# Evaluation of Specific Absorption Rate as a Dosimetric Quantity for Electromagnetic Fields Bioeffects

Dimitris J. Panagopoulos,
Olle Johansson,
George L. Carlo

Published: June 4, 2013
DOI: 10.1371/journal.pone.0062663

## Abstract

**Purpose:** To evaluate *SAR* as a dosimetric quantity for EMF bioeffects, and identify ways for increasing the precision in EMF dosimetry and bioactivity assessment.

## Methods

We discuss the interaction of man-made electromagnetic waves with biological matter and calculate the energy transferred to a single free ion within a cell. We analyze the physics and biology of *SAR* and evaluate the methods of its estimation. We discuss the experimentally observed non-linearity between electromagnetic exposure and biological effect.

## Results

We find that: a) The energy absorbed by living matter during exposure to environmentally accounted EMFs is normally well below the thermal level. b) All existing methods for *SAR* estimation, especially those based upon tissue conductivity and internal electric field, have serious deficiencies. c) The only method to estimate *SAR* without large error is by measuring temperature increases within biological tissue, which normally are negligible for environmental EMF intensities, and thus cannot be measured.

## Conclusions

*SAR* actually refers to thermal effects, while the vast majority of the recorded biological effects from man-made non-ionizing environmental radiation are non-thermal. Even if *SAR* could be accurately estimated for a whole tissue, organ, or body, the biological/health effect is determined by tiny amounts of energy/power absorbed by specific biomolecules, which cannot be calculated. Moreover, it depends upon field parameters not taken into account in *SAR* calculation. Thus, *SAR* should not be used as the primary dosimetric quantity, but used only as a complementary measure, always reporting the estimating method and the corresponding error. Radiation/field intensity along with additional physical parameters (such as frequency, modulation etc) which can be directly and in any case more accurately measured on the surface of biological tissues, should constitute the primary measure for EMF exposures, in spite of similar uncertainty to predict the biological effect due to non-linearity.

**Citation:**Panagopoulos DJ, Johansson O, Carlo GL (2013) Evaluation of Specific Absorption Rate as a Dosimetric Quantity for Electromagnetic Fields Bioeffects. PLoS ONE 8(6): e62663. doi:10.1371/journal.pone.0062663
**Editor:** Nils Cordes, Dresden University of Technology, Germany
**Received:** November 21, 2012; **Accepted:** March 22, 2013; **Published:** June 4, 2013