NUCLEAR INSTALLATIONS AND CHILDHOOD LEUKAEMIA - TESTING THE HYPOTHESES, EXPLORING THE IMPLICATIONS - A REVIEW

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INTRODUCTION:

Two hypotheses have, since 1983, been pursued in relation to nuclear installations and childhood leukaemia. One is environmental, the other occupational. The transition from one to another and the segregation of one from another have often been unclear as have been the implications to be drawn from one as opposed to the other. Examination of the evolution of the two hypotheses demonstrates a number of phenomenological patterns common to modern health scares which makes them comparable to other such events. The scientific and public policy inferences which may be drawn from these events are considered by examining the processes concerned with testing these hypotheses.

ANALYSIS OF PUBLISHED STUDIES

The sentinel reports relevant to both hypotheses derive from population sets in the vicinity of the Sellafield nuclear generating and reprocessing complex in West Cumbria[1,2]. The later occupational hypothesis derived from multiple analyses of a geographical subset (Seascale) which was being examined in pursuit of the environmental hypothesis. Thus it was drawn from what was occupationally a "sub" sub-population. In each case a similar cycle of studies was pursued in exploration of the theories. Figures 1a and 1b show the secular trends in observed/expected or in relative risks and associated confidence intervals relevant to the two hypotheses. Both sets of data show a similar pattern of regression to the mean after the sentinel study.

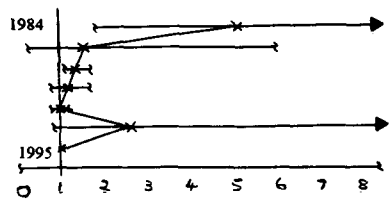

Fig. 1a Childhood leukaemia and the "environmental" hypothesis, summary of studies. O/E or RR and CIs. Unweighted. Highest exposed group in each study.

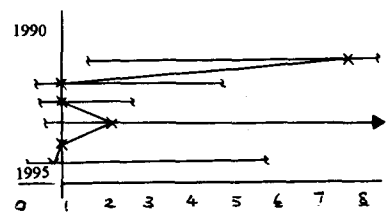

Fig. 1b. Childhood leukaemia and the "occupational" radiation hypothesis, summary of studies. O/E or RR and CIs. Unweighted. Highest exposed group in each study.

When considering the characteristics of the studies that were performed to test the two hypotheses, there is a strikingly similar pattern. Scientific work in the UK was initially concentrated on nuclear establishments in three areas, Sellafield[1], Dounreay[3] and Aldermaston/Burghfield[4]. In the geographical studies, significant excesses of childhood leukaemia were observed in all three studies. However the discharge history of the sites differed by orders of magnitude although derived doses were, by comparison with background, minute in all cases. By contrast the occupational studies carried out at Dounreay[5] and Aldermaston/Burghfield[6] did not support the preconceptual paternal irradiation (PPI) hypothesis but had vanishingly small power anyway.

Later and larger environmental (geographical) studies in the UK and elsewhere have continued to demonstrate a pattern of regression to the mean. For a number of reasons this is somewhat surprising. Firstly because the regression has continued despite the discovery of a slightly elevated risk of childhood leukaemia round potential nuclear sites generally historically. Secondly and paradoxically because such excesses of childhood leukaemia might actually be expected, at least from time to time, if an alternative, population mixing hypothesis were to be plausible.

Difficulties in discerning the crucial nature of the transition and separation of the environmental and occupational hypotheses may most relevantly be addressed by examining the key paper initiating the transition, that of Gardner[2]. This paper omitted to identify the critical importance of its derivation of the occupational hypothesis from a "geographical" sub-population of the Sellafield workforce who happened to live or to have lived in the village of Seascale. This turned out to be about 7% of the workforce and, on average, they had a slightly lower radiation dose than other workers. Thus it was left to others to infer that the most apposite test of the PPI hypothesis was by re-examining it in the whole of the population of Sellafield radiation workers from a subset of whom it had been derived[7]. When eventually performed, this test was negative. As with this study, other tests of the occupational hypothesis were uniformly negative.

The population mixing hypothesis, attributable to Kinlen, proposed that childhood leukaemia was the rare consequence of processes initiated by common viral infections and thus an excess of leukaemia would manifest in situations of "unusual" exposure to infection[8]. Specifically this would be unusually common occurrence of infection or particular liability to exposure to new strains of infection. The hypothesis was derived a priori and then tested initially in "new towns" (areas of rapid, mass resettlement) in the UK, and then in relation to military camps, wartime evacuation etc. The phenomenology is illustrated in Fig 2 and may be contrasted with Figs 1a and 1b. Of particular relevance to the nuclear debate are two other studies by Kinlen in pursuit of the mixing hypothesis. The first of these examined the temporary and recurrent migration patterns of Scottish workers serving the development of the Shetland oil industry[9]. This provided a plausible alternative explanation of the Thurso (Caithness) leukaemia cluster previously attributed to Dounreay. Similarly Kinlen's examination of large greenfield industrial, construction sites demonstrated the striking similarity of the pattern of excess of childhood leukaemia for these; including Sellafield when considered as a greenfield site[10]. It should perhaps be explained that Sellafield, in many ways, has been not so much a greenfield site but a series of greenfield sites with a rapidly turning over, serially migrant but constantly present large contractor population throughout many years of its existence.

DISCUSSION

In retrospect the leukaemia/nuclear installation debates have been characterised by early, small positive studies with a rapid fall off in positivity in later studies, large and small.

The phenomenology of the leukaemia/nuclear installation studies thus shows a pattern of secular regression to the mean similar to that seen in a number of health scares, as exemplified by the VDT - miscarriage data. This latter is shown in Fig. 3. In contrast this pattern is not seen in studies testing the population mixing concept (Fig. 2).

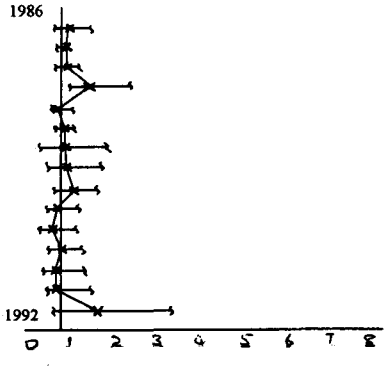

Fig. 3 Work with VDTs and spontaneous abortions, summary of studies. RR and CI for highest exposed group in each study.

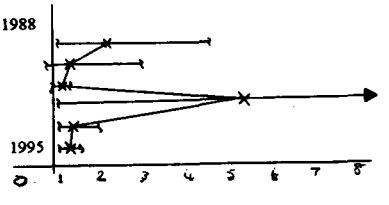

Fig 2. Tests of the childhood leukaemia population mixing hypothesis, summary of studies. O/E or RR and CI for highest "at risk" population group in each study.

The inference that may be available from the foregoing is that the population-mixing hypothesis may be describing events more plausibly than the hypotheses linked to radiation. The recognition of the phenomenology, that is the temporal trend or history of the studies relevant to a particular theory is of interest in itself but is more importantly a prescription for redoubled caution in progressing scientific research and delineating public policy in relation to it.

In scientific terms it is first necessary to re-emphasise the primarily hypothetical nature of case referent studies. Additionally, it is important to have higher regard to the long established criteria for inferring causation as propounded, among others, by Bradford-Hill. Thus it is prudent to show proper scientific caution by exercising due regard for the null hypothesis and similarly to view with caution the dissonances discernible in the biological and general scientific plausibility of novel ideas (especially across different scientific disciplines). Further it may be necessary to form a detached view of how much science should actually be done and completed before speculation is reasonably regarded as being ended and replaced by some degree of certainty. Finally, and this passes over into public policy also, the science that is done might usefully be planned so that it may be optimally focused and reorganised to serve the public interest.

In public health scares, initial "official" caution about a new hypothesis is discernible until a threshold of concern, often modulated by media attention, is overcome. A second characteristic is the subsequent caution manifested before the previously alien hypothesis, then adopted, is discarded and abandoned. It is suggested that such features, being generic, are capable of generic solution perhaps by effectively separating expert scientific advice from policy making based on that advice. Also, although this may be a counsel of perfection, some attempt might be made to avoid stigmatisation of a putative "guilty" party and putative populations at risk during the investigative phase.

By such more rigorous scientific criteria the population-mixing hypothesis performs quite well but still needs to meet a number of "robustness" requirements. Thus it is of importance to its viability that biological agents of effect be identified as well as the process by which the effect might be manifested. Further tests would usefully include the capacity to explain the Seascale cluster, demonstrate some form of dose response relationship and attempt to explain the negative findings reported round many nuclear installations.

CONCLUSIONS

The main thesis of this paper has been to demonstrate the particular phenomenology of the nuclear installations/childhood leukaemia sagas and to infer the scientific and public policy implications of the experience of investigation of these hypotheses and their confounders. If, as appears to be the case, we live in a period where science policy is more populist and thus liable to be impacted more directly and immediately by "public concern" issues, it follows that there may also be new challenges for public information and understanding and new requirements for the operation of the process of public science policy.

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