Elisabeth Cardis for the MobiKids consortium
Mobile phones, RF and health

• History of mobile phone use
  • 1st generation – analogue phones
    ✓ started in early 1980’s
      – “bag telephones” with antenna on the bag
      – car phones
      – mainly 450 MHz range
      – costs were high and phones unwieldy
    ✓ late 1980’s – early 1990s …
      – “Smaller” hand held phones with antennas
      – 800-900 MHz
      – still expensive … “businessmen”
Mobile phones, RF and health

- 2nd generation - digital phones
  - started around 1992
  - 800-900 MHz
  - then 1500, 1800-1900 MHz
  - prices decreased
  - subscription prevalence increased
  - „„, but use still low …
    ✓ 100 hours lifetime,
    ✓ 2-2.5 hours monthly in Interphone controls (interviewed 2000-2004)

Lönn et al, 2004
Mobile phones, RF and health

• Today …
  • 4.6 billion users in the world
  • Increasingly 3G, 3.5G, 4G
  • Higher frequencies … 2.2 GHz though now re-using lower frequencies
  • Prevalence of use still increasing, particularly in young people
  • So is amount of use …
    … not unusual to see young people using phones 1 or more hour a day
Mobile phones and brain tumours in young people

• Public and public health interest
  • International recommendations
    ✓ WHO International EMF Project
    ✓ EU supported EMF-Net
  • National recommendations
Use of mobile phones during childhood and adolescence

• Benefits – non-negligible
  • Emergencies
  • Communication with family
  • Communication with friends

• What are the potential risks?
  • Cognitive effects
  • Brain and CNS tumours

• Health effects of RF not demonstrated at this point

  … but if there is a risk, it is likely to be greater for exposures in childhood and adolescence …
Why would the risk be larger?

• Children who start using phones will have much more exposure
  • Many more years of use
  • Greater quantity of use as much cheaper than before

• Children may be more vulnerable
The relative mean MSAR1g tends to be higher in children than in adult brain tissues

(results normalized to children)

Exposure is greater ...

Wiart et al, 2008
What do we know about health effects of RF?

- Have been reviewed over the years by a number of national and international committees
  - Most reviews have been inconclusive – some suggesting lack of effects at athermal levels

- WHO-IARC Monographs evaluation 31 May 2011
  - Based on a critical review of all available peer-reviewed studies, classified RF as “possibly carcinogenic to humans – 2B” *

The INTERPHONE study

- **Objectives**
  - To determine whether mobile phone use increases the risk of cancer, and
  - To examine the association with other known / suspected risk factors

- **Design**
  - Population based case-control studies:
    - Glioma
    - Meningioma
    - Acoustic neurinoma
    - Parotid gland tumours
  - All persons aged 30-59 years who reside in the study regions (metropolitan areas in most countries)
  - Case diagnoses: 2000 until late 2004

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### INTERPHONE - study results

- **Meningioma:** 2409 cases and 2662 controls
- **Glioma:** 2708 cases and 2972 controls
- **Acoustic neuroma (AN):** 1105 cases and 2145 controls

- **Reduced OR among ever regular users**
  - **Meningioma:** 0.79 (95% CI 0.68-0.91)
  - **Glioma:** 0.81 (95% CI 0.70-0.94)
  - **AN:** 0.85 (95% CI 0.69-1.04)

- **No increased risk for use 10+ years**
  - **Meningioma:** 0.83 (95% CI 0.61-1.14)
  - **Glioma:** 0.98 (95% CI 0.76-1.26)
  - **AN:** 0.76 (95% CI 0.52-1.11)

- **Overwhelming majority of ORs below 1 ... risks underestimated ?**

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*The INTERPHONE Study Group. Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. IJE 2010*

*The INTERPHONE Study Group. Acoustic neuroma risk in relation to mobile telephone use: Results of the INTERPHONE international case–control study. Cancer Epidemiol, 2011*
INTERPHONE - study results

- No evidence of exposure response relationship but ...
- Increased OR in highest users (>= 1640h)
  - Glioma: 1.40 (95% CI 1.03-1.89)
  - Risk highest
    ✓ On side of head where phone is used 1.96 (1.2-3.2)
    ✓ For tumours in the temporal lobe 1.87 (1.1-3.2)
INTERPHONE study results

- Recent 5-country analyses with estimated RF dose at the location of the tumour *(Cardis et al, OEM, 2011)*
  - a dose-response relationship for glioma 7+ years before dx
  - no association in short-term users

... Results suggestive, but biases and error prevent a causal

- *Caution needed until more definitive conclusions can be drawn*
CHANGES IN PATTERN OF USE

- Interphone study subjects
  - Light users compared to today
    ✓ Few used the phone more than 10 years
    ✓ Median cumulative call time over life: 100 hours
    ✓ Highest group \( \geq 1640 \) hours: about 30 min/day over 10 years
  - Not unusual today for people to speak one hour or more, particularly young people

- Need more research, particularly among young people
  - CEFALO study just published
  - Mobi-Kids starting with funding from the EU 7th framework programme
• Aydin et al 2011, JNCI
  • 352 cases, 646 controls
  • 7-19 years old, 2004-2008
  • Participation rates - 83% cases, 71% controls
• Results
  ✓ Ever regular use (194 cases) OR 1.36 (95% CI 0.92-2.02)
  ✓ No evidence of increase with duration or amount of use
    …only 52 cases with subscriptions for 4 years or more
• Interpretation difficult
  ✓ Relatively small number of subjects
  ✓ Subjects young – median 13 years
  ✓ Very few long term or heavy users
    - median years of use 2.7
    - median cumulative hours of use lifetime: 35
  ✓ Most ORs above 1 …
Mobi-Kids

- **Overall objective**
  - To assess the risk of brain tumours in young people in relation to:
    - childhood and adolescent exposure to EMF from communication technologies
    - other potential environmental and host factors

- **Case-control study**
  - **Cases**
    - Benign and malignant brain tumours
    - Aged 10-24, 2010-2013
    - Rapid ascertainment from diagnosing and treatment hospitals
  - **Controls**
    - 2 per case
    - *Appendicitis controls*, to minimise selection bias related to non-participation.
    - Individually matched on age, sex and region
MobiKids countries – about 2400 cases expected

- EU funding
  - Austria
  - France
  - Germany
  - Greece
  - Israel
  - Italy
  - The Netherlands
  - Spain*

- Separate funding
  - Australia
  - *New Zealand
  - Canada
  - India
  - Korea
  - Japan
  - Taiwan
  - US?

*CREAL coordinator
Collection of information on patients

- MRI and CT scans review for tumour localisation
- Histological slides, case notes for a sample of cases
- Saliva in some countries
  - to contribute to future international consortia on genetic aspects and gene-environment interactions in the aetiology of this rare disease
- Detailed study questionnaire
## Detailed study questionnaire

### Interview Status Summary

#### FPrimary 11-01-15-01-0001

<table>
<thead>
<tr>
<th>Status *</th>
<th>Main Questionnaire Section</th>
</tr>
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<tbody>
<tr>
<td>Completed</td>
<td>A. General Information</td>
</tr>
<tr>
<td>On-going</td>
<td>B. Mobile Phone Use</td>
</tr>
<tr>
<td>Pending</td>
<td>C. Other wireless communication devices usage</td>
</tr>
<tr>
<td>Pending</td>
<td>D. Exposure to other (not communication) sources of ELF and RF</td>
</tr>
<tr>
<td>Pending</td>
<td>E. Occupational</td>
</tr>
<tr>
<td>Pending</td>
<td>F. Medical Radiation</td>
</tr>
<tr>
<td>Pending</td>
<td>G. Medical History</td>
</tr>
<tr>
<td>Pending</td>
<td>Index Questions On Water And Disinfection By-Products (country specific)</td>
</tr>
<tr>
<td>Pending</td>
<td>H. Interview responsiveness &amp; status</td>
</tr>
</tbody>
</table>

**Main Questionnaire Status:**

- **Last Section:** B_MobilePhone_Use 2
- **Last Field:** B1_MPI

<table>
<thead>
<tr>
<th>Status *</th>
<th>Parental Questionnaire Section</th>
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<tbody>
<tr>
<td>Pending</td>
<td>I. Maternal Questionnaire</td>
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<tr>
<td>Pending</td>
<td>Mother Questions On Water And Disinfection By-Products (country specific)</td>
</tr>
<tr>
<td>Pending</td>
<td>J. Family History of Cancer</td>
</tr>
<tr>
<td>Pending</td>
<td>K. Paternal Questionnaire</td>
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<tr>
<td>Pending</td>
<td>L. Interview responsiveness (Parental)</td>
</tr>
</tbody>
</table>

**Parental Questionnaire Status:**

- **Last Section:**
- **Last Field:**

### Index Name:

- hjh

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Validation of self-reported mobile phone use

- Historical traffic/billing records from providers for cases and controls
  - Frequency and duration of voice and data use
  - Identification of phones (in some countries through IMEI)
- Laterality
  - Interview hands a phone to the subject
  - Photograph if not in person
- Software-modified-smartphones (SMSP) study among volunteers
  - Frequency and duration of voice and data use
  - Laterality
  - Hands free
  - Estimated power
  ... Validation and information on use patterns
• Tumour diagnosis: central review of sample of histological slides by international panel of neuropathologists to verify diagnosis

• Tumour localisation: review of MRI/CT scans - mark precise location of tumour on specially developed grids
Exposure assessment

• Exposure assessment subcommittee: 
  Myron Maslany, Joe Wiart, Hans Kromhout, Malcolm Sim, Ae-Kyoung Lee, Masao Taki, Elisabeth Cardis

• Exposure assessment - EMF
  • Estimation of RF and ELF exposure at different locations of the brain from mobile and DECT phones and other communications technologies
  • Estimation of EMF exposure from other residential and occupational sources
Objective: characterise the exposure

Tumor localisation

SAR distribution in brain:
- highly localized
Phone Models designed and used

Closed Slide phone  Bar phone  PDA  Flip phone  Opened Slide phone

Top antenna  Center antenna  Bottom antenna

Plastic $\varepsilon = 5$  Metal  Antenna support $\varepsilon = 3$
RF Exposure assessment

• Study of factors modifying spatial distribution
  • phone position
  • frequency band
  • Hand
  • Ear
  • Distance of the phone from head
ELF exposure assessment

Peak resultant magnetic flux density of all 47 phone models measured

Resultant magnetic flux density patterns for phones with different battery positions.
Exposure assessment – others

- Questions – pets, living on farm, etc.
- Evaluation of availability of geocoded data on other exposures for linkage with *residential and school history of subjects*
  - ✓ land use
  - ✓ water companies
  - ✓ pesticide use
  - ✓
Current status

- Ethics approvals:
  - Obtained or ongoing in most countries (hundreds of hospitals !)
- First interviews started early 2011

Data collection duration: 2.5-3 years