THE ANALOG COMPUTER AS A TRAINING AID IN NUCLEAR MEDICINE

Kinetic studies present a useful, and increasingly important, branch of nuclear medicine. The varying (time-dependent) concentrations of materials as well as the changing amounts of activity due to radiodecay (also a time-dependent event) present a picture that is difficult for the trainee to comprehend. Both compartmental interchange and radiodecay can be closely described by simple differential equations. Since the equations can be readily solved by an analog computer, a means is at hand for presenting a graphic display. Once the program is wired on the analog computer, the trainee can vary the rate constants (potentiometers) and observe the effects on each output with an x-y recorder or an oscilloscope. Such a use of the analog computer was foreseen by Weinshelbaum (*1*) who described a model of radiodecay as well as one of a familial decay scheme (parent → daughter → end-product). We have used the analog computer for a number of years,* both to assist in the one-line processing of studies (*2*) and as an aid in teaching the fundamentals of clinical radioisotopic procedures (*3*). Because of increasing interest in the subject, we wish to make the simpler models available to other laboratories. These programs are as follows:

1. First-order decay. Included is a logarithmic transformation showing the use of such an approach in obtaining a linear function.
2. Decay of two radionuclides in the same sample. This is particularly useful for showing the growing contamination of ^{197}Hg by ^{203}Hg.
3. Model of a radionuclide generator (parent → daughter → end-product).
4. Three-compartment model of distribution (approximating ^{131}I-rose bengal kinetics).
5. Combined flow and decay (such as blood flow or compartmental distribution when a short-lived radionuclide is used).
6. The precursor-product relationship (simulating ^{75}Se-proteins in the bloodstream or ^{131}I-proteins). That is, free ^{75}Se-selenomethionine can be followed as it goes from the bloodstream to depot sites; the radiolabel then reappears in the bloodstream in the form of ^{75}Se-proteins.
7. A model of the radiation received by an organ. The relationship between radiodecay and buildup of the radiation dose is illustrated.
8. Simulation of gamma-ray absorption (exponential decrease as well as the inverse square relationship).
9. Reference to literature data from which other programs can be constructed. Data are available for the radioisotope renogram, iron metabolism, splenic uptake of ^{51}Cr-erythrocytes, kinetics of water and electrolyte exchange across the placenta, blood flow between cojoined twins, kinetics of emptying the stomach, small intestine and gall bladder and the metabolism of iodide and the thyroid hormones.

The programs are presented in conventional analog-computer symbols. In addition, rate constants are suggested in certain cases to simulate known data. Copies of the programs can be obtained from the author.

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* Supported by USPHS Grants CA 06519 and AM 09429.

REFERENCES

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