IMPLEMENTATION OF THE NEW IAEA CODE OF PRACTICE IN BRAZIL

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Abstract

In order to implement the new IAEA code of practice in Brazil the national calibration laboratories, the National Laboratory for Metrology of Ionizing Radiation and the Laboratory of Instrument Calibration, are calibrating clinical dosimeters in terms of air kerma and absorbed dose to water in a ^{60}Co gamma ray beam. The $N_{D,w}/N_K$ ratios thus obtained are then compared with the literature values; a satisfactory agreement has been found. Additionally, several training courses have been organized for the dissemination of the new formalism among medical physicists. The planned target date for the full implementation of calibration in terms of absorbed dose to water is December 2002, following the same decision of the Nordic countries.

1. INTRODUCTION

The IAEA recently published the final version of a new code of practice based on standards of absorbed dose to water [1]. This will be implemented in Brazil gradually, making the transition from the existing code of practice used in the country, IAEA Technical Reports Series No. 277 (TRS 277) [2], which is based on an air kerma calibration.

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In both calibration laboratories in Brazil, the National Laboratory for Metrology of Ionizing Radiation and the Laboratory of Instrument Calibration (LNMRI and LCI), in which there is no access to a linac, the approach used is to provide radiotherapy centres with a calibration factor in terms of absorbed dose to water for the ionization chamber at the reference quality ^{60}Co, and with theoretically derived quality correction factors for the appropriate chamber type, which must be applied to other beam qualities.

This paper discusses the investigations carried out to give confidence in the use of the new code of practice and the plans for its implementation.

2. PRELIMINARY INTERCOMPARISONS

In order to implement the new formalism, which is based on absorbed dose to water, a series of intercomparisons has been performed in Brazil since 1997. The first step of its implementation was to analyse the long term stability of four secondary standard chambers used as transfer instruments (NE 2561 chambers) with traceability to the Bureau international des poids et mesures (BIPM) in terms of the quantity of interest. The second step consisted of the calibration of the transfer and reference standards from the LNMRI and LCI in order to evaluate the ratio $N_{D,w}/N_K$ for such chambers. In a preliminary analysis the ratios thus obtained were compared with the values acquired by other laboratories, such as the National Physical Laboratory (NPL) in the United Kingdom and the IAEA Dosimetry Laboratory.

The procedure thus adopted at the LNMRI and LCI was to analyse the ratio between the ^{60}Co calibration factor in terms of absorbed dose to water and the calibration factor in terms of air kerma for the four transfer standards before offering the calibration service in terms of absorbed dose to water to users. Moreover, a series of intercomparisons between these standards was performed in order to establish general chamber behaviour.

The long term stability of the secondary standards was evaluated from their recalibration results and also from intercomparisons performed since 1997 in terms of air kerma and absorbed dose to water. The recalibration of the national standard (the NE 2561 chamber No. 168) at the BIPM shows a variation of ±0.08% on the ratio $N_{D,w}/N_K$ over six years. However, an overall variation of ±0.22% was found for the three remaining secondary standards after their recalibration. The short term stability was measured by the results obtained during the intercomparisons, showing a maximum deviation of 0.18% compared with the response of the national standard in a ^{60}Co beam. The typical procedure established for the intercomparisons consists of the normalization of all measurements to the response of the LNMRI national standard (the NE 2561 chamber No. 168).

The results obtained for these four NE 2561 chambers give an $N_{D,w}/N_K$ ratio of 1.084 ± 0.013 and show a good agreement of –0.7% and –0.5% compared with the ratios obtained by the NPL [3] and IAEA [4], respectively. Since these results demonstrated the validity of such an approach, some clinical dosimeters have since then been calibrated. The ratio $N_{D,w}/N_K$ obtained for the NE 2571 chambers (1.096 ± 0.013) shows an excellent agreement of ±0.3% with the literature values [4–6]. The ratio $N_{D,w}/N_K$ for the PTW N30001 Farmer chambers (1.091 ± 0.013) gives an agreement of +0.3% compared with IAEA values [4]. However, for the NE 2505/3A and NE 2581 chambers ratios of 1.096 ± 0.013 and 1.096 ± 0.013, respectively, were found, which present a larger variation (+1.2%). The $N_{D,w}/N_K$ ratio found for the Exradin A12 chambers was 1.104 ± 0.013. It should be pointed out that the LNMRI participated in a recent intercomparison promoted by the Inter-American Metrology System, which showed an agreement of –0.2% compared with BIPM values for this type of chamber [7]. No reported values have been found in the literature for the Wellhöfer IC 70 (1.095 ± 0.013) or PTW N30013 (1.092 ± 0.013) chambers. The values of N_K and $N_{D,w}$ determined by both the LNMRI and LCI, with the corresponding $N_{D,w}/N_K$ ratios, are given in Table I. The relative uncertainty of the calibration factor N_K is 0.8% (coverage factor $k = 2$) and for $N_{D,w}$ is 0.9% (coverage factor $k = 2$), giving a combined uncertainty of 1.2% (coverage factor $k = 2$) for the ratio $N_{D,w}/N_K$.

3. TRAINING COURSES

The above intercomparisons and the evaluation of the long term stability of the secondary standards took place at the same time as training courses on the new formalism of absorbed dose to water, and in this way the updated knowledge of the laboratory staff was transferred to hospital physicists. These courses have demonstrated their effectiveness for radiotherapy centres in Brazil, since practical lectures and experimental procedures on absorbed dose determination in water are given.

The training courses have been organized at the LNMRI since 1996, and had a total of 165 participants by 2002. In the first year the course was held at a hospital in central Brazil; theoretical aspects of the IAEA protocol (TRS 277) were covered, followed by an intercomparison in terms of absorbed dose to water involving seven hospitals. In 1997, 53 medical physicists attended the course and an intercomparison in terms of absorbed dose to water was performed using the TRS 277 formalism. Participants from 17 hospitals brought their own dosimetry systems, which were compared with the LNMRI secondary standard. The results showed an overall agreement of ±1%, which is the

TABLE I. VALUES OF N_K AND $N_{D,w}$ DETERMINED BY THE LNMRI AND LCI, WITH THE RESPECTIVE $N_{D,w}/N_K$ RATIOS

Hospital	Chamber model	N_K (mGy/division)	$N_{D,w}$ (mGy/division)	$N_{D,w}/N_K$
1	A12	43.12	47.72	1.107
2	A12	43.01	47.34	1.101
3	N23333	9.571	10.43	1.090
4	N30001	49.38	54.17	1.097
5	N30001	48.91	53.01	1.084
6	N30001	10.24	11.19	1.093
7	N30002	48.61	52.97	1.090
8	N30013	47.97	52.74	1.099
9	N30013	48.77	53.19	1.091
10	N30013	49.77	54.06	1.086
11	NE 2505/3A	40.83	44.76	1.096
12	NE 2505/3A	40.73	44.61	1.099
13	NE 2561	93.08	101.7	1.092
14	NE 2561	96.31	103.9	1.078
15	NE 2561	93.14	100.6	1.080
16	NE 2561	93.30	100.6	1.079
17	NE 2561	94.25	103.0	1.093
18	NE 2571	962.0	1046	1.088
19	NE 2571	959.6	1055	1.100
20	NE 2571	42.81	47.01	1.098
21	NE 2571	1048	1149	1.097
22	NE 2571	8.993	9.869	1.097
23	NE 2571	412.0	449.5	1.091
24	NE 2571	714.5	783.6	1.096
25	NE 2571	1017	1113	1.095
26	NE 2571	959.6	1055	1.099
27	NE 2571	405.5	445.3	1.098
28	NE 2571	8.699	9.556	1.098
29	NE 2571	413.9	454.2	1.097
30	NE 2581	1231	1336	1.085
31	NE 2581	965.2	1063	1.102
32	NE 2581	1229	1349	1.097
33	NE 2581	8.773	9.635	1.098
34	NE 2581	934.8	1022	1.094
35	NE 2581	1229	1349	1.097
36	IC 70	44.57	48.47	1.088
37	IC 70	44.50	49.06	1.103

same agreement obtained by the LNMRI in the intercomparison of calibration factors in terms of N_K and $N_{D,w}$ promoted by the IAEA/World Health Organization network of secondary standards dosimetry laboratories (SSDLs) in 1997 [4]. It should be pointed out that larger variations were observed in the first analyses, which were due to mistakes in selecting the appropriate correction factors for the chambers. In the following year an intercomparison was completed with only two hospitals, since the ionization chambers showed some leakage due to their transport to the SSDL in Rio de Janeiro. To avoid such problems it was decided to focus in the subsequent training courses on the experimental practice of the procedure for the determination of absorbed dose to water in a ^{60}Co beam.

In the next courses a practical comparison between N_K and $N_{D,w}$ formalisms was promoted, which demonstrated their advantages and disadvantages. Some changes have recently been introduced, and specific courses on the main chapters of TRS 398 have been organized. The first, held in August 2002, dealt with the code of practice for high energy electron beams and included practical lectures at the hospital that covered the beam quality specification, the calibration of plane-parallel chambers using the cross-calibration procedure and the determination of output factors. The numbers of medical physicists who attended the training courses are shown in Fig. 1.

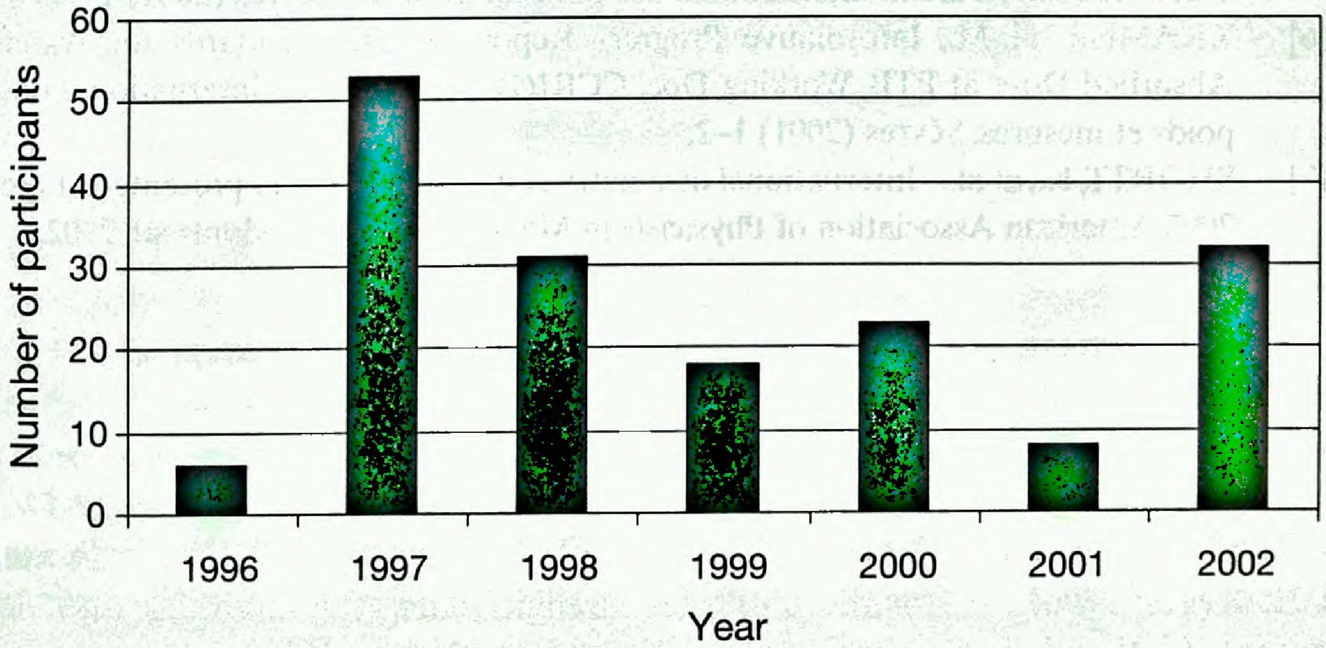

FIG. 1. Number of participants in the training courses organized in order to promote the IAEA codes of practice.

4. CONCLUSION

The method adopted in this investigation and the comparison of the $N_{D,w}/N_K$ ratios with the literature values gives us confidence in the results thus obtained and allows us to provide calibration factors promptly in terms of absorbed dose to water for hospitals in Brazil. The planned target date for the full implementation of calibration in terms of absorbed dose to water is December 2002, following the same decision of the Nordic countries [3].

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