ASSAY OF ^{32}P-SODIUM PHOSPHATE USING A COMMERCIAL DOSE CALIBRATOR

A. Michael Zimmer, Edward A. Silverstein,* and Richard A. Holmes

Medical College of Wisconsin, Milwaukee, Wisconsin

Dose calibrators are not usually used to measure the activity of pure beta-emitting radionuclides. In this work, the activity of ^{32}P-sodium phosphate was accurately measured with a Capintec CRC-2 dose calibrator. Using a calibration knob setting of 012 on the 1-mCi range, the ^{32}P dose (in mCi) could be calculated directly simply by multiplying the instrument readout by 10. The dose calibrator response was found to be linear at this knob setting and moderate alterations in geometry produced no significant changes.

Although ionization-chamber dose calibrators are used extensively in nuclear medicine for the assay of radiopharmaceuticals (*1*), they are not usually thought of as instruments suitable for assaying pure beta-emitters because of anticipated difficulties with penetration and geometry. It would be clinically expedient to be able to assay commercial ^{32}P radiopharmaceuticals easily and accurately in the laboratory before patient administration, in order to verify the accuracy of the manufacturer's stated activity. In the past, manufacturers of dose calibrators have not supplied a setting for ^{32}P (*2*). Recently, one manufacturer (Capintec, Mt. Vernon, N.Y.) has supplied such a setting for ^{32}P, but it is quite insensitive. This study was undertaken to assay ^{32}P radiopharmaceuticals in a simple, sensitive, and reliable manner using a commercial dose calibrator.

MATERIALS AND METHODS

Commercial ^{32}P-sodium phosphate (Mallinckrodt, St. Louis, Mo.) was used in the study. The dose calibrator was a Capintec Model CRC-2 instrument. Samples were assayed in sterile plastic syringes that were centrally placed in the sample holder. The absolute activity of the ^{32}P was measured to within 5% in a liquid scintillation counter (Searle Analytic, Chicago, Ill.) by placing a standard aliquot of ^{32}P in 10 ml of scintillation cocktail and counting it (*3*). Although greater accuracy could have been obtained using a standard source from the National Bureau of Standards, liquid scintillation counting was sufficiently accurate for work with ionization chambers.

One milliliter of the standardized ^{32}P-sodium phosphate solution was withdrawn into a 6-ml plastic syringe and placed in the ionization chamber. The readout from the dose calibrator was then plotted as a function of the calibration knob setting to determine a convenient and sensitive setting for ^{32}P. This procedure gave a calibration knob setting of 012, which was used throughout the study.

Using the 012 setting, the linearity of the dose calibrator was tested by measuring varying volumes of ^{32}P solution, ranging from 0.50 ml (0.43 mCi) to 4.30 ml (4.13 mCi), in a 6-ml plastic syringe. The effect of altered geometry on the measurement of ^{32}P activity was also evaluated using different syringe sizes (3, 6, and 12 ml) and different volumes (1.20–6.20 ml) within the same syringe.

RESULTS

The readout of the Capintec dose calibrator is shown as a function of the calibration knob setting in Fig. 1. The sensitivity of the readout increased at the lower knob settings. With a calibration knob setting of 012, the instrument readout, multiplied by a factor of 10, gave a direct readout in millicuries. Other calibration knob settings, including specific fixed radionuclide settings, could be utilized with an appropriate multiplication factor to assay ^{32}P.

The linearity of the dose calibrator was studied with increasing ^{32}P activities. The graph in Fig. 2 shows good linearity from 0.43 mCi to 4.13 mCi.

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For reprints contact: A. M. Zimmer, Nuclear Medicine Sect., Univ. of Illinois Medical Center, 840 S. Wood St., Chicago, Ill. 60612.

* Present address: Sect. of Medical Radiation Physics, Rush-Presbyterian-St. Luke's Medical Center, Chicago, Ill. 60612.

The largest deviation from linearity was 5.3% at 4.13 mCi.

Table 1 shows the effect of self-absorption on the ^{32}P readings: various volumes of the ^{32}P solution were used in the same 6-ml plastic syringe. The data show that the readout was not significantly changed with volume over the range 1.2–6.2 ml, establishing that self-absorption is constant over this range.

The effect of syringe-wall absorption was tested by assaying the same ^{32}P dose in different-sized syringes ranging from 3 to 12 ml. The ^{32}P assay held to about ±4% (Table 2), indicating that syringe-wall absorption was unimportant in this range.

TABLE 1. SELF-ABSORPTION EFFECT*

^{32}P activity (mCi)	Total volume (ml)	Capintec readout × 10 (mCi)
1.03	1.20	1.09
1.03	2.20	1.09
1.03	3.20	1.09
1.03	6.20	1.08

* The same dose and plastic 6-ml syringe were used with varying volumes.

TABLE 2. SYRINGE-WALL ABSORPTION EFFECT*

^{32}P activity (mCi)	Total volume (ml)	Syringe size (ml)	Capintec readout × 10 (mCi)
1.72	2.00	3	1.69
1.72	2.00	6	1.63
1.72	2.00	12	1.56

* The same dose (1.72 mCi) was used with varying plastic syringes.

DISCUSSION

The primary clinical use of ^{32}P-sodium phosphate is in the treatment of polycythemia rubra vera. Exclusive reliance on the manufacturer's stated dose is often tolerated because most commercial dose calibrators do not include settings for ^{32}P.

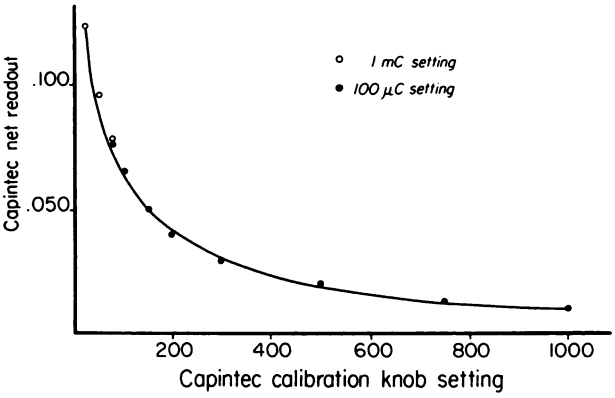

FIG. 1. Readout as function of calibration knob setting.

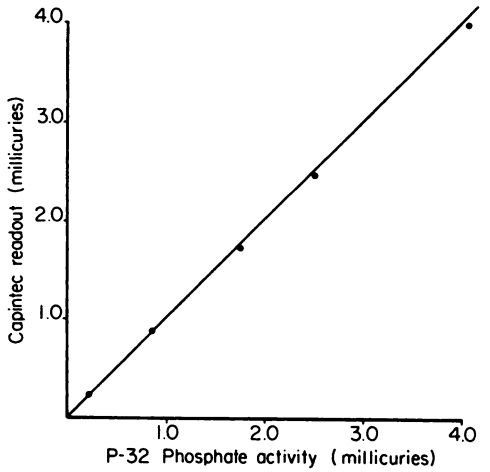

FIG. 2. Linearity of dose calibrator at recommended ^{32}P setting (012).

The beta particles from the ^{32}P solution are stopped by the combination of water in the syringe, the syringe walls, and the aluminum and plastic liners of the dose calibrator chamber, so that the actual readout results from the production of bremsstrahlung. Changes in any of the above factors could significantly affect the corresponding readout.

Changing the volume of solution or the size of the syringe did not affect the readout unless the syringe and its contents extended beyond the dose calibrator chamber opening. A calibration knob setting of 012 proved to be optimal with respect to simplicity and sensitivity. The multiplication factor of 10 permitted easy conversion to dose from the instrument's readout. Using this technique in the National Polycythemia Treatment study, we found excellent agreement with the manufacturers' stated assays.

In conclusion, our laboratory has determined an accurate and sensitive calibration knob setting for ^{32}P that produces a linear response over a wide activity range. Accuracy is also not significantly affected by geometry within the experimental limits.

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