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Precision and Stability Tests Analysis of the Dose Calibrator CRC-25R

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ABSTRACT

Dose calibrator is a measuring tool that is widely used in hospitals to determine radionuclide activity in nuclear medicine services. In determining this activity, it has several factors; namely precision, accuracy and stability which is become depinning factor of the tool suitability. The aim of this research is to determine the level of precision, accuracy and stability of the Capintec dose calibrator type CRC-25R with an I-131 source and a standard Cs-137 source at the Nuclear Medicine Installation of RSUD A.W. Sjahranie Hospital Samarinda. Data processing in this research was carried out using quantitative analysis techniques, namely descriptive statistics. This analysis technique uses primary data obtained direct measurements of radionuclide activity. Data processing was carried out by measuring radionuclide activity, namely source I-131 and standard source Cs-137 of 0,1 ml using a Capintec type CRC-25R for 7 days. These results are visualized in the form of tables and graphs of precision, accuracy and stability tests from both source with predetermined limits. Base on this research, it can be concluded that if we look at the precision, accuracy, and stability test using I-131 source and Cs-137 standard; source on the Capintec type CRC-25R at A. W. Sjahranie Samarinda Hospital, it can be used to measure a constant source over a long period of long time.

I. Introduction

Nuclear medicine in Indonesia has experienced significant development, starting from the establishment of an atomic reactor center in Bandung to nuclear specializations in several hospitals [1]. Nuclear medicine is a branch of medical science that utilizes the energy of artificial atomic nuclei for diagnostic, therapeutic, and medical research purposes [2]. One of the main instruments in nuclear medicine is the dose calibrator, a tool used to measure the dose of radioisotopes in radiopharmaceuticals that will be given to patients [3].

However, errors in measuring radiation doses can endanger patients, so a measuring tool that meets standards is needed [4]. The dose calibrator must be precise and stable. In addition, radiopharmaceuticals or radiation sources are needed to test the dose calibrator [5].

Based on previous studies, the author wants to conduct a study on the dose calibrator at one of the largest hospitals in East Kalimantan, namely RSUD A.W. Sjahranie Samarinda. This research was conducted to test the Capintec type CRC-25R dose calibrator using standard Cs-137 and I-131 sources at the Nuclear Medicine Installation of RSUD A.W. Sjahranie Samarinda. The focus of the research is the precision, and stability tests on the dose calibrator.

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II. Method

A. Materials

The materials used in this research are the I-131 source and the standard Cs-127 source at the Nuclear Medicine Installation. In this research, the radionuclide doses used over 7 days are different. The second radionuclide used in this research is Cesium-137. In this research, the radionuclide doses used over 7 days are the same.

B. Procedures

Prepare the tools and materials to be used. Measure the background activity by first removing the dipper from the dose calibrator. Then, press the Test (Tc) button followed by pressing the 1 (daily) button and the enter button until the data becomes OK. Then, make a call for the Cs-137 source by pressing the Cs-137 menu. Next, press the enter button until the data is OK. Place the Cs-137 source into the dipper and measure the activity of the Cs-137 source using the appropriate nuclide button until the measurement reading is stable. Then, record the measurement results of the background activity and Cs-137 activity. Calculate the measurement results of Cs-137 activity with equations (1) and (2) hen, do the same steps for I-131.

III. Results and Discussion

Data collection in the form of activity values on each source, namely the I-131 source and the Cs-137 standard source, and then from the obtained activity values, precision tests, accuracy tests, and stability tests are carried out. at the Nuclear Medicine Installation of A.W. Sjahranie Samarinda Regional Hospital. This research uses quantitative research, which is by analyzing the results of measuring these sources. data collection is carried out for 7 days with 10 trials conducted every day.

The collected data is then processed and analyzed based on the tests conducted, where the precision and stability [6] test equations can be seen below:

$$precision = \frac{A_i - Ar}{Ar} \quad (1)$$

$$\text{Stability} = \frac{H_{2\text{-}n} - H_1}{H_1} \times 100\% \quad (2)$$

A_i = initial activity

Ar = avarage activity

H_1 = day-1 reference activity

H_{2-n} = activity on day 2-n

n = many measurements

The results of the tests are analyzed using a graph created in the Origin program. By looking at the comparison on the graph, it is easier to review whether the dose calibrator is feasible or not to use.

The precision value obtained after calculating the RSD will be displayed in the table below

Table 1. Calculation of relative standard deviation for precision dosimeter for I-131.

	Day1(%)	Day2(%)	Day 3(%)	Day4(%)	Day5(%)	Day6(%)	Day7(%)
Precision	0,0042	0,0057	0,0012	0,0012	0,0014	0,0016	0,0211

The stability value required by the IAEA in Technical Report Series No.454 (2006) in measuring activity using a dose calibrator tool is +2%. The stability value of the activity measurement results of the I-131 radionuclide source obtained a stability value of 1.3828%,

0.268%, 0.04%, 0.087%, -0.106%, -0.195%, -0.23%. Based on these results, it shows that the Capintec CRC-25R dose calibrator has high accuracy (4.43 to -2.40%) and meets the limit required by the IAEA in Technical Report Series No.454 (2006), which is ± 5%.

Meanwhile, the results of measuring the activity of the I-131 radionuclide source obtained a precision value of 0.0042%, 0.0057%, 0.0012%, 0.0012%, 0.00148%, 0.0016%, 0.0211%. Based on these results, it shows that the Capintec CRC-25R dose calibrator has good precision (0.00148% - 0.0211%) and meets the required limit, which is ± 1%.

The precision value obtained after calculating the RSD will be displayed in the table below.

Table 2. Calculation of relative standard deviation for precision and accuracy dosimeter for Cs-137.

	Day 1(%)	Day 2(%)	Day 3(%)	Day 4(%)	Day 5(%)	Day 6(%)	Day 7(%)
Precision	0,0105	0,0133	0,0103	0,0114	0,0257	0,0057	0,01332

The precision value of the RSD calculation of the Cs-137 radionuclide source activity obtained a value of 0.010556%; 0.01332%; 0.010354%; 0.011366%; 0.025717%; 0.005787%; and 0.01332%; based on these results, it shows that the Capintec CRC-25R dose calibrator has good precision, this meets the limit required by the IAEA in Technical Report Series No.454 (2006), which is ± 1%.

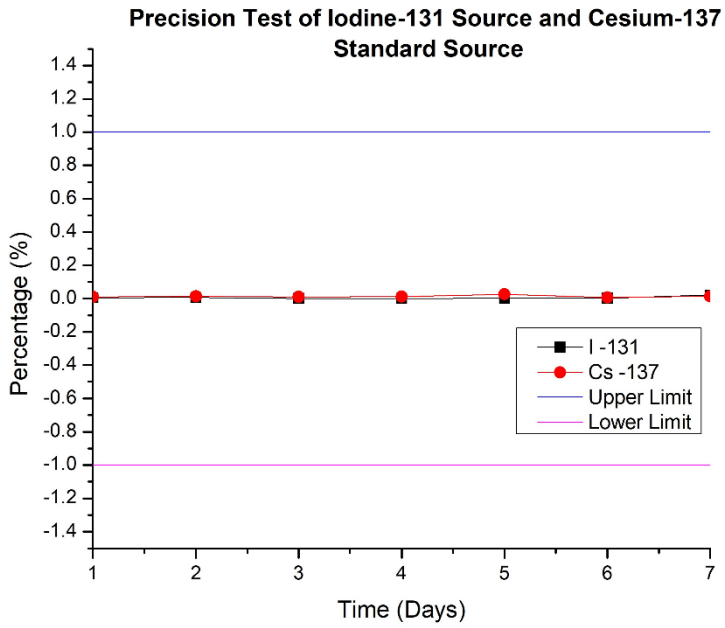

Fig. 1 Chart Precision Test of Iodine-131 Source and Cesium-137 Standard Source

Cs-137 as the standard source used in this research where Cs-137 has a half-life of about 30.5 years and can be in low or high radiation, so Cs-137 is made a standard source, while I-131 has a half-life of about 8 days, this is also what causes the red line to look more constant compared to the black line which is I-131. However, it can be observed that both lines are still within the tolerance limit of ± 1%. So this can be stated that the conformity or precision of the dose calibrator at Abdul Wahab Sjahranie Regional Hospital is good for use.

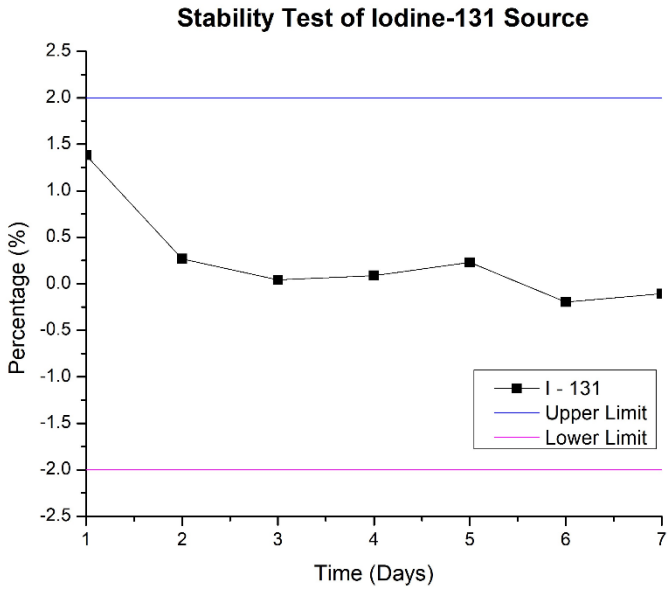

Fig. 2 Chart Stability test of dose calibrator with I-131 source

The stability test graph is shown in Figure 2 where this is a graph of the stability test of the dose calibrator with the I-131 source. Stability test is the ability of something to maintain the value it has over a certain period of time, this accuracy test is intended to see whether the dose calibrator can maintain the value obtained over a certain period of time (stable or constant), where the stability test on the dose calibrator has a tolerance limit of ± 2% as required by the IAEA in Technical Report Series No.454 (2006). It can be seen that the red line is the I-131 source, the blue line is the upper limit valued at 2%, and the purple line is the lower limit valued at -2%. The activity value of the graph on the I-131 source for the stability test is in the range of -0.23% - 1.3828%. All seven of these activity data are still within the range of parameters set by the reference (IAEA in Technical Report Series No.454 (2006)) which is ± 2%

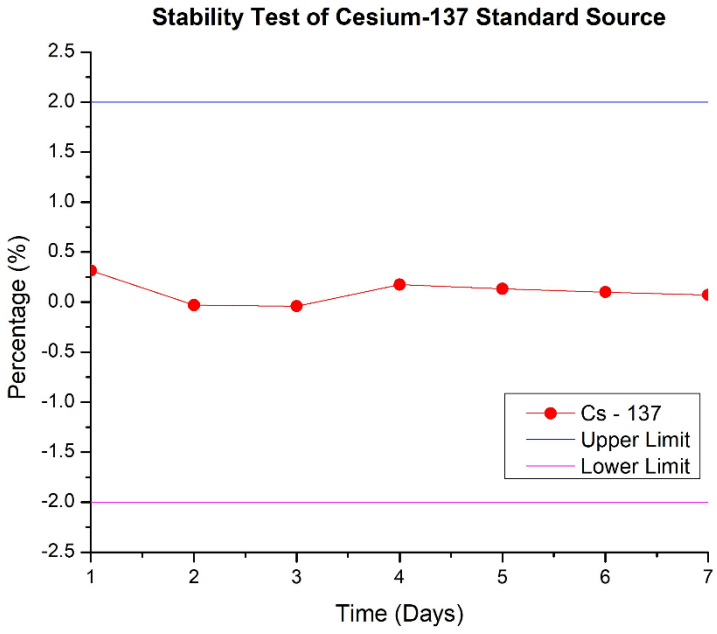

Fig. 3 Chart Stability test of dose calibrator with Cs-137 standard source

The precision test graph is shown in Figure 3 where this is a graph of the stability test of the dose calibrator with the Cs-137 standard source. It can be seen that the red line is the Cs-137 standard source, the blue line is the upper limit valued at 2%, and the purple line is the lower limit valued at -2%. The activity value of the graph on the Cs-137 standard source for the stability test is in the range of -0.042% - 0.316%. All seven of these activity data are still within the range of parameters set by the reference which is ± 2%.

Based on these results, it shows that the Capintec-CRC 25R dose calibrator for both sources have good precision, accuracy, and stability and is still within the set standard limits. Therefore, the Capintec-CRC 25R dose calibrator can be used to measure radiation sources over a long period of time.

IV. Conclusion

The radiation tool characteristic test of the dose calibrator using both sources obtained high precision of 0.0211% (I-131 source) and 0.0257% (Cs-137 standard source). Meanwhile, the high stability is 1.3838% (I-131 source) and 0.316% (Cs-137 standard source). Based on the evaluation results, the Capaintec CRC 25R dose calibrator has good characteristics and performance, so the measurement results from the dose calibrator can be trusted. Based on this research, the author suggests adding a correction factor and testing on the radiation tool dose calibrator such as a daily test, linearity test, and so on.

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