

**Latest radiation epidemiology publication from NDA Radiation Epidemiology Programme (July 2014):
Cancer mortality and incidence in the BNFL worker cohort**

Summary:

The NDA contract under which Public Health England (PHE¹) took over the management of the BNFL (British Nuclear Fuels Limited) radiation epidemiology cohort, included an agreement for PHE to review the epidemiological work² that was approved by the Epidemiology Governance Group but which remained unfinished by Westlakes Scientific Consulting when it closed and to consider what work could be usefully completed. One project identified for completion was a first analysis of cancer mortality and incidence in relation to occupational external radiation exposure across the whole BNFL cohort.

Following confirmation of this approach with the Epidemiology Governance Group, this project has been completed and a paper reporting the results has been accepted for publication in the peer reviewed Journal for Radiological Protection.

This summary provides a brief overview of the project and findings. The paper, 'The cancer mortality and incidence experience of workers at British Nuclear Fuels plc, 1946-2005' is due to appear in the next printed edition of the journal but was published electronically on 23rd July 2014.

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Main findings:

- The cohort showed the expected 'healthy worker effect'.
- Overall the risk of developing solid cancer³ from occupational external radiation exposure agreed with the risks reported in other major national and international studies.
- More surprisingly, for workers who received cumulative external doses in excess of 200mSv, the study found the raised risk associated with external radiation was smaller among radiation workers who were also monitored for internal radiation exposure compared to those who received only external exposures - a similar finding was noted in a previously reported analysis of non-cancer disease in the same cohort⁴. The reason for this difference is not yet understood but could be related to factors not available for analysis in this study such as internal dose or lifestyle factors. A future study incorporating these factors would increase the possibility of explaining this result.

¹ PHE is an Executive Agency of the Department of Health – for further information see www.gov.uk/government/organisations/public-health-england

² For further information about the project, see www.hpa.org.uk/Topics/Radiation/UnderstandingRadiation/UnderstandingRadiationTopics/RadiationEpidemiology/NDAEpidemiologyResearch

³ Solid cancers are those that form an abnormal mass of tissue e.g. lung cancer, as opposed to cancers of the blood e.g. leukaemia which generally does not.

⁴ McGeoghegan D, Binks K, Gillies M, Jones S, Whaley S. The non-cancer mortality experience of male workers at British Nuclear Fuels plc, 1946-2005. *Int J Epidemiol* 2008; 37: 506-18.

Background/Introduction:

The BNFL radiation epidemiology cohort was set up to study the risks of occupational radiation exposure in the UK civil nuclear industry. Current occupational exposure limits for ionising radiation are based mainly on scientific evidence arising from the study of the long-term health of the populations exposed to the atomic bombings in Hiroshima and Nagasaki and from patients medically treated with X-rays. Analyses of the health of the BNFL cohort can provide reassurance that the UK protection standards derived from the Japanese cohort studies are transferable to occupational exposure scenarios, i.e. lower and protracted external exposures and exposures to internally deposited radionuclides such as plutonium, uranium and tritium, experienced by UK civil nuclear workers.

In recent years, attention has focused on the role of internal exposures and in particular how cancer mortality and incidence in workers with internal exposures differs from that in workers only exposed to external radiation.

The aim of this study was to estimate the cancer mortality and incidence risk associated with external radiation exposure in the combined BNFL cohort of nuclear workers and to determine if these risks are modified by the potential for internal exposure. Assessments of the internal doses were not available for use in this study.

Methods:

The BNFL worker study cohort consists of all employees of BNFL, the United Kingdom Atomic Energy Authority (UKAEA) or the Ministry of Supply (MoS) ever employed at the Sellafield, Springfields, Capenhurst or Chapelcross sites.

The cohort comprised 64,956 individuals who were employed at the study sites between 1946 and 2002, followed up to 2005. The cohort has three distinct sub-populations; a group of 22,389 non-radiation workers, a group of 19,756 classified radiation workers who received only external exposure and a group of 22,675 classified radiation workers who in addition to receiving external radiation exposure were also monitored as they had the potential to be exposed to internal emitters.

Mortality and cancer incidence of the workers was compared to that of England and Wales by calculating standardised mortality and cancer incidence ratios. The hypothesis that the risk of cancer increased as cumulative external radiation exposure increased was tested.

The study also examined how the cancer risk in workers exposed to external radiation differed to that in workers who were also monitored for potential exposure to internal radiation.

Results:

The comparison of cancer risks in the cohort with the England and Wales population showed the expected 'healthy worker' effect with overall cancer mortality rate 7% lower than the national population rate.

The best estimates of the risk of various cancers from exposure to a standard unit of external radiation dose (1 Sievert) were calculated by assuming a straight line relationship between risk and dose. This is the relationship recommended by the International Commission on Radiological Protection (ICRP⁵). For all radiation workers in the cohort considered together as a single group, the risk for cancer mortality and incidence increased as dose also increased. Statistically significantly increased risks were seen for groupings of all cancers, solid cancers, digestive cancers, leukaemia excluding chronic lymphatic leukaemia (CLL), non-melanoma skin cancer (NMSC) incidence, and benign and unspecified cancer incidence. Overall the risks were consistent with those seen in other major national and international studies.

An unexpected result occurred when comparing the cancer risk between workers who were only exposed to external radiation and those who were also monitored for potential exposure to internal radiation (estimates of actual internal doses were not available). Overall the estimates of risk, associated with external exposure, for those who were monitored for internal radiation were lower (and not statistically significantly different from a zero risk). Analyses of individual cancer types indicated that the overall difference in risk between the two groups was mainly driven by that for digestive cancers. Categorical analyses also revealed that the difference in the straight line dose response relationship between the two groups was only apparent for those exposed to cumulative external doses in excess of 200mSv. Similar findings have also been observed for non-cancer mortality outcomes in this cohort².

⁵ ICRP, the International Commission on Radiological Protection, is an independent, international organisation of leading scientists and policy makers in the field of radiological protection. Its work helps to prevent cancer and other diseases and effects associated with exposure to ionising radiation. ICRP developed the International System of Radiological Protection which is used in the UK and world-wide as the common basis for radiological protection standards, legislation and practice.

Conclusion:

This analysis provided the first estimates of cancer risk in the whole BNFL cohort when analysed as a single group (individual sites have previously been examined separately). Whilst it clearly shows the 'healthy worker effect', it also provides further evidence of a link between cancer and occupational external radiation exposure. The risks of cancer mortality and incidence found in relation to cumulative external ionising radiation exposure were consistent with values used by national and international bodies in setting radiation protection standards.

The study also found the raised risk from external radiation exposure was smaller among radiation workers who were also monitored for internal radiation exposure compared to those who received only external exposures. The reason for this difference is not understood and warrants further investigation. The collection of lifestyle factors (such as smoking habits or Body Mass Index (BMI)), the inclusion of more recent follow up information and the estimation of internal dose would, for example, increase the likelihood of a better understanding of this result in a future project.

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