Introducting ICRP Publication 152: Radiation Detriment Calculation Methodology

Q&A Report | 9 December 2022

#	Question	Answered Live?	Complementary Answer
1	The socioeconomic aspect can be significant for an individual and must be considered when justifying a medical exposure. The choice between a $50 x-ray today and a $500 MRI next week must be weighed against the healthy life lost (a) by delaying treatment and (b) in working extra days to pay for the procedure.	Yes	There is no doubt that the cost of medical procedure is an important factor, but it is not the deleterious effect of radiation itself. An example of the socioeconomic effects given in Pub 26 is the need to restrict the use of some areas or products. (NB)
2	What kind of lifetime excess risk is used in detriment calculation? According to publication 103, the lifetime attributable risk (LAR) is calculated. But according to publication 152, the REIC is calculated...	Yes	The REIC and LAR produce almost the same results if the calculations are performed at 0.1 Sv. Both Pub 103 and Pub 152 calculated the lifetime risk using REIC at 0.1 Sv and multiplied by 10, although it was called lifetime attributable risk in the Pub 103. (WZ)
3	In slide 14, what is the basis for assigning the weighting (expressed in %) between ERR and EAR for different organs? Thanks.	Yes	Both ERR and EAR models were derived using Japanese Atomic bomb survivor's data. The ERR is associated with baseline rates but EAR model is independent of baseline rates. Average of both model with 50%:50% ratio is a good practice when the risk is transferred across the different population. However, due to variation of population baselines, 50%ERR+50%EAR models are not the best combination for certain types of cancer. For example,the 100% ERR model for thyoid cancer was preferred because the number of radiation induced thyroid cancers predicted by ERR model was less susceptible to variation in thyroid screening intensity and therefore to variations in background thyrid cancer incidence rates (Pub 103). The 100% EAR model was used for female breast cancer because a pooled analysis of radiation effects provided evidence against the use of ERR models (Preston et al 2002). 30%ERR+70%EAR model was used for lung cancer to give more weight is given to EAR model, because cancer baseline rates are largely due to smoking. (WZ)
4	ICRP 103 states that the risk coefficent of 5%/Sv is the estimated overall FATAL risk coefficient. However, detriment is calculated considering a fatal and a non-fatal component (e.g., quality of life). This is confusing - could you please explain?	Yes	The fatal risk coefficient for cancers (nominal risk) was 5% per Gy in Pub 60 (1991) but no more in Pub 103 (2007). Since Pub 103, detriment is no more based on mortality risk models but on incidence (morbidity) risks models, and estimated lifetime risks are then weighted by cancer severity. (DL) The description may not be wrong as fatal cancers are a major component of radiation detriment. But at the same time, what radiation detriment represents is not easily understood, and that is why it is necessary to improve comprehensibility. (NB)
5	The risk models in Publications 1991, 1992, 2003 use cancer statistic collected 40 years ago. That statistic has since substantially changed (e.g. cancer survival doubled, among others). That statistic is part of the Radiation Detriment formula. How are you planning to update the numerical values of the related parameters of the Detriment formula to be able to apply it to the modern day risk estimates? Thank you	No	Dominique's presentation has answered this question. (WZ) Yes, there is a clear need to update some of the risk models and refence data for cancers. This will be considered in the frame of the work of TG122. (DL)
6	What is the motivation for the formula q=k+q_{min} ·(1-k) for adjustment for quality of life loss?	Yes	Lifetime risk gives the probability of development of cancer, but this is not the whole story of the detriment. A person died at young age clear sufferd a bigger loss than a person died at old age. As survival rate for cancer improves, the quality of life which relates with pain and discomfort should also be taking into account as part of adverse health effect due to radiation exposure. Most of risk models nowadays are derived based on incidence data as the incidence data are more accurate than mortality data and less suscestible for misclassification. Lifetime risk based on incidence data and models takes adjustment of lethality, quality of life and relative life lost provides a more comprehansive picture of harmfull effect of radiation exposure. (WZ) The Quality of Life factor q is a weight given to non-fatal conditions, and it was assumed to be proportional to the lethality fraction k in P60 (q = k) as the difficulty of curing is thought to represent the decrease in quality of life. In Pub 103, the factor qmin was introduced to assign the minimum weight that is not parallel to the lethality. (NB)

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7	As we now have more computing power, is there too much emphasis on the idea of risks based on effective doses etc and we should be looking much more at specific risk related to organ exposure	Yes	Risk estimates derived from epidemiology studies are based on organ doses. The lifetime risk calculation used in the construction of the detriment is also based on organ doses. (WZ) Effective dose is a practical tool for RP, but it is not a one-size-fits-all solution. In the situations where the likely consequences of an exposure of a particular individual need to be assessed, more precise risk estimates should be sought based on individual organ/tissue doses. (NB)
8	Thanks a lot. please explain more how to consider other parameters like air polution in the rate of cancer cases such as lung cancer	Yes	The potential impact of risk factors other than radiation is not considered in the risk models considered in the construction of the detriment. But the impact of all risk factors is integrated in the baseline rates. (DL) There were no studies on this topic, it might be something to consider for the future epidemiological study. (WZ)
9	Could the re-calculated radiation detriments of different organs bring about any changes on the tissue weighting factors? Thanks.	Yes	The recalculated radiation detriments calculated in Pub 152 for the whole population mostly agreed with those in the Pub 103, so there is no need for any change at the present. (WZ) Future revision of the detriment calculation may have an impact of wT values. (DL)
10	Comment: Excellent and much appreciated descriptions and sensitivity analyses. Thank you. It is of interest to note differences between the REID-based NASA cancer risk and Detriment. While the quantities mostly mirror. NASA NSCR-2012 considers age 35+ only and omits heritable effects to obtain "tissue weights", and an uncertain distribution of DDREF centered on 1.5 rather than 2 . These presentations help to clarify how the high tissue weight organs like lung, stomach, liver, etc, have a much higher weight than the 0.12 derived for sex-averaged tissue weight of ICRP	Yes	ICRP did not use the values of relative radiation detriment directly for tissue weighting factors considering that those values are imprecise because of uncertainties associated with their estimation. In that context, efforts should be made to identify the sources of uncertainty and to quantify their magnitude. The same applies to the variation due to sex, age and other influential factors. It is suggested in Pub 152 to calculate lifetime risks separately for sexes and selected age categories, and to average these estimates in the last stage. (NB)
11	it would be very interesting to include African population	Yes	Any population data could be used in the analysis as long as good quality demographic data are available (all-cause mortality, cancer incidence and mortality data). (WZ) Only two reference populations are considered in the calculation of the detriment at the time being (Asian and Eur-American). Feasibility of extension to other populations (including the African population) will be considered in the frame of the work of TG122. (DL)
12	Thanks a lot for the clear presentations. I have a question on the reference population and the possible evolution: What is the “robustness” of the data on incidence in the current reference population and what about the available data now? If you include a large number of different populations with significant different life expectancy, what could be the impact on the calculation of detriment? What would be the “degree of conservatism” in that case?	Yes	Demographic data needs to be updated for the future analysis. (WZ) To estimate the global average, data of wider populations should be incorporated. At the same time, it is desirable to compute the average across the populations in the last stage to know how variable the estimates are. Such information will provide the basis for better handling of the variation in RP practice. (NB)
13	Why is a lineair quatradic model assumed for leukaemia? And is it still accurate?	Yes	The linear quadratic model for leukaemia was derived based on data from Japanese atomic bomb survivor's study. It is still valid. (WZ) Recent results showed different shape of risk model for different leukaemia subtypes. This point will be considered in the frame of the work of TG122, for leukaemia and for other cancer types. (DL)
14	Also notable for how REID alone is used to represents space exposure "detriment" are average radiation quality >> 1.0 and that missions are <<1 Sv. The latter also serves to increase the importance of a few organs. This enhances the differences between ICRP-defined wT from REID- or detriment-based importance factors.	No	In Pub 152, there is the following description: "There may be situations where radiation detriment, as well as effective dose, is used to control doses of several hundred mSv. However, it should be noted that the DDREF of 2 does not apply to low-LET radiation at such doses except dose rates below 0.1Gy h–1, and the risks may be greater than implied by the nominal risk coefficients." In the case of space exposure, the particularity of radiation quality is also an important issue. It will be worth discussing the applicability of radiation detriment and effective dose to space radiation in more detail. (NB)

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15	Q for Dominique: Given the variations between countries, in cancer incidence but also in variation of this incidence, maybe to improve the detriment at a world level is a too much complex challenge....	Yes	Only two reference populations are considered in the calculation of the detriment at the time being (Asian and Eur-American). The use of updated data providing a better representativeness of the variation of reference rates in the world appears as a good evolution for the RP system, and some data sources seem to provide good quality data for that today. The pertinence and feasibility of such extension to other populations will be considered in the frame of the work of TG122. (DL)
16	If there is a significantly higher overall or specific risk for any particular population sector (other than by age), is it reasonable to average the detriment estimate across all sectors? Surely the ethical value for radiation protection would be the maximum?	No	It is a matter of how to handle the variation in RP practice. There is not a simple answer, but it is desirable to calculate radiation detriment separately for different conditions and average across them in the last stage to know how variable it can be. (NB)
17	And may be detriment calculation per country or group of countries should be more performant ?	No	The sensitivity analysis has shown that there are variations in detriment between different populations. It is possible to perform detriment calculation for those populations that have similar demographic data. (WZ)
18	Can you explain the calculation of the values for the relative years of cancer-free life lost in more detail, please?	No	The relative cancer-free life lost is the average years of life lost for a particular cancer divided by the average years of life lost for all solid cancer combined. The method for calculating the years of life lost for a particular cancer can be found in the paper by Thomas D et al 1992. Health Physics 63(3): 259-272. (WZ) The method is also explained in the Supporting Guidance 1 for Pub 60. However, Pub 103 is likely to have taken a different approach as the above-mentioned method cannot reproduce the values of the relative years of cancer-free life lost. (NB)
19	Indeed, radiation detriment is an intricate concept. Some of the suggested potential evolutions may even make the concept more complicated. So it is of paramount importance not to make the future concepts even more complicated.	No	There is no doubt that a simple, comprehensible and robust indicator is desirable. Achieving it while integrating different asplects of health imapct is quite a challenge. (NB)
20	Q for Dominique: rather than trying to tweak detriment, might it be better to try to express consistently all radiation harm in terms of QALy/DALY?	No	Use of QALY or DALY would indeed facilitate comparison with other pollutants. Pertinence and feasibility of such evolution will be considered in the frame of the work of TG122. (DL)
21	An open-source tool for radiation-detriment calculation is an excellent idea, for educational and communication purposes.	No	Agree. (WZ) That's a point that will be considered in the elaboration of the new recommendations, but careful attention must be given to quality assessment and user interface to avoid potential misinterpretation or erroneous use. (DL)
22	Will the ICRP interest in individual-based risk analysis for exposures in the medical setting (or elsewhere) accelerate the use of detriment-based tissue/organ weights? Or, is more analysis necessary, such as the impact of uncertainties in the evidence base?	No	There is ongoing debate as to the individualized approach. Assessment of uncertainty and variability will be necessary as a basis for discussion. (NB) A reflexion has been launched on this topic within the ICRP Main Commission. (DL)
23	Why consider from 0 - 14 years and not up to 17 years?	No	For most epidemiology studies, the ages for children were define as 0-14 years. We followed this convention for the sensitivity analysis to identify the lifetime risk of cancer for children after radiatuion exposure. However, there is nothing to against using 0-17 years for the analysis. (WZ)
24	Legitimate uses of detriment in practice e.g. medical/diagnostic radiological applications of applications?	No	Since detriment takes into account of lifetime risk, lethality, quality of life and relative life lost, it gives a complete picture of harm caused by the radiation exposure, it should be a useful quantity in practice. (WZ) Some elements about the usefulness of the effective dose in medical practice can be found in Pub 147. (DL)

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25	Sensitivity Analysis--- Has a sensitivity analysis been carried out for the total risk or detriment, summed across all cancers (for the same parameters)? What would be the impact on the total risk or detriment of the same parameters?	No	Detriment was calculated for each individual cancer type and summed up as the total detriment for all cancers. (WZ) Some elements on sensitivity can be found in Pub 152 and in Zhang et al. IJRB 2020. (DL)
26	Many presentations by experts often contain the statement “the risk of radiation is 5% per Sv’, implying that this is a scientific fact. This is normally taken (by other RPs and the public) to mean that the risk of death is 5% per Sv. Given that most exposures are around the mSv level and less, where there are very large uncertainties in risk, and that detriment includes risks other than death, how should we best move towards a more honest and accurate communication of risk?	No	The fatal risk coefficient for cancers (nominal risk) was 5% per Gy in Pub 60 (1991) but no more in Pub 103 (2007). Since Pub 103, detriment is no more based on mortality risk models but on incidence (morbidity) risks models, and estimated lifetime risks are then weighted by cancer severity. (DL) It is exactly the challenge of improving transparency and comprehensibility of radiation detriment. It includes how to communicate uncertainties. (NB)
27	Detriment as QALY is useful at poplation level for policy purpose. However, for individual cancer case, we need to calculate the attributed share, which need risk model including uncertainties as ILO standard requiere. This would be useful to provide this information and the appropriate step to transfer population epidemiology.	No	There is the following statemetn in Pub 152: "Radiation detriment is intended for inferring risks from exposure situations for radiological protection purposes, or to assess risks retrospectively for exposures of identified individuals. However, it should be recognised that there are significant differences in risk between sexes and in respect of age at exposure. For estimation of the likely consequences of an exposure of a given individual or population, it is preferable to use specific data relating to the exposed individuals and customised risk models when they are available." (NB)
28	What is the probality of excess cataract for radiation workers in cathlab and for brain tumour?	No	Cataract is not included in the detriment calculation. More information on risk for lens opacities can be found in Pub 118. Brain tumour is included in the detriment, but no specific risk model was developed for brain tumour in Pub 103. This point will be considered in the frame of the work of TG122. (DL)
29	Thank you for your excellent presentations. As far as I understood, P152 recommends to calculate sex and age-at-exposure numbers for the detriment, and only deriving at the very end an averaged risk factor. Doesn't this implicitly imply that no changes in dose limits (for the effective dose) are foreseen in the process of revision of the general ICRP recommendations?	No	It is possible to calculate radiation detriment for different sexes, ages and geographical regions. However, it does not necessarily mean different sets of coefficients and numerical criteria should be used. From a practical point of view, some sort of averaging will be necessary. The suggestion is to compute the average in the last stage to know how the estimates can vary. Such information will provide the basis for better handling of the variation in RP practice. (NB)
30	I think that the expression of uncertainty related detriment calculation is important for easily understanding and detail risk estimation. Is there any plan how express detriment value with uncertainty?	No	The consideration of uncertainties is a major issue for the evolution of the calculation of the detriment. But this issue is much wider and applies also to dosimetric aspects and to the application of RP, and includes ethical and communication dimensions. A reflexion has been launched on this topic within the ICRP Main Commission. (DL)
31	why the african population is not included?	Yes	Only two reference populations are considered in the calculation of the detriment at the time being (Asian and Eur-American). The use of updated data providing a better representativeness of the variation of reference rates in the world (including in Africa) appears as a good evolution for the RP system, and some data sources seem to provide good quality data for that today. The pertinence and feasibility of such extension to other populations will be considered in the frame of the work of TG122. (DL)

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32	How to treat smoking when setting baseline incidence, which is one of the characteristics of the population. The LSS risk model also takes into account the effect of smoking in its analysis. On the other hand, smokers were assumed in the radon risk estimation. Is there a need to clarify the nature of the population commonly treated by the ICRP's system of radiological protection?	No	Smoking is a major cause of cancer, particularly lung cancer. A study by Pierce et al. 2003 (Radiation Research 159, 511-520) has found that risks from radiation and smoking were consistent with additivity. Therefore the EAR model need to be weighted more when transfer risk between populations. this is the reason that 30%ERR model and 70%EAR model were used in Pub 103 for the risk transfer between population for lung cancer. (WZ) Up to now, the potential impact of risk factors other than radiation is not considered in the risk models considered in the construction of the detriment (even for radon, mode elements available in Pub 115). But the impact of all risk factors (including smoking) is integrated in the baseline rates. (DL) There is the following description in Pub 152: "It is desirable to calculate lifetime risks separately for sexes and selected ages (age groups), and to average these estimates in the last stage. ... The same applies to other influential factors, including modifiable lifestyle factors. ... If factors that greatly influence the sensitivity to cancer induction are identified in the future, whether modifiable or not, the variation of risk with them should be assessed." (NB)
33	It seems that differences between sex, age and geography cannot completely be negligible. How is ICRP going to manage this aspect, in the next Recommendations? Can we imagine a RP System which differentiates between those elements?	No	We consider it is important to consider and illustrate variations of risk with region, sex and age, but not necessary to include it in the management of RP. (DL) See also answer to No.29.
34	Great talks. Considering that the ERR and EAR models assume multiplicative and additive interactions between radiation and the baseline, is there any evidence to exclude the possibility to adopt supra-multiplicative or sub-additive interaction?	No	There could be cases that different weights apply to ERR and EAR models. For example, 30%ERR model and 70%EAR model were applied to lung cancer risk transfer. New models will be required if there is evidence of supra-multiplicative or sub-additive interaction. However, this is not the case when we are assessing the detriment for the whole population in general. (WZ)
35	I appreciated the push to approach detriment from a more “popular” perspective, like DALI, to ease comparisons between chemical, radiation and other risks. Is this approach feasible witchin the ICRP System? Can we see an assessment similar to DALI in the future?	No	Nothing has been decided yet. The issue is a subject of future discussions. (NB) Pertinence and feasibility of such evolution will be considered in the frame of the work of TG122. (DL)
36	Detriment is a tough problem...Risk of outcome and impact of outcome are two different metrics, and both change a great deal with new evidence base/mosdels.	No	I agree. Indeed, two steps are clearly distinguished in the calculation of the detriment: the calculation of the lifetime risk of cancer (which depends on radiation exposure) and the weighting for cancer severity (which does not depend on radiation exposure). (DL) It is therefore important to assess the sources and magnitude of uncertainty. (NB)
37	I suppose the question that I was really wanting was to wonder what is the benefit nowadays of combining the many elements in to a single figure whereas we may now want to look at each element individually	No	There is the following description in Pub 152 regarding the usage of radiation detriment: "Radiation detriment is used by the Commission for various purposes, including assessing the consequences of radiation exposures to recommend dose limits, and comparing the consequences of different distributions of organ/tissue dose within the body to select a set of tissue weighting factors. In addition to these primary purposes, radiation detriment may also be used in practice, for example, to evaluate the significance of an exposure in the process of optimisation." (NB)
38	How to calculate the radiation detriments of eye lens and circulatory diseases? Thank you.	No	New ICRP task groups have been set up to work on these topics. (WZ) These issues will be considered in the frame of the work of TG119 and TG123. (DL)
39	Is it time to separately clearly the difference between a single detriment figure that we use for the frameworks for protection of the general public, and the specific irradiation situations such as incidents or - more specifically - medical exposure and treatments (and in those there is huge variation in DDREF surely)	No	A reflexion has been launched on this topic within the ICRP Main Commission. (DL) See also answers to No.14 and 27.