Letter to the Editor Re: "Optimizing the Use of Computer Radiography in Pediatric Chest Imaging"

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Dear Dr. Honeyman-Buck,

I am writing concerning the article by R. Sanchez Jacob et al. entitled "Optimising the use of computed radiography in pediatric chest imaging" in the Online First September 13, 2007, issue of the *Journal of Digital Imaging*. The authors took on the task of defining just how much radiation exposure is necessary to produce a pediatric computed radiography image of acceptable quality. I wish to express concerns about three aspects of their work and its interpretation.

First, the manner in which the results are presented makes it difficult to judge their validity. The authors chose to use the term "Dose Level (DL)" as the name for the Agfa exposure indicator, which is actually "lgM". Nowhere in their primary reference¹ is the term "DL" used, nor is it found in the cited Agfa vendor reference document². I am unaware of anyone in North America who is familiar with the "DL" nomenclature, including Agfa and original equipment manufacturer technical personnel. The use of "Dose Level" instead of "lgM" obscures the logarithmic relationship between the actual dose and the lgM value, as can be observed in the linear "Dose Level" independent axis in Figures 2–5. The authors do not specify the "Speed Class" that was used to acquire the images. As explained in the article by Schaetzing et al.¹, the meaning of the Agfa exposure indicator in terms of exposure or air Kinetic Energy Released in Matter (KERMA) depends directly on the speed

class selected for the exam. In addition, the authors do not specify the parameters used for digital image processing, including the values for MUSI-Contrast. The appearance of the images, especially the perception of noise, depends directly on the amount and type of image processing. Agfa has developed specific pediatric processing and technique recommendations based on patient age groups (premies/babies, toddlers/infants, schoolchildren, teenagers, and adults). Were the authors using special pediatric processing and associated radiographic techniques?

My second area of concern relates to omission from the literature review of a key paper by Huda et al.³ that reinforces the physical determination that approximately 200 speed class technique is necessary to match the noise characteristics of screen-film receptors and that pediatric radiologists would tolerate no less than 300 speed class technique for pediatric intensive care unit examinations. Assuming that Sanchez Jacob et al. were using an Agfa Speed Class setting of 400 and assuming that the exposure indicator was calibrated to yield an lgM value of about 2 at an air KERMA of 2.5 μGy , the authors' recommendation of DL = 1.6–1.7 corresponds to 1.25 μGy or roughly 800 speed class, according to International Organization for Standardization (ISO) definitions. These images are going to be extremely noisy compared to screen-film images.

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My third area of concern is the authors' interpretation of their results. They conclude that because "no strong correlation exists between individual image quality scoring (neither global nor individual noise-related criteria scoring) and DLs", the target exposure level should be reduced to 1.6–1.7. An alternative interpretation is that the metrics they chose for scoring image quality have little or no relationship to noise. The authors scored each image according to seven criteria promoted by the Commission of the European Communities for pediatric image quality. The Commission notes, "The Image Criteria for paediatric patients presented for a particular type of radiograph are those deemed necessary to produce an image of standard quality"⁴. In a manner of speaking, any image that does not get a maximum score is substandard. The vast majority of the images the authors scored are substandard, even at their current target exposure level. Given the weak positive correlation reported for all except the 10- to 16-year-old group, lowering the exposure level is certain to result in a larger percentage of substandard images.

Further discussion is needed regarding the European Commission criteria and noise. The first three criteria are largely assessments of technical errors in the projection, such as positioning and inspiration. As the authors correctly surmise, these have little to do with noise. But when these criteria are included in the data along with the four criteria the authors interpret as having noise-related properties, their so-called "global scoring", the correlations with dose actually improve! We know that for these imaging systems, noise as a fraction of signal improves roughly with the logarithm of exposure, which would be linearly with the IgM (or "DL")⁵. We also know from observer preference studies that radiologists' assessments of image quality improve in the same manner. To observe no correlation over the tremendous range

of receptor exposures, the authors studied (from a factor of 128 for the youngest group to a factor of 32 for the oldest group) can only mean that the criteria used have at best a weak relationship to the noise in the image. Detection of disease processes is very dependent on image noise, and radiologists' level of certainty regarding a diagnosis is strongly affected by noise.

Another factor not taken into account by the authors is that reducing the signal-to-noise ratio in the image has adverse effects on the specific parameters applied for digital image processing. A reduction in dose level cannot be considered without concomitant adjustment of image processing parameters⁶.

The authors' recommendations, while intended to reduce pediatric radiation dose and potential harmful effects, are actually counter productive. Lowering the exposure indicator target is likely to reduce the diagnostic benefit of the diagnostic examination with reduction of a tiny and uncertain risk to the individual patient.

Respectfully submitted,

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