Influences in CT Scan Lung Nodule Volumetry

To the Editor:

We read with great interest the well-written article by Mehta et al¹ in *CHEST* (March 2014), which reported that the addition of nodule volume to existing malignancy prediction models increases the proportion of correctly classified nodules. However, we would like to highlight some aspects regarding lung nodule volumetry.

Lung nodule measurements made with CT imaging are used in clinical practice to assess size changes estimated from serial scans obtained over time to predict the likelihood of malignancy and to monitor the tumor response to treatment.² Size measurements need to be accurate and consistent to enable the assessment of nodule changes in a short time interval. The precision and accuracy of volume measurements depend on several factors, including the image-acquisition and reconstruction parameters, the nodule characteristics, and the performance of algorithms for nodule segmentation and volume estimation.²⁻⁴

Goodman et al³ presented results on the variability of volumetric measurements made with a commercial semiautomated software program (Advantage Lung Analysis; GE Healthcare). The evaluation was performed on 50 nodules across three repeat scans read by three observers. The second and third scans were acquired during two breath holds performed 10 to 20 min after the first scan. Nodule volume was estimated as the average volume measurement of the three observers at the first scan and was used as the baseline truth to measure interobserver variability. This measure of interobserver variability is inherently biased because each observer is compared against a standard that is based, in part, on his/her own contours. Interscan variability was measured as the percentage difference between the average volume measurements and the estimated volume. The results revealed significant interscan variability (on the order of 13%) but minimal interobserver variability. Findings from several other studies have demonstrated differences in the volumetric measurement error, ranging from 10% to 40%, between scans acquired with thin and thick section widths. Even

with these limitations, we can generally conclude that section thickness/width is one of the most important CT scan acquisition parameters to control. In a recent article about nodule volumetry with phantom correlation, Xie et al⁴ reported that the CT scan-derived volume of small nodules is largely underestimated, with considerable variation.

These data highlight the need to standardize all variables in CT scanning to obtain a reliable volumetric assessment of the pulmonary nodule. This standardization is even more important in studies that will use volumetric CT scanning in the follow-up of these nodules.

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Response

To the Editor:

We thank Dr Hochegger and colleagues for their interest in our study on the utility of nodule volume in the context of malignancy prediction for small pulmonary nodules.¹ The letter raises several important points, including that there may be significant interobserver and intraobserver variability in nodule volume measurement, which itself depends on various factors like image acquisition, reconstruction, nodule characteristics, and the use of a segmentation algorithm.^{2,3} We agree that variability in volume measurement is a significant challenge for introducing semiautomated volumetric software into daily practice.

Nodule volumes, however, can be consistently reproduced using standardized protocols. Gietema and colleagues⁴ demonstrated that under certain conditions (using standard CT image slice thickness, fixed energy, scan time of 10 s, and a soft kernel for reconstruction), a high degree ($r = 0.99$) of interobserver correlation can be achieved for small- and intermediate-sized nodules using semiautomated volumetric software. It has also been shown that variability in volume measurements is related to nodule size, morphology, and location. For small- to intermediate-sized solid nodules surrounded by lung parenchyma, volumetric measurements are reproducible. Wang and colleagues⁵ demonstrated that as long as consistent reconstruction parameters are applied using soft kernel, the volume measurements are very reproducible. In their study, no statistically significant benefit for consensus double reading on semiautomated volumetry was found. Based on these findings, the fourth screening round image reading in the Dutch-Belgian randomized lung cancer screening trial (NELSON) is, in fact, performed by only one reader.⁶

With the recent grade B recommendation by the US Preventive Task Force for lung cancer screening using low-dose CT imaging, the incidence of pulmonary nodules has the potential to rise dramatically. Because

the majority of these nodules are not cancer, volume-based nodule management has been suggested to be more accurate than diameter measurements, with significantly lower false-positive rates. We agree with the call to standardize the performance and interpretation of CT scans to ensure reliable volumetric measurements of pulmonary nodules, thereby improving the ability to predict malignancy.

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