would neither speak to them nor release his data unless he could place a person of his choosing on the panel. Carter negotiated well into the night with HHS officials and with the Biogenics Corporation over whether Picciano's demand should be met and, if so, who would be an acceptable addition to the panel. Finally, the Biogenics Corporation insisted that Jack Killian, a controversial figure in the field of cytogenetics, be a member of the HHS panel.

At this point, says Carter, negotiations ceased and the panel members went home. Killian was completely unacceptable to the panel because he had been Picciano's collaborator in a previous highly disputed study of chromosome damage among workers at Dow Chemical Company. The HHS panel, Carter reports, questioned whether Killian might also have some association with Biogenics. Picciano says he sees nothing wrong with insisting that Killian be a member of the HHS panel. "I think it is a normal procedure in a scientific review to appoint someone or object to someone on the team," he explains.

Unable to see Picciano's data, the HHS panel was forced to rely on his written report. On 21 May, HHS released the panel's assessment of the report and its conclusion that the study "provides inadequate basis for any scientific or medical inferences from the data (even of a tentative or preliminary nature) concerning exposure to mutagenic substances because of residence in the Love Canal area."

The three cytogeneticists on the HHS panel were Sheldon Wolff of the University of California at San Francisco, Arthur Bloom of Columbia University, and Michael Bender of Brookhaven National Laboratory. All agree that the most glaring deficiency of the study was its lack of simultaneous controls and that, for this reason alone, the results are meaningless.

Everyone has some amount of chromosome damage, which may be caused by viral infections, medical or dental x-rays, or exposure to chemicals, to sunlight, or to certain medications. It is thus extremely important that the cells of a suspect population be compared to those of a control population to see if the suspect population has, on the average, excessive chromosomal aberrations. The controls should be closely matched to the exposed subjects in terms of age, sex, medical history, and geographic area because all of these factors can affect the numbers of aberrations. Since cells are grown in the laboratory before they are examined for chromosome damage and laboratory conditions can affect the number of chromosomal aberrations, the controls and test cells should be cultured at the same time. In addition, Bloom stresses, the person assessing the aberrations should not know which cells are from the exposed population and which from the controls. "This is a very subjective science," he says.

Rather than following this prescription for a well-controlled study, Picciano compared the chromosomes of the Love Canal population to those of a population that he had studied earlier and that, he

Chromosome Damage: What It Is, What It Means

Chromosome damage is an important test of whether people have been exposed to toxic chemicals. But the test is hard to interpret. Some damage occurs naturally because of such things as colds, flu, x-rays, and sunlight, and damage also increases as a person ages. People who have come into contact with a toxic substance, however, may have more damage than a comparable group that has not been so exposed.

Excess damage in a population may have some meaning but on an individual basis it does not. On the average, a population with damaged chromosomes may have more cancer and more birth defects than otherwise expected, but the individuals in the population whose chromosomes are damaged are not necessarily those who will suffer these ill effects. Chromosome damage is just an indicator, a sign that the population may have been exposed to something that damages DNA. Many of the substances that cause chromosomal aberrations are also thought to cause cancer and birth defects. But the white blood cells sampled for a test of chromosome damage are not themselves likely to give rise to cancer, and they cannot contribute to birth defects because they are neither sperm nor egg cells.

The assessment of chromosome damage is as much an art as a science. White blood cells must be carefully cultured, then stained and examined under the microscope. The 46 chromosomes in a human cell can be individually identified by their characteristic shapes and sizes. If there is damage, it often appears as breaks and deletions or as rings, which are formed from chromosome fragments. Cells with damaged chromosomes usually die or repair the damage.

Although the chromosomes are the carriers of genes, almost never can specific chromosomal aberrations be associated with specific birth defects or cancer. One exception is Down's syndrome, in which individuals inherit an extra chromosome 21 and this extra chromosome shows up in all their cells. But most genetic defects and most DNA damage that may lead to cancer involve submicroscopic changes in DNA and quite often do not lead to physical changes in the chromosomes. There is only indirect evidence associating chromosome damage with birth defects and cancer.

Perhaps the best evidence correlating damaged chromosomes with an increased incidence of cancer comes from the survivors of Hiroshima and Nagasaki. They had a significant amount of chromosome damage, which was directly related to the dose of radiation they had recieved. Moreover, the more radiation they were exposed to, the greater their incidence of cancer. But even in that population, those with the greatest amount of chromosome damage were not necessarily those who got cancer.

Among the Hiroshima and Nagasaki survivors, there was no statistically significant increase in birth defects and miscarriages. Ionizing radiation is known to cause birth defects and miscarriages, but the normal rate of these incidents is so high that it is very hard to show a significant increase, especially in a small population, according to Jean French of the Center for Disease Control. Nearly 11 percent of all children born have genetic defects, and as many as 50 percent of all pregnancies are estimated to end in a spontaneous abortion.

"It's a scary thing to tell people they have chromosome breaks," says Arthur Bloom of Columbia University. "But the breaks are by no means a harbinger of cancer or birth defects."—GINA BARI KOLATA

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