Establishment of an in vivo dose–response relationship between Na-24 activity and neutron doses in C57BL/6 mice

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Neutron dose estimation is critical in nuclear criticality accidents, where individuals may be exposed to neutron radiation. Neutron exposure can activate elements within the body; in particular, neutron activation of stable sodium-23 (Na-23) to radioactive sodium-24 (Na-24) in blood serves as an important biomarker for estimating neutron dose in exposed individuals.

Na-24 activation has been measured in victims' blood following nuclear criticality accidents, and its value has been further supported by ex vivo studies of human blood as well as in vivo animal experiments. Additional in vivo investigations of neutron exposure and Na-24 activation are needed to confirm the applicability of this method in a complex living system. The current objective is to establish the feasibility of measuring Na-24 activation after neutron exposure in an in vivo model at our institute.

In the current study, C57BL/6 mice were exposed to 0, 1.5, 4.5, or 6.0 Gy mixed-field radiation (65% neutron + 35% gamma; n = 4 mice per group). At 24 hours post-irradiation, blood was collected and Na-24 activity was measured using a Germanium detector. After correcting for the time elapsed between irradiation and Na-24 assay, as well as for blood weight, a dose–response curve was generated by plotting counts per minute (CPM) from Na-24 activity against radiation doses. Linear regression analysis showed a significant correlation between CPM and radiation doses.

In summary, we demonstrated that Na-24 activity can be successfully measured at 24 hours following mixed-field radiation exposure in vivo, and that a linear dose–response relationship is detectable across the 0–6.0 Gy range.

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