Universiteit Utrecht

Uncertainties in risk estimations of electromagnetic fields of overhead power lines

[Faculty of Science
Chemistry]

***A. de Jong**, J.A. Wardekker, J.P. van der Sluijs*

Technology and Society, Copernicus Institute, Utrecht University, The Netherlands

Introduction

In 2000, the Health Council of the Netherlands concluded on a 'relatively consistent association between the occurrence of childhood leukaemia and living in the vicinity of overhead power lines' (1). Making use of estimations on numbers of dwellings in different (magnetic) zones close to overhead power lines, the National Institute for Public Health and the Environment (RIVM) translated the relative risks of Ahlbom et al. (2) and Greenland et al. (3) into an annual number of extra cases of childhood leukaemia (4, 5). In their calculations, the presence of overhead power lines, in case of a causal relationship between exposure to ELF EM fields and childhood leukaemia, adds 0.4-0.5 extra cases leukaemia annually (to a total of 110 cases).

Objective

To come up with a prioritised list of sources of uncertainty; to give insight in the strong and weak points in the current available knowledge. In order to achieve this, both sources of uncertainty and assumptions in the already mentioned risk studies have been mapped systematically.

Method

In (4,5), a calculation chain has been used in order to make an estimate of the potential amount of extra cases of childhood leukaemia. The distinct steps in this calculation chain are:

- estimation magnetic field strength zones in the vicinity of overhead power lines
- determining the number of dwellings in each zone
- converting to the number of inhabitants in each zone
- converting to the number of children in each zone
- adapting 'Relative Risk' on calculated number exposed children for each magnetic field strength zone

On this calculation chain (the model) an uncertainty typology is adapted (6). The typology distinguishes for each (source of) uncertainty in the model location, nature, range, recognized ignorance, methodolgical unreliability and value diversity among analysts. These 6 characteristics of uncertainty are elaborated for each of the sources of uncertainty in the calculation chain.

Besides, assumptions in the distinct steps of the calculation chain are inventorised, based on both document analysis and interviews with experts.

References

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Results

Uncertainty typology

In total 18 sources of uncertainty have been found. The eight most important ones are described in Table 1.

Table 1: **Uncertainty typology overhead power lines and child leukaemia**

Uncertainty characterizations	Nature Epistemic / Ontic	Range Statistical/ Scenario	Recognized ignorance	Methodo-logical Unreliability	Value diversity among analysts
Context uncertainty					
Share overhead power lines in total exposure ELF EMF	E	Sc	++	+	+
The nature of the effect (cancer) is stochastic	O	St			
Model structure uncertainty					
Shape possible exposure-response relationship	E	Sc	+		+
Responsible damaging characteristic(s) ELF EMF	E	Sc	++	++	+
Parameter uncertainty					
Relative Risk as function of magnetic field strength	E/O	St			
Calibration: poor and/or inaccurate measurements; uncertainty about number of exposed children	E	St		+	
Input data uncertainty					
Exposure assessment indirect	E/O	St/Sc	++	++	+
Selection bias	E	St		++	+

Assumptions in the calculation chain

In total at least 13 important assumptions prior to the calculation chain are inventorised, and nine in the calculation chain. The two most important assumptions in the calculation chain are:

Estimation magnetic field strength zones in the vicinity of overhead power lines

- The time-weighted average of the magnetic field strength causes the effect

Adapting 'Relative Risk' on calculated number exposed children for each magnetic field strength zone

- The median value of the number of children inside distinct outlines of the magnetic field, as used in (2, 3) is a good estimation for the total number of exposed children in these zones

Conclusions

The lack of evidence for causality is the most important a priori source of uncertainty. The most important sources of uncertainty when setting up risk studies are:

- responsible damaging characteristic(s) ELF EMF
- responsible damaging period of exposure
- shape possible exposure-response relationship
- exposure assessments are indirect and in case of leukaemia over the year prior to diagnosis

Strong points in the current available knowledge of the Dutch situation are:

a) knowledge about the situation on overhead power lines in the Netherlands ((crucial) parameters, zone wides of magnetic fields),

b) knowledge about the number of dwellings (and children) in the vicinity of overhead power lines

Weak points concern the understanding of the mechanisms responsible for child leukaemia by exposure to ELF EMF: the responsible damaging characteristic(s) of ELF EMFs, the shape of the exposure-response relationship and the responsible damaging period of exposure. Besides, weak points are found for direct and time-continuous values for exposure by children, and estimates for remaining sources of ELF EMF.