Refined health data on radiation effects

Two recent studies narrow in on the relationship between observable health effects and exposure to relatively low levels of ionizing radiation.

A study done by Scottish researchers of 197 British nuclear-dockyard workers has found chromosomal changes — aberrations — in a population of men occupationally exposed to radiation in doses below the maximum permissible occupational limits. The types of white-blood cell changes found and believed attributable to the radiation exposures (based on earlier studies) were dicentric (ring) aberrations, acentric fragments and other cells with "unstable" aberrations. A report of the study, by H. J. Evans, K. E. Buckton, G. E. Hamilton and A. Carothers of the Medical Research Council at Western General Hospital in Edinburgh, Scotland, appears in the Feb. 15 NATURE.

Workers who received cumulative exposures of 20 to 30 rem over the decade showed a fourfold increase in these aberrations — to 4 in 700 cells sampled — above their pre-employment levels. (Rem is a unit of absorbed dose that accounts for the relative biological destructiveness of the particular type of radiation received.) The current maximum-permissable occupational limit is five rem per year.

The men in this study worked at a British facility (which opened in 1968) to service and refuel nuclear submarines. As most workers had no previous radiation exposure, blood samples were taken prior to employment for use as background control samples against which future samples would be compared. Most men were then sampled several times over the 10-year period. Film-badge dosimeters providing approximate readings of the external exposures each received were compared with the degree of (or number of) cell changes.

The significance of the British study is that it shows a clear before and after change within a population exposed to low levels of radiation, according to William P. Brandom of the University of Denver. Brandom, who had not seen the British study but who is conducting similar research on plutonium workers and uranium miners, added that this study may be useful in establishing the degree of blood-cell changes that are attributable to external radiation exposures. Most of the workers he studies have inhaled radioactive particles that settle in the body and continue to emit radiation internally.

There is a long history of studies linking chromosomal changes in white blood cells with radiation exposure. In fact, measurement of the number of aberrations has been proposed as a possible "biological dosimeter," particularly for those individuals on whom dose estimates were not available.

(Brandom is in fact looking for elevated chromosome-aberration levels in five persons who may have been unwittingly exposed to radiation while working at one of four sites near Denver that in recent weeks were found to be emitting radiation in excess of federal safety limits. It's believed radium ore was mined at these sites around the turn of the century.)

The effects of dental X-rays on blood cells may diminish into the background level in time. Individuals who received large exposures, however, may show distinguishable imprints in their blood years later, although the types and number of changes will become less representative of the dose as the period from exposure increases. Brandom says chromosome aberrations are detectable in some Japanese atomic-bomb survivors today. It is possible that military personnel exposed to high radiation doses in nuclear-weapons tests during the 1950s (SN: 2/11/78, p. 92) may also show some latent imprints. In fact, such chromosome aberrations may be the best and perhaps only sign of possible radiation exposure among these veterans, many of whom are now requesting disability benefits for cancers and leukemias they fear are related to participation in bomb tests.

While it now appears that some soldiers who observed nuclear-weapons tests may have been exposed to dangerous radiation levels, those living downwind of the Nevada Test Site and subject to fallout were believed safe, according to official government reports. A study in the Feb. 22 NEW ENGLAND JOURNAL OF MEDICINE indicates otherwise. Joseph Lyon, Melville Klauber, John Gardner and King Udall studied all children 15 years of age or younger between 1951 and 1958 who died of leukemia, a cancer long associated with radiation; during that period, 26 nuclear tests dumped fallout onto Utah. The researchers found a 40 percent increase statewide in the leukemia incidence for that population over identical groups prior to and following that period. But for children born in southern Utah — a region receiving the highest fallout levels — childhood leukemia incidence was two and a half times higher than for children born before or after.

"We can't say from this study that fallout causes cancer," Lyon says, "but I think we can say without question there is an association between fallout exposure and the increased incidence of childhood leukemia deaths in Utah." The researchers estimate a bone-marrow dose of six to 10 rads could have produced the cancers.

Since that time childhood leukemia incidence throughout Utah has fallen back to normal levels, levels below the national average. A follow-up study will try to reconstruct radiation doses by community and confirm death diagnoses and place of residence for all children identified in the current study. □

Childhood leukemia: A 40 percent cure

Treatment of childhood leukemia is one of the great success stories of 20th century cancer research. In the early 1960s, Donald Pinkel, then medical director of St. Jude Children's Research Hospital in Memphis, with his colleagues started trying a combination of existing cancer drugs and radiation treatment on children with acute lymphocytic leukemia (the most common form of childhood leukemia). Now, 18 years later, the therapy package, called "total therapy," has proved to be so successful in countering this formerly fatal form of cancer that it can be considered a real cure in many instances. A number of children with leukemia who were given the treatment are now disease-free adults, married and with children of their own. What's more, "total therapy" for childhood leukemia has been adopted by many hospitals in the United States and in other countries.

"Total therapy," in fact, has been offered to child leukemia patients long enough now to better determine its ability to cure childhood leukemia, according to a report in the Feb. 8 NEW ENGLAND JOURNAL OF MEDICINE by Stephen L. George and his colleagues at St. Jude Children's Research Hospital.

George and his co-workers have followed the fates of 639 children with leukemia who were treated with "total therapy" at St. Jude between 1962 and 1975. They have found that 278 (44 percent) of all patients have been completely free from disease for two and a half years while on therapy and thus have qualified for stopping therapy altogether. What's more, four-fifths of this group (223 out of 278 patients) have not relapsed in the four years following cessation of therapy, and *none* of the 79 patients out of the 223 who have remained in complete remission at least four years have relapsed at all.

Thus, nearly 50 percent of all children with leukemia are able to stop therapy, 70 to 80 percent of this 50 percent will remain free from leukemia for at least four years and four years appears to provide an operational definition of a childhood leukemia cure.

Taking all these findings together, the investigators conclude that 40 percent of all children diagnosed for acute lymphocytic leukemia today can expect to be cured by "total therapy."

Still other valuable information has emerged from this study that should make "total therapy" of childhood leukemia even more effective than it is now. The proportion of patients who have relapsed after treatment with two drugs was significantly lower than for patients receiving three or four drugs. In addition, the results showing that 70 to 80 percent of patients who stop therapy after two and a half years

of complete remission are disease-free at least four years later suggest that two and a half years after complete remission is the optimal time for most patients to stop therapy. In other words, if they stayed on intensive therapy for longer than two and a half years, they would probably receive no benefit and would undoubtedly suffer undesirable side effects. True, the 20 to 30 percent who would eventually relapse without further therapy might benefit from it, but there is currently no way to identify these patients at the time that therapy is stopped. □


Project Concern

The great blizzard: A mind-blower

A mother and her four sons live in a small but cozy beachfront cottage on the Massachusetts coast. The father had died of cancer a year earlier. Then, the great blizzard of '78 wipes away the home and most of the family's other possessions. For the next few weeks, the group huddles in a stark motel room. The mother reverts to alcoholism and is admitted to a psychiatric hospital while the children get into various scrapes in the neighborhood.

This story has a happy ending — the mother licks her drinking problem, the family is reunited and obtains federal funds to rebuild on their old property. But it is a graphic reminder that blizzards, hurricanes, floods and other natural disasters can trigger far more than physical devastation among their victims.

The onset of emotional problems — particularly depression and sleep loss — "can and does happen to 'normal' people who are not on the rolls of psychiatric clinics," says Calvin Frederick, chief of the National Institute of Mental Health's Disaster Assistance and Emergency Mental Health project. However, such difficulties more often strike the "more vulnerable" members of society, primarily children and the elderly, he says. "People are less able to cope during a disaster," says Frederick. "Their usual guideposts are threatened and their dependency heightened — they realize their helplessness."

A survey of 115 storm victims who were helped by the NIMH-funded Project Concern program of the Massachusetts Department of Mental Health showed that 84 percent felt they had experienced emotional problems that would not have occurred if the storm had not hit. About 60 percent said they experienced depression or anxiety problems and more than one-third had trouble sleeping or controlling their tempers.

Frederick emphasizes that in many cases, the depression is of the serious, "clinical" variety and occurs in persons who might not actively seek out professional help. Many of those treated in Massachusetts were identified and referred by "outreach contacts" such as churches and small business organizations, where a person's financial problems often exposed emotional ones. For most, the difficulties faded shortly after physical recovery from the blizzard, but for others problems persisted for months beyond.

Such symptoms appear to accompany all major disasters, Frederick says. And he suggests that individuals and families might help prevent emotional problems by running through drills, similar to fire drills, before the storm or flood hits. Family members should meet among themselves and with neighbors and "talk openly about the tension and anxieties they should expect," Frederick says. "They should rehearse their feelings to some extent, imagine how it's going to be ... think about the worst. That's good mental hygiene." □

Muons: Does the flavor keep?

Flavor is that certain *je ne sais quoi* that makes basil different from bay. Restaurant critics can — or claim they can — follow basil or bay from leaf to finished sauce, and they pontificate sagely about soupçons of tarragon or too strong a statement of shallots. "Flavor" has been imported into the terminology of particle physics to serve as a name for the ineffable I'm-not-sure-what that makes a given particle what it is on the most fundamental level. Flavor, or rather difference of flavor, is what makes a charm quark a charm quark and not a strange quark. It is what makes a muon a muon.

The importance of being muon can be approached from two directions. The first is that of experimenters, who, in working with muons, found that muons avoid certain routes of radioactive decay. To put it shortly, the muon always decays to an electron, an electron neutrino and a muon neutrino (which shares the flavor of muonness). The muon never decays into three electrons or combinations of electron and gamma rays that are allowed by other applicable rules.

An empirical law of muon number conservation was thus established. Muonness could not get lost. It is almost impossible to prove a negative experimentally, and so experimenters continue to test the empirical law. About a year ago a hint that some of the gamma-ray decay modes had been seen came from the DESY laboratory in Hamburg. Not much has been heard of that hint since, but it gave a sharp stimulus to discussion of muonness. In the Feb. 26 PHYSICAL REVIEW LETTERS 17 physicists from the Los Alamos Scientific Laboratory, The University of Chicago and Stanford University (J. D. Bowman, et al.) present experimental results that are a strong support for conservation.

They used the Clinton P. Anderson Meson Physics Facility at Los Alamos, which was designed to provide copious fluxes of muons. They were able, in a reasonable time, to observe 36 billion decays of positively charged muons. They report no instances of decay into electrons and gamma rays. They calculate that if there are any such decays, they are fewer than 2 in 10 billion of the electron-neutrino-neutrino variety. They give a statistical confidence of 90 percent to the result.

The second significance of muonness is theoretical. Theoreticians are the people who are supposed to provide the reasons for things experimenters find. One of the things they have been working toward is a unified field theory that would explain everything in physics as arising from the fundamental nature and geometry of the universe. As they apply that geometry, they seem to be moving in varying ways toward a general law of Conservation of Flavor, which would demand that no matter what mixings, churnings or transmutations went on in a physical process, the flavors that went in at the start were discernible at the end. The law would apply to all flavors in physics and would pick up the empirically determined rule of conservation of muonness and give it its place in a much bigger picture.

But as a number of theorists now see it, conservation of flavor should not be absolute when applied to muonness, but slightly broken. Slightly broken conservation laws, rather than the absolute ones of the past, are of special philosophical interest. They are related to the slightly broken symmetries that are the mathematical foundations of these theories. Ratios of neutrinoless to neutrinoful decay paths of one in 100 million or greater are generally predicted. The discrepancy between the Los Alamos experiment and these predictions is enough to suggest further work, by theoreticians, experimenters or probably both. □