



EDITORIAL

## Learning from the past; planning for the future: the Bernard Wheatley Award for 2019

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## Editorial



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## Learning from the past; planning for the future: the Bernard Wheatley Award for 2019

At the end of each year, I survey my growing, and somewhat daunting, stack of copies of the Journal. The four issues from 2019 are not quite as bulky as those from 2018. Nevertheless, the multi-year trend is for the publication of more and longer papers with no decline in quality. This year, in reviewing candidates for the Bernard Wheatley Award, the Editorial Board has been particularly aware of the immense amount of technical work that often underpins a few pages, or at most a few tens of pages, of published text. This is exemplified by the first of the papers that made it onto our shortlist, which relates to the dosimetric basis for epidemiological studies of patients who were exposed to diagnostic, fluoroscopic imaging while undergoing treatment for tuberculosis (Borrego *et al* 2019). Excess mortality in these patients was first reported in the 1960s (Steinitz 1965) and the Canadian Fluoroscopy Cohort Study was initiated in the 1970s (Newcombe 1975). Nearly half a century later, you might think that there would be little to add to our understanding of health effects in this population. However, advances in computational power and in the formulation of human phantoms have allowed Borrego *et al* (2019) to calculate updated dose coefficients for both paediatric and adult patients. These dose coefficients relate to both fluoroscopy and radiography procedures and the study included an examination of how the organ dose coefficients were affected by alternative assumptions on technical parameters and setup geometries. In total, the authors simulated ten different phantoms, and calculated energy deposition for 58 female and 57 male organs and tissues. The 2400 Monte Carlo simulations were performed over a few weeks on a multi-processor system at the US National Institutes of Health, with the calculations distributed over several thousand processors. The authors are making their dataset of dose coefficients openly available and we look forward to seeing what effect their use has on the results of epidemiological studies of tuberculosis patients.

Tuberculosis patients from the 1930s onward were exposed to much higher doses than would be incurred today in most diagnostic procedures. However, unintended and accidental radiation exposures remain a concern in medical practice. Therefore, we were happy to be able to publish a paper by Martin *et al* (2019) giving guidance on the prevention of unintended and accidental radiation exposures in nuclear medicine. This paper is based on the collation of information presented at an IAEA meeting in May 2018. That meeting reviewed unintended and accidental exposures that had occurred, discussed the causes and factors contributing, and considered others that could occur. Particularly useful are tables that summarise errors that may contribute to incidents during the preparation of radio-pharmaceuticals or to incidents during patient preparation and administration, and factors that could be neglected or set incorrectly during imaging. Potential exposures of patients, staff and members of the public are considered, and it was good to see that the paper emphasised the need for detailed investigation and follow-up of incidents. This paper serves as a reminder that there is a need to bring to the attention of a wider audience work that is undertaken in

international meetings and workshops that might otherwise appear only in specialist reports and often after a considerable delay. On this point, we welcome the arrangement that has been put in place between the Journal and the IAEA to publish a special issue describing work that has been undertaken under the MODARIA (Modelling and Data for Radiological Impact Assessments) programme. This special issue will cover work carried out under the auspices of the IAEA between 2012 and 2019, and it is tentatively scheduled for publication in 2021.

Although an important role of the Journal is to draw the attention of the readership to key studies relating to radiological protection that have already been completed, it is equally important to describe developments that are planned or projected to occur over the next few years. By publishing papers related to future programmes of research and development, the Editorial Board hopes to stimulate debate on whether the scope and content of those programmes are appropriate, and whether their objectives are achievable. In 2018, the Journal published several papers setting out a strategic agenda for research in radioecology (Garnier-Laplace *et al* 2018, Muikku *et al* 2018, Thorne 2018). Last year, these papers were complemented by the publication of a paper by Perko *et al* (2019) setting out a strategic research agenda for social sciences and humanities in radiological protection. This matter is important because radiological protection is not simply a technical discipline. Rather, the technical issues interact with a network of social, political, economic and ethical issues in a context in which dominant modes of communication are changing rapidly. Furthermore, issues in radiological protection tend to provoke deeply held views on other issues such as energy policy and the legitimacy of research on nuclear weapons. Perko *et al* (2019) wisely comment that although research in the social sciences and humanities relating to radiological risk has been conducted for many years, that research has been fragmented and often circumscribed such that whereas some areas have been addressed in depth many have remained largely unexplored. They, therefore, set out six interacting lines of research, each encompassing a variety of research topics. The research lines comprise:

- The effects of social, psychological and economic aspects on radiological protection behaviour and actors' choices.
- Holistic approaches to the governance of radiological risks.
- Responsible research and innovation in radiological protection to achieve socially responsive and ethically sound processes and outcomes.
- Stakeholder engagement in radiological protection research and development, policy and practice in ways that enhance responsiveness to societal needs and concerns.
- Risk communication.
- Assessment and development of a radiological protection culture amongst stakeholders to increase understanding and enhance decision making.

An important aspect of this paper is the use of a gap analysis to identify the top research priorities relating to topics that have previously only been addressed to a limited degree. However, as in the case of radioecology (Thorne 2018), the next step is 'for European research institutions, as well as national and international authorities, including the European Commission, to invest resources in the identified research lines and topics' (Perko *et al* 2019). Time will tell whether these resources will be forthcoming, but at least we now have clear guidance on priorities for the research to be undertaken.

At a more detailed level, planning of research can include pilot studies to evaluate the feasibility of proposed approaches and determine the resource implications of implementing them. Careful planning through a pilot study is exemplified in the work of Riddell *et al* (2019) who aim to reconstruct estimates of exposure to Plutonium in workers from the UK Sellafield plant. This is of importance because the UK Sellafield workforce includes one of the world's

largest cohorts of workers exposed to Plutonium, and this workforce was also comprehensively monitored for internal exposure. Nevertheless, for several hundred workers exposed in the period 1952–1963, the urinalysis results available are not adequate to provide the accurate and unbiased exposure estimates required for epidemiology. To address this problem, Riddell *et al* (2019) propose a Job Exposure Matrix (JEM) approach that involves estimating the average exposure of a typical worker in a homogeneous exposure group. At Sellafield, a cohort of 630 workers employed in the period 1952–1963 was identified. These workers were associated with 81 job titles and 61 work groups. However, an expert group was convened and concluded that work group was likely to be a better proxy for exposure than job title. Expert judgement was also used to aggregate the 61 work groups into a final set of 14. For these groups, a total of 4487 annual work records were identified and linked to 6899 contemporaneous urinalysis results. Statistical analyses were then used to identify biased or unreliable data and corrections were made to the 1952–1953 data, as these were known to be unreliable. The successful results obtained from this pilot study give confidence that the JEM approach is appropriate for estimating exposures to Plutonium in an occupational context.

All the above papers on our shortlist involved large teams of authors, reflecting either the intrinsic scope of the work, or the need for inputs from a variety of institutions, and national and international organisations. However, our next paper has only three authors (albeit each from a different institution) and the following paper only a single author.

Rääf *et al* (2019) address a neglected issue, which is the dose to the thyroid from radionuclides other than radioisotopes of iodine following a nuclear accident. Specifically, they examine doses to members of the Swedish population in the aftermath of the Chernobyl accident. Using relatively simple analytical models developed in earlier studies they demonstrate that the time-integrated absorbed dose to the thyroid in the first five years after the accident was 0.5–4.1 mGy for infants and 0.3–3.3 mGy for adults. However, the contribution from I-131 ranged from 9% to 79% for infants and 4%–58% in adults, with the remainder coming from Cs-134 and Cs-137. The large variations in the percentage contributions arose from variations in the proportions of wet and dry deposition, differences in grazing restrictions for dairy cattle, and variations in transfers of Cs-134 and Cs-137 through the food chain depending on local conditions. We particularly liked this study because it used straightforward and readily available techniques to identify and quantify an issue of importance in respect of emergency planning and preparedness.

Another relatively neglected topic relates to the amount of useful radioecological information that is available concerning the Kyshtym accident of 1957. Neglect of this information has been due, in large part, to its having been published in Russian. Also, some of the publications do not identify the location at which the work was undertaken, meaning that the link with other information on the Kyshtym accident is difficult to establish. In these circumstances, Fesenko (2019) has undertaken the important task of providing a succinct review in English of the radiation effects on biota arising from the Kyshtym accident. It is a revealing statistic that 33 of the 50 references associated with this article were published in Russian and several of the others are by Russian authors (including a PhD thesis from Moscow University). The results obtained are primarily relevant at much higher doses than would arise in most accident contexts (tens to hundreds of gray). However, some of these results are of more general radioecological relevance. For example, it seems that after a period of increased mutation rate, populations of trees can stabilise at a higher level of radio-resistance with a lower mutation rate and that higher rates of radiation damage per unit dose can occur at lower compared with higher doses. Interesting changes in communities of soil invertebrates were also observed. Overall, this review is mainly of importance in drawing attention to the wealth of data available. It is to be hoped that its publication will encourage

others to examine the data in more detail to elucidate the mechanisms involved in giving rise to the observed ecological effects.

All the papers summarised above are significant contributions to the literature relating to radiological protection, which is why they reached the shortlist of contenders for the Bernard Wheatley Award. However, it should be recognised that they also represent a small selection from the many other excellent papers published during the year covering topics as diverse as trade-offs between image noise and dose in CT scanning, the design of patch sources for brachytherapy and trends in time of estimates of the risks of childhood leukaemia arising from exposures to magnetic fields.

Notwithstanding the importance and quality of the shortlisted papers described above, we felt that, out of all the papers published in 2019, that by Carnicer *et al* (2019) addressing the overall issue of radiation dosimetry in a proton therapy facility was outstanding and should receive the Bernard Wheatley Award for 2019.

In a proton therapy facility, the energy spectrum of primary protons can extend up to 230 MeV. This means that there is the potential for irradiation from secondary neutrons and photons exhibiting spectra extending up to energies above those available from standard calibration sources. As neutron dose rates are typically one to two orders of magnitude higher than gamma dose rates in such a facility, calibration of the response of neutron detectors at energies above 20 MeV is an important consideration. As Carnicer *et al* (2019) remark, even though most measurements are required behind shielding, neutrons with energies above 20 MeV represent half the contribution to  $H^*(10)$  at these positions.

Carnicer *et al* (2019) address the calibration issue for all the types of neutron and gamma detectors in use at the Centre Antoine Lacassagne proton therapy site. These include a variety of commercially available instruments and a home-made environmental thermoluminescent dosimeter with polyethylene moderator. Calibration factors at lower energies were taken from the literature but were supplemented by calculations with the Monte Carlo code MCNP6. On this basis, theoretical calibration factors were derived for each standard source and detector, and for neutron and gamma spectra computed at various workplace locations using MCNP6 and MCNPX. From these calibration factors, it was possible to define impact factors as the ratio of the calibration factor for the neutron or gamma field at a specific workplace location for a specific type of detector to the calibration factor for that detector and a standard source.

The Editorial Board particularly liked this paper because it addresses an important issue in a developing application of ionising radiations, involves a well-judged combination of practical measurements and Monte Carlo simulations, recognising the limitations and uncertainties of both approaches, makes appropriate use of state-of-the-art techniques, and presents the results obtained in terms of scaling factors that can readily be applied. Furthermore, it is clearly written, makes good use of the existing literature, and uses well-designed figures to illustrate key aspects of the results obtained.

In summary, consideration of the winner of, and shortlisted candidates for, the Bernard Wheatley Award emphasises the importance of examining the legacy of the past using the most up-to-date techniques available and learning from that legacy, so that we can plan future programmes of research and development with a focus on key issues identified both from our past experience, and from the exciting developments in various areas of science and technology that are impacting upon the discipline of radiological protection.

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## References

- Borrego D, Apostoaei A I, Thomas B A, Hoffman F O, Simon S L, Zablotska L B and Lee C 2019 Organ-specific dose coefficients derived from Monte Carlo simulations for historical (1930s–1960s) fluoroscopic and radiographic examinations of tuberculosis patients *J. Radiol. Prot.* **39** 950–65
- Carnicer A, Angellier G, Hofverberg P, Bergerot J-M, Gerard A, Peucelle C, Vidal M and Hérault J 2019 Study on the responses and calibration procedures of neutron and gamma area and environmental detectors for use in proton therapy *J. Radiol. Prot.* **39** 250–78
- Fesenko S 2019 Review of radiation effects in non-human species in areas affected by the Kyshtym accident *J. Radiol. Prot.* **39** R1–17
- Garnier-Laplace J, Vandenhove H, Beresford N, Muikku M and Real A 2018 COMET strongly supported the development and implementation of medium-term topical research roadmaps consistent with the ALLIANCE strategic research agenda *J. Radiol. Prot.* **38** 164–74
- Martin C J, Marengo M, Vassileva J, Giammarile F, Poli G L and Marks P 2019 Guidance on prevention of unintended and accidental radiation exposures in nuclear medicine *J. Radiol. Prot.* **39** 665–95
- Muikku M, Beresford N A, Garnier-Laplace J, Real A, Sirkka L, Thorne M, Vandenhove H and Willrodt C 2018 Sustainability and integration of radioecology—position paper *J. Radiol. Prot.* **38** 152–63
- Newcombe H B 1975 *Cancer Following Multiple Fluoroscopies* (Ontario, Canada: Chalk River Laboratories)
- Perko T *et al* 2019 Towards a strategic research agenda for social sciences and humanities in radiological protection *J. Radiol. Prot.* **39** 766–82
- Räaf C L, Tondel M and Isaksson M 2019 A model for estimating the total absorbed dose to the thyroid in Swedish inhabitants following the Chernobyl nuclear power plant accident: implications for the existing international estimates and future model applications *J. Radiol. Prot.* **39** 522–47
- Riddell A, Wakeford R, Liu H, O'Hagan J, MacGregor D, Agius R, Wilson C, Peace M and de Vocht F 2019 Building a job-exposure matrix for early Plutonium workers at the Sellafield nuclear site, United Kingdom *J. Radiol. Prot.* **39** 620–34
- Steinitz R 1965 Pulmonary tuberculosis and carcinoma of the lung. A survey from two population-based disease registers *Am. Rev. Respir. Dis.* **92** 758–66
- Thorne M C 2018 Radioecology in Europe *J. Radiol. Prot.* **38** E5–9