Report

2009 Australian Radionuclide Dose Calibrator Survey

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INTRODUCTION AND METHODS

The Technical Standards Committee (TSC) of the Society has undertaken national Australian dose calibrator surveys in 1991, 1994, 1996, 1998, 2000, 2003, 2005 and 2007/08. The TSC instigated a similar survey in 2009 in collaboration with the Quality Control Office of ARI. ARI is appointed as a Verifying Authority under the Regulations to the National Measurement Act, 1960 which means that the calibration sources are directly traceable to the national standard. ARI are able to issue calibration sources of 99mTc and 131I, with a least uncertainty of 2%, and 67Ga and 201Tl, with a least uncertainty of 5%, in an activity range of 100 - 6000 MBq.

As in the previous surveys the following sources were available:

^{99m}Tc	600 MBq in 5 mL
^{131}I	600 MBq in 3 mL
^{131}I	6 GBq in 3 mL
^{67}Ga	200 MBq in 2 mL
^{201}Tl	125 MBq in 1 mL

Not all institutions used all four radionuclides – this varied according to their type of work. The Society is very grateful for the cooperation of ARI in conducting this survey.

I am very pleased to report the cooperation of Lantheus Medical Imaging (in Victoria and South Australia) and Global Medical Solutions (in NSW, Queensland and West Australia) in the distribution of sources and the recording of the results in this latest survey.

These surveys serve two purposes. They provide national data on the accuracy and reproducibility of the dose calibrators used across Australia and they also provide an opportunity for the calibration of an individual calibrator to be adjusted, and brought within specifications, if the initial check shows that the readings were in error.

In 2009 measurements were recorded on 126 calibrators at 90 institutions.

Each source was measured ten times, repositioning the source between each measurement. The minimum, maximum and mean of the ten readings were recorded. After correcting for decay between the time of calibration and the time of measurement, the difference between the calibrated activity and the measured activity was expressed as a percentage of the calibrated activity. The ANSI Standard for dose calibrators (Calibration and usage of "dose calibrator" ionization chambers for the assay of radionuclides) states that the measured activity shall be within ± 10 percent of the stated activity.

The reproducibility of the measurement was calculated as (max-min)/2 as a percentage of the mean value. The ANSI Standard states that all the results of the ten consecutive measurements shall be within ± 5 percent of the average.

RESULTS AND DISCUSSION

Tables 1 to 5 and Figures 1 to 5 present the results for ^{99m}Tc, ^{131}I (6 GBq), ^{131}I (600 MBq), ^{67}Ga and ^{201}Tl respectively.

98% of the dose calibrators were found to satisfy the ANSI Standard with respect to accuracy for ^{99m}Tc. However errors of greater than10% were found in 2 of the 123 calibrators tested – the largest error being 19% high.

The results were much better for the 74 calibrators tested with 6 GBq of ^{131}I where all calibrators were within ±10% of the calibrated activity and 84% were within ±5%. Similar results were found with 67Ga. However the results were poorer for 600 MBq ^{131}I and ^{201}Tl with only 98% being within ±10% of the calibrated activity. Table 6 presents the average difference found for each set of calibrated sources

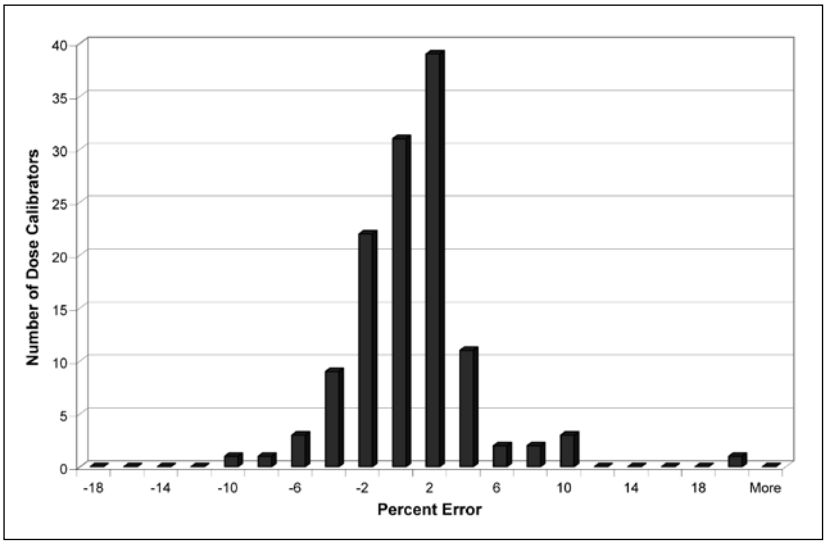

Figure 1: Distribution of errors using calibrated sources of 600 MBq ^{99m}Tc in 2009.

Table 1: Technetium-99m results (nominally 600 MBq)

	Number of Calibrators	Percentage of Calibrators
Total number tested	123	
Within ± 5% Error	105	85%
Within ± 10% Error	121	98%
Within ± 5% Reproducibility	123	100%

Table 2: I-131 results (nominally 6000 MBq)

	Number of Calibrators	Percentage of Calibrators
Total number tested	74	
Within ± 5% Error	62	84%
Within ± 10% Error	74	100%
Within ± 5% Reproducibility	74	100%

Table 3: I-131 results (nominally 600 MBq)

	Number of Calibrators	Percentage of Calibrators
Total number tested	123	
Within ± 5% Error	105	85%
Within ± 10% Error	121	98%
Within ± 5% Reproducibility	123	100%

Table 4: Ga-67 results (nominally 200 MBq)

	Number of Calibrators	Percentage of Calibrators
Total number tested	123	
Within ± 5% Error	114	93%
Within ± 10% Error	123	100%
Within ± 5% Reproducibility	123	100%

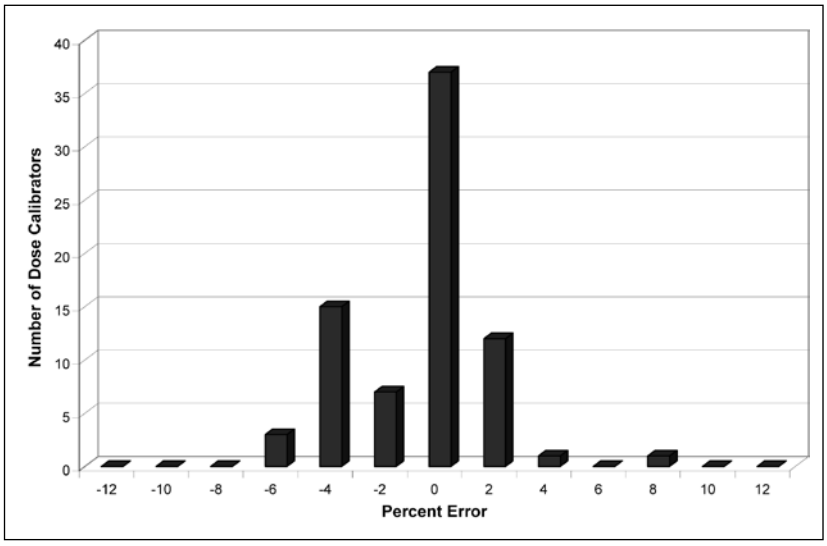

Figure 2: Distribution of errors using calibrated sources of 6 GBq ^{131}I in 2009.

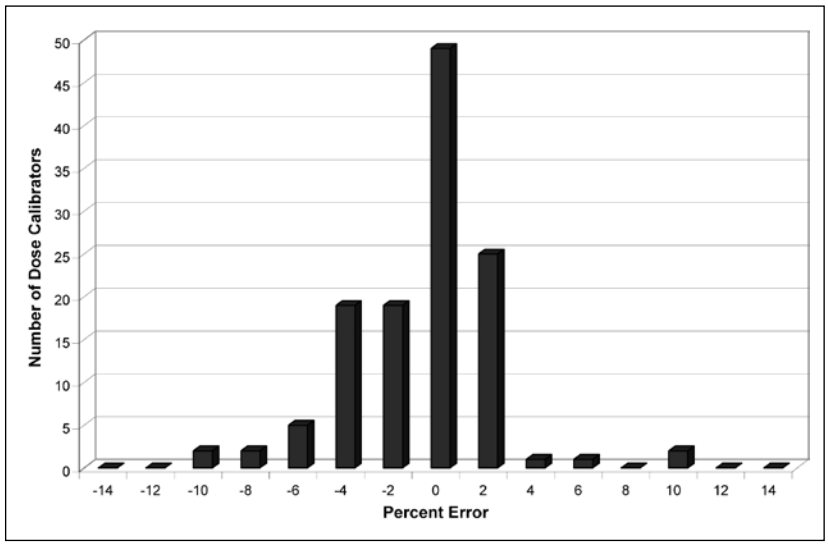

Figure 3: Distribution of errors using calibrated sources of 600 MBq ^{131}I in 2009.

between the calibrated activity, as specified by ARI, and the activity measured on the dose calibrator. A negative difference indicates that the dose calibrator was reading lower than the stated activity.

All ^{6}7Ga sources had a minimum 72 hour "wait" period from the end of bombardment until ^{67}Ga was processed to allow for the decay of any ^{66}Ga impurities, so that the problems noted in the 2007/08 report were avoided.

Reproducibility was particularly good, with all of the calibrators having a reproducibility of better than 5 %.

Dose Calibrator Quality Control

Table 7 indicates that 96% of sites are performing constancy checks with a long-lived check sources (usually ^{137}Cs). This is a significant improvement on the 84% in 2007. The compliance rate for this essential quality control parameter has risen dramatically since 2000 when only 48% of sites performed the check on a daily or weekly basis.

Table 8 presents the frequency of background measurements performed on these dose calibrators. These measurements are essential to detect contamination of the well of the ionisation chamber or the unsuspected presence of a hot source close to the chamber. The percentage of institutions that performed daily background measurements increased to 94% from 82% in 2007. Background measurements must be performed at least daily to ensure accurate patient doses.

In May 2008, ARPANSA published Code of Practice for Radiation Protection in the Medical Applications of Ionizing Radiation (RPS 14). This Code was adopted into Schedule 11 of the National Directory for Radiation Protection (RPS 6) in December 2009 and therefore must be implemented by all State and Territory radiation regulators. Section 3.1.22 of this Code states: The Responsible Person must ensure that a Quality Assurance program for all dosimetry and associated measuring instruments is implemented and regularly reviewed to ensure their continued accuracy". The accompanying Safety Guide for Radiation Protection in Nuclear Medicine (RPS 14.2) provides recommendations for such a QA program for dose calibrators (section 7.5) with detailed test procedures provided in Appendix F. The Safety Guide recommends daily constancy checks,

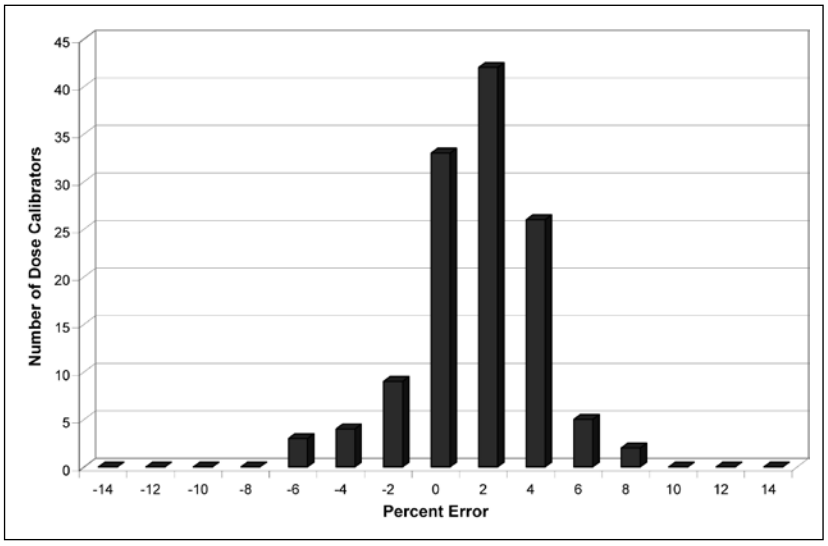

Figure 4: Distribution of errors using calibrated sources of 200 MBq ^{67}Ga in 2009.

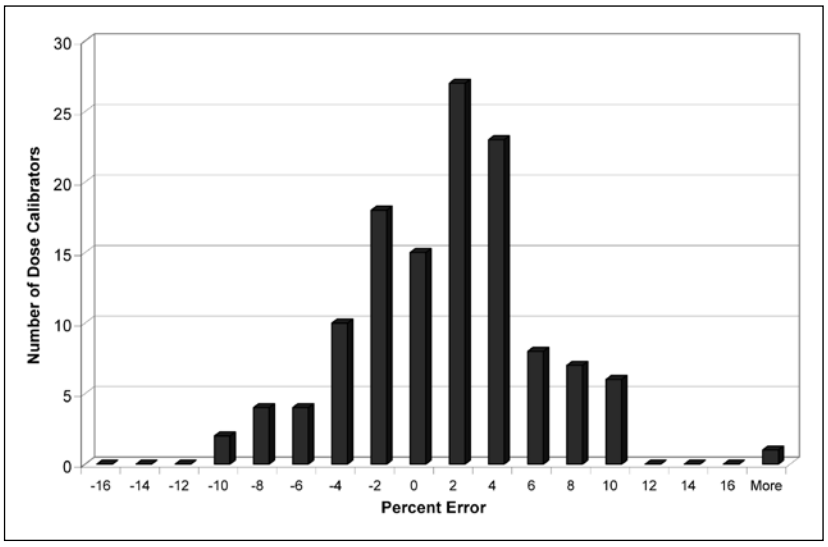

Figure 5: Distribution of errors using calibrated sources of 125 MBq ^{201}Tl in 2009.

Table 5: Tl-201 results (nominally 125 MBq)

	Number of Calibrators	Percentage of Calibrators
Total number tested	123	
Within ± 5% Error	91	74%
Within ± 10% Error	120	98%
Within ± 5% Reproducibility	123	100%

Table 6: Average difference between calibrated and measured activities

Year of Survey	^{99m}Tc 600 MBq	^{131}I 6 GBq	^{131}I 600 MBq	^{67}Ga 200 MBq	^{201}Tl 125 MBq
2000	-2.8%	-2.6%	-3.5%	-4.5%	-0.5%
2003	-2.0%	-2.2%	-2.6%	-3.8%	1.2%
2005/06	-1.6%	-1.6%	-2.2%	-4.0%	1.1%
2007/08	-1.5%	-1.0%	-2.8%	-0.2%	-1.9%
2009	-0.4%	-1.5%	-1.8%	0.5%	0.6%

Table 7: Use of check sources for dose calibrator stability

Year of Survey	Daily Checks	Weekly checks	Monthly checks	Less frequently	Never (or not specified)
2000	37%	11%	13%	6%	33%
2003	47%	21%	4%	2%	26%
2005/06	66%	13%	3%	-	18%
2007/08	77%	5%	-	2%	16%
2009	90%	5%	-	1%	4%

Table 8: Measurement of Background (Contamination check)

Year of Survey	Daily Checks	Weekly checks	Never (or not specified)
2000	83%	4%	13%
2003	86%	2%	11%
2005/06	80%	4%	16%
2007/08	82%	3%	15%
2009	94%	5%	1%

annual linearity and accuracy checks and assessment of geometry independence at time of purchase and whenever there is any change in sample geometry.

REFERENCES

American National Standard: Calibration and usage of "dose calibrator" ionization chambers for the assay of radionuclides. ANSI N42.13-2004

ARPANSA, National Directory for Radiation Protection (including amendments 1-4), Radiation Protection Series No. 6, 2010 http://www.arpansa.gov.au/pubs/rps/rps6.pdf

ARPANSA, Code of Practice for Radiation Protection in the Medical Applications of Ionizing Radiation, Radiation Protection Series No. 14, 2008. http://www.arpansa.gov.au/Publications/codes/rps14.cfm

ARPANSA, Safety Guide for Radiation Protection in the Nuclear Medicine, Radiation Protection Series No. 14.2, 2008 http://www.arpansa.gov.au/Publications/codes/rps14_2.cfm