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Determination of the Absorbed dose to Water using N_D^W in High Energy Photon Beams

Dong O.Shin[1,3], Young H.Ji[3,5], Seong H.Kim[4], Won S.Seo[2], Dong H.Lee[5], Sung Y. Park[3], Soo I. Kwon[3], Sung S.Chu[6], Jin O. Kang [1], Seong E.Hong[1]

Dept. of Radiat. Oncol.[1], Neurosurgery[2], College of Medicine, Kyung Hee Univ., Dept. o f Physics, College of Science, Kyonggi Univ.[3], Dept. of Radiat. Oncol., College of Med icine, Han Yang Univ.[4], Dept. of Radiat. Oncol., Korea Cancer Center Hospital[5], Dept. o f Radiat. Oncol., College of Medicine, Yonsei Univ.[6]

INTRODUCTION

Most of the present protocols of absorbed dose have been based on N_x or N_k of ion chamber which are calibrated in the reference beam of ^{60}Co at standard dosimetry labora tory. This approach is very complex and consequently leads to large uncertainty. For this reason, some primary standard dosimetry laboratories around the world are working towar d developing the study on an absorbed dose to water calibration factor, N_D^W, interesting q uantity in the clinical reference dosimetry. This is based on primary standard of absorbed dose to water in photon beam from beam quality of ^{60}Co and linear accelerator.

N_k and N_D^W in a ^{60}Co-beam of two different types of cylindrical chambers were given from KFDA, Korea second standard dosimetry laboratory, and N_D^W derived from N_k we re compared with N_D^W taken from KFDA. TPR_{10}^{20} and %dd(10) were evaluated to determi ne the beam quality conversion factor, k_Q of ion chamber used.

METHOD

Beams used for the measurement of absorbed dose to water at the reference depth wer e Co-60(Picker C/M 60), 4 MV(Siemens), 6 MV, 10 MV, and 21 MV X-ray(Microtron MM22). Relative depth doses were measured using water Acquisition System with P-type diode and RK ionization chamber. Absorbed doses of IAEA Code of Practice (1987) bas ed on air-kerma, new IAEA Code of Practice (1998) and AAPM TG-51(1998) based on absorbed dose to water calibration factor were compared under the reference conditions. T he measurements of absorbed dose under the reference conditions were performed with tw o Farmer type ion chamber, NE 2571, PTW N23333 which were calibrated by KFDA. T he N_k values of air-kerma calibration factor of NE 2571 and PTW N23333 were 4.097E-2(Gy/su) and 4.710E-2(Gy/su), respectively. Also absorbed dose to water calibration factor s, N_D^W were 4.494E-2(Gy/su) and 5.125E-2(Gy/su), respectively. The beam qualities of IAE A Protocol and AAPM TG-51 were determined by using TPR_{10}^{20} and %dd(10), respectiv ely. For photon beams of 10 MV and above, 1mm lead foil was placed below the accele rator at about 50cm from the phantom surface to obtain the %dd(10)x, photon component of the photon beam percentage depth dose at 10 cm depth for a field size of 10×10 cm^2. k_Qs were calculated first using stopping power ratios and perturbation factor for ea ch TPR_{10}^{20} and %dd(10). Then absorbed doses under the reference conditions were calculat ed and compared for the different protocols by normalizing to the IAEA Code of Practice (TRS-277).

With the absorbed dose to water-based protocols We first determined k_Qs, the beam quali ty conversion factor accounting for changes in the factor from the reference beam quality to the user's beam quality by using stopping-power ratios and perturbation factors.

RESULTS

With two calibration value N_k based on air-kerma and N_D^W based on absorbed dose to water calibration factor respectively for two types ion chamber NE 2571and PTW N233 33, absorbed doses in high energy photon beams were calculated for three types of proto cols based on different formalism. The differences between N_D^W derived from air-kerma a nd N_D^W taken directly from SSDL were 1.34% for NE 2571 and were 0.87% for PTW N23333. The differences of absorbed dose between NE 2571 and PTW N23333 were less than 0.5%. Under the reference conditions the differences of absorbed dose for two form alism based on absorbed dose to water calibration factor were less than 1%. Absorbed do se calculated from different beam quality index TPR_{10}^{20} (IAEA Code of Practice) and %dd (10)(AAPM,TG-51)were inconsistent by less than 1%

DISCUSSION

Discrepancy of N_D^W calculated from the air-kerma based on IAEA TRS-277(1987) form alism in a Co-60 beam from N_D^W directly measured in the water phantom in the same b eam shows 1.34% and 0.87% for ion chambers, NE 2571 and PTW N23333, respectively. But this may be due to systematic errors and is a problem to be considered and solved.

Because the uncertainties of physical quantities such as stopping-power ratio and mass-e nergy absorption coefficient used in the clinical field to convert the air-kerma calibration factor of ion chambers to the absorbed to air calibration factor are 2.4% (IAEA TRS-27 7), this discrepancy may be considered to be within the uncertainties. A number of PSDL s around the world are giving lots of study on how to measure N_D^W, using the direct me asurements such as calorimetry and chemical dosimetry as well as the ionization chamber s and by their intercomparison. The Absorbed dose to water at the reference depth in the user' beam is determined by the N_D^W-based formalism considering only a single the k_Q fa ctor and it attributes greatly to simplify clinical external beam dosimetry protocols. The k_Qs tabled in the new protocols are mostly calculated from the already existing data. So me efforts are undergoing to obtain k_Q from the direct measurement but those data are n ot enough to take a good comparison with the calculated values. Further studies on this s ubject are needed.

CONCLUSION

Present dosimetry protocols based on N_x or N_k have much complexity to make errors in the determination of the absorbed dose to water because of a number of steps in the dosimetric chain.

Recently, new calibration protocols based on standards for the absorbed dose to water do n't require large tables of stopping-power ratios and mass-energy absorption coefficients in the determination of N_D^{air}, so that uncertainties and possible errors are greatly reduced.

Formalism based on absorbed dose to water is simplified due to a unique quantity, N_D^W, i nterested in clinical reference dosimetry.

Therefore, a very robust system of primary standards for absorbed dose to water is expec t in the next few years because results compared between N_k and N_D^W-based formalism are in good agreement with the errors of less than 1% under the reference conditions in a high energy photon beam.