

ADOPTION OF THE IAEA CODE OF PRACTICE FOR ABSORBED DOSE DETERMINATION BY THE CALIBRATION LABORATORY OF SAO PAULO

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Abstract.

Using the worksheets proposed by the IAEA Code of Practice the absorbed dose to air factors (N_D) of the clinical dosimeters calibrated by the Calibration Laboratory of São Paulo from 1987 to 1991 were determined. The N_D factors were obtained from the N_x (calibration factor in terms of exposure) and N_k (calibration factor in terms of air kerma) values.

1. Introduction.

The measurements of ionizing radiation need calibrated instruments, that under specific conditions will allow the establishment of a correspondence between the instrument values and the measured quantities: exposure (X), kerma (K) or dose (D).

The success or the failure of a treatment with radiation depends on the absorbed dose delivered to the tumour. According to the ICRU⁽¹⁾, an accuracy of 5% in the transferred absorbed dose in some kinds of treatments is needed. There are many international Codes or Protocols with recommendations about the absorbed dose determination from measurements of exposure or other appropriate quantities^(2,3).

The International Atomic Energy Agency (IAEA) developed a Code of Practice⁽⁴⁾ and recommended it for use at all radiation therapy centres and calibration laboratories throughout the world, just following its flow charts and using the worksheets.

At the Calibration Laboratory of IPEN clinical dosimeters are being calibrated since 1980, representing the link between the users and the primary dosimetric standards, by its secondary dosimetric standards and by providing technical assistance.

According to the Brazilian regulations, every clinical dosimeter has to be sent for recalibration each two years⁽⁵⁾. The calibration factors are obtained in terms of exposure (N_x) and in terms of air kerma (N_k). The objective of this work was to study the IAEA Code of Practice application to several dosimeters in order to recommend it for the users of the calibration laboratory.

2. Materials and Methods.

The secondary dosimetric standard for gamma and X radiation of the Calibration Laboratory of São Paulo consists of an electrometer, model 2560, an ionization chamber, model 2651, a radioactive check device, model 2562, all from Nuclear Enterprises Ltd. (NE), England, and a calibration certificate obtained from the National Physical Labora-

tory. This system participates annually of the national intercomparisons organized by the Brazilian Secondary Standard Dosimetry Laboratory (SSDL) at Rio de Janeiro.

The gamma radiation of a ^{60}Co source (15 TBq) is utilized for the calibrations and the substitution technique is applied. The calibration factors are obtained in terms of exposure, N_x , in C/kg and in terms of air kerma, N_k , in Gy/scale unit.

Four clinical dosimeters calibrated by the laboratory in the period from 1987 to 1991⁽⁶⁾ were used to determine the absorbed dose to air factors. They were selected because of the regularity of their calibration. Their characteristics can be seen in Table 1.

In order to make the dosimetry procedure as simple as possible, the IAEA Code of Practice provides all factors necessary for the use of the worksheets. It is necessary to know the thimble chamber model and type or its physical characteristics, as the thickness of the inner cavity, the wall and the buildup materials. The absorbed dose to air factor is related to the air kerma calibration factor by :

$$N_D = N_k (1-g) k_{att} k_m$$

where g is the factor of the released energy that is dissipated as Bremsstrahlung; k_{att} is the factor that considers the radiation attenuated in the wall of the ionization chamber; and k_m is the factor that takes in account the non-air equivalence of the ionization chamber wall and buildup cap materials.

3. Results.

The N_x and N_k values of the clinical dosimeters calibrated by the laboratory from 1987 to 1991⁽⁶⁾, and the IAEA's formalism were utilized in order to determine the absorbed dose to air factors (N_D). The obtained factors can be seen in Table 2 .

The difference in the relations between N_k and N_D depends on the ionization chamber type and model. For the Nuclear Enterprises Ltd. ionization chambers of the Baldwin Farmer type, model 2505/3, the most used model in Brazil (about 40%), this relation was 2.2%, and for the model 2571 it was 1.8%. During the cited time period, the major variation between the calibration factors of a clinical dosimeter was 9%, while it was less than 5% in

the other cases. The combined uncertainties were less than 2.5% in all cases.

In a simple way, using the IAEA proposed worksheets⁽⁴⁾, it was possible to determine all N_D factors without having to perform complicated measurements or to apply several conversion and correction factors.

4. Conclusion.

This work presents the performance of the clinical dosimeters calibrated by our Calibration Laboratory in the last five years, in relation to the absorbed dose to air factors (N_D). The feasibility of the IAEA Code of Practice application by the radiation therapy centres and the calibration laboratories could also be demonstrated. This kind of laboratories shall improve in a near future the calibration methods in order to provide the users with absorbed dose to water calibration factors too.

5. Acknowledgment.

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Table 1. Clinical dosimeters utilized in the present study. They are all of the Baldwin Farmer type, from Nuclear Enterprises Ltd.

Dosimeter	Electrometer Model	Thimble Chamber Model
A	2570/1	2571
B	2570/1	2571
C	2502/3	2505/3
D	2502/3	2505/3

Table 2: N_D factors obtained from the N_K values using the IAEA's formalism. All values are in mGy/scale unit

Dos. : Clinical Dosimeter
Year : Year of Calibration

Dos.	A		B		C		D	
	N_K	N_D	N_K	N_D	N_K	N_D	N_K	N_D
1987	8.88	8.72	-	-	8.69	8.50	-	-
1988	-	-	8.92	8.76	8.65	8.46	9.09	8.89
1989	8.86	8.70	8.86	8.70	-	-	9.59	9.38
1990	-	-	-	-	8.68	8.49	9.07	8.87
1991	8.81	8.66	8.35	8.20	8.65	8.46	9.02	8.82