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RENAL DYSFUNCTION AFTER TOTAL BODY IRRADIATION: DOSE-EFFECT RELATIONSHIP: IN REGARD TO KAL AND VAN KEMPEN-HARTEVELD (*INT J RADIAT ONCOL BIOL PHYS* *2006;65:1228–1232*)

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To the Editor: We read with considerable interest the article on the dose-effect relationship for radiation-induced renal dysfunction by Drs. Kal and van Kempen-Harteveld (1). Their review concludes that a biologically effective dose (BED) to both kidneys above 21 Gy poses a risk of renal dysfunction that exceeds 20%. It would be highly relevant to radiological terrorism response issues to see what their dose-effect curve would look like if the conversion was to a single dose delivered at a high dose rate rather than to BED. Our calculation is that a BED of 21 Gy is roughly equivalent to a single dose (at high dose rate) of 6 Gy. This dose is higher than the 4.5 Gy we had estimated for a similar risk (2), but our estimate was based on a smaller dataset and on different assumptions about dose-rate effects.

The connection between radiation-induced renal dysfunction after therapeutic total body irradiation, and radiological terrorism, comes from a consideration of how our estimate of survivable total body dose has changed since 1945. In 1945 at Nagasaki (3) the acute 50% lethal dose (LD₅₀) has been estimated to be in the 2–4 Gy range, but in 1986 at Chernobyl (4) the LD₅₀ was in the 5–6 Gy range. This difference reflected in part the different pre-existing health status and age structure of the exposed populations (5), but much of it was also due to advances in our knowledge of how to treat radiation injuries. In 2003, Anno et al. (5) estimated that the LD₅₀ would be as high as 7 Gy when antibiotics and transfusion support were provided, and experimental studies (e.g., MacVittie et al. (6)) suggest that the addition of hematopoietic cytokines to supportive care could boost the LD₅₀ by another 40%. With whole body doses of 7 Gy and above being acutely survivable, both our analysis (2) and that of Drs. Kal and van Kempen-Harteveld (1) imply that radiation nephropathy will be a significant risk for some radiation accident and radiological terrorism scenarios.

References

1. Kal HB, van Kempen-Harteveld ML. Renal dysfunction after total body irradiation: Dose-effect relationship. *Int J Radiat Oncol Biol Phys* 2006;65:1228–1232. [PubMed: 16682132]
2. Moulder JE, Cohen EP. Radiation-induced multi-organ involvement and failure: the contribution of radiation effects on the renal system. *Brit J Radiol Suppl* 2005;27:82–88.
3. Levin SG, Young RW, Stohler RL. Estimation of median human lethal radiation dose computed from data on occupants of reinforced concrete structures in Nagasaki, Japan. *Health Phys* 1992;63:522–531. [PubMed: 1399638]
4. Mould, RF. Chernobyl the real story. Oxford: Pergamon Press; 1988.

5. Anno GH, Young RW, Bloom RM, et al. Dose response relationships for acute ionizing-radiation lethality. *Health Phys* 2003;84:565–575. [PubMed: 12747475]
6. MacVittie TJ, Farese AM, Jackson W. Defining the full therapeutic potential of recombinant growth factors in the post radiation-accident environment: the effect of supportive care plus administration of G-CSF. *Health Phys* 2005;89:546–555. [PubMed: 16217198]