H, Patsios D, Paul NS et al (2007) Lung cancer screening with low-dose computed tomography: Canadian experience. *Can Assoc Radiol J* **58**(4): 225–35

Royal College of Radiologists (2007) *Making the best use of clinical radiology services '6'.* Royal College of Radiologists, London

KEY POINTS

- Computed tomography colonography screening for colorectal cancer has been shown to be as effective as conventional colonoscopy for the detection of clinically significant colonic polyps.
- Coronary artery calcification scoring is recognized as being the most sensitive indicator of the risk for coronary artery disease either alone or in combination with other traditional risk factors.
- Low-dose lung computed tomography has been shown to be able to detect small, early-stage, resectable lung cancers.
- Any theoretical risks from the modest doses of radiation involved with such computed tomography techniques are either too small to measure or non-existent.