

Analysis of radionuclides for induced-radioactive waste from medical linear accelerator

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Purpose:

Linear accelerator (Linac) with 10 MV or higher energy generates photo-neutron through photo-nuclear reaction. As components of Linac are activated by neutron, analyzing radioactive waste in the process of disposal of linac is an important issue, but it is not clear for information of radionuclide generated depending on parts of linac, and it is not possible to quantitatively evaluate the activation dose accurately. The objective of this study is to evaluate and analyze radionuclides for each part of the discarded linac.

Materials and Methods:

We measured radioactivity of the Elekta linac equipment's head parts disposed from Hospital using survey meter (ESM FH 40 GL, Thermo Inc, Germany) and HPGe gamma spectrometer (Falcon 5000, Canberra Inc, Meriden, USA). The surface dose rate of the 13 parts such as wave guide, carousel, ion chamber, flattening filter, MLC, difference filter, scattering foil, and other parts was measured with survey meter and compared between reading measured after 45 days of disposal and those previously measured at the time of removal and disposal. And also we analyzed the radioactive nuclides generated by each part using the portable HPGe gamma spectrometer and compared the radionuclide identified through the measurement with the radionuclides reported in the Japanese society.

Results:

At the time of disposal, the components that showed high surface radiation dose rates were MLC, Target, and Difference filter. Surface dose rate were 2032, 3318, and 27100 nSv/h, and after 45 days, the dose rate was confirmed to decrease to 153, 459, and 152 nSv/h, respectively. In addition, the surface radiation dose rate of carousel, ion chamber, flattening filter, and scattering foil decreased from 149 ~ 191 nSv/h to 129 ~ 139 nSv/h. As a result of analysis with the HPGe detector, Co-60(Half value life 5.271 y) nuclides were identified in most equipment parts. Other nuclides were confirmed to occur such as Am-241(432.2 y), Am-243(7370 y), Cf-252(2.647 y), Pm-145(17.70 y) U-232(68.90 y), Tb-158(180.1 y), Re-184(38.19 d) and so on. Representatively, the nuclides confirmed from target was Co-60, Am-243, Cf-252, Pa-232, Pm-145, Re-184, these results was corresponded with the Japan's report.

Conclusions:

The surface dose rate and radionuclides were analyzed for the disposed linac. As a result, long-lived radionuclides such as Co-60, Am-241, Am-243, and Cf-252 were mainly detected. We will analyze the short-lived radionuclides that tail away fast after removal and disposal and intend to establish standards for managing radioactive waste for linac.

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Keywords:

Linear accelerator, Disposal, Activation, Radioactive waste, HPGe detector, Survey meter