Correspondence

Reply to "Comment on the 'Report of AAPM TG 204: Size-specific dose estimates (SSDE) in pediatric and adult body CT examinations'" [AAPM Report 204, 2011]

(Received 24 April 2012; accepted for publication 24 April 2012; published 6 July 2012)

[http://dx.doi.org10.1118/1.4725757]

Dear Editor,

Dr. Li and Dr. Behrman make accurate observations in regards to thoracic CT, and the possible overestimation of the effective diameter and commensurate underestimation of the SSDE correction factor that might occur. The air in the lungs leads to a smaller tissue mass in the CT cross section, that in terms of radiation dose, should be reflected by a smaller effective diameter than the outer physical dimensions of the patient would suggest. This issue was recognized by Task Group (TG) 204: Indeed, an Appendix B was written and proposed for inclusion, and this Appendix would have addressed the very issue mentioned by Dr. Li and Dr. Behrman. Due to the need for timeliness of publication of Report 204 and some subtle complexities to algorithms discussed in Appendix B, it was determined that Appendix B should be eliminated from the document and be dealt with subsequently. AAPM Task Group 220 (*Determination of a Patient Size Metric for CT Size Specific Dose Estimation*), chartered in August 2011, was formed specifically for this reason and a number of algorithms with minor differences are currently being evaluated for their accuracy in that Task Group.

An example of a thresholding method, typical of the algorithms being discussed in TG 220 and that originally discussed in Appendix B, is provided in the following figures. Figure 1 illustrates the CT image provided in the editorial, screen captured from the document. A histogram of that screen-captured image is shown in Fig. 2. Using simple image thresholding procedures, all gray scale values lower than 67 were truncated to black, and this image is shown in Fig. 3. Note that using actual 12 bit CT images, a threshold in Hounsfield Units would be used. The threshold segments air from tissue in the CT image, and due to the bias that scattered radiation adds in regions of air in the lungs, a threshold of -800 to -900 has been shown to be effective. By eliminating low density voxels in the image corresponding to air, the tissue area in this example was reduced from 819 cm^2 to 640 cm^2, resulting in a decrease in the calculated effective diameter from 32.3 cm to 28.5 cm. The 28.5 cm value is quite consistent with that described by Huda *et al.*[1] for thoracic CT, with only a 3% difference in effective diameter. This translates to an SSDE of 24.6 mGy, which is less than 15% higher than the SSDE calculated using the effective diameter equation given in AAPM Report 204.

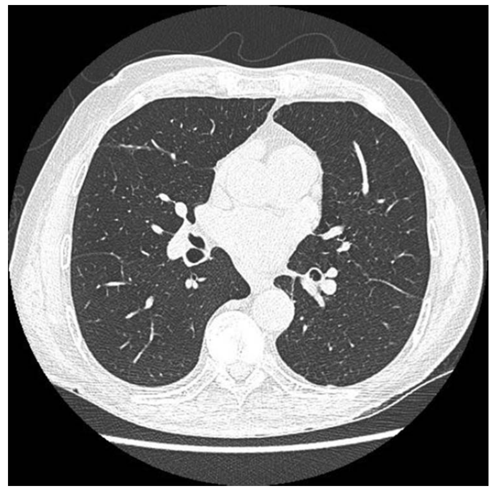

FIG. 1. Image as screen captured.

The Task Group responsible for AAPM Report 204 was well aware of the issue raised by Dr. Li and Dr. Behrman with regard to the lung. It was also recognized that the patient size estimation methods provided were based on geometrical measures and not true patient attenuation, and that patient dimensions can vary considerably from a simple ellipse. The report notes this limitation and states several times that SSDE is an *estimate* (indeed, the "E" in "SSDE" stands for estimate). It is much better than no size correction, but is still a broad *estimate*. A statement was included in the report that differences of up to 20% between "true dose" and SSDE estimates are likely for individual patients, who may not conform to the assumptions used. The thoracic CT image example used by Dr. Li and Dr. Berhman has what they refer to as "an enormous lung volume, surrounded by relatively thin chest

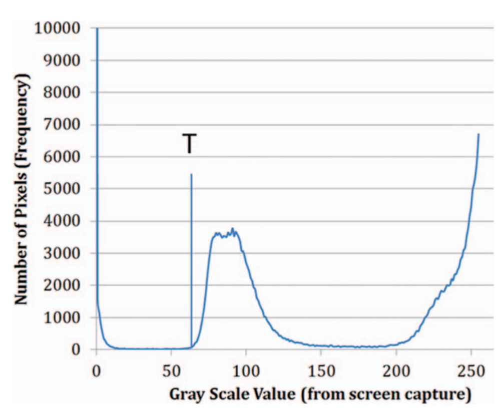

FIG. 2. Histogram of screen capture, with threshold value (T) at GS-67 - placed to segment air from tissue in the image.

FIG. 3. Image with threshold at a gray scale value of 67.

wall." That a discrepancy of 15%–38% (depending on which method is used to calculate effective diameter) is found for this relative extreme example is thus not surprising, but rather encouraging. Keep in mind that Report 204 was designed to allow technologists, physicists, or radiologists to use simple caliper tools at the CT console or on a PACS system to determine body dimensions, as these tools are available presently. The more sophisticated algorithms mentioned above and being discussed in TG-220 will require time to be integrated into CT systems, PACS systems, and dose surveillance systems. That the methods of AAPM Report 204 perform so well using simple body dimensions in such an extreme example is encouraging and demonstrates that the SSDE can indeed give users a way to confidently correct for patient size. We all look forward to the not-to-distant future, when patient size can be more accurately estimated using software that will require deployment to the radiology community. In the meantime, the methods of Report 204 can be considered useful for providing more accurate estimates of patient dose than $CTDI_{vol}$.

[1] W. Huda, E. Scalzetti, and M. Roskopf, "Effective doses to patients undergoing thoracic computed tomographic procedures," Med. Phys. **27**, 838–844 (2000).

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