LETTERS TO THE EDITOR

The new ICRP memorandum and quantities in radiation protection dosimetry Selection of healthy workers in underground metal ore miners - possible effect on leukaemia mortality

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Dear Sir

I was most interested to read the new ICRP memorandum, ‘The evolution of the system of radiological protection: the justification for the new ICRP recommendations’ [1]. However, I was disappointed to note that certain significant issues remain unresolved, including those in respect of dosimetric quantities. Indeed, the ICRP again refers to ‘persistent difficulties with, and understanding of, the definitions of the Commission’s dosimetric quantities and specifying their application’.

It is good to note that the ICRP will ‘no longer use the term equivalent dose to avoid confusion with dose equivalent in other languages’. No translation is needed here to achieve confusion! However, the use of the alternative term weighted averaged absorbed dose in an organ or tissue does not resolve the question of measurement for such mean-value quantities as against the ICRU’s operational point-quantities. The retention of effective dose along with new weighting factors which presumably still apply to incident beams irrespective of the size, shape and composition of the medium concerned, results in consequences which require further attention, as also mentioned by Dunster [2]. I raised these issues in my letter to the journal in 2002 [3], and they are discussed by ICRU in their report 51 [4]. I am not suggesting that there is an easy solution.

Another quantity which calls for further comment is the new approach to collective dose. The new ICRP memorandum [1] states that ‘the product of the mean dose and number of individuals in a group, the collective dose, is a legitimate arithmetic quantity, but it is of limited utility since it aggregates information excessively’. It is now suggested that ‘for making decisions, the necessary information should be presented in the form of a matrix, specifying the number of individuals exposed to a given level of dose and when it was received’. It has been my contention [5, 6] that unless there is a threshold dose, then it is illogical to ignore the possible effect of any dose, however small, to the overall population.

I note that in table 4 in the new memorandum [1], it is now assumed that proportionality of the dose to effect, i.e. the LNT relationship, applies to a limited range only, i.e. above a few mSv/year. This line is clearly convenient but in reality side-steps the issue. Logically this can only presuppose that there is such a threshold, a quest which clearly needs to be pursued!

Yours faithfully,

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Selection of healthy workers in underground metal ore miners—possible effect on leukaemia mortality

Dear Sir

Recent correspondence has suggested the need for more detailed study and understanding of the ‘healthy worker effect’ in radiation exposed employees. One data set in which this effect could be studied in more depth is that of the underground metal ore miners occupationally exposed to elevated radon and gamma radiation levels, and to other possible carcinogens in the mine environment. These miners suffer a substantial excess of radon induced lung cancer; however, cancers other than lung may yield information regarding a possible healthy worker effect. This in turn could influence assessment of leukaemia mortality in these men.

Mortality from cancers other than that of the lung in radon exposed miners has been investigated in a collaborative cohort analysis of 11 separate studies, comprising around 47,000 men for whom the expected number of deaths was calculated [1]. Within this analysis 116 non-lung cancer deaths were observed compared with 133.3 expected, in the period within ten years since first underground employment. This deficit, although not statistically significant (O/E = 0.87, 95% CI = 0.72–1.04), was felt by the studies’ authors to be consistent with the selection of healthy workers for employment [1]. Further details given within their work support this suggestion as shown below.

The observed deaths included two from carcinomatosis (widespread disseminated cancer throughout the body). One of these deaths was of a man previously registered with lung cancer. The other occurred in a cohort where, within ten years since first employment, lung cancers had already risen to a statistically significant radon related excess and comprised nearly half the total cancer deaths. Both these carcinomatosis deaths were assigned to the ‘Other and Unspecified Cancers’ category, and both occurred within the highest radon exposure level of the collaborative analysis (>1500 WLM) where only 0.02 ‘Other and Unspecified’ cancer deaths were expected within the first ten years (2 observed, 0.02 expected, $p < 2 \times 10^{-4}$).

Accordingly it seems reasonable to conclude that the primary site for both these cancers was the lung, as was suggested by the studies’ authors [1]. Removing these two deaths from the tally for non-lung cancers yields 114 deaths observed, which is significantly less than the 133.3 expected based on a one sided test (O/E = 0.86, $p < 0.05$).

In addition, the authors indicated that the majority of unspecified cancer deaths in these miners were also probably attributable to lung cancer [1]. Rather than removing individual...
deaths on a case by case basis, and to prevent inclusion of any lung cancer related deaths, it may be preferable for the present purpose to exclude the whole of the ‘Other and Unspecified Cancers’ category, and therefore only to consider the 27 specific cancer types studied in the collaborative analysis. This yields 99 observed versus 122 expected deaths, which again is a significant deficit (O/E = 0.81, \(p < 0.02\)).

Despite the overall deficit in specified non-lung cancer deaths within the first ten years since start of employment, mortality from leukaemia was significantly elevated during this same period (O = 21, E = 10.9, \(p < 0.005\)). Given the short latent period of (radiation induced) leukaemia the authors indicated that this excess is consistent with an occupational cause [1]. If leukaemia mortality is also excluded to leave only specified cancers other than lung or leukaemia, then the observed and expected deaths become 78 and 111.1 respectively and the deficit is increased (O/E = 0.70, \(p < 0.001\)).

In contrast, at times greater than ten years since first employment the total number of observed deaths for combined cancer sites is close to that expected for each of the circumstances outlined above, therefore the data appear to be consistent with the initial selection of healthy workers.

Within the collaborative analysis, the individual cohorts applied various techniques for mitigating the effects of (self) selection of healthy workers, in particular excluding data for a period of time immediately following the start of employment. However, the exclusion period varied between the individual studies, and when considered as a whole the measures taken appear not to have completely eliminated the anticipated selection effects. Moreover both the occupational exposure period in these miners and the latent period for leukaemia are often short. Therefore choosing to omit many years of data following the start of employment could exclude some of the most pertinent information regarding leukaemia risk. When studying leukaemia, a short exclusion period together with alternative mitigation methods may be preferable.

Since the apparent deficit in non lung cancer mortality occurs over the same time period as the leukaemia excess in these miners it must be important to fully understand the nature and cause of the apparent healthy worker selection effect, in order to correctly predict the expected number of leukaemia deaths. A healthy worker selection effect may not apply to the same extent to leukaemia as to other cancers; however, any correction for such an effect, if appropriate, is likely to increase the significance of the observed excess in leukaemia mortality. Meanwhile, further studies of cancer mortality in uranium miners (in Eastern Europe for example) [2] are underway and, with appropriate correction for any healthy worker effect should provide further valuable insight into the possibility of an increased leukaemia mortality in these men.

Yours faithfully,

Jonathan Eatough

References