Purpose: To investigate radiation dosimetry for 99mTc produced by medical cyclotrons, based on theoretical reaction cross-sections and yields. Several other technetium isotopes produced in a cyclotron are chemically inseparable from 99mTc. This could increase patient absorbed dose. We compared the resulting doses to those from 99mTc produced by conventional 99Mo/99mTc generators.

Methods: We simulated natural and enriched molybdenum thick targets irradiated by 10-30MeV protons. All reaction channels leading to any given reaction product were considered in final yields. The cross-section calculations were performed using the EMPIRE code. A computer graphical user interface for automatic calculation of isotope yields and activities was created. The pertechnetate, phosphonate as well as MIBI radiation absorbed doses were calculated by OLINDA/EXM 1.1 using the adult male reference. Generator produced 99mTc was assumed to have 100% radionuclide purity.

Results: The thick target yields for 99mTc, 99gTc and other isotopes were determined for 16-10MeV, 19-10MeV and 24-10MeV energy protons. The difference of radiation doses between pure-Tc (reactor produced) and mixture-Tc (cyclotron produced) in main organs were estimated. In highly enriched targets (99.5% 100Mo), the mixture-Tc doses are about 0.5% larger than the pure-Tc doses. These differences decreased in the first few hours from the end of beam (EOB) and then increased to 1% after 24 hours from EOB. In targets with lower enrichment (97.4% 100Mo), the 0-8 hours after EOB doses from the mixture-Tc isotopes exceeded the pure-99mTc dose by ~1% or less. For radiopharmaceuticals injected in patients 24 hours after EOB, this difference increased to 2-5%.

Conclusion: Other radioisotopes, which will be produced in the cyclotron together with 99mTc must be considered for their potential to increase patient dose exposure. The differences between the radiation absorbed doses from technetium produced by cyclotrons and nuclear reactors are minimal at EOB, and increase slightly after 24 hours.