

## Microsatellite analysis for determination of the mutagenicity of extremely low-frequency electromagnetic fields and ionising radiation *in vitro*

Robert J. Mairs, Kate Hughes, Sara Fitzsimmons, Kevin M. Prise, Anne Livingstone, Lesley Wilson, Nazia Baig, Anne Marie Clark, Alan Timson, Gaurang Patel, M.Folkard, Wilson J. Angerson, Marie Boyd

*Targeted Therapy Group, Division of Cancer Science and Molecular Pathology, Glasgow University,  
Cancer Research UK Beatson Laboratories, Glasgow, G61 1BD, UK  
Department of Child Health, Yorkhill Hospital, Glasgow, UK  
Gray Cancer Institute, Mount Vernon Hospital, P.O. Box 100, Northwood HA6 2JR, UK  
Department of Clinical Physics, Western Infirmary, Glasgow G11 6NT, UK  
Department of Surgery, University of Glasgow, Royal Infirmary, Glasgow G31 2ER, UK*

**Received 28 March 2006; received in revised form 28 June 2006; accepted 1 August 2006. Available online 20 September 2006**

### Abstract

Extremely low-frequency electromagnetic fields (ELF-EMF) have been reported to induce lesions in DNA and to enhance the mutagenicity of ionising radiation. However, the significance of these findings is uncertain because the determination of the carcinogenic potential of EMFs has largely been based on investigations of large chromosomal aberrations.

Using a more sensitive method of detecting DNA damage involving microsatellite sequences, we observed that exposure of UVW human glioma cells to ELF-EMF alone at a field strength of 1 mT (50 Hz) for 12 h gave rise to 0.011 mutations/locus/cell. This was equivalent to a 3.75-fold increase in mutation induction compared with unexposed controls. Furthermore, ELF-EMF increased the mutagenic capacity of 0.3 and 3 Gy  $\gamma$ -irradiation by factors of 2.6 and 2.75, respectively. These results suggest not only that ELF-EMF is mutagenic as a single agent but also that it can potentiate the mutagenicity of ionising radiation.

Treatment with 0.3 Gy induced more than 10 times more mutations per unit dose than irradiation with 3 Gy, indication hypermutability at low dose.

*Keywords:* ELF-EMF; Gamma radiation; Microsatellite mutations