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Contamination problem of workers handling with 177Lu-labeled radiopharmaceuticals

Introduction
The 177Lu emits mainly electrons up to a maximum energy of 498 keV and photons with energies of 113 keV and 208 keV, which can effectively irradiate the skin on the hands of radiopharmaceutists in the preparation of these radiopharmaceuticals for patients. Finger-mounted monitors (finger dosimeters) with a thermoluminescent dosimeter (TLD) are used to control the skin irradiation on the hands of radiopharmaceuticals. Finger dosimeters are commonly equipped with a TL detector that detects both photons and electrons with a sensitive layer thickness of 0.9 mm. Due to the relatively low energy of the electrons emitted by 177Lu, it is recommended to use a TLD with a thin sensitive layer 0.05 mm thick, which has the same response to the radiation dose from both electrons and photons emitted by 177Lu.
To test the effectiveness of radiation protection measures for NM therapeutic sites using 177Lu-labeled radiopharmaceuticals, the presentation proposes a method of testing them and a procedure to ensure effective investigation of excessive worker exposure by the required supervisory body based on legal dosimetry of the worker's finger or whole body dosimeter.

Methods
Continuous measures require:
- introduction of a method of selective indicative gamma and beta irradiation of the skin of the hands with a pair of TLDs with different sensitivities of gamma and beta radiation,
- mapping by selective indicative gamma irradiation and beta irradiation of the skin on the hands using TLD placement at standard sites on a hand according to the ORAMED project [1], in routine manipulations with therapeutic doses of 177Lu-labeled radiopharmaceuticals,
- a method of contamination measurement with a collimated gamma spectrometer to determine the position of the maximum local contamination of the glove and to estimate the value of the area activity.

Results
A model experiment with contaminated work gloves handling a 177Lu-labeled radiopharmaceutical. Table 1 shows the responses of dual ring monitors placed on the left hand and the results of gamma spectrometric model measurement of contaminated work gloves at the thumb and forefinger sites, as shown in Figure 1.
A dual monitor placed on the tip of the index finger shows that contamination there causes local irradiation of the skin, which is caused mainly by electrons (approx. 100% according to tab.1). In this case, the MCP-7 TLD, which is still commonly used in conventional finger monitors, registers five times less actual skin irradiation (1208/258 - ratio of values shown in tab.1).

Conclusion
A new method for a comprehensive examination of excessive skin irradiation on the hands of workers handling 177Lu-labeled radiopharmaceuticals has been proposed. Method allows also the assessment of other exposure circumstances, such as personal responsibility of the worker for excessive irradiation or deficiency in organizational and technological measures of radiation protection in the workplace.

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References
[1] FÜLÖP, M., et al. Exposure optimization caused by handling of radiopharmaceuticals. In: IRPA15 Final Programme & Congress Abstract Book. 15th International Congress of the IRPA, Seoul, 18 January –5 February 2021.

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