CHILDHOOD LEUKAEMIA AROUND NUCLEAR FACILITIES IN GREAT BRITAIN

R. Wakeford, K. Binks and A.J.M. Slovak

Health and Safety Directorate, British Nuclear Fuels plc, Risley, Warrington, Cheshire, UK.

ABSTRACT

The elevated levels of childhood leukaemia incidence around certain nuclear facilities in Great Britain that have been found by epidemiological studies must be viewed with caution. The various inferential problems associated with these studies produce an uncertain interpretation. More research into the causes of childhood leukaemia is required before the distribution of cases is properly understood.

INTRODUCTION

Since the broadcast in 1983 of a television documentary which identified an excess of childhood leukaemia cases in the coastal village of Seascale near the Sellafield nuclear establishment in North-West England, there has been considerable scientific interest in whether the risk of childhood leukaemia is elevated in the vicinity of nuclear installations, and, if so, the reason for this excess risk. Since the Sellafield report, a number of other studies have been published which appear to support the interpretation of a raised risk; but detailed radiological assessments have demonstrated that radiation doses due to discharges are too low to be able to account for the excess cases. This apparent conflict of evidence has led to suggestions that radiation risks have been grossly under-estimated, or that novel leukaemogenic mechanisms are involved. However, before reaching such conclusions, the evidence for a raised risk should be scrutinised more closely.

EPIDEMIOLOGICAL EVIDENCE

The evidence for a discernible excess risk of childhood leukaemia around nuclear installations derives from various epidemiological studies. Epidemiology is predominantly an observational science that relies upon the statistical analysis of health data produced under the uncontrolled conditions of "everyday life". Causal inference based upon non-experimental data is fraught with difficulties, particularly when the health effect of interest is childhood leukaemia which is uncommon (~450 cases per year in Great Britain) and for which the major causes remain unknown (<20% of cases can be accounted for by known causes). Furthermore, childhood leukaemia is a convenient grouping of various types and subtypes of leukaemia, which may have different major causes [1].

It is in the nature of an uncommon disease that, even if the underlying risk is uniform, the distribution of cases will be heterogeneous, in much the same way as winning lottery numbers are not regularly distributed amongst the sequence of ticket numbers. It is possible that the Seascale grouping of cases has arisen purely through the vagaries of chance; but it is also possible that it reflects an excess risk, whatever the cause may be. By itself, the Seascale observation does not allow us to distinguish between these two possibilities, and independent corroborating evidence is required before an excess risk can be inferred. However, reliable supporting evidence is difficult to generate, because the "background" conditions under which further datasets are produced will differ (to a greater or lesser extent) from those experienced by the original cases, and these conditions could modify the risk of childhood leukaemia. In addition, should prior knowledge of the data available for analysis influence the structure of that analysis (eg the choice of location, geographical boundaries or time periods) then severe interpretational problems can result. [2], [3].

We would argue that the influence of prior knowledge has had a major impact upon the development of evidence in this area of epidemiology. The analysis of childhood leukaemia cases around the Dounreay installation in Northern Scotland produced an incidence rate which was ten times the national average when employing geographical and temporal boundaries which were suspiciously tight about the case data; but when more "reasonable" boundaries were used in the analysis, the rate was reduced to twice the national average, and the excess leukaemia incidence did not achieve the margin whereby it could be conventionally regarded as "statistically significant". The reported excess of cases in the vicinity of the Aldermaston and Burghfield establishments (in Berkshire, England) relies heavily upon the decision to include Burghfield (and thereby the town of Reading) in the analysis. Burghfield had featured strongly in an earlier television documentary, and the decision may have been compromised by this knowledge. Other researchers have chosen to exclude this "minor" nuclear weapons facility from their analyses. Similarly, the Hinkley Point (Somerset, England) study was undertaken with the knowledge that leukaemia rates were generally raised in Somerset, and the authors failed to point out that, unlike in previous reports, their result of an excess of cases in young persons was driven by an excess amongst young adults rather than children. However, despite these (and other) shortcomings these three studies have been disconcertingly influential in scientific circles [2], [3].

Cook-Mozaffari et al., have avoided these various selection and reporting biases by including all 15 of the major nuclear installations of England and Wales in their studies [2], [3] These studies have not been without

weaknesses, being based unavoidably upon mortality data for largish geographical areas, but their strength lies in the comprehensiveness and coherence of analyses which have not been influenced by prior knowledge. In the latest study by this group, an elevated level of leukaemia mortality was found for young people living in areas defined as being associated geographically with nuclear installations: the adjusted mortality rate for these areas was 14% above that for England and Wales [3]. However, the authors do not conclude that this result supports a link between radioactive discharges and excess childhood leukaemia deaths, because, for example, for those areas associated geographically with the installations, rates are higher for populations living further from the installations than the rate for the population living nearest the installations. That the elevated leukaemia mortality rate might have more to do with the "background" risk factors pertaining in those areas geographically associated with nuclear facilities than with factors directly linked with the operations at the facilities is lent support by a subsequent study by Cook-Mozaffari et al. [4] in which the same analyses were performed for areas around potential nuclear power station sites. This study revealed a pattern of cancer mortality which was "strikingly similar" to that for existing sites. Similar studies in other countries (for example, USA and France) have not found any evidence of an excess risk around nuclear installations, which, at present, leaves the UK reports puzzlingly isolated.

Recently, the results of a study by Gardner et al. have indicated that the excess of childhood leukaemia cases near Sellafield may be linked to the occupational doses of radiation received by fathers prior to the conception of their children [5]. This potential explanation is of particular interest because it does not depend upon the somatic doses of radiation received from discharges, but upon occupational exposure of the paternal germ cells. However, it must be appreciated that parental exposure to radiation was only one of a large number of potential explanatory factors examined in this study, and that, under these circumstances, the effects of chance are difficult to quantify. Also, the positive statistical association is based upon four cases and a similarly small number of controls, so that results are not especially robust against minor perturbations in the data. Given the context of this study, a direct causal interpretation of the association cannot be accepted without confirmatory evidence. Presently, such evidence does not exist: a review of earlier studies of low dose preconceptual irradiation has not revealed any reliable associations with childhood cancers, and more recent studies have failed to provide strong support (for example, the excess of childhood leukaemia cases around Dounreay cannot be accounted for by preconceptual work in the nuclear industry), although the results of statistically more powerful studies are not yet available. Perhaps most

importantly, the risk of childhood leukaemia in the children of the Japanese A-bomb survivors is statistically incompatible with that suggested by the Sellafield study, a detectable excess risk being absent in the Japanese children. For these, and other, reasons it is not possible at the present time to be able to interpret the results of Gardner et al. with any confidence. [5].

CONCLUSION

Despite the extensive research that has taken place in response to the Seascale childhood leukaemia cases, a satisfactory explanation of the various reports of raised levels of childhood leukaemia incidence around UK nuclear facilities remains elusive. The interpretation of a number of these reports has been hampered by problems of statistical inference, and the results of further work on the association between childhood leukaemia and paternal preconceptual irradiation must be available before this association is properly understood. It may be that these results will be explicable only when the major causes of childhood leukaemia have been identified, and the results of Kinlen et al., eg [6], are of particular interest in this respect.

REFERENCES

1. Doll, R., 1989, The Epidemiology of Childhood Leukaemia, Journal of the Royal Statistical Society, Series A, 152, 341-351.

2. Wakeford, R., Binks, K. and Wilkie, D., 1989, Childhood Leukaemia and Nuclear Installations, Journal of the Royal Statistical Society, Series A, 152, 61-86.

3. Wakeford, R., Binks, K. and Wilkie, D., 1991, The Test of Hypothesis and Leukaemia Near Nuclear Installations, In: "Statistics in Medicine" (eds F. Dunstan and J. Pickles), Clarendon Press, Oxford, UK.

4. Cook-Mozaffari, P., Darby, S. and Doll, R., 1989, Cancer Near Potential Sites of Nuclear Installations, Lancet, ii, 1145-1147.

5. Wakeford, R., 1991, Editorial, Journal of Radiological Protection, 11, 73-74.

6. Kinlen, L.J., Hudson, C.D. and Stiller, C.A., 1991, Contacts between Adults as Evidence for an Infective Origin of Childhood Leukaemia: an Explanation for the Excess Near Nuclear Establishments in West Berkshire?, British Journal of Cancer, 64, 549-554.