

"THE DEVELOPMENT OF SCAN ANALYSIS TECHNIQUES
EMPLOYING A SMALL COMPUTER"

Final Report

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4. Manuscript - "The MARK IV System for Radionuclide Computed Tomography of the Brain"

1. ABSTRACT

During the thirteen year duration of this contract the goal has been to conceive, develop, and apply computer based analysis of radionuclide scan data so as to make available improved diagnostic information based on a knowledge of localized quantitative estimates of radionuclide concentration. Under the support of this contract, the concepts of both transmission and emission computed tomography were developed and applied to patients. First the MARK II Scanner was designed, constructed, and applied to patients producing for the first time cross-section pictures of radionuclide distribution and, later, transmission computed tomographs produced essentially as later put forward by Hounsfield of EMI. Work centered on emission computed tomography in the hope of evolving an accurate *in vivo* analog of the autoradiograph. A more advanced brain scanner, the MARK III was designed, constructed, and applied to brain tumor patients. Computer processing centered on reconstruction techniques for cross-section scanning. Work progressed from simple back projection reconstructions to methods of successive approximations which were independently developed under this contract but also independently developed about the same time by other groups in x-ray crystallography and x-ray tomography. More recently, the MARK IV Scanner was designed, constructed, and applied to patients with further developed reconstruction software. This device now permits quantitative estimates of radionuclide concentration in the brain as applied to determinations of local cerebral function including circulation and local metabolism. The line of investigation carried out for the past thirteen years under this contract at The University of Pennsylvania will be continued by this group at the ERDA supported laboratory at UCLA beginning 1 September, 1976.

2. REPORT

In the past thirteen years of support under this contract, the University of Pennsylvania group has introduced both radionuclide and transmission computed tomography. The pattern of investigation has included conception of the scanning modes, testing and prototypes, construction of prototype hardware, and application to patients. Computer software development supported by this contract included the introduction of simple back projection reconstruction of transverse section images and later the more effective iterative methods using successive approximations.

Transmission computed tomography is now widely applied in Radiology under the stimulus of the pioneering work in the EMI laboratories which followed the initial demonstration of transmission computed tomography supported by this contract. The main concentration of effort in this laboratory, however, has been in extending the usefulness of radionuclide studies of patients by applying radionuclide computed tomography for accurate quantification of labeled compounds localized in a particular part of an organ deep within the body. More recently, the MARK IV Scanner has been developed under this contract and applied to determinations of local cerebral blood volume, flow, and local metabolism in the brain. This system is described in more detail in the prepublication manuscript enclosed as an appendix.

On September 1, 1976, the University of Pennsylvania group will move to the ERDA supported laboratory at UCLA where this work is to continue. During this past project year, the Pennsylvania group was joined by Drs. Phelps and Hoffman from Washington University and the direction of computed tomography here now is very much concerned with

positron annihilation scanning as well as our previously established "singles" scanning for radionuclide computed tomography. At UCLA, our directions of investigation will continue to be those concerned assessing local function, primarily in the brain and heart, but with the added dimension of applying a much wider range of radiopharmaceuticals labeled with cyclotron products.

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