Master's Thesis Engineering Technology

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Analysis of calibration, accuracy and uncertainty of activity meters in nuclear medicine

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Introduction

Radiopharmaceuticals used in diagnostics or therapy in nuclear medicine are measured in well-type activity meters before administration in settings determined in a standard 5 ml NIST ampoule. In the clinical routine, other geometries are used during the measurement introducing deviations due to 3 factors: volume, position and container type. This thesis deals with the concrete determination and evaluates the possibility for traceability.

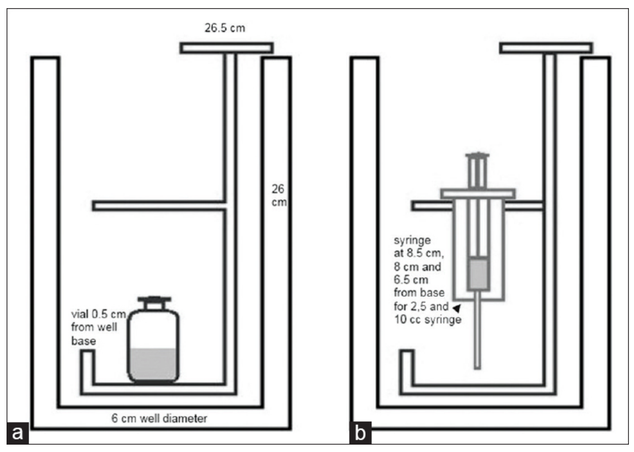

Figure 1 Activity meter scheme

Reference chain

Determination of the correct activity and controlling the activity is done by tracing the response to a secondary reference. For this, the gamma counter is introduced. The gamma counter is an accurate device used in radiopharmacy to measure CPM of a sample. The gamma counter is seen as a possible internal reference for the traceability. To achieve this, the conversion factor from CPM to activity should be calculated. This is done by measuring samples in the fidelis and in the gamma counter. This results in a factor of 0,0475 Bq/CPM for Tc-99m and 0,0198 Bq/CPM for F-18 To ensure the accuracy of the gamma counter a QC program is recommended.

Methods

- **Isosensitivity**
  Measuring quasi-point source of Tc-99m in an acrylic device along the longitudinal axis. The set up is shown in figure 2.
- **Container type**
  Measuring the activity concentration in the containers from figure 3 where the volume is kept constant to eliminate the volume influence.
- **Volume dependence**
  Measurement of dilutions where the activity is kept constant in the vials and syringes shown in figure 3.

Experimental results

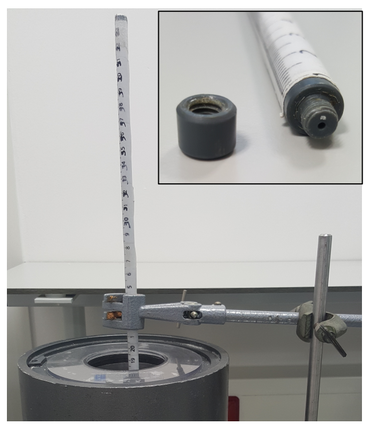

Figure 2 Set up for spatial sensitivity test.

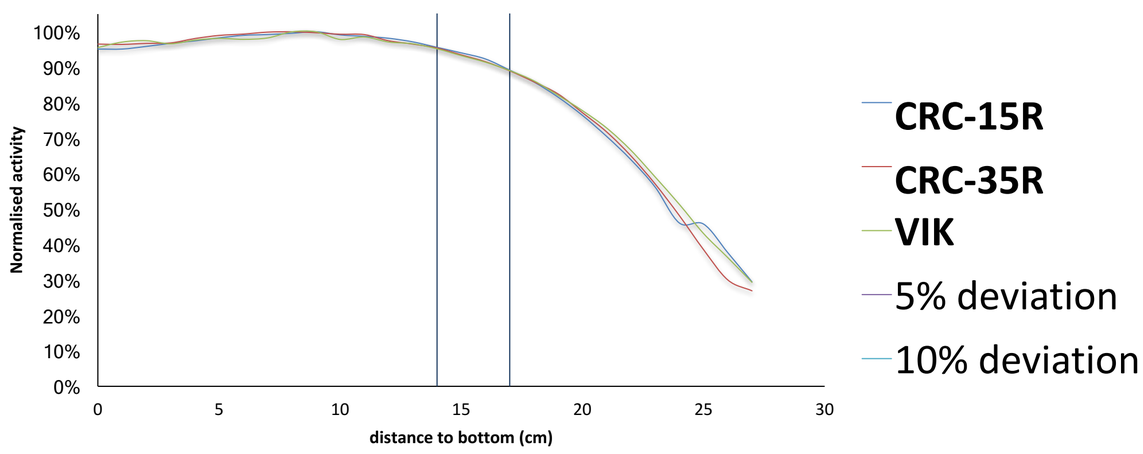

Figure 4 Isosensitivity with 5% and 10% deviation height

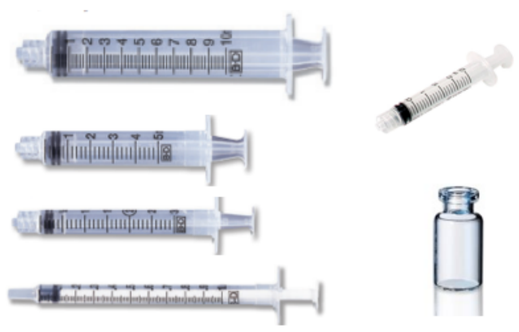

Figure 3 containers used during experiments

Table 1 Correction factors for activity meters

	^{111}In	^{123}I	^{99m}Tc	^{18}F
terumo	0,84	0,87	1,15	1,06
BD 3ml	0,89	0,85	1,13	1,00
BD 5ml	0,89	0,87	1,13	0,96
BD 10ml	0,93	0,89	1,07	0,97
vial	1,09	1,29	0,94	1,05

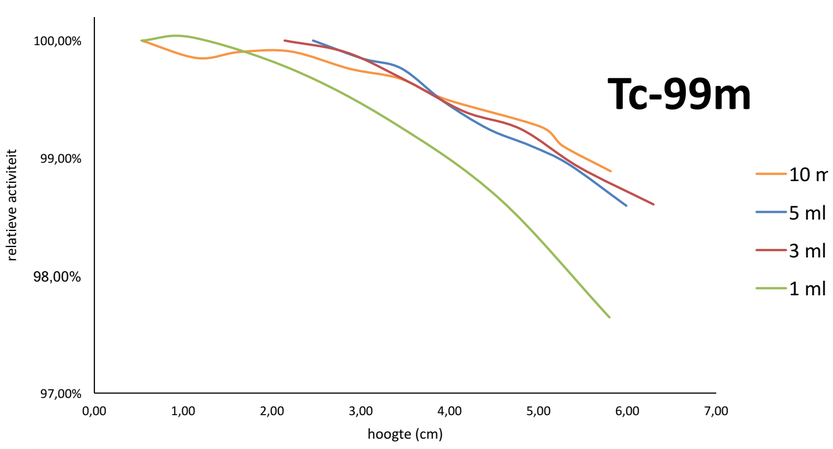

Figure 5 Volume dependence when measuring syringes of Tc-99m

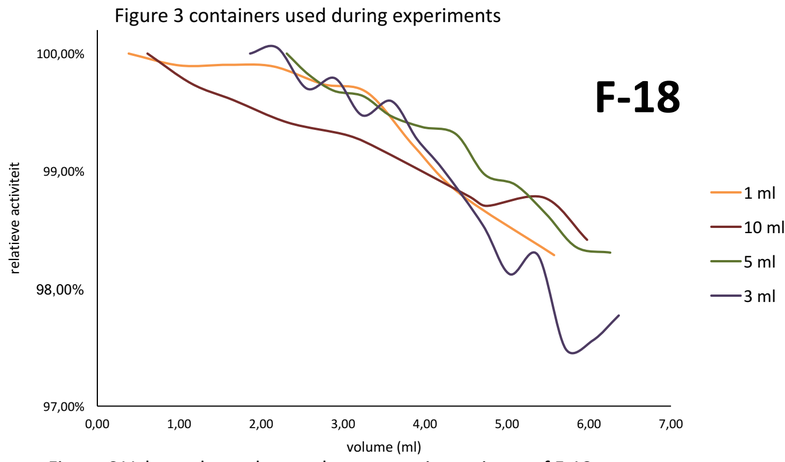

Figure 6 Volume dependence when measuring syringes of F-18

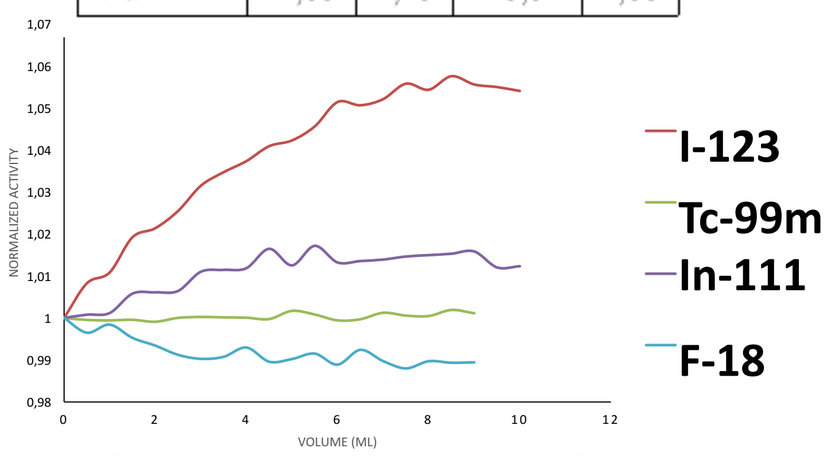

Figure 7 Volume dependence for isotopes I-123, In-111, Tc-99m and F-18

Conclusion

The gamma counter is a proper way to refer the apparent activity in the activity meter to the secondary standard, the Fidelis of the SCK. The experiments show that correction factors for height and recipients are necessary, correction for volume is necessary for I-123. The list of correction factors for recipient and volume influences can be narrowed down by using a copper sleeve. This gives the opportunity to use a mean correction factor of 1,81 for In-111 in all recipients and a correction factor of 3,80 and 4,35 for I-123 in resp. syringes and vials. Measuring F-18 can be done without correction factor and Tc-99m measurements can be corrected with the a mean correction factor of 1,07 without the use of a copper sleeve.

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