Alice Stewart

Pioneering woman scientist whose research into the dangers of x-rays and nuclear radiation shook the establishment

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Alice Stewart, who has died aged 95, achieved worldwide fame, and changed medical practice, through her tenacious investigations and demonstration of the connection between foetal x-rays and child cancers. She went on to attract the enmity of the nuclear and health physics establishments - and the hostility of the British and American governments - by insisting that her studies showed that the adverse effects of exposure to low-level radiation were far more serious than had been officially accepted.

She was also the first woman member of the Association of Physicians, and only the ninth (and youngest) to become a fellow of the Royal College of Physicians.

Stewart's entire life and career were devoted to social medicine, to the improvement of the lives of others, and to the bitter battles that have to be fought to ensure that findings contrary to policy or received wisdom - however important these may be to public or worker health - are investigated in a balanced and adequate way and, where necessary, acted upon.

Her pioneering work in industrial epidemiology, and on the effects of low-level radiation, earned her the 1986 Right Livelihood Award, the so-called "alternative Nobel prize" which is awarded by the Swedish parliament the day before the real Nobel, and the 1991 Ramazzini Award. In Britain, her findings on low-level radiation were regarded as so controversial that the British embassy even refused to send a car to collect her at the airport when she flew to Stockholm to receive the Livelihood prize.

Stewart was a brilliant student who matured into a gifted, decisive, tough, fearless and dedicated researcher. But she was also a lover of home, garden and countryside who, at a time of hostility toward professional women, managed to bring up a family while also carving out a career that reached international stature.

Born in Sheffield, where both her parents were doctors known for their interest in child welfare, she went from school to Girton College, Cambridge, to study medicine. She was, however, one of only four women among 300 men on her course, and recalled having to run the gauntlet of hostile male students stamping their feet in protest at the women's attendance at lectures.

Because, at that time, the Sheffield medical establishment did not accept women as hospital residents, Stewart went from university to the Royal Free hospital, in north London, for her clinical training. There, she mopped up the prizes, and revealed outstanding gifts for the diagnosis of rare conditions. After spells at the Manchester children's hospital and the London School of Hygiene, she became registrar in general medicine at the Royal Free, largely on the basis of her student record. It was an appointment without precedent, made, she later said, because she was "something of a whizz kid".

World war two found her working at the Elizabeth Garret Anderson hospital, in London, and then setting up an emergency clinical unit at St Albans. A trail of accidents and vacancies brought her to the Nuffield department of clinical medicine at Oxford, where, for the medical research council, she investigated the effects on workers of exposure to TNT in munitions factories, the effects of carbon tetrachloride, and the mysterious prevalence of tuberculosis among workers in the boot and shoe industry.

These studies revealed Stewart's brilliance in epidemiology and social medicine, and led, inevitably, to her involvement with the Oxford child health surveys, which had collected information on hundreds of thousands of children across Britain for 30 years.

Shortly after the war, she became involved in the Oxford child cancer studies. The incidence of child leukaemias was increasing in Britain at the time and, in 1955, it was suggested that there might be an environmental cause. Through analysis of the Oxford survey information, Stewart showed a clear connection between leukaemia before the age of 10 and the mother's exposure to x-rays during early pregnancy.

Resisted briefly by the medical profession, this finding later led to dramatic changes of practice. But it was aggressively opposed by many physicists and radiobiologists, by the committees of the international commission for radiation protection (ICRP), and by the powerful nuclear lobbies, within and outside government, that ICRP appeared to serve. The Oxford findings implied that low-level radiation - being imposed on nuclear workers and the public by fallout and nuclear-waste disposal - could be far more serious in its effects than had been officially admitted.

Stewart survived opposition and, already a professorial fellow at Lady Margaret Hall, Oxford, became director of the Nuffield institute of social medicine. Further analyses of the Oxford childhood cancer survey strengthened her initial findings. In the early 1970s, on the basis of these and other studies, she further infuriated the establishment by pointing out that, until the nature of radiation damage to genes was understood at the molecular level, predictions of second-generation and long-term genetic effects were premature.

While visiting the United States to discuss the Oxford survey findings in 1974, Stewart and her statistician, George Kneale, were invited by Professor TF Mancuso to become consultants on a major investigation he was directing for the US government into the health of nuclear workers at Hanford, the weapons complex that had produced plutonium for the Manhattan Project. Designed to parallel that of survivors of the Japanese A-bombs, this long-term study became known as the Hanford survey.

At that time, it was the largest of its kind into the long-term health effects of low-level radiation on workers in the nuclear industry. Since the industry was required by law to work within the exposure levels laid down by the ICRP, the study was seen as a test of these standards, as well as an investigation of worker health. The Stewart-Kneale analysis revealed roughly 10 times the cancer incidence predicted from A-bomb survivor studies.

An immediate and damning official outcry ensued. Mancuso was deprived of his directorship by the US government; the first full survey results were never published in their original form; and the use of outside consultants was promptly banned.

In spite of this, the Hanford survey, and Stewart's collaborative studies, continued. Information was added year by year, many of the early criticisms of the study were eliminated, and the findings, although modified, remained largely unchanged. They suggested adult sensitivity to radiation broadly in line with the findings of the Oxford child cancer survey - roughly 10 times the official figures.

Much of this work was carried out after Stewart's retirement from Oxford, when she became senior research fellow in the department of social medicine at Birmingham University. Her unit was housed in a caravan; she was deprived of research support from British sources; and, although her findings increasingly gathered approval elsewhere in the world, she and her work were subjected in Britain to professional isolation - and often to malicious, and unjustified, attacks.

However, grants continued to flow from the United States and elsewhere. With characteristic energy and brisk determination, Stewart commuted up the motorway year after year from her cottage in Oxfordshire to continue the study and reanalysis of the growing body of

information. It was difficult, but she always smiled when asked why she went on when recognition eluded her in her own country. "Good people are seldom fully recognised during their lifetimes, and here, there are serious problems of corruption. One day it will be realised that my findings should have been acknowledged."

In her later years, because of official recalculation of radiation doses to the Japanese bomb survivors, she was able to nod knowingly as ICRP guidelines on permitted levels of radiation for the public were reduced by two thirds. New evidence of the highly localised molecular damage produced by radiation in genetic material also reinforced her findings of high sensitivity during foetal development and of second-generation effects.

Sitting in her cottage or, preferably, out in its leafy garden where, when they were young, her grandchildren would play before having tea with home-made jam, Stewart would reflect quietly that the world was beginning to learn. "Plants get all their energy from the sun and so should we," she would say. Then she would smile wistfully, for she knew how very long that learning curve might be.

She married her husband Ludovick in 1933; they divorced in the 1950s. She is survived by her daughter, a doctor in general practice; her son predeceased her.

· Alice Stewart, epidemiologist, born October 4 1906; died June 23 2002

This obituary has been revised since the writer's death