Receptivity to expert advice, education and training is highly dependent on situational and cultural context

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European ALARA Network (EAN) Workshop 2-4 October 2023, Vienna
ALARA for interventional radiology & nuclear medicine
Session 4: Education and training; culture
3 October 2023
Receptivity to expert advice, education and training is highly dependent on situational and cultural context

I keep six honest serving-men

(They taught me all I knew)

Their names are **What** and **Why** and **When**

And **How** and **Where** and **Who**

Rudyard Kipling *Just so stories* (1902)
The system of radiological protection is based on:

- the science of radiation, combining scientific knowledge from different disciplines
- a set of values rooted in ethics and morality
- experience accumulated from the day-to-day practice of radiological professionals

*ICRP Publication 138. Ethical foundations of the system of radiological protection. Ann. ICRP 47(1), 21 2018*

RP is much more than time/distance/shielding/containment of radioactivity …
It also involves culture (attitudes, beliefs, behaviours) and requires soft skills, including communication.

“There’s nothing soft about soft skills.”
Communicating radiation risks to non-specialists is challenging

Radiation risks are poorly-understood by most people
Radiological science is complex, and incomplete
Radiation metrology is baffling to most people
Radiation protection jargon can be a foreign language to lay people
Radiation safety concepts and culture may be unfamiliar to others
Widespread intolerance of ambiguity and statistical uncertainty
Communicating radiation risks is important
Communicating in a crisis exacerbates the challenges
Radiation Protection Practitioners need good communication skills

They should be able to translate relevant science, legislative requirements, regulator expectations and complex technical jargon into language right for the audience: orally, in writing and visually.

But there’s more to it than that. **Good communication of messages requires:**

- good creation/articulation of **message** (oral/written/visual ...)
- good **channels of communications** to target audiences
- good **listening skills and willingness to listen**

Effective communication implies 2-way communication, engagement and follow up action.
Elements of communication

- Composing and sending message
- Transmission of the message
- Receiving and understanding message
Parallels between communication and imaging systems

Good communication requires a high signal:noise ratio

- Clear message, tailored to the particular audience
- Loss-less medium through which the message is transmitted without deleterious attenuation
- Sensitive audience attuned to the message
Risk: combination of:
- severity/consequence/impact of harm
- likelihood/probability that harm will occur

Risk communication: exchange of information about risks

Perception of risk: may differ markedly from scientific assessment of risk
Context and the wider risk landscape

Risk communication and decision-making involve situational awareness and understanding how particular risks relate to other risks.

Know your audience and understand their viewpoint(s).

Context, communication channels and situational awareness are very important in communication and decision-making.
Balancing radiation and other risks

Decision-makers, whether in government (local/national), regulators, emergency services, other agencies, nuclear site operators, hospitals, universities, other organisations and individual members of the public, often need to consider, juggle and try to balance many types of risk ... of which radiation is just one of many.
Types of risk

- Health (physical, psychological)
- Quantitative / Qualitative
- Individual / Population
- Reputational
- Financial
- Legal
- Societal
- .....

Communicating radiation risks
Quantitative / Qualitative communication of x-ray imaging risks

Quantitative risks  e.g. (from ICRP 103):

Nominal risk coefficient for stochastic effects after exposure to radiation at low dose rate:

Cancer:  $5.5 \times 10^{-2} \text{ Sv}^{-1}$ (whole population) / $4.1 \times 10^{-2} \text{ Sv}^{-1}$ (adults)

Heritable effects:  $0.2 \times 10^{-2} \text{ Sv}^{-1}$ (whole population) / $0.1 \times 10^{-2} \text{ Sv}^{-1}$ (adults)

Qualitative risks  (see e.g. Wall, Kendal, Edwards et al, BJR 79 (2006), 285–294):

<table>
<thead>
<tr>
<th>Risk band</th>
<th>Risk Range</th>
<th>Typical type of X-ray examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negligible</td>
<td>&lt; 1-in-a-million</td>
<td>Radiography of chest/limbs/teeth</td>
</tr>
<tr>
<td>Minimal</td>
<td>1-in-a-million to 1-in-100,000</td>
<td>Radiography of head/neck/joints</td>
</tr>
<tr>
<td>Very low</td>
<td>1-in-100,000 to 1-in-10,000</td>
<td>Radiography of spine/abdomen/pelvis</td>
</tr>
<tr>
<td>Low</td>
<td>1-in-10,000 to 1-in-1,000</td>
<td>CT/angiography/interventional radiology</td>
</tr>
<tr>
<td>Moderate</td>
<td>&gt; 1-in-1,000</td>
<td>High dose (CT/angioplasty/interventional radiology procedures - risk depends on anatomical site exposed, and patient’s age, sex, prognosis)</td>
</tr>
</tbody>
</table>
Why are radiation risks difficult to understand?

- Radiation cannot be detected using the five human senses (sight, hearing, touch, smell, taste)
- Unclear relationship between dose and risk at low doses and low dose-rates
- Radiation metrology is baffling to most non-specialists
- Receiver(s) of message unfamiliar with concepts of statistical probability and uncertainty
- Manifestation of radiation-induced pathology is delayed, sometimes for decades
- Radiation-induced cancer is indistinguishable from cancer from other causes
- Qualitative risk semantics may not be persuasive (esp. high consequence, low likelihood risks)
- Quantitative (numerical) risks are often poorly-understood
- Low dose radiation risks are a matter of (legitimate) scientific debate
- Prejudicial predisposition (e.g. anti-science/anti-nuclear lobbies; personal/political agendas)
- Radiation ticks many fright factor boxes
Fright Factors
Risks seen as being more worrying (and less acceptable) if perceived

to be **involuntary** (such as exposure to pollution) rather than voluntary (dangerous sports or smoking)
to be **inequitably distributed** (some benefit while others suffer the consequences)
to be **inescapable** through taking personal precautions
to arise from an **unfamiliar or novel** source
to result from **man-made, rather than natural**, sources
to cause **hidden and irreversible** damage, such as through the onset of illness many years after exposure
to pose some particular danger to **small children or pregnant women**
or, more generally, to **future generations**
to threaten a form of death (or illness/injury) arousing **particular dread**
to damage **identifiable rather than anonymous victims**
to be **poorly understood by science**; and
to be subject to **contradictory statements** from responsible sources (or, even worse, from the same source)
Radiation risks tick many ‘fright factor’ boxes

<table>
<thead>
<tr>
<th>Fright Factor (modified by context)</th>
<th>Medical exposures</th>
<th>NPP accident → emergency release of radioactivity to environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>involuntary</td>
<td>-</td>
<td>✓✓✓</td>
</tr>
<tr>
<td>inequitably distributed</td>
<td>-</td>
<td>✓✓✓</td>
</tr>
<tr>
<td>inescapable</td>
<td>-</td>
<td>✓✓</td>
</tr>
<tr>
<td>unfamiliar or novel</td>
<td>-</td>
<td>✓✓✓</td>
</tr>
<tr>
<td>man-made, rather than natural</td>
<td>✓</td>
<td>✓✓✓</td>
</tr>
<tr>
<td>hidden and irreversible</td>
<td>✓</td>
<td>✓✓</td>
</tr>
<tr>
<td>small children or pregnant women</td>
<td>✓✓</td>
<td>✓✓✓</td>
</tr>
<tr>
<td>future generations</td>
<td>✓</td>
<td>✓✓✓</td>
</tr>
<tr>
<td>particular dread</td>
<td>✓</td>
<td>✓✓✓</td>
</tr>
<tr>
<td>identifiable victims</td>
<td>✓</td>
<td>✓✓✓</td>
</tr>
<tr>
<td>poorly understood by science</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>contradictory statements</td>
<td>✓</td>
<td>✓✓✓</td>
</tr>
</tbody>
</table>
Impact of poor channels of communication on decision-making

Poor channels of communication can → suppression of messages

Likelihood increases with number of tiers through which messages pass

Can lead to distortion and misrepresentation of original message

Can happen if corporate structures allow messages to be filtered by multiple hierarchical tiers before reaching decision-makers

Organisational change and loss of organisational memory may exacerbate these barriers to good communication
Good communication also requires receptivity to message

Recipients of messages should:

• Be attentive and curious:
  - Listen completely and attentively
  - Maintain a sense of curiosity and appreciative inquiry

• Be aware
  - Be mindful of what’s going on

• Be aware of their own biases, preconceptions and limitations
  - Be alert to bias (including Dunning-Kruger Effect) and preconceived ideas
  - Welcome input from subject matter experts

• Respond appropriately
  - Acknowledge message, provide feedback, follow up action as required

• Develop active listening skills

10 tips for active listening - Heart Matters magazine – BHF ; 16 ways to improve your communication skills with patients - BHF
Risks from medical exposure to radiation in context of other risks

- Differential diagnosis, prognosis, urgency
- Financial, staff, equipment
- Diagnostic/therapeutic
- Age, health, willingness/ability to comply
- Resources available
- Alternative techniques
- Patient profile
- Patient expectations
- Patient management
- Professional risks
- Risks of making wrong decision
- Corporate risk appetite
- Vested interests
-辐射风险
- CULTURE
- Financial implications
- Competing bids
- Targets
- Reputational risks
- Other agendas
- Risk aversion
- Budget costs, capital & revenue consequences, funds available
- Probably scarce resources
- True costs and benefits: legal requirements, regulator expectations, roles & responsibilities
- Which may change
- Which may be hidden
- Managing upwards, "good news only", ...
- GMC referral, loss of career
- Patient management & associated implications for doctor-patient relationship
- Protocols, pathways, guidance
- Communicating radiation risks
Willingness of decision-makers to listen?

Good news only culture → problems

"Hear no evil, See no evil, Speak no evil"

*Kikazaru* (hear not)

*Iwazaru* (say not)

*Mizaru* (see not)

Images: Three wise monkeys - Wikipedia
Amongst many definitions of culture, Matsumoto has defined it as:

*The set of attitudes, values, beliefs and behaviours shared by a group of people, but different for each individual, communicated from one generation to the next* (1996)

*Culture is a dynamic system of rules, explicit and implicit, established by groups to ensure their survival, involving attitudes, values, beliefs, norms and behaviours* (2004)

See also:
- Culture, context, and behavior (Matsumoto, 2007)
- Culture, psychology, and education (Matsumoto, 2011)
  - https://www.worldcat.org/title/culture-and-psychology/oclc/32347701
  - https://mrmikesibpsychology.weebly.com/cultural-norms.html
  - http://davidmatsumoto.com/content/2007%20Matsumoto%20JOP.pdf
  - https://scholarworks.gvsu.edu/orpc/vol2/iss1/4/
Culture is:

• "the way we do things round here *(deliberately or non-deliberately, consciously and unconsciously)*"

• "what people do when no-one is looking"

• "all about the behaviours that people demonstrate"

"Culture shapes the way we think about the world, even the way we see the world. This is why we are often blind to our own biases."

- Heinrich J. *The weirdest people in the world: how the west became psychologically peculiar and particularly prosperous* (2020)  
  Publisher: Allen Lane  ISBN-13 : 978-1846147968


- Khamsi R. *Can culture dictate the way we see?* (2007)  [https://www.newscientist.com/article/dn11785-can-culture-dictate-the-way-we-see/](https://www.newscientist.com/article/dn11785-can-culture-dictate-the-way-we-see/)
The culture of the organization comprises the mix of shared values, attitudes and patterns of behaviour that give the organization its particular character. Put simply, it is ‘the way we do things round here’.

INSAG-13 'Management of operational safety in nuclear power plants' (1999)

In its report on the Chernobyl accident, INSAG coined the term 'safety culture' to refer to the safety regime that should prevail at a nuclear plant.

**Safety culture** ... is primarily generated by the attitudes of managers.

New information has highlighted a number of broader problems contributing to the accident. These include: ... *A general lack of safety culture in nuclear matters, at the national level as well as locally*.

INSAG concluded that the need to create and maintain a 'safety culture' is a precondition for ensuring nuclear power plant safety.

The concept of 'safety culture' relates to a very general concept of dedication and personal responsibility of all those involved in any safety related activity.

Radiation Safety Culture is the core values and behaviors resulting from a collective commitment by leaders and individuals to emphasize safety over competing goals to ensure protection of people and the environment.

Definition adopted from the U.S. Nuclear Regulatory Commission (NRC) definition of Nuclear Safety Culture (NRC 2011), with its applicability expanded to include non-NRC regulated sources of radiation such as machine-produced radiation and natural background sources of radiation.

PS026-0 Radiation Safety Culture (hps.org)
Key Safety Culture Characteristics (IAEA)

- **Senior management commitment**, involvement and visible leadership in safety
- **Effective** and **open communications**
- **Availability** of **sufficient** and **competent** staff and quality training
- **Effective learning**, questioning attitude
- **Ownership** of safety and self-assessment
- Recognise strategic business importance of safety
- Absence of safety vs. production conflict
- Quality documentation and procedures
- Clear roles, responsibilities, accountabilities
- Human, technology and organisation knowledge
- Good working conditions
- Employee awareness of work process and safety
The Iceberg of Ignorance


- 4% of problems are known to top managers
- 9% of problems are known to middle management
- 74% of problems are known to supervisors
- 96% of problems are NOT known to top managers
- 100% of problems are known to front-line employees
Safety Culture (INSAG-4)

International Nuclear Safety Group, 1991

Policy-level commitment
Managers' commitment
Individuals' commitment
Safety culture

Nuclear and radiological safety are the prime concerns of this report, but the topics discussed are so general that successful application of the principles should lead to improvements in other important areas, such as industrial safety, environmental performance and, in some respects, wider business performance.

This is because many of the attitudes and practices necessary to achieve good performance in nuclear safety, including visible commitment by management, openness, care and thoroughness in completing tasks, good communication and clarity in recognizing major issues and dealing with them as a priority, have wide applicability.

Key issues in safety culture

1. Commitment
2. Use of procedures
3. Conservative decision making
4. A reporting culture
5. Challenging unsafe acts and conditions
6. The learning organization
7. Underpinning issues:
   - Communication
   - Clear priorities
   - Organization

An organisation’s culture can have as big an influence on safety outcomes as the safety management system. ‘Safety culture’ is a subset of the overall company culture.

Many companies talk about ‘safety culture’ when referring to the inclination of their employees to comply with rules or act safely or unsafely.

However, we 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.

HSE Common Topic 4: Safety culture
Maturity of organisational safety culture
Radiation Safety Culture within an organisation

- Organisational culture
- Safety culture
- Radiation Safety culture
Radiation Safety Culture can struggle to compete with other organisational priorities, such as meeting production / service delivery targets, particularly in the non-nuclear sectors.

Four sector-specific Working Groups were established, together with an overarching coordinating group, to review the current level of achievement, identify the driving forces and propose a framework for improvement.

Sector-specific working groups:
- Medical
- Nuclear
- Research & Teaching
- General Users

https://srp.uk/resources/radiation-safety-culture
Radiation Safety Culture in Health Care

- Organisational culture
- Safety culture
- Radiation Safety culture
- Radiation Safety Culture in Health Care
Actions considered to be essential to strengthen radiation protection in medicine

1. Enhance the implementation of the principle of justification
2. Enhance implementation of principle of optimization of protection and safety
3. Strengthen manufacturers' role in contributing to the overall safety regime
4. Strengthen radiation protection education & training of health professionals
5. Shape & promote strategic research agenda for radiation protection in medicine
6. Increase availability of improved global information on medical & occupational exposures in medicine
7. Improve prevention of medical radiation incidents and accidents
8. **Strengthen radiation safety culture in health care**
9. Foster an improved radiation benefit:risk dialogue
10. Strengthen the implementation of safety requirements globally

https://www.iaea.org/resources/rpop/resources/bonn-call-for-action-platform
The following are qualities or traits of a healthy organization culture for safety and apply to all organizations that deal directly or indirectly with ionizing radiation.

Individual Responsibility

Questioning Attitude

Communication

Leader Responsibility

Decision-Making

Work Environment

Continuous Learning

Problem Identification and Resolution

Raising Concerns

Work Planning

https://www.iaea.org/sites/default/files/20/05/harm
onization_05_05_2020-final_002.pdf
## Safety Culture Principles

*(A Harmonized Safety Culture Model, IAEA Working Document 2020)*

Overarching principles that provide traits and attributes that are present in organizations with a healthy safety culture

<table>
<thead>
<tr>
<th>Principle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INDIVIDUAL RESPONSIBILITY:</strong></td>
<td>All individuals are personally accountable for safety</td>
</tr>
<tr>
<td><strong>QUESTIONING ATTITUDE:</strong></td>
<td>Individuals remain vigilant for assumptions, anomalies, conditions, behaviours or activities that can adversely impact safety and then appropriately voice those concerns</td>
</tr>
<tr>
<td><strong>COMMUNICATION:</strong></td>
<td>Communications support a focus on safety</td>
</tr>
<tr>
<td><strong>LEADER RESPONSIBILITY:</strong></td>
<td>Leaders demonstrate a commitment to safety in their decisions. Leaders are role models for safety</td>
</tr>
<tr>
<td><strong>DECISION-MAKING:</strong></td>
<td>Decisions are systematic, rigorous, thorough, and prudent</td>
</tr>
<tr>
<td><strong>WORK ENVIRONMENT:</strong></td>
<td>Trust and respect permeate the organization</td>
</tr>
<tr>
<td><strong>CONTINUOUS LEARNING:</strong></td>
<td>Learning is highly valued</td>
</tr>
<tr>
<td><strong>PROBLEM IDENTIFICATION AND RESOLUTION:</strong></td>
<td>Issues potentially impacting safety are systematically identified, fully evaluated, and promptly resolved according to their significance</td>
</tr>
<tr>
<td><strong>RAISING CONCERNS:</strong></td>
<td>Personnel feel free to raise safety concerns without fear of retaliation, intimidation, harassment or discrimination</td>
</tr>
<tr>
<td><strong>WORK PLANNING:</strong></td>
<td>The processes of work planning and controlling work activities is implemented so that safety is maintained</td>
</tr>
</tbody>
</table>
Safety Culture Principle 3

**Communications support a focus on safety**

Leaders use formal and informal communication to frequently convey the importance of safety.

The organization 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.

**Attributes** (Trait 3)

| CO.1 | Free flow of information |
| CO.2 | Transparency              |
| CO.3 | Reasons for decisions    |
| CO.4 | Expectations             |
| CO.5 | Workplace communication  |
**Communication attributes** (safety culture trait 3)

**Principle 3: Communications support a focus on safety**

**CO.1 Free flow of information:** Individuals communicate openly and candidly, both up, down, and across the organization. The flow of information up the organization is considered to be as important as the flow of information down the organization.

**CO.2 Transparency:** Communication with oversight, audit, regulatory organizations and the public is appropriate, professional and accurate.

**CO.3 Reasons for decisions:** Leaders ensure that the reasons for technical and administrative decisions are communicated to the appropriate individuals in a timely manner.

**CO.4 Expectations:** Leaders frequently communicate and reinforce the expectation that safety is emphasized over competing goals.

**CO.5 Workplace communication:** Communication about safety is included in all work activities so that everyone has the information necessary to work safely and effectively.
HSE describe Human Factors as:

“environmental, organisational and job factors, and human and individual characteristics which influence behaviour at work in a way which can affect health and safety”
The Job

- PPE
- Tool Design
- Work Environment
- Written Procedures
- Cognitive Demands
- Time Pressures
- Shift patterns
- Physical Demands

JOB
The Organisation

- Safety Systems
- Management Support
- Systematic Approach to Training
- Safety Culture
- Communication
- Company Values
Industries in which HF/E and safety culture are well established

High risk industries:
- Aviation
- Nuclear
- Rail
- Oil
- ...

Others in which there is much scope for improvement: e.g.
- Healthcare
  - Clinical Human Factors Group (CHFG)
  - System Engineering Initiative for Patient Safety (SEIPS) framework
  - ...
Maturity of organisational safety culture

Safety Culture Ladder

- **Pathological**: who cares as long as we’re not caught
- **Reactive**: safety is important, we do a lot every time we have an accident
- **Calculative**: we have systems in place to manage all hazards
- **Projective**: we are good at the things that we do well
- **Generative**: safety is how we do business round here

Increasing trust and accountability

Increasingly informed
SEIPS (System Engineering Initiative for Patient Safety)
The Swiss cheese model of system accidents

The Swiss cheese model of how defences, barriers and safeguards may be penetrated by an accident trajectory

https://www.bmj.com/content/320/7237/768
In the Swiss Cheese model, an organisation's defences against failure are modelled as a series of barriers, represented as slices of the cheese.

The holes in the cheese slices represent individual weaknesses in individual parts of the system, and are continually varying in size and position in all slices.

The system as a whole produces failures when holes in all of the slices momentarily align, permitting "a trajectory of accident opportunity", so that a hazard passes through holes in all of the defences, leading to an accident.

https://www.skybrary.aero/index.php/James_Reason_HF_Model
The assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, protection and safety issues receive the attention warranted by their significance.

For a more detailed discussion of safety culture, see INSAG-4, *Safety Culture* (1991) 