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ABSORBED DOSE DETERMINATION IN HIGH ENERGY PHOTON BEAMS USING NEW IAEA TRS - 398 CODE OF PRACTICE

S. SURIYAPEE
King Chulalongkorn Memorial Hospital
Bangkok, Thailand

S. SRIMANOROATH
Division of Radiation and Medical Devices
Department of Medical Science, Ministry of Public Health
Bangkok, Thailand

C. JUMPANGERN
King Chulalongkorn Memorial Hospital
Bangkok, Thailand

The absorbed dose calibration of 6 and 10 MV X-ray beams from Varian Clinac 1800 at King Chulalongkorn Memorial Hospital Bangkok, Thailand were performed using cylindrical chamber 0.6 cc NE2571 Serial No.1633 with graphite wall and Delrin build up cap and Ionex Dosemaster NE 2590 Serial No.223. The absorbed dose determination followed the IAEA code of practice TRS-277 [1]. The new IAEA code of practice TRS-398 [2] have been studied to compare the result with the IAEA TRS-277. The calibration factor in terms of absorbed dose to water $N_{D,W}$ was derived from N_K - $N_{D,air}$ basis. The N_K factor was provided by SSDL , Ministry of Public Health. The value of the N_K factor is 4.145 x 10^7Gy/C. Then the absorbed dose to air chamber factor $N_{D,air}$ can be calculated using the expression

$$N_{D,air} = N_K (1-g) k_{att} k_m \quad \text{---------- [1]}$$

The N_{D,W,Q_o} calibration factor in term of absorbed dose to water at a reference beam quality Q_o was calculated from

$$N_{D,W,Q_o} = N_{D,air} (S_{w,air})_{Q_o} p_{Q_o} \quad \text{---------- [2]}$$

$N_{D,air}$ was updated according to IAEA TRS-381 [3]

$$N_{D,air} = N_K (1-g) k_{att} k_m k_{cel} \quad \text{---------- [3]}$$

The meaning of the factors g, k_{att} k_m k_{cel} was given in IAEA TRS-277 and IAEA TRS-381 [1,3]

$(S_{w,air})_{Q_o}$ = Water to air stopping power ratio of Co-60 gamma radiation
p_{Q_o} = The over all perturbation factor of Co-60 gamma radiation

The factor $(S_{w,air})_{Q_o} p_{Q_o}$ for various types of chambers could be found in the table 37 of IAEA TRS-398 [2].The calculated value of $N_{D,air}$ = 4.071 x 10^7Gy/C and N_{D,W,Q_o} = 4.513 x 10^7Gy/C.

The measurement were made in a water phantom, the standard field size of 10x10 cm was used. The measurement depth were the same for both protocols, 5 cm for 6 MV X-rays beams and 10 cm for 10 MV X-ray beams. The IAEA TRS-277 protocol [1] recommended the used of effective point of measurement which is displaced from the center of the chamber equals to 0.6 of the radius of the chamber (0.6x3.15=1.89 mm), so the %DD at 4.81 cm (5-0.189 mm) for 6 MV X-ray beams and % DD at 9.81 cm (10-0.189 mm) for 10 MV X-ray beams were used to correct for the effective depth when the maximum absorbed dose was calculated.

The absorbed dose was calculated by following equations :

TRS-277 protocol : $D_{w,Q}$ (P_{eff}) = $M_Q N_{D,air} (S_{w,air})_Q p_Q$ ---------- [4]
TRS-398 protocol : $D_{w,Q}$ (center) = $M_Q N_{D,w,Q_o} k_{Q,Q_o}$ ---------- [5]

M_Q is the reading of the dosimeter corrected for recombination and environment condition.
k_{Q,Q_o} values were determined as a function of $TPR_{20,10}$ by the table 14 IAEA TRS-398 [2]. The various factors for the absorbed dose determination for IAEA TRS-277 and IAEA TRS-398 are listed in table 1 .

The absorbed dose to water of 10x10 cm beams at depth of maximum dose are compared between IAEA TRS-277 and IAEA TRS-398 in table 2.

Table 1. The various factors in IAEA TRS-277 and IAEA TRS-398 for determining the absorbed dose to water of 10x10 cm , 6 and 10 MV X-ray beams

Type	IAEA TRS-277					IAEA-TRS-398			
MV	Depth (cm)	%DD	$TPR_{20,10}$	$(S_{w,air})_Q$	p_Q	Depth (cm)	%DD	$(S_{w,air})_{Q_o} p_{Q_o}$	k_{Q,Q_o}
6	4.81	87.4	0.677	1.120	0.994	5.0	86.6	1.102	0.994
10	9.81	74.5	0.738	1.105	0.996	10.0	73.7	1.102	0.986

Table 2. Comparison of the maximum absorbed dose D_{max} (cGy/mu) of 10x10 cm, 6 and 10 MV X-Ray beams using IAEA TRS-277 and IAEA TRS-398

Type of X-ray beams	D_{max} TRS-277	D_{max} TRS-398	D_{max}TRS-398/ D_{max}TRS-277
6 MV	1.002 cGy/mu	1.000 cGy/mu	0.998
10 MV	1.000 cGy/mu	1.004 cGy/mu	1.004

Comparing between two protocols, the absorbed dose to water determined according to IAEA TRS-398 are comparable to the absorbed dose to water determined according to IAEA TRS-277 with the maximum discrepancy of 0.4 %. The factor that may contribute to the small difference in absorbed dose between two protocols is likely to be k_{Q,Q_o}. With careful derived of k_{Q,Q_o}, the perturbation factors may be the main factor. The uncertainty associated with the measurement would be less due to the same measurement point of two protocols.

Although the calculated $N_{D,W}$,$_{Q_o}$ calibration is not recommended, it is the option used during an interim to practice before the implementation of the new code of practice [2].

REFERENCES

[1] IAEA INTERNATION ATOMIC ENERGY AGENCY , "Absorbed Dose Determination in Photon and Electron Beams: An International Code of Practice", Technical Report Series no. 277 (2nd ed in 1997), IAEA, Vienna (1987).

[2] IAEA INTERNATION ATOMIC ENERGY AGENCY , "Absorbed Dose Determination in External Beam Radiotherapy: An International Code of Practice ", Technical Report Series no. 398, IAEA, Vienna (2001).

[3] IAEA INTERNATION ATOMIC ENERGY AGENCY , "The Use of Plane Parallel Ionization Chambers in High- Energy Electron and Photon Beams: An International Code of Practice", Technical Report Series no. 381,IAEA, Vienna (1997).