Reported cancer clusters and nuclear facilities: What connection?

Most clusters remain unexplained, even after careful investigation

by Joel I. Cehn

Reports of clusters of cases of disease, allegedly resulting from exposure to ionizing radiation, frequently appear in the press. To the laymen, these reports are difficult to interpret and are often frightening. How do we evaluate such reports?

A cluster of disease cases refers to what appears to be an unusual increase in the number of cases. Such clusters can occur either in space or time, or both. Clusters in time would occur, for example, during a winter flu epidemic. Clusters in space are represented by so-called "leukaemia houses" in which several families, successively occupying the same residence, have experienced leukaemia among one or more children. More commonly, clusters refer to groupings over space and time: disease rates in a small geographic area are increased for a period of time.

Study of such clustering is important; clusters of cases in a population may provide important clues to agents later recognized as harmful. Much of our knowledge of dangerous exposures has resulted as a consequence of the observations of an astute physician, who has noted an unusual occurrence of disease. Some examples:

- The relationship between deafness in children and the existence of measles during the mother's pregnancy was first recognized by an alert Australian ear specialist. He saw an unusual number of cases of deafness in children, which he traced back to a recent epidemic of measles.
- The role of vinyl chloride in the genesis of a variety of liver cancer was first uncovered by an industrial physician. He observed several cases of this rare disease among employees of one manufacturer — a far higher incidence than could reasonably be expected.

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Spectacular as these discoveries are, the truth is that most clusters remain unexplained, even after careful investigation. A US public health agency examined 108 space-time clusters over a 22-year period (1961-82).[1] In *none* of these were cause and effect relationships clearly and consistently defined. In a recent publication, a researcher stated that, "there is little scientific value in the study of disease clusters". A refreshingly direct opinion!

One reason for this lack of success is that clusters can, of course, result from chance alone. The candid scientist, referred to above, described something called the "Texas sharpshooter's method". The sharpshooter first fires at the wall, and then paints the target around the bullet hole. This method can be used to locate clusters. *(See accompanying figure.)* Anyone who has flipped coins or played roulette has experienced unusual runs of good or bad luck. And in spite of the enormous odds against it, there do exist very large families of all boys, or all girls, just as a matter of chance. How, then, when clusters occur, can we determine whether this is an example of chance, or the result of exposure to some agent? The answer is complex, if the suspect agent has not been identified as hazardous. Then, tests of the casual relationship must be rigorous and extensive. Studies of other exposed populations, as well as animal studies will be necessary. If, as with ionizing radiation, the biology and toxicology are well understood, then the process is quite straightforward:

- Is there indeed an increased number of cases?
- Have the exposures been adequately measured, and if so, do they consistently correlate to the observations of increased numbers of cases?

The first, apparently simple question is frequently difficult to answer. For example, an individual develops cancer — not an unusual event, since one out of four persons will do so.

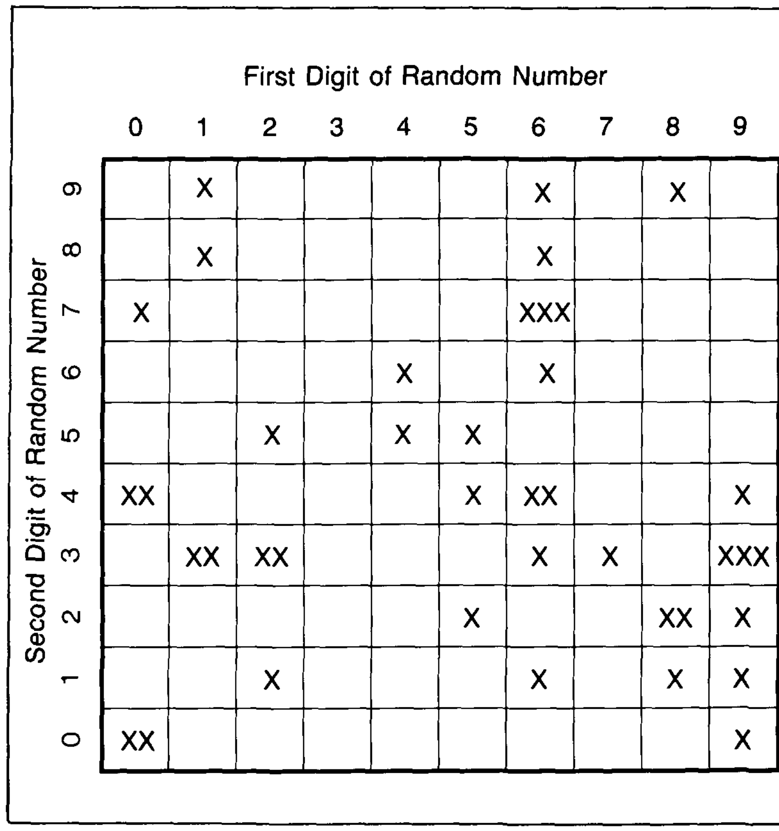
This person happens to live near a nuclear facility. Because of the heightened awareness of radiation related to the facility, neighbours may begin to search their memories and thus recall the appearance of cancer among others living nearby. Suddenly, one has the creation of a "cancer cluster". The fact that cancer is such a common disease makes it possible to gerrymander clusters out of random data (like the Texas sharpshooter). A 1968 study showed that clusters could be created in this way, and would be randomly distributed themselves.[2] This article briefly reviews reported cancer clusters, focusing on leukaemia. This form of cancer has a short latency period (as short as 2 years), and much is known about it. We have learned that acute forms of leukaemia are more sensitive to radiation than chronic forms. Although rare in adults, it is the main form of cancer among children. Let's begin with the reports of leukaemia clusters around nuclear facilities in England and Scotland.

Studies in the United Kingdom

There has been much in the literature concerning radiation-related leukaemia in the United Kingdom. In 1983, a television programme claimed there was a 10-fold increase in the incidence of leukaemia in children, living in the village of Seascale, in West Cumbria. Not long afterwards, a similar charge was made concerning an area of Northern Scotland. The fact that both areas host a reprocessing plant (Sellafield and Dounreay) resulted in a high-level inquiry into the role of radiation exposure.

Government scientists tested the hypothesis that radiation was the culprit. They did so by examining the leukaemia rates during the weapons' testing period of the late 1960s and early 1970s. Since the radiation doses from test fallout were larger than those from reprocessing effluents, leukaemia rates should have been proportionately higher. They were not. In fact, rates did not increase at all following the high fallout period. To quote the report, "These findings weigh heavily against the hypothesis" that plant effluents are to blame, unless "the doses have been grossly underestimated".[3] Another set of studies examined leukaemia in an area west-southwest of London. The area includes the Harwell nuclear power station, and two nuclear weapons facilities (Aldermaston and Burghfield). Although a statistically significant increase in childhood leukaemia is reported, it is not there consistently. It's a case of now you see it, now you don't. For example, when the incidence was analysed ward by ward, it was found that, "the geographic distribution of the cases was not significantly different from chance". Or, when the nuclear wards were compared to neighbouring wards, rather than to all of England and Wales, the effect again disappeared.[4]

An excellent rebuttal was published a few years ago by two British scientists.[5] They show how a cancer cluster in Lydney, near the Berkeley nuclear power station, could be "discovered" by looking only at a particular time period and age group. Narrowing the search in this way artificially maximized the size and significance of the cluster. This again raises the question of whether a cluster exists at all.



A plot of 40 random numbers gives the appearance of clusters.

To further fuel the debate, researchers have come forward with a new theory. The cause of the excess leukaemias near Sellafield is not the child's exposure to radiation, but the father's. A single study found such a correlation.[6] The fathers were exposed while employed at the plant. This study has raised a few eyebrows, since this effect has never been seen before. The 40-year investigation of the Japanese bomb survivors has turned up no hint of such an effect. The researchers concede that the numbers involved are small (just 4 cases) and the uncertainty is large. It remains to be seen if this finding will be confirmed by others. Another theory holds that a virus plays a role in childhood leukaemia. People who live in areas that are geographically isolated may escape exposure to this virus and thus have reduced immunity. Then, when there is an influx of population due to industrial growth, the virus is introduced to the area and leukaemia rates go up. Population growth near Sellafield and Dounreay fits this pattern, as it does in other areas where rates are elevated.[7]

Studies in the United States

The earliest study was performed in 1949 around Oak Ridge, Tennessee. Of concern was the gaseous diffusion plant built there during World War II. No excess cancers were found. Through 1975, at least 10 groups of studies were published. Many looked at leukaemia as "an indicator of radiation exposure". Nine out of the ten found no effect on public health. The tenth was a collection of notorious studies by Dr Ernest Sternglass. These have since been repudiated as flawed by a long list of organizations and government agencies.

One recent study is the most comprehensive. Researchers at the National Cancer Institute examined mortality from 16 types of cancer in 107 counties.[8] These counties are those which host, or are near, all 62 major nuclear facilities which started up prior to 1982. Overall, cancer mortality was no higher in the study counties than in a control group of 292 similar counties without nuclear facilities. If cancer clusters had been found, a second study was planned to examine possible causes. The Institute undertook the study as a follow-up to the cancer cluster reports from the United Kingdom, which were discussed above. Despite these results, cancer clusters near nuclear facilities are still being reported. In Massachusetts, elevated leukaemia rates are alleged near a nuclear power plant. This effect is limited to a period of only 5 years, while the plant has oper-

Sellafield, the UK's centre for reprocessing spent fuel. (Credit: BNFL)

ated for over 14. In San Francisco, a suspected cluster was said to be caused by a hospital incinerator, which burned small quantities of radioactive waste. The hospital ended this practice, rather than engage in a protracted debate.

It is questionable whether real clusters even exist in these cases, let alone whether they are related to radiation. Assuming for a moment that they are real, research tells us that they are likely to remain unexplained. For example, one study found a somewhat higher rate of leukaemia and Hodgkin's disease among young people in remote areas of England and Wales.[9] These areas at one time were considered potential nuclear plant sites, but these facilities were never built. There is nothing to which to conveniently attribute the higher disease rates.

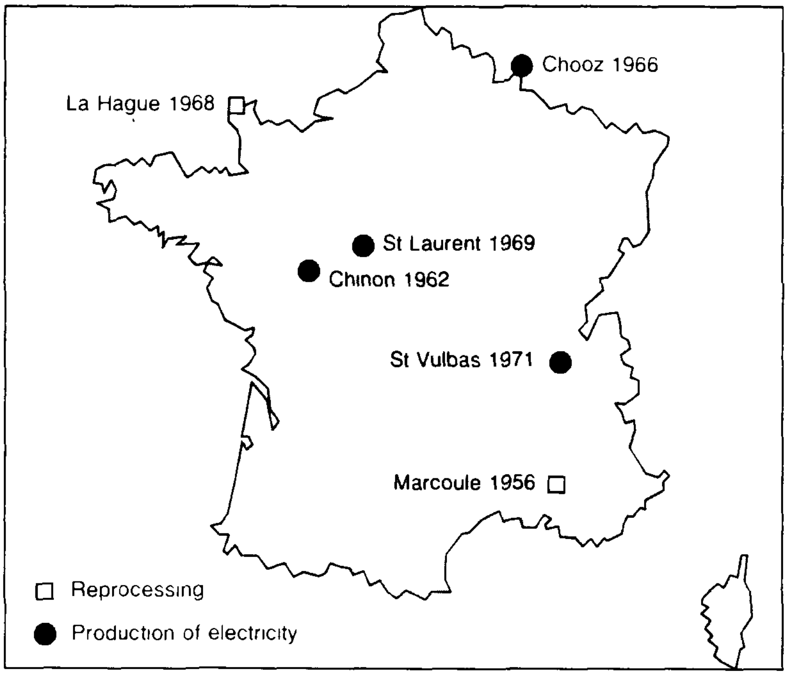
Studies in France and other countries

Besides prompting the US study, the reports from Britain have also prompted other national studies. A French study of cancer mortality around six nuclear facilities was published in late 1990.[10] No excess of leukaemia was found. For ages 0 to 24 years, a total of 58 cases were observed between each plant's start-up and 1987. Sixty-seven cases would be expected based on national rates; 62 cases based on matched controls. Either way, rates around the plants are lower than expected, but not significantly so. Additionally, the researchers found a deficit of brain cancer (6 cases versus 14.5 expected) and an excess of Hodgkin's disease (12 cases versus 6.1 expected). They conclude that these latter findings are likely due to chance, given the small number of cases. Researchers in Canada, Germany, and elsewhere have come to similar conclusions.

Communicating with the public

Cancer clusters can be found, but they don't correlate well with exposure to radiation. In fact, it's just as easy to locate clusters distant from nuclear plants, as close by. Yet, the studies continue.

Apparently, the large body of scientific evidence has not convinced the public, including some scientists, that radiation is actually a weak carcinogen. There appears to be an expectation that exposure to radiation (or even living near a nuclear plant) automatically results in cancer. Thus, while performing quality health effect studies is important, it is not enough. There is also a need for better communication of the scientific knowledge we do have.



Location of the six nuclear facilities that were examined in studies in France.

References

1. "Twenty-two years of cancer cluster investigations at the Centers for Disease Control", G.G. Caldwell, *American Journal of Epidemiology* (132)S43-7 (1990).

2. "Significance of leukaemia clusters," Andrew G. Glass et al., *The Journal of Pediatrics*, Vol. 73, No.1 (1968).

3. "Fallout, radiation doses near Dounreay, and childhood leukaemia", Sarah C. Darby and Richard Doll, *British Medical Journal*, Vol. 294 (7 March 1987).

4. "Childhood leukaemia in the West Berkshire and Basingstoke and North Hampshire District Health Authorities in relation to nuclear establishments in the vicinity", Eve Roman et al., *British Medical Journal*, Vol. 294 (7 March 1987).

5. "Drawing the line with leukaemia", D. Taylor and D. Wilkie, *New Scientist* (21 July 1988).

6. "Results of a case-control study of leukaemia and lymphoma among young people near Sellafield nuclear plant", M.J. Gardner et al., *British Medical Journal*, Vol. 300 (17 February 1990).

7. L.J. Kanlen, *The Lancet* (10 December 1988).

8. *Cancer in Populations Living Near Nuclear Facilities*, S. Jablon, Z. Hrubec, J.D. Boice et al., National Cancer Institute, Bethesda, MD, NIH Publication No. 90-874 (July 1990).

9. "Cancer near potential sites of nuclear installations", P. Cook-Mazaffari, S. Darby and R. Doll, *The Lancet* (11 November 1989).

10. "Overall mortality and cancer mortality around French nuclear sites", C. Hill and A. Laplanche, *Nature* (25 October 1990).