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# Ethical, logical and scientific problems with the new ICRP proposals

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**Abstract**
Last year the ICRP proposed a new system of radiation protection designed to be simpler, more oriented toward individual protection and reflective of important ethical standards. This article argues that the proposal violates important norms of scientific simplicity, is in fact less protective of individuals than the current system and makes a number of ethical errors. After outlining 12 ethical errors, five logical errors and two scientific problems with the new ICRP proposal, the present authors suggest possible ways to remedy these deficiencies.

In an attempt to rid radiation standards of a disease—overemphasis on utilitarian ethics—the ICRP proposes a cure that is worse than the disease. It is worse in incorporating an egoistic *ethics*, a *science* that misunderstands simplicity and a *logic* that is not consistent. Let us see what is wrong with the proposed ICRP cure in each of these three main areas.

## 1. Twelve ethical shortcomings

Because the ICRP recognises that radiation-protection standards have evolved to reflect ethical standards (ICRP 2001, p 113), any ICRP recommendations ought to employ the best possible ethical analysis. (Ethical analysis is the process of critically evaluating and defending norms through techniques such as assessing their assumptions, consistency, consequences and completeness.) Unfortunately the proposed recommendations (ICRP 2001) fall short of employing good ethical analysis and include at least 12 ethical errors.

### *1.1. Ethical problem 1: ignoring future generations*

Much of the ethical controversy over the ICRP proposals concerns their relationship to utilitarianism. Utilitarianism is the view that ethically correct actions are those (a) that treat people according to the 'moral ideal of impartiality' and (b) that achieve 'the maximum balance of pleasure over pain in the long run' (Lyons 1992, pp 1261, 1263). As many ethicists have

realised, utilitarian ethics is superior to egoistic ethics, insofar as it sanctions principle (a) and treats people impartially, but questionable insofar as it sanctions principle (b) which cares 'only about the size of the benefits pie' and not about 'how it is divided among persons' (Lyons 1992, p 1265). Egoistic ethics is the view that ethically correct actions are those (c) that promote 'the agent's own long-term interests'; (c) 'implies that the interests of others may be ignored'. As such, egoistic ethics rejects both principles (a) and (b) (Lyons 1992, p 1261).

The ICRP correctly notes that it wishes to correct its principles' overemphasis on benefit–cost analysis and utilitarian ethics (ICRP 2001, pp 115–7). Unfortunately, the new ICRP proposals offer an alternative, egoism, that is worse than overemphasising utilitarianism. Indeed the ICRP proposals return to some of the very problems—partiality and purely self-interested behaviour—that utilitarianism corrects. When Jeremy Bentham and John Stuart Mill proposed utilitarian ethics several hundred years ago, they did so, in, part, to avoid the egoism of earlier eras and its rejection of principle (a) above. Bentham (1748–1832) expressed one of the essential utilitarian formulae of this principle (a) of equality in his *Principles of Morals and Legislation*, ch XVII, section 1: each person is to count for one and none for more than one. This is the impartiality principle that each person's interests should be taken equally into account in ethical decision making.

In arguing against use of traditional collective dose, the new ICRP proposals violate principle (a) of utilitarian ethics by not counting doses to people distant in time and space. If particular radionuclides have long half-lives, then it is arguably correct to calculate the collective dose likely to arise during their specific lifetimes. By ignoring collective doses one violates duties to treat similar (with respect to half-life) radionuclides similarly and different radionuclides differently. Ignoring these doses to future people amounts to discounting their interests, against which most ethicists, including utilitarians, have argued (see e.g. Parfit 1983). Even the United Nations and virtually all the developed nations of the world are repeatedly on record, in their laws, regulations and resolutions, to protect future generations as much as they protect the present. Ignoring collective dose would violate this protection and resort to a questionable ethical 'cure' (the egoism of this generation) that is worse than the disease of overemphasising utilitarianism.

Clarke (1999, p 109) seems to have recognised the egoistic ethics underlying the new proposals. He has noted that this generation's pragmatic concerns, about the cost of contamination cleanup from activities such as weapons tests, Chernobyl and decommissioning, have driven the new ICRP proposals. If indeed Dr Clarke is right, that expediency and the financial concerns of this generation are driving the new proposals, then these proposals may fall victim to egoistic ethics and therefore to ignoring duties to future generations.

### *1.2. Ethical problem 2: ignoring environmental ethics*

The new proposals also are egoistic in ignoring many responsibilities in environmental ethics. Environmental ethics is the branch of ethical theory that argues for protecting any 'environment or ecosystem', any natural object or nature, from damage (Shrader-Frechette 1981, p 17). As such, environmental ethics requires humans to reject principle (c) of egoism and instead, so far as possible, to protect the land, air, water, and all living and nonliving things that are the Earth's life-support system. In focusing on individual human dose, the new proposals ignore environmental ethics. Apart from whether there is an individual human nearby to receive a dose, additional radioactive releases often are problematic for at least four additional reasons.

(1) It is important to protect the entire biotic and abiotic environment.
(2) The synergistic, cumulative or additive, and genetic effects of many small releases to the environment could be risky, with respect to threats such as species losses.

(3) Releases on one side of the globe could affect both humans and their biotic and abiotic environments on the other side of the globe, as is evident from nuclear-weapons tests.
(4) It is impossible to know whether a particular human or a natural object will receive an additional radiation exposure.

For all these reasons, calculating collective dose and long-term human and environmental effects, rather than focusing merely on individual human dose, is more consistent with environmental ethics.

### *1.3. Ethical problem 3: ignoring scale of human exposure*

Another ethical difficulty is that the new ICRP proposals argue against aggregating all levels of dose and all periods of time into a single value (ICRP 2001, p 117). Because these proposals allege that the need for protective action is influenced by the individual dose, but not by the number of exposed individuals (ICRP 2001, p 118), they again betray an egoistic assumption, an emphasis on only a particular individual rather than on the entire group that might be exposed in space and time.

Such an assumption is particularly problematic because virtually all moral philosophers (except egoists) agree that scale is a fundamental variable in ethics. To see why this is the case, suppose one person receives (what the ICRP calls) a 'trivial' dose of radiation, 0.05 mSv (or 5 mrem), for which the ICRP (2001, pp 119–20) proposes that no protective action is necessary. Suppose, on the other hand, that 10 000 people receive this same additional dose. If the ICRP is correct in ignoring the scale of exposure, then the two exposures are not ethically different. But they are ethically different because larger populations, like the 10 000 exposed people, have larger numbers of sensitive individuals and people with prior high exposures from sources such as x-rays and radiation therapy, and therefore higher long-term risks.

The 10 000-person exposure also is more ethically serious because the genetic effects of repeated small exposures to a large group will be more serious than the genetic effects of repeated small exposures to a single individual. This is why, for example, the US Public Health Service practice, half a century ago, to perform portable x-ray screening of thousands of rural US children has been so criticised.

Moreover, in risk assessment, analysts typically weight some low-probability exposure to a very large group by a factor $n$, in order to account for the fact that even small risks to large numbers of people are more serious than imposing the same risk on a single person (see Shrader-Frechette 1991). Also, in ethics we know that, because it is more serious to threaten a whole species, race or culture than simply to threaten an individual, the scale of exposures or potential victims is an essential moral variable. Yet ignoring collective dose ignores this fundamental moral variable.

### *1.4. Ethical problem 4: ignoring stakeholder consent*

Still another respect in which the new ICRP proposals are, in part, egoistic is that they ignore stakeholder consent to additional radiation exposures. According to the US National Academy of Sciences, stakeholders are those (such as potential victims) who stand to gain or lose from a particular risk imposition (National Research Council (NRC) 1996). Victims' free informed consent to any additional risk is a fundamental principle of medical ethics, ever since at least the Nuremberg Trials (see Shrader-Frechette 1991). Therefore all stakeholders, not only scientists or medical doctors, should participate in the justification of additional radiation exposures. Yet, contrary to free informed consent, the new ICRP (2001, p 118) proposal claims that the responsibility for the justification of a particular (radiological) procedure falls on the relevant

medical practitioners (p 118). This claim is ethically problematic because it is contrary not only to free informed consent, but also to the ICRP (2001, p 115) principle that the question of radiation protection is one of risk acceptability. It is ethically justifiable for experts alone to make decisions about risk calculation and measurement, but not about risk acceptability.

Moreover best risk-assessment practice recognises this fact. A recent risk-assessment committee of the US National Academy of Sciences noted that stakeholder deliberation was equally important as expert analysis (NRC 1996). Even utilitarians would not ignore stakeholders and appeal merely to expert judgment in a case of risk acceptability, as the new ICRP proposals have done. To do so would be to employ egoistic ethics.

### *1.5. Ethical problem 5: ignoring information necessary to ethical analysis*

The new ICRP proposals also fall short of the necessary requirements for reliable ethical analysis. Both good science and ethics require that one should not ignore any of the relevant data: that one should not engage in what the English mathematician Charles Babbage called 'trimming the data'. Some of the necessary data for reliable ethical analysis are the calculated total ethical costs or risks associated with any action. Ignoring the various exposures arising from collective doses from various sources, as the ICRP has proposed to do, means that all the contributions of radiation exposure to a particular person's dose will not be counted, as the following considerations show.

(a) I can determine my total individual dose of radiation only by adding all the doses I receive from each source.
(b) But the new ICRP proposals tell me not to add those doses that I receive (as a member of a collective-dose population) from weapons testing, Chernobyl and various other sources.
(c) Therefore the new ICRP proposals prevent me from learning my total individual dose, because they ignore collective doses that I receive as a member of a large group.

If (a), (b) and (c) are correct, then the ICRP proposals (to abandon collective dose) trim the dose data and fall victim to egoistic ethics because they ignore the rights of all persons to have all their costs and risks counted.

### *1.6. Ethical problem 6: ignoring undesirable and unethical consequences*

Reliable, nonegoistic ethical analysis also requires that one take account of the possible consequences of one's actions, especially consequences that affect others. In order to defend adequately its new proposals, the ICRP must consider a number of consequences likely to follow from them. For example, if the ICRP abandons its concept of collective dose, and instead considers only doses to individuals (presumably nearby in space and time), then this abandonment will promote a 'disperse and dilute' or 'higher-smokestack' strategy. This strategy is to use radiological emission and effluent techniques (such as poorer radwaste canisters) that send the exposures to people farther away in space and time. By sending them farther away, one can claim that no known individuals receive a significant dose, and therefore that such doses need not be counted. Yet if there are radiological releases, even if they are not counted as part of individual doses, obviously the radiological burden for the planet will be increased, just as it was for weapons testing.

Such a 'dilute and disperse' strategy is egoistic because it ignores the rights of distant peoples who are likely to receive higher radiation doses. Given the cumulative character of the effects of radiation exposure and the long half-lives of many radionuclides, such violations of rights are almost certain. Another undesirable ethical consequence of abandoning collective dose is that the ICRP will appear unstable in its recommendations. As a result, it may lose

prestige and acceptance in both the scientific and public arena. Worse still, the ICRP could be seen as being biased, making changes that are merely expedient, in order to reduce cleanup and decommissioning costs. If so, these ICRP changes could cause people to reject nuclear technology as unsafe or to lose trust in nuclear regulators.

### *1.7. Ethical problem 7: ignoring the practicality of its recommendations*

Making ethically sound recommendations requires the ICRP not only to avoid errors in ethical theory, errors such as egoism, but also to avoid principles that cannot be practiced successfully. A good theory of ethics is useless if it is not practically achievable. This is why the ethicist Emmanuel Kant emphasised that 'ought implies can'.

The new ICRP (2001, p 117) proposals, insofar as they abandon collective dose and emphasise the dose to an individual from a controllable source, err because they ignore the fact that this new proposal cannot be reliably carried out. It cannot be carried out because, as was mentioned in discussing ethical problem 5, there would be no individual-dose calculations that included collective-dose contributions from various sources. Calculation of individual doses likewise would require taking account of all environmental exposures and possible movement of individuals into or out of areas of higher radiation. It is obvious that no nation will monitor individual doses in this way. Indeed, even in the developed world, it is difficult to keep track of medical records that are far easier and less expensive to obtain than radiation-dose records. Such radiation records also would be more difficult to obtain and maintain (than collective-dose records based on emissions and effluents) because of individual variations among people and the need for continual individual monitoring. This is why most pollution-control regulations are written in terms of emission or effluent standards, not merely in terms of individual-dose standards, as the new ICRP proposals are.

Because of the practical difficulties with monitoring individual doses, the new ICRP proposals will have either to estimate individual doses or to use average doses. It has said it will do the latter (ICRP 2001, p 122). Yet both of these alternatives are undesirable, regarding individual protection. Estimation is undesirable because it could be manipulated or misused by those having an interest in showing low dose. Using average doses is undesirable both because it is dependent on the model and distribution chosen, and because using average doses fails to respect the rights of the most sensitive segments of the population. Average dose figures also could cover up high doses to minorities or especially sensitive people. For the new ICRP proposals to sanction only individual, and not both individual and collective, dose standards implies that the ICRP can guarantee that all contributions to individual doses can be monitored, recorded and regulated in an ethically reliable way. If it cannot guarantee these practices, then it ought not to promote the ethical theory of abandoning collective dose in favour of individual dose.

### *1.8. Ethical problem 8: naturalistic fallacy regarding background radiation*

One of the most serious ethical problems with the new ICRP proposals is that they commit the naturalistic fallacy. The naturalistic fallacy, as defined by British ethicist Moore (1951), means the attempt to reduce the normative question of what *ought* to be the case to the descriptive question of what *is* the case, for example, to reduce ethical problems to purely scientific problems. The naturalistic fallacy is erroneous because no amount of information about what is the case is sufficient to establish what ought to be the case. What is natural or normal is not necessarily desirable or good, because often what is the case is ethically unacceptable. Moreover, attempting to reduce ethical problems to scientific ones ignores necessary nonscientific conditions such as equity, fairness, compensation and consent.

By virtue of proposing ethically acceptable radiation standards on the basis of the assumption that natural background radiation levels are ethically acceptable (see ICRP 2001, pp 119–20), the new proposals define ethically acceptable radiation levels in terms of a purely scientific criterion, natural background levels. The ICRP (2001, p 117) also notes approvingly that a majority of the ICRP members agreed with the use of natural background radiation in setting standards. However, just because background radiation of a certain level is natural or normal does not mean that it is benign or desirable. Some experts say that even 1 mSv of background radiation is responsible for one in 40 fatal cancers (UNSCEAR 1994), and background radiation is typically several times greater than 1 mSv. If they are correct, if all exposures to ionising radiation carry a small risk, then background radiation ought not be used as a criterion for ethically acceptable exposure levels.

If one wished to argue that additional radiation exposures, below background, were negligible or trivial, then one could just as easily argue, for example, that particular cases of typhus or tuberculosis are negligible or trivial, provided that they were below the normal level of typhus or tuberculosis. Obviously, however, this normalcy would not entail that causing additional cases of typhus or tuberculosis, or additional radiation exposures, below the background rate, was ethically acceptable. Just as any *additional* cases of typhus or tuberculosis ought to be prevented, so far as possible, so any additional radiation exposure ought to be prevented if one can easily do so and if there are no ethically compelling grounds not to prevent it. In short, preventable risks are not necessarily ethically acceptable, just because they are statistically or quantitatively at or below normal levels (see Shrader-Frechette 1991). Besides, if one were to accept such preventable risks, or if one were to accept the naturalistic fallacy in cases of public-health risks, then there would be less medical progress because one could claim all preventable public-health risks were ethically acceptable, if they were below the normal level.

### *1.9. Ethical problem 9: naturalistic fallacy regarding dose evaluation*

The new ICRP proposals also commit the naturalistic fallacy insofar as they presuppose that quantity of radiation risk, alone, determines its acceptability (ICRP 2001, p 119, table 1) and assert that 'no protective action' is necessary for certain 'trivial' doses of radiation (ICRP 2001, p 120). By virtue of reducing nonquantitative and ethical criteria (such as consent, equity, compensation and fairness) for radiation standards to purely quantitative and scientific criteria for risk acceptability, the proposals commit the naturalistic fallacy and attempt a crude ethical reduction of what is ethical to what is scientific.

To see the errors in such a reduction, suppose a judge in a court of law announced that he was simplifying the treatment of murder cases, so as to save money spent on costly trials. Suppose further that his proposed simplification was to reduce cases of premeditated murder, voluntary manslaughter and involuntary manslaughter to one simple case: murder. In response to the judge, ethicists would protest that his simplification ignored equity, fairness, intention, voluntariness and other relevant ethical considerations. So also with the new ICRP proposals. No radiation exposure is trivial if it is easily preventable, or if A caused it carelessly or unnecessarily, or if A caused it and benefits from it while B bears the risks. What is a trivial dose is a function of ethical parameters, factual circumstances, previous exposures, how many doses are received, whether the person is especially sensitive and so on. Besides, given the linear, no-threshold hypothesis and ALARA, no dose is automatically ethically acceptable. Even a utilitarian would not use a purely quantitative criterion for radiation exposure but instead would argue that each person ought to have an equal voice in the decision about acceptable radiation risk. ICRP ethical errors such as the naturalistic fallacy and egoism suggest that, because the

ICRP (2001, p 113) admits that its recommendations ought to reflect ethical standards, the main commission of the ICRP ought to include biomedical ethicists who can help reduce such ethical errors.

### *1.10. Ethical problem 10: increased utilitarian emphasis*

In the face of ethical errors, such as the previous one of committing the naturalistic fallacy in evaluating dose acceptability, it is puzzling that the ICRP (2001, p 117) claims to want both to move away from utilitarianism and to limit the inequity in radiation protection (ICRP 2001, p 116). The proposed ICRP scheme is even more utilitarian, in at least some respects, than is the current set of ICRP recommendations. For example, the use of average dose, in place of individual dose, is a fundamentally utilitarian move that ignores the high-dose end of the distribution of exposures. Using an average dose promotes inequity because it ignores minority rights to equal radiation protection.

The new proposals also are more utilitarian than the current recommendations insofar as they sanction moving from radiation doses that are as low as reasonably achievable (ALARA) to those that are as low as reasonably practicable (ALARP) (ICRP 2001, p 120). What is *achievable* is a function of current *science*. But what is *practicable* is a function of *economics* and benefit–cost analysis. Because the new proposals recommend an ALARP standard, they are more utilitarian than the current ones, despite the fact that the ICRP (2001, p 115) criticises an overemphasis both on utilitarianism and on the use of differential benefit–cost analysis (ICRP 2001, p 117). If ICRP were really serious about making its recommendations less tied to utilitarian and benefit–cost criteria, then it would recommend exposures that were as low as possible/achievable, not those that are as low as practicable. It also would recommend standards based on protecting the most sensitive individuals, not merely average protection.

In spite of its wishing to make its recommendations less utilitarian, the ICRP betrays crude, utilitarian presuppositions in many of its new proposals. For example, it asserts that 'the principal aim of medical exposures is to do more good than harm to the patient' (ICRP 2001, p 118). The aim of doing more good than harm, however, is purely utilitarian. Medical doctors are required, explicitly, *not* to follow such a utilitarian standard. One reason they are not is that there are many medical treatments that would do more overall good than harm, yet doctors ought to recommend only a few such treatments. Instead doctors are required to follow the 'best professional practice' standard. In other words, doing more good than harm is merely a necessary, but not a sufficient, condition for ethical medical treatment. By confusing a necessary and a sufficient condition, the ICRP employs a utilitarian standard.

### *1.11. Ethical problem 11: the proposals are less protective of individuals*

Still another ethical difficulty with the ICRP proposals is their failure to make recommendations consistent with their claims that current radiation standards have provided insufficient protection for the individual (ICRP 2001, p 115) and that the new proposals are based on an individual-related philosophy (ICRP 2001, p 123). At least eight reasons, already discussed, suggest that the new proposals are less protective of individuals: the emphasis on ALARP and average dose, rather than ALARA (ICRP 2001, p 122); commission of the naturalistic fallacy; and ignoring the scale of exposures, free informed consent, stakeholder rights, rights of future generations and the collective-dose contributions to individual dose.

In addition to the eight considerations already discussed, at least five additional reasons show that the new ICRP proposals are less protective of individuals. For one thing, the proposals are not consistent with the *precautionary principle*. This principle requires that

uncertainty about harmful effects not be used as an excuse for doing nothing to mitigate possible harmful effects and that actions to prevent possible harm be undertaken even before the causal connection between a particular situation and harmful events is clear (Hey 1991). In the existing ICRP recommendations, both ALARA and the LNT hypothesis are evidence that the ICRP is following the precautionary principle (Persson 1996, p 2). Yet because the new ICRP proposals reject collective dose as uncertain because not directly measurable, the ICRP uses this uncertainty as an excuse for ignoring collective dose and therefore violates the precautionary principle.

A tenth reason the new proposals are less protective is that the choice (about allowable dose) would be dependent on 'judgment' rather than on collective dose (ICRP 2001, p 120). *Subjective judgment* about radiation standards is not protective and is liable to manipulation and pressure. Moreover, it is not consistent for the ICRP to fault collective dose for not being measurable (ICRP 2001, p 117), but then to propose subjective judgment as the alternative to collective dose (2001, p 120). An 11th reason for believing that the ICRP is wrong to claim the new proposals are more protective of individuals is that the proposed emphasis on restricting dose to individuals, by means of subjective judgments about *protective action levels* (PALs) (ICRP 2001, p 123), would not make the exposures ALARA. By calling doses 'negligible' or 'trivial' in PALs the doses may not be ALARA, and if not the PALS proposals are less protective than ALARA.

Twelfth, the ICRP (2001, p 117) has admitted that only a minority of ICRP members believes that the new proposals must improve radiation protection in order to accept the proposals. But this admission implies that a *majority* of ICRP members believes the changes should be made even if there is no improved protection. It also suggests that ICRP members do not believe the new proposals are more protective of individuals.

A 13th reason for believing the new proposals are less protective is that the ICRP proposes eliminating talk of radiation 'practices' in favour of radiation-related 'endeavours' (p 118). If one is required to engage in a certain practice this requirement entails *habitual performance* of something, because that is what a practice is, but if one is required to engage in a certain endeavour this requirement entails merely an *attempt* to do something. Because requiring practices (performances) rather than endeavours (attempts to perform) is more protective, the ICRP shift to the latter terminology is less protective of individuals.

### *1.12. Ethical problem 12: ignoring the need for education*

The new ICRP proposals likewise fail ethically because they ignore the need for better education among radiation professionals. After claiming users of radiation recommendations have 'confused justification and optimisation of protection', the ICRP (2001, p 117) proposes some alleged simplifications (including rejecting ALARA and collective dose but sanctioning PALs) that involve a number of ethical problems, as already discussed. If this discussion is correct, and if it is true that virtually all nuclear users in the world have accepted the earlier ICRP recommendations, then it seems reasonable to better educate those who have confusions about the existing system. As Thomas Jefferson put it, when leaders find people unable to perform their duties, the solution is not to change a good system but to educate the people. Part of the required ethical education includes the ICRP. If it makes new proposals that involve ethical errors, one solution is for the ICRP to employ both ethical expertise and stakeholder (workers, citizens) representation on its main commission, to help avoid such errors. This solution is consistent with the ICRP (2001, p 113) claim that its proposals reflect ethical standards and that radiation protection is in part a question of the acceptability of risk (p 115). Questions of risk acceptability and of ethics ought not be decided by scientists alone but also by those affected by the risks.

## 2. Five logical shortcomings

Apart from the ethical problems with the new ICRP proposals there also are a number of logical difficulties that need to be corrected. Logical problems are serious because, from a fallacious argument, no correct conclusion follows.

### *2.1. Logical problem 1: begging the distortion question*

The new ICRP proposals commit the logical fallacy of begging the question, of assuming what they need to prove, when they claim that calculating collective dose distorted the process of optimisation of protection (ICRP 2001, p 117). The ICRP needs to explain precisely the nature of the distortion and whether the dose calculations, for example, extended beyond the lifetimes of the radionuclides considered. Has the ICRP called this practice a 'distortion' because it believes any process that does not discount future deaths distorts? In any case, the ICRP must prove the distortion charge, not merely beg the question.

### *2.2. Logical problem 2: inconsistency regarding additivity of doses*

The new ICRP proposals also are inconsistent in admitting the need for collective-dose calculations for workers, but denying the need for collective-dose calculations for the public (ICRP 2001, p 117). Because many members of the public (those who receive x-rays or cancer treatment, for example) have radiation exposures that are as great as those of nuclear workers, it is inconsistent to calculate the collective dose for workers but not for the public. By admitting the need for collective doses in the worker case, the ICRP has admitted that even small exposures are additively or cumulatively important and ought to be monitored. It is inconsistent for the ICRP proposals to reject dose additivity in the collective dose of the public, but to accept dose additivity in the collective dose of workers. This inconsistency also betrays an inconsistency regarding the linear, no threshold (LNT) hypothesis. The ICRP proposals accept LNT and additivity for workers but deny LNT and additivity for the public. Such an inconsistency is both incompatible with science and a betrayal of the alleged ICRP goal of making its new recommendations simpler than existing ones.

### *2.3. Logical problem 3: inconsistency regarding measurability*

The new ICRP proposals also have a second problem with consistency. They inconsistently reject collective dose for the public, in part because it is not measurable (ICRP 2001, p 117), yet accept it for workers, although the worker case has the same measurability problems. It also is inconsistent for the ICRP to reject collective dose as not measurable but to propose using PALs that are, on its own admission, dependent on (nonmeasurable) judgment (ICRP 2001, p 120, table 2).

By rejecting collective dose as not directly measurable, the ICRP (2001, p 117) is not only inconsistent but also commits the naturalistic fallacy in employing a purely scientific criterion (direct measurability) for what is also an ethical decision. Rejecting collective dose as not measurable also is inconsistent with scientific reliance on nonmeasurable and nonobservable quantities. No one has seen quarks, for example, but virtually all high-energy physicists believe they exist. Neutrinos were believed to exist for some 25 years before they were actually observed and measured. If science used only what is directly measurable, one could never develop either hypotheses or theory. Moreover, to reject whatever cannot be directly measured is to assume that what cannot be measured is not real, and that what is not real cannot be harmful. Obviously, however, things not yet directly measurable can be

harmful. And if the arguments given earlier in discussion of ethical problem 7 are correct, then although the ICRP (2001, pp 117–9) proposes to reject whatever is not directly measurable, it is inconsistent in proposing a system in which individual doses will not be directly measured. Instead the ICRP intends to use models, estimates and averages to calculate individual doses. But if so, then the ICRP has an inconsistent position on measurability as a criterion for acceptable dose.

### *2.4. Logical problem 4: inconsistency regarding benefit–cost analysis and utilitarianism*

The ICRP likewise is inconsistent when it criticises utilitarian principles of radiation protection and says the optimisation principle overemphasised benefit–cost analysis (ICRP 2001, p 117), yet itself employs an even more utilitarian and benefit–cost method in its PALs framework. Discussing its table 2 and PALS, the ICRP admits using benefit–cost analysis: 'The comparison would aim at selecting the plan where the step to the plan next higher in stringency would result in an improvement insufficient to offset the increase in resources needed to take the step' (ICRP 2001, p 120). The ICRP also is inconsistent to reject a utilitarian emphasis in its existing recommendations but to propose new recommendations that use average, rather than individual, doses (ICRP 2001, p 121) because, as discussed earlier, average dose is a utilitarian concept. It likewise is inconsistent to reject a utilitarian emphasis in its recommendations but then to propose using the utilitarian norm of ALARP, rather than ALARA, as already discussed.

### *2.5. Logical problem 5: inconsistency regarding individual protection*

In addition, the ICRP is inconsistent to claim that its new approach 'is based on an individual-oriented philosophy and represents a potential shift by the Commission from the past emphasis on societal-oriented criteria' (ICRP 2001, p 113), but then to propose recommendations that lessen individual radiation protection. Not only is the ICRP rhetoric of individual protection inconsistent with the consequences of its own new proposals (see ethical problems 5 and 11), but also the ICRP may be wrong to suggest that its past emphasis was societal. Neither the dose-limitation nor ALARA principles are societal criteria. Both principles suggest that the past emphasis has been both societal and individual.

## 3. Two scientific shortcomings

In addition to the ethical and logical difficulties with the new ICRP proposals, there also are some fundamental scientific problems. The proposals are less empirically driven than they ought to be, and they seriously misunderstand scientific simplicity.

### *3.1. Scientific problem 1: proposals not driven by empirical facts*

The ICRP admits that the most powerful argument for revising its recommendations are new empirical data (ICRP 2001, p 116). Yet, when one looks for new empirical data to justify the most recent proposals, there are none. Their absence suggests that the revision is driven by something other than science. If the earlier analysis is correct, an egoistic and fallacy-laden ethics, and/or one of expediency, may be driving the new recommendations.

### *3.2. Scientific problem 2: misunderstanding the simplicity criterion*

In defending its new proposals, the ICRP claims that they represent a simpler approach to radiation protection (2001, p 113). It also asserts that the current model-weighting factors

for determining radiation dose are more complex than can be justified and need to be simpler (p 122). These and other statements, as well as the text of the new proposals, reveal that the ICRP understands simplicity in terms of expediency, facility or ease of mathematical manipulation. This is a peculiar notion of simplicity, however, one more related to pragmatic concerns than to defensible science.

Among scientists, a new theory or approach satisfies the simplicity criterion and is able to replace an older theory only (a) if the newer approach has comprehensive explanatory and predictive power that is at least equal to the old approach and (b) if the newer theory has fewer variables and is more easily manipulable (see e.g. Sober 1975). As Hempel (1966, p 40) put it: simplicity argues only for accepting alternative hypotheses that would account for the same phenomena. Hence, for the ICRP to make a scientifically defensible claim that its new proposals are simpler than the current system, it must show that the new proposals are at least equal to the old ones in comprehensive explanatory and predictive power. Yet because of the problems with ethical errors, incompleteness, fallacies, ignoring important variables such as scale of exposures and logical inconsistencies, the new proposals arguably have less comprehensive explanatory and predictive power than the current system of radiation protection. A scientific system cannot have more explanatory power if it is saddled with internal inconsistencies, as the new proposal is. In any case, the ICRP has not argued that its new proposals have the requisite comprehensive explanatory and predictive power. One reason the new proposal does not have the requisite explanatory and predictive power of a genuinely simpler approach is that, contrary to best risk-assessment practices, it reduces and compares both voluntary and involuntary risk exposures, on the basis of the PALs criterion. Yet assessors have repeatedly warned, in comparative risk assessment, that such reductions and comparisons are illegitimate, because dose quantity is not the only relevant variable (see Shrader-Frechette 1991).

Rather than employing the standard, scientifically defensible, notion of simplicity, the ICRP has merely used the term, 'simpler', in a nonscientific way, in an attempt to justify a crude reduction in radiation protection. It has a pragmatically simpler approach only because it has ignored important considerations such as environmental ethics, duties to future generations, dangerous consequences and problems of scale in its new proposals. It has a pragmatically simpler approach only because it has committed errors, such as adopting the naturalistic fallacy and reducing the principles of optimisation, justification and dose-limitation to ones based merely on PALs and natural radiation levels. The ICRP has admitted that radiation protection requires ethical standards, yet its new proposals have violated numerous ethical principles in reducing radiation protection to a more egoistic system. This system is simpler in neither the requisite scientific nor ethical sense.

## 4. Conclusion

How have all these ethical, logical and scientific errors arisen in a body so distinguished as the ICRP? One reason may be that the ICRP Main Commission does not include either a biomedical ethicist or stakeholders who are either workers or those living near nuclear facilities. Another reason may be that, as Clarke suggested in a recent article, huge resources are necessary to deal with problems such as radiologically contaminated land, with effects of Chernobyl, with results of weapons testing and with decommissioning of nuclear facilities. As a result, Clarke (1999, p 109) claims that 'these concerns have led to an increased pressure from some individuals to propose a threshold in the dose–response relationship in order to reduce the expenditure'. If Clarke is right, that responding to pressures from vested interests and reducing expenditures (rather than sound science and ethics) are driving the ICRP, then its new proposals are likely to be questionable. To remedy these apparent ethical deficiences, the ICRP might follow the suggestions, suggested respectively in discussion of ethical problems 4, 9 and 12:

(1) to include stakeholder representatives on the main commission of the ICRP,
(2) to employ biomedical ethicists to help in avoiding ethical errors in framing its recommendations, and
(3) to educate those who employ nuclear standards and who have difficulty in interpreting them.

To remedy the logical and scientific errors discussed earlier in the paper, one remedy might be

(4) to employ a more stringent standard of peer review before publishing proposals for a change in ICRP recommendations.

All four of these suggestions, while they may not avoid all ethical, logical and scientific problems with ICRP recommendations, nevertheless may help to reduce them in the future.

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## Résumé

Au début de cette année, la CIPR proposait un nouveau système de radioprotection conçu pour être plus simple, mieux orienté vers la protection individuelle, et refléter des concepts importants sur le plan de l'éthique. Cet article démontre que la proposition viole des normes importantes de la simplicité scientifique; en fait, elle protège moins l'individu que ne le fait le système actuel, et elle commet un certain nombre d'erreurs éthiques. Après avoir relevé douze erreurs d'éthique, cinq erreurs logiques, et deux problèmes scientifiques, présents dans la nouvelle proposition de la CIPR, les auteurs suggèrent des moyens possibles pour remédier à ces déficiences.

## Zusammenfassung

Anfang dieses Jahres schlug die ICRP ein neues Strahlenschutzsystem vor, das einfacher sein sollte, orientiert am Schutz des Einzelnen und wichtige ethische Normen berücksichtigen sollte. Dieser Artikel argumentiert, dass der Vorschlag gegen wichtige Normen der wissenschaftlichen Einfachheit verstößt, tatsächlich den Schutz des Einzelnen weniger gewährleistet als das aktuelle System, und eine Anzahl ethischer Fehler enthält. Nach einem Überblick über 12 ethische Fehler, fünf logische Fehler, sowie zwei wissenschaftliche Probleme mit dem neuen ICRP-Vorschlag empfehlen die Autoren mögliche Wege zur Beseitigung dieser Mängel.

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