A Review of the Scientific Basis for Radiation Protection of the Patient

B.M. Moores\textsuperscript{1}, D. Regulla\textsuperscript{2}

1. IRS Ltd, Liverpool
2. Helmholtz Zentrum, Muenchen

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20-fold increase in population doses arising from medical practices has occurred in the developed nations over past 40 years.
Effective doses now range from $\mu$Sv to 10s of mSvs for different examinations.

Variations of $>100X$ not uncommon for the same type of examination.
Can these changes be supported on scientific grounds?

Can we consider radiation protection to be scientific?
Test for scientific basis of an activity

“Truly scientific activities or principles are open to falsifiability, refutability or testability”
Karl Popper

In any test it should be possible to obtain a result that can disprove any hypothesis or principle
ICRP’s Principles of Radiation Protection

- Justification
- Optimisation (ALARA)
- Dose Limits
**PRINCIPLE OF JUSTIFICATION**

Any decision that alters the radiation exposure situation should do more good than harm.

Radiological procedures will improve diagnosis or treatment.

Application of procedures to an individual patient should be justified.
All of the previous are aims

Is it possible to demonstrate that justification does not protect patients?
(Principle of falsifiability)
Socio-cultural studies (Boltanski and Thevenot) have shown that the reasons for justification depend upon six main logic areas:

1. Civic (Jean Jacques Rousseau)
2. Market (Adam Smith)
3. Industrial (Claude Henri de Rouvroy, Comte de Saint-Simon)
4. Domestic (Jacques Benign Bossuet)
5. Inspiration (Augustine of Hippo) and
6. Fame (Thomas Hobbes)
Justification is a worthy aim of all clinical interventions within the framework of medical ethics and cannot be applied to radiation protection alone.

Effects of justification on radiation protection of the patient cannot be quantified nor verified or falsified.

Cannot be considered a scientifically based principle.
PRINCIPLE OF OPTIMISATION (ALARA)

ICRP 26 stated:

“Techniques and equipment used should allow the reduction of doses received by tissues in the region of the body under examination to the minimum compatible with obtaining the necessary information....
ICRP 103 stated:

“the diagnostic reference level (DRL) has as its objective the optimisation of protection, but it is not implemented by constraints on individual patient doses”

Constraint of minimum compatible with obtaining information removed
DRLs obtained from measurements of existing practice (assumed optimised)

Patients may undergo an examination with a method that involves a higher dose as long as it provides more information (more good than harm)
DRLs take no cognisance of fact that for most examinations imaging requirements are patient specific.

Not the case for radiotherapy which involves individualised treatment planning.

Implies that fundamental principles of radiation protection can be dose dependent.
DRLs can be defined in a standard way but they are not standard or universal quantities

Impossible to falsify the premise that adherence to DRLs, as defined, can ensure optimisation of protection

Cannot be considered a scientifically based principle
ALARA WATERFALL

AFTER M.C. ESCHER
Rational scientific framework for radiation protection of the patient in diagnostic radiology must be based upon measurable risk-benefits.

Risks expressed in terms of organ doses and benefits in terms of information gained and clinical impact.
“One essential challenge for biomedical imaging is to demonstrate its value to the biomedical research community, to the general medical community and to society as a whole. Assessment of the value of any particular technology should start with a rigorous examination of the technology itself and of the accuracy with which it can help reveal disease or injury and lead to proper diagnosis. It must then show its value in improving treatment, patient outcomes and quality of life.”
Radiation protection needs to implement such goals within its operational framework if it is to become truly scientific.