

Chernobyl: Consequences of the Catastrophe for People and the Environment

NCRP Report No. 163, Radiation Dose Reconstruction: Principles and Practices, National Council on Radiation Protection and Measurements

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Book reviews

Chernobyl: Consequences of the Catastrophe for People and the Environment (Annals of the New York Academy of Sciences)

A V Yablokov, V B Nesterenko, A V Nesterenko and J D Sherman-Nevinger (eds)
Hoboken, NJ: Wiley-Blackwell (2009)
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With the 25th anniversary of the Chernobyl accident, it is appropriate that the radiological protection community reappraises the longer term effects of the resulting acute and chronic exposure to ionising radiation. This book aims to summarise ‘in a brief and systematic form’ (p x) a large amount of information, much of which was previously available only from the Russian and Ukrainian literature. The book presents a series of individual articles in four main sections that address contamination, public health impacts, environmental impacts and radiation protection. Whilst much of this information is derived from non-peer-reviewed literature, the authors make the very reasonable point that, under the circumstances prevailing in the most affected countries in the immediate aftermath of the accident, ‘we cannot refuse to discuss data that were acquired in the absence of strict scientific protocol’ (p 38). Whilst we may want to evaluate such data carefully, an objective review based on all available information should offer an opportunity for critical examination of primary data and comparison to accepted or hypothesised causal relationships. Unfortunately, this is an opportunity which is squandered.

In my opinion, the book suffers from three main drawbacks. First, it reflects a conspiracy-theory approach which implies time and again that the International Atomic Energy Agency, the World Health Organisation and others ‘completely neglected’ or misinterpreted significant information sources when evaluating health effects (e.g. pp 5, 36, 50, 76, 319). The allegation that ‘secrecy was the norm’ following the accident has some foundation when aimed at the USSR (p 33) but as someone who undertook early measurements of deposition in the UK, albeit as a minor contributor to the overall picture, it seems to me unreasonable to assert equally that the UK adopted a policy of secrecy or that it ‘grossly underestimated’ Chernobyl derived fallout (p 14) with the clear implication that it deliberately underestimated radiological impacts.

Second, Yablokov *et al* cite information in an uncritical fashion, such as an account of pigs literally ‘glowing’ as a consequence of contamination (p 19), and fail to provide supporting evidence for many statements or simply compare different quantities without regard to units. For example, where official reports are cited as estimating 9 000 Chernobyl-related deaths, Yablokov *et al* (p 32) counter that ‘nearly 400 million human beings have been exposed to Chernobyl’s radioactive fallout’. Maybe so, but exposure and effect are not the same measure. In addition there are numerous instances of simple errors, such as citing radionuclide half-lives incorrectly. Such errors are bound to occur in any substantial volume but add to a sense of unease with respect to the level of scientific rigour applied in compiling this work.

Third, Yablokov *et al* exaggerate a sufficient number of associations which can be checked to cast doubt over those associations which are less easy to judge. A rather tortuous set of sums presented in chapter 7 leads to the conclusion that 985 000 additional deaths occurred globally in the years 1986–2004 as a consequence of the Chernobyl accident. Unfortunately, this is based on unconvincing interpolations from poorly supported risk factors.

Perhaps, for me, the most disappointing aspect of this book is the absence of any critical commentary. For instance, chapter 3 presents population morbidity rates across national boundaries and between different groups. Figure 3.5, cited from the National Ukrainian Report (2006) illustrates the rate of ‘invalidism’ in Ukrainian liquidators from 1988–2003, with the commentary that a ten-fold rise is apparent. Indeed the figure does illustrate such a trend, but also shows that invalidism had risen to 200% of the subject group. Such a finding would appear to warrant some explanation. In the same chapter, figure 3.6, cited from Busby (1995) causally links low birth weights for babies born in Wales 1986–7 with fallout from Chernobyl. To be substantiated, such an observation would require analysis of the many potential underlying socio-economic factors associated with low birth weights and would require far greater regional resolution to reflect the uneven distribution of fallout across Wales. It would also require similar analysis of birth weights across the UK, with appropriate comparison between regions

receiving higher and lower fallout as a result of the Chernobyl accident. None of this is discussed.

Again, citing Busby (1995), figure 7.7 is presented as evidence of a link between an elevated rate of stillbirths, neonatal and perinatal mortality across England and Wales 11 months after the Chernobyl accident. There is no discussion of why such an observation should be linked to a single month, nor is the information placed in a context which would allow consideration of other social, economic or environmental factors. However, annual data for livebirths, stillbirths and neonatal deaths are readily available for the period 1981–2001 for England and Wales from the Office for National Statistics (2008). There is a clear trend of decreasing rates of early neonatal, neonatal and post neonatal deaths throughout the period. Over the years 1981–92 there is also a trend in decreasing rates of stillbirths. That trend was reversed in 1993/1994 and remained little changed throughout the remainder of the period to 2001. One wonders, had another nuclear accident occurred in 1992/1993 whether that would not have been identified just as readily as the cause, and with as little critical consideration of the mechanism. It might be argued that this is an unfair observation and that, in any case, an effect limited to a single month would not show in annual statistics. Elsewhere, however, annual data are cited for Finland, Sweden and Switzerland (figures 7.14, 7.17 and 7.18) as evidence for a causal rise in infant mortality rates in the years immediately following the Chernobyl accident. The data and interpretation are ascribed in each case to Körblein (2008, personal communication). The resultant inability to interrogate the originating data and the hypothesised causative mechanism is frustrating.

The citation of apparently contradictory observations ascribed to a single causative factor is also difficult to accept at face value and, if it can be supported, at least deserves more detailed discussion. Thus we discover in chapter 5 that exposure to radionuclides derived from the Chernobyl accident caused both delayed puberty and accelerated sexual development among boys, lactation amongst elderly women, both earlier and delayed onset of sexual maturation in girls, and heavier menstruation in the immediate aftermath of the accident followed by a decrease and even cessation of menstruation after 5 or 6 years. The age of the women in the last observation is not given nor is any explanation offered. With respect to environmental impacts following the Chernobyl accident, the book is again somewhat disjointed. Chapter 8 presents repetitive lists of radionuclides deposited in a number of countries with limited attempts to quantify resultant activity concentrations and even less to place this in context

by comparison to other sources, including naturally occurring radionuclides.

Chapters 9 and 10 consider, respectively, the impact on flora and fauna. Some data of use for determining uptake factors are presented, albeit a more systematic approach could have been adopted. Again, however, a somewhat haphazard approach to identifying effects appears to be evident. For example, table 9.12 lists a number of 'radiation-induced morphological changes in plants'. These include an increase or decrease in leaf or flower size and quantity, a speed-up or inhibition of stem, root and flower growth, and any colour change associated with the stem or flowers. Such a list of qualifying effects appears to cover a wide range in natural variability. This lack of critical observation is disappointing, partly because anyone, like myself, who has undertaken field work in the red forest region will recognise that areas of poor regrowth correlate with soils containing the highest activity concentrations whilst at the same time the general area has been described as a wildlife haven by sober commentators (Baker and Chesser 2000), reflecting the absence of pressure from human populations. By failing to present information in a systematic fashion, with clear observations, associations and putative causations, the book does a disservice to those who are trying to investigate and quantify radiological impacts.

This is a long book presenting a large number of observations and it is not possible in a short review to present a detailed exploration of each instance where information appears to be used to support a conclusion the validity of which must, at best, be regarded as unproven. The greatest sense of frustration in reviewing this book is that the information it contains might well indicate effects which are not currently recognised. Amongst the long catalogue of specific disorders, morbidity and mortality rates, there may well be impacts which can, and should, be attributed to both short and long term radiation exposure following the Chernobyl accident.

The book concludes that continuing international studies are required to identify the long term impacts from Chernobyl. This is a conclusion with which we can all agree, provided that such studies are soundly based and objectively analysed. Sadly, in my opinion, this book contributes little to such an aim.

References

- Baker R J and Chesser R K 2000 The Chernobyl nuclear disaster and subsequent creation of a wildlife preserve *Environ. Toxicol. Chem.* **19** 1231–2
- Busby C 1995 *Wings of Death. Nuclear Contamination and Human Health* (Aberystwyth: Green Audit Books)

National Ukrainian Report 2006 *Twenty Years of the Chernobyl Catastrophe: Future Outlook* (in Russian)

Office for National Statistics 2008 *Mortality statistics. Childhood, Infant and Perinatal. Review of the National Statistician on deaths in England and Wales, 2006 (Series DH3 No. 39)* (Newport: ONS)

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There are a wide variety of reasons for undertaking retrospective evaluations of radiation doses incurred by individuals and populations. Epidemiological studies clearly need to be based on realistic estimates of doses to the exposed populations, but dose estimates may also be required in a wide variety of other contexts, ranging from evaluation of entitlement to compensation for over-exposure through to decisions on medical treatment in the immediate aftermath of a radiation accident.

Because of this wide range of applications, techniques for dose reconstruction are many and various. Furthermore, because dose reconstruction typically depends upon the manipulation of historical data, the techniques used often have to be developed or adapted on a case-by-case basis, depending on the extent of the available data and their relationship to the dosimetric quantities required.

In view of the diversity of issues of relevance, this recent report from the NCRP makes no attempt at comprehensive coverage. Rather, as set out in its title, it focuses on the principles involved, but uses a wide variety of case studies to illustrate the considerations that arise in applying those principles. An extensive bibliography also directs the reader to a wide range of sources that are likely to provide useful insights to practitioners confronted with the need to develop an approach to dose reconstruction tailored to a specific context.

The NCRP report is built around five essential steps and two foundation elements of the dose reconstruction process. The essential steps comprise:

- Definition of exposure scenarios;
- Identification of exposure pathways;

- Development and implementation of methods for estimating dose;
- Evaluation of uncertainties in estimates of dose;
- Presentation and interpretation of analyses and results.

The two foundation elements relate to:

- The collection, organisation, evaluation of validity, use and archiving of data, taking into account consideration of the rights of privacy of subjects of dose reconstructions;
- The use of proper quality assurance and quality control procedures to achieve confidence in the credibility of the dose reconstruction process.

Although these essential steps and foundation elements are relevant to all applications of dose reconstruction, the issues that arise are rather different in the medical, occupational, environmental and accidental contexts, so these areas are discussed in distinct sections of the report, together with their own case studies.

A key underpinning consideration in dose reconstruction is the purpose for which the reconstruction is undertaken. For epidemiology, the aim is likely to be the provision of realistic estimates of absorbed doses to specific organs and tissues, together with estimates of uncertainty, for each individual in the exposed population. In contrast, for the purpose of determining entitlement to compensation, it may be sufficient to determine either upper or lower bounds on the dose received. If the upper bound is less than the compensation threshold then no compensation will be payable, whereas if the lower bound is larger than the threshold then compensation will be payable. If the threshold lies between the lower and upper bounds, then more realistic dose reconstruction will be required. Similarly, following an accident, roles of dose reconstruction may be to identify individuals who should be subject to continuing medical surveillance or, conversely, to reassure potential victims that they have not, in practice, been subject to significant exposure.

Overall, *NCRP Report No. 163* provides an excellent account of both the principles of dose reconstruction and many of the techniques of relevance. Furthermore, the breadth of the subject area and the accessibility of the writing mean that the report is more widely applicable, e.g. it provides a useful introduction to areas such as external and internal dosimetry, and the identification, quantification and propagation of uncertainties.

In a brief review, it is not possible to draw attention to the wide variety of strengths of this report. Two areas that particularly struck me

relate to the definition of individual and population attributes relevant to dose reconstruction and to the role of biodosimetric techniques as a complement to approaches based on environmental measurements or modelling.

With respect to individual attributes relevant to dose reconstruction, the report identifies seven principal variables that are determinants of dose. These comprise time, distance, shielding, age, intake, biokinetics and anthropometric characteristics. This list is relatively self-evident, though I would consider age primarily as a factor determining intake, biokinetics and anthropometric characteristics and not as a principal variable in its own right. However, the strength of the report lies in its identification and characterisation of a wide range of covariates to these principal variables. These covariates include gender, reproductive status, diet, ethnicity, lifestyle, health status, socio-economic status, religious affiliation, employment status, level of activity and energy expenditure. Information on these covariates may be available from historical records. If so, that information can be used to condition values of the principal variables. Specifically, the tables relating energy requirements to age, gender, ethnicity, and pregnancy/lactation status are likely to be of considerable value to readers concerned with prospective dose assessments as well as with dose reconstruction.

The review of biodosimetric techniques includes consideration of non-persistent dicentric chromosomal aberrations, symmetric chromosomal translocations that can be transmitted to daughter cells and thus persist for many years after radiation exposure, somatic mutation assays (e.g. of glycophorin-A), micronucleus assays, electron paramagnetic resonance spectroscopy (typically of teeth) and neutron-induced activity in body tissues. Several of the case studies include comparisons between whole-body doses calculated using environmental measurements/models

and biodosimetric approaches, e.g. table 9.4, which shows good agreement between doses calculated by a time and motion method and by a cytogenetic method for individuals accidentally exposed to a lost brachytherapy source. Of particular interest is that this comparison was made successfully at whole-body doses of around 0.1 Gy.

Given its length and complexity, the report is remarkably free from typographical errors (the '+' for 'x' in equation 7.10 is a rare exception). Several of the techniques described in the case studies were new to me, e.g. use of data from a volcanic-ash study to model dermal contamination from descending fallout (section 7.5.6.4.3). However, the reader should be aware that the case studies do not provide simple prescriptions that can be directly applied in other contexts. Rather, they provide stimuli to show how lateral thinking can be applied to develop case-specific approaches. In this respect, the report is perhaps least successful in the context of environmental dose reconstruction, where the complexities of the situations described (Nevada test site, Marshall Islands, Hanford, Mayak and Chernobyl) mean that an overview is given of the dose reconstructions that have been undertaken rather than a description of the details of the techniques used (except in the case of the Nevada test site, for which a very helpful account is given of how intakes of radionuclides by ingestion were related to external photon exposure rates normalised to 12 hours after each test explosion).

Overall, this is an extremely useful report that can be applied both in the field of dose reconstruction and in the context of other types of dose assessment studies. It also contains a wealth of historical detail that will be of more general interest and a bibliography that serves as an extremely helpful gateway to the wider primary and secondary literature in this area.

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