Radiation Protection Culture, Communication and Context

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Abstract

'Keeping the ICRP recommendations Fit for Purpose' draws attention to the need to ensure that the *System* adapts to changes in science and society, remaining attuned to evolving societal and ethical values. The cultural context in which the *Recommendations* now exist is very different from the setting in which they were first conceived. The age of deference to scientific authority has to a large extent gone, driven in part by the emergence of social media, fake news and widespread distrust of experts. Keeping the *Recommendations* fit for purpose requires acknowledgement of this changing landscape in order that they remain relevant and provide leadership to enable radiation risks to be suitably managed. This in turn requires radiation risks to be well understood by decision-makers and other stakeholders, and the corollary of good communication.

'Keeping the ICRP recommendations Fit for Purpose' ends with a quote from a recent report of a Nuclear Energy Agency workshop: *'to be trusted, you must communicate successfully; to communicate successfully, you must be trusted'*. It is sometimes said that trust is hard-earned but easily lost. Organisational change is one circumstance in which there may be loss of organisational memory leading to loss of trust, inadvertent or contrived. Hierarchical structures may introduce, or exacerbate, barriers to good communication.

Communication, the transmission of messages, can be considered in terms of a simple signal:noise engineering model. It has three components, all of which are essential to good communication: transmission of a clear signal; a medium through which the signal is transmitted without distortion; and an efficient receiver to detect the signal. If the signal is subjected to significant attenuation as it passes through the medium, or if the receiver introduces significant 'noise', transmission suffers - however clear the original signal. This model can be applied to communication within and between organisations, both in general and specifically in respect of radiological protection.

Organisational culture is key to good communication, and hence safety culture. IAEA, WHO, IRPA and IOMP have been proactive in recent years in emphasizing the importance of culture in radiation protection. The IAEA's recently-published harmonized safety culture model, developed from earlier NRC work, has identified traits, principles and attributes which make culture a more tangible ingredient of a good safety culture. Local context, values and ethics are highly relevant, as is the location of the ICRP system within ever-changing highly complex systems.

Keywords: culture; communication; context; ethics; values

Introduction

'Keeping the ICRP recommendations Fit for Purpose' (Christopher Clement et al 2021) outlines the evolution of the General Recommendations which set out the global *System of Radiological Protection*. It describes how the first General Recommendations were produced in 1928 and have been repeatedly revised at intervals since then, in the light of new knowledge and experience. This paper is offered as a contribution to the review of the current version, *Publication 103* (ICRP 2007) which is getting underway.

The paper has a focus on radiological protection in healthcare. Radiation makes huge contributions to diagnosis, treatment and research. However, the very familiarity with the benefits of medical radiological procedures may contribute to a desensitization to associated risks, which go beyond biological risks. A tenet of the System of Radiological Protection is that it takes account of the latest scientific knowledge, ethical values and practical experience (ICRP 2021). It must continue to do so!

Culture

The importance of organisational culture

The culture of the organisation in which radiological protection is practiced has a significant impact on aspirations to maintain or improve radiation safety. The International Nuclear Safety Group has described the culture of an organisation as comprising "*the mix of shared values, attitudes and patterns of behaviour that give the organisation its particular character. Put simply, it is 'the way we do things round here'*" (INSAG 1999).

An appreciation of the importance of culture to safety can be gauged by the frequency with which it is referred to in the World Health Organisation Global Patient Safety Action Plan 2021-2030 (WHO

2021). Whilst this example is from the health sector, the underlying message is transferrable and applicable in most if not all industries.

Radiation protection practitioners who seek to ensure that good radiological safety practice is implemented within the organisations in which they operate may find that the organisational culture is not conducive to such implementation. Integration of local, national and international systems and standards may not be straightforward in a landscape of competing organisational priorities.

Safety Culture

The idea of safety culture has existed since 1980 (James Reason 1997). The concept was boosted by an authorative report from the then *International Nuclear Safety Advisory Group* (INSAG-4 1991). INSAG, now renamed the *International Nuclear Safety Group*, have re-visited safety culture in subsequent reports (INSAG-7 1992; INSAG-13 1999; INSAG-15 2002; INSAG-27 2017). They define safety culture as *the assembly of characteristics and attitudes in organisations and individuals which establishes that, as an overriding priority, protection and safety issues receive the attention warranted by their significance*. This terminology is quoted in the IAEA Safety Glossary (IAEA 2018).

The UK's *Advisory Committee on the Safety of Nuclear Installations* developed understanding of safety culture through the following definition: *"The safety culture of an organisation is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation's health and safety management. Organisations with a positive safety culture are characterised by communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures"* (ACSNI 1993).

Four critical safety culture subcomponents been identified: a *reporting culture*, a *just culture*, a *flexible culture*, and a *learning culture*. Together they interact to create an *informed culture* (James Reason 1997).

The importance of safety culture can be judged by its identification as a major contributory factor to serious accidents, such as the damage to nuclear reactors and consequent release to the environment of substantial quantities of radioactivity at the Three Mile Island, Chernobyl and Fukushima-Daiichi nuclear power plants (INSAG-4 1991; INSAG-7 1992; INSAG-27 2017).

Radiological safety within an organisation which uses radiation is strongly dependent on the prevailing organisational culture. The System of Radiological Protection should endeavour to ensure that the voices of those who advocate good radiological safety practice are properly heard by organisational leaders and senior managers. This can be particularly difficult in a target-driven culture where their focus is on financial and other targets. This difficulty can be compounded in the aftermath of corporate restructuring and loss of organisational memory.

Assessing organisational culture

Sociologist Ron Westrum categorized organisational culture in terms of information flow within the organisation. He described three ranges of climate within an organisation: *pathological in which information is hidden; bureaucratic in which information is ignored; or generative in which information is actively sought* (Westrum 1996).

Psychologist Patrick Hudson developed Westrum's model, examining the notion of a safety culture in terms of organisations being informed and trusting (Hudson 2001i, Hudson 2001ii). His evolutionary framework, sometimes referred to as the safety culture ladder, is contained in the IRPA guidelines for establishing a radiation protection culture (IRPA 2014). It introduces two further stages, 'reactive'

and 'proactive', in the evolution of a generative culture, and suggests 'calculative' as an alternative term for 'bureaucratic'.

The table below shows the five stages of Hudson's evolutionary model of safety culture, corresponding with increasing trust within an organisation and it being increasingly informed as culture evolves from lower to higher levels. The italicized indented text in the final column is from a paper he wrote for a BMJ Quality and Safety Supplement (Hudson 2003).

Generative	Increasingly informed ↑	Increasing trust ↑	Safety is how we do business around here *There is active participation at all levels. Safety is perceived to be an inherent part of the business. Organisations are characterised by chronic unease as a counter to complacency.*
Proactive			We work on the problems that we still find *With improved performance, the unexpected is a challenge. Workforce involvement starts to move the initiative away from a purely top down approach*
Calculative			We have systems in place to manage all hazards *Safety is driven by management systems, with much collection of data. Safety is still primarily driven by the management and imposed rather than looked for by the workforce*
Reactive			Safety is important, we do a lot every time we have an accident *Organisations start to take safety seriously, but action is taken only after incidents*
Pathological			Who cares, as long as we're not caught *Safety is a problem caused by workers. The drivers are the business and the desire not to get caught by the regulators*

The UK's Health and Safety Executive (HSE) Safety Culture Maturity Model also has 5 iterative levels: emerging; managing; involving; cooperating; continually improving (HSE 2001). HSE is a regulator, and has published advice which guides inspections considering safety culture (HSE inspectors human factors tool kit). They note that 'safety culture' is a subset of the overall company culture. Their guidance to inspectors refers to poor understanding within many companies, with a tendency to talk about 'safety culture' when actually referring to the inclination of their employees to comply with rules or act safety or unsafely. In contrast to this, they (HSE) find that the culture and style of management is even more significant, for example a natural, unconscious bias for production over safety, or a tendency to focussing on the short-term and being highly reactive. In this respect they refer to management decisions that appear consistently to put production or cost before safety. They identify management commitment, visible management, good communication between all levels of employee, and active employee participation in safety as key aspects of an effective culture. They suggest a set of questions which enable seven dimensions of safety culture to be assessed: management commitment; communication; employee involvement; training/information; motivation; compliance with procedures; learning organisation.

IAEA Harmonized Safety Culture Model

Culture can be a nebulous concept. The IAEA's *Harmonized Safety Culture Model* (IAEA 2020), based on the Nuclear Regulatory Commission *Safety Culture Policy Statement* (NRC 2011), makes it more tangible by identifying traits, principles and attributes of a good safety culture. It seeks to align global safety culture guidance across industries that deal with ionising radiation.

The model has ten traits:

- Individual responsibility
- Questioning attitude
- Communication
- Leader responsibility
- Decision-making
- Respectful work environment
- Continous learning
- Problem identification and resolution
- Raising concerns
- Work planning

Fundamental principles are associated with each trait:

- *(Individual responsibility).* **All individuals are personally accountable for safety.** All individuals feel it is their duty to know the standards and expectations and rigorously fulfil those standards and expectations. There is personal ownership for safety. They have a commitment that promotes safety both individually and collectively.
- *(Questioning attitude).* **Individuals remain vigilant for assumptions, anomalies, conditions, behavioursor activities that can adversely impact safety and then appropriately voice those concerns.** All employees are watchful for and avoid complacency. They recognize that minor issues may be warning signs of something more significant. Individuals are aware of conditions and alert to potential vulnerabilities and then report them.
- *(Communication).* **Communications support a focus on safety.** Leaders use formal and informal communication to frequently convey the importance of safety. The organisation maintains a variety of communication channels including direct interaction between managers and workers. Effective dialogue is encouraged. Effective communication in support of safety is broad and includes workplace communication, reasons for decisions and expectations.
- *(Leader responsibility).* **Leaders demonstrate a commitment to safety in their decisions and behaviours.** Leaders are role models for safety. Executive and senior managers are the leading advocates of safety and demonstrate their commitment both in word and action. Leaders throughout the organisation set an example for safety. Corporate policies emphasize the overriding importance of safety.
- *(Decision-making).* **Decisions are systematic, rigorous, thorough, and prudent.** Leaders support conservative decisions and the ability to recover quickly from unforeseen circumstances. Leaders follow the decision-making process. Responsibility for decision-making is clear.
- *(Respectful work environment).* **Trust and respect permeate the organisation.** A high level of trust is cultivated in the organisation. Differing opinions are encouraged, discussed, and thoughtfully considered. Employees are informed of steps taken in response to their concerns.
- *(Continous learning).* **Learning is highly valued.** The organisational capacity to learn is well developed. The organisation employs a variety of approaches to stimulate learning and improve performance, including human, technical and organisational aspects. Individuals and teams are highly competent and seek opportunities for improvement.
- *(Problem identification and resolution).* **Issues potentially impacting safety are systematically identified, fully evaluated, and promptly resolved according to their**

significance. Identification and resolution of a broad spectrum of issues, including human performance and organisational issues, are used to strengthen safety and improve performance.

- *(Raising concerns).* **Personnel feel free to raise safety concerns without fear of retaliation, intimidation, harassment, or discrimination**. The site creates, maintains, and evaluates policies and processes that allow personnel to raise concerns freely.
- *(Work planning).* **The process of planning and controlling work activities is implemented so that safety is maintained**. Work is managed in a deliberate process in which work is identified, selected, planned, scheduled, executed, and critiqued. The entire organisation is involved in and fully supports the process. All relevant parts of the organisation work together to support the process of controlling work.

For each trait, the model identifies attributes which, if present, indicate a healthy culture for safety:

- Individual responsibility (IR)
  - *IR.1* Adherence
  - *IR.2* Ownership
  - *IR.3* Collaboration
- Questioning attitude (QA)
  - *QA.1* Recognize unique risks
  - *QA.2* Avoid complacency
  - *QA.3* Question uncertainty
  - *QA.4* Recognize and question assumptions
- Communication (CO)
  - *CO.1* Free flow of information
  - *CO.2* Transparency
  - *CO.3* Reasons for decisions
  - *CO.4* Expectations
  - *CO.5* Workplace communication
- Leader responsibility (LR)
  - *LR.1* Strategic alignment
  - *LR.2* Leader behaviour
  - *LR.3* Employee engagement
  - *LR.4* Resources
  - *LR.5* Field presence
  - *LR.6* Rewards and sanctions
  - *LR.7* Change management
  - *LR.8* Authorities, roles, and responsibilities
- Decision-making (DM)
  - *DM.1* Systematic approach
  - *DM.2* Conservative approach
  - *DM.3* Clear responsibility
  - *DM.4* Resilience
- Respectful work environment (WE)
  - *WE.1* Respect is evident
  - *WE.2* Opinions are valued
  - *WE.3* Trust is cultivated
  - *WE.4* Conflicts are resolved
  - *WE.5* Facilities reflect respect

- Continous learning (CL)
  - *CL.1* Constant examination
  - *CL.2* Learning from experience
  - *CL.3* Training
  - *CL.4* Leadership development
  - *CL.5* Benchmarking
- Problem identification and resolution (PI)
  - *PI.1* Identification
  - *PI.2* Evaluation
  - *PL.3* Resolution
  - *PL.4* Trending
- Raising concerns (RC)
  - *RC.1* Supportive policies are implemented
  - *RC.2* Confidentiality is possible
- Work planning (WP)
  - *WP.1* Work management
  - *WP.2* Safety margins
  - *WP.3* Documentation and procedures

The working document (IAEA 2020) expands on each of these attributes. For example the complete RC.1 attribute reads:

> ***RC.1 Supportive Policies are Implemented:*** *The organisation clearly states and effectively implements a policy that supports an individual's rights and responsibilities to raise safety concerns. The organisation does not tolerate harassment, intimidation, retaliation or discrimination for raising concerns.*

Its authors describe it as a framework with a unified structure for safety culture guidelines which can be translated into different languages and aligned across cultures and sectors. They recommend that each industry customizes the model to fit their particular needs. In line with this recommendation, the IAEA's Radiation Protection of Patients (RPOP) Unit have adapted the groundbreaking NRC and IAEA safety culture work outlined above (NRC 2011, IAEA 2020) specifically to healthcare (IAEA 2021).

Raising Concerns / Reporting / Speaking up / Speaking out / Whistleblowing

The environment in which concerns are raised is a key component of organisational culture. Power dynamics within an organisation may inhibit the raising of legitimate concerns in the first place, and may act to suppress concerns that are raised. Countless people throughout the ages have learnt to their cost that it can be dangerous to speak truth to power (Wikipedia). From the field of science, Galileo was condemned for heresy for supporting the evidence-based heliocentric model of the solar system proposed by Copernicus (Galileo Galilei, Nikolai Copernicus).

The phenomenon of organisational resistance to evidence, and hostility to people who provide such evidence in the course of seeking progress through better understanding, is not a historical anomaly of a bygone age. Many organisations have whistleblowing policies which purport to provide an environment in which staff are encouraged to speak up if they are aware of safety-related problems. However, there is substantial evidence that such policies, if they exist, may amount in practice to no more than virtue-signalling window-dressing. This is why the IAEA harmonized safety culture model attribute RC.1 quoted above is so important. It is not sufficient for an organisation to have policies which on paper support an individual's rights and responsibilities to raise safety concerns, unless

they are effectively implemented. There should be zero tolerance of harassment, intimidation, retaliation or discrimination against people who raise such concerns.

If the notion of employer reprisals against staff who disclose safety problems seems abstract, harsh even on the motivations of those who suppress reports that all is not well, the report of the 2015 *Freedom To Speak Up* review ('*an independent review into creating an open and honest reporting culture in the NHS'*) identifies that retaliation against staff who raise concerns is a serious issue. This is linked to what has been described as a 'good news only' culture in which middle managers are reluctant to report risks (Conrad, Walker & Willaert 2013). I suggest it would be helpful if the revised Recommendations could emphasize that organisational culture of this type is incompatible with good safety culture, in radiological protection as in other areas. Suppression of what managers may consider to be unwelcome news is of course completely alien to good scientific practice (AHCS 2021) and professional codes of conduct (HCPC 2016, GMC 2013).

Whilst this particular example (the *Freedom To Speak Up* review) is from healthcare, and is not specifically concerned with radiological protection issues, the importance of a culture in which it is safe for all staff to speak up if they are aware of safety issues is applicable to all industries, not least those which use radiation. In this respect it is noteworthy that radiation safety culture in the medical sector is perceived to be poorer than in the nuclear sector (Cole et al 2014). Their paper notes undoubted scope for improvement in radiation protection culture in the medical sector in particular. Ensuring a safe environment for staff to report concerns about radiation issues is an important part of this. Unfortunately staff who do so may be regarded as troublemakers. They may be considered whistleblowers, and some may embrace this term. However it has pejorative connotations, e.g. rat, sneak, snitch, betrayer (Roget's Thesaurus). It seems an inappropriate term for staff who, in good faith, raise concerns with their managers, as is usually the case when healthcare staff first speak up.

Nevertheless, the whistleblower term is used widely, particularly for staff who suffer a pattern of reprisals after reporting safety-related issues, including loss of career. They may find that regulators have no powers to protect them and that professional bodies and unions are equally reluctant to step up. *"When they need protection it just isn't there"* (Kim Holt, 2015). If they seek seek support through the legal system they discover that there is little or no effective protection for staff who raise concerns in the public interest.

This is a global issue, in response to which a number of initiatives have been launched in various countries. The European Whistleblower Protection Directive, which is required to be transposed into national legislation of the 27 EU Member States by 17 December 2021, illustrates changing societal attitudes towards 'whistleblowers' (EU Directive 2019/1937). It prohibits any form of retaliation against persons reporting breaches of Union law, explicitly including legislation concerning radiation protection and nuclear law.

Ethics and values

I welcome the identification in ICRP Publication 138 (ICRP 2018) of the three pillars on which the System of Radiological Protection is built:

- the science of radiological protection combining knowledge from different disciplines;
- a set of ethical and social values;
- the experience accumulated from the day-to-day practice of radiological protection professionals.

Radiation protection practice usually entails making a balanced judgement, taking into account a number of different factors. Questions of ethics may arise, giving rise to ethical dilemmas which can be viewed through different ethical lenses. For example deontological ethics emphasize duty to do

the right thing for an individual, whereas utilitarian ethics focus on the greatest good for the greatest number. Applying different ethical theories may not lead to the same outcome.

Jim Malone, Friedo Zölzer, Gaston Meskens and Christina Skouru have compiled an authoritative and thought-provoking, pragmatic, practical framework for radiation protection in medicine, rooted in the medical tradition (Malone et al 2019). I look forward to reading the forthcoming ICRP Task Group 109 report on Ethics in Radiological Protection for Medical Diagnosis and Treatment.

'Keeping the ICRP recommendations Fit for Purpose' suggests that Task Group 109 might develop a set of values which bring together radiological protection and medical ethical values in particular scenarios. There is already considerable overlap, but some divergence. Perhaps ICRP could invite the international community to contribute case studies and personal stories which illustrate some of the ethical dimensions of radiological safety practice in healthcare and other settings? Such an initiative could provide useful material for the revised Recommendations, building on the valuable scenarios in Malone et al 2019.

Ethics and values are closely interlinked. Many organisations publicise their stated values, the qualities and guidelines they espouse to guide their conduct and actions. Common examples include: fairness, honesty, openness, integrity, respect, dignity, inclusion, collaboration. The extent to which they are put in practice determines the true culture of an organisation.

Bearing in mind the well known general principles of justification, optimization and dose limitation, coupled with the practical principles (maxims?) of time, distance, shielding and containment of unsealed radioactive materials, it could be helpful for the Recommendations to carefully define their usage of the terms ethics, values and principles. This may be necessary in attempts to align ethical principles of radiological protection (ICRP 2018) and medical ethics (Beauchamp and Childress 2019).

Communication

The importance and challenge of communicating radiation protection issues

The importance of good communication between all levels of employee has been mentioned above as one of the key aspects of an effective organisational culture (HSE inspectors human factors tool kit). Communicating radiation protection issues can be very challenging for many reasons, including: inability to detect ionising radiation through the five senses; latency of radiation-induced biological effects; unfamiliarity with the principles of radiological protection; complicated radiation dosimetry; controversy regarding nuclear power, nuclear weapons and radioactive waste; inherent uncertainty of stochastic effects; scientific argument about matters such as the linear no threshold hypothesis; and indeed the scientific method itself, in which debate between experts, hypothesis and falsification are not only legitimate but fundamental to progress. Whilst an understanding of how these and other concepts/theories/dimensions/notions play into radiological protection may be second nature for radiation protection practitioners, we must not forget how alien they may be to others, particularly those with little or no scientific training.

When communicating messages it is essential to know the intended audience, and how best to craft the message for that particular audience. This may require multiple iterations of the same message, refined and adapted to the needs of each audience. Successful communication also requires an audience with the capacity and willingness to listen. It can be particularly difficult to communicate with organisational leaders and senior management at a time of significant organisational change, when there may be a loss of organisational memory. Newly-appointed senior decision-makers grappling with new roles and structures may have little or no previous knowledge or experience of

radiological protection issues, and the roles and responsibilities of radiation protection experts (outlined e.g. in IRPA 2016).

ICRP Publication 103 identifies that organisations using radiation need expertise in radiological protection (para 311) and that operating management who appoint external consultants and advisory organisations remain responsible taking decisions on the basis of such advice (para 312). It also points out the need for appropriate expertise within regulatory authorities (para 304, which mentions the risk of decisions about radiation safety being unduly influenced by economic or other non-radiological considerations). However, there appears to be a lacuna in respect of the implicit need for organisations to take advice from radiation protection experts who they employ! I suggest that this is an area which needs to be strengthened when the System is revised. Case studies could help to illustrate the need for this. Perhaps competent authorities could be prompted to regulate the extent to which organisational leaders take advice from radiation protection experts when making decisions affecting compliance with relevant legislation.

Effective communication requirements

There is, quite rightly, a focus in the radiological protection field on communications in nuclear or radiological emergencies. The emphasis in this paper is however on communication from radiation protection practitioners to organisational senior managers and leaders in less urgent circumstances. However, whilst the issues may be more mundane in the eyes of managers/leaders who do not properly understand the issues, such communications and effective working relationships are essential if there is to be a strong radiation safety culture.

Communication is a two-way process, requiring good listening/reading/comprehension skills on the part of those receiving messages, as well as the ability to speak/write clearly, concisely and precisely. The words used must be appropriate to the situation and to the roles, prior knowledge, priorities and capabilities of those for whom the message is intended. The medium through which the message is transmitted is vitally important to the effectiveness of the communication.

Many books and articles have been written on how to communicate. This section considers communication from a signal:noise viewpoint. It identifies three separate components, each of which must function well for there to be effective communication / good signal:noise. Analogies can be drawn with the quality of an x-ray, gamma camera or ultrasound image.

1. **Source** of message/signal
2. **Medium** through which message/signal is transmitted
3. **Receiver** of transmitted message/signal

However clear the original message/signal, if it suffers significant attenuation (absorption + scatter) as it is transmitted through the medium through which it has to traverse it will be distorted. If the receiver/detector is insensitive the signal:noise ratio will be further impaired. Communication channels within organisations must take into account all three of these components. It is essential that they are all suitable for there to be good communication within an organisation, and hence a healthy safety culture.

Organisational leaders are responsible for ensuring that effective channels of communication exist, in which the voices of radiation protection experts are properly heard. This may be a particular problem in the health sector as the scientific workforce is so small compared with the numbers of doctors and nurses.

Radiation risk perception from different stakeholder perspectives

As is well-known in radiation protection circles, different stakeholders may have very different perceptions of radiation risk. Unless well-informed, those unfamiliar with radiation science and lacking practical experience in this area may seriously over-react to trivial radiation incidents. The

converse also applies. Senior managers need to be alert to reputational risks which may arise if they ignore, downplay or misrepresent concerns raised by radiation protection experts. When considering justification of medical exposures to ionising radiation, risks of not performing the procedure in question must be considered as well as the benefits and concomitant radiation doses.

Context

The importance of context

Situational awareness is important in consideration of any radiation safety issue. Context is crucial. Available resources, including equipment and staff, must be taken into account. Organisational change is a particular circumstance where problems may arise, particularly if this impairs communication of radiological protection matters.

Management structures / Organisational hierarchy

A good safety culture requires organisational management structures and hierarchy to facilitate and encourage the effective communication of radiation safety concerns to senior managers. Processes and layers of management which introduce barriers to the upward transmission of valid warnings are antithetical to safety culture. I would like to see the roles and responsibilities of radiation protection experts, radiation protection officers and medical physics experts more clearly promoted within the revised Recommendations.

The concept of high reliability organisations is a topic of increasing interest, particularly in the context of patient safety. It may be helpful for the System to refer to the five principles of high reliability organisations cited by Weick and Sutcliffe:

- Preoccupation with failure
- Reluctance to simplify
- Sensitivity to operations
- Commitment to resiliency
- Deference to expertise

Clinical research

Clinical research involving exposure of participants to ionising radiation is an area which perhaps deserves careful review. Experience of reviewing research proposals is that this is an area where there is a common tendency for researchers to underestimate radiation risks or use misleading comparisons in participant information sheets. However low such risks may be there are important ethical considerations involved, bearing in mind that participation in clinical trials is (or should be) voluntary, following informed consent.

Conclusions

We live in a world of complexity, in which the need for a systems approach is increasingly recognized. The System of Radiological Protection is itself a complex system. The practice of radiation protection takes place within many other complex systems. This paper has focused on the culture within which radiation protection practitioners in operate, in healthcare in particular. The provision of healthcare varies greatly in different parts of the world and it is important to consider radiation safety issues in context. This requires stakeholders to be well-informed which in turn requires good communication, the third main theme of this paper. I hope it is a helpful contribution.

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