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Effect of increased ^{99m}Tc/^{99}Tc ratios on count rates in sentinel node procedures: a randomised study

Dear Sir,

The work of Gommans et al. on the effect of specific activity of ^{99m}Tc-nanocolloid (colloid albumin) on count rate in sentinel node procedures, presented most recently in this journal [1], is an excellent example of the application of basic principles to improve a clinical procedure. By increasing specific activity, and thereby reducing the number of particles labelled with a given amount of radioactivity, higher nodal count rates can be achieved, which in turn should improve detection of the sentinel node [2, 3, 4]. In previous work, an increase in specific activity was achieved by labelling a small portion of the kit [3], while in the most recent paper, Gommans et al. [1] turned their attention to maximising the specific activity of ^{99m}Tc used in labelling. However, in the discussion on this, Gommans et al. are somewhat imprecise.

Unlike many other radionuclides, ^{99m}Tc is never truly carrier-free and contains varying amounts of its decay product, ^{99}Tc, with the amount of ^{99}Tc present at elution being dependent upon the elution history of the ^{99}Mo/^{99m}Tc generator and increasing with time due to decay of ^{99m}Tc. Equations for calculation of the amounts of ^{99m}Tc and ^{99}Tc in generator eluates were derived by Lamson et al. [5]. It must be remembered that 14% of ^{99}Mo decays directly to ^{99}Tc, bypassing ^{99m}Tc. Based on these equations, the mole fraction of ^{99m}Tc (i.e. the fraction of total Tc atoms present which are ^{99m}Tc) is 0.277 for an elution 24 h after the previous one, and 0.768 for a second elution after 2 h [5]. The corresponding ^{99m}Tc/^{99}Tc ratios are thus 1:2.6 and 3.3:1 in 24- and 2-h elutions, respectively, rather than 1:2 and 9:1, as suggested by Gommans et al. [1]. Moreover, this ratio applies at the instant of elution and declines continuously thereafter.

We can compare the effects of the two approaches which have been taken to increase the specific activity of ^{99m}Tc-nanocolloid: reduction of the amount of albumin colloid used and increase in the ^{99m}Tc/^{99}Tc ratio. The commercial nanocolloid kit contains 0.5 mg colloidal albumin [6]. Gommans et al. have shown previously that the mean particle diameter is 12 nm; thus, there are approximately 550×10^{12} particles in a kit vial [3]. Increasing specific activity fourfold by labelling only 25% of a kit with the same amount of ^{99m}Tc resulted in a corresponding increase in sentinel node counts of sixfold (mean of 108 to 672 cps) while maintaining compliance with the manufacturer's instructions; using 10% of the kit, the nodal count rate increased to 924 cps [3]. In the more recent work, increasing the specific activity of the Tc used in labelling 2.8-fold resulted in an increase in sentinel node counts of only 1.6-fold (mean of 1,070 to 1,738 cps) [1], suggesting diminishing returns from the latter intervention. This is indeed borne out when one calculates the loading on the particles. Theoretically, 1.3 GBq of ^{99m}Tc is equivalent to 40×10^{12} atoms. Thus, in a 24-h elution there would be 144×10^{12} atoms of Tc and 52×10^{12} in a 2-h elution. If this is added to 10% of a kit or 55×10^{12} particles, we can see that there is no net improvement: we are already at an average of ~1 atom of ^{99m}Tc per particle. Thus, the effective specific activity (MBq/μg colloid) is more important than true specific activity (MBq/μg Tc). To put it more simply: the same amount of ^{99m}Tc has been added to the same number of particles, so the amount of ^{99}Tc is largely irrelevant in this situation.

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