Purpose:

In pediatric chest CT, the detection of subtle lung nodules represents a challenging clinical task, especially with dose reduction. Our purpose was to correlate the diagnostic performance of this task with radiation estimates to develop a framework for the definition of size-specific optimized protocols.

Methods:

The relationships between diagnostic performance and radiation estimates were derived for nine pediatric age groups (mean age: 0.2, 0.7, 1.4, 2.5, 4.1, 6.2, 8.2, 11.3, 14.7 years) using a 4-mm nodule as the representative task. First, diagnostic performance (area under ROC) was related to contrast-to-noise ratio (CNR) based on an earlier observer study. CNR was then related to patient diameter and imaging parameters using phantom data. Diameter, age, and imaging parameters were further used to obtain radiation estimates (CTDlvol, SSDE, effective dose, risk index) using Monte Carlo data. Clinical operating points were selected for the nine age groups as equal-slope points on the plots of AUC versus radiation estimates.

Results:

AUC initially increased rapidly with radiation estimate, and then approached a plateau. To achieve the same AUC, more dose (and greater risk) was needed to scan a larger child. When a dose estimate (CTDlvol, SSDE, effective dose) was used for optimization, the equal-slope points generally corresponded to equal-risk points, resulting in an AUC decrease of ~0.14 from the youngest to the oldest age group. When risk index was used for optimization, the equal-slope points resulted in CTDlvol ratio of 1:6, SSDE ratio of 1:4, effective dose ratio of 1:4, and risk index ratio of 1:2 between the youngest and the oldest, corresponding to a moderate AUC difference of 0.08.

Conclusions:

We developed an integrated framework for performance-based, size-specific, protocol optimization in pediatric CT. By accounting for the risk difference between age groups, the concept of risk index has innovative applications in pediatric protocol optimization.