MEDICAL PRACTICE

Contemporary Themes

Anxieties and fears about plutonium

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The first almost open-ended public inquiry into a planning application in this country is about the building of a plant to extract plutonium from used nuclear fuel. The Windscale Inquiry, sitting at Whitehaven under Mr Justice Parker, began in mid-June and seems unlikely to last less than four months. That is a measure of public, or at least political, anxieties about plutonium: the local planning authority had approved the application, but the Secretary of State for the Environment invoked his rarely used powers to set aside this approval. There had been intense lobbying from outside the area by anti-nuclear and conservation groups of various persuasions.

Causes for anxiety

The commonest kind of plutonium, plutonium-239, has a radioactive half life of about 20 000 years, and sometimes the length of this half life seems to be the chief reason that an anxious person will give for his fear of plutonium. But every time someone throws a cabbage leaf on his compost heap he is discarding into the environment in an uncontrolled manner radioactive material with a half life 50 000 times that of plutonium. Ordinary potassium, an essential element in all living cells, contains the radioactive isotope potassium-40 and has done so right through the course of evolution. Plutonium is indeed much more toxic gram for gram or μCi for μCi than potassium-40 but this is because of the nature of its radioactivity, not because of the relative length of half lives.

Like radium, plutonium emits α -particles; and natural α -particles, although they cannot penetrate the thickness of the skin may be highly damaging when they penetrate thinner

membranes, like the respiratory epithelium of the bronchi, or are emitted from plutonium or radium atoms incorporated into the tissues after reaching the blood stream. Nevertheless, medical men are accustomed to handling radium in hospitals, and even to inserting radium needles into patients, without any particular fear so long as precautions are appropriate. The rationale for anxiety about plutonium is based not so much on the properties of plutonium as on the quantities of plutonium that have been and will be handled at reprocessing plants such as the one at Windscale (from fractions of a tonne up to ten tonnes a year) and the possibility of blackmail by terrorists who may have stolen enough plutonium to justify their claim that they have a nuclear bomb. The roots of anxiety, however, are commonly something quite different and they have often been watered and nourished, sometimes with an apparent disregard for scientific accuracy, for reasons that have not been made explicit.

Anxiety might indeed be justified if our current ideas about the toxicity of plutonium¹ were ill-founded. At first sight this seems unlikely since safety standards for plutonium are based on carefully thought out principles and on evidence agreed by informed experts, such as those who advise the Medical Research Council or constitute the International Commission on Radiological Protection (ICRP). Some of the anti-nuclear organisations seem convinced, however, that the only experts to be trusted are those who are not paid from Government or commercial sources. This may drive them into a frustrating cul-de-sac since it is hardly possible to become an informed expert without close contact with one's subject matter.

There is an even more extreme view that "you should never believe an expert (particularly one who is trying to sell you something)."² After reading such an exhortation it is odd to find the author himself writing a condensed summary of a great deal of technical information (for sale)³ so as to persuade his readers to make one choice rather than another about sources of energy. In particular he emphasises the extreme toxicity of inhaled plutonium aerosols, relying on "detailed lung modelling by a plutonium expert," because there is "no persuasive evidence against . . . a histopathological hypothesis consistent with all

clinical evidence.”³ This hypothesis, however, which was proposed by a physicist, was found to be “too tenuous to be worth further discussion” in an MRC report,¹ so perhaps there is also some misunderstanding about what is meant by an expert.

Disputed interpretations

Over the past years a few scientifically educated people, especially in the USA, have been saying forcibly and frequently, though rarely in refereed papers in scientific journals, that accepted ideas about the toxicity of plutonium grossly underestimate its ability to do harm. None of these protesters seems actually to have done scientific work on plutonium toxicity and all the observations they use have been made by others. Thus disagreement can be only over hypotheses and interpretations. The scientific level of these disagreements may be illustrated by the following brief account of some particular points; it would take far too long to go through all the technical arguments.

“Sagan’s statement that ‘the experience of 30 years supports the contention that plutonium can be used safely’ is manifestly indefensible . . . (because) no meaningful epidemiological study of plutonium-exposed workers has ever been done.”⁴ What is true is that no exhaustive epidemiological study has yet been done. Meaning can be attributed to non-exhaustive studies, and it remains true that so far “there has been no cancer in man which can confidently be attributed to plutonium.”¹ That is so in spite of the high index of suspicion among those concerned with the industrial medical care of plutonium workers, who know what kinds of cancer they should be looking out for. There is sound evidence about this derived from very large experimental programmes on plutonium administered in various ways to a great variety of mammals and from the considerable human experience of cancer caused by other α -emitting radionuclides, isotopes of radium and their radioactive daughters, and thorium dioxide.

Acceptability at risk

There can, of course, be legitimate controversy over the meaning of the phrase “used safely.” There could be a wide range of possible opinions on what might be an acceptable risk for plutonium workers in earning their livelihood or for all the rest of us who might suffer as a result of routine and accidental releases of plutonium into the environment from activities at work. Often anxieties about plutonium are emphasised by calculating the expected number of casualties in a large population given some particular level of exposure to plutonium.⁴ In the 200-million population of the USA a risk of 1 in a million, which is really rather low in the scale of risk an individual might take trouble to avoid, nevertheless implies 200 casualties, which may seem unfortunate or terrible depending on circumstances (deaths one by one on the roads in the UK over a fortnight or deaths all in a few moments when one large passenger aircraft crashes). Nevertheless, even extreme calculations about the most hazardous form of exposure to plutonium, inhalation of insoluble plutonium-containing particles, recognise that the individual cases of lung cancer so induced would not be recognised, nor would there even be a measurable increase in the overall death rate from the disease.⁴ So, in relation to plutonium as to all exploitation of atomic energy, there is something new in our concern: argument, often heated argument, about whether some kind of harm that is not detectable is at a level that is acceptable or not acceptable. The scientific reason for lack of detectability is simply that the kind of harm is cancer and cancer is naturally very common. Fear of cancer is a well-known contributor to anxiety and uncertainty is another.

Misrepresentation of evidence

But are the extreme calculations of the risk of lung cancer

from plutonium scientifically acceptable? This is not the place to go through all the details, but it may be illuminating to give examples of how evidence has been misrepresented. Clearly an important factor in relation to inhaled insoluble particles is the rate at which they are removed from the respiratory tract. The more slowly a plutonium particle is removed from the respiratory tract the larger the number of α -particles hitting the respiratory epithelium and the greater the risk of lung cancer. It has been claimed very vigorously that cigarette smokers must be 125 times more at risk than non-smokers because of the gross loss of cilia from the respiratory epithelium of cigarette smokers,^{4, 5} and two different sets of observations have been used as a basis for this claim.

On the first occasion⁵ the observations were on histological sections of lungs and reported the percentage of slides showing focal lesions with absence of cilia somewhere on the slide. The percentage of slides with one or more focal lesions was 1.1% in non-smokers and 37.5% in cigarette smokers.⁶ In calculating the risks of plutonium Gofman translated this into “in the heavy smokers . . . 37.5% of the cells had lost their cilia entirely.”⁵

On the second occasion⁴ the observation was that in the respiratory epithelium of the larger airways some 30% of all cells were ciliated in non-smokers as against 22-23% in heavy smokers.⁷ This was translated into “Ide and co-workers showed 30% of ciliated cells to be denuded of their cilia among smokers. Thus, in the cigarette smoker, the bronchi will have sizeable regions free of cilia.”⁴

If the reported evidence has to be misrepresented in this way to make a case, then the case is likely to be worthless. And the case is no better if the evidence has merely been misunderstood. In fact there is now evidence on lung cancer in uranium miners which “permits exclusion of smoking as a major causal agent.”⁸ This is directly relevant to the plutonium problem because the cause of lung cancer in uranium miners is the inhalation of α -emitting particles from mine air. If smoking is thus discounted as an important factor specifically potentiating lung cancer induction by plutonium α -particles the risks emphasised in Gofman’s statements,^{4, 5} and in articles based on them,⁹ are going to be seriously overestimated.

Additional examples of the level of scientific discussion have been given elsewhere¹⁰; they indicate a cavalier attitude to arithmetical accuracy and show how reliance is placed on a personal hypothesis that has had no general acceptance as the basis for enumerating cases of induced cancer. Such a catalogue encourages a paraphrase of the exhortation never to rely on an expert into, “Never rely on a self-appointed expert.” The basis of all ICRP recommendations is in fact the agreement of groups of experts after free discussion based on evidence accessible to everyone because it is published in the ordinary scientific journals and books.

Misunderstandings

Anxieties about plutonium are built not only on misinformation. They may also arise from understandable misunderstandings of what are unavoidably complex technical matters. For instance, radiation exposure causes hereditary damage and many people have been led to believe that too much radiation exposure could threaten or even end the continued existence of the human race. It is then easy to imagine that plutonium escaping from Windscale could also do all this. In fact because of plutonium’s metabolism, and hence its tissue distribution, the hereditary damage it may cause is only a minor part of the total of harm it may do.¹ And nowadays the hypothesis that increased mutation from radiation could threaten the survival of the human race has lost scientific credibility.

Balancing costs and benefits

The newly revised recommendations of the ICRP¹¹ reiterate as a first principle the need to justify every use of radiation by

setting the risks against the benefits. They add that the balance of cost (including risks) and benefits should also be considered for alternative means of achieving the same benefits so that the optimum choice of means can be made. The benefits of nuclear power include the saving of life, limb, and health endangered by other means of getting energy, such as mining coal, drilling for oil, harnessing wave power at sea, maintaining wind mills, and so on—and vice versa, of course. Historically it is a new departure to attempt a disinterested assessment in advance of the cost and benefit of a large scale technology with a view to making a deliberate choice of what is best. It may be disturbing to feel that these large decisions on incomprehensible matters are being taken on one's behalf by faceless bureaucrats or "experts," especially if deaths and disablement form part of the equations. It may be disturbing to realise that those who reap the benefits are usually not those who are exposed to the risks, though this has obviously been true of coalmining from its beginning as an industry. Anxieties about nuclear power are only too natural.

Major issues

It seems likely that misunderstandings about the toxicity of plutonium will be of only minor significance for the Windscale Inquiry. The major issues in relation to risk are the engineering of means of containing plutonium and radioactive waste and the possibility of blackmail by terrorists. In neither case are the risks of indefinite magnitude, as they might be with the escape of a

self-replicating virus or bacterial pathogen; the risks are calculable,¹² since they depend quantitatively on how much plutonium is liberated where and in what form. It ought to be reassuring to know that even approximate calculations can be made, so that the bad and the worse, and even the worst, can be planned for. But, because this kind of technical power is historically so new, it may also appear arrogant, over-weening, or repulsive. The report of the Windscale Inquiry may become a landmark in our social evolution.

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For Debate . . .

Mothers' experiences of induction

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Summary

Mothers of a random sample of 2182 legitimate live births were interviewed about their experiences of pregnancy, labour, and delivery. Of these, 24% reported that their labours were induced, and data about this from a subsample of mothers tallied with information obtained through the doctors in charge in 88% of cases. All but 3% of the mothers who were induced perceived some medical reason for the induction. The proportion of inductions in the 24 study areas ranged from 6% to 39%. A relatively small proportion of labours in "teaching" hospitals, small hospitals with less than 100 beds, and GP maternity hospitals were induced, but a comparatively high proportion of private patients had an induction. There was no clear association between induction and the mother's age or parity. Despite being given more pain relief, those who were induced reported similar intensities of pain during the first and second

stages of labour to those whose labour started spontaneously; they also reported that they had "bad pains" for a similar period. The period they had contractions was shorter for the induced than for those starting spontaneously, and the intensity of pain at delivery was rated somewhat less by those who were induced.

There was no difference between induced babies and others in the proportion who were held by their mothers immediately after their birth. Two-fifths of the mothers who were induced would have liked more information about induction; and a similar proportion said they had not discussed induction with a doctor, midwife, or nurse during their pregnancy. Only 17% of the mothers who had an induction said they would prefer to be induced if they had another baby. This contrasts with 63% of those who had epidural analgesia who would opt for the same procedure next time, while 83% of those who had had a baby in hospital, and 91% of those having had a home birth, would want their next baby in the same type of place.

Introduction

In recent years obstetric care has been increasingly interventionist, and in particular the proportion of deliveries in NHS hospitals that were induced rose from 15% in 1965 to 41% in