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Initial experiences in testing: the IAEA/AAPM code of practice on small field dosimetry

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Purpose:

The International Atomic Energy Agency (IAEA) has established a coordinated research project focusing on clinical testing of the procedures described in the upcoming IAEA/AAPM code of practice on small field dosimetry. The initial task was the determination of beam quality based on square fields with different sizes using a standard MLC shaped 6 MV photon beams. Additionally, field output factors ($f_{Q_{clin}, Q}^{clin, ref}$) were determined for field sizes ranging from 10 x 10 cm² down to 0.5 x 0.5 cm².

Materials and Methods:

Thirteen participants from different countries were asked to experimentally determine the $TPR_{20,10}(S)$ or $\%dd(10, S)_X$ in a 4 x 4 cm² ($S = 4$) and 6 x 6 cm² ($S = 6$) 6 MV flattened photon field. The 4 x 4 cm² and 6 x 6 cm² fields were assumed to be “virtual” machine specific reference fields. The participants had to apply the formalism proposed in the IAEA/AAPM code of practice on small field dosimetry in order to determine $TPR_{20,10}(10)$ or $\%dd(10, 10)_X$, respectively. These calculated beam quality specifiers were compared to the experimentally determined beam quality specifiers $TPR_{20,10}$ or $\%dd(10)_X$ determined in the 10 x 10 cm² field.

Furthermore, the centers were asked to determine field output factors according to the IAEA/AAPM code of practice on small field dosimetry for field sizes ranging from 0.5 x 0.5 cm² to 10 x 10 cm² in a 6 MV flattened photon beam using at least three different detectors. For each center, the standard deviation with respect to the mean value of the field output factors measured with these three different detectors was calculated for each field as a measure for the agreement amongst the determined field output factors.

Results:

So far, the data of eight machines using $TPR_{20,10}$ and seven machines using $\%dd(10)_X$ were collected. The $TPR_{20,10}$ values ranged between 0.667 and 0.685 while the $\%dd(10)_X$ values ranged between 66.4% and 67.6%. The mean value of the differences between calculated $TPR_{20,10}(10)$ and experimentally determined $TPR_{20,10}$ in the 10 x 10 cm² field was -0.05% with a standard deviation of 0.4%. The mean value of the differences between calculated $\%dd(10, 10)_X$ and experimentally determined $\%dd(10)_X$ in the 10 x 10 cm² field was -0.05% with a standard deviation of 0.6%. The differences of the individual centers did not exceed 1.1% and 1.2% for $TPR_{20,10}(10)$ and $\%dd(10, 10)_X$, respectively.

For the relative dosimetry task, the data of eight centers was been received so far. As depicted in Figure 1, for the majority of centers the standard deviations of field output factors was below 1 % over a wide range of field widths. An increase of the standard deviation with decreasing field width over the 1 % threshold was observed for five centers at a field width of 1 x 1 cm². For two of these centers the standard deviation dropped below 1 % at the 0.5 x 0.5 cm² field. In total, five centers submitted a sufficient number of field output factors for the 0.5 x 0.5 cm² field. The standard deviations of these field output factors was below 1%.

Conclusion:

The formalism proposed in the IAEA/AAPM code of practice on small field dosimetry for determination of beam quality in a 10 x 10 cm² based on experimental data in machine specific reference fields can be applied

with a sufficient degree of accuracy. The slightly larger differences between the calculated and experimentally determined beam quality specifiers observed for $\%dd(10, 10)_X$ might be related to uncertainties associated with automated scanning phantoms.

The increasing variation of field output factors with decreasing field size might be attributed to positioning uncertainties of the detectors and uncertainties of the applied correction factors. Further investigation regarding this topic is necessary.

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