Looking at Genes in the Workplace

Screening for individual susceptibilities and monitoring of the workplace promise to stir up a host of legal, ethical, and scientific questions

The Office of Technology Assessment (OTA) raised some eyebrows at a congressional hearing last month when it said that at least 59 major corporations may be planning to inaugurate some kind of genetic testing of employees in the foreseeable future. This apparent surge of interest is occurring despite the fact that very few tests have been developed to screen employees for susceptibilities to certain chemicals, and their usefulness so far is questionable. Moreover, the whole idea of genetic screening is looked on with great suspicion by labor unions.

The OTA's testimony was part of a report of preliminary findings from a study of the problems and promises posed by two types of genetic testing. One is biochemical genetic testing of individual workers for certain genetic traits; the other is cytogenetic monitoring, which entails testing groups of workers for aberrations in chromosomes that might occur from exposure to chemicals. The OTA said only six companies are currently engaged in such testing, down from 17 who have done it in the past 10 years. The dip mainly reflects a decline in testing for the sickle cell trait among blacks. The OTA presented its figures at hearings held by a subcommittee of the House Science and Technology Committee chaired by Representative Albert Gore, Jr. (D–Tenn.), who predicted that genetic testing "is likely to become the source of legal concerns very soon."

Indeed, although the field is in its infancy it raises a host of concerns relating to confidentiality, the use of human subjects in research, discrimination in the workplace, and the proper use of findings—particularly when the implications of such findings are not known. The subject is especially sensitive because of its rancorous setting in the world of labor-management relations. Increasing interest in the subject is evidenced by the OTA study as well as a government-funded project at the Hastings Institute, which is examining the ethical implications.

The two types of testing at issue are sometimes confused in the rhetoric of critics, but they pose somewhat different problems. Biochemical genetic screening for "susceptible" workers is the more politically controversial of the two since it is aimed at pinpointing individuals who may be unsuitable for certain types of jobs, but it falls into a time-honored tradition. In the past, makers of tar and creosote denied employment to fair-skinned and freckled people because of their higher susceptibility to skin cancer. The railroads for years have been screening out applicants whose x-rays show a potential for back problems. More recently, companies have been grappling with the difficult problem of how to prevent pregnant women from being exposed to chemicals that might cause birth defects. Genetic screening is at least as problematic because it could lead to discrimination against certain racial and ethnic groups, and because in most cases it is impossible to predict when a person with a given trait will suffer from exposure to a given substance.

There are probably thousands of genetic deficiencies that render individuals unusually vulnerable to certain chemicals, but only a few are known presently and several, such as the sickle cell trait, occur primarily to members of minority groups. The sickle cell trait, which some believe could interfere with the blood's oxygen-carrying capacity in a person exposed to oxidizing chemicals, is probably not a very useful one to know about because there is no solid evidence that it makes any difference in the workplace. Indeed, the Air Force Academy recently reversed a 10-year-old policy of barring blacks with the trait from pilot training because no one could demonstrate that a low-oxygen environment would precipitate a medical crisis.

There are several other traits, though, that give cause for concern. One—which also predominates among minorities—is called G6PD or glucose-6-phosphate dehydrogenase deficiency. This occurs in 10 percent of American black males and a higher percentage of Mediterranean Jews. It can predispose carriers to a hemolytic crisis causing anemia from lack of oxygen resulting from exposure to certain chemicals such as napthalene. Another much-talked-about deficiency is that for alpha-1 antitrypsin (AAT) which can predispose individuals to lung disorders and emphysema from exposure to lung irritants. The severe form of the deficiency, which only affects one person in 2000 or 3000, is clearly linked to emphysema. But among those who carry the heterozygous trait—2 to 4 percent of the population—no ill effects can be reliably predicted.

For a while during the 1970's, Dow Chemical Company and Du Pont Corporation did limited testing for AAT and G6PD deficiencies in employees assigned to work with cyanogenic compounds. However, according to Du Pont's medical director Bruce Karrh, tests were terminated because they did not supply any additional useful information. The only company *Science* could learn of (the OTA poll is anonymous) that currently does any genetic screening is Du Pont, which screens blacks for the sickle cell trait. This program was begun in 1972 at the request of black employees at a time when sickle cell anemia was getting a lot of publicity and screening for the trait was regarded as a public service. Although the information is not used for employment decisions but only, said Karrh, for the "information and edification" of black employees, the company came in for a good bit of criticism following a series of articles in the *New York Times* in early 1980.

There appears to be very little support at present for biochemical genetic screening within the scientific community. The tests are regarded as arbitrary and, although valid, not very predictive. Says Gilbert Omenn of the University of Washington, "The extent of debate is way out of proportion to the scientific knowledge and any test applications at this time." This being so, the political objections to such screening begin to appear compelling. Union officials such as Anthony Mazzochi of the Oil, Chemical and Atomic Workers Union have decried such testing as having devastating potential for discriminating against certain groups of workers and creating, in effect, leper colonies of susceptible workers who may be assigned to low-paying jobs because they are regarded as genetically unfit.

Although companies are by no means rushing into the business of genetic screening, many critics believe they are attracted to it as an alternative to cleaning up the workplace. If genetically hy-

0036-8075/82/0723-0336$01.00/0

persensitive workers can be identified and removed from some plants, the argument goes, companies may be able to press successfully for less stringent occupational exposure standards. Some observers, including toxicologist Samuel Epstein of the University of Illinois, contend that industry is putting a big emphasis on "weeding out the susceptibles" rather than taking the steps necessary to clean up the environment entirely. Others argue that the latter is not always technically feasible. Companies nowadays are getting very interested in preventive medicine and are trying to educate workers on the dangers of alcohol, smoking, overeating, and lack of exercise. But some see even this as evading their real responsibilities and trying to "blame the victim," as Epstein puts it. If such plainly positive activities on the part of management are looked on with suspicion, then a very extensive set of legal and ethical safeguards indeed will have to be designed to make genetic screening acceptable.

Cytogenetic monitoring, on the other hand, is not as controversial politically but probably more so scientifically. This involves monitoring a group of workers over time to test for increases in chromosome aberrations. What may be the earliest such program was carried on for about 10 years at Dow under the supervision of then medical director Jack Kilian who is now at the University of Texas. The program proceeded smoothly until Kilian's group found what it regarded as significantly raised levels of chromosomal aberrations among workers exposed to benzene and epichlorohydrin. The results of the studies are very controversial and Dow, which had doubts about their validity, went back to a "research mode," according to its present medical director. Now it is following groups of workers who have not been exposed to chemicals to see what effect other factors, such as age, smoking, and time of year, have on the rate of chromosome aberrations.

Another instance of industrial involvement in cytogenetic monitoring is a research program at Johnson & Johnson. Researchers have been monitoring the effects of ethylene oxide, a sterilant gas, on workers at three plants with three different levels of exposure, matched with three control groups. After 6 months they found that employees in the plant with the highest exposure had significantly higher incidence of a chromosomal abnormality known as SCE than the control group, according to a preliminary report by the company. They thereupon discontinued the use of ethylene oxide at that plant. The company is also doing chromosome studies on individuals before they are placed in jobs involving potential exposure to ethylene oxide.

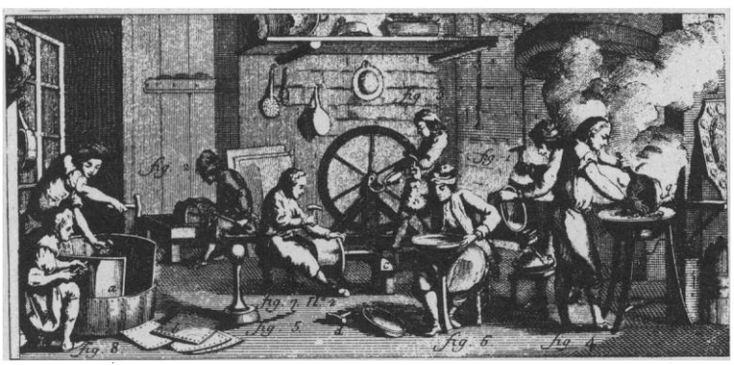
Cytogenetic monitoring is of dubious value in determining an individual's susceptibility to cancer. All that can be said is that some substances that cause cancer cause aberrations, and, therefore, a group with high numbers of aberrations may be more susceptible. But an individual from that group who develops cancer may not be one with significant chromosome damage. The only good epidemiological data linking chromosome aberrations to cancer comes from Hiroshima and Nagasaki survivors. They were exposed to massive radiation doses, which may have caused chromosome damage and other changes on a scale far greater than that caused by exposure to chemicals, so the Japanese survivors may not tell us much about the effect of lower levels of cell damage.

Nonetheless, some scientists, including Kilian, believe there is no reason to delay in introducing cytogenetic monitoring into the workplace since the association between chromosome damage and cancer has been established beyond question. Margery Shaw of the University of Texas concurs. She believes enough close correlations already have been found—between mutagenicity and carcinogenicity; between carcinogens and substances that disrupt DNA; between chromosome breakage and SCE's, for example—that chromosome monitoring can be used as an indicator of potential health hazards much as badges are used to monitor workers' exposures to radiation. Marvin Legator, also of the University of Texas, contends that cytogenetic monitoring, in combination with other tests for abnormalities in semen and mutagens in urine, "can serve as an advance warning system" of hazardous chemicals in an environment. But, he says, progress has been stymied because industry does not want to use the tests until they are validated and industry is the only party in a position to validate them. Kilian asserts that industries do not want to get involved because cytogenetic monitoring will open up new possibilities for getting sued by workers.

Other scientists believe there is still too much uncertainty surrounding the technology. Richard Albertini of the University of Vermont says "the big problem with a monitoring system is that we don't have a disease outcome" and thus it is impossible to meaningfully interpret the results of any tests. J. Grant Brewen, cytogeneticist at Allied Chemical Corporation, puts it more succinctly: there is "not a shred of evidence," he says, that directly links chromosome damage to any disease. Brewen has another problem with cytogenetic monitoring: he says that counting structural aberrations in chromosomes is not particularly useful because to achieve substantial positive results would require very high levels of exposure, high enough to manifest themselves in systemic toxicity. He believes there is more promise in looking at SCE's, which are numerically more sensitive. However, he warns that while chromosome changes can indicate effects of chemicals, the absence of such changes do not necessarily mean there has been no effect on the organism. Therefore, he says, cytogenetic monitoring could lead to a "false sense of security."

Most observers seem to agree that neither biochemical genetic screening nor cytogenetic monitoring is going to be widely adopted any time soon. Although the OTA reports 59 companies are thinking about it, the uncertainty is too great and the potential usefulness too questionable for many to actually begin programs in the near future. Unions have a lot more things on their minds which seem to them more important than genetic screening. And to industries, opening up new programs of genetic testing may just seem like asking for trouble.

—CONSTANCE HOLDEN



Tinkers