Full body CT scan: will it save lives?

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Full body CT screening is being promoted as a potentially life-saving procedure, but is it?

The advent of rapid multislice computed tomography (CT) scans means the whole body can be scanned in less than one minute, and very high resolution images in any plane can be created in around five minutes. The application of this in an unstable patient with severe multi-organ trauma is clear. However, 'full body (brain, neck, chest, abdomen and pelvis) CT screening' is now being promoted for the early detection of diseases, particularly cancer, with the claim that it may save lives.

To meet this claim, full body CT screening must be able to detect a clinically undetectable abnormality that would otherwise cause death and that can be treated with life-saving or significantly life-prolonging interventions. Can it achieve this? In examining this question it is worth looking at the results to date of an established screening program such as mammographic screening for the early detection of breast cancer.

When screening works

The success of a population based screening program, as in mammographic screening, is critically dependent on a quality assurance program that ensures detection accuracy and the correct management of positive findings. The breast cancer screening detection program arose because of both the accuracy of mammography in detecting breast cancer and the high incidence of breast cancer in women who were aged 50 to 69 years and undergoing screening. The peak annual incidence was in women aged 60 to 64 years: 321 cancers per 100,000 women.[1,2]

Mammography has a high sensitivity (around 80 to 90%) for breast cancer detection and a good specificity (90 to 98%) for the detection of normals. Moreover, for women recalled with a possible abnormality on screening, there is a clear pathway for

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assessment. Even so, the age-standardised breast cancer annual mortality per 100,000 women has so far only fallen from 71.9 deaths in 1988 (before the screening program) to 59.4 deaths in 1998 (the program was implemented from about 1991 to 1995).[3] This is 12.5 fewer breast cancer deaths per 100,000 women in the population. In women aged 50 to 69 years after adjustment for the age-standardised participation of 54%, the annual breast cancer mortality fell by 22.8 per 100,000 women or 32% – a figure that could improve to 40% or more once the short follow up bias has passed.

Reading screening mammograms to detect these cancers is a significant undertaking. It takes a radiologist two to three hours of high concentration to read 500 mammograms, which involves viewing 2000 new films in addition to previous films for comparison. Among these 2000 films, the radiologist is likely to see between zero and two obvious cancers, one to two probable cancers, and an average of 17 indeterminate findings.

Feasibility according to incidence

It is difficult to imagine it being feasible to read images that have been taken for screening purposes for cancers with a significantly lower incidence than breast cancer. For example, if the breast cancer incidence were only 30 cancers per 100,000 women per year, a screen reader would have to read 5000 films to detect zero to two obvious cancers and one to two probable cancers.

Accurate cancer detection at such a low incidence seems unlikely owing to the difficulty in maintaining concentration while reading thousands of normal (and essentially identical) films. Furthermore, quality assurance that a radiologist is iden-

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tifying significant abnormalities would be difficult to achieve, since diagnostic radiologists are assessed by looking at how many abnormities they have detected for every so many films. With a very low expected number of abnormalities, it may be impossible to determine whether a lower than expected detection rate represents inaccurate reading, or is simply a result of normal variation in the rate of lesions in a population sample. This leads to the notion that cancers suitable for accurate detection by CT screening would have to have an annual incidence similar to or greater than that of breast cancer, roughly 250 cases per 100,000 people in the selected population.

Consider the incidence of some common cancers in the 60 to 64 years age group as shown in the Table. CT screening in this age group is only feasible (using a cut-off yearly incidence of 250 cases per 100,000 population) for lung cancer in smokers, prostate cancer in men and breast cancer in women. Bowel cancer can be added to this list. Although annual bowel cancer incidence per 100,000 people is only 200 and 127 in men and women, respectively, it rises to 283 in men aged 65 to 69 years and to 244 in women aged 70 to 74 years. Large bowel screening is directed primarily at the detection of pre-cancerous polyps, which are much more numerous than cancers, and the polyp incidence is sufficient for screening.

All other cancers in this list that might be considered for CT screening have incidences about one-fifth to one-tenth of that required for population based screening. Furthermore, the high incidences of benign thyroid nodules, liver cysts and haemangiomas, cortical renal cysts and functional ovarian cysts are likely to confound early cancer detection in these organs.

Screening programs generally target a specific age cohort according to what age group is most often affected by the disease. Often a 20-year age cohort is used, for example screening people aged 50 to 69 years. Full body CT screening is being promoted for people in a much broader age group, which will reduce the overall incidence of disease in the population being screened.

How well can CT screen?

If a condition is common enough to make screening feasible, the next question is whether the screening is accurate enough to detect the condition in its early stages.

Cancer

Breast and prostate cancer are not detectable by CT unless the tumour is advanced, hence CT is not a viable screening tool for these cancers in their early stages. However, is CT screening for lung cancer and large bowel polyps sufficiently accurate?

In the ELCAP (Early Lung Cancer Action Project) study of 1000 asymptomatic subjects aged 60 or more years with a minimum ten pack-year history of cigarette smoking, CT screening detected 27 lung cancers of which 23 were stage 1.[4] The five-year survival for people in the study diagnosed with lung cancer was expected to be between 60 and 100%, while the overall lung cancer cure rate in the USA was 12%.

CT colonography has a 90% detection rate for polyps larger than 10 mm in diameter. Although it is less accurate than colonoscopy, the rate is sufficient for CT colonography to be considered for polyp screening.[5,6] The scan would also detect many asymptomatic large bowel cancers.

Coronary artery disease

Coronary artery disease is the other area where CT screening can be applied. Coronary artery atheroma contains calcium (coronary artery calcium [CAC]), which can be detected by CT and expressed as a score called the CAC (or Agatston) score.[7] The higher the CAC score, the higher the chance of a future coronary artery event.[7,8] All conventional cardiovascular risk factors are significantly associated with the presence of any detectable CAC, and the mean CAC score increases in proportion to the number of risk factors.[9] In one study, however, 8%

Table. Annual cancer incidence per 100,000 people aged 60 to 64 years [1,2]

Primary organ	Men	Women
Lung, trachea, bronchus	158.4	68.1
– in cigarette smokers	760.2	245.1
Prostate	338.3	–
Breast	–	320.8
Large bowel	199.5	126.9
Uterine body	–	53.6
Ovary	–	34.4
Bladder	46.0	17.1
Kidney	43.4	21.7
Non-Hodgkin's lymphoma	43.4	31.1
Head, neck	36.4	16.8
Uterine cervix	–	16.3
Stomach	34.6	12.4
Pancreas	27.0	19.2
Oesophagus	21.6	7.8
Larynx	21.1	3.4
Brain, central nervous system	17.9	12.4
Liver, intrahepatic bile ducts	14.6	3.6
Mesothelium	11.4	1.6
Thyroid	6.2	13.5
Small bowel	5.7	2.3
Nose, paranasal sinuses	3.6	0.5
Gall bladder, extrahepatic bile ducts	3.4	8.0
Hodgkin's disease	1.8	1.0

of people at low coronary risk, according to conventional risk factors, had CAC scores in the top quartile of the distribution.[10] These people had a higher chance than expected of a future coronary event. Thus CT screening can detect unsuspected significant coronary artery disease.

CT and radiation

As we have seen, population based CT screening could only be used to estimate CAC scores and to detect lung cancer in smokers and large bowel polyps or cancer. Screening for these requires three separate CT examination techniques; none involves using intravenous or oral contrast.

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The lungs can be screened using a low dose technique that gives about the same x-ray dose as a chest x-ray (approximately 0.04 mSv). A CAC score requires scans limited to the position of the coronary arteries, with a skin entry dose of up to 10 mSv – this is four times the annual Sydney background dose, but it is limited to the area scanned. CT colonography involves the same colon preparation as a colonoscopy, per-rectal air insufflation of the colon, and supine and prone low dose scans that would give a skin entry dose of about 5 mSv to the abdomen.

Population self-selection

The population based cancer incidences used above will not necessarily be those found in an actual CT screening program. In the mammographic screening program, the expected breast cancer incidence per 100,000 women aged 50 to 69 years is 292 annually, but the cancer detection rate is 388.[3] In men and women aged 60 to 70 years who smoke, the lung cancer rate is 670 per 100,000 per year, but the ELCAP program detection rate was 2700.[1,2,4] Thus, a population offered screening self-selects a subgroup with a higher than expected cancer incidence.

In full body CT screening offered by commercial providers who sell direct to the consumer, not only will this phenomenon occur but also symptomatic patients who elect full body CT instead of a conventional medical assessment will have a host of other pathologies found. Some of these people will need a second conventional CT scan with contrast medium for proper assessment, and some may have been more appropriately imaged by another modality.

Conclusion

Despite the large number of cancers, only two – lung cancer in smokers and colon cancer – are candidates for CT screening based on their incidence, the ability of CT screening to detect them or their precursor (colon polyps) early, and the ensuing mortality reduction likely to result. All other cancers have an incidence too low to be considered, will have their detection confounded by a high incidence of benign pathologies, or are unlikely to be detected early. Meanwhile, the estimation of the CAC score will reveal a small number of low risk patients with unsuspected significant coronary artery atheroma.

Symptomatic patients should be discouraged from having a full body CT scan as an initial investigation because another imaging modality may be more appropriate. If a possible cancer were found, a further diagnostic CT scan with contrast would be required, and this may well have been anticipated by prior clinical assessment. MT

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