March 1995 *Journal of Nuclear Medicine Technology* entitled "A Technique for Measurement of Strontium-89 in a Dose Calibrator (*1*)."

Capintec is pleased that the Mayo Clinic has developed a method for the successful measurement of ^{89}Sr using a Capintec CRC-12R dose calibrator. In addition, we concur with the authors' position that it is a good quality assurance practice to confirm the activity of all dosages determined by volumetric calculation through the use of a suitable measurement device. However, the successful use of a conventional dose calibrator for measurement of pure high-energy beta emitters requires a clear understanding of the limitations inherent in the use of a well-type ionization chamber for this purpose. Because of the low ratio of bremsstrahlung production per unit of activity, dose calibrator ionization chambers produce extremely low levels of current during measurement of pure beta emitters. Calibration factors generally require a multiplier (typically × 100), and displayed readings fluctuate more with beta than with gamma emitters. Dose calibrators do not possess energy discrimination abilities. Strontium-89 contains small amounts of radioactive ^{85}Sr and this trace impurity can vary with target material. Since ^{85}Sr produces a 514-keV gamma at 98%, this variability can cause significant errors when measuring ^{89}Sr in a dose calibrator. In addition, the slight variability between ionization chambers, normally undetectable in the energy ranges typically used in nuclear medicine, becomes significant when measuring bremsstrahlung and contributes to calibration difficulties.

The author cites costly liquid scintillation counters as an alternative method of measurement. However, the inconvenience of using an aliquot and the wait for results make this technique impractical for routine use in a clinical environment.

To meet the need for a practical assay method for pure high-energy beta-emitting radiopharmaceuticals, Capintec has developed a new type of dose calibrator, the Beta-C Counter. This device utilizes a thin-crystal sodium iodide detector optimized for sensitivity to bremsstrahlung and a six-channel pulse-height analyzer to provide sufficient energy discrimination to separate bremsstrahlung spectrum from higher-energy gamma-emitting impurities. This provides a significant improvement in accuracy over the conventional dose calibrator. In addition, sample holders provide a fixed geometry which places the vial perpendicular to the face of the crystal. Since the wall thickness of a vial varies less than the bottom thickness from lot to lot, this positioning minimizes container variability. The source-to-detector distance has been set to accommodate the clinical activity range of interest without the need to aliquot.

Beta-C instrument comparisons have shown variability of less than ±3% under typical lab conditions, compared to ±10% found with the conventional dose calibrator. Precision is also significantly improved. With counting times as short as 2 sec, counting errors of less than 1% are achieved. The unit is less expensive than the conventional dose calibrator and, given cost containment considerations, can also function as a calibrator for low activity levels of gamma emitters provided it has been calibrated appropriately for each nuclide.

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REFERENCE

1. Herold TJ, Gross GP, Hung JC. A technique for measurement of strontium-89 in a dose calibrator. *J Nucl Med Technol* 1995;23:26–28.

To the Editor: We read with interest the article by Herold et al. (*1*) regarding the dose calibrator measurement of ^{89}Sr. We employed a virtually identical approach approximately two years ago when establishing the calibration settings for our Capintec CRC 15R.

In addition to the required posting of these settings on the dose calibrator we require all personnel who would potentially be involved in preparing a dose of ^{89}Sr to review and sign a copy of the procedure.

One technical point we wish to address pertains to the two measurements which are taken of the original vial of ^{89}Sr. We feel that the measurement of residual activity in the empty vial at the same setting as the full vial may be inappropriate. It should be performed only after adding a sufficient volume of saline to the vial to re-establish the original volume (in most cases 4 ml). A correction factor (or another setting) for measuring the vial after removal of a dose can then be established. The measured activity of a soft gamma or pure beta-emitting radionuclide will vary significantly between what may essentially be considered a point source and when dispersed in a larger volume. In order to establish the magnitude of this potential error, the residual activity was measured in twelve empty vials of Metastron® and remeasured after adding 4 ml of 0.9% NaCl. The results are shown in Table 1.

Additionally, the theoretical self-absorption of the ^{89}Sr beta emission from a cylinder of water 15 mm high and 19 mm in diameter within a glass vial of approximately 1 mm thickness was calculated by integration and compared with an essentially unattenuated point source within the same glass vial. The calculated value is 17.34%. This value is in close agreement with the geometric variation derived from our experimental data.

Admittedly, this is somewhat academic for single-dose vials. However, for multidose vials of pure beta emitting radiopharmaceuticals this geometric correction cannot be ignored. Additionally, the NRC has recently clarified its position on the assay of pure beta-emitters by issuing an informational notice (*2*). The NRC states:

> Part 35 does not require licensees to measure patient dosages of radiopharmaceuticals containing pure beta-emitters provided they are unit dosages obtained from a manufacturer or preparer licensed pursuant to 10 CFR 32.72 or equivalent Agreement State requirements. Otherwise, the licensee is required to measure by direct measurement, or by combination of measurements and calculations, the activity of each dosage of an alpha- or

TABLE 1
Dose Calibrator Readings of ^{89}Sr Residual Vial Activity

Number of vials*	Average μCi of empty vials (range)	Average μCi of same vials plus 4 ml volume (range)	Percent difference (±1 s.d.)
12	134 (110–171)	105 (82–137)	22.5% (±2.6%)

*Metastron® vials were supplied by MPI Pharmacy Services, Livonia, MI.

beta-emitting radionuclide, before medical use. Licensees may also use any available instrumentation to assay patient dosages containing pure beta-emitters, to satisfy this requirement.

In conclusion, accurate measurement of pure beta-emitting radionuclides with a dose calibrator is readily accomplished with proper attention to all aspects of geometric variation.

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1. Herold TJ, Gross GP, Hung JC. A technique for measurement of strontium-89 in a dose calibrator. *J Nucl Med Technol* 1995;23:26–28.
2. US Nuclear Regulatory Commission, Information Notice: IN 94-70, Issues associated with the use of strontium-89 and other beta-emitting radiopharmaceuticals. Washington, DC: NRC; September 29, 1994.

Reply: Although we do not dispute the fact that there are limitations inherent in using a dose calibrator to measure ^{89}Sr activity, we still believe that the technique we used provides a good means of measurement to confirm the volumetric calculation. Multiple lots of ^{89}Sr-chloride injection (Metastron®, Amersham Healthcare, Arlington Heights, IL) were used in the performance of our studies (*1,2*), and the small percentage of variability which we found indicates that the problem of ^{85}Sr impurity in the ^{89}Sr preparation may not be as large as was indicated in the comments from Ms. Dell. Recently, the National Institute of Standards and Technology has determined a dial setting for measuring ^{85}Sr with a dose calibrator, so that correction can be made for the amount of ^{85}Sr impurity in the ^{89}Sr sample (*3*).

We have evaluated a Beta C® counter (Capintec Inc., Ramsey, NJ) in our institution and have found it to be superior to the dose calibrator for the measurement of ^{89}Sr activity in the 37-MBq (1-mCi) range; however, we have found a lower variability using the dose calibrator technique for the 74, 101 and 148-MBq (2, 3 and 4-mCi) ranges (*2*).

We agree that there may be some variability which exists among the ionization chambers of different dose calibrators, which is why we recommend that calibration factors be determined for each dose calibrator used for measurement of ^{89}Sr (*1*). Also, while the Beta C counter may be less expensive than a dose calibrator, this advantage is negated by the fact that the dose calibrator has a greater usefulness and is required equipment in all nuclear medicine departments.

We concur with the points raised by Dr. Porter and Ms. Eck. We would also remind the reader to be mindful of the limitations of dose calibrator measurement for ^{89}Sr which were presented in our original article (*1*).

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1. Herold TJ, Gross GP, Hung JC. A technique for measurement of strontium-89 in a dose calibrator. *J Nucl Med Technol* 1995;23:26–28.
2. Gilster BG, Chadbourn DG, Herold TJ, Hung JC. Comparison of the dose calibrator and ßeta C counter in the measurement of strontium-89 [Abstract]. *J Nucl Med Technol* 1995;23:126.
3. Radioactivity Group. More notes on the use of SRM 4426A, strontium-89. Gaithersburg, MD: National Institute of Standards and Technology; 1995.