COMMENTARY

Cancer risks from diagnostic radiology: the impact of new epidemiological data

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In 2008, as part of the BJR Hounsfield review series, we published ''Cancer risks from diagnostic radiology'' [1], which included an estimate of the lifetime cancer risk as a function of age at exposure, from the radiation associated with a head CT scan and an abdominal CT scan. These risk estimates were based on age-specific, gender-specific and organ-specific cancer risks derived primarily from the Japanese A-bomb survivors [2, 3]. We estimated that these risk estimates were probably good to within a factor of three, in both directions.

Now, Pearce et al [4] have published in *The Lancet* the first epidemiological study to show an excess incidence of leukaemia and brain cancer in children and adolescents who had received CT scans. The authors studied a cohort of 178 604 children who underwent a CT scan between 1985 and 2002 in various hospitals in the UK, estimated organ doses involved, and then identified subsequent malignancies via linkage to the National Health Service Central Registry. The average follow-up time was a little under 10 years. This study was possible in the UK because of the available electronic records, but would be incredibly difficult to repeat in many other countries, including the USA. It is a large, well-conducted, record-based cohort study, and so deserves attention.

We know from the ongoing study of the Japanese A-bomb survivors that to obtain lifetime risk estimates the irradiated population needs to be studied for at least 50–60 years! To focus on leukaemia (and to an extent brain cancer) in children is effectively a shortcut because these malignancies have a short latent period in children. For example, the great majority of radiation-induced leukaemias appear within 10 years of exposure.

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Pearce et al [4] reported that the risk of leukaemia was positively associated with estimated doses delivered by CT scans to the red bone marrow, as was the risk of brain cancers associated with estimated doses delivered by CT scans to the brain. Quantitatively, having two to three head scans triples the estimated risk of brain cancer, while five to ten head scans triples the estimated risk of leukaemia. Of course, these very small radiation risks must be viewed in the context of the extraordinary clinical usefulness of CT in a great variety of clinical settings.

Human epidemiology trumps all calculations and estimates, of course. So how do these new data impact our review [1] of what was known in 2008?

1. The new data confirm that the cancer risk associated with the radiation from a CT scan is very small, but not zero. It can be detected in a cohort of a few hundred thousand children. The individual risk is very small and is far outweighed by the benefit of the diagnosis, provided the scan is clinically justified. The new study is important because it provides human epidemiological data supporting the notion that doses as low as those involved in CT scans can induce a detectable cancer incidence in humans.
2. Our estimated lifetime risk of leukaemia from one paediatric head CT scan, based on the A-bomb data, was about 1 in 10 000 [1, 2]. The estimate of Pearce et al [4] based on the epidemiological data was also about 1 in 10 000. Good agreement!
3. Our estimate of the lifetime risk of brain cancer from a paediatric head CT scan was about 1 in 2000 [1, 2]. The risk estimate of Pearce et al [4] was 1 in 10 000, to the end of follow-up. A big difference here, but there is a simple explanation: the average length of follow-up in the Pearce et al paper is only about 8–10 years. The study of children epilated with X-rays for the treatment of tinea capitis [5] shows that only about 10% of the final lifetime risk of brain cancer shows up in the first decade after irradiation. If this factor of 10

is corrected for, the lifetime brain tumour risk estimate would be about 1 in 1000, agreeing reasonably well with the A-bomb-derived estimate of 1 in 2000. The reason for the difference may be that some of the CT scans were performed on children with early symptoms of a brain tumour that was only diagnosed much later. The authors tried to avoid this problem as far as possible by excluding brain tumours occurring within 5 years of the scan.

4. In order to get a result in a relatively short time, Pearce et al [4] focused on leukaemia and brain cancer in irradiated children. It is therefore quite a limited study. A knowledge of the spectrum of all the other solid cancers after paediatric CT, and all malignancies after adult CT, must await further studies, and these are likely to take many years and involve significant difficulties. There are many other groups studying (or planning to study) national cohorts of CT patients. Some will have a longer follow-up and larger numbers, so they may well contribute further information about cancer induction at low radiation doses. However, they all suffer from the same limitation; namely, that these efforts focus on paediatric CT. They will not provide data relevant to the vast majority of CT scans, given that at least 90% of all CT scans are in adults.

Meanwhile, for most CT scans, we have estimates based only on organ doses and the Japanese A-bomb data. These estimates have proved to be in reasonable agreement with the epidemiological data in the few cases where it is possible to check them (*i.e.* for leukaemia and brain cancer from a head CT scan). Based on the Japanese A-bomb data, the risk estimates for abdominal CT scans are about 10 times larger than for head CT scans because of all of the radiogenic organs located in the trunk of the body, and, as pointed out above, there are no epidemiological data in sight to check these numbers. Estimates are all we will have for the foreseeable future, but even if they are only approximate, they are important at a time of increasing concern about the major increase in the collective dose from medical radiation over the past two decades, with much of it due to the burgeoning use of CT. The current estimate is almost 5 million CT scans per year in the UK, and about 85 million per year in the United States. The Pearce et al study [4] is an important piece of additional evidence to show that low doses of radiation do carry some (admittedly small) risk, which must be taken into account.

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