ELFSTAT Project: Assessment of infant exposure to extremely low frequency magnetic fields (ELF- MF, 40-800 Hz) and possible impact on health of new technologies

I. Liorni, S. Fiocchi, M. Parazzini, Laurent Le Brusquet, Martin Röösli, B. Struchen, Paolo Ravazzani

ELFSTAT Project: Assessment of infant exposure to extremely low frequency magnetic fields (ELF-MF, 40-800 Hz) and possible impact on health of new technologies

Liorni I[1], Fiocchi S[1], Parazzini M[1], Le Brusquet L[2], Röösli M[3,4], Struchen B[3,4] and Ravazzani P[1]

[1]CNR Consiglio Nazionale delle Ricerche, Istituto di Elettronica e di Ingegneria dell'Informazione e delle Telecomunicazioni IEIIT, Piazza Leonardo da Vinci, Milano, Italy
[2] Laboratoire des signaux et systèmes (UMR CentraleSupélec, CNRS, Université Paris-Sud), Gif-sur-Yvette, France
[3]Epidemiology and Public Health, Swiss Tropical and Public Health Institute, Basel, Switzerland
[4]University of Basel, Basel, Switzerland

Summary (max 750 characters)

ELFSTAT Project started in November 2015 and is founded by the French ANSES (2015-2018, Grant agreement n. 2015/1/202). The main purpose of ELFSTAT is to characterize children's exposure to low frequency magnetic fields (MF, from 40 to 800 Hz) in real exposure scenarios using stochastic approaches. Both the global exposure at personal level and tissue dosimetry due to far- and near-field sources will be investigated. Finally, prediction of the impact of new technologies (e.g. smart grids, electric vehicles) on children's exposure will be carry out, enlarging the frequency range to the intermediate frequencies (IF).

Abstract (max 12000 characters)

Introduction

Extremely low frequency magnetic fields (ELF-MF) have been classified as possibly carcinogenic to humans based on reasonably consistent epidemiological data for childhood leukemia [1]. Despite the classification and consequent implementation of numerous health risk assessment processes to evaluate possible risk of ELF exposure of children, the real everyday exposure to ELF-MF in Europe is not well known. Indeed, only a few studies analysed children exposure to ELF-MF by collecting personal measurements, correlating the daily exposure patterns to children's movement and behaviour [2-5]. Furthermore, the exposure assessment to MF sources other than power lines has been not yet addressed. Therefore, an improved knowledge of these exposure contributions is needed to better understand biological mechanisms and to interpret previous epidemiological studies as well. A correct assessment of the induced fields in tissues should also be carried out. Indeed, so far, the estimation of induced fields are limited to exposure of a few children's anatomies [6-7] and on fetal exposure [7-11].
Personal exposure measurements and computational dosimetry contribute to provide the picture of the impact of exposure on health. However, due to the high variability of real exposure scenarios, the exposure assessment by means of those tools turns in high time-consuming processes.
ELFSTAT project aims, therefore, to develop stochastic models able to provide exposure assessment of children in several exposure conditions and hence considering the high variability of real exposure scenarios, on the base of a relatively few experimental and/or computational data.

Methodology

ELFSTAT Project is divided in three Work Packages (WP):

WP1-Stochastic Models: the aim is to develop stochastic models to model personal exposure and tissue dosimetry.
The exposure will be characterize in terms of magnetic field amplitude at personal level and induced electric field for tissue dosimetry. Through a literature review on stochastic methods and the implementation and validation of the most promising approaches, the best stochastic methods will be identified for both personal exposure and tissue dosimetry.

WP2- Children exposure assessment to ELF-MF: the aim is to characterize children's exposure to low frequency magnetic fields (MF) from 40 to 800 Hz using stochastic models developed in WP1. Furthermore,

appropriate indicators to represent children's exposure based on the stochastic exposure assessments will be developed.
To fulfil this aim the most significant children real exposure scenarios will be identified and, on the base of the developed stochastic models both personal children exposure and the tissue exposure will be characterized.

WP3- Exposure to new technologies ELF devices: the aim is to evaluate the impact of new technologies for energy on children exposure.
A systematic literature review will be conducted about research papers on the ELF-MF exposure of new technologies. From the already available databases of personal measurements, the exposure patterns revealed in the time activity diaries will be used to predict the behaviour of children in proximity to new sources and to simulate temporal exposure patterns to the new sources. An estimation of the change of exposure due to these new sources will be done to evaluate the impact on children's exposure of these new technologies.

Conclusions

ELFSTAT Project aims to develop innovative stochastic models to provide exposure assessment of children in a wide range of exposure conditions at ELF to far-field and near-field sources. Ongoing work is about the development of stochastic models of induced electric field in fetal tissues due to the variation of dielectric properties by means of the polynomial chaos theory. Furthermore, literature reviews about the most suitable approaches to use for the development of stochastic models of external magnetic field amplitude is ongoing.

Aknowledgement

The ELFSTAT Project is supported by The French National Program for Environmental and Occupational Health of Anses (2015/1/202).

References

[1] IARC Monographs on the evaluation risks to humans. 2002. Volume 80. Non-Ionizing Radiation, Part 1: Static and extremely low-frequency (ELF) electric and magnetic fields. IARC Press, Lyon, France.

[2] Forssén UM, Ahlbom A, Feytching M. 2002. Relative contribution of residential and occupational magnetic field exposure over twenty-four hours among people living close to and far from a power line. Bioelectromagnetics, 23(3): 239-44.

[3] Struchen B, Liorni I, Parazzini M, Gaengler S, Ravazzani P, Röösli M. 2015. Analysis of children's personal and bedroom exposure to ELF-MF in Italy and Switzerland. J Expo Sci Environ Epidemiol. doi:10.1038/jes.2015.80.

[4] Magne I, Souques M, Lambrozo J, Bedja M, Fleury G, Le Brusquet L, Carlsberg A. 2011. Exposure of the french population to 50 Hz magnetic field: general results and impact of high voltage power line. Proceedings of the 10th International Congress of EBEA, Rome, Italy, 21-24 February.

[5] Magne I, Deschamps F, Lambrozo J, Le Lay M, Richard JL, Bedja M, Fleury G, Le Brusquet L, Souques M, Lambrozo J, Carlsberg A. 2011b. Analysis of high voltage network and train network in the EXPERS study. Proceedings of the 10th International Congress of EBEA, Rome, Italy, 21-24 February.

[6] Dimbylow P. Development of pregnant female, hybrid voxel-mathematical models and their application to the dosimetry of applied magnetic and electric fields at 50 Hz. 2006. Phys Med Biol, 51, 2383-2394.

[7] Bakker JF, Paulides MM, Neufeld E, Christ A, Chen XL, Kuster N, van Rhoon GC. 2012. Chidlren and adults exposed to low frequency magnetic fields at the ICNIRP reference levels: Theoretical assessment of the induced electric fields. Phys Med Biol, 57, 1815-1829.

[8] Dimbylow P, Findlay R. 2010. The effects of body posture, anatomy, age and pregnancy on the calculation of induced current densities at 50 Hz. 2010. Radiation Protection Dosimetry, 139, 532-535.

[9] Cech R, Leitgeb N, Pediaditis M. Fetal exposure to low frequency electric and magnetic fields. 2007. Phys Med Biol, 52, 879–888.

[10] Zupanic A, Valic B, Miklavcic D. 2007. Numerical Assessment of Induced Current Densities for Pregnant Women Exposed to 50 Hz Electromagnetic Field. International Federation for Medical and Biological Engineering Proceedings, 16(7), 226-229.

[11] Liorni I, Parazzini M, Fiocchi S, Douglas M, Capstick M, Gosselin MC, Kuster N and Ravazzani P. 2014. Dosimetric study of fetal exposure to uniform magnetic fields at 50 Hz. Bioelectromagnetics, 35(8): 580-597.