experience in obstetrics and gynecology since 1970 and very little before then.

Other witnesses called by the prosecutor in the first few days of the trial were physicians and other medical personnel from BCH. They seemed to do little to advance his case. Hugh R. Holtrop, a senior BCH physician who examined the patient when she came to the hospital seeking a "termination of pregnancy," said he believed her to have been 20 to 22 weeks pregnant at the time. When pressed by Flanagan as to whether she could have been 23 weeks pregnant, Holtrop answered that it was possible but "I doubt it." Holtrop refused to go as high as 24 weeks.

Alan Silberman also testified for the prosecution. A third year medical student who had been on the obstetrics and gynecology service only 3 days when the patient was admitted to the hospital, Silberman was among those who examined her. At the top of her chart he wrote a note saying, "looks about 24 weeks." Under questioning, Silberman insisted that he had no memory of the patient whatever and that he would not stand by the 24-week estimate. He had put it down, he said, merely as a note to remind him to ask for someone else's opinion, as he had had no experience examining pregnant women. Silberman wanted no part of any suggestion that he was an expert.

Next to take the stand was James Penza, like Holtrop, a senior obstetrician and gynecologist at BCH. Many of the questions he was asked had to do with descriptions of routine procedure in hysterotomy abortion. Flanagan is trying to show that Edelin's methods were not routine and that he took longer than is usual to remove the amniotic sac containing the fetus from the uterus. Penza refused to be pinned down, saying that, depending upon a number of circumstances, it could take anywhere from several seconds to several minutes. He also refused to admit to Flanagan that the fetus was "alive" just prior to the operation (one point Homans would like to establish is that it could have been dead as many as 24 hours prior to surgery). Penza declared that he does not speak in terms of a fetus being alive or dead but rather viable or nonviable. He admitted that it was viable, to Flanagan's satisfaction, although Penza did not say that by "viable" he meant capable of living on its own.

Next came surprising testimony from Mamie Horner, an operating room technician who had testified for the prosecution before the grand jury that indicted Edelin. She had told the grand jury that she "vividly recalled" being present at the hysterotomy abortion. But on the witness stand at the trial, she stunned everyone by insisting that it was all a mistake, that she had not been present after all and had been confused as to which operation Flanagan was asking about before the grand jury. At that point, court recessed for Martin Luther King Day, which came as another surprise to the attorneys, who had not anticipated having a day's break in the trial.

Asked what he thought about this turn of events, Flanagan, the prosecutor, said the jury "could infer that she made a mistake, or that she's prejudiced one way or another." As for the doctors' testimony, Flanagan suggests that they may be trying to protect both Edelin and themselves. "Doctors don't like to testify against each other," he said, adding that it is also the "Pontius Pilate routine. None of them had anything to do with it."

Edelin, in all of this, says that he still does not understand what he is supposed to have done that was illegal. He reportedly remarked at a breakfast meeting at Temple Isaiah in Lexington, where he was a guest speaker recently, "I'd like to tell a funny story about the indictment but there aren't any."

—BARBARA J. CULLITON

RESEARCH NEWS

Leukemia: A Second Human Tumor Virus

The search for a human tumor virus has been exceptionally frustrating. Investigators working with malignant human cells have frequently observed viruslike particles in the cells; they have observed extensive homologies between DNA from human tumors and RNA from animal tumor viruses; and they have observed in human tumors antigens similar to those present in animal tumor viruses. This evidence has convinced many virologists that viruses are involved in human cancer, but the viruses themselves have remained curiously elusive.

Several investigators have announced the isolation of tumor viruses thought to be of human origin only to discover later that they were of animal origin. Others have also isolated what they thought to be human viruses but discovered their animal origin before making an announcement. In the face of this frustration, some virologists had begun to argue that perhaps human tumor viruses were somehow different and might never be isolated. It was thus with a great deal of satisfaction (and some envy) that virologists last June greeted the announcement that Charles McGrath, Marvin Rich, and their associates at the Michigan Cancer Foundation had isolated a human virus that is implicated in breast cancer. The announcement in this issue (p. 350) that Robert E. Gallagher and Robert C. Gallo of the National Cancer Institute have isolated a human virus associated with acute myelocytic leukemia should be greeted with even more satisfaction (and envy), both because theirs is a somewhat different type of virus and because their evidence of its human origin is perhaps even firmer than the evidence accumulated by McGrath and Rich.

The history of premature announcements of human tumor viruses may lead many skeptics to question the new discoveries. But there are very substantial differences between the earlier studies and the two recent ones. Some of the first viruses, for example, were isolated from long-term cultures of poorly defined tumor cells; maintenance of the cells for such long periods increases the risk of contamination. The breast virus was also isolated from a long-term culture, but the cells in that culture were characterized much more fully than in the previous studies to show that they were not contaminated. The leukemia virus was isolated from

cells that had been cultured for only 5 weeks.

Many of the earlier investigators, moreover, used animals or animal tissues in their isolation procedures. In one instance, human cells were injected into the brains of cats; in another, filtrates from human tumors were injected into primates. In the two recent isolations, the investigators used only biological materials of human origin. Gallagher and Gallo, furthermore, isolated the same virus three times from a single bleeding of a patient, further reducing the possibility that the observed results arise from contamination.

The most important difference, however, involves the characterization of the viruses and of the tumors from which they are derived. In at least three of the earlier reports, almost no characterization of the viruses was attempted before their isolation was announced. Subsequent characterization showed that they were animal viruses. In another case, the virus was characterized and shown to be distinctive and different from other known viruses, but a relationship between the virus and the human tumor was not established. That virus was subsequently shown to represent a new class of animal viruses.

In the most recent cases, in contrast, a large body of preexisting evidence indicated that the tumors in question contain RNA and proteins characteristic of animal tumor viruses [*Science* **184**, 1162 (1974), and **185**, 48 (1974)]. McGrath and Rich, in association with Justin McCormick of the Michigan Cancer Foundation and M. R. Das of the Tata Institute in Bombay, have some preliminary evidence suggesting that RNA in the virus may be identical to RNA in human tumors. They have also shown that RNA from the virus is homologous to DNA from human placental tissue, which also suggests that the virus is of human origin.

Gallo and Gallagher, in conjunction with Charles J. Sherr and George J. Todaro of the National Cancer Institute, have characterized the leukemia virus more fully. They have shown by immunological techniques that the major proteins of the virus are identical to proteins previously isolated from other patients with acute myelocytic leukemia. They have also shown that proteins from the new virus are very closely related to proteins in two viruses that cause leukemia in subhuman primates, but are more distantly related to proteins from a mouse leukemia virus. This immunological evidence, Gallo argues, is by far the strongest evidence that the virus they are reporting is what it is claimed to be.

Although both the new viruses are RNA viruses, there are substantive differences between the two. The breast virus is suspected to be a type B RNA tumor virus, a type that in animals has been associated exclusively with mammary tumors. The leukemia virus is a type C RNA tumor virus, a type that is the most common class of animal tumor viruses. Type C RNA tumor viruses have been implicated in the production of leukemias, lymphomas, and sarcomas—tumors derived from a class of tissues that includes connective tissue, cartilage, bone, muscle, and white blood cells. The principal apparent differences between type B and type C are the size of the major internal protein and the size and spacing of glycoprotein surface spikes.

One Endogenous, One Exogenous

The breast virus is also thought to belong to another category known as endogenous viruses—viruses in which the principal mode of transmission is from parent to progeny. Endogenous viruses are postulated to be produced by a gene, known as a virogene, which may be part of the genetic complement of each member of a species. Alternatively, they might be transmitted from mother to fetus by cell-to-cell infection during gestation. The potential for production of such a virus would thus always be present in each member of the species, but actual production would normally be suppressed by cellular controls. All type B RNA tumor viruses are now thought to be endogenous viruses.

The leukemia virus, however, may be an endogenous or an exogenous virus. Exogenous viruses are transmitted between members of a species by infection. Gallagher and Gallo have shown that proteins from the human leukemia virus are very closely related immunologically to proteins from oncogenic exogenous primate viruses and are much more distantly related to proteins from endogenous primate viruses.

Neither of the new viruses has been proved to be a causative agent in human tumors. But the observation that the leukemia virus is infectious may elicit alarm among friends and families of leukemia patients, particularly in light of a report that is to be published this month by Steven Schimpff and his associates at the Baltimore Cancer Research Center. They studied all of the leukemia and lymphoma patients in three relatively rural census districts in West Virginia—a total of 53 patients—and found that 61 to 75 percent of the patients in each district could be linked in close social relationships. This finding, they say, suggests contagion or a common origin of the disease. Their results are reminiscent of an earlier study by Nicholas J. Vianna of the New York State Health Department, in which he found an unusual cluster of 31 cases of Hodgkin's disease, a type of lymphoma, among a group of friends and their acquaintances in Albany. Other, similar reports have since been published.

Such studies have been severely criticized for their poor handling of statistics and lack of proper controls. Malcolm C. Pike of the University of Southern California, for example, argues that the high incidence of contacts could occur by chance alone. He and Peter G. Smith of Oxford University duplicated Vianna's study among Hodgkin's disease patients at the Oxford clinic and found that 54 of 91 had the same type of social links. As a control, however, they examined 66 patients with other diseases and found the same incidence of social links among them. Furthermore, a large body of literature suggests that there is not an increased incidence of Hodgkin's disease among the spouses of patients with the disease or among doctors who have treated patients with the disease.

It thus seems highly unlikely that the leukemias and lymphomas are contagious in the usual sense of the term. Rather, it appears that tumor initiation may result from a complex interaction of infection by a tumor virus, environmental insults (such as exposure to radiation), and a genetic predisposition to cancer. The last factor may be especially important: although there is a normal incidence of Hodgkin's disease among spouses of patients, for example, there is a higher incidence among siblings or children of patients.

The isolation of human cancer viruses should provide an exceptionally useful tool in understanding the mechanism of cancer causation, but the relevance of viruses to the majority of human tumors is still questionable. Acute myelocytic leukemia, the type with which the human virus is associated, accounts for less than 1 percent of human tumors; all the types of tumors associated with type C RNA tumor viruses in animals account for only about 15 percent of human tumors.

—THOMAS H. MAUGH II