

The Manhattan Project—A Continuum of Science

Here we have Doctor Harold Agnew's eyewitness account of a momentous event in the history of Science, and his recital of some of the previous discoveries upon which it was based. This constituted the Nuclear Pioneer Lecture, given at the opening session on 20 June 1977 in Chicago, at the 24th annual meeting of The Society of Nuclear Medicine. This event, described here so delightfully, both was the culmination and the beginning of much that led to the emergence of "Nuclear" Medicine.

The experimentally controlled nuclear fission chain reaction in Chicago on 2 December 1942 led to the first publicly announced shipment on 2 August 1946 of a reactor-generated radionuclide for civilian applications—5,730-year carbon-14 for cancer research. It had been generated in the second, quickly assembled, graphite-moderated, nuclear reactor "pile" in Oak Ridge, Tennessee, which went into operation on 4 November 1943.

In September 1946, we received our first of many shipments of 14.3-day phosphorus-32, produced in this reactor, which was used chiefly in the treatment of polycythemia rubra vera. We drove to Oak Ridge to have transferred directly from this reactor to us the first 5.26-year cobalt-60 that ever was used for cancer treatment, in our University Hospital, in August 1948. This was less than six years after the climactic occurrence described here by Harold Agnew.

Over 1100 shipments of radioactive materials were made in the first year. In 60 of the 160 institutions receiving them, the radionuclides were used for medical research, diagnosis, and therapy. There occurred a crescendo of increased shipments until, by 1954, more than 500,000 millicuries of 8.04-day iodine-131 alone were distributed. This bellwether "twinkling" atom showed us the way in many ways; and, more than any other, heralded to our profession that "The Peaceful Atom" had a multifaceted significance and usefulness in medicine.

Importantly and relevantly, 1954 also was the year of founding, on 30 May, of The Society of Nuclear Medicine, less than a dozen years after the epochal event in Chicago on 2 December 1942.

Historically, the principal origins of the nuclear fission chain reaction derived from convergences of fundamental discoveries made in Europe. In 1905 Albert

Einstein discovered analytically in Switzerland that matter might be transmuted into energy, and vice versa. His derivation, which was stated simply in his famous equation, $E = mc^2$, was confirmed experimentally 27 years later by Cockroft and Walton in England in 1932. This led to a general cognizance by physical scientists worldwide of the tremendous energies involved in such transformations. Thus, the number of ergs released in the transmutation of only one gram of matter into energy becomes the square of the velocity of light in centimeters, or 9×10^{20} ergs [21.5 trillion calories!].

Lise Meitner (Austrian-born physicist) discovered nuclear fission based upon her intuitive explanation for the strange experimental chemical finding by Otto Hahn and Fritz Strassmann of the presence of a radionuclide of barium after they had exposed uranium to neutrons, in Berlin. Hahn relayed this puzzling result to his former close colleague of three decades in his letter to Lise Meitner at Christmas time in 1938. It was sent to her in Stockholm, where she had fled earlier that year to escape from consequences of Hitler's anti-Semitic laws.

Meitner's discovery was published, jointly with her much younger nephew, Otto Frisch, in *Nature* on 11 February 1939. Frederic Joliot (discoverer of artificial radioactivity in January 1934 in Paris) had predicted the chain reaction in his Nobel Lecture in 1935. And, just ten weeks after the Meitner-Frisch paper appeared, Joliot and his colleagues in Paris published in *Nature* also their experimental finding entitled the . . . "Number of Neutrons Liberated in the Nuclear Fission of Uranium" . . . was 3.5 ± 0.7 . Knowledge that more neutrons were liberated than were required to induce fission was the essential link to predict that a chain nuclear fission reaction was possible. Patents were applied for immediately for the construction of nuclear reactors in May 1939. Ironically, Hitler's war began only a few months later and interrupted the considerable progress already made by Joliot and his colleagues; and, thus, prevented their possible demonstration of the first controlled nuclear fission chain reaction.

We estimate that more than 90% of the "twinkling" atoms we now use in Nuclear Medicine stem from the success of the experiment so vividly portrayed in Doctor Agnew's presentation. For, Fermi had submitted a Letter to the Editor of *Nature* on 10 April 1934, just two months to the day after publication there of the discovery

of artificial radioactivity, entitled "Radioactivity Induced by Neutron Bombardment." And, during the next few months, he and his students in Rome described the production similarly of radionuclides of many elements, including several we use in Nuclear Medicine today. The weak neutron sources they used were derived from radon-beryllium mixtures, as described by Agnew. The second graphite-moderated reactor, at Oak Ridge, provided concentrations of neutrons many tens of millions of times greater, and made it for many years the bulk producer of most of the radionuclides used in Nuclear Medicine.

Our lore depends, then, largely upon the practical spinoffs stemming from the seminal intuitions of a dozen prime scientists in a half dozen countries. The catholicity and beneficence of Science never has been exemplified better!!!

WILLIAM G. MYERS, Historian
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ANNUAL SPRING MEETING Pacific Northwest Chapter Society of Nuclear Medicine

March 27-29, 1981

**Alderbrook Resort
ANNOUNCEMENT**

Union, Washington

Drs. Raymond Marty, Program Chairman and Michael Graham, Program Co-Chairman announce the following plans for the Pacific Northwest Chapter Spring Meeting.

Clinical Aspects of single photon emission tomography.
Practical aspects and applications of the 400T system.

John Keyes, M.D.
Dave Williams, M.D., James
Ritchie, M.D., James Cald-
well, M.D., and Glen Hamil-
ton, M.D.
Thomas Davis, M.D.

Combined Imaging Modalities in the evaluation of the Abdomen.
Nuclear Medicine, Ultrasound, CAT scans and conventional radiography in the
evaluation of renal function.
Evaluation of the gallbladder and biliary tree by various imaging modalities.
General overview of the various imaging modalities and their appropriateness and
cost effectiveness.

Tom Rudd, M.D.
John Denney, M.D.

Wil Nelp, M.D.

There will also be a Technologist sponsored program.

Application for AMA category I credit for physicians will be on file.

There will be a Chapter General Business Meeting on Saturday, March 28, 1981 at the scheduled lunch.

For further information and hotel and registration cards, please contact: Jean Parker, Administrator, Pacific Northwest Chapter, SNM, P.O. Box 40279, San Francisco, CA 94140.

NUCLEAR MEDICINE REVIEW SYLLABUS

Peter T. Kirchner, M.D., Editor

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