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Editorial

No. 3
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The Health Protection Agency

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The Health Protection Agency (HPA) comes into being on 1 April as a special health authority, comprising some parts of the Public Health Laboratory Service, the Communicable Disease Surveillance Centre, the Centre for Applied Microbiology and Research, the National Focus for Chemical Incidents, the National Poisons Information Service, the Chemical Incident Response Service, other regional providers, regional health emergency planning advisers, consultants in communicable disease control and their staff. The Chairman of the Board of the new agency will be Sir William Stewart who will become Chairman of NRPB at the same time. NRPB will work in partnership with HPA and the aim is for NRPB to join the Agency formally when appropriate legislation is enacted by Parliament. This merger is currently timetabled for April 2004.

One of the main reasons for setting up HPA is to share the skills of organisations with expertise in dealing with biological, chemical and radiological hazards. NRPB has developed its own comprehensive nuclear and radiological emergency plans and has advised many other organisations on their own emergency arrangements. It takes part in the development and implementation of UK emergency exercises for nuclear incidents. NRPB has developed and maintains advice on emergency reference levels of dose for the introduction of countermeasures and guidance on recovery. NRPB is the coordinator of the National Arrangements for Incidents involving Radioactivity (NAIR). Assessments are carried out on the impact of accidental releases and NRPB acts as a coordinator for radionuclide monitoring resources in the UK.

NRPB has developed computer models for the dispersion of radionuclides released in the environment. They cover the consequences of releases in almost any situation, including normal and accidental releases to the atmospheric and aquatic environments (including sewers) from all types of sites and facilities, and releases to groundwater from landfill sites. Radiation doses and risks are calculated by combining the results of computer modelling with data on human habits, inhalation, and ingestion. The computer models have been verified and validated within a formal certificated quality management system. In principle the models and modelling techniques are applicable to a range of chemical and biological agents, and therefore to the work of HPA generally.

For many years NRPB has carried out research on inhalation and biokinetics. The work has involved model development and experimental research, especially on clearance of materials from the respiratory tract. The models for particle deposition and clearance from the respiratory system have a thorough pedigree and a potentially wide application in inhalation toxicology. Similarly, NRPB work on cell/molecular biology and cytogenetics may be applicable elsewhere, particularly in assessing risks from chemicals. The mechanisms and genetics of radiation and chemically-induced cancer are somewhat different, but the general approach and the cellular/animal models are relevant. NRPB has considerable experience in the chromosomal analysis of blood lymphocytes and a component of the damage to chromosomes from genotoxic chemicals is distinguishable from that due to ionising radiation.

There are other areas where NRPB experience could be of use to HPA, and we look forward to gaining from the experience of our new colleagues in the biological and chemical fields. Good communications between NRPB and HPA will be essential, and between all its divisions and the public. We hope that the NRPB experience of dealing directly with the public and the news media on issues of radiological protection will be useful within HPA.

Michael Clark

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NRPB changes

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There have been a number of changes announced recently at NRPB. Sir William Stewart FRS, FRSE, has been appointed by the Health Ministers as Chairman of the Board with effect from 1 April 2003. He succeeds Sir Walter Bodmer FRS, whose term of office ended on 31 March 2003. Sir William was appointed Shadow Chair of the Health Protection Agency in 2002 and took up his post at the Agency on 1 April 2003.

Professor Roger Cox has been appointed the next Director of NRPB. He takes up his new appointment on 22 August, when the present Director, Professor Roger Clarke, retires. Professor Cox has been appointed Acting Director when required, with immediate effect. Presently Professor Cox is Head of Division, responsible for the Environmental Assessments, Operational Protection and Radiation Effects Departments.

Dr Jill Meara has been appointed a Deputy Director of NRPB. She joins Dr John Stather who was appointed a Deputy Director in 1997. Dr Meara is a public health physician and is responsible for the Communications, Dose Assessments and Population Exposure Departments.

Michael Clark

Internal links

- [New Chairman of NRPB Appointed \(P2/03\)](#)
- [Professor Roger Cox to be NRPB Director \(P7/03\)](#)
- [Dr Jill Meara Appointed a Deputy Director of NRPB \(P8/03\)](#)

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COMARE view on Bradwell cancer cluster claims

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Using the best available statistics from the Office for National Statistics (ONS), the Committee on Medical Aspects of Radiation in the Environment (COMARE) has shown there is no evidence of excess risk of cancer mortality in the vicinity of Bradwell power station in Essex. Furthermore there is no significant excess of breast cancer mortality in women living near the Blackwater estuary or in Maldon.

The environmental group Green Audit has claimed that there is increased mortality from cancer near Bradwell using information from ONS, in particular, excesses of breast and prostate cancer mortality. Green Audit disclosed their findings to local and national news media, and the subsequent publicity caused some understandable concern in the local population. A report to the North-East Essex Health Authority by the Small Area Health Statistics Unit (SAHSU), based at Imperial College, London, using the same mortality data from ONS, did not find any evidence of excess cancer mortality in the area. A request has been made by COMARE to ONS to examine the large differences between the numbers of deaths in these two reports. Two further Green Audit reports and one new SAHSU report have been produced on cancer mortality in the Bradwell area.

After a detailed review, COMARE concluded that all three reports from Green Audit contained errors resulting in an over-estimation of cancer mortality risks. Furthermore, the first SAHSU report to the local health authority contained errors that led to an under-estimation of the risks. The second SAHSU report corrected these errors and this report, along with further analyses by ONS for COMARE, do not indicate any significant excess of cancer mortality around Bradwell. These analyses do not indicate any substantial or statistically significant risk of breast cancer mortality in groups of wards bordering the Blackwater estuary, or in Maldon compared with Burnham-on-Crouch, as claimed by Green Audit.

Serious concerns have been expressed by COMARE about studies relating to public health that are published without formal peer review, such as those by Green Audit. Such publications often raise public concern that is subsequently difficult to allay even if the results are unsubstantiated. It has been stated by COMARE that any organisation or individual dealing with epidemiological data has a responsibility to ensure that the data are correct before publication.

Michael Clark

External link

- COMARE press release on cancer mortality around Bradwell nuclear power station, Essex
www.comare.org.uk/press_releases/comare_pr01.htm

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MTHR announces funding for base station studies

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The Mobile Telecommunications and Health Research Programme (MTHR) has announced funding for two new projects and an extension to an existing project.

An epidemiological study of early childhood leukaemias and other cancers near to mobile phone base stations will be funded by MTHR. This study should address public concerns about possible health risks from exposure to emissions from base stations. It is the first proposal to be supported by MTHR concerning mobile phone base stations and is one of the first such studies in the world.

A study to investigate whether exposure to radiofrequency signals is linked to symptoms reported by mobile phone users will also be funded by MTHR, along with an extension of an existing pilot study to explore the feasibility of undertaking a cohort study of brain cancers and neurodegenerative diseases in mobile phone users.

In addition to this work, the Home Office has agreed to provide funding as an adjunct to the MTHR programme, to support research on the TETRA emergency services radio system. This research will be under the scientific direction and management of the MTHR Programme Management Committee (PMC).

Professor Lawrie Challis, Chairman of the PMC, commented: 'Exposures to radio-frequency waves from mobile phone masts are tiny compared to exposures from handsets, even if you live close to a mast. However, there is some public concern about the proliferation of mobile phone masts and we feel strongly that there should be research to investigate whether they could cause health effects or not. We also want to investigate whether people could differ in their sensitivity to radio-frequency emissions. The introduction of the TETRA system for the police and other emergency services has introduced new issues into the mobile phones and health debate, so we are pleased to be able to contribute to research on TETRA, supported by the Home Office.'

This is the second tranche of funding announced by MTHR and a third call for research proposals was announced in December 2002. This includes a call for additional work on base stations. Nine proposals have been received and these are presently being evaluated.

Michael Clark

External link

- MTHR press release announcing funding into mobile phone base station research
www.mthr.org.uk/press/p4/p4_2003.htm

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Resilience or panic?

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In December 2002, Bill Durodié and Simon Wessely, from the War Studies and Psychiatry Departments of King's College, London published an editorial in *The Lancet* about what governments should do to help prevent panic in the aftermath of a terrorist attack (*Lancet*, **360**, 1901-2, 2002). They conclude a summary of the evidence with a robust challenge to the way unquantified risks can be managed by the precautionary principle.

Repeated reassurances and merely asking people 'not to panic' can be counterproductive and increase anxiety rather than induce habituation. A successful approach must reinforce people's values and ask for increased alertness only in specific instances. It should not raise a general vague anxiety or emphasise people's vulnerabilities. The acknowledgement by the Prime Minister, Tony Blair, of the difficulties of accurate prediction and the reminders of the Chief Medical Officer that the UK has faced a terrorist threat before, implicitly from the IRA, and dealt with it in a resilient way are seen as models of good practice. However, the authors note that the strategy has not yet proved robust to the recriminations after an attack.

There is scant evidence that widespread acute public panic does in fact usually occur. Studies of natural and man-made disasters over the years show rapid habituation to the situation followed by development of effective acute coping mechanisms. However, there are exceptions and disasters involving radiation and those in confined spaces are thought more likely to generate panic.

Measures are also needed to counteract the long-term psychological consequences of a disaster. Involving the public in planning and making use of existing support networks may help. Non-specialist support organisations need access to urgent information to allow them to help in the right way. The information vacuum must be filled before rumours, misinformation and hoaxes take over. Information can be prepared beforehand but should not be too general or vague.

The authors feel that the precautionary principle, with its concentration on preventing hazards of unknown risk may in some cases help to do the terrorists work for them by letting the public become victims of their fears rather than victims of the disaster itself. They conclude

'The best form of defence is offence, it is time societies moved on to promoting what is known and what they are for rather than fearing the unknown and what they are against.'

Jill Meara

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Nuclear powered satellite plans

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NASA has unveiled plans for its Jupiter Icy Moons Orbiter (JIMO), as part of its Project Prometheus, to develop nuclear powered propulsion for deep space exploration. The orbiter is scheduled for launch in 2011 and its nuclear reactor would power an ion-drive propulsion engine. This engine produces a small but constant thrust by expelling ionised gas at high velocities, and is more efficient in payload terms than traditional chemical rocket propulsion. The reactor can also transform the amount of power available for scientific measurements. The Cassini spacecraft, presently travelling towards Saturn, has less than a kilowatt of power available whereas JIMO could have tens of kilowatts (*Nature*, **421**, 991, 2003).

It remains to be seen whether such plans are politically acceptable in the USA and worldwide. There have been vociferous protests about previous launches of spacecraft containing radioactive thermoelectric generators, and the Columbia accident has heightened public awareness of the risks of space travel.

Michael Clark

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Risk of risk assessment

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Probabilistic risk assessment (PRA) is a method used by scientists and engineers to estimate the likely failure rates of complex systems. It has been widely applied in the nuclear industry for over twenty-five years. The first step in the assessment is the construction of a fault tree that identifies events that could lead to system failure. Then probabilities are assigned to the potential faults and the severity of the consequences of the failure is assessed. Finally, the probabilities are combined by addition and/or multiplication (depending on the precise fault tree) to give an overall probability of failure at a given level of severity. This process can then identify which parts of the complex system are critical to overall safety of the system and need to be redesigned.

There is a healthy scepticism of theoretical methods in practical science and engineering. The traditional engineering method to ensure safety is to identify components of a system which are judged to be critical to safety, and make them as robust as possible or provide considerable redundancy in their design. This was the approach used by NASA before the Challenger disaster in 1986 (*Science*, **299**, 100 1-2, 2003) and afterwards expert panels recommended that NASA use PRA to assess the safety of the shuttle. Studies in 1989 and 1993 gave very high probabilities of catastrophic failure, 1 in 78 and 1 in 90 missions. Subsequent studies in 1995 and 1998 gave reduced values of the probability of catastrophic failure as 1 in 145 and 1 in 245 launches.

Sadly, the Columbia re-entry accident this year is the second catastrophic failure in 113 shuttle flights, indicating inadequacies in PRAs used by NASA. Perhaps some systems are just too complex to assess the risk accurately, and fundamental uncertainties remain.

Michael Clark

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Through a glass, slowly

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Vitrification of liquid high-level radioactive wastes is widely proposed as a means of pre-treating the waste for long-term disposal in geological formations. Once set in glass, and then encapsulated in special steel, it is claimed that the waste will remain isolated from the environment for many thousands of years. A new project aims to test the leaching of materials from glass using the combined skills of archaeologists and material scientists.

In 1970, Walter Fletcher of the British Glass Industry Research Association arranged for a wide variety of modern and simulated archaeological glasses to be buried in limestone soils in a quarry in Ballidon, Derbyshire (*Nature*, **421**, 783-4, 2003). Fletcher designed the experiment so samples could be exhumed for centuries to come and the Ballidon experiment is run now by the University of Sheffield. The original aim of the experiment was primarily to improve archaeological dating methods, but its relevance to research on radioactive waste disposal was recognised.

In 1986, George Wicks of the Savannah River Technology Centre in South Carolina, USA, arranged for two types of glass designed for radioactive waste to be buried with the archaeological and modern samples at Ballidon. The first results were obtained last year and Wicks reports that leaching appears to decrease with time. He also notes that leaching seems to be less than predicted from laboratory tests.

The combination of archaeology and material sciences has brought together two different points of interest. Normally archaeologists are focused on dating artifacts from the extent of corrosion and are not interested in the impact of leachates on soil. The material scientists are interested in both aspects, the corrosion and dispersion of leachates. The archaeologists' experience of the corrosion of ancient glass can provide a useful insight into predictions for leaching from other types of glass.

Michael Clark

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European Committee on Radiation Risk

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The environmental group Green Audit published a report on 30 January 2003 which attracted some media interest and enquiries (Green Audit. 2003 Recommendations of the European Committee on Radiation Risk. Editor Chris Busby with Rosalie Bertell, Inge Schmitz-Feuerhake, Molly Scott-Cato and Alexei Yablokov).

The European Committee on Radiation Risk (ECRR) is a self-styled organisation and is not a formal scientific advisory committee to the European Commission or to the European Parliament. Dr Chris Busby of Green Audit and the Low Level Radiation Campaign, is secretary of ECRR.

It is maintained by ECRR that the scientific evidence for the harmful effects of ionising radiation accumulated by the international scientific community over several decades is flawed and risks are being under-estimated significantly. This hypothesis, originally proposed by Dr Busby, is currently being considered in detail by the Committee Examining Radiation Risks from Internal Emitters (CERRIE). This Committee was set up by the Committee on Medical Aspects of Radiation in the Environment (COMARE) and their conclusions will be published in due course. Dr Busby is a member of CERRIE.

Michael Clark

External links

- European Committee on Radiation Risk
www.euradcom.org
- Committee on Medical Aspects of Radiation in the Environment (COMARE)
www.comare.org.uk

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A first for NRPB as Radiation Protection Advisers

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The Ionising Radiations Regulations 1999, which regulate the use of radiation sources in the workplace, require employers to consult with a Radiation Protection Adviser (RPA) on a wide range of radiological issues. RPAs may be either individuals or bodies and NRPB is the first RPA body in the UK to be formally recognised by the Health and Safety Executive (HSE) in accordance with the provisions of an HSE statement on radiation protection advisers. The attainment of this recognition is a measure of the depth and breadth of experience of the staff within NRPB who provide RPA services and radiological protection training courses.

Michael Clark

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New liver radiotherapy treatment

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Radiotherapy is a potent tool in cancer treatment but risks unacceptable systemic side effects. *New Scientist* (21/28 December 2002) recently reported a new surgical procedure, done in Pavia, Italy, that may help to avoid systemic complications in some patients. One patient has been treated who had successful treatment for colon cancer but had later developed multiple secondary tumours in his liver. The liver tumours were resistant to chemotherapy and too numerous for a surgical resection. Conventional radiotherapy would have risked destroying his liver.

The patient's liver was removed, treated with radiotherapy away from the rest of the body and then reimplanted during a 21-hour operation. The radiotherapy technique is called boron neutron capture therapy and was first attempted in the 1950s. The isolated liver was injected with boron, attached to phenylalanine. This compound is preferentially taken up by rapidly dividing tumour cells. Two to four hours later a low energy neutron beam was directed at the liver. This split the boron into high-energy particles that kill the nearby cancer cells. To be effective, a high dose of neutrons is needed across the whole liver. This is impossible with the liver in the body because of blocking of the neutron beam by other tissues and the high tissue doses that would result.

The patient is alive and well and the staff of the institute in Pavia are seeking permission to use the technique in six more patients. There are only a few reactors capable of producing suitable neutron beams. They realise that it is too early to judge the effectiveness of the technique which would need to be reserved for patients with the worst prognosis, who were fit enough to stand up to the procedure and who do not have cancer in other organs. They are also looking into adapting the technique to use in other transplantable organs.

Jill Meara

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Anthrax cure for cancer?

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There have been many claims of cures of cancer over the years and although the prognosis for many types has improved dramatically, it is still a major cause of premature death. Recently researchers at the National Institutes of Health (NIH) in Bethesda, USA, have made the surprising discovery that a genetically-engineered anthrax toxin can selectively attack cancer cells with minimum damage to healthy cells (S Liu *et al*, *Proc. Natl. Acad. Sci.* **100**, 657, 2003).

Most human malignant tumours overexpress the cellular receptors for urokinase plasminogen activator, an enzyme precursor. The NIH research team has developed an anthrax toxin that is activated solely by the urokinase. They did this by replacing one of the toxin's peptides with an artificial protein sequence that generates a tumour-specific toxin. This engineered toxin showed significant cytotoxic activity for melanoma, Lewis lung cancer, connective tissue cancer and some solid tumours.

It remains to be seen whether this discovery can be turned into a practical anti-cancer drug.

Michael Clark

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Radioactive decay bugs

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Geomicrobiologists from Princeton University have found that microbes in the deepest parts of a South African gold mine use radioactive decay products to survive. Professor J C Onstott and his colleagues at Princeton discovered microbes living in water trapped in rock fissures in the mine. The organisms feed on hydrogen gas dissolved in the water, converting it to methane by combining with carbon dioxide (*Science*, **229**, 1307, 2003). The hydrogen could have come from other microbes, from water interacting with certain minerals, or from radioactive decay. Onstott favours the radioactive decay hypothesis because when alpha particles interact with water, they produce hydrogen, oxygen and hydrogen peroxide. The concentration of helium, also produced by alpha decay, was consistent with the radioactive decay hypothesis. This research indicates how microbes can survive extremely inhospitable environments on this planet, with a little help from alpha particles from naturally-occurring materials.

Michael Clark

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Sunsmart campaign

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Cancer Research UK has launched a new campaign to reduce the risk of skin cancer in Britain. Using the logo 'Sunsmart', which has been used successfully in Australia for many years now, the campaign gets its message across by comparing skin cancer rates in sun-drenched Australia with those in Britain. Although average Australians get a higher dose of ultraviolet radiation from the sun than average British citizens, they are more careful in the sun. Furthermore, Australians have learnt to recognise the early signals of skin cancer and are more likely to seek early advice from their doctors. Hence skin cancer cases in Australia are more treatable and there are fewer fatalities.

Each year around 5,800 British people are diagnosed with malignant melanoma, compared to more than 7,800 Australians. This is despite Australia's population being around a third of that of Britain. Although there are more cases of melanoma in Australia, there are fewer deaths than in Britain, with 1,050 and 1,650 deaths each year respectively. For every 100 people diagnosed with melanoma in Australia 13 people die from it, while in Britain there are 28 deaths for every 100 diagnosed cases.

More information on the Sunsmart campaign can be found on the Cancer Research UK website in the pages about cancer/reducing risk. There are helpful leaflets on how to protect yourself in the sun, and special hats and T-shirts are available. Much of this material will be targeted at schools for them to use over the summer months. The main messages of the campaign are given as the acronym **SMART**.

Stay in the shade 11-3

The sun is most dangerous in the middle of the day - find shade under umbrellas, trees, canopies or indoors.

Make sure you never burn

Sunburn can double your risk of skin cancer.

Always cover up

Sunscreen is not enough - wear a T-shirt, a wide-brimmed hat and wraparound sunglasses (eyes get sun-damaged too).

Remember to take extra care with children

Young skin is delicate, keep babies out of the sun completely.

Then use factor 15+ sunscreen

Apply sunscreen generously between 15 and 30 minutes before you go outside (it doesn't work immediately), and reapply often. Also, report mole changes or unusual skin growths promptly to your doctor.

Jill Meara

External link

- Cancer Research UK
www.cancerresearchuk.org

Article

No. 3
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The meeting of the ICRP Main Commission - January 2003

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The Main Commission of the International Commission for Radiological Protection (ICRP) met from 24 to 26 January 2003 in Vienna. There are three reports that are approved for publication in the *Annals* and for each of these the Commission has approved a commentary on its implications for radiological protection, to be published as an editorial at the front of the relevant issue.

The Commission hopes that by this means readers will be helped with how it intends the report to be used, and the Commission can give advance indications of its future intentions.

Reports approved

Biological Effects for Prenatal Irradiation

The Commission adopted the report, from a Task Group of Committee 1, which assesses the risk to health following prenatal irradiation. The report considers

- effects from pre-implantation irradiation
- the period of greatest risk of malformation
- the risk of induction of IQ loss and the establishment of a threshold for clinically recognisable IQ shifts
- the risk of cancer induction *in utero*.

The editorial to the report gives an interim view on the implications of the report under the title 'How radio-sensitive is a developing embryo and foetus'. The main conclusions are that there is no justification for establishing specific tissue weighting factors for the embryo/foetus, and that the current recommendations to protect pregnant workers continue to be well founded.

Protection of Non-human Species from Ionising Radiation

The current policy of ICRP with regard to the protection of the environment has been that the standards needed to protect humans will ensure other species are not at risk. The Commission set up a Task Group to address these issues and has adopted its recommendations, which are that ICRP should take a lead to establish policy in this area.

The Commission intends to develop a framework that will be designed to be harmonised with its proposed approach for the protection of humans. The proposed system does not intend to set regulatory standards. Rather it is a practical tool to help regulators and operators establish compliance with legislation.

In the editorial the Main Commission emphasises that the report is but the first step along the path which will lead to a series of publications over the next few years. Thus, the report is exploratory rather than advisory and actual recommendations will be considered in future reports. It is emphasised that the framework for radiological protection of the environment must be practical and simple. In order to progress the work a new Task Group of the Main Commission has been established, to be chaired by Dr Lars-Erik Holm, the Commission Vice-chairman. It will include specialists with knowledge in the relevant areas who will have the task of defining end points of

interest, reference organisms and reference doses as well as models for assessing and managing radiation exposure in non-human species.

Relative Biological Effectiveness (RBE), Radiation Weighting Factors (w_R), and Quality Factor (Q)

This report was produced by a Task Group of Committee 1 and is a review of the radiobiological and dosimetric information from which proposals are developed on how radiation weighting factor (w_R) values should be established in the future.

The report covers the concept of relative biological effectiveness (RBE), its quantification, and its application to w_R . It also addresses the issue of RBE for deterministic effects, where w_R are not applicable. The major changes are a reduction in w_R for high-energy protons from five to one and a reduction by about a factor of two in w_R for neutrons of low intermediate energies. The latter takes account of the changing gamma and neutron components of absorbed dose through a body from external neutron fields.

The editorial discusses the implications of the report for radiological protection. It also suggests that there should be revised w_R . However, these should not be implemented at the present time, since the Commission has yet to consider the basis on which the tissue weighting factors are established. In the meantime, the editorial recommends that calculations of equivalent dose or effective dose remain unchanged.

Discussion of the new recommendations

The Commission continued its discussions of how to express a policy for protection in its next recommendations. The Commission approved, for publication, a paper describing how protection was evolving and how that led to justification for new recommendations. The paper reviews a totality of recommendations made in Publication 60 and nine subsequent reports over the past twelve years. This analysis is used to propose a way forward to produce a simpler system, which can be more coherent to explain and to apply.

The Commission will next produce a draft of recommendations which will be circulated worldwide by the end of 2003 for discussion and consultation.

Future activities

The Main Commission has decided that for the next few years all meetings of the Committees will be joint meetings with the Main Commission. The next meeting of the Commission and Committees is scheduled from 2 to 6 November 2003 in Buenos Aires. The 2004 meeting of the Main Commission and Committees is suggested for 10 to 14 October in Beijing, and the 2005 meeting is likely to be held in Switzerland, probably Berne, with the dates yet to be decided.

The Main Commission itself intends to have additional meetings between these meetings to progress new recommendations.

Roger Clarke

External link

- International Commission on Radiological Protection
www.icrp.org

Article

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Third epidemiological study of participants in the UK atmospheric nuclear weapons tests

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A third epidemiological analysis has been carried out of participants in the UK atmospheric nuclear weapons testing programme. This covered mortality to the end of 1998 – a further eight years compared with the previous analysis. Overall mortality and incidence of cancer continued to be very similar in test veterans and in a matched control group. Reports of a recent raised risk of multiple myeloma amongst test veterans were not substantiated. However, the possibility that test participation caused a small absolute risk of leukaemia other than chronic lymphatic leukaemia cannot be ruled out.

Introduction

In the 1950s and 1960s the United Kingdom conducted a series of atmospheric tests of nuclear weapons and an associated experimental programme. The nuclear weapons tests, in Australia and around Christmas Island in the Pacific, are detailed in Table 1. The experimental programme took place at Maralinga in Australia. It started in 1953 and clean-up operations continued until 1967.

TABLE 1 UK atmospheric nuclear weapons tests, 1952-58

Operation Round	Location	Date
Hurricane	Monte Bello Islands	3 October 1952
Totem 1	Emu Field	14 October 1953
	Emu Field	26 October 1953
Mosaic 1	Monte Bello Islands	16 May 1956
	Monte Bello Islands	19 June 1956
Buffalo 1	Maralinga Range	27 September 1956
	Maralinga Range	4 October 1956
	Maralinga Range	11 October 1956
	Maralinga Range	21 October 1956
Grapple 1	Off Malden Island	15 May 1957
	Off Malden Island	31 May 1957
	Off Malden Island	19 June 1957
Antler 1	Maralinga Range	14 September 1957
	Maralinga Range	25 September 1957
	Maralinga Range	9 October 1957
Grapple X	Off Christmas Island	8 November 1957

Grapple Y	Off Christmas Island	28 April 1958
Grapple Z 1	Christmas Island	22 August 1958
2	Off Christmas Island	2 September 1958
3	Off Christmas Island	11 September 1958
4	Christmas Island	23 September 1958

A series of 25 American tests, part of Operation Dominic, and known as Operation Brigadoon, took place off Christmas Island between 25 April and 11 July 1962. UK personnel known to have attended are also included in the present study.

Two epidemiological analyses of UK participants in the UK atmospheric nuclear weapons testing programme have already been published. Both considered all causes of mortality and incidence of cancer. The first analysis, published in 1988, covered mortality to the end of 1983 (Darby et al, 1988a and 1988b). The second, published in 1993, extended this follow-up period by seven years to the end of 1990 (Darby et al, 1993a and 1993b). A third epidemiological analysis, covering mortality to the end of 1998, has recently been published in the peer reviewed literature (Muirhead et al, 2003a) and also as an NRPB report (Muirhead et al, 2003b) which contains fuller details. The present article gives a summary of this third analysis for the general reader. The fuller papers give the definitive account.

Both the first and second published analyses suggested that test participation had no detectable effect on life expectancy or on the total risk of cancer. However, looking at individual causes, the first analysis found evidence for an increased risk of leukaemia and multiple myeloma, both for mortality and incidence, among the test participants compared to the controls (Darby et al, 1988a and 1988b). However, it was concluded in the later, second, analysis that the earlier excesses of these cancers appeared to have been chance findings, although the possibility that test participation may have caused a small risk of leukaemia in the early years after the tests could not be completely ruled out (Darby et al, 1993a and 1993b).

Background to the third analysis

During the last few years, there have been reports of raised numbers of multiple myeloma among test participants, based on records for just over 2,000 British servicemen in the British Nuclear Test Veterans Association (Rabbit Roff, 1999a and 1999b). This prompted the present, third, analysis, which was conducted under the oversight of an Advisory Group chaired by Professor Nicholas Wald. The full membership of the Advisory Group is given elsewhere (Muirhead et al, 2003b). One of the first recommendations of the Advisory Group was that the third analysis should not be limited to a study of multiple myeloma as had first been suggested, but rather, like the first two analyses, should consider all causes of mortality and incidence of cancer.

The cohort of test participants for the third analysis is very similar to that for the second analysis. It consists of over 20,000 servicemen and employees of the Atomic Weapons Establishment and the Atomic Energy Authority who had taken part in the tests ('test participants') and a carefully selected control group of a similar size. The control group was carefully selected to match the test participants in terms of factors like age, service and officer/other ranks status. Controls had served in tropical or sub-tropical locations, but not in test locations (Muirhead et al, 2003b). Standard methods were used to follow up test participants and controls using the facilities of the National Health Service Central Registers (NHSCRs) (Muirhead et al, 2003b). The staff at the NHSCRs were blind to the participant/control status of those involved. Subsidiary checks were carried out at other agencies, as described in the full report of the study. When all these procedures had been completed, the status of test participants and controls at the end of the follow-up period was as shown in Table 2. It can be seen that a very high degree of follow-up was achieved and that the status of test participants and of controls was very similar.

TABLE 2 Status of test participants and controls on 1 January 1999

Status	Test participants		Controls	
	Number	%	Number	%
Alive	14560	68.2	15364	68.8
Dead	4902	22.9	5217	23.4
Emigrated	1882	8.8	1738	7.8
Lost to follow-up	13	0.1	14	0.1

Total **21357** **22333**

Death certificates were provided by NHSCRs for test participants and controls who had died and details of cancer registrations were also made available. Standard methods were used to calculate standardised mortality ratios (SMRs). Relative risks (RRs) in test participants relative to controls (Muirhead et al, 2003a and 2003b) were calculated for mortality and for incidence of cancer. In the analyses of cancer incidence, cancer registrations were supplemented by references to cancer on death certificates. Where more than one type of cancer was mentioned, preference was given to leukaemia, multiple myeloma or lymphoma if these were mentioned.

Comparison of cases of multiple myeloma with those held by other organisations

As part of the third analysis, a comparison was made of data on multiple myeloma held by the study investigators and by the University of Dundee; further details are given in the report of the study (Muirhead et al, 2003b). A number of the cases held by Dundee proved to be in individuals who were not eligible for the cohort. The percentage of confirmed test participants on the Dundee list (ie 81%) is compatible with the coverage by the study of all participants in the nuclear tests (85%) estimated previously (Darby et al, 1993b).

The comparison did not reveal additional death certificates or cancer registrations with multiple myeloma among test participants in the study cohort during the period for which mortality and cancer data were known to be largely complete. Other cases, reported as multiple myeloma on the Dundee list, were not confirmed by death certificates or cancer registrations. Two of the potentially most relevant such cases had been awarded war pensions. Since corresponding data were not available for controls, cases identified in this way could not be included in the analysis. However, with the agreement of the appropriate authorities, details of these two cases were given to an independent expert for assessment. These checks found that one man had myelodysplastic syndrome, which is quite distinct from multiple myeloma, whilst the other man appeared to have had multiple myeloma of a very mild nature that was unrelated to his death. It is thought that, during the relevant period, cancer registrations may have been about 90% complete. It may be entirely reasonable that war pensions tribunals should apply their own criteria, but it is clear that such cases cannot be included in our analysis because no similar recategorisation of diagnoses amongst controls has been undertaken.

The accuracy and completeness of diagnoses of haematological neoplasms (leukaemia, multiple myeloma and related diseases) was also assessed against data held by the Leukaemia Research Fund (Cartwright, 1990). The Leukaemia Research Fund maintains a registry, covering parts of England, of haematological neoplasms collected independently of data provided to NHSCRs and which are the subject of detailed review. The comparison did not suggest any omissions of haematological neoplasms from the study in either test participants or controls. Furthermore, there was good overall agreement between the Leukaemia Research Fund and study diagnoses. Further details of this intercomparison are given elsewhere (Muirhead et al, 2003b).

Presentation of results

Tables 3 to 5 contain SMRs and RRs in test participants relative to controls. Where an SMR of 100 occurs it means that the death rate for the cause in question in the group considered (here test participants or controls) is the same as in men in England and Wales who were born at the same time ('the general population'). Where SMRs are above 100 it means that death rates are higher than in the general population.

However, it is expected that men selected for service in the armed forces will have somewhat different mortality from the general population and more weight is usually given to RRs. Where there is a RR of one it means that mortality (or cancer incidence) in test participants was the same as in controls. Where there is a RR above one it means that the risk in test participants was higher. However, it is important to remember that the play of chance will often mean that SMRs and RRs are somewhat higher or lower than the expected value. Confidence intervals (CI) are calculated to indicate whether any such elevation is statistically significant; those for RR are presented here, while those for SMRs are in the report (Muirhead et al, 2003b). Where RRs differ from one it is helpful to see whether this may be because the SMR in test participants or in controls is exceptionally high or low.

Results

Table 3 compares the mortality by broad cause in participants and in controls over the whole of the follow-up period. It shows that mortality rates in both test participants and controls were lower than those in men of the same ages in England and Wales for all causes of death, for all cancers and for all other diseases (ie SMRs were less than 100). In contrast, SMRs for accidents and violence continued to be somewhat elevated in both test participants and controls (SMRs of 121 and 116 respectively). Relative risks of mortality in test participants compared to controls were close to one for each of these broad causes of death.

TABLE 3 Observed deaths and standardised mortality ratios (SMRs) among test participants and controls and relative risks (RR) and confidence intervals (CI) of mortality in test participants compared with controls, for broad causes of death, plus leukaemia and multiple myeloma, over the full follow-up period (up to 1998)

Cause of death	Test participants		Controls		Mortality in test participants relative to controls RR (90% CI)
	Obs	SMR	Obs	SMR	
Leukaemia	45	98	33	68	1.45 (0.96, 2.17)
Leukaemia excluding CLL	40	106	23	58	1.83 (1.15, 2.93)
Multiple myeloma	22	96	18	73	1.43 (0.81, 2.54)
All neoplasms	1546	93	1645	92	1.01 (0.96, 1.08)
Other diseases	2769	80	2961	79	1.01 (0.97, 1.06)
Accidents and violence	436	121	417	116	1.07 (0.95, 1.21)
Unknown	106		139		
All causes	4857	89	5162	88	1.01 (0.98,1.05)

Table 4 compares mortality for the period of the second analysis (to the end of 1990) with that in the further eight years of follow-up, to 1998. For multiple myeloma, the RR among test participants relative to controls up to 1990 was 1.90 (90% CI 0.71-5.23). During the extended follow-up period of 1991 to 1998, the RR was 1.21 (0.58-2.53). Mortality rates for both participants and controls were consistent with national levels, during both the extended and full follow-up periods. Relative to national rates, mortality among test participants was consistent with a constant level over the follow-up period, although there was some variability in SMRs for specific time categories. In contrast, myeloma mortality among the controls tended to increase over time relative to national rates.

For leukaemia, excluding chronic lymphatic leukaemia (CLL) which is not thought to be induced by radiation exposure, the RR up to the end of 1990 was 1.84 (1.02-3.33). Over the next eight years the RR was very similar, 1.81, although the elevation was not statistically significant (90% CI 0.80-4.18). Over both periods, the SMR for test participants was close to national rates, while that for controls appeared to be a little low.

TABLE 4 SMRs and observed numbers of deaths among test participants and controls, with relative risks (RR) and confidence intervals (CI) of mortality among test participants compared with controls, for selected causes of death and by calendar period

Cause of death	Up to 31 December 1990			1 January 1991-31 December 1998		
	Test participants SMR (obs)	Controls SMR (obs)	RR (90% CI)	Test participants SMR (obs)	Controls SMR (obs)	RR (90% CI)
Leukaemia	100 (29)	56 (17)	1.75 (1.01,3.06)	94 (16)	87 (16)	1.12 (0.59,2.13)
Leukaemia excluding CLL	109 (27)	58 (15)	1.84 (1.02,3.33)	102 (13)	59 (8)	1.81 (0.80,4.18)
Multiple myeloma	77 (9)	48 (6)	1.90 (0.71,5.23)	114 (13)	98 (12)	1.21 (0.58,2.53)
All neoplasms	82 (761)	86 (850)	0.96 (0.88,1.05)	106 (785)	100 (795)	1.07 (0.98,1.17)
All diseases other than neoplasms	76 (1565)	75 (1665)	1.02 (0.96,1.08)	86 (1204)	86 (1296)	1.01 (0.94,1.08)
Accidents and violence	122 (374)	119 (359)	1.06 (0.94,1.21)	116 (62)	102 (58)	1.13 (0.82,1.55)
All causes	84 (2768)	84 (2959)	1.00 (0.96,1.05)	95 (2089)	93 (2203)	1.03 (0.98,1.08)

Table 5 gives results in similar format to Table 4, but for incidence of cancer rather than mortality. For both leukaemia

(excluding CLL) and multiple myeloma the relative risks in test participants relative to controls over the most recent eight years of follow up are a little lower in terms of incidence than mortality. It can be seen that for leukaemia (excluding CLL) the RR remains above one (1.39) while for multiple myeloma it is below one (0.79), though neither difference is statistically significant.

Table 5 also shows three types of cancer for which the second analysis had left a suggestion of excesses or deficits in test participants. For non-melanoma skin cancer there had been a significant deficit in test participants while for cancer of the bladder there had been a suggestion of an excess. In both instances, the RR over the subsequent eight years of follow-up was close to one. For cancer of the liver, incidence up to the end of 1990 had been higher in participants than controls at a level which just reached statistical significance. Over the next eight years, incidence in participants was again higher than in controls, though the elevation was not significant. In view of the large number of cancer types studied, this may be a chance finding.

TABLE 5 Number of incident cancers among test participants and controls, and relative risks (RR) and confidence interval (CI) of incident cancer in test participants compared with controls for selected types of cancer, by calendar period

Type of cancer	Up to 31 December 1990			1 January 1991-31 December 1998		
	Test participants	Controls	RR (90% CI)	Test participants	Controls	RR (90% CI)
Leukaemia	37	29	1.31 (0.84,2.04)	30	24	1.37 (0.86,2.22)
Leukaemia excluding CLL	30	21	1.46 (0.88,2.45)	19	15	1.39 (0.74,2.61)
Multiple myeloma	17	10	2.05 (0.99,4.30)	18	25	0.79 (0.45,1.38)
Cancer of liver	15	7	2.31 (1.00,5.48)	18	11	1.84 (0.92, 3.71)
Non-melanoma skin cancer	137	187	0.78 (0.64,0.95)	196	215	0.97 (0.82,1.15)
Cancer of bladder	81	67	1.27 (0.95,1.69)	77	86	0.97 (0.74,1.28)
All neoplasms	1326	1456	0.97 (0.91,1.03)	1369	1462	1.01 (0.95,1.07)

In addition to the analyses described above, sub-analyses were carried out to try to identify special groups in whom any risk of test participation might have been concentrated. Details are given in the report (Muirhead et al, 2003b). No striking findings were observed, though the numbers of individuals in some groups were small and hence the statistical uncertainties were large.

Conclusions

Overall levels of mortality and cancer incidence in UK nuclear weapons test participants have continued to be similar to those in a matched control group, and overall mortality has remained lower than expected from national rates. There was no evidence of an increased raised risk of multiple myeloma among test participants in recent years, and the suggestion in the first analysis of this cohort of a raised myeloma risk relative to controls is likely to have been a chance finding. There was some evidence of a raised risk of leukaemia other than CLL among test participants relative to controls, particularly in the early years after the tests, although a small risk may have persisted more recently. This could be a chance finding, in view of low rates among the controls and the generally small radiation doses recorded for test participants. However, the possibility that test participation caused a small absolute risk of leukaemia other than CLL cannot be ruled out.

Acknowledgements

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Article

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Mobile phones and health - an update

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The widespread availability of mobile phones is a fairly recent phenomenon. Their use has escalated over the past decade and to many they are an essential part of business, commerce and society. There are now about 47 million mobile phones in circulation in the UK, which is approaching an average of nearly one phone for every person. The phones are supported by about 36,000 base stations, which provide the link between the mobile phone user and the phone network. The Independent Expert Group on Mobile Phones (IEGMP), chaired by Sir William Stewart, was set up in 1999. It issued its report *Mobile Phones and Health* in May 2000. This article summarises the evidence on possible health effects reviewed in the report, it describes the main recommendations and the outcome to date.

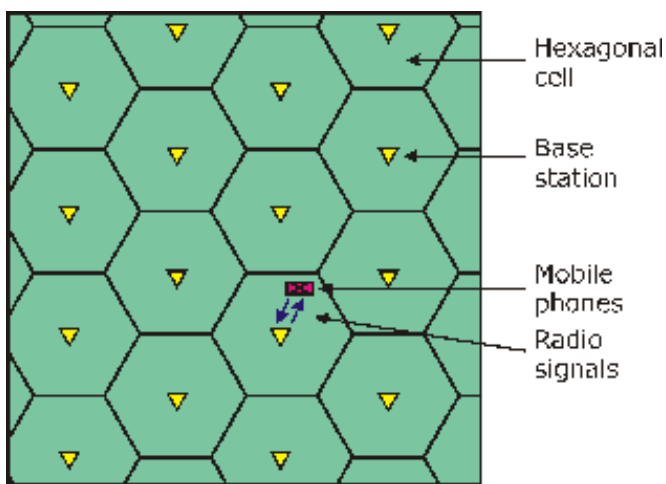
Introduction

The extensive use of mobile phones has been accompanied by a public debate about possible adverse health effects. The main concerns relate to the emissions of radiofrequency (RF) radiation from the phones (the handsets) and from the base stations that receive and transmit the signals and allow communication with the network. Because of the developing concerns through the late 1990s the Department of Health (DH) together with the Department of Trade and Industry (DTI) decided to sponsor a review of the issue. The then Public Health Minister, Tessa Jowell, asked the Chairman of NRPB to set up an Independent Expert Group on Mobile Phones (IEGMP). The remit of IEGMP was:

to consider present concerns about the possible health effects from the use of mobile phones, base stations and transmitters. To conduct a rigorous assessment of existing research and to give advice based on the present state of knowledge. To make recommendations on further work that should be carried out to improve the basis for sound advice.

IEGMP came together in September 1999, under the chairmanship of Sir William Stewart, FRS FRSE. Following ten meetings of IEGMP through to April 2000, after hearing evidence from thirty witnesses, listening to public views at five open meetings in Liverpool, Edinburgh, London, Cardiff and Belfast and reviewing hundreds of scientific papers and extensive media coverage of the issue, IEGMP published a report entitled *Mobile phones and health* ('the Stewart Report') in May 2000 (IEGMP, 2000). The report is available on the IEGMP website. Up to the end of 2002 the site had received just over a million hits.

The Stewart Report provides information on the interaction of radiofrequency fields with tissues, it examines epidemiological (human health) studies, research on cells in culture, experimental animals as well as on volunteers, and concerns about the use of mobile phones and driving. It also describes the operation of mobile phones and reviews recommendations on exposure standards for RF radiation.



A schematic cellular network

This diagram was first published in the Stewart Report and is reproduced here with the permission of IEGMP.

The main conclusions on health effects in the Stewart Report can be summarised as follows:

- exposure to RF radiation below guidelines does not cause adverse health effects to the general population;
- there is some scientific evidence which suggests that there may be biological effects occurring at exposures below these guidelines;
- biological effects do not necessarily result in health effects;
- gaps in knowledge justify a precautionary approach to the use of mobile phone technologies until much more detailed and scientifically robust information on any health effects becomes available;
- there are possible indirect effects on well being in some cases;
- drivers should be dissuaded from using either hand-held or hands-free phones whilst on the move.

The review of the scientific information relevant to concerns about exposure to RF radiation was comprehensive and did not demonstrate any clear health effects caused by the use of mobile phones or being in proximity to base stations. However, from the evidence heard by IEGMP it was clear that there was considerable public concern about the possible health implications of the use of this rapidly developing technology. The Stewart Report contained 33 recommendations, many of which were designed to provide more information about phones and base stations. The recommendations focused on five areas:

- advice to Government;
- advice to industry;
- identification of research requirements;
- the need for better public information and consumer choice;
- the rôle of NRPB.

The Government, industry and the Board of NRPB welcomed the Stewart Report and considerable effort has gone into implementing the recommendations. The remainder of this article reviews the main recommendations and the outcome to date.

Advice to Government

Exposure guidelines

Advising on exposure guidelines for the UK is the responsibility of NRPB. Exposure guidelines recommended by NRPB (NRPB, 1993 and 1999) and by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) (ICNIRP, 1998) for limiting exposure to electromagnetic fields and radiations are based on comprehensive reviews of the scientific information available and are designed to prevent established adverse health effects. They relate to exposures of people rather than to emissions from devices. For RF radiation the exposure guidelines are designed to prevent adverse health effects resulting from whole body or partial body heating. Basic restrictions on exposure are given in terms of values of the specific absorption rate (SAR) which is a measure of

absorption of energy in body tissues.

The earlier recommendations by NRPB (NRPB, 1993) were designed to limit any increase in body temperature to a fraction of a degree. It was considered that the recommended exposure guidelines were appropriate both for workers and for members of the public. Further advice was provided by ICNIRP on exposure guidelines (ICNIRP, 1998). For workers, the rationale and basic restrictions were essentially the same as those of NRPB but a two-tier system was recommended by ICNIRP that made a distinction between occupational and general public exposure. Reductions in basic restrictions by a factor of five were recommended for members of the public compared with those for workers, on the assumption that age and health status, and hence thermal sensitivity, may be different from those of workers. Although little scientific justification for this reduction factor was given, members of the public include the frail, infants and young children and people with disease or taking medicine that may compromise thermal tolerance. Table 1 gives the basic restrictions on exposure recommended by NRPB and ICNIRP.

TABLE 1 Basic restrictions on exposure recommended by NRPB and ICNIRP for workers and members of the public

		SAR* (W/kg)	
		Worker NRPB/ICNIRP	Public NRPB ICNIRP
Whole body**	0.4	0.4	0.08
Head and trunk**	10	10	2.0
Limbs**	20	20	4.0

* SAR (specific energy absorption rate) is a measure of the rate at which energy is absorbed by unit mass of tissue in an electromagnetic field. It is measured in the units of watts per kilogram ($W\ kg^{-1}$).

** For calculating SAR the averaging time is taken to be 6 minutes for all tissues. ICNIRP also uses 6 minutes for the whole body but NRPB uses 15 minutes. The averaging mass is taken to be 10 grammes (g) by ICNIRP while NRPB uses 10 g for the head (and fetus) but 100 g for the trunk, limbs and neck.

In relation to exposure guidelines, IEGMP concluded that:

the balance of evidence to date suggests that exposures to RF radiation below NRPB and ICNIRP guidelines do not cause adverse health effects to the general population. (paragraph 1.17)

However it also considered that:

there is now scientific evidence, however, which suggests that there may be biological effects occurring at exposures below these guidelines (paragraph 1.18).

Although this did not necessarily mean that these effects lead to disease or injury, it was also concluded that:

it is not possible at present to say that exposure to RF radiation, even at levels below national guidelines, is totally without potential adverse health effects, and the gaps in knowledge are sufficient to justify a precautionary approach (paragraph 1.19).

It is recommended by IEGMP that, as a precautionary approach, the ICNIRP guidelines for public exposure be adopted for use in the UK rather than the NRPB guidelines. The guidelines did not, however, need to be formalised in statute as they might be subject to change as more information became available. It was felt that this would bring the UK into line with other countries in the European Union (EU) and accord with the recommendations in the report on mobile phones and health of the House of Commons Select Committee on Science and Technology (Science and Technology Committee, 1999). The Government agreed, in line with the recommended precautionary approach, that the emissions from mobile phones and base stations should meet the ICNIRP guidelines as expressed in the EU Council recommendation of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 hertz (Hz) to 300 GHz) (EC, 1999b). The Board of NRPB also accepted the recommendation to adopt the ICNIRP guidelines for mobile phone frequencies.

The mobile phone network operators agreed that exposure to the fields from base stations should meet the ICNIRP public exposure guidelines. The regulatory framework that provides the basis through standards (BSI, 2001) under Article 3.1 (a) of the Radio and Telecommunications Terminal Equipment Directive (EC, 1999a) for assessing the compliance of mobile phones and mobile phone base stations against the public exposure guidelines is now clearer although progress with developing these harmonised standards has been slow.

At the request of Government, NRPB is presently reviewing the scientific basis for its exposure guidelines for electromagnetic fields from static fields up to 300 GHz. It will issue in 2003 a consultation document on exposure guidelines for electromagnetic fields (EMFs) in the frequency range 0-300 GHz.

Exposures of the general public from base stations

At the open meetings of IEGMP, concern was expressed about the levels of exposure of people to RF radiation from base stations. The evidence presented to IEGMP on such exposures came principally from measurements made by NRPB and published in NRPB-R321 (Mann et al, 2000). Measurements had been made at 118 locations around 17 base station sites.



A mobile phone macrocell base station

The maximum exposure at any of these locations was 0.18% of the field level for the public above which action is recommended by ICNIRP, whilst the average level of exposure was about 0.002%.

It was concluded by IEGMP that:

the balance of evidence indicates that there is no general risk to the health of people living near to base stations on the basis that exposures are expected to be small fractions of guideline (paragraph 1.33).

The members of IEGMP were, however, concerned that there could be indirect effects on wellbeing in some cases, particularly if individuals are concerned about their exposures. One of the recommendations made by IEGMP was that there should be an independent random, ongoing, audit of all base stations. The Radiocommunications Agency (RA) has taken this forward. It measured 100 base stations in 2001, with emphasis on measurements of sites near to schools. A further series of measurements at school and hospital sites was carried out in 2002. The latest information is available on the RA website. NRPB has also undertaken further measurements and will be publishing these results during 2003. The results of these more recent measurements are consistent with the conclusions in the Stewart Report.

The Sitefinder website, a database of mobile phone base stations, has been devised by RA, which provides information on the location of all existing macrocell base stations throughout the UK with details of their radio power, type of transmission, height and the operator. More information on a particular site can be obtained on request. Microcell and picocell base stations are expected to be added to Sitefinder later this year. Macrocell base stations form the basis for the network and have ranges of up to about 35 km (22 miles). Smaller base stations operating over smaller distances (microcells) are used to infill the network where the density of users is large. Even

smaller 'picocells' are used in and around buildings.

The NRPB measurements provide spectral information on the various sources of RF exposure of the population. These measurements demonstrate that exposures arise not only from base stations but also from a wide variety of sources including radio and TV transmitters, satellites, pagers and radar. Often signals from a distant base station can give a higher exposure than those from a local base station as the antennas tend to be directed towards the horizon. Total exposures, however, need to comply with guidelines not just exposures from a particular source. Detailed measurements on one base station site were reported by NRPB (Fuller et al, 2002).

It was considered by IEGMP that there was a need for more information to be made available to both local authorities and members of the public about the siting of and emissions from base stations. The Stewart Report recommended changes to planning guidance so that, for all base station sites, permitted development rights for their erection be revoked and that the siting of all base stations should be subject to the normal planning process. The then Department for Transport, Local Government and the Regions (DTLR) issued new guidance to local authorities in England on planning policy for telecommunications (DTLR, 2001) after wide consultation through the website of the Deputy Prime Minister. The aim of the new guidance is to provide for more discussions between operators and local authorities on development proposals for telecommunications equipment and to minimise visual intrusion. Mast sharing is encouraged. Where a mast is to be installed near to a school or college local consultation is also required prior to the submission of an application for planning permission. The Government's view is that the objectives of the recommendations in the Stewart Report are now met by the planning process. Revision of arrangements in Scotland, Wales and Northern Ireland have been undertaken separately.

To address concerns about the siting of base stations near schools, the then Department for Education and Employment (DfEE) issued information about the conclusions and recommendations in the Stewart Report to local authorities and schools through *Spectrum* magazine and currently on the Teachernet website.

The issue of base station siting has also been addressed by the mobile phone companies and through the Mobile Operators Association (MOA), formerly the Federation of the Electronics Industry (FEI). They have published ten commitments on their website which indicate that the mobile phone operators are working to involve the local population much more in decisions about the planning and siting of base stations. The network operators will also provide schools with information about emissions from local base stations on request. A code of best practice on mobile phone network development has been published by the Office of the Deputy Prime Minister with the cooperation of central government, local government and industry (Office of the Deputy Prime Minister, 2002). Details of the consultation process and a declaration of conformity with ICNIRP guidelines are issues dealt with in the document.



A mobile phone microcell base station

Clear, well defined exclusion zones, as recommended by IEGMP, should be delineated around all base stations within which exposure guidelines might be exceeded. In practice exclusion zones should be in place around all base station antennas to prevent the public from exceeding exposure guidelines. Some improvements in signage are being

made to provide for more consistency.



A mobile phone picocell base station

Exposure of workers

It was proposed by IEGMP that a register of occupationally exposed workers should be established. The Health and Safety Executive (HSE) has been discussing with industry the setting up of a register of occupationally exposed workers. Additionally, NRPB has carried out a study to determine the feasibility of carrying out an industrywide epidemiological investigation to examine any relationship between exposure to RF in the workplace and the risk of damage to health. Key features of the study have been the development of a method for exposure assessment, an examination of the availability of workers records and assessments of job categories. The results of the feasibility study will be reported in 2003.

Mobile phones and driving

The review by IEGMP demonstrated that there was experimental evidence showing that the use of mobile phones whilst driving has a detrimental effect on drivers' responsiveness. This translates into a substantial increased risk of an accident and the evidence suggested that the negative effects of phone use while driving are similar whether the phone is hand-held or hands-free. It was, therefore, recommended that 'drivers should be dissuaded from using either hand-held or hands-free phones whilst on the move' (paragraph 1.22). A leaflet has been issued by the Department of Environment, Transport and the Regions (DETR) which gives guidance on using mobile phones in a car and advising against their use while driving (DETR, 2000). It is available from road safety officers, driving instructors and test centres. In August 2002 the Department of Transport issued a consultation document seeking views on the possible introduction of a specific offence to prohibit the use of any hand-held mobile phone or similar device by drivers.

Shields and hands-free kits

There has been interest in the extent to which shielding devices and hands-free kits could reduce the exposure of phone users. The Stewart Report contained a recommendation that independent testing should be available which would allow the effectiveness of such devices to be demonstrated and information provided at the point of sale. Independent testing for these two categories of add-on device was therefore commissioned by DTI. The report on hands-free kits was published in July 2000 (Manning and Gabriel, 2000) and concluded that they offer very substantial reductions in SAR compared to the normal use of the phone next to the head. Further work has since been commissioned to consider the electromagnetic interference effect on hands free kit cabling. A summary of this work is available on the Link Mobile Telecommunications and Health Research Programme(MTHR) website.

The report on shielding devices was published in June 2001 by DTI. It found that devices such as buttons placed on to the phone casing had no effect, but that many of the shielding devices gave appreciable reductions in the maximum SAR. Generally this was attained by causing a similar reduction in the efficiency of the phone. The phone may also boost power to improve the signal and overcome the shielding from the device. For such devices to be effective they needed to be designed in such a way that they increased the distance between the phone antenna and the head. When combined with the application of large dimension screening components between the head and phone SAR could be reduced without impairing the efficiency of the phone.

Advice to industry

SAR values for phones

It was recommended by IEGMP that the industry should make available to consumers information on the SAR from phones once a standard method of testing became available. Individuals could then choose to use a phone with a low exposure if they so wished. The international standards body CENELEC agreed a standard testing protocol that was issued in September 2001. Information on the SAR for new phones was made available by the main manufacturers from October 2001 and is now available for all phones of members of Mobile Manufacturers Forum (MMF). A convenient index to the information given by manufacturers has been provided by the MMF website. The SAR is given in watts per kilogram and the ICNIRP basic restriction for the head and trunk of members of the general public is 2 W kg^{-1} averaged over 10 g of tissue (Table 1). Phones are tested to ensure that this restriction is not exceeded, even when the phone is operating at its maximum power. In use, however, a mobile phone may operate at less than full power because it has adaptive power control which ensures that it only uses sufficient power to communicate with the base station network. This conserves battery life. In practice, text messaging has become a very popular means of communication among children. This use of the phone does not bring it into close contact with the head, although the phone is likely to be in contact with other parts of the body, and the phone is in use for only a short time compared with voice communication.

Sensitive groups

There was concern that there may be sensitive groups in the population. In particular, it felt that:

if there are currently unrecognised adverse health effects from the use of mobile phones, children may be more vulnerable because of their developing nervous system, the greater absorption of energy in the tissues of the head and a longer lifetime of exposure (paragraph 1.53).

It is, therefore, recommended in line with the precautionary approach that:

the widespread use of phones by children for non-essential calls should be discouraged (paragraph 1.53).

It is also recommended that the mobile phone industry should refrain from promoting the use of mobile phones by children.

Subsequent to publication of the Stewart Report, the Department of Health has issued two information leaflets on mobile phones and on base stations (DH, 2000a and 2000b). These leaflets summarise some of the main conclusions in the Stewart Report. In relation to the exposures of children, it is stressed that the use of phones by children should be kept to a minimum and limited to essential calls only. Seven million leaflets were printed in 2001 and made widely available in shops selling mobile phones. They have also been distributed to GPs' surgeries, post offices and libraries, as well as to local authorities. A further two million leaflets were printed in 2002 and a revision is expected in 2003.



Text messaging is increasingly popular with mobile phone users

Research priorities

A number of areas where more research was desirable were identified. These relate particularly to signals from handsets although research on the consequence of exposure to RF would also be applicable to base station transmissions. The areas identified were brain function, exposure to pulse signals, dosimetry, sub-cellular and cellular changes, physiological and sociological studies, epidemiological and human volunteer studies. It was also recommended that this should be supervised by 'a demonstrably independent panel' and funded jointly by the mobile phone companies and the public sector.

The Link Mobile Telecommunications Health Research (MTHR) Programme was launched in February 2001 with a total budget of £7.4 million funded by Government and industry on a 50:50 basis and overseen by an independent programme management committee (PMC), originally chaired by Sir William Stewart and now chaired by Professor Lawrie Challis. There was a second call for further research proposals in February 2002 and a third call for research proposals to complete the portfolio of studies needed was announced in December 2002. To date fifteen projects have been funded by MTHR with another three projects funded directly by DTI, but managed by MTHR. Details of the research being funded can be found on the MTHR website.

The emphasis has been on epidemiological and volunteer projects to examine the risk of effects on people. Support has been given to teams involved in an international project (INTERPHONE), co-ordinated by the International Agency for Research on Cancer (IARC) in Lyon, to examine the risk of brain tumours from mobile phone use, whilst other epidemiological studies are examining possible links between phone use and leukaemia, and investigating the feasibility of a large cohort study of phone users. Volunteer studies are examining possible effects on brain function and blood pressure and are investigating whether adverse symptoms experienced by some phone users could be linked to vestibular dysfunction. There is also a study comparing the use of mobile phones whilst driving with other distractions such as tuning a radio. Other studies are examining the possibility of effects on brain function and behaviour, and cellular mechanisms that may underlie any effects. The programme includes a large dosimetry component to refine knowledge of the deposition of energy in the body and help resolve current uncertainties about absorption in young brains. There is also a project to assess exposures from picocell and microcell base stations. Considerable effort has been put into ensuring that the work is carried out by strong research teams and a very important aspect of the programme is that the PMC is ensuring that the studies use standardised exposure systems, have sound dosimetry and are of high quality.

The need for a further review of research relevant to concerns about human health and exposure to RF was identified by IEGMP. It recommended that this should be carried out within three years of publication of its report. The Government asked NRPB to undertake this review and the Board of NRPB requested its [Advisory Group on Non-ionising Radiation \(AGNIR\)](#), chaired by Sir Richard Doll, to carry this out. The review is now proceeding and will be completed in 2003.

Advice to NRPB

The Stewart Report gave advice to NRPB on how it might better prioritise its work in relation to public concerns about non-ionising radiation (NIR). Since publication of the Stewart Report the Board of NRPB has set up a [new Advisory Group on Radiation, Risk and Society](#), under the chairmanship of Sir Kenneth Calman, which is examining how NRPB might tackle issues of public concern. It has redesigned its website to facilitate accessibility and has developed content for the site directed at providing information for the general public. NRPB recently hosted an open meeting in Birmingham, chaired by Lord Winston, to address public concerns about exposure to EMFs. It is also providing 'plain English' text on key issues for a number of the reports it publishes on the website. More effort has been put into giving advice to the public on concerns about NIR, it has carried out further base station surveys and has extended its research programme relevant to health concerns related to exposures to EMFs. It answers about 12,000 questions a year on concerns about sources of and exposures to NIR.

A [video](#) (in PAL and NTSC standards) has been prepared by NRPB (also available as a CD) which addresses the health issues of mobile telephony, describes the technology of mobile phones and base stations and shows how measurements of exposure can be made. It includes interviews with experts including members of IEGMP. This has been made available to all local authorities.

Terrestrial trunked radio (TETRA)

In the Stewart Report, a number of studies were examined on the effects of radiofrequency (RF) fields on the rate of loss of radiolabelled calcium from brain and other tissues. These studies, most of which were carried out in the late 1970s and early 1980s on isolated tissues, had suggested that when the RF signal was modulated at around 16 Hz the rate of calcium efflux was increased. It was concluded that although no obvious health risk was suggested, as a precautionary measure, amplitude modulation around 16 Hz should be avoided, if possible.

Terrestrial trunked radio (TETRA) systems being deployed for use by the emergency services in the UK and in a number of other countries use a network of base stations to serve terminals that are either vehicle mounted or in the form of separate handsets. Its operation results in power modulation of some of the RF signal at a pulse frequency of 17.6 Hz. TETRA is also used in some commercial applications.

At the request of the Home Office, and following publication of the Stewart Report, the NRPB AGNIR prepared a report on the possible health effects of TETRA. The report described the operating characteristics of TETRA systems, their physical dosimetry and studies relevant to consideration of any biological effect. The report was published by NRPB (NRPB, 2001).

It was recognised by AGNIR that calcium plays an important role in many biological processes, especially in the function of nerve cells. Moreover, as IEGMP had pointed out, there is evidence that RF fields, amplitude-modulated at about 16 Hz, may influence the leakage of calcium ions from tissues. However, findings have been contradictory; they are more uncertain for living than for non-living tissue, and no associated health risk has been identified. It is notable that the signals from TETRA base stations are not pulsed, whereas those from mobile terminals and repeaters are. The conclusion from AGNIR was that:

although areas of uncertainty remain about the biological effects of low level RF radiation in general, including modulated signals, current evidence suggests that it is unlikely that the special features of the signals from TETRA mobile terminals and repeaters pose a hazard to health.

A number of recommendations for further research were suggested by AGNIR. These include proposals for experimental investigations of the possible biological effects of specific TETRA signals or RF radiation amplitude modulated at about 16 Hz as well as other frequencies using human volunteers, animals and cellular systems. Also recommended are physical and theoretical dosimetry studies to improve the assessment of the amount and pattern of absorbed energy from the use of hand portables or any other transmitting equipment deployed for use.

This research is being supported by the Home Office or through the MTHR programme.

Recent developments

A number of other national bodies have prepared reports on mobile phones and health. A report by an Expert Panel of the Royal Society of Canada concerning a review of the potential health risks of radiofrequency fields from wireless telecommunication devices has been issued (Royal Society of Canada, 1999), and this was referred to in the report by IEGMP. The Department of Health in France (Zimirou et al, 2001) and the Health Council of the Netherlands (2000 and 2001) have issued similar reports. In the UK, the British Medical Association (BMA) has issued a report on mobile phones and health (BMA, 2001) published on the BMA website. The conclusions in these and other recent reports are very similar to those of IEGMP in relation to possible health effects from exposure to RF from both mobile phones and base stations, although the Health Council of the Netherlands did not see a reason to recommend that mobile telephone use by children be limited as far as possible.

Conclusions

The Stewart Report is a milestone in the way that issues of public concern are addressed. Considerable progress has been made in implementing the recommendations in the report and providing more information to the public. The current research programme should provide further information to address the health concerns about exposures to radiofrequency radiation from the use of mobile phones and base stations.

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External links

- Independent Expert Group on Mobile Phones
www.iegmp.org.uk
- Radiocommunications Agency (part of Ofcom from December 2003)
www.ofcom.org.uk/static/archive/ra/rahome.htm
- Sitefinder
www.sitefinder.radio.gov.uk
- Office of the Deputy Prime Minister
www.odpm.gov.uk/
- Department for Education and Employment (Teachernet)
www.teachernet.gov.uk
- Mobile Operators Association
www.mobilemastinfo.com/index3.htm
- Department of Trade and Industry
www.dti.gov.uk
- Mobile Manufacturers Forum
www.mmfai.org/
- Link Mobile Telecommunications and Health Research Programme
www.mthr.org.uk
- Home Office
www.homeoffice.gov.uk
- British Medical Association
www.bma.org.uk
- Department of Health (France)
www.sante.gouv.fr
- International Agency for Research on Cancer (IARC)
www.iarc.fr

Report

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UNSCEAR 2003 meeting

[eBulletin](#) > [No. 3](#)>

The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) met in Vienna from 27 to 31 January 2003 to discuss technical annexes for a report or reports planned for 2005. The following report highlights issues discussed.

Medical radiation exposures

Medical radiation exposures remain an important focus for the work of the Committee since these overwhelmingly represent the largest artificial source of ionising radiation for populations. An updated review is in preparation that will cover practice with diagnostic x-rays, nuclear medicine and radiotherapy. The initial emphasis has concentrated on rapidly evolving technologies and applications such as digital and interventional radiology, computed tomography and endovascular brachytherapy. Further development of the draft document will provide a more balanced overview of all medical radiology, with particular reference to paediatric and *in utero* exposures, and with some consideration of exposures to patients from accidents and volunteers in medical research. In preparation for the assessment of global practice, a questionnaire has been distributed to UN member states for the systematic collection of national data on equipment, annual numbers of radiological procedures and patient doses. These forms will be revised and re-issued prior to data analysis.

Natural man-made and occupational exposures

The Committee is to gather together new data on radiation exposure from natural, man-made and occupational sources. Previous UNSCEAR reports have examined occupational and public exposure to radiation in separate annexes but the intention for the present annex is to compile the data in a single report. It will attempt to make a first step towards a global assessment of world-wide levels of exposure to ionising radiation, whatever the source. The annex will not repeat data in earlier compilations but will provide updated material, in part based on input from questionnaires that will be circulated to UNSCEAR representatives. The document will contain only summary information on exposures to radon, as this will be the subject of a separate annex.

Radioecology

A new departure for UNSCEAR is to prepare a document on radioecology. This will provide state-of-the-art models for describing the behaviour of radionuclides in a number of environments, predicting their transfer to man and allowing the assessment of individual and collective doses. It will also give information for assessing radionuclide concentrations in biota from which absorbed doses could be calculated if required and provide an overview of the effects of radiation on non-human biota with a consideration of which endpoints are appropriate (for example, death, loss of fecundity, mutation). This will refer to material in the annex in the 1996 UNSCEAR report on the effects of radiation on the environment and give an update on the information presented there.

Radon

The radon draft was very substantial, though not equally developed in all directions. There was considerable discussion of the overlap between this, the comprehensive 'Sources to Effects' radon document and other

UNSCEAR publications. In particular, there was significant debate about whether radon epidemiology should be discussed in the radon document or the epidemiology document. The final decision was for the former, and while most of the present draft text reviewed the various epidemiological studies of miners, an extensive discussion of the domestic case-control studies will now be included.

Epidemiological evaluation and dose-response of diseases other than cancer

In recent years it has been increasingly clear that the A-bomb survivors show a dose-response at doses above about 0.5 gray (Gy) for diseases other than cancer - principally diseases of the cardiovascular, digestive and respiratory systems.

The discussion centred on the epidemiology of cardiovascular disease in the A-bomb survivors. However the consultant emphasised the need to seek confirmation of A-bomb observations in other populations, to improve the quality of the epidemiological data in order to strengthen the dose-response relationship and to discuss possible biological mechanisms of disease induction. Judgements on risks at doses below about 1 Gy require some knowledge of biological mechanisms and an inter-comparison of incidence and mortality data is also important.

Epigenetic effects of exposure to ionising radiation

The purpose of this document was to discuss novel cellular responses to radiation, principally induced and persistent genomic instability and the transfer of damage signals between cells (the bystander effect), and in addition to explore the implications for the induction of health effects. Because of timetable problems the Committee discussed the document with the consultant via a teleconference link. This was a 'first' for UNSCEAR and, in spite of an early technical problem, the process worked well.

In discussion it was agreed that the document would be developed in order to provide more detailed information on the various manifestations of induced genomic instability and bystander effects, to compare and contrast the mechanisms of conventional and novel radiation responses, and to consider heritable variation in these responses.

Cancer epidemiology

Annex I of the UNSCEAR 2000 report provided a comprehensive review of epidemiological studies of cancer following radiation exposure. A new document will update this material, based on new data for groups such as the Japanese atomic bomb survivors, nuclear and medical workers, and groups exposed around the Techa River and Semipalatinsk in the former Soviet Union. The document will address issues such as how to transfer radiation risk estimates across populations, the effect on risks of dose protraction or fractionation, and the impact of dose measurement errors. The relationship between risk and dose will be modelled, and the extent to which new information on temporal and age patterns in radiation risks supports the projection models used in the UNSCEAR 2000 report will also be considered.

Chernobyl

Belarus, the Russian Federation and Ukraine have been designated as collaborators to the Committee in studying the health effects of the Chernobyl accident. Scientists from the first two of these countries gave presentations on recent research at the meeting. Following on from the earlier review of this topic in Annex J of the UNSCEAR 2000 report, a new document will be prepared based on updated data, with the aim of assessing the long-term radiation-related health effects of the accident and how this affects our knowledge of radiation risks. Particular emphasis will be placed on cancer, and specifically on the findings of new case-control and cohort studies that should be completed during the next few years. Other health outcomes, such as non-cancer mortality, will also be considered. There was strong interest expressed at the meeting about the psychological effects of the accident. This issue will be discussed in the document, but it was generally concluded that such effects are beyond the remit and expertise of the Committee. UNSCEAR hopes to publish the document in 2006, 20 years after the accident, although this timescale may depend on when new epidemiological findings become available.

Next meeting

UNSCEAR will meet next in Vienna from 26 to 30 April 2004.

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