Surveillance on performance of dose calibrators in nuclear medicine (NM) centers in Bulgaria

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Introduction

In the nuclear medicine departments in hospitals and clinics, quantification of the activity of medical radionuclides is done by using dose calibrators. All generator eluants, radiopharmaceuticals, and patient dosages have to be measured. It is very important to perform the QC test procedures correctly since patient safety is highly dependent upon the reliability of this instrument. As required by the licensing agency, dose calibrators must be QC-tested at regular intervals.

Purpose

The purpose of this study is to carry out quality control (QC) of dose calibrators in some nuclear medicine departments in Bulgaria.

Materials and Methods

The methods used for QC are based on established international and national recommendations. For each type of dose calibrator the requirements of the producer are taken into account. Depending on the type of dose calibrator there might be a need to modify the QC procedures. The following sources of photon radiation were used for the measurements - Tc-99m, Cs-137 and Ba-133. To ensure the proper operation of a dose calibrator, four QC parameters must be tested: accuracy, precision, constancy and linearity.

Materials and Methods

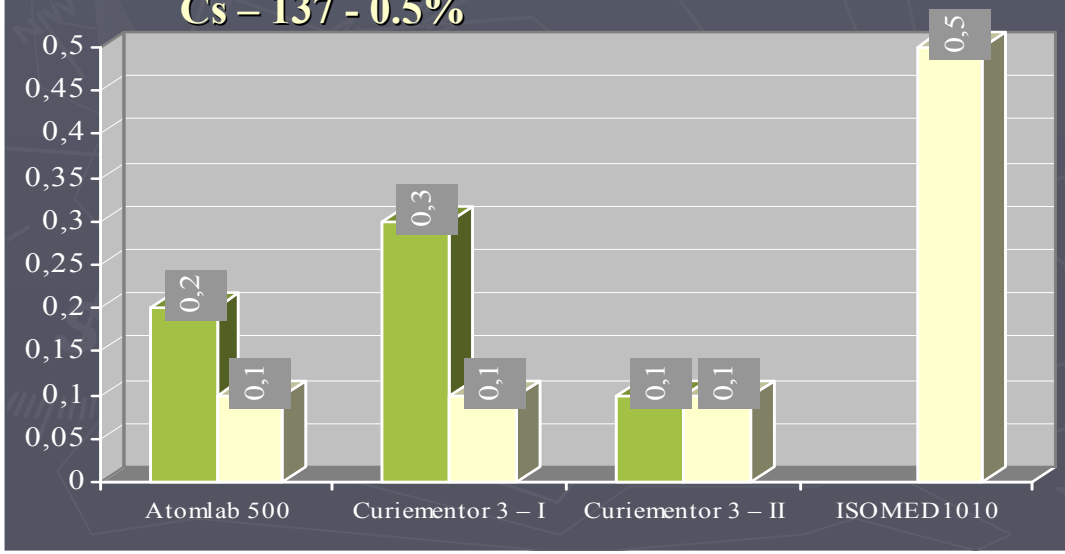
We have performed the following test on four dose calibrators from three different types:

- **Precision and accuracy test** - This test is designed to show that the calibrator is giving correct readings throughout the entire energy scale that we are likely to encounter. We have made 20 measurements with Cs-137 and Ba-133 test sources and calculated the precision and accuracy according to the formulas given by IAEA. ISOMED1010 dose calibrator was not able to measure Ba-133, that was the reason we did not perform that measurement with it.
- **Constancy test** - Constancy means reproducibility in measuring a constant source, usually Cs-137, over a long period of time. The Cs-137 source is measured every day. Values are recorded in the dose calibrator logbook and are compared with recent values to determine if the instrument is maintaining constancy on a daily basis.
- **Linearity test** - This test is designed to prove that the dose calibrator readout is linear for sources varying from the MBq range through the GBq range. A high activity Tc-99m source (50-300 mCi) is measured at T_0 and at predetermined time intervals up to 72 hours. Expected and actual measurements are compared to determine if the instrument is linear throughout the activity range we are likely to use. This test was performed for: Atomlab 500, Curiementor 3 – I and ISOMED1010.

Results

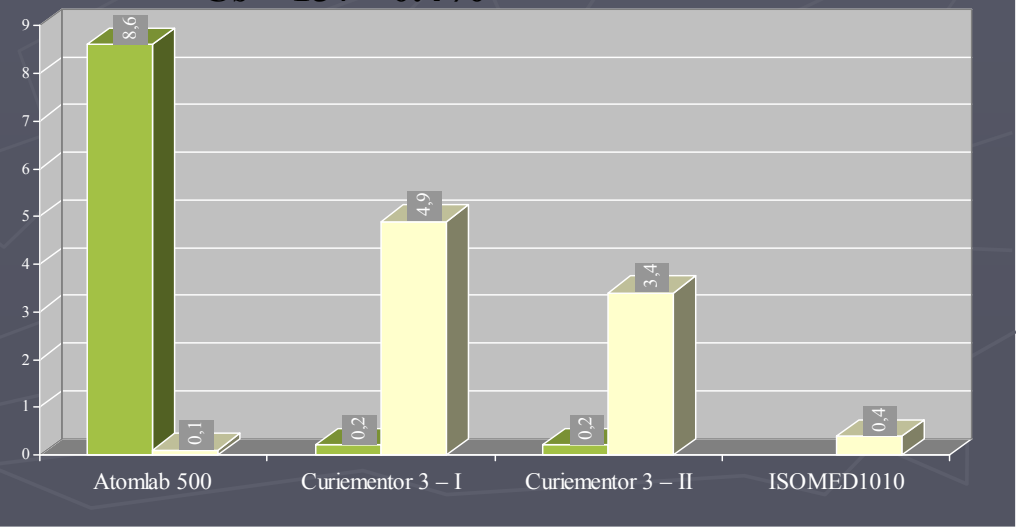
Precision

- Atomlab 500
  - Ba – 133 - 0.2%
  - Cs – 137 - 0.1%
- Curiementor 3 – I
  - Ba – 133 - 0.3%
  - Cs – 137 - 0.1%
- Curiementor 3 – II
  - Ba – 133 - 0.1%
  - Cs – 137 - 0.1%
- ISOMED1010
  - Cs – 137 - 0.5%



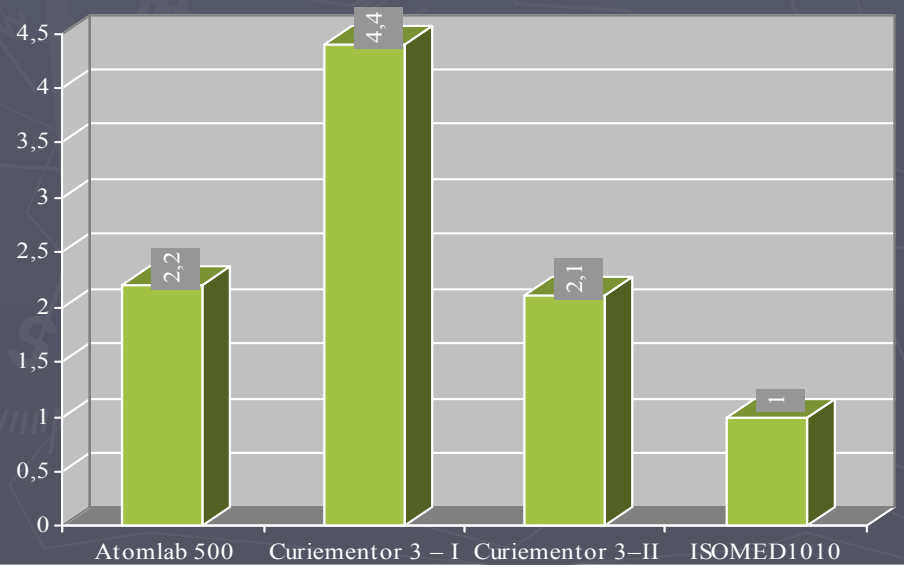
Accuracy

- Atomlab 500
  - Ba – 133 - +8.6%
  - Cs – 137 - +0.1%
- Curiementor 3 – I
  - Ba – 133 - -0.2%
  - Cs – 137 - +4.9%
- Curiementor 3 – II
  - Ba – 133 - -1.1%
  - Cs – 137 - +3.4%
- ISOMED1010
  - Cs – 137 - 0.4%



Results

- Constancy
  - Atomlab 500
    2.2%
  - Curiementor 3 – I
    4.4%
  - Curiementor 3 – II
    2.1%
  - ISOMED1010
    1%



- Linearity
  - Atomlab 500

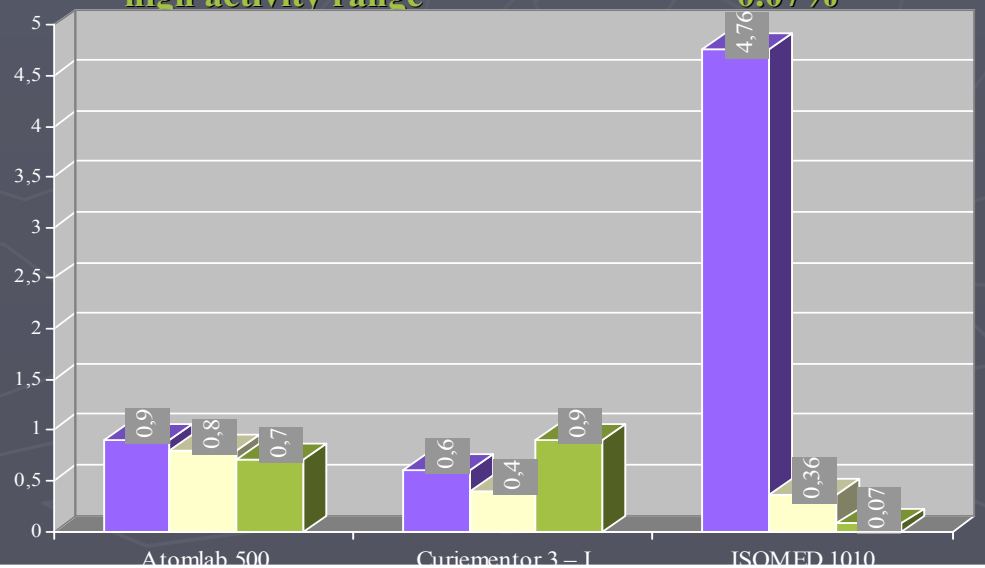
low activity range	0.90%
medium activity range	0.80%
high activity range	0.70%

  - Curiementor 3 – I

low activity range	0.60%
medium activity range	0.40%
high activity range	0.90%

  - ISOMED1010

low activity range	4.76%
medium activity range	0.36%
high activity range	0.07%



Results

Measurements of standard sources with different energies showed differences in accuracy on the same dose calibrator. Keeping in mind our measurements estimated from the tests for accuracy, precision and constancy we have obtained results within the national standards of ±5%. Only one dose calibrator showed a 8.6% deviation from measurements with Ba-133 test source, which does not exceed the national limit of 10% for the accuracy. Linearity of dose calibrators was also very good, not exceeding the limit of ±10% for all activity ranges.

Conclusion

Our results from the measurements show that the parameters that were traced for dose calibrators are within the Bulgarian and International standards. It is essential to perform daily testing for background activity and constancy. Deviations from normal values of these two parameters is the first sign of degradation of the dose calibrator. Regular QC should cover precision, accuracy and linearity of the instrument, according to IAEA standards and Ordinance № 30 (31 October 2005) of Ministry of Health. That will guarantee accuracy of the used patients radioactive doses and therefore proper practice of nuclear medicine diagnosis.