A New Technique for Measurement of Carrier Thallium

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Manufacturers of thallium-201 use the Rhodamine-B spot test for detection of "carrier" or elemental thallium. A more exacting and simpler quantitative technique for measuring carrier thallium is described and this spectrophotofluorometric technique takes advantage of thallium's native fluorescence.

Research was undertaken to determine microgram quantities of carrier thallium in available Tl-201 products. Thallium is an extremely toxic element; it has an LD_{50} of 13–20 mg/kg in rats (*1*) and a minimum lethal dose of approximately 2.8 mg/kg in man (*2*). Thus, the importance of carrier thallium determination cannot be overemphasized if the product is intended for human use. A carrier thallium test is performed to confirm adequate chemical separation of the Pb-201 parent from the unreacted thallium target material.

Manufacturers of Tl-201 are currently using the Rhodamine-B spot test for detection of carrier thallium. Rhodamine-B is a fluorescent dye that is combined with thallium via a reaction (Fig. 1). The Rhodamine-B–thallium complex is extracted in benzene. The amount of fluorescence given off by the complex is directly proportional to the amount of thallium present. Using this method, the total amount of thallium present in the sample can be determined semiquantitatively by direct visual comparison with prepared standards (*3*).

Because the Rhodamine-B test was found to be rather tedious and insensitive, an alternative was sought. The simplest and most accurate means of quantitating microgram amounts of carrier thallium is a spectrophotofluorometric (SPF) technique (*4*).

Materials and Methods

The SPF technique entails use of the following equipment:

1. Aminco Bowman spectrophotofluorometer model no. J482026 (Fig. 2);
2. clean quartz cuvette;
3. cuvette cleaning solution (95% ethanol, 5% HCl);
4. 2.0-ml thallium-201 solution;
5. thallium chloride standards containing from 0.1–100 μg/ml; and
6. 0.9% NaCl for injection.

After appropriate startup and warmup procedures for the spectrophotofluorometer are performed, the excitation wavelength is set to 222 nm, and the emission wavelength is set to 385 nm.

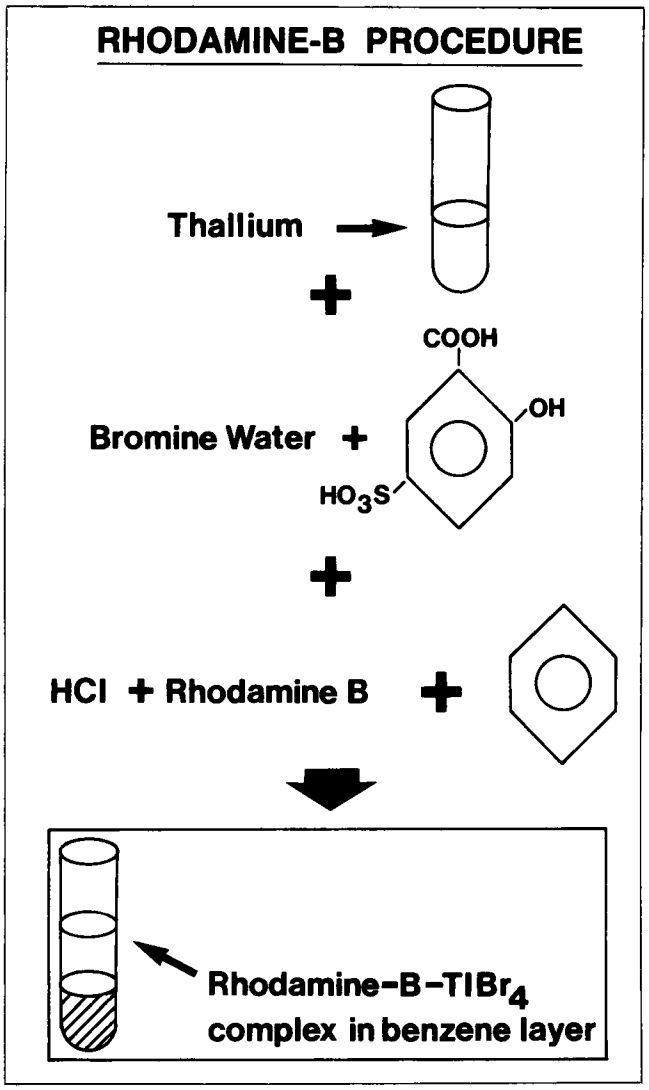

FIG. 1. Rhodamine-B spot test for detection of carrier thallium.

Perform blanking before any samples or standards are run by placing 2.0 ml of 0.9% NaCl into a clean cuvette. Insert the cuvette into spectrophotofluorometer; open the shutter to the P-M tube; and then turn zero adjust knob until the relative intensity of NaCl sample reads zero.

Thallium standards of the following concentrations are prepared: 0.1, 1.0, 2.0, 5.0, 10, 20, 50, 75, and 100 μg/ml. This

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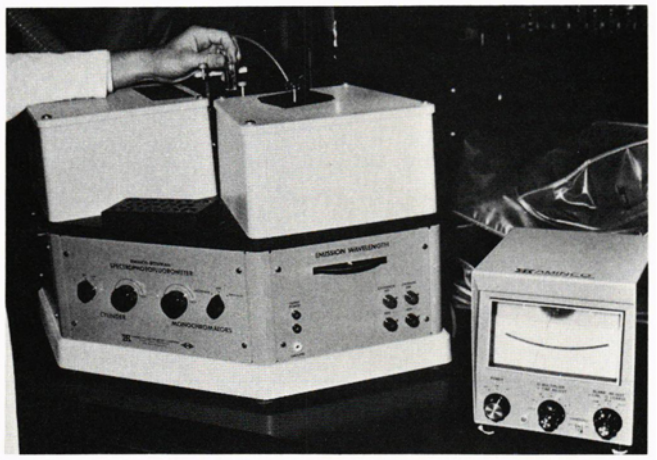

FIG. 2. Aminco Bowman spectrophotofluorometer.

is done by weighing out the proper amount of thallium chloride powder and placing this in a volumetric flask, then adding purified water to the exact volume of the volumetric flask. Avoid contact with or inhalation of the toxic thallium chloride chemical.

After blanking, place 2.0 ml of Tl-201 sample into a clean cuvette (it is imperative that the cuvette is perfectly clean and dry). Place the cuvette into spectrophotofluorometer, excite with ultraviolet light, and record the relative intensity given off by the sample. Repeat this procedure with each of the thallium standards.

To determine the thallium concentration of a sample, construct a standard curve by plotting the log of the relative intensity on the y-axis versus the log of the thallium concentration on the x-axis. After the relative intensity of the thallium sample is determined and the standard curve constructed, the amount of thallium in a sample can be determined by extrapolation from the standard curve (Fig.3).

Discussion and Conclusion

The SPF technique is feasible since thallium emits a characteristic native fluorescence when dissolved in water or saline. A log-log plot of the relative fluorescent intensities generated from thallium standard solutions shows a linear relationship from concentrations ranging from 1 μg/ml to 60 μg/ml. Thallium concentrations greater than 60 μg/ml display concentration quenching or absorption (Fig. 3).

The Rhodamine-B test for carrier thallium determination is

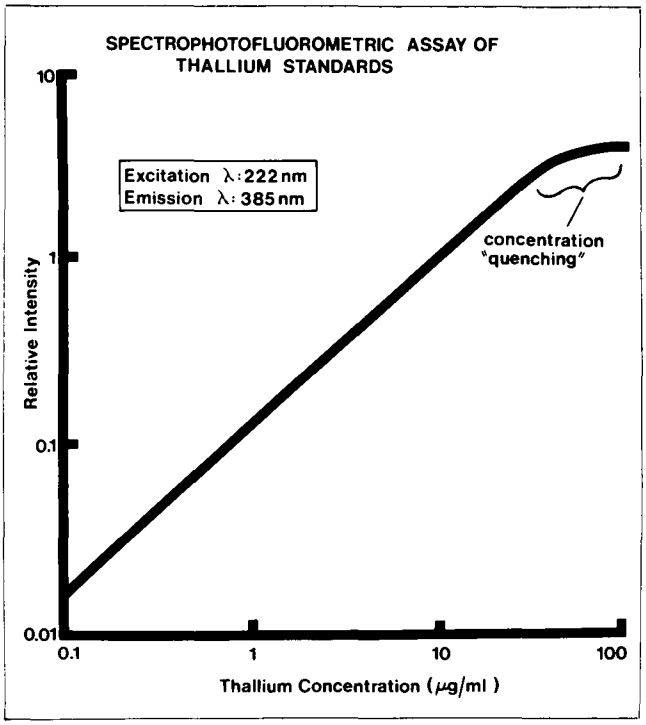

FIG. 3. Standard fluorescent intensity curve for thallium.

only semiquantitative in nature and rather time-consuming. The SPF method is easily performed, extremely sensitive and consistent, and requires only about 20–30 min to complete. The only drawback to the SPF technique is the initial expense of the spectrophotofluorometer but this may already be present in your institution. This method, however, is not necessarily intended for routine use by those receiving Tl-201 as a radiopharmaceutical. Rather, it is intended for those manufacturing Tl-201, or receiving Tl-201 as a radiochemical, with intent to document its suitability for human use.

References

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