Rapid Spot Test for Stannous Tin Levels in ^{99m}Tc Kits

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A rapid color spot test method to determine approximate levels of the stannous ion in ^{99m}Tc radiopharmaceutical kits has been developed using a light-activated porphyrin reduction process.

There is a need for simple quality control procedures to be used on radiopharmaceuticals immediately before administration *(1)*. Since kits containing tin will not reduce technetium if the stannous ion [Sn(II)] has been oxidized to the stannic [Sn(IV)] form, we have sought a sensitive, rapid, and convenient color change spot test method for determining if the amount of Sn(II) in the kit, after activation with $^{99m}TcO_4^-$, is within given limits. Such a test should be unaffected by the presence of ligands or reducing stabilizing agents such as ascorbic acid, and should use only a few drops of the activated pharmaceutical. The levels of Sn(II) to be determined are relatively small, and the common spot tests for Sn(II) *(2)* are either not sensitive enough (starch-iodine, diazine-green reagent, mercuric chloride, SnS or sodium hydroxide precipitations, zinc reductions) or involve too many analytical manipulations (the dimethylglyoxime–ferric chloride test) to be useful. A light-activated procedure using the porphyrin tetra(4-N-methylpyridyl)porphine tosylate is a useful method to rapidly ascertain the levels of Sn(II) in radiopharmaceuticals.

Materials and Methods

Tetra(4-N-methylpyridyl)porphine tosylate (TMPyP) was either synthesized *(3)* or purchased from Man-Win Coordination Chemicals (Washington, DC). Various commercial tin diphosphonate, tin pyrophosphate, or tin glucoheptonate kits were used as sources of Sn(II). Similar yields were also found with $SnCl_2 \cdot 2H_2O$ in 0.1 *M* HCl, or in other tin diphosphonate or tin gluconate preparations *(4)*. For the porphyrin reagent, 13.6 mg of TMPyP was dissolved in 1.0 l of 1.0 *M* HCl, producing a grass green solution.

Many commerical kits initially contain 0.19 mg of $SnCl_2$/ml (1×10^{-3} *M*) and are usually diluted 1:1 with $^{99m}TcO_4^-$ before use. One-tenth milliliter [5×10^{-5} m*M* of Sn(II)] of the final preparation can be used for the Sn(II) assay. It is difficult to decide at what level below the manufacturer's stated amount of tin should a kit be rejected. We arbitrarily assume that the amount of Sn(II) can be found to be lower by a factor of five without ill effects on the labeling procedure. This decision can of course be made in the individual's laboratory, and the test modified accordingly.

For the porphyrin test, 0.1 ml of the stannous solution [5×10^{-5} m*M* Sn(II)] is added to 1.0 ml of the TMPyP solution (1×10^{-5} m*M*) and the color remains green. If the test tube is moved to within 1 in. of a light bulb or fluorescent light, the color immediately changes from green to yellow-orange. This color change indicates that at least 1.0×10^{-5} m*M* of Sn(II) is present. Serial dilution studies indicate that the test is positive (yellow-orange) above 1×10^{-5} m*M* Sn(II), and essentially negative (remains basically green) below this level. One-tenth milligram of ascorbic acid added to 1.0 ml of the TMPyP solution produced no photoreaction, nor did it interfere with the spot test. The test was negative when Sn(II) was air oxidized to Sn(IV).

The TMPyP solution is stable for months in the dark at room temperature.

Discussion

The photoactivated poryphrin reagent, TMPyP, can be used to rapidly indicate the approximate stannous ion levels of stannous containing radiopharmaceutical kits. This method removes at least one element of uncertainty in the preadministration procedure, and is a novel and ready means for determining if the reducing capacity of a kit is at fault after an abnormal scan is observed.

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As with any color spot test, marginal color changes are difficult to interpret. Since we would rather err on the positive side, we discard kits that give a marginal color change.

The basis of the spot test is that the porphyrin in acid (green) is reduced to the two-electron reduction product, the dihydroporphyrin (yellow-orange), by Sn(II). One mole of Sn(II) reduces one mole of porphyrin. Light is necessary because the photoexcited state of the porphyrin is a better oxidizing agent than the ground state species.

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