Quality Control Procedure for Pipetting Systems*

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Our laboratory has developed a simple and rapid radionuclide procedure to make evaluations of the reproducibility of pipettes. Five semiautomatic and one automatic pipette were evaluated by delivering diluted ^{125}I-human serum albumin aqueous or pooled serum samples. Each sample was counted in an autogamma counter. The results were statistically analyzed by calculating means, standard deviations, and coefficients of variation. The automatic pipette and one semiautomatic pipette demonstrated low coefficients of variation. All other pipettes evaluated showed inconsistency in the delivered volumes. The radionuclide method, as outlined in this study, can easily be incorporated as a quality control procedure for pipetting systems in any nuclear medicine laboratory.

The need to assess the reproducibility and accuracy of pipettes has become important with the increasing clinical application of radioimmunoassay procedures. The typical bioassay requires pipetted volumes ranging from 100 μl to several milliliters, whereas the average radioimmunoassay requires much smaller volumes from 10 to 200 μl. In order to obtain reliable results from radioimmunoassay studies, it is essential to have reproducible pipettes *(1)*. Inconsistent pipetting, or lack of reproducibility, results in great variability in the resultant standard curves and consequently large errors in patient assay values.

A host of commercial pipettes are available today, with both their reproducibility and accuracy varying considerably *(1)*. Previous studies *(2, 3)* have demonstrated that, under the conditions for optimal performance recommended by the manufacturers, the stated tolerance limits were often not clinically attained. In these studies the volumes of water and serum delivered were determined gravimetrically by repeatedly weighing the delivered volumes under strictly controlled environmental conditions.

This investigation was undertaken to determine tolerance limits of several recent models of semiautomatic and automatic pipetting systems and to establish a simple and rapid radionuclide technique for quality control of pipettes.

Materials and Methods

Five semiautomatic pipettes and one automatic pipette were evaluated: 0.2-ml Biopette and Micro Biopette (Schwarz/Mann, Orangeburg, NY); Pipetman P1000 (Rainin Instrument Co., Inc., Boston, MA); Oxford Laboratories (Foster City, CA); Eppendorf (Brinkmann Instruments, Inc., Westbury, NY); Micromedic Automatic Pipette High Speed (Micromedic Systems, Inc., Philadelphia, PA).

The pipettes were maintained and operated by one technologist according to the manufacturers' specifications. A known amount of radioactivity, radioiodinated human serum albumin (Mallinckrodt, Inc., St. Louis, MO), was added to water and to pooled serum. A completely randomized design was employed for the statistical evaluation of the study. Each pipette was evaluated by prewetting the tip and then delivering 10-, 25-, 50-, and 100-μl volumes of both aqueous and serum solutions into counting tubes. Five replicate samples for each volume and pipette were measured in an automatic gamma scintillation counter (Packard Instrument Co., Downers Grove, IL). Different tips were used for all samples and pipettes, except for the automatic pipette which utilized the same delivery tip. All tips were plastic except for the Micro Biopette, which was siliconized glass. Following the pipetting, each sample was diluted to 1 ml to maintain constant geometry. Approximately 60,000 counts were collected for each sample, resulting in a coefficient of variation of 0.4% due to counting statistics, which was considered negligible in the overall statistical evaluation.

Results and Discussion

The results were statistically analyzed by calculating

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TABLE 1. Percent Coefficients of Variation for Aqueous Samples Delivered

Pipette	Volume delivered (μl)			
	10	25	50	100
0.2 Biopette	*	2.0	1.9	3.1
Micro Biopette	3.6	3.4	4.7	1.7
Pipetman	11.4	6.6	3.8	3.2
Oxford	5.1	*	8.0	4.0
Eppendorf	*	0.6	0.3	*
Micromedic	1.4	0.7	0.2	0.1

**Volumes not included*

TABLE 2. Percent Coefficients of Variation for Serum Samples Delivered

Pipette	Volume delivered (μl)			
	10	25	50	100
0.2 Biopette	*	6.8	2.1	3.1
Micro Biopette	2.5	3.1	3.6	2.0
Pipetman	8.8	7.4	8.5	7.2
Oxford	6.7	*	12.7	4.7
Eppendorf	*	1.8	1.7	*
Micromedic	0.8	0.6	0.4	0.1

**Volumes not delivered*

means, standard deviations, and coefficients of variation for each volume delivered. The results for aqueous and serum samples are listed in Tables 1 and 2, respectively.

The automatic pipette showed the lowest coefficient of variation, which was well within the manufacturer's stated tolerance limits *(4)*. The reproducibility of the Eppendorf pipette closely approximated that of the automatic pipette. All other pipettes evaluated showed inconsistency in the delivered volumes, resulting in higher coefficients of variation. In general, however, better reproducibility was achieved when aqueous samples were pipetted. All but one of the pipettes had a smaller coefficient of variation when delivering larger volumes. No significant differences were observed when either siliconized glass or plastic tips were used.

The mere fact of having made a substantial financial investment in a high-quality pipetting system does not in itself guarantee a correspondingly high level of performance from the system as used in the laboratory. It is necessary to verify the manufacturer's stated specifications by repeatedly testing the instrumentation under clinical laboratory conditions. The radionuclide method described herein is well suited for this task and is easily incorporated as a quality control procedure in any nuclear medicine laboratory. It has the additional benefit of testing the pipetting performance of the laboratory personnel.

References

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