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Dr. Charles L. Dunham  
 Chief, Medical Branch  
 Division of Biology and Medicine  
 United States Atomic Energy Commission  
 Washington 25, D.C.

Dear Chuck:

Please find enclosed the available data from the University of California Hospital which was compiled by members of Dr. Stone's staff who incidentally are quite unaware of the classified nature of this material to the best of my knowledge. I discussed this matter with Dr. Stone and told him that it should not be discussed with anyone in the Division of Radiology with the exception of the two of us.

You will note that there has been a review of the overall situation together with rather fairly detailed accounts obtained from eight patients. The picture is not too clear since a number of patients received stable strontium and several others received some amounts of radio-strontium. In addition, in some instances P<sup>32</sup> was given which certainly confuses the issue. However, Brunn, Erickson and Reid received quite substantial amounts of strontium<sup>89</sup>. Consideration must be given that this radioisotope was cyclotron produced, has a half-life of 53 days and decays by emitting beta-particles with a maximum energy of 1.5 Mev. Another point that should not be ignored is the fact that at the time these studies were done there was considerable ambiguity as to the size and value of the microcurie. Extrapolating from my own experience to the present I estimate that these patients got from 20 to 50 per cent more radiation than appear on the charts.

I have discussed the situation with Dr. John Lawrence but to date I have not received any information that would be of value to you concerning those patients treated at Donner Laboratory. I gather that a number of these received both P<sup>32</sup> and Sr<sup>89</sup> which would confuse the picture. As soon as I get any additional data referring to strontium in humans I will let you know as soon as possible.

Our own experimental program is progressing very nicely using both rats and monkeys. The technical details are being well worked out and we should have some data for you within the next month or six weeks. If you should find someone who would be in your opinion both competent and the type of person who would fit in with our small organization, another pair of hands would be most welcome.

Sincerely yours,

Joseph G. Hamilton, M.D.

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 DOE ARCHIVES

Experience with Strontium Isotopes

The use of radioactive strontium ( $\text{Sr}^{89}$ ) in the treatment of patients with metastatic carcinoma to bone and in osteogenic sarcoma was initiated in 1940 by Charles Pecher (1). The rationale, based on experimental animal studies, for the use of  $\text{Sr}^{89}$  was:

1. The easy production and availability of  $\text{Sr}^{89}$  as compared with that of  $\text{Ca}^{45}$ .
2. Strontium given in small amounts is handled similarly to calcium by the body. Strontium in concentrations of 20 mg/cc given i.v. is nontoxic.
3. Strontium when injected intravenously concentrates rapidly in the skeleton. After 24 hours the radioactivity per gram wet weight was approximately 100 times lower in the soft tissues than in the bones.
4. The highest concentration of  $\text{Sr}^{89}$  occurred in the bony tissues in regions of new bone formation such as epiphyseal line, or neoplastic osteoplasia.
5. Because of the rapid uptake in the skeleton, particularly in osteoplastic lesions, and because of the short path of strontium beta rays in the tissues, the radiation dose in the bone and bone lesions is high as compared with that of soft tissues. Pecher realized the limiting factor in  $\text{Sr}^{89}$  treatment, namely, the unavoidable effect on the bone marrow.

Pecher's experimental findings were confirmed by Treadwell (Mrs. Anne de G. Low-Beer), et al, (2), who investigated uptake of radiostrontium by bone tumors in six patients prior to biopsy or amputation.

The patients treated by Pecher received total doses of one to six millicuries of  $\text{Sr}^{89}$ . At autopsy these doses were found to be sub-therapeutic in effect. In terms of roentgen equivalents, it was estimated from the concentration of radiostrontium detected in the tissues that 200 r to 600 r is delivered to the bony tissue when 1 mc  $\text{Sr}^{89}$  is administered i.v. to an adult. In later studies doses as high as 10 mc  $\text{Sr}^{89}$  were administered without ill effects after six months. One patient, a physician, received 8 mc  $\text{Sr}^{89}$  in four months. The bone pain disappeared almost completely. Serum phosphatase activity dropped from 42 to 6 Bodansky units in six months.

Pecher noticed irritation of the skin and itching in some of the animals who received strontium. Low-Beer and Low-Beer subsequently investigated the concentration of  $\text{Sr}^{89}$  in the skin, hair, and sweat, using horses as experimental animals. They found high concentration in hair and sweat. This study was partly influenced by the experience with a strontium preparation called Strontiuran (Ciba or Shering), which was used in Europe in the 1920's and 1930's for skin diseases.

At the UC Hospital, Low-Beer and Sears (unpublished) studied eight patients with bone atrophy in 1943 and 1944, with  $\text{Sr}^{89}$  given in doses of 200 to 500 microcuries. Several more patients with disturbance of bone metabolism were studied by Low-Beer, giving small test or tracer doses. No follow-up is available on these patients.

