Rapid Responses to:

PAPERS:
Gerald Draper, Tim Vincent, Mary E Kroll, and John Swanson
Childhood cancer in relation to distance from high voltage power lines in England and Wales: a case-control study
BMJ 2005; 330: 1290 [Abstract] [Full text]

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Danger of Power Lines

3 June 2005

John E Burgess, Consultant Occupational Physician
East Anglia

Send response to journal: Re: Danger of Power Lines

3 June 2005

Sirs

I was interested to hear, on the early morning news today, of a definitive study about childhood leukaemia and its incidence related to living in proximity to overhead power lines. My colleagues in the power industries have laboured long over similar articles and hypotheses.

Naturally, I was soon reading the actual article in the BMJ. I must assume that the statistical methodology is suitable but there was one more obvious correlation which sppears to have been completely disregarded.

The relative risks for disease groups at varying distance from the power lines are itemised. I concur that there may be a higher relative risk for childhood leukaemia. More obvious to me were the relative risks of CNS/Brain tumours which appear to have considerably lower relative risks the nearer one lives to the transmission cables. Does this imply that there is a positively beneficial effect for the prevention of these illnesses or is this also a result of "chance" or "confounding"?

Whilst the estimated figure of 5 extra deaths from leukaemia is of concern and sufficient to undertake further study and action is it not also important to mention to the many thousands of worried parents who live in these areas that there may be a reduction in the incidence of other childhood cancers. Perhaps a figure of the number of deaths prevented by this apparent advantageous effect, and in line with the statistical methods applied for leukaemia, should also be calculated and if it is more than 5 then maybe we should take more care before worrying a generally uninformed public with "horror" headlines.

Sincerely

Dr John Burgess

Competing interests: None declared

Associated with pregnancy?

3 June 2005

Wen Bin Liang, taking master of public health
Curtin University of Technology

Send response to

The ‘home address at birth’ may be related to the address of accommodation of the mothers during the pregnancy. While the research shows that there seems to be relationship between leukaemia and the ‘exposure’ during the earliest period of the babies or even during the time of the pregnancy, there might be difference in the age of the disease onset between the cases which were ‘exposed’ and the cases which were ‘unexposed’.

Competing interests: None declared

journal:
Re: Associated with pregnancy?

Childhood cancer in relation to distance from high voltage power lines: Some important considerations

3 June 2005

Sarah J. Hepworth, Medical statistician
Paediatric Epidemiology Group, University of Leeds, Leeds, LS2 9LN,
Richard G. Feltbower, Roger C. Parslow, Patricia A. McKinney

Send response to journal:
Re: Childhood cancer in relation to distance from high voltage power lines: Some important considerations

The paper from Draper and colleagues [1] on the relation between childhood cancer and the distance of birth residence close to high voltage power lines presents some notable findings. The study has distinct advantages of size, in terms of the number of case children, and the unbiased selection of the control sample. However, the findings are inconsistent with another large UK study where estimates of dose to extremely low frequency magnetic fields from power lines were used [2]. If this investigation was established primarily to examine risk in relation to exposure to magnetic fields it is not clear why the categories used as a measure of exposure were extended beyond 200m distance to high voltage power lines, a point at which their contribution to exposure can be considered equivalent to 'background' levels compared to the contribution from other sources [3]. The strength of the findings are based on trend statistics with the reference group comprising birth residences over 600m distance from power lines, an analysis that can have no basis for inferring associations with extremely low frequency magnetic fields. No plausible biological evidence yet exists linking magnetic field exposure to cancer per se or to childhood leukaemia. Despite this, the paper quantifies the possible number of cases of childhood leukaemia 'associated' with high voltage lines for which the main exposure will be to magnetic fields.

The statistically significant associations revealed in this geographical analysis lack any adjustment for population characteristics other than social class, estimated by the Carstairs index (it is unclear how this measure was calculated for the period prior to the 1981 census). Crucially, it is known that the areal distribution of childhood leukaemia varies with other factors, also measurable using census data, such as population density and population mixing [4], neither of which have been adjusted for in the analysis as potential confounders for the excess risk. The authors indicate that the mobility of cases did not differ with respect to power line proximity as assessed by different postcodes recorded between birth and diagnosis. Apart from mobility of the individual, characteristics of the area in which they live may also influence the risk of disease and these need to be considered in the analysis.

It is of interest that the level of risk was diluted by the use of all controls as the comparison group, although the authors fail to clarify this. Matched analyses may be preferred in a matched study design but findings can be considered to be less robust if the estimates are noticeably different when the matching is broken. All controls, irrespective of the case diagnosis, were selected to represent the entire population and the reasons why differences were observed merit more detailed investigation.

The findings of this study are of interest in that they point towards geographical correlates of risk for childhood leukaemia but do not support the hypothesis that electromagnetic fields have a causal role.

1. Draper G, Vincent T, Kroll ME, Swanson J. Childhood cancer in relation to distance from high voltage power lines in England and Wales: a case- control study. BMJ 2005;330:1290-2.

2. UKCCS Study Investigators (Writing committee: J Skinner, MP Maslanyj, TJ Mee, SG Allen, J Simpson, E Roman, NE Day). Childhood cancer and residential proximity to power lines. Br J Cancer 2000; 83(11): 1573- 1580.

3. Vistnes AI, Ramberg GB, Bjørnevik LR, Tynes T, Haldorsen T. Exposure of children to residential magnetic fields in Norway: is proximity to power lines an adequate predictor of exposure? Bioelectromagnetics 1997; 18: 47-57.

4. Parslow RC, Law GR, Feltbower R, Kinsey SE, McKinney PA. Population mixing, childhood leukaemia, CNS tumours and other childhood cancers in Yorkshire. Eur J Cancer 2002; 38: 2033-2040

Competing interests: None declared

Finding effect far from lines

3 June 2005

Volker Koenigsbuescher, IT Manager, former nonmedical practitioner *CH - 4002 Basel*

Send response to journal: Re: Finding effect far from lines

Sirs,

In your conclusion you wrote: "but it is nevertheless surprising to find the effect extending so far from the lines."

But is it surprising? If the effect exists at all and if children live near the lines, it will happen that they play or walk under or close to them or visit neighbor houses closer to under the the lines. So one might expect an partial effect related somehow to the partial time they spend in the "effected" zone.

Volker Koenigsbuescher

Competing interests: None declared

Re: Childhood cancer in relation to distance from high voltage power lines: Some important considerations

3 June 2005

David R. Whitlock, engineer *Separation Technologies*

Send

There may be potential bias in the cases for which addresses could not be identified. Presumably, power lines are in more developed areas, where addresses might be more durable over time. Distances could not be calculated for some 12% of cases. A modest bias favoring inclusion of cases close to power lines and exclusion of cases far from power lines

response to journal: Re: Re: Childhood cancer in relation to distance from high voltage power lines: Some important considerations

(because the address couldn't be identified) might produce the observed result.

Presumably a stability of address effect due to proximity to power lines would extend beyond 600 meters. Examination of the data set for excess cases at large but fixed distances, for example 1,000 to 1,500 meters might show such an effect.

Competing interests: None declared

Proximity of power lines to motorways and railways

4 June 2005

Thomas Netter, Postdoc
Zurich, Switzerland, 8050

Send response to journal: Re: Proximity of power lines to motorways and railways

Sirs,

The BMJ article on childhood cancer in relation to distances from high voltage power lines does not seem to take into account the fact that high voltage power lines are often built alongside motorways and railways. Not only are pollutants carried and generated by the vehicles but aerodynamic friction may charge the aerosols.

Competing interests: None declared

Nitrogen oxides and ozone near power lines

6 June 2005

Robin N Poston, Senior Lecturer
Dept Histopathology, King's College London, London SE1 1UL

Send response to journal: Re: Nitrogen oxides and ozone near power lines

The possibility that nitrogen oxides and ozone in the atmosphere around power lines may explain the increased risk of childhood leukaemia in their neighbourhood has lacked consideration. It is known that arcing and corona electrical discharges from power lines generate them. These compounds are mutagenic, and leukocytes and stem cells could be exposed during traffic through the pulmonary capillaries of children in the proximity. No studies have been reported on the mutagenicity of air near power lines, in contrast to the extensive work on similar pollutants produced by vehicles, and these would be of interest.

Competing interests: None declared

Omissions from the Draper et al. study

6 June 2005

Roger W Coghill, Research Director
Coghill Research

This study though large, omitted any cases near to 132kV powerlines. Whilst there are some 10,000 circuit kilometres (c/km) of 400 kV lines in the UK (but only around 6,000 c/km in 1970) and some 4000 c/km of

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275kV lines(only 5,300 in 1970), there are over 20,000 c/km of 132kV lines in the UK and some 260,000 pole-mounted transformers (1) similar to those near homes in an early Denver US study first reporting the issue (2). Should the same effect be found near these lower voltage sources, the suggestion that only five cases per year would be added is therefore dramatically understated. Moreover, the principal exposure to electric and magnetic fields is not from powerlines at all, but from domestic electric appliances in the home, and these effects could also augment the likely number of cancer cases.

In seeking an explanation why the elevated incidence is seen at distances where the magnetic field is down to background levels it should be remembered that at powerline frequencies (50 Hertz in the UK) there is no association between electric field strengths and magnetic field strengths, since the exposee is in the near field of the source. Magnetic fields from powerlines will attenuate at 1/the cube root whereas the electric field may only attenuate at the reciprocal of the distance, and may therefore still be at above average levels much further away, accelerated or diminished by metal objects or screening respectively, being least nearest the pylon structures themselves, and greatest along the perpendicular to the span midpoints.

This study thus points strongly to the electric field as a candidate for investigation. The hypothesis put forward by Henshaw (3), however, cannot be anything like a complete answer since within homes corona discharges are not likely from domestic appliances or wiring within the home. Our 1996 study (4) found a near fivefold elevation of childhood leukaemia incidence (with good confidence intervals) when the electric component was on average 20 V/m., and we found that powerlines were only a minor source of exposure.

The UKCCCR study (5) measured electric fields at leukaemic children's bedplaces and also found elevated incidences, but only reported spot and 48 hours measurements which were unrepresentative in the former case, and diluted to one third in the latter period the child's nocturnal exposure in arguably the most important residence locus, the bedplace. I speculate that if the UKCCCR data were re-analysed to reflect only the night-time bedplace exposure this study too would find similarly high incidence to ours.

Should the electric component prove to be the bio-active parameter, (and most epidemiological research todate has been directed only to the magnetic component) then the issue of a biological mechanism becomes much easier to identify, since electric fields are superpositive (E = E1 + E2 ...+En), and several important life processes (heart beat rate, brain EEG, ATP synthesis) are known to be mediated via electric fields and the transport of electrons, all three being processes which powerline and other sources would inevitably perturb, and all with adverse effects linked to EMF exposure reported in the relevant epidemiological literature. Moreover there are many in vitro and animal studies reporting adverse electric field effects, particularly on lymphocytes and on the synthesis of melatonin, a primary oncostatic agent. Indeed, the supplementary use of melatonin is proving a useful adjuvant as a radioprotective agent, not only at power but also at radiofrequencies (6).

1. Statistics of Electricity Supply. Electricity Council, Millbank, London, 1987

2. Wertheimer N and Leeper, E. (1979) Electrical Wiring Configurations and Childhood Cancer. Am. J. Epidemiol. 109: 273-284

3. Henshaw DL Ross AN et al. (1996) Enhanced deposition of radon daughter nuclei in the vicinity of power frequency electromagnetic fields Intl. J. Radiat. Biol 69: 25-38

4. Coghill RW Steward J et al. (1996) ELF electric and magnetic fields measured in the bedplaces of children diagnosed with leukaemia: a case control study. Europ. J. Cancer Prev. 5: 153-158

5. Skinner J Mee TJ et al. (2002) Exposure to power frequency electric fields and the risk of childhood cancer in the UK Brit J Cancer 87: 1257-1266

(6) Vijayalaxmi Reiter RJ et al., (2004) Melatonin as a radioprotective agent: a review Intl. J Radiat. Oncol. Biol Phys 59(3): 639-653

Competing interests: None declared

The need for accurate measurements on electromagnetic fields.

6 June 2005

W John Lincoln, Director of EMR Surveying company *EMR Surveys P/L, 10 Annette Place, Belrose, NSW, 2085, Australia*

Send response to journal: Re: The need for accurate measurements on electromagnetic fields.

I am an electrical engineer with a small company involved in the measurement of electromagnetic fields in domestic and commercial locations. I am also a member of the ARPANSA, ELF WG. (ARPANSA is an Australian Government authority resposible for the health protection in areas of both ionising and non-ionising radiation. The ELF WG is a working group preparing an Australian Standard for electromagnetic radiation from 0 Hz to 3 kHz)

The paper from Gerald Draper et al considers a subject of great interest to my colleagues and I and has received significant press coverage in Sydney.

I am interested in whether the authors have confidence that the distance from power lines is a true representation of the magnetic and or electric fields that may be experienced.

Did the Authors take any spot measurements of fields to confirm whether there was a relationship?

Was the countryside level, undulating, steep etc.? Could there have been influence from lower voltage lines or cables? Were the lines of the same configuration, did they consist of more than one circuit, and did they carry similar currents?

If the Authors considered there was a relationship between magnetic fields generated by the High Voltage transmission lines and childhood

leukaemias, what steps did they take to investigate the increasing relative risks between 300 and 599 metres?

Our Working Group meet again on Tuesday 14th June and it would be valuable to us if we could open a dialogue by then.

Competing interests: None declared

What Are The Chances?

7 June 2005

Adrian P Gaylard, Chartered Physicist
Independant Researcher

Send response to journal: Re: What Are The Chances?

Draper et al do well to mention that their results do not show causation, rather association. Furthermore, they also point to the risks of chance association. Bradford-Hill(1) proposed nine tests to apply to statistical associations before causation could be asserted, namely: strength, consistency, specificity, temporality, biological gradient, plausibility, coherence, experimental evidence, and analogy. I would like to comment on plausibility. The issue is not just that there is as yet no plausible biological mechanism for the induction of leukaemia by the electric or magnetic fields associated with power lines. As the RR for CNS/brain tumours takes values either side of unity (and if we are to understand them as indicators of a real risk), any biological mechanism would also have to protect from CNS/brain tumours out to 199m, induce CNS/brain tumours from 200m-399m and then continue to protect against such between 400 and 499m, again causing them from 500m-599m. A similar, though less striking observation can be made for "other diagnoses". Alternatively, we would need separate biological mechanisms for the causation of individual types of cancer by power lines. Under these circumstances chance would seem to be a more likely explanation.

(1) The Environment and Disease; Association or Causation? Hill Bradford AS (1965) Proc. R. Soc. Med.; 58: 295.

Competing interests: None declared

Draper et al's findings may have a causal origin

7 June 2005

Denis L Henshaw, Professor of Human Radiation Effects
H H Wills Physics Lab, University of Bristol, Tyndall Ave, Bristol, BS8 1TL

Send response to journal: Re: Draper et al's findings may have a

The finding of increased incidence of childhood leukaemia by birth address up to 600 metres from high voltage powerlines may have a causal origin in terms of both the associated electric and magnetic fields.

A plausible explanation for the approximate 70% increased incidence in childhood leukaemia up to 200 metres from powerlines may be via the disruption in the body of the hormone melatonin. Russ Reiter of the University of Texas and I have just completed a review of this topic as part of last June's World Health Organisation meeting on EMF and Child Health held in Istanbul. Our review of 14 international studies in human populations are consistent in indicating that magnetic fields down to 0.2 microtesla or lower can suppress the nocturnal production of melatonin in the pineal gland. Melatonin is a powerful antioxidant which acts as a natural anti-cancer agent. The hormone has been shown to be highly

causal origin

protective of oxidative damage to human blood cells. In animals, melatonin has been shown to be highly protective of oxidative damage to the fetus, the site where initial leukaemic damage is believed to occur in children. Leukaemia has been induced in mice exposed to constant light, which also has the effect of suppressing nocturnal pineal melatonin. Full details of our review may be found on our website below.

At Bristol, we are also researching the effects of corona ion emission from high voltage powerlines. These ions can be carried hundreds of metres from powerlines by the wind (they have been detected up to 7 km away) and this could explain the observed increased childhood leukaemia up to 600 metres from powerlines. Corona ions are produced by the ionisation of the air under the intense electric field on the surface of powerline cables. Once emitted into the atmosphere, corona ions attach themselves to particles of air pollution thereby increasing the electric charge on such particles. At ground level, when subsequently inhaled, these charged pollutants then have a much higher probability of becoming trapped in the lung by mirror-charge (static electricity) effects. We are particularly interested in pollutant particles in the approximate size range 20 - 300 nanometres since these predominantly contain the potentially carcinogenic polycyclic aromatic hydrocarbons (PAHs). Once in the lung, such particles would readily pass into the bloodstream. Ambient exposures to PAHs have been shown to produce heritable mutations in mice. In figure 3 of Fews et al 1999 we demonstrate that corona effects are prominent at 600 metres even from 132 kV powerlines which were not those mainly considered in the Draper et al study. The National Radiological Protection Board's report on corona ions concedes the plausibility of the above proposed scenario. There is substantial mechanistic evidence to suggest that air pollution is a causal factor in the incidence of childhood leukaemia. The ubiquitous nature of air pollution exposure is such that a link with childhood leukaemia has been difficult to demonstrate in an epidemiological study with case-control design. However, increased childhood leukaemia in relation to pollution hazard sites in the UK has been reported.

Overall, the distance profile of childhood leukaemia rates observed by Draper et al could be fitted by a model comprising the fall-off of magnetic fields within 200 metres of powerlines and the continuing presence of corona ion effects up to 600 metres away.

Full details of these scenarios may be found via our response statement to the Gerald Draper et al study at www.electric-fields.bris.ac.uk

Key references

1. Henshaw D L and Reiter R J, 2005. Do magnetic fields cause increased risk of childhood leukaemia via melatonin disruption? Bioelectromagnetics (In Press).

2. Henshaw D L, 2002. Does our electricity distribution system pose a serious risk to public health? Medical Hypothesis, 59,39-51.

3. Fews A P, Henshaw D L, Wilding R J & Keitch P A, 1999. Corona ions from powerlines and increased exposure to pollutant aerosols. Int. J. Radiat. Biol, 75 (12), 1523-1531.

4. National Radiological Protection Board. Particle deposition in the vicinity of power lines and possible effects on health. Documents of the NRPB 2004, 15(1).

Competing interests: None declared

Childhood cancer and power lines

8 June 2005

tony fogarty, GP locum
202 Unthank Rd, Norwich,, NR2 2AH

Send response to journal: Re: Childhood cancer and power lines

'Power lines may be linked to childhood leukaemia' and 'Leukaemia:avoid living near high voltage lines...'

These headlines do a grave disservice to the thoughtful paper by Draper et al, distorting their cautious conclusions. They are a gift to the superficial fear-mongering elements in the media and will be quoted unquestioningly for years to come. 'Brain tumours more than halved by living near power lines' would be as valid and erroneous. Headlines which are seemingly written to catch attention rather than to convey the truth are not suitable for a serious scientific journal.

Competing interests: None declared

Mechanisms of leukaemogenisis by powerlines

8 June 2005

Alan W Preece, Emeritus Professor *University of Bristol, Bristol Oncology Centre, Horfield Road, Bristol, BS2 8ED*, Mary G. Wright

Send response to journal: Re: Mechanisms of leukaemogenisis by powerlines

The elevation of leukaemia risk out to 600m does indeed make it unlikely that magnetic fields are associated with risk, but does not dismiss the possibility of a physical mechanism associated with high voltage. In the full text of this paper, the authors claim to have tested Fews at al (1) hypothesis albeit in an oversimplified model. To test this hypothesis correctly, the wind direction used to assign correctly up or down wind status to a case or control must reflect the predominant wind direction in that area. While for the country on average, southwest is the predominant wind direction, there are areas of England and Wales where the predominant wind direction is not southwest as demonstrated by the Meteorological Office’s wind roses. Incorrectly assigning up and down wind status will smear the result.

Also, the authors have included only a small proportion of the 132kV lines. These lines like the 275 and 400kV will produce small air ions in as large quantities and are maybe 5 or 6 times as frequent as the higher voltage lines.

Given that the study only includes a small fraction of the 132kV lines and the assumption that the prevailing wind is from the southwest for the whole country, this study cannot be said to test the hypothesis, and therefore there may still be a mechanism to be tested.

(1) Fews AP, Henshaw DL, Wilding RJ, Keitch PA. Corona ions from powerlines and increased exposure to pollutant aerosols. Int J Radiat Biol 1999;75:1523-31

Competing interests: None declared

Other incidental carcinogens near power lines

9 June 2005

Wayne A. Hunter, EMC Engineer
Agilent Technologies, Wilmington DE 19808

Send response to journal: Re: Other incidental carcinogens near power lines

The authors also did not indicate whether any of the power lines in question were in use in the 1940s and 1950s when the use of spray herbicides, which are now banned due to carcinogenic and other health effects, were sprayed under the power lines to assist with plant control. These materials also would have a similar effect of reduction in incidence of carcinogenic effects with distance. Since the bio-persistence of toxicity for many of these chemicals is over 100 years, the material is still available for inhalation and injestation. The effect on small children breathing trace amounts of vapor or inhaling dirt with the material could also be a significant impact to this study. It would be interesting to assess the data in regard to the age of the power line and use of herbicides for plant control as a possible source of the increase in incidence.

Competing interests: None declared

Levels of Exposure

11 June 2005

Bonnie M McKinnon, Consultant
Calgary, AB T3L 1L2

Send response to journal: Re: Levels of Exposure

I have been eagerly waiting for current information with respect to EMF's and any relation to health issues. I am not in the health field, and have been subjected to pouring over inconclusive research linking distances, wire codes, etc., now corona ion emissions. I am a consumer, looking to purchase a home which borders on a Transportation Utility Corridor. After reading all these reports, I have not been able to ascertain exposure at constant levels of X mG may or may not producing cause. I have received readings of 60 mG at the back of the lot, 30 mG mid-back yard, 15 mG at the back of the house, 10 mG mid-house, 8 mG front of house, and 3.7 mG at the sidewalk. Are these levels consistent with research which has not proven cause, or are the levels higher or lower?

Competing interests: None declared

Electrical occupations and leukaemia

13 June 2005

Marie B Mc Devitt, Public Health Specialist
Stockport PCT, Regent House, Stockport SK4 1BS, England

Send response to journal: Re: Electrical occupations and

Although the authors of the paper on powerlines and childhood leukaemia (1) state that there is no accepted biological mechanism to explain the epidemiological results they found, there are a couple of points which may be of relevance.

Firstly, according to a study on occupational mortality in Great Britain (2) two major groups of electrical occupations show raised standardised mortality ratios (SMRs) for both all leukaemias and for acute myeloid leukaemia. For electrical and electronic engineers the SMR for all leukaemias for men aged 20-64 years was 202 and similarly for electricians, fitters, plant operators etc the SMR for acute myeloid leukaemia was 155. Both SMRs were statistically significant at the 95% confidence level.

leukaemia

Secondly, apparently all chemical reactions are basically electric in nature since they involve exchanging or sharing negatively charged electrons between atoms to form ions or bonds (3).

Perhaps electric or magnetic fields are having some particularly sensitive effect on the electrical charges of the cells in the bone marrow?

1. Draper G, Vincent T, Kroll ME, Swanson J. Childhood cancer in relation to distance from high voltage power lines in England and Wales: case control study. BMJ 2005;330:1290-3.

2. Office of Population Censuses and Surveys. Occupational mortality, decennial supplement 1979-80, 1982-83. Series DS no6. London: HMSO, 1986.

3. Vander A, Sherman JH, Luciano DS. Human Physiology-the Mechanisms of Body Function. McGraw-Hill, 1975.

Competing interests: None declared

Not so plausible causal origin

14 June 2005

Les A Coulton, Senior Research Scientist *University of Sheffield Medical School, Beech Hill Rd. Sheffield, S102RX*

Send response to journal: Re: Not so plausible causal origin

Professor Henshaw suggests that the higher incidence of childhood leukaemia near power lines could be due to two independent phenomena namely suppression of nocturnal pineal melatonin and corona ion emission. Doesn't it seem rather unlikely that to explain the distribution of leukaemia patients there needs to be invoked two unrelated biological mechanisms which by chance lead to the same uncommon disease whilst not affecting other childhood cancers?

A report of the independent Advisory Group on Non-ionising Radiation (AGNIR) which investigated the possible effects of corona ions or electric fields on intake of radioactive particles or other airborne pollutants stated that the main health hazards of airborne particulate pollutants are cardiorespiratory disease and lung cancer. The report concluded:

"However, it seems unlikely that corona ions would have more than a small effect on the long-term health risks associated with particular air pollutants, even in individuals who are most affected. In public health terms, the proportionate impact will be even lower because only a small fraction of the general population live or work close to sources of corona ions."

AGNIR is also considering the interaction between melatonin and electromagnetic fields and the report is currently in its final draft.

Given that neither of the suggested mechanisms has yet been shown to be of significance to human health, and that Professor Henshaw's construct relies on both of them, this hypothesis is not a strong candidate to explain the Draper findings.

Competing interests: None declared

High voltage magnetic fieldsand childhood malignancies

15 June 2005

Dr JK Anand, Retired public health physician
N/A

Send response to journal: Re: High voltage magnetic fieldsand childhood malignancies

Whatever be the mechanism involved, it seems desirable to conduct animal epidemiological studies. This suggestion was made by me fifteen years ago(1).

JK Anand

Reference.

The Veterinary Record, 1993, 132/1,24 (2 January)

Competing interests: None declared

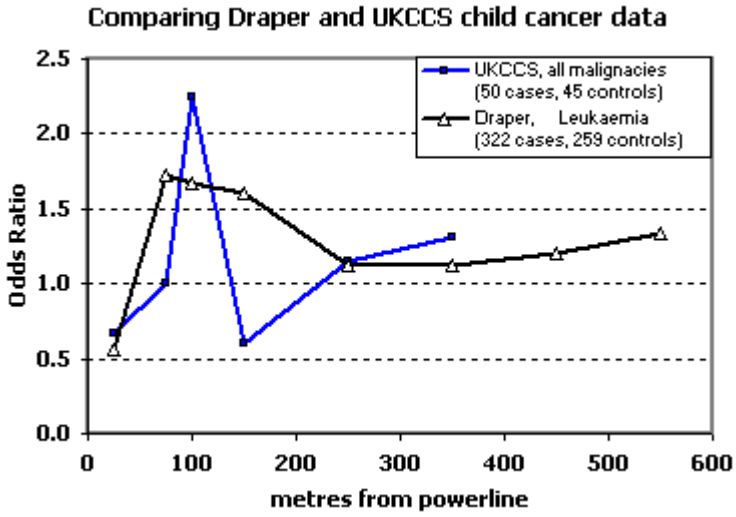
Both Draper and UKCCS data support Henshaw hypothesis

16 June 2005

Alasdair M Philips, Director of Powerwatch
CB6 2QA

Send response to journal: Re: Both Draper and UKCCS data support Henshaw hypothesis

Despite the statements of some scientists, the UKCCS [1] did find elevated incidence of childhood leukaemia close to powerlines. When the UKCCS data is plotted as simple Odds Ratios for 275 kV and 400 kV powerlines [2], it shows a similar peak as this latest study at 100 metres and, more importantly, rising again after 150 metres.



This new study supports a likely magnetic field effect on child leukaemia incidence near to powerlines. 100 metres is beyond the typical 400 nanotesla point, but this is without taking polarisation / ellipticity of the field into account which induces higher currents in people and will be likely to increase the effective distance [3].

After a dip, both studes then show an ongoing rise in incidence after a few hundred metres which would closely fit the Henshaw charged aerosol hypothesis. Actual measurements [4] have found charged

aerosol effects from about 150 metres to several km from powerlines before diffusing to ground level - a long way from the source of the corona ions and affecting a significant number of people.

If Henshaw is right, then the adverse health effects of powerlines will extend to well over 1 km from the powerlines. It would be easy to test for this by extending the analysis of the Draper data up to a distance of at least 2km to see how far the elevated risk continues.

Refs:

[1] UKCCS Investigators, Childhood cancer and residential proximity to power lines, 2000, Br.J.Cancer, 83(11), 1573-1580

[2] Graph available at:
www.powerwatch.org.uk/external/20050614_bmj_275-400kV.gif

[3] Ainsbury, E, et al, Conference poster,
www.leukaemiaconference.org/programme/posters/day3-ainsbury1.pdf

[4] Fews A.P., et al, Modification of atmospheric DC fields by space charge from high voltage power lines, 2002, Atmospheric Research, 63: 271 - 289

Competing interests: Powerwatch comments on potential health effects of electromagnetic fields

Missing dose - effect relation

17 June 2005

Gerhard Juli, Engineer
Public Utility 87435 Kempten, Germany

Send response to journal: Re: Missing dose - effect relation

Like many of similar studies (e.g. Ahlbom, Feychting), Draper, Vincent et alt. lack a relation between the dose and effect. Not calculated is the duration of living close to power lines. Excluded is the 11 kV (kilovolt) system, which is much more widespread then higher voltage systems. The magnitude of the magnetic fields of 11 kV-systems is the same like those of higher voltages. This is true also for cables lying underground because of the proximity to the public (around 1m).

At a distance of about 50 ... 100 m from the axis of a overhead powerline system the strength of the electric and magnetic fields fall to the background level.

When measuring electromagnetic fields, I always found the highest levels (out of occupational locations) in households, especially close to devices whith magnetic components like dishwashers, transformers (battery chargers), speakers, computers.

What about trains? Because they use 25 kV single-phase low frequency alternating current (ac), the fields of those powerlines are a multiple of that of “ordinary” powerlines.

Even systems not intended to carry electric current like central heating, gas pipes, water pipes can produce magnetic fields of considerable strength due to balancing currents.

Competing interests: None declared

Comments on Draper et al BMJ 1290 4June 2005

21 June 2005

Michael J O'Carroll, Professor Emeritus *University of Sunderland (home address) Garden House, Welbury, Northallerton DL6 2SE*

Send response to journal: Re: Comments on Draper et al BMJ 1290 4June 2005

Introduction

These comments are primarily from the viewpoint of a mathematician. While the paper reports a major study in scale, some of the statistics are weak, particularly in the findings at greater distances from powerlines.

On the other hand some responses have seized upon those results at greater distances (up to 600 metres), where associated fields may be negligible, to dismiss any hypothesis for a magnetic field effect. Such dismissive claims do not stand up to mathematical scrutiny. Such claims also overlook the possibility of associated exposure in time spent closer to the line, for example at nursery or school. Further, while hastily relying on weak statistical results, such claims dismiss the stronger statistical association with childhood leukaemia established for flux densities above 0.4 microTesla.

Possible understatement of potential effects

The exposure metric in this study is proximity of birth address to National Grid power lines. That would seem an uncertain proxy for any particular field effects, compounded by uncertainty in the timing of exposure. Genetic evidence suggests, in many cases, a two-stage causal process of in-utero genetic damage followed by conversion in childhood to the disease. Address at birth may be better correlated with the first stage than the second. Uncertainties in relevant exposures would tend to dilute statistical evidence indicative of causation.

General population studies which ignore susceptible subsets can greatly mask possible causal associations [1]. It would be helpful to study the relation of exposure in utero to incidence of genetic damage (identifiable by blood tests) and, separately, the relation of exposure prior to diagnosis in children with genetic damage to incidence of the disease. The risk in these two subset-related stages could be in the region of 1 in 200, in contrast to the whole population risk of 1 in 20,000 per year, with potentially much greater statistical resolving power for small relative risks.

Statistical features

Table 1 shows some odd features in the data. Firstly, the relative risk (RR) is more like a step function with distance (suggesting a possible exposure threshold) than an inverse power relation. Secondly, within the 200 - 600 metre range there is a strange counter-trend; as results in this range are barely statistically significant (CI 1.02 - 1.49) this suggests chance variations or chance events rather than something more systematic.

The authors estimate, with qualifications, that about 1% of childhood leukaemia would be attributable to National Grid lines. That leads to about 5 attributable cases per year, some ten times higher than suggested by previous studies. The 1% of cases would reflect an

average relative risk of about 1.25 on the 4% of children living within 600 metres. Discounting the contribution from the most uncertain range of 200 - 600 metres would leave a population of about 0.7 % of children (population is lower closer to powerlines) within 200 metres with a relative risk of about 1.7 of which 0.7 is attributable. That amounts to about 0.5 % of cases, which would only reduce the estimated attributable outcome to 2.5 cases per year. So the stronger statistical findings in the range 0 - 200 metres alone support about half the increased attribution.

Table 1 shows large variations in the distributions of the three sets of controls. The controls need not be similarly distributed, as they match different case sets, but such differences are not explained. Maldistribution of controls would not wholly explain the finding, as the authors observe, but the differences remain disconcerting.

Conclusions

1. The study is important in that it is on a large scale and deals with proximity of birth address to powerlines. In contrast, other key studies, which lie behind the statistical association of childhood leukaemia with magnetic flux density, refer mainly to pre-diagnosis exposures. The extent that this study might represent exposure to EMF in utero or pre-diagnosis is unclear.

2. The study finds statistically significant results of two kinds. First there are stronger results for birth addresses within 200 metres of a power line. Second there are weaker results in the range 200 - 600 metres with statistical quirks.

3. The results within 200 metres broadly reinforce the known doubling of risk of childhood leukaemia for pre-diagnosis exposure above 0.4 microTesla. However, they suggest the number of attributable cases from National Grid lines would be about 5 per year, some ten times more than previous estimates; this reduces to five times more using only the stronger results. This may be a reflection of a greater effect of pre- natal exposure compared with pre-diagnosis exposure, but this is not clear. There are uncertainties in both old and new estimates.

4. The results in the range 200 - 600 metres are likely to be spurious. They should not be relied on to support or deny an effect up to 600 metres. The argument that these results are incompatible with magnetic field levels should not be relied on to dismiss magnetic field hypotheses nor to counter the established statistical association with magnetic flux densities.

5. The uncertainty in exposure metric, and between pre-natal and pre-diagnosis exposure, would tend to understate any potential underlying causation. Better focused studies on the two stages would be helpful and could be much more robust statistically.

Reference

[1] M J O'Carroll, Searching for causes: focusing epidemiology, Paper P1-15, Children with Leukaemia: Scientific Conference 6-10 September 2004.

Competing interests: None declared

Re: Childhood cancer in relation to distance from high voltage power lines in England and Wales: a case- control study.

22 June 2005

Leeka Kheifets, Professor *UCLA, Los Angeles, 90095*, Maria Feychting , Joachim Schuz

Send response to journal: Re: Re: Childhood cancer in relation to distance from high voltage power lines in England and Wales: a case-control study.

Re: Childhood cancer in relation to distance from high voltage power lines in England and Wales: a case- control study. Leeka Kheifets1, Maria Feychting2, Joachim Schüz3 1. Department of Epidemiology, School of Public Health, UCLA, CA, USA 2. Institute of Environmental Medicine, Karolinska Institutet, Sweden 3. Institute of Cancer Epidemiology, Danish Cancer Society, Denmark We have read with interest the paper from Draper and colleagues [1]. Given its large size the risk estimates in the paper should be stable. Furthermore, because contact with the subject was not necessary selection bias due to the differential participation among cases and controls, which plagued some of the previous studies [2], has been avoided. Thus we were particularly surprised by the dependence of the results on the chosen control group noted by the authors, (who used CNS and other cancer controls for leukaemia cases in one of the comparisons). To explore this further we combined all controls into one group and used it for comparison. We felt this is justified based on both theoretical and empirical grounds: exposure at birth among controls chosen for leukaemia, brain tumours and other cancers should not depend on the cancer subtype; crude odds ratios calculated by us did not differ (beyond first decimal) from the matched results presented by authors (data not shown). Use of the combined control group revealed a pattern different than the one presented in the original paper (Table 1). As would be expected, results for all cancers combined show no relation to the distance. For both leukaemia and brain cancer results at two distances are noteworthy: for the 50-100 meters category an excess of leukaemia and a deficit for brain tumours is observed. For the 500-600 meters category we observed a modest excess for both leukaemia and brain tumours. Of note is that the trend reported in the original paper is not present when the combined control group is used, thus indicating that the trend depended on the leukaemia controls rather than on the leukaemia cases. We agree with the authors that the results of this study do not support a possible magnetic field association, as has been reported by the IARC monograph [2]. However, distance is known to be a very poor predictor of magnetic field exposure, and therefore, results of this material based on calculated magnetic fields, when completed, should be much more informative. Further insight might be gained by details on the methods used for the control selection and sensitivity analyses by age, sex and time period. 1. Draper G, Vincent T, Kroll ME, Swanson J. Childhood cancer in relation to distance from high voltage power lines in England and Wales: a case- control study. BMJ 2005; 330:1290-2. 2. Ahlbom A, Day N, Feychting M, et al. A pooled analysis of magnetic fields and childhood leukaemia. Br J Cancer, 83, 692-8 (2000). 3. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Vol 80

Non Ionizing radiation, Part 1: Static and Extremely Low – Frequency Electric and Magnetic Fields. 2002 Distance of address at birth from nearest National Grid line and estimated odds ratios using all controls combined Leukemia CNS Other tumours All cancer combined All controls Distance No. cases OR (95% CI) No. cases OR (95% CI) No. cases OR (95% CI) No. cases OR (95% CI) No. controls 0-49 5 0.94 (0.34-2.57) 3 0.83 (0.24-2.84) 7 1.00 (0.41-2.42) 15 0.94 (0.46-1.90) 16 50-99 19 1.73 (0.99-3.05) 4 0.53 (0.19-1.51) 15 1.04 (0.56-1.91) 38 1.15 (0.72-1.84) 33 100-199 40 1.18 (0.82-1.70) 26 1.12 (0.73-1.73) 37 0.83 (0.57-1.20) 103 1.01 (0.77-1.33) 102 200-299 44 0.93 (0.66-1.30) 38 1.17 (0.82-1.68) 66 1.05 (0.78-1.41) 148 1.04 (0.82-1.31) 143 300-399 61 1.23 (0.91-1.66) 35 1.04 (0.72-1.50) 79 1.21 (0.92-1.59) 175 1.18 (0.95-1.47) 149 400-499 78 1.15 (0.89-1.50) 40 0.86 (0.62-1.22) 80 0.89 (0.69-1.16) 198 0.97 (0.80-1.18) 204 500-599 75 1.24 (0.95-1.63) 54 1.31 (0.96-1.78) 86 1.08 (0.83-1.39) 215 1.18 (0.97-1.44) 182 ™600 9378 1 (ref) 6405 1 (ref) 12406 1 (ref) 28189 1 (ref) 28252

Competing interests: For LK work for EPRI and consulting with utilities

Control Selection in the study of Childhood cancer in relation to distance from high voltage power lines in England and Wales

22 June 2005

Leeka Kheifets, Professor of Epidemiology *UCLA, Los Angeles, 90095*, Maria Feychting , Joachim Schuz

Send response to journal: Re: Control Selection in the study of Childhood cancer in relation to distance from high voltage power lines in England and Wales

Leeka Kheifets1, Maria Feychting2, Joachim Schuz3

1. Department of Epidemiology, School of Public Health, UCLA, CA, USA

2. Institute of Environmental Medicine, Karolinska Institutet, Sweden

3. Institute of Cancer Epidemiology, Danish Cancer Society, Denmark

We have read with interest the paper from Draper and colleagues [1]. Given its large size the risk estimates in the paper should be stable. Furthermore, because contact with the subject was not necessary selection bias due to the differential participation among cases and controls, which plagued some of the previous studies [2], has been avoided. Thus we were particularly surprised by the dependence of the results on the chosen control group noted by the authors, (who used CNS and other cancer controls for leukaemia cases in one of the comparisons). To explore this further we combined all controls into one group and used it for comparison. We felt this is justified based on both theoretical and empirical grounds: exposure at birth among controls chosen for leukaemia, brain tumours and other cancers should not depend on the cancer subtype; crude odds ratios calculated by us did not differ (beyond first decimal) from the matched results presented by authors (data not shown).

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Further insight might be gained by details on the methods used for the control selection and sensitivity analyses by age, sex and time period.

1. Draper G, Vincent T, Kroll ME, Swanson J. Childhood cancer in relation to distance from high voltage power lines in England and Wales: a case- control study. BMJ 2005; 330:1290-2.

2. Ahlbom A, Day N, Feychting M, et al. A pooled analysis of magnetic fields and childhood leukaemia. Br J Cancer, 83, 692-8 (2000).

3. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Vol 80 Non Ionizing radiation, Part 1: Static and Extremely Low ¨C Frequency Electric and Magnetic Fields. 2002

Competing interests: For LK work with EPRI and consulting for utilities.

Control selection in the Study of Childhood cancer in relation to distance from high voltage power lines in England and Wales

28 June 2005

Leeka Kheifets, Professor of Epidemiology
UCLA, Los Angeles, CA 90095, Maria Feychting, Joachim Schuz

Send response to journal: Re: Control selection in the Study of Childhood cancer in relation to distance from high voltage power lines in England and Wales

Re: Childhood cancer in relation to distance from high voltage power lines in England and Wales: a case- control study.

Leeka Kheifets[1], Maria Feychting[2], Joachim Schuz[3]

1. Department of Epidemiology, School of Public Health, UCLA, CA, USA

2. Institute of Environmental Medicine, Karolinska Institutet, Sweden

3. Institute of Cancer Epidemiology, Danish Cancer Society, Denmark

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We have read with interest the paper from Draper and colleagues [1].šš Given its large size the risk estimates in the paper should be stable. Furthermore, because contact with the subject was not necessary selection bias due to the differential participation among cases and controls, which plagued some of the previous studies [2], has been avoided.š Thus we were particularly surprised by the dependence of the results on the chosen control group noted by the authors, (who used CNS and other cancer controls for leukaemia cases in one of the comparisons).šš To explore this further we combined all controls into one group and used it for comparison.š We felt this is justified based on both theoretical and empirical grounds: exposure at birth among

controls chosen for leukaemia, brain tumours and other cancers should not depend on the cancer subtype; crude odds ratios calculated by us did not differ (beyond first decimal) from the matched results presented by authors (data not shown).

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2. Ahlbom A, Day N, Feychting M, et al. A pooled analysis of magnetic fields and childhood leukaemia. Br J Cancer, 83, 692-8 (2000).

3. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Vol 80 Non Ionizing radiation, Part 1: Static and Extremely Low – Frequency Electric and Magnetic Fields.š 2002

Distance of address at birth from nearest National Grid line and estimated odds ratios using all controls combined

š	Leukemia		CNS		Other tumours	
Distance	No. cases	š OR (95% CI)	No. cases	š OR (95% CI)	No. cases	š OR (95% CI)
0-49	5	0.94 (0.34-2.57)	3	0.83 (0.24-2.84)	7	1.00 (0.41-2.42)
50-99	19	1.73 (0.99-3.05)	4	0.53 (0.19-1.51)	15	1.04 (0.56-1.91)
100-199	40	1.18 (0.82-1.70)	26	1.12 (0.73-1.73)	37	0.83 (0.57-1.20)
200-299	44	0.93 (0.66-1.30)	38	1.17 (0.82-1.68)	66	1.05 (0.78-1.41)
300-399	61	1.23 (0.91-1.66)	35	1.04 (0.72-1.50)	79	1.21 (0.92-1.59)
400-499	78	1.15 (0.89-1.50)	40	0.86 (0.62-1.22)	80	0.89 (0.69-1.16)
500-599	75	1.24 (0.95-1.63)	54	1.31 (0.96-1.78)	86	1.08 (0.83-1.39)
™600	9378	1 (ref)	6405	1 (ref)	12406	1 (ref)

Competing interests: For LK work with EPRI and consulting with utilities

Fields from Transit System

29 June 2005

Donald S Amstrong, EMC consultnat *Derby DE56 4BY*
Send response to journal: Re: Fields from Transit System

If Bonnie McKinnon reads this, the flux densities she has seen, with 15 mG at the house, are consistent with a three-rail transit railway [no overhead cables] with a typical load of 1000 amps at a distance of 10 metres, thirty feet. This is a dc field and I know of no suggestion that dc or slowly varying fields affect health. Draper et al were reporting on ac fields from ac overhead power lines.
Competing interests: None declared

Authors' reply

4 July 2005

Gerald Draper, Honorary Senior Research Fellow *Childhood Cancer Research Group, University of Oxford, 57 Woodstock Rd, Oxford, OX2 6HJ*, Tim Vincent, Mary E. Kroll, and John Swanson
Send response to journal: Re: Authors' reply

We thank everyone who has commented on our paper; we respond here only where we feel we can add anything to what we have already said in the paper.
Various commentators have criticised us for publishing alarming results that we are unable to explain. We should have preferred to delay publication until we could offer a definitive explanation for our results. However, once the analysis was complete, it would have been unethical not to publish results of potential public health significance. Moreover, a partial version of these results had been leaked and it became clear that the only satisfactory way to respond to these leaks was to publish the complete results.
We address first the responses concerning problems of methodology and interpretation of the results, and then those that suggest possible explanations of the results.
We do not agree with the statement by Hepworth et al that "the findings are inconsistent with [the UKCCS1] study" – the only other UK study with which comparison can be made. We consider that our results are entirely consistent with that study: their relative risk (for acute lymphoblastic leukaemia) of 1.42 for 0-400 m seems to agree rather well with ours of 1.69 for 0-200 m and 1.23 for 200-600 m. This conclusion is not weakened by the fact that the UKCCS estimate was not statistically significant; this lack of statistical significance could be a consequence of the smaller sample size in that study.
Hepworth et al and Kheifets et al raise questions concerning the controls. As we stated in our paper, it seems possible that the elevated relative risk for leukaemia depends, at least partly, on an unrepresentative set of controls, since the addresses of the leukaemia controls tend to be further from power lines than those of the controls for the other diagnostic groups. We are puzzled by the suggestion by Hepworth et al that findings can be considered to be less robust if the estimates are noticeably different when the matching is broken, though, as Kheifets et al point out, in the present analysis the estimates in fact remain essentially unaffected. This is, however, quite separate from the question of whether the complete set of controls should have been used. Kheifets et al show that different estimates are then obtained. Although these authors do not say so, these estimates would provide little evidence for a relation between distance and leukaemia risk. There are

two reasons for regarding these latter estimates as unsatisfactory. First, they do not take account of the original matching factors, particularly year of birth and birth registration district. In fact, adjusting for birth year has little effect on the estimates whichever set of controls is used. One cannot, however, allow for a possible effect of birth registration district in the unmatched analysis. Secondly, and in our view more importantly, it is invalid to re-analyse the data using alternative controls if this is done simply because the first set gives unexpected results. (The situation is different if the original analysis is subject to bias. It is extremely unlikely that there is any important source of bias here.)
Hepworth et al suggest that adjustment for confounding factors might explain our results. Neither our (admittedly less than adequate) measure of socio-economic status (reported in the paper) nor population density (not reported) explains the findings. We considered the question of population mixing but it is not clear that an appropriate measure is available for the whole of England and Wales over a period of 34 years. We agree there might be other confounding factors that could explain our results were we able to identify them.
Whitlock raises the question of bias arising from possible differences in the likelihood of omitting cases near and far from lines. We think this is unlikely, but such an effect would presumably apply also to the controls and to the other diagnostic groups.
Coghill, Hepworth et al and O'Carroll refer to our calculation that the association with distance that we reported implies that five cases of childhood leukaemia a year in England and Wales would be attributable to high voltage power lines if the association is causal. None of these writers repeats our distinction between (chance) association and causality. Coghill makes suggestions about the numbers of cases attributable to 132kV lines. We do not agree with all his reasoning, but in any event he goes beyond our data. O'Carroll's calculations are based on the assumption that the results at 0-200 metres are due to magnetic fields while those at 200-600 metres are due to chance. We do not think it justifiable to make an arbitrary division of our results into two bands.
Some of our correspondents over-interpreted, perhaps misinterpreted, the findings. Burgess draws attention to the finding of a decreased relative risk for CNS/brain tumours near the lines. But this decrease, unlike the increase for leukaemia, is not part of a statistically significant trend, nor does it correspond to any prior hypothesis. We agree with Gaylord's suggestion that the pattern of results for CNS/brain and other tumours appears to be due to chance; this particular argument cannot be applied to leukaemia though we have emphasised that, for other reasons, we regard it as possible that the results are in fact due to chance. Phillips appears to place too much emphasis on small, probably chance, increases in relative risks at greater distances. His graph appears to contain some inaccuracies and compares our leukaemia results with the UKCCS 'all malignancies'. As explained above, we do however agree with him that our results relating to distance and leukaemia risk are consistent with those of the UKCCS.
We, and our respondents, have considered a number of alternative explanations for our results. Henshaw and Preece refer to Henshaw's corona ions hypothesis. Coulton questions its plausibility; we tested for it without taking any view on its plausibility. We described our test as "oversimplified". Preece, who devised the method, points out the simplification that all addresses in the north-east quadrant from the line are considered "exposed", i.e. that the wind that transports these ions is assumed to be from the south-west, whereas one ought to consider actual wind directions. Additionally, all addresses within 600 m are

considered equally exposed, without taking account of the actual distance or the different propensity of different lines to produce ions, and the method considers the closest point of the line only. We are analysing our data using a better test, agreed with both Preece and Henshaw, avoiding these simplifications.

Coghill, Juli, Lincoln and Preece raise questions about the measurement of fields and about other sources of EMFs. We made no assumption about a direct equivalence between field and distance. We shall analyse calculated fields in a further paper; these fields, which are still being checked, take into account the line characteristics mentioned by Juli. We are investigating the possibility of analysing proximity to, and calculated fields from, lower voltage distribution systems, but not those from domestic appliances. Electric fields, suggested by Coghill, appear no more likely to explain risks at 600 m than magnetic fields.

We shall investigate as many as possible of the various suggested explanations put forward by Koenigbuescher, Netter, Poston, Coghill, Henshaw, Preece and McDevitt, though in many cases the relevant data will not be available.

1 UK Childhood Cancer Study Investigators. Childhood cancer and residential proximity to power lines. Br J Cancer 2000; 83:1573-80.

Competing interests: GJD, TJV and MEK: no conflict of interest. JS is employed by National Grid Transco and worked on this project with their permission

Childhood Cancer and distance from high-voltage power lines – what do the data mean?

5 July 2005

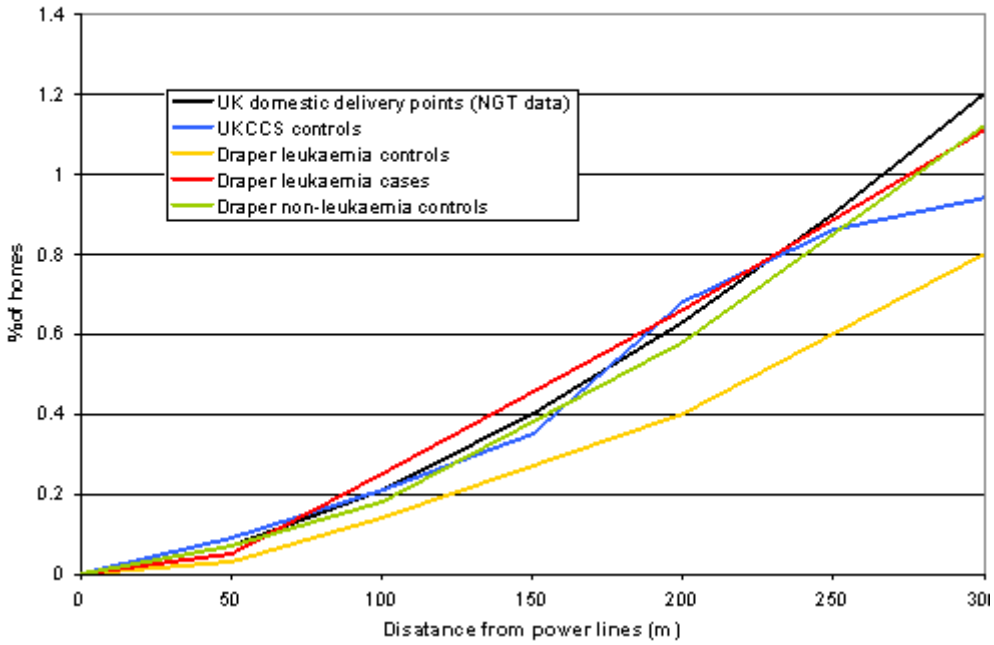
Eve Roman, Professor of epidemiology [corrected from researcher 20.7.05] *Department of Health Sciences, University of York, YO10 5DD*, Nick Day, Tim Eden, Patricia McKinney, Jill Simpson

Send response to journal: Re: Childhood Cancer and distance from high-voltage power lines – what do the data mean?

Draper and colleagues1 used distance of mother's home from high-voltage (HV) overhead transmission lines at the time of her child's birth as a proxy for her child's subsequent power-frequency magnetic field exposure(reviewed in Ahlbom et al2). As the authors acknowledge, this is a crude estimate since, in contrast to other more comprehensive reports 2, no household measurements were taken, no data on more prevalent low- voltage distribution sources were collected, no information from other time-points was obtained, and no validatory home visits were carried out.

National data on the distribution of houses in relation to HV lines in the UK was provided (J Swanson NGT personal communication) to the United Kingdom Childhood Cancer Study (UKCCS) for their study of power lines and childhood cancer in order to assess the representativeness of study subjects 3. These assessments of distance to power lines in the UKCCS were made for all registered controls, who have been shown to represent the general population4. A plot of the distributions of the Draper study leukaemia and non-leukaemia cases and controls, national and UKCCS populations by distance from HV lines (see figure [corrected figure with different scale on x axis added 20.7.05]) seem to clearly show that the leukaemia controls in the study from Draper et al are systematically different. Their positive result over 100m may therefore be explained not by an excess of cases but by a deficit of controls.

Figure: Draper et al study - proportion of subjects living close to power lines; con national data supplied by National Grid Transco and the UKCCS



Nick Day
Tim Eden
Patricia McKinney
Eve Roman
Jill Simpson

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3. Skinner J, Maslanyj M, Mee TJ, Allen SG, Simpson J, Roman E et al. Childhood cancer and residential proximity to power lines. UK Childhood Cancer Study Investigators. Br.J.Cancer 2000;83:1573-80.
4. UK Childhood Cancer Study Investigators. The United Kingdom Childhood Cancer Study: objectives, materials and methods. UK Childhood Cancer Study Investigators. Br.J.Cancer 2000;82:1073-102.

Competing interests: None declared

reply to authors' reply

20 July 2005

Michael J O'Carroll, Professor Emeritus
Garden House DL6 2SE
Send response to journal: Re: reply to authors' reply

In their reply to responses received, the authors say: "O'Carroll's calculations are based on the assumption that the results at 0-200 metres are due to magnetic fields while those at 200-600 metres are due to chance. We do not think it justifiable to make an arbitrary division of our results into two bands."
I made no such assumption. I simply estimated how much of the associated excess incidence found by the authors would be in the range 0- 200 metres. On that point I concluded "So the stronger statistical findings in the range 0 - 200 metres alone support about half the

increased attribution".
I made no such arbitrary division. The authors made the division in presenting their results. I made comments on the statistical nature of their results so divided. I made only tentative conclusions about possible reasons for their results and I made no assumptions about causation. Far from using arbitrary banding or incurring statistical effects of so doing, I cautioned against taking the results from 200 to 600 metres out of context to support or deny an effect.
Finally, I was careful to distinguish between association and cause, contrary to the general allegation which the authors make against several respondents.
Competing interests: None declared

Re: Childhood Cancer and distance from high-voltage power lines – what do the data mean?

21 July 2005

David E Jeffers, retired engineer (ex NGC)
none
Send response to journal: Re: Re: Childhood Cancer and distance from high-voltage power lines – what do the data mean?

Prof. Roman makes an interesting point but the distribution of housing density with distances from power lines, which was produced recently for the UKCCS, should not be applied over the timescale of the Draper et al study.
The study considered data for the period 1962-95 and there have been profound social, environmental and economic changes during this time. The 400-kV electical network was developed during the 1960's and, initially, much of it ran through industrial landscapes. Most of the heavy manufacturing industry which these lines were designed to serve is long gone and, as in London Docklands, for example, urban development has taken its place. This has resulted in the construction of housing near to existing over head power lines and, as a consequence the number of houses near lines increases with time.
Mention is also made in some of the reponses to the effect of power line corona on particulate pollution. The start of the study falls between the Clean Air Act of 1956 and its extension in 1968. The early stages of the period covered by the study would have seen a marked fall in general pollution levels.
Competing interests: None declared

Proximity and exposure metric deficiencies.

25 July 2005

Michael J O'Carroll, Professor Emeritus, University of Sunderland
Garden House, Welbury, Northallerton DL6 2SE
Send response to journal: Re: Proximity and exposure metric deficiencies.

The authors estimate an increased attribution, if the association were causal, of about 5 cases of childhood leukaemia per year in England and Wales, among some 400,000 children with birth address within 600 metres of National Grid powerlines. About half of those five cases would be within 200 metres.
The NRPB [1] estimated that about two attributable cases per year in the UK would be associated with time-weighted average (TWA) magnetic fields (MF) above 0.4mT (and none below), of which about half a case would be attributable to exposures from powerlines. MF in excess of 0.4mT from powerlines would probably all occur well within 200 metres.
The population of the UK is about 13% more than that of England and Wales. National Grid powerlines include all those at 275 and 400 kV but exclude almost all those at 132 kV and lower voltages. The Draper study has a more restricted definition, in terms of both geography and exposure sources, than the key MF studies. If the only relevant cause

were MF above 0.4mT, the estimate from the Draper study of 2.5 attributable cases per year would at first sight be surprising, compared with only 0.5 from MF studies, even though both estimates are imprecise.

Does this resurrect the "wire code paradox", said to be resolved in [2], in another form? A question arises as to whether inappropriate metrics in the MF studies tend to suppress any association compared with proximity to powerlines.

MF exposure metrics in the constituent studies in both [2] and [3] are generally arithmetic averages with respect to time over 24 hours or more during the year preceding diagnosis. Some are weighted to track the individual case or control exposure over time.

One quirk in [3] is the decision "to use geometric means from all studies, because they are less affected by outliers". For positive numbers not all the same, the geometric mean G will always be less than the arithmetic mean A. That will mean G is less affected by high outliers but more affected by low ones (and critically affected by a zero!). This might be one deficiency in exposure metric for this seminal pooled MF analysis.

Another possible deficiency, having regard to melatonin hypotheses, might be the dilution of night-time exposure by 24-hour averaging. Although MF from powerlines in the UK are lower at night than in daytime, they may be the dominant night-time source. Analysis of pooled German studies [4] found an OR of 4.28 (1.25-14.7) for night-time exposures above 0.4mT. That gives an attributable RR of 3.28, compared with the attributable RR of 1 from 24-hour TWA, which lies behind the estimate of half a case per year near powerlines in the UK.

The above figures from [1], [3] and [4] could be broadly reconciled as follows, taking proximity to powerlines as a proxy for night-time exposure. Take the normal (non-attributable) EMF-associated cases to be, like the NRPB conjectured attributed cases, 0.5 per year from powerlines sources and 1.5 from non-powerlines sources. Then take the excess (attributable) cases to be 1.5 from powerlines and 0.5 from non-powerline sources. This preserves the overall RR of 2 while allowing the night-time (powerline) RR to be about 4 and incidentally implying a daytime RR of about 1.3. As the data are so imprecise, such a reconciliation is not to be taken prescriptively; it merely indicates a possible broad compatibility.

As well as dilution of night-time exposure above 0.4mT, might there be dilution above 0.2mT, where UK data suggest there are far more children? A joint EEA/WHO review [5] notes "If regression dilution were concealing a relative risk of 1.5 for children exposed to between 0.2 and 0.4mT, then the annual number of attributable cases might be six or seven". Metric dilution might also contribute to the concealment of such an association for night time exposure; Schutz [4] found OR = 3.21 (1.33- 7.80) above 0.2mT.

For the avoidance of doubt, these comments aim to raise questions, not to infer conclusions. The questions open possibilities for the findings of increased hypothetically attributable cases within 200 metres to be reconciled in terms of exposure metric deficiencies in MF studies. Other questions, e.g. about the distributions of controls, may point the other way. I don’t want to exaggerate a marginal consideration, and acknowledge the perspective in the editorial comparing 5 attributable cases with 500 others. But given public (and scientific) interest, might it yet be worth re-analysing MF studies, such as UKCCS, for night-time exposure?

[1] Board of NRPB Response Statement R3/2001. [2] Greenland et al, Epidemiology 11(6), 624-634, 2000. [3] Ahlbom et al, British Journal of Cancer 83(5), 692-698, 2000. [4] Schutz et al, Int J Cancer 91, 728-735, 2001. [5] Tamburlini et al, EEA Environmental Issue report No. 29, 2002.
Competing interests: None declared

Authors' reply to Roman et al

25 July 2005

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Send response to journal: Re: Authors' reply to Roman et al

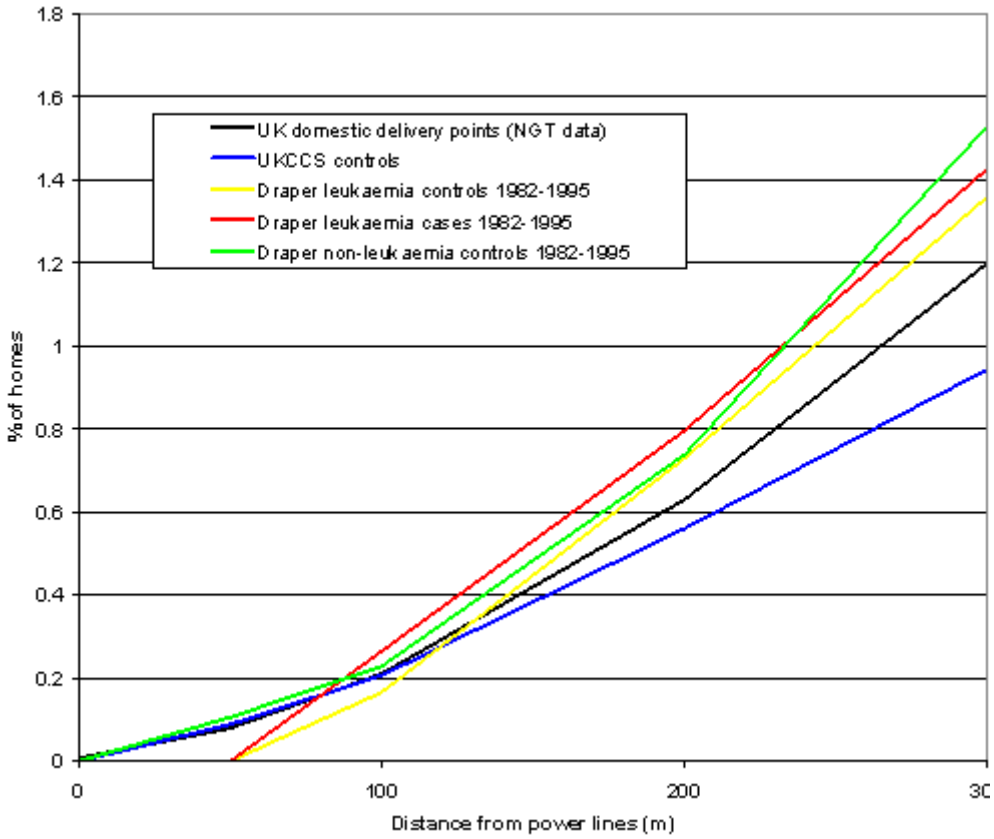
Roman and colleagues say that we used distance as a proxy for magnetic field exposure; this is correct only in a rather weak sense of the word "proxy". They go on to say that we "acknowledge [that] this is a crude estimate [of power-frequency magnetic field exposure]"; we said nothing like this. The distance analyses are similar to those used by the writers of the letter in their capacity as authors of the United Kingdom Childhood Cancer Study (UKCCS) paper [1]. We shall be presenting our analysis of calculated magnetic fields in a subsequent paper, and we regard the distance analysis in this paper as a separate analysis in its own right.

We drew attention in our paper to the possibility that the leukaemia controls are, by chance, unrepresentative.

In discussing this point, however, Roman et al make invalid comparisons in the graph accompanying their letter. Their two sets of comparison data refer to addresses in the 1990s. Our study extends over a much longer period (1962-1995), during which there were increases in the numbers of lines and of houses situated close to lines. The numbers quoted in our paper relate to the whole of this period. Their finding that there is a smaller proportion of addresses close to the line when comparing the average over the whole of this period with data for the 1990s is unsurprising given the time trend in the number of houses near lines. Our unpublished data show that when data relating to more closely comparable periods are used we actually have, for most of the distances considered, higher proportions of leukaemia controls living near lines than are found for the two comparison groups, not lower as they suggest: see attached graph. (We have taken the values for UKCCS controls from table 1 of [1].) Even when the periods are comparable, the distributions of birth addresses (our data) and diagnosis addresses and all homes (their comparison data) are not necessarily expected to be the same .

To summarise: we suggested ourselves that the distribution of our leukaemia controls means that chance has to be more seriously considered as an explanation for our results, but the evidence for this comes from internal comparisons within our data and not from suggested comparisons to other data.

1 UK Childhood Cancer Study Investigators. Childhood cancer and residential proximity to power lines. Br J Cancer 2000; 83:1573-80



Competing interests: GJD, TJV and MEK: no conflict of interest. JS is employed by National Grid Transco and worked on this project with their permission

Induced electric field

10 August 2005

Katarina Vestin, unemployed
none
Send response to journal: Re: Induced electric field

Why isn't there a discussion about a possible correlation between incidence of leukemia and r*B, that is the product between the distance from the power line and the strength of the magnetic field?
The electric field induced by the time-varying magnetic field is one possible cause of the health effects, and as far as I can see this induced field is proportional not to the magnetic field itself, but to the above product.
Competing interests: None declared