Radiation Safety Decisions –
How we are Prone to Errors

Health Physics Society
Annual Meeting
Baltimore, MD

American Academy of Health Physics
Special Session
“New Frontiers in Radiation Risk Communication”

3:00 pm, Tuesday, July 15, 2014
(TPM – C.2)

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Health physicists have long been puzzled and often frustrated about how people can make instant decisions regarding radiation with little or no actual data. Studies in psychology show that our ability to make instant decisions for safety is a part of how our brains are wired for our protection. We are programmed to fear first and think second. We have survived by this innate ability to foresee dangers and take protective actions accordingly. Instant prediction of danger is not something we do consciously by evaluation of facts or circumstances. For example, if we took the time to analyze whether a nearby snake looks angry and whether it is close enough or fast enough to strike us, it may be too late. Instead our subconscious has automatically responded with an order to our body which says jump back. In fact, we have probably jumped back before we are even consciously aware of the snake at our feet. Our subconscious functions as a superfast computer processing all incoming signals by associations with images and experiences in our memories. Thus we are programmed for instant response without any conscious thought. While this instinct for safety is important for our survival, it is also prone to substantial errors for some dangers, such as radiation.

In the process of making decisions for radiation safety, there are at least 15 or more ways that our subconscious is prone to errors relative to the actual circumstances. My studies are showing that even professionals with technical understanding are also prone to errors. This can be demonstrated by the question, “Are your sources of radiation safe?” An instant answer to this question can only come from the subconscious because a conscious evaluation of data takes time to process. Also, when asked, “How do you know?” the answers invariably come down to beliefs in what we have heard or read about radiation safety. Our subconscious mind is prone to running ahead of the facts to draw coherent conclusions from a few scraps of evidence. Subconscious impressions then become the basis for instant decisions and long term beliefs.
Making Decisions for Radiation Safety - How We are Prone to Errors

Overview
- How do we make decisions for radiation safety?
  - Do we have all the information needed?
  - Role of the subconscious mind
- Role of fears and radiation mythology
- How we are prone to errors
- How to help a frightened person

Ferrar, Straus, and Giroux, New York
2011

How Do We Make Radiation Safety Decisions?
- What information do we rely upon?
- What observations?
- What experience?
- What others have told us?
- How do we evaluate this information?

Are Your Radiation Sources Safe?
- How do you know that?
- What does “Safe” mean?
- What data or understanding did you bring to your decision?
- How long did you take to answer?

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Name five pieces of information related to your decision

1. ____________________________
2. ____________________________
3. ____________________________
4. ____________________________
5. ____________________________

What is the Most Important Factor?

- Survey measurements
- Dosimetry
- Sealed source design
- Regulatory limits
- Radiation Safety Plan
- Training
  - ALARA
  - Time, Distance, Shielding
- Inspections and audits
- Swipes and leak tests

Do you have all the facts needed for a fully informed, analytical, rational decision?

- How much do you rely on information provided by others?
- How do you judge trustworthy data?
- Who do you respect as a resource?
- How would you defend your decision?

How does the Public Make Decisions for Radiation Safety?

- Many of you were able to answer the question about radiation safety because you already have knowledge and experience
- How would you answer the question without direct knowledge or experience?
- What information would you rely upon?
- What source would you trust?
- What would you conclude about safety?
- How long would it take to decide?

Making Decisions for Safety

- We make countless decisions for safety every day
- Many are automatic and we do not even think about them
  - Looking carefully before pulling into traffic
  - Watching where we step
- We are constantly on the alert for danger
- When alerted - we make instant decisions for safety?

Role of Fear in Decisions for Safety?

- Origin of fears
- What is real vs what is imagined?
- Does it make a difference?
- Conscious vs subconscious mind
- How we make decisions for radiation safety?
  - Why do people decide to run?
Is It OK to be Afraid of Radiation?
- Fear is a feeling and all feelings are OK
  - Not to be judged as good or bad
- Difficult when basis of fear does not seem justified
- Fear is a response to pain or danger
- A car sliding sideways off the road will cause fear
- Radiation does not produce any sensation or specific stimulus to warn us of danger
- Radiation fears are not a true fear
- Radiation fears are based on imagination and mythology

Fears are Natural and OK
- Fear is a natural response of our minds for our protection
- Our minds are always alert to danger
- We have survived by paying attention to our fears and when to react for safety
- However, all of our thoughts about being harmed
  - May themselves be harming us

Fear May Be the Greatest Danger
- Fear, anxiety, stress, and worry kill through
  - high blood pressure
  - addictions, drugs
  - heart disease
  - weight loss or gain
  - depression, insomnia
  - suicides, abortions
  - post traumatic stress disorder

Fears and Imagination
- All fears are based on imagination
- Fears summon powerful predictive forces
- Fear is about what might happen next
  - Not what is happening now
  - Example - fear of heights
  - If we tell that person, “You do not need to be afraid,” will that help them?
- Radiation fears are based on imagination of unacceptable consequences
  - Cancer and death

Two Systems for Safety Decisions
1. Conscious
   - Reason and rational analysis of facts -
     - Favored by technical specialists
     - May lead to intelligent decisions, but, very slow and takes effort
     - For safety decisions, we often do not have all the facts, time to gather facts, or knowledge to understand them
2. Subconscious
   - Emotion, instinct, and gut reactions, very fast,
     - Does not need all the facts
     - Origin of most decisions, especially for safety
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Role of Our Conscious Mind < 1%
- Very Slow, deliberate, rational, thinks, reasons, makes decisions and choices based on sensory input
- Source of knowing and awareness
- Serves as the captain of our ship, the giver of orders
- Processes information to make decisions
- Can only deal with one thing at a time

Subconscious Mind > 99.999%
- The seat of our emotions / creativity.
- Takes orders from the conscious mind without judgments
- A Very Fast, super computer
- Functions 24/7 operating the machine we call our body
  - Regulates our heart, our breathing, digestion of food, healing of cells, etc
- Handles thousands of inputs simultaneously for our health and protection
- Programmed to fear / react instantly to danger

Role of the Subconscious Mind
- The subconscious reacts automatically to messages from the conscious mind
- Most health effects could be controlled by the subconscious mind
- The subconscious does not judge good or bad
  - Carries out expectations of the conscious mind
- Placebo effect
- What happens to retirees?
- What happens when a spouse dies?
- What will happen in Japan?

Subconscious – Source of Fears
- Fear is a natural response for safety
- We survive by paying attention to fears
  - Reacting as needed for protection
- Some fears we think about before acting
- Others result in automatic subconscious reactions
  - Can we take the time to think about the danger of a snake?

Fears of Radiation are Involuntary
- Instinctive fears of heights, snakes, spiders, closed spaces, submersion, public speaking,
- Repeated message “Deadly Radiation”
  - Transferred to subconscious mind for protection
  - Radiation is now an instinctive source of fear
  - Fear of radiation – not a conscious choice
- Subconscious reacts automatically to radiation without consulting the conscious mind
- Decision to “RUN” is now automatic

How We Make Quick Decisions
- We process, sort, compare, categorize, and analyze information, in relation to
  - Immediate circumstances - radiation
  - Experiences – what have we heard?
  - Life factors, such as health, wealth, traditions, and lifestyles
  - Loss aversion – need to be safe
- With all these inputs we come up with instant judgments
  - Quick judgments are crucial to survival
- Based on limited information – associations in memory - May not be best in the long term
Instant Subconscious Processing

Stimulus → Response

Family & Children → Death
Chernobyl → Fukushima → Media Stories
Cancer → “Deadly Radiation”
X-rays → Property Damage
Loss Avoidance

Sources of Radiation Fears
- Perceptions of radiation risks
  - Related to images of unacceptable consequences
- Lack of information
  - Forces people to rely on what they have heard or believe about radiation
  - “Deadly Radiation”
  - Use of imagination, anticipation of losses, worst case images of disaster
- Radiation Myths

Radiation Myths Abound
- When dealing with radiation fears, consider:
  - Most of what people believe is mythology, without special training in radiation safety,
  - People rely on what they have always heard as the basis for understanding radiation
  - Myths help explain science in ways that are understandable to lay persons
  - Perpetuated by the media

Myth of “Deadly Radiation”
- Media has used these words for over 60 years
- Now accepted as basis for understanding radiation
- Assumes cause and effect automatically
  - Analogy with “Deadly Aspirin”
- Results
  - Fears of radiation seem out of proportion to risks as we would technically understand them

“No Safe Level of Radiation” - Myth
- The only safe level is zero radiation
- Predicted by LNT
- Every radioactive atom is harmful
- Every atom must be removed
- Basis of antinuclear sentiments and opposition to nuclear technology
- Ignores radiation all around us

Myth of Models for Estimating Risk
- 10 - 50 rem
- LNT
- Hormesis
  - Are small doses of radiation beneficial?
Emotion as a Basis for Judgments
- We make decisions on feelings of liking or disliking, without deliberation
- When confronted with a difficult decision and no knowledgeable solution, we substitute an easier question related to what we like or dislike
- We may not understand radiation risks, but we know how we “feel” about cancer

Answering Easier Question
- We are never stumped
- People draw conclusions about probability of radiation risks without understanding either probabilities or radiation.
- Rather than analyzing the math – people will substitute an easier question, “How do I feel about dying of cancer?”
- By matching intensity of fears with dollars, people can conclude that a lot should be spent to avoid radiation.

Myth of LNT
- Leads to views - “No Safe Level of Radiation”
  - No level without risk
  - The only safe level is zero
- However, there is no zero
  - We are all exposed to radiation all the time
- The debate on low dose effects will go on because of lack of data
- Propose a new message: “It is actually very difficult to seriously harm someone with radiation!”

What Does Zero Mean?
- Zero health effects start at 560,000 cancer deaths a year in US
- Zero radiation starts at background
  - 310 mrem / year average across US
  - 600 – 800 mrem / yr in Yangjiang, China
  - 1,500 – 2,500 mrem / yr in Kerala, India
  - 6,000 - 6,800 mrem / yr in Guaraapari, Brazil
  - 10,000 – 26,000 mrem / yr in Ramsar, Iran

True Model for Estimating Cancer Risk

Ways we are Prone to Errors
- Decisions by subconscious mind are crucial for safety – especially for imminent danger
  - Does not do well for dangers that are not imminent
- Subconscious acts on impressions which may not be based on good information and therefore has no clues to errors or biases
- Conscious mind is not inclined to second guess subconscious decisions
  - Wants to conserve energy

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Saying, “It is Safe”

- Difficult for many reasons
- First – What does safe mean?
  - For many, safe means NO radiation
- Second – if we share what we believe is safe
  - People can discount our views
  - People can disagree
- Acceptable answer can only be determined by individuals

Steps from “Cause to Effect”

1. What are properties of radiation
   - α, β, γ, x-ray?
   - Form and quantity?
2. Where is it located
   - Inverse square law?
3. How is it contained
   - Shielding?
4. How will it move in the environment?
5. What are the exposure conditions
   - mR/hr?
6. What is the duration of the exposure – hr?
7. How much energy is deposited in our body – mrem?
8. What are the health risks at 1 death / 1,000 person – rem

How can we Help a Frightened Person?

- Rather than saying, “It is Safe”
- Let them know, “it’s OK to be afraid”
- We can be a technical resource
- Provide information and evidence
  - From which people can derive their own answers of what safe means for them
  - Show-and-tell, common radioactive items
  - Fiesta ware, lantern mantels, K-40, depression glass, and Vaseline glass
  - Compare with radiation sources

Review

- How do we make decisions for safety?
- Are our decisions based on specific, provable, rational, technical information?
- Do we make such decisions fast or slow?
- All decisions for safety come from our fast subconscious mind
- Immediate reaction to fear
- Imagination will win every time
- We may rationalize later

References

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Questions?

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