Institution: University of Leeds

Unit of Assessment: 2

Title of case study: Guiding international policy on mobile phone exposure and adult brain tumours: the UK North and Interphone study

1. Summary of the impact

More than 6.5 billion people worldwide use mobile phones, and identification of any associated health risks is of vital importance to global public health. Researchers at Leeds have had a central role in the design, scientific direction, conduct, and dissemination of Interphone, the largest and most comprehensive case-control study of mobile phone use, which showed that mobile phone use is not associated with an increased risk of brain tumours. Interphone, for which Leeds was the largest study centre from 13 countries, along with a concurrently run UK North study, has made a major contribution to government policy recommendations, international exposure guidelines for non-ionising radiation, and international assessment of carcinogenicity.

2. Underpinning research

In the late 1990s the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the World Health Organization (WHO) recommended research into the possible adverse health effects of mobile phone use.

In 1999, Leeds researchers – Principal Investigator Patricia **McKinney** (Senior Research Fellow, 1993-2001, Reader, 2001-2005, Professor 2005-date) and Roger **Parslow** (Research Associate, 1996-2001, Senior Research Fellow, 2001-2007, Senior Lecturer, 2007-date) – designed and obtained funding for an independent 'UK North' (Scotland, West Yorkshire, Trent and West Midlands) epidemiological case-control study investigating risk factors for adult brain tumours, including mobile phone use.

At the same time, McKinney and Parslow collaborated with the International Agency for Research on Cancer (IARC) in Lyon to assess the feasibility of an international study combining multiple national data sets. Once shown to be viable, the multinational Interphone study was set up to determine whether mobile phone use increased the risk of brain tumours. McKinney played a key role in establishing and implementing Interphone from its inception in 2000 and was one of five scientists on the epidemiology committee, formulating the scientific direction and conduct of the research (1). Also in 2000 in Leeds, Parslow managed the design and programming of the common data collection tool (the computer assisted personal interview (CAPI)) used by all 13 countries in Europe, North America, Asia and Australia contributing to Interphone.

As part of the UK North study in Leeds, work was done to validate how accurately individuals remember their past use of mobile phones by comparing individual 'recall' with mobile phone records (2). The results showed reported use may not represent actual use, a finding replicated in Interphone, using validation data from Leeds and 10 other international centres (3). Leeds also ran a pilot study, provided the only UK data, and consulted on data analysis, for Interphone research of mobile phone power output, leading to a new exposure assessment for mobile phone radio-frequency radiation (4). Through this key validation work, Parslow and Sarah **Hepworth** (University of Leeds; Research Fellow, 2002-05, Senior Research Fellow 2005-date) made the only UK contribution to a series of studies (2,3,4) that enhanced the scientific robustness of Interphone.

In 2006, independently of Interphone, an academic collaboration between the UK North study in Leeds and the UK South study (run by Professor Anthony Swerdlow, Institute of Cancer Research, London) published national results showing that overall mobile phone use was not associated with an increased risk of developing a brain tumour (5). This was led by Leeds (Hepworth and McKinney, first and last authors) who contributed 60% of the brain tumour cases in the study.

This UK data combined with that from 12 other countries was used to create an Interphone dataset on over 5,000 brain tumours. Leeds was the largest Interphone study centre contributing 23% of overall cases. Results from Interphone published in 2010 showed no evidence of an increase in

risk of developing a brain tumour as a result of using a mobile phone (6). Interphone remains the largest and most comprehensive case control study of different independent populations.

3. References to the research

1. Cardis E, et al (including McKinney PA and Hepworth SJ). The INTERPHONE Study: Design, Epidemiological Methods, and Description of the Study Population. Eur J Epid 2007; 22: 647-664. DOI: 10.1007/s10654-007-9152-z.
   McKinney and Hepworth worked at IARC on this publication; McKinney made a substantial contribution to the concept and design and was a member of the Epidemiology Sub-committee (named in alphabetical order as the 1st group of non-IARC authors) who wrote and critiqued the output for important intellectual content.

2. Parslow RC, Hepworth SJ, McKinney PA. Recall of past use of mobile phone handsets. Rad Protect Dosim 2003; 106: 233-40.
   A novel paper on how (in)accurately individuals recall their true mobile phone use.

3. Vrijheid M, et al for the Interphone Study Group (including McKinney PA, Hepworth SJ and Parslow RC). Validation of Short-Term Recall of Mobile Phone Use for the Interphone Study. Occ Environ Med 2006; 63: 237-43. DOI: 10.1136/oem.2004.019281.
   First international paper on the validation of recall of mobile phone use. Parslow worked as a Technical Advisor at IARC advising on analyses, interpretation and output: Leeds was the largest contributor of data. McKinney, Hepworth and Parslow critiqued the paper and UK North was the only centre to provide 3 authors on the paper.

4. Vrijheid M, et al (including Hepworth SJ and Parslow RC). Determinants of mobile phone output power in a multinational study: implications for exposure assessment. Occ Environ Med 2009; 66: 664-71. DOI: 10.1136/oem.2008.043380
   First international exposure assessment of mobile phone power output by direct measurement. Parslow was a member of the Interphone Expert Working Group on RF radiation measurement. Hepworth advised on statistical analyses and all Leeds authors contributed to study design, conduct and critiqued the paper.

5. SJ Hepworth, MJ Schoemaker, KR Muir, AJ Swerdlow, MJA van Tongeren, PA McKinney. Mobile phone use and risk of glioma in adults: a UK case-control study. BMJ 2006; 332: 883-86. DOI: 10.1136/bmj.38720.687975.55 (full paper).
   The largest (over 950 brain tumour cases) published study with significant international impact for academia, commerce, media and the general public.

6. The INTERPHONE Study Group (including McKinney PA and Hepworth SJ). Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case–control study. International Journal of Epidemiology 2010; 39: 675-94. doi:10.1093/ije/dyq079
   Final results paper of Interphone. McKinney had a major input into the intellectual content and interpretation of results.

McKinney was principal investigator of the UK North study which received £1.7 million total funding from i) the EU European 5th Framework programme 'Quality of Life and Management of Living Resources' FP5 (26%); ii) IARC (2%); iii) the UK Government (44%, including the Health and Safety Executive 22%, the Department of Health 7%, and the Mobile Telecommunications and Health Research Programme 15%); and iv) the mobile phone industry (28%).

4. Details of the impact

It has been estimated that globally there are almost as many mobile phone subscriptions as there are people. Rigorous, high quality, independent research is vital for governments and agencies responsible for safeguarding public health against a background of increasing concern over potential harms.

Impacts on health and welfare and public policy and services

International policy

The International Agency for Research on Cancer (IARC) produces monographs on environmental factors and the risk of human cancer providing scientific support for action taken by national health agencies tasked with preventing exposure to potential carcinogens. The long-awaited monograph evaluating the carcinogenicity of mobile phone exposure was delayed more than two years to ensure the inclusion of evidence from Interphone [**A**].

Primary evidence from Interphone showed that overall, mobile phone users had no increased risk of brain tumours (although in a single small subgroup of those with the highest cumulative call time, a raised glioma risk was seen). No trend in increasing risk was observed for cumulative call time or for increasing numbers of calls or years of mobile use. The World Health Organization (WHO) website [**B**] notes '*Based largely on these [Interphone] data, IARC has classified radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B)*', a low risk category which also includes coffee consumption. It also cites Interphone (the only individual study discussed) as '*the largest retrospective case-control study to date … showing no increased risk of glioma or meningioma with mobile phone use of more than 10 years'*.

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) is an independent international body that publishes *Exposure Guidelines for Non-Ionising Radiation*, endorsed by the WHO, and which includes radiofrequency fields from mobile phones. These guidelines are on the radiation protection agenda of virtually every country worldwide. They have been formally adopted as national standards in over 50 countries including Australia, Canada, many countries in Europe, Latin America and SE Asia, and form the basis of the US and Japanese guidelines. In 2010/11, ICNIRP published specifically on Interphone [**C**], commenting on its large size and noting that '*Interphone added greatly to the volume of evidence available*' and that the outcomes include an important contribution to the evidence base for the ongoing review of international exposure guidelines.

The ICNIRP Standing Committee on Epidemiology states '*the accumulating evidence is increasingly against the hypothesis that mobile phones cause brain tumours in adults'*. It adds, "*importantly, Interphone has provided valuable methodological insights aiding the interpretation of epidemiological research into mobile phones and health*" [**D**].

UK Government policy

The Health Protection Agency (HPA), now part of Public Health England, has a statutory responsibility to advise the Department of Health on health effects related to mobile phones and has adopted the ICNIRP standards on radiation protection exposure for mobile phones. In their public health advice, the HPA quote their independent Advisory Group on Non-Ionising Radiation (AGNIR) which states: '*The INTERPHONE study … has contributed importantly to our understanding of possible health risks from use of mobile phones*' [**E**]. A dedicated web section on Interphone on the HPA website has seen approximate 200 visitors a month since April 2010 (**E**). A major HPA report on radiofrequency electromagnetic fields published in 2012 addresses Interphone in detail and concludes there is no convincing evidence that mobile phone technologies cause adverse effects on human health [**F**].

Public debate and awareness

A measure of the significance of the impact of both the UK and the Interphone studies for the general public was the management of media dissemination by the Science Media Centre, London [**G**], an organisation that independently promotes the voices and views of the scientific community to the news media. McKinney gave press and TV (BBC, ITV, Sky News) briefings (e.g. *Mobile phones 'unlikely' to cause cancer*, BBC News), and we are aware of over 75 news articles, including articles in all the UK national broadsheets (e.g. *Mobile phone study finds no solid link to brain tumours,* The Guardian) and across the international press (including the New York Times and Reuters) that reported on Interphone.

Impact on commerce

Reassurance for industry

Interphone has enabled governments in over 50 countries worldwide to adopt scientifically validated exposure guidelines that have allowed continued expansion of the mobile phone industry, leading to major economic benefits. Without Interphone results, as one UK AGNIR committee member points out: '*There would have been pressures to restrict exposures to the radiofrequency radiation from mobile phones on a precautionary basis'* [**H**]**.** He added that Interphone results have '*helped to allay public anxieties about mobile phone technology'* potentially increasing their commercial value.

The mobile phone industry is forecast to have a global market value of $334.8 billion in 2015. Mobile phone network operators and manufacturers both in the UK and worldwide have committed over $13.4 billion since 2000 towards investigating health impacts of mobile phone usage. Funding to the University of Leeds and Interphone was 'firewalled' to ensure the independence of the academic researchers but the results were unsurprisingly welcomed by the industry [**I**]. The UK Mobile Operators Association, a consortium of all UK network operators, stated that '*Interphone is likely to be recognised as an important part of the wider scientific evidence'* underpinning the WHO policy advice on RF Environmental Health Criteria [**J**].

5. Sources to corroborate the impact (indicative maximum of 10 references)

[A] Letter from Head IARC Monographs Section, International Agency for Research on Cancer (IARC), confirming *Non-Ionizing Radiation, Part II: Radiofrequency Electromagnetic Fields* http://monographs.iarc.fr/ENG/Monographs/vol102/mono102.pdf was scheduled immediately after the release of the Interphone results to ensure their contribution to the evidence base.

[B] World Health Organisation*. Electromagnetic fields and public health: mobile phones*. June 2011 Fact sheet 193 http://www.who.int/mediacentre/factsheets/fs193/en/

[C] International Commission on Non-Ionising Radiation Protection (ICNIRP). (i) '*Guidance on Radiofrequency*' specifically noting Interphone http://www.icnirp.de/documents/ICNIRPnote.pdf (ii) Swerdlow AJ, et al, ICNIRP Radiation Protection Standing Committee on Epidemiology. *Mobile Phones, Brain Tumours and the Interphone Study: Where Are We Now?* Environmental Health Perspectives 2011; 119: 1534-38. http://www.icnirp.de/documents/SCIreview2011.pdf

[D] Letter from Vice Chair of ICNIRP, corroborating the important contribution of Interphone to on-going work on ICNIRP's guidelines on exposure to mobile phones.

[E] Health Protection Agency. (i) Health advice on mobile phones following the Interphone study. http://www.hpa.org.uk/Topics/Radiation/UnderstandingRadiation/UnderstandingRadiationTopics/ElectromagneticFields/RadioWaves/MobilePhones/info_HealthAdvice/ (ii) HPA Advisory Group on Non Ionising Radiation (AGNIR) statement on Interphone. http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb_C/1274088317073

[F] Health Protection Agency. Health Effects from Radiofrequency Electromagnetic Fields: a report of the independent Advisory Group on Non-ionising Radiation. April 2012. http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1317133827077

[G] Letter from Chief Executive of the Science Media Centre, attesting to the media impact and widespread national and international coverage of the Interphone results. This included: *Mobile phones 'unlikely' to cause cancer*, BBC News http://www.bbc.co.uk/news/health-13988882; *Mobile phone study finds no solid link to brain tumours,* The Guardian http://www.guardian.co.uk/science/2010/may/17/mobile-phones-brain-cancer-study; *No link found between mobile phones and cancer,* Nature News http://www.nature.com/news/2010/100517/full/news.2010.246.html.Portfolio of full media coverage available on request.

[H] Letter from member of the DH Stewart Committee on Mobile Phones and AGNIR (2001-09) stating that Interphone has been pivotal in managing health risks from mobile phones.

[I] Mobile Operators Association statement on Interphone http://www.mobilemastinfo.com/2010/mobile-operators-welcome-publication-of-interphone-study.html

[J] Letter from the Chair of the UK Mobile Operators Association Science Working Group confirming that identifying health risks of mobiles has global significance to the industry.