Radiation exposure during lung cancer diagnostic work-up: how important in the wider picture?

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The paper by Rintoul *et al*[1] has highlighted the radiation burden for patients undergoing imaging investigations for lung cancer and calculated the *lifetime attributable risk* of developing a further malignancy as a result of that radiation exposure. Patients who underwent curative-intent surgery or radical (chemo) radiotherapy received an average radiation dose of approximately 28 mSv in their work-up. As might be expected, those patients with more advanced disease, in whom radical treatment was not possible and underwent best supportive care, received approximately half the radiation dose (approximately 15 mSv).

Using standard conversion factors, the authors have derived the lifetime risk of developing a second cancer as a consequence of the radiation exposure as approximately 1:1700 for all cancers and 1:5000 specifically for lung cancer in patients undergoing curative-intent surgery or radical (chemo)radiotherapy. It is important for the physician, radiologist and, of course, the patient to determine whether this risk is acceptable by evaluating the benefits gained from the diagnostic imaging undertaken and putting that risk into context of other causes of morbidity and mortality that the patient might suffer.

Accurate staging is essential to identify those patients with resectable, potentially curable disease but equally to avoid undertaking futile treatment in those with more advanced disease or operating on those who, in fact, have benign disease. Although a relatively high radiation dose investigation, positron emission tomography (PET)-CT has had a significant effect on accurate staging of patients and, by better patient selection, on overall survival.[2]

The reduction in futile resections has also been the result of other diagnostic advances leading to more robust preoperative assessment, for example the increasingly routine use of endobronchial ultrasound to diagnose involvement of N2 nodes precluding curative surgery, but nevertheless the use of PET imaging has had a major impact, and the National Institute for Health and Care Excellence guidelines have clearly identified the role and impact of CT-PET imaging and, since 2011, have recommended that all patients potentially suitable for treatment with curative intent are offered PET-CT before treatment.[3]

The benefit of the radiation exposure in determining resectability (or otherwise) is therefore relatively clear, but this must be weighed up against the risk of the radiation causing a second cancer in these patients.

It is first important to put the radiation exposure into the context of natural background radiation exposure. The average UK annual background effective radiation dose is approximately 2.7 mSv, of which approximately half is derived from radioactive radon gas. In areas where the natural background radon levels are high, however, annual radiation dose may be as high as 6.9 mSv, for example in Cornwall, Derbyshire or Aberdeen (and in much of the USA). The average radiation burden from diagnostic imaging prior to radical treatment for lung cancer is therefore equivalent to approximately 4–10 years of background radiation depending on where the patient lives.

Unlike those exposed to radiation in their place of work (eg, in the nuclear power industry or in radiology/radiotherapy departments), whose exposure is very carefully monitored and clear upper limits are set, there are no dose limits for patients undergoing diagnostic imaging. Under the Ionising Radiation (Medical Exposure) Regulations 2000, all requests for diagnostic imaging requiring radiation exposure undergo *justification* and *optimisation* to confirm that the indication for the radiation exposure is appropriate and the examination is tailored to minimise the radiation dose *as low as reasonably practicable* while still achieving diagnostic quality images.[4] As long as the benefit/risk assessment process of justification and optimisation has taken place for each examination, there is no constraining dose limit for a patient undergoing a particular examination or for the cumulative dose received from multiple examinations. While *diagnostic reference levels* are agreed nationally and set upper limits of average radiation dose for a range of patients undergoing a particular examination, these do not limit the amount of radiation given to an individual patient during a particular investigation. The authors however noted that their results suggested that radiation doses received by patients with lung cancer have reduced significantly over the last decade or so as a result of advances in imaging dose reduction technology.

The calculated lifetime risk of cancer attributable to the diagnostic imaging undertaken of approximately 1:1700 also needs to be put into the context of the risks of the operative procedure itself and the patient subsequently developing a recurrence of their disease or developing a second malignancy unrelated to the imaging radiation. Between 30% and 50% of patients will develop local or distant recurrence of their disease despite curative-intent surgery, and about a third of patients will develop a second primary cancer.[2 5]

Overall, while the risks of ionising radiation in diagnostic imaging must be minimised, the benefits of that imaging in patients undergoing curative-intent treatment for lung cancer need to be put into the context of the benefits of the imaging that is undertaken. CT-PET scanning in particular, although a relatively high dose investigation, would appear to have a significant impact on patient selection for surgery — ensuring patients with potentially resectable disease are not denied the opportunity for surgery, reducing futile surgery in those with advanced disease and avoiding surgery in patients with benign disease. The subsequent risks of patients later developing a cancer attributable to the diagnostic imaging radiation are, while not negligible, small compared with the current natural history of disease recurrence and development of unrelated new cancers. As future targeted therapies for cancer become more successful and survival improves, however, it is likely that the relative detriment of the imaging radiation will rise and require more scrutiny, but hopefully imaging dose reduction technology will have evolved further by then. Finally, however, as personalised tumour immunotherapies evolve, we may find our current dependence on anatomical staging diminishing and the associated radiation burden will no longer be an issue.

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