In March 2013, the Health Protection Agency (HPA) in the UK, published a report entitled Human Radiosensitivity [1]. It is surprising to see that this publication has not received further attention in occupational medical circles. Given the public profile, media interest and research focus of ionizing radiation [2], there would appear to be a high probability that considerations of sensitivity will come to the fore in occupational radiation protection in the very near future.

The fact that there are differences between patients in their response to ionizing radiation has long been demonstrated in the clinic, particularly in relation to skin damage following radiotherapy for breast cancer. With tests, it would be possible to increase doses to the less sensitive to enhance the chance of cure, while reducing dose to the less sensitive to avoid distressing side effects. For occupational physicians however, it was possible, to take some comfort from the likelihood that there was a major difference in mechanisms leading to killing of cancer and normal cells at acute doses of 10s of Gray in the clinic, and the possible induction of cancer at annual doses of a few millisieverts (mSv) in the workplace. It is clear, however, that life evolved at far higher natural background radiation than present today and that there are complex systems of radiation repair, many of which are based on genetics. Therefore, even before considering newer radiobiology, such as bystander effects and genomic instability, common sense would have suggested that the heterogeneity in the human population would exhibit, to some extent, heterogeneity in radiation sensitivity.

So what does the HPA work tell us? In summary, that there is known genetic radiation sensitivity, but it goes on to question the ethics of genetic testing, indicating that it could already be done for some well known genes. It indicates that risk of cancer from radiation ‘to some extent’ relates to factors that apply to cancer in general and raises the potential of lifestyle factors in relation to occupational risk. Finally, it indicates that, in certain situations, risk of specific cancers can be much higher in certain human subgroups.

As occupational physicians, we must recognize that individual sensitivity is not purely a radiation matter. It is not an issue which we have, however, routinely addressed, nor does it feature heavily in relation to regulatory controls of occupational hazards. It is suggested that, with the profile of ionizing radiation driving the issue forward, there is now a need for the issue to be explored more fully within occupational health and safety as a whole so that we operate a set of principles which can be applied throughout the field.

Comparing the HPA data with non-radiation issues provides many examples. Genetic sensitivity to carcinogenesis is of course already well established in relation to the exposure to sunlight. This is particularly relevant since, like ionizing radiation, sunlight is in no way occupationally specific and the whole population is constantly exposed. While there are issues around occupational exposure to sunlight, levels are not currently specified based on exposing the most sensitive humans. The carcinogenesis issue, however, is in no way confined to light. Only in April 2014 [3] there was a report in UK occupational medicine literature on interactions of specific genotypes and lung function following occupational exposure to vapours, dusts and fumes. Genetic factors are linked to a wide range of occupational disease end points including bladder cancer from aromatic amines, dust disease from silica, acute toxicity from pesticides and chronic disease toxicity from beryllium [4].

With regard to lifestyle, the indication of a greater than additive risk between radon and smoking raised by reference [1] in relation to lung cancer induction, is of course mimicked by the well established multiplicative risk between asbestos and smoking for the same end point. Intuitively, in the complex systems of cancer causation, where lifestyle factors are already well established, it is clear that there will be synergisms between lifestyle and occupational factors. This raises the very real profile for considerations of lifestyle factors in relation to fitness for work in various situations.

Looking for risks which can be much higher in certain human subgroups, away from radiation, the risks of type I anaphylaxis to latex immediately spring to mind. These are almost exclusively borne by the strongly atopic who have existing multiple allergies. The decision to eliminate latex gloves, where possible, from the UK, based on standard systems of hierarchy of control, of course raises other ethical and work sustainability issues in relation to the effect on natural latex agriculture and farming vis-à-vis the petrochemical industry involved in the manufacture of synthetic gloves. It is clear that many large organic molecules occurring in the natural environment will cause some allergy to the human population. Does this necessarily lead to a situation where these are avoided in the workplace, in favour of man-made, non-sustainable alternatives?

So what do we do about individual sensitivity? In their leading article Nelson and Kelsey [5], introducing Mehta’s paper [3] end by saying ‘traditionally we strive to protect the most susceptible to exposure as a matter
of principle. This principle should not be abandoned’. It is questioned, however, if this is indeed what we do, or whether indeed this is the current consensus. Looking at the simple hazard of noise, the documentation supporting the establishment of a 90 dB (A) limit in 1984 [6], indicated ‘such a sound level ensures that 80% of the population would suffer a hearing loss of no more than 20 dB after 50 years exposure’. Presumably, the other 20% had a reasonable chance of such an effect.

In the past, the issue of sensitivity has been significantly examined in relation to the employment of women and exposure to teratogens in the workplace. Particularly in the USA, there has been dichotomy between issues such as civil rights prohibiting discrimination in employment on grounds of sex, and the so-called foetal protection policies. In 1991, the US Supreme Court ruled that ‘an employer could not determine if a work environment was too hazardous for a pregnant worker, and employers could only intervene when an employee’s pregnancy interfered with their ability to undertake their job’. These sorts of consideration have led on the need for specific standards for the unborn child, and this probably accounts for the significant difference between the 1985 and 1999 regulations in the UK for ionizing radiation, moving from a description of ‘women of child bearing age’ to the treatment of the foetus as a member of the general public in terms of dose limitation.

Whether a female worker is pregnant is, of course, comparatively easy to determine. Other considerations, such as genetic screening, are more problematic, and that in many ways has probably been the key determinant in delays in taking forward consideration of this important ethical issue. It is only meaningful to consider sensitivity in circumstances where there is a readily available and feasible method of established sensitivity by a test. As the HPA report indicates, tests are now increasingly available. In the international field, however, the International Labour Organization continues to indicate that genetic screening of workers should be prohibited, or at least limited to cases explicitly authorized by national legislation [7]. In the US legislation prohibits discrimination on the basis of genetic information and indicates employers are not able to enquire regarding genetic testing until after a job offer has been made [8]. In Europe, an advisory group to the European Commission has been less dogmatic, concluding that workers and their representatives should be involved in deciding when and how genetic testing in the workplace is done [9].

Individual sensitivity in the workplace is, quite clearly, a fact of life. Sat in our clinics, we see workers who have been exposed way beyond the hand/arm vibration action level for many years, although apparently immune to the effects of such exposure. On the other hand, we see individuals essentially minimally exposed at or around the action level for a short period who apparently developed symptoms in a short period of time. What we need is a clear implementable and ethical set of standards as to how the sensitivity issue should be addressed, which operate equally for ionizing radiation as for the rest of occupational hazards. The stimulus and drive given by the HPA report [1] could be used to take this forward. While the Faculty of Occupational Medicine has long had an ethical code of practice, involvement of our speciality with specialists in ethics is not a routine or every day activity. Nevertheless, it seems clear that, pushed by ionizing radiation, the issue needs to be addressed. There is a need for a major piece of work involving regulators, specialists in ethics, trade unions and employers to examine the issue as a whole. Stakeholder discussion and the development of consensus, based on a common view of the data and knowledge provides the best way forward if the issue is to be appropriately resolved. It would be hoped that occupational physicians could play a key part.

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References