ELUTION PARAMETERS OF THE ^{99}Mo-^{99m}Tc GENERATOR

Roger D. Tippetts* and Gordon N. Kenney

Veterans Administration Hospital and Presbyterian Hospital, Denver, Colorado

It is widely recognized in nuclear medicine that high radioisotope doses are useful. This generally means that short half-life (under 1 week) materials are needed to keep the radiation exposure to the patient within accepted limits. However, the shipping time required makes short-half-life materials impractical to use at places distant from production facilities. Because of these considerations (high activity and short half-life) radioisotope generators (*1*) are becoming more and more popular in departments of nuclear medicine for diagnostic uses. It is the purpose of this paper to describe some of the important elution parameters of the ^{99}Mo-^{99m}Tc generator (*2*). It is believed that these parameters will have a more general application to all types of radioisotope generators using ion exchange elution methods.

MATERIALS AND METHODS

One each of five presently commercially available ^{99}Mo-^{99m}Tc generators was acquired [from General Radioisotope Processing Corporation (GRPC), Mallinckrodt/Nuclear (M/N), Neisler (Neisler), New England Nuclear/Picker (NEN/P) and Squibb (Squibb)]. Each of these generators had been eluted several times the previous week, usually once a day, before the elutions described in this paper were performed. Each generator was identically eluted by withdrawing successive 1-ml aliquots from the bottom of the column by applying suction. Total elution time was approximately 5 min. This elution procedure differs in minor detail from elution technique recommended by the manufacturer. The effect on the resultant elution curves produced by this modification of the elution technique was not investigated, but rather a standard elution technique was used for all generators to make the resultant elution curves most comparable. Each separate aliquot eluted was received by a small test tube. The quantity of activity contained in each aliquot was determined by an ion chamber measurement (Tracerlab, Inc. Source Calibrator). Since each generator tended to deliver a few air bubbles during suction elution, each aliquot was assumed to be, for purposes of calculations, equal in size and equal to the total volume eluted (determined by weight) divided by the number of aliquots taken. In all cases this value was slightly less than 1 ml. In no case was there any wide variation in this method *vis-a-vis* actual volume of each aliquot. No measurement of ^{99}Mo breakthrough was made.

RESULTS AND DISCUSSION

In all cases when the activity of each aliquot was plotted against volume eluted, a bell-shaped curve which skewed toward the right resulted. Since several radioisotope generators were to be compared, we normalized each curve. Such normalization allows easy comparison between the generators and for the same generator from day to day. In Fig. 1 we have plotted the activity against volume eluted as percent of maximum activity per aliquot. Here we see that initially essentially no activity is eluted. The activity per aliquot increases rapidly reaching a maximum, depending on the generator between about 12 and 22 ml eluted. There follows a somewhat slower decline which finally approaches the volume axis asymptomatically. When the activity of later eluted aliquots became less than 1% of the maximum activity or zero as measured on the source calibrator, the generator was arbitrarily considered 100% eluted. These values were either 35 or 40 ml except

Received June 7, 1968; revision accepted Feb. 25, 1969.

For reprints contact: Gordon N. Kenney, Radiation Therapy and Nuclear Medicine Section, Presbyterian Medical Center, 1719 East 19th Ave., Denver, Colorado 80218.

* Deceased.

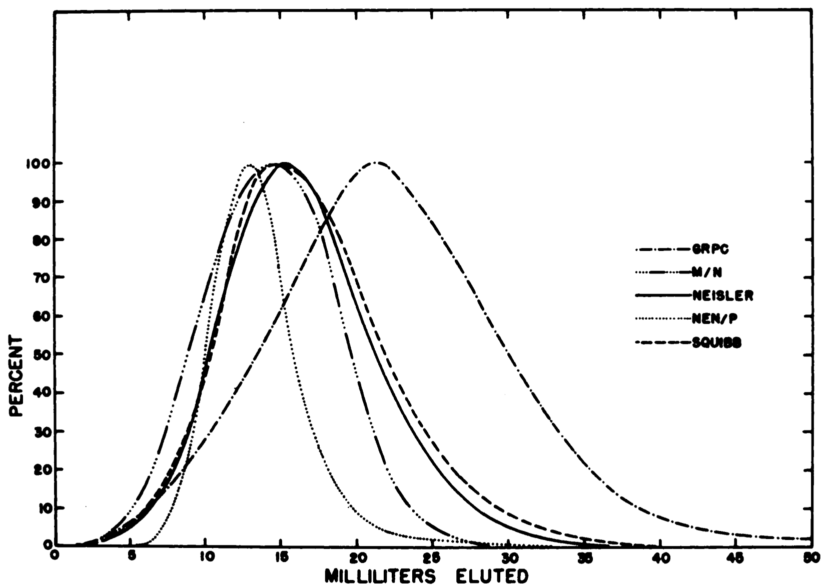

FIG. 1. Instantaneous concentration of eluted ^{99m}Tc from ^{99}Mo-^{99m}Tc generators of several manufacturers. Concentration is expressed as percent of maximum concentration against volume eluted.

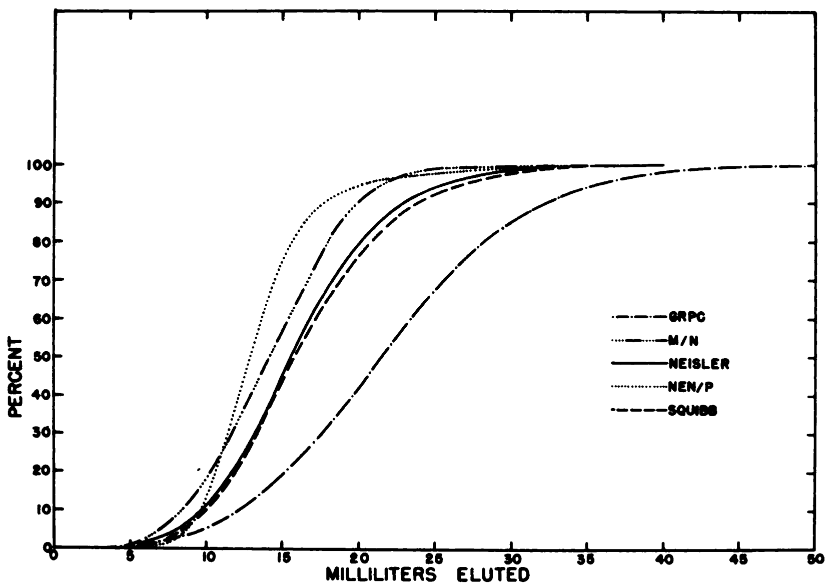

FIG. 2. Accumulated ^{99m}Tc activity as function of volume eluted expressed as percent of maximum elutable activity.

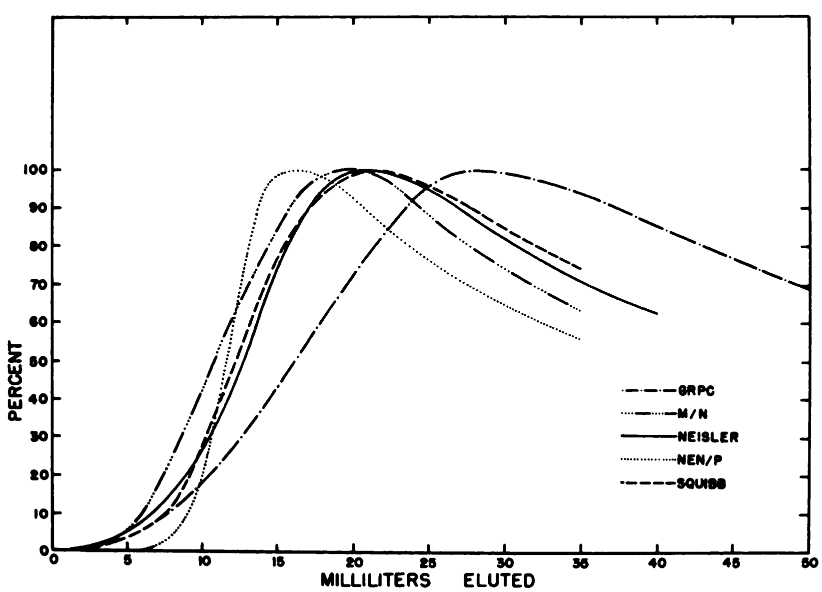

FIG. 3. ^{99m}Tc concentration contained in single receiving vial when entire elution is delivered to that vial expressed as percent of maximum concentration possible. No pre-elution.

for GRPC generator. The GRPC generator did not reach this low value even after 50 ml had been eluted, but we considered it 100% eluted.

In Fig. 2 we have plotted the accumulated gross activity against the total volume eluted up to that point. Notice that all curves remain essentially at zero activity for the first 5 ml and then rise in a sigmoid fashion to 100% total elutable activity at different volumes later. Finally, in Fig. 3 we plot the concentration against the volume eluted as a percent of the maximum concentration. In this case the entire activity is pooled into a single vial just as one would normally do in a routine elution procedure. Here we see that the occurrence of the maximum attainable concentration is not identical with that of Fig. 1, but rather occurs somewhat later for any given generator. Note also that the decline of these curves is not nearly as rapid as those of Fig. 1, generator for generator.

CONCLUSIONS

An analysis of these curves reveals the following important points:

1. There are significant differences between the generators available on the market.
2. Such curves as Fig. 1 reveal the position for the maximum possible instantaneous activity which can be obtained for any given generator as a function of volume eluted.
3. A curve such as that of Fig. 2 gives information as to the efficiency of any given elution; that is, if your generator will deliver 100% in 40 ml, as does that from Neisler, and you elute 20 ml total volume, it then follows that you have eluted about 82% of the maximum possible activity.
4. In any given elution into a single vial, as shown in Fig. 3, the point of maximum obtainable concentration is revealed. Note also that in the case of Fig. 3 even a higher concentration could be obtained if a small initial part (about 5 ml) of the elution volume is discarded; i.e. it adds several milliliters of liquid to the vial but almost no activity—hence there is an intial dilution which can be avoided.

It is recommended that each user of a radioisotope generator determine similar curves for his particular elution method. This is important because as the generator becomes older the maximum possible elutable activity decreases and could produce an undesirable concentration level so that it becomes useless under the standard elution method. That is, it is necessary to consider the parameters of specific activity, total volume, total activity and positions of the maximum activity and specific activity in the elution scheme and the elution method.

REFERENCES

1. YANO, Y. AND ANGER, H. O.: Ultrashort-lived radioisotopes for visualizing blood vessels and organs. *J. Nucl. Med.* **9**:2, 1968.

2. HARPER, P. V., LATHROP, K. A., JIMINEZ, F., FINK, R. AND GOTTSCHALK, A.: Technetium 99m as a scanning agent. *Radiology* **85**:101, 1965.