Purpose: Conventional calculation methods of patient release criteria for compliance with NRC regulations are based on the assumption that both patient and bystander are each a single point in space. This study was intended to assess the patient-specific external radiation exposure to a bystander interacting with the patient following radionuclide therapy with 131I.

Methods: 131I-sodium iodide treatment for hyperthyroidism and thyroid cancer and 131I-tositumomab treatment of non-Hodgkin's lymphoma were considered. 131I distribution provided by the patient SPECT image was rendered on the SPECT-fused CT images. The CT images were then imported to a Monte Carlo based simulation code, MCNPX 2.7, as a source phantom. For a target phantom, we employed the adult male hybrid phantom developed at the University of Florida and National Cancer Institute. A single orientation - patient and a bystander facing one another at 1.0 m - was considered. S factors (dose per unit cumulative activity (A)) for each organ in a bystander was obtained from the MC calculations and effective dose (EDE) per A was calculated based on tissue-weighted individual organ doses. The results were compared with the calculations using UF/NCI adult hybrid source/target phantoms and the revised adult ORNL stylized source/target phantoms.

Results: EDE per A of the stylized phantom was 1.5% higher than that of the hybrid phantom for uniform source localization in the thyroid. However, EDE per A of the hybrid phantom was 20% less than that of stylized phantoms for a torso source. The difference is attributed to the realistic shape of the frontal body comparing to the simple ellipsoidal trunk of the stylized phantom.

Conclusions: Based on the realistic hybrid phantoms and accurate MC radiation transport calculation tools, patient specific dosimetry for a bystander is feasible. S factors will be calculated using the patient CT image with 131I bio-distributions and hybrid phantoms.