

How We Make Decisions for Radiation Safety

Continuing Education Lecture

Health Physics Society

Annual Meeting

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How Do We Make Decisions for Radiation Safety?

Ray Johnson, MS, SE, PE, FHPS, CHP
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Continuing Education Lecture
HPS Annual Meeting, Sacramento CA
Thursday Morning - 7/26/2012

Have you found yourself puzzled by people's decisions and reactions about radiation? Have you felt that their decisions were not rational or based on any real understanding of radiation risks? How much do workers or the public really know about radiation risks when they express concerns for radiation safety? Are you willing to accept that radiation fears are OK, when the basis of those fears seems to be mythology which is not technically defensible? Psychologists tell us that all feelings (fears) are OK. We have survived as a species by paying attention to our fears. While our subconscious minds are programmed from birth for certain universal fears, such as fear of the dark, heights, snakes, spiders, closed spaces, and submersion, we are not naturally programmed for fear of radiation. However, we now seem to be in an era where radiation fears are instinctive. Perhaps hearing repeatedly about "deadly radiation" our subconscious minds have now included radiation along with snakes and spiders.

Our programmed response to imminent physical dangers is to fear first and think second. While an instinctive immediate reaction is appropriate to avoid a striking snake, this response mechanism does not do well for issues such as radiation safety. However, studies in neurosciences are showing that we have learned how to make decisions and cope with dangers for which we have little understanding. The author, David Ropeik, describes *Bounded Rationality* as our approach to making decisions when we do not have all the data, time to acquire more data, or the intellectual ability to process the data. Ropeik shows that we are constantly making judgments without perfect knowledge, but doing the best that we can at the time. We process, sort, compare, categorize, and analyze information in relation to our immediate circumstances, experiences, and life factors, such as health, wealth, traditions, and lifestyles. With all these inputs we can come up with instant judgments. Such quick judgments are crucial to our survival. However, because they are based on limited information, these decisions may not always be best for us in the long run.

How Do We Make Decisions for Radiation Safety

Ray Johnson, MS, SE, PE, FHPS, CHP
Director, Radiation Safety Counseling Institute

Health Physics Society Annual Meeting, Sacramento CA
Session THAM-E.10, Thursday - 7/26/2012

How often do we evaluate risks as part of a process for decisions on radiation safety? Most of us make decisions based on the requirements of regulations (public and worker dose limits), the requirements of our radioactive materials license, or the requirements of our radiation safety plan. In particular, our radiation safety plan usually spells out how we will implement the principles of ALARA. Our normal goal is to reduce radiation exposures to as low as we can reasonably achieve, without regard to the risks. We know in theory that we are reducing risks by reducing exposures, but how much do we really know factually about risks, especially at low doses and low dose rates? As specialists in radiation safety we follow the theory of the linear non-threshold model for understanding the relationship of radiation dose and effects. However, we also know that this model gets fuzzy below a cumulative dose of 100 to 150 millisieverts (10 to 15 rem).

How much do workers or the public really know about radiation risks. For lack of knowing technically, I suggest that radiation professionals, concerned workers, and the public alike make decisions for radiation safety based on gut instinct. These are the urgings of our subconscious mind intended for our protection. Our subconscious is programmed to detect sources of danger and react automatically to protect us. For protection our minds create images of unacceptable consequences to be avoided. Unfortunately the automatic reactions programmed into our subconscious to avoid imminent dangers of snakes, spiders, heights, dark places, and submersion, etc. are not usually appropriate for dealing with dangers of radiation. Risks of radiation injury are usually not imminent, but matters of future random chance. Because we have primarily only heard bad things about radiation for the past 50 years, many people have now included radiation aversion into their automatic subconscious reactions to avoid danger. This may help explain why we find so many people inherently afraid of radiation and making decisions for safety based on an automatic response of their subconscious minds and not on factual understanding of radiation risks.

Understanding and Responding to Radiation Fears – Part I

Ray Johnson, MS, SE, PE, FHPS, CHP
Director, Radiation Safety Counseling Institute

Professional Enrichment Program, PEP M-1
Health Physics Society Annual Meeting, Sacramento CA
Monday - 7/23/2012

A university RSO recently told of a researcher who found out that another nearby researcher was using C-14 and threatened to call the university provost and his congressman to express his concerns for exposure to radiation. How can you understand the basis for such fears and how can you best respond? Is the best response a matter of explaining the health risks of C-14? Will a technical answer change the person's fears? Recent studies in neurosciences are showing that fears originate in our subconscious mind as a natural mechanism for our protection. Fear is actually a good thing. The author, Gavin DeBecker, says fear is a gift for our safety. We have learned to survive over the ages by paying attention to our fears. Some fears are programmed into our subconscious from birth, including fear of the dark, snakes, spiders, heights, closed spaces, and submersion. Other fears include the fear of public speaking, fear of intimacy, and fear of failure or social rejection. Our brains are programmed to protect us in many different ways. However, the processes for instinctive reactions to avoid imminent dangers of snakes or spiders are not appropriate for dealing with dangers of radiation. Radiation effects are not usually imminent, but matters of future random chance.

Because most people have been hearing about “deadly radiation” for their whole lifetimes, most have come to conclude that the dangers of radiation are imminent or at least a surety. Most have little idea that the type of radiation or quantity makes any difference. Thus, people are as afraid of C-14 or backscatter x-ray machines at the airport as they would be for high energy sources of radiation. Because instinctive reactions for safety come from the subconscious mind, they are based on imagined unacceptable consequences and not on reality as we would understand the technology. If a fearful person is asked about why they are afraid, they may rationalize an answer that makes no sense because the subconscious origin of their fear is out of their awareness. Consequently, even the best rational technical response may not allay the person's fears. Trying to tell the fearful person that they do not need to be afraid, may also not be helpful. Understanding the basis for radiation fears can provide insights on a number of more helpful responses which will be explored in Part II of this series.

Understanding and Responding to Radiation Fears – Part II

Ray Johnson, MS, SE, PE, FHPS, CHP
Director, Radiation Safety Counseling Institute

Professional Enrichment Program, PEP W-1
Health Physics Society Annual Meeting, Sacramento CA
Wednesday - 7/25/2012

How can you best respond to a person fearful of radiation? Psychologists know that attempts to confront fears directly may not be helpful. Since fears come from the subconscious mind, this means the basis of the fear is not in a person's awareness. Thus, our conscious mind does not know why we are afraid. Our subconscious mind is programmed to ever be on the alert for any signals to predict danger before it occurs. Sensory signals flow through our spinal cord to the midbrain where the information is screened by the thalamus and the amygdala. In particular the amygdala recognizes signals of danger and immediately mobilizes automatic responses for protection. Before our conscious mind is even aware of any danger, the amygdala has directed our body to react without the benefit of a slow rational analysis. If a snake is about to strike us, we do not want to take the time to process the degree of danger before deciding to jump back. The amygdala not only responds to explicit signals of danger, but also to implicit memories of danger. Since radiation does not give any sensory (explicit) warnings, our reactions to radiation have to come from memories of what we have always heard about radiation.

Since most of what people have heard about radiation is mythology, instinctive reactions against radiation do not seem to have any rational technical basis. Efforts to rationally discuss a person's fears of radiation, when they are in their automatic response mode, will likely result in frustration for both parties. However, there are ways to explore the basis of fears when a person has moved beyond their immediate fear response. The question to uncover the underlying images of fearful consequences for specific circumstances is to ask, "What's so bad about that?" This question should be posed very gently and may need to be repeated several times to peel away several layers to get down to the real underlying image that drives the fear. Underlying bases for fear may include dying, loss of control, loss of health, loss of family, loss of income, etc. Another tool for response to a fearful person is called "Active Listening." With this approach we respond to the apparent feeling conveyed along with a brief statement of the content. Since technical people often have difficulty identifying the feeling part of a message, it might be helpful to note that all feelings can be captured by one of the following words, "Mad, Sad, Glad, and Afraid." There are also five key responses that can be used "when you do not know what to say" which are not confrontive or defensive.

No. 1 – Radiation Safety Psychology

Health Physics Society Newsletter – May 2012

An Introduction and Brief History of My Counseling Career

Ray Johnson, CHP

Introduction

This new monthly column will address issues regarding general perceptions about radiation risks that have puzzled specialists in radiation safety for decades. While many such specialists have ideas about why the public seems so fearful of radiation, they generally are not prepared to deal with the psychology of risk perceptions. Likewise psychologists, who understand how to provide help with fears, generally do not understand the principles or practice of radiation safety. Although I am not the ultimate authority on matters either of psychology or radiation safety, I have attempted to provide a bridge for transfer of understanding between these two professions for more than 30 years.

How I Got Started

In the middle 1970s, at about 13 years into my career in radiation safety, I found myself attempting to provide helpful responses to public inquiries of concerns for fallout from Chinese atmospheric nuclear weapons tests. While I had the data and understood the technology of radiation safety, I was totally unprepared for questions such as, “It’s raining, should I keep my children home from school?” Or, “When fallout arrives over the US, should I stop nursing my baby?” The underlying aspect of such questions was about fears of radiation. Even with more than eight years of college, I had not learned how to hear and respond to fears in a helpful way. I did not know how to identify feelings or have any vocabulary for describing or discussing fears.

No Understanding of Feelings

Although my wife could have told me this, I discovered my deficiency in a men’s group at church. I was about 35 when at a Saturday meeting one of the men described an issue at home. The leader of the group (Rev. Dr. James Morgan) asked me for my feelings on the issue. So I told him what I thought. He again asked for my feelings and again I told him what I thought. Finally after he patiently asked me a third time for my feelings, I suddenly realized that I had no idea what he was asking about. I had given him my thoughts twice, what more could he want. When he at last said, “I wanted to know your feelings, not your thoughts,” I understood that an awareness of feelings was totally lacking in my education up to that time.

TA Training

When I asked Dr. Morgan how I could learn about feelings, he said that he taught a nine-month class on Transactional Analysis (TA) which was mainly about training counselors to hear and respond to feelings. I enrolled and quickly found that I was the only engineer in a large group of people learning to become psychological counselors and therapists. Needless to say, I felt like a

fish out of water and was overwhelmed for most of the class. However, I began to see possibilities and enrolled a second time. After considerable progress, I enrolled a third time as an assistant to Dr. Morgan.

First Presentations

I was just nearing the end of my third enrollment in TA when the Three Mile Island (TMI) nuclear plant accident occurred in March 1979. Using my newly gained insights in psychology, I presented a paper at the annual meeting of the Health Physics Society in Philadelphia in July 1979 on “Communication – the Health Physicists Dilemma.” Within a few months I was invited to be the dinner speaker at a program by The Oak Ridge Institute for Science and Education (ORISE) and later at a joint meeting of three HPS Chapters at Cherry Hill, NJ to discuss TMI.

I had an interesting experience while driving to Cherry Hill. I had with me another invited speaker, a Ph.D. Social Psychologist from the Nuclear Regulatory Commission. We had been collaborating to study psychological issues at TMI. All the way to NJ he kept asking for my counsel on how to deal with girlfriend issues. Although he was a psychologist, he knew nothing about interpersonal relations or how to deal with feelings. Although I had no degree, I was a trained and experienced counselor.

Early 1980's

I continued to take training, workshops, and seminars on listening skills, journaling, death and dying, EST, etc. while practicing counseling informally in my church. I also presented numerous seminars, classes, and retreats for the church on listening to God, each other, and ourselves. In early 1983, Dr. Allen Brodsky called a meeting at his house to discuss communication needs of health physicists. More than 30 attended. At this meeting, I volunteered to lead a committee on communications for the Baltimore Washington Chapter of the Health Physics Society. Larry Petcovic was part of this committee. Together we put on a Myers-Briggs Type Indicator (MBTI) workshop with help from staff of Johns Hopkins. Larry and I then presented a morning Continuing Education Lecture on communications at the annual meeting of the HPS in Baltimore in 1983.

1984

This year I attended a year-long Johns Hopkins program on Organizational Systems and Communications. Larry and I began writing a monthly column for the HPS Newsletter on *Insights in Communication*. We continued this column until 1989. At the 1985 midyear HPS meeting in Colorado Springs, I presented the first MBTI workshop for HPs. Larry and I continued to present these workshops to over 3,500 HPs at HPS meetings until about 1989.

1990s to the Current Day

I once again wrote a monthly column, *Communication Insights*, for the HPS Newsletter from 1994 until 2001. I also wrote and presented several hundred papers, articles, workshops, and seminars on radiation risk communication to the HPS, ANS, AAHP, AARST, and AIHA. I have continued training in counseling and have served as a Commissioned Stephen Minister and counselor in my church since 2003.

Topics for this New Column

Possible topics could include (in no particular order):

- The basis of radiation fears
- Hearing and responding to fears
- How people make decisions for radiation safety
- The role of the subconscious mind and radiation fears
- Counseling fearful or angry workers or others
- Facing the terror of nuclear terrorism
- Practical tools for radiation risk communication
- How to talk with people who are fearful of radiation
- The gift of fear
- Brain based learning for HPs
- Emotional intelligence
- Communication with the subconscious mind
- Neuroscience marketing
- What to say, when you do not know what to say
- Communication with the media
- Active listening skills
- Becoming a radiation myth buster
- Effective presentations
- How to stay non-defensive
- How to position for win-win
- Non-advocate communication
- Techniques for persuasion
- How to achieve credibility with any audience
- Leadership and motivation

Other ideas for this column are welcomed. Contact webed@hps.org

No. 2 – Radiation Safety Psychology

Health Physics Society Newsletter – June 2012

The Power of the Subconscious Mind

Ray Johnson, CHP

For decades we (radiation safety specialists) have been puzzled by the widespread fears of radiation which seem irrational and unwarranted by the circumstances. We keep asking ourselves, “Why do so many people view radiation with such great alarm?” We have also wondered, “Why are our best efforts to provide truthful, factual, information about radiation risks not always helpful for alleviating fears?” In my counseling training from many years ago, I learned that fears are driven by images in people’s minds. From this insight I proposed that the reason people are fearful of radiation is because of an image in the back of their minds of unacceptable consequences that may result from radiation exposure. While I still believe this is true, I am now learning there are more than images that drive people’s fears and reactions to radiation. After reading several books on the workings of the subconscious mind, I now realize that people’s fears are about automatic or instinctive functions of the subconscious mind for their protection.

Our Conscious Mind

To help understand the workings of the subconscious mind, we need to distinguish the functions of the conscious and subconscious. Our conscious mind functions rationally in a relatively slow deliberate manner to think, reason, and make decisions and choices based on sensory input. This function, which is the source of our awareness, occupies less than one percent of our brain. Our conscious mind serves as the captain of our ship and the giver of orders. However, our conscious minds can basically only deal with one thing at a time (have you noticed when looking for a street address on a dark night, that you automatically reach over and shut off the car radio).

Our Subconscious Mind

This is the seat of our emotions and creativity. More than 99.999 % of stimuli to the brain are processed subconsciously. Our subconscious mind functions exceedingly fast like an enormous super computer which operates the machine we call our body. Without our awareness, our subconscious mind functions 24/7 regulating our heart, our breathing, the digestion of food, the healing of cells, etc. Better than any computer, our subconscious is a multi-tasker which handles hundreds of thousands of inputs simultaneously for our health and protection. Our subconscious mind takes orders from the conscious mind without judgments. Our subconscious mind is also programmed from infancy to react instantly to signs of danger. Do we want to allow the slow acting conscious mind to take time to think about whether a snake is going to strike?

Fears of Radiation May Now be Involuntary

Fear is a natural response of our subconscious to protect us from danger. We have survived by paying attention to our fears and reacting accordingly. For most of us, our subconscious mind is already programmed with instinctive fears of heights, snakes, spiders, closed spaces, being submerged, etc. After hearing repeatedly the message “radiation is deadly” for our entire lives, the conscious mind of many people has transferred this message to their subconscious for their protection. Thus, radiation has now become programmed into their subconscious mind as another instinctive or involuntary source of fear. This means adverse reaction to radiation is often now automatic and leads people to quickly conclude, “Radiation, I don’t want anything to do with that.”

Our subconscious mind hears that radiation is very dangerous and to assure our safety our subconscious attaches terrible feelings (fears) to radiation. By linking radiation with emotional trauma, a powerful negative association is formed to avoid this source of danger and a radiation phobia is born. Thus, fear of radiation is no longer a rational conscious choice based on logical analysis, but a gut instinct (feeling). Our subconscious does not consult with our conscious mind before raising the alarm of fear. For protection our subconscious has to react before we can even consciously think about it. Avoidance of radiation is now an automatic response.

Can we Talk a Person Out of Their Fears?

Since radiation may now be the source of automatic instinctive fear, the question is whether we can talk someone out of their fear of radiation. Like other instinctive fears, such as fear of snakes, can we talk someone out of their fear by saying, “It’s only a harmless garter snake.” Can we change a person’s fear of radiation by saying, “You do not have to be afraid, it’s only like a chest x-ray.”

Since fears of radiation come from our subconscious, efforts to speak to the rational thinking mind may not help. Giving out facts about radiation safety does not change the feelings. Fears of radiation are based on images of unacceptable consequences. All fears are the result of imagination of what will happen next. A person afraid of heights imagines getting near the edge and falling. Appeals to the conscious mind with explanations about reality and safety may not change these images and the basis of fear. The least helpful response is to say, “You do not have to be afraid.” Trying to tell people that they do not need to fear radiation does not connect with their gut feelings and images of danger. ***The imagination of the subconscious mind will win over the rational conscious mind every time.***

It may also not be helpful to ask a person fearful of radiation, “Why are you afraid?” Since their fear comes from their subconscious, they do not know the answer. If forced, they may rationalize an answer that may not make any logical sense to a technical person. At this point, if a technical person attempts to correct errors of technology, the fearful person may become distrustful and even angry because their fears are not about facts, but feelings. Experts are wrong to think they can ease fears of radiation by simply “getting the facts out.” While facts are

evaluated by the rational conscious mind, fears come from subconscious gut feelings, not logical analysis. The gut feeling of a fearful person will tell them that even though radiation injuries are very unlikely to occur, that is not an adequate justification for ignoring risks of possible future effects.

Fears May be the Greatest Danger from Radiation

Fear, anxiety, stress, and worry can cause drastic psychological and physical effects such as

- high blood pressure
- addictions to alcohol and drugs
- heart disease
- weight loss or gain
- depression, insomnia
- suicides, abortions
- post traumatic stress syndrome

Since our subconscious mind reacts automatically to messages forwarded from our conscious mind without judgment, all of the effects above could be controlled by our subconscious. We all know of the “placebo effect” where our subconscious mind produces a beneficial outcome for some type of medication because our conscious mind believes the medication will work. Since our subconscious does not judge messages from our conscious mind, it will carry out the expectations of the conscious mind. For example, a person retires and says to themselves that their useful lifetime is now over. How long do they live after retirement? A person dies and their spouse concludes they no longer have a reason for living. How long before the spouse also dies?

Studies of the subconscious mind show that it will attempt to carry out whatever the conscious mind believes. Henry Ford is reported to have said, “If you believe you can or believe you cannot, you are right.” Your subconscious mind takes the orders you give it based upon what your conscious mind believes and accepts as true. When you repeatedly say to people, “I can't afford it,” your subconscious mind takes you at your word and sees to it that you will not be in a position to purchase what you want.

Because our conscious beliefs so strongly affect the reactions of our subconscious mind, I am now asking questions about how beliefs may affect our physical reaction to radiation. Is it possible if people believe that they will be harmed by radiation, that their subconscious will cause that to happen? To put this question into a current context, I would wonder, “***How many persons evacuated from the Fukushima province in Japan will suffer harmful effects because they have been told that they should expect effects from radiation?***” Will their belief in harmful radiation effects cause them to happen? I hope someone more knowledgeable than myself will explore such questions.

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No. 3 – Radiation Safety Psychology

Health Physics Society Newsletter – July 2012

How Do We Make Decisions for Radiation Safety – Part I?

Ray Johnson, CHP

The answers to this question are very complex. Despite my studies for 25 years with the Myers-Briggs Type Indicator (MBTI) trying to understand how people acquire information and make decisions, I still have much to learn. While the MBTI provides helpful insights on dominant data gathering preferences using our five senses or intuition and dominant decision making preferences using either logical thinking or feeling, decisions for safety involve all of these preferences at the same time. Our brains are programmed to protect us in many different ways. In this article I would like to share some observations drawn from a recent book by David Ropeik, “How Risky is it, Really? Why Our Fears Don’t Always Match the Facts.”

Two Systems for Safety Decisions

People make decisions for radiation safety based on how much they fear radiation. There is nothing wrong with fear which is a natural response of our minds for our safety. We have survived as a species by paying attention to our fears and reacting as needed for protection. While we may take time to think about dangers, most of our fears originate at a subconscious or instinctive level which reacts very rapidly as appropriate for protecting us from imminent danger, such as a striking snake. Psychologists have commonly believed that there are two separate systems involved in safety decisions: 1) reason and rational analysis of facts and 2) emotion, instinct, and gut reactions. Ropeik says these are not separate systems. We are not perfectly rational or completely emotional and instinctive.

System 1 seems to be favored by technical specialists and may lead to more intelligent judgments, however, this approach is very slow and takes more effort. Also, we often do not have all the facts for making a good decision, the time for gathering the facts, or the knowledge to understand what the facts mean. On the other hand, System 2 is often favored by non-technical people based on gut instincts and feelings which are much faster and do not need all the facts before sounding an alarm for safety. Ropeik says we actually use both systems all the time and he says we are *Affective*. This means we make decisions using both our minds and heart. We decide based on facts and how we feel about the facts, as well as instincts, values, cultural views, personal experience, and life circumstances.

We are Programmed to Fear First and Think Second

Our first reactions to danger happen subconsciously in the part of our brain close to the top of the spinal cord called the amygdala. Sensory information speeds from our five senses through our spinal cord to a group of cells in the center of our brain called the thalamus. These cells act as a relay station between the midbrain which sits directly on top of the spinal cord (sensory pathway) and the larger cerebral cortex (where thinking occurs). The thalamus also shares a signal with the amygdala which resides closer to the cerebral cortex, so it responds quicker. The

amygdala recognizes signals of danger and immediately mobilizes automatic responses for protection. Ropeik calls these Fight, Flight, and Freeze responses. Before you are even consciously aware of danger, your body has already reacted without benefit of a slow rational analysis. If a snake is about to strike you, you do not want to take time to process the degree of danger. Somewhat later processing of information by the cerebral cortex may modify the fear response.

While the amygdala responds immediately to external indications of danger, it may also respond to memories of previous signs of danger. These memories of danger are implicit, meaning that you cannot consciously recall them, but the amygdala, whose goal is to protect us, will always remember. As the amygdala responds it also enhances our ability to consciously recall explicit memories of danger. Thus, recall and reaction are speeded up when the same danger is encountered again.

Programmed Fears and Flaws for Dealing with Radiation

Some fears seem natural or common to most everyone, such as fear of the dark, snakes, spiders, heights, closed spaces, and being underwater. Other fears include public speaking, fear of intimacy, and fear of failure or social rejection. These fears are also about survival because we have learned to rely on others to protect us. Our sensory system and amygdala are constantly scanning for signs of danger and quickly leap to action at the first hint. The amygdala takes control immediately with a fear response which overrides conscious processes. While this may be appropriate for response to a striking snake, this process does not do well when considering issues such as safety of radiation. Our programmed fear response does not know what to do with radiation which is not programmed into our alert system. However, other parts of our subconscious brain have evolved to allow us to process information and make quick judgments for our protection.

Bounded Rationality

Ropeik describes *Bounded Rationality* as our approach to making decisions when we do not have all the data, time to acquire more data, or the intellectual ability to process the data. Ropeik shows that we are constantly making judgments without perfect knowledge, but doing the best that we can at the time. We process, sort, compare, categorize, and analyze information in relation to our immediate circumstances, experiences, and life factors, such as health, wealth, traditions, and lifestyles. With all these inputs we can come up with instant judgments. Such quick judgments are crucial to our survival. However, because they are based on limited information, these decisions may not always be best for us in the long run.

Mental Shortcuts

Some of the tools described by Ropeik for mental shortcuts to quick decision making include: the framing effect, categorization, loss aversion, anchoring and adjustment, awareness and recall, and optimism bias. Much of how we see a certain risk has to do with how it is framed or presented (in DC, this is called spin). We also tend to categorize perceived risks that seem similar and this could lead us to jump to conclusions based on small samples. This shortcut may also lead to problems with probabilities where we see patterns that seem suspicious (perceived

cancer clusters lead to questions of causation when the clusters may be purely random chance). Because we are inclined to avert losses, we tend to hold onto stocks longer than we should when the value is going down.

For our survival we are also very sensitive to factors which may cause a loss of health. The media is especially vocal on losses (dangers) that may affect our health or that of our children. Anchoring is a process which influences the starting point or anchor for a decision. People tend to be more influenced by the first data presented. Recall has to do with whether the danger comes readily to mind. The greater our recall and awareness of a certain risk, the more concerned we become. Vivid, dramatic, or frightening events are recalled more quickly (where were you on 9/11/01?). The media plays a big part on our recall abilities according to how they report stories. For example, many people fear nuclear power plants because they believe the plants might blow up like an atomic bomb. Even after learning that this can't happen, images of Hiroshima, Nagasaki, Chernobyl, and Fukushima come so readily to mind that these images may override any rational judgment about risks from nuclear power.

Numeracy may also be an issue when people try to comprehend risks from radiation. Because many people have trouble with numbers, difficulties with trying to understand the data may lead people to rely on their affective mental shortcuts. People are also often optimistically biased that certain risks will not happen to them (such as health risks of being overweight, heart disease, stroke, diabetes, etc.). Certain ways of dying get more attention, such as cancer (the predominant fear for radiation). As people associate radiation with cancer, fears of radiation risks escalate far beyond the fears of much greater health risks listed above. The fact that "we are actually very resistant to harmful effects of radiation" gets lost.

Ropeik says that risks have personality traits that help us instinctively judge their character, even before we consciously process the facts. The media have done a great job conditioning people's minds with the words "deadly radiation." Thus, today the word "radiation" alone takes on the personality trait of great risk independent of any actual facts.

The Role of Trust

Another factor in decisions for radiation safety is trust. Our survival may depend on knowing who to trust for our safety. Promises of absolute safety may lead to mistrust if something happens. Lack of trust increases fears. Organizations perceived as creating risks are not likely to be seen as trustworthy. The appearance of withholding information is a cause for mistrust and increased fears. Failing to take fears seriously, failing to be open, and failing to share the decision making process with affected people all lead to mistrust.

If any of the above discussion attracts your interest, you are encouraged to get the book by Ropeik who provides much more elegant perspectives than I could offer in this article.

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No. 4 – Radiation Safety Psychology

Health Physics Society Newsletter – August 2012

How Do We Make Decisions for Radiation Safety – Part II?

Ray Johnson, CHP

Last month this column drew upon observations from a recent book by David Ropeik, *“How Risky is it, Really? Why Our Fears Don’t Always Match the Facts.”* The McGraw Hill Companies, Inc. 2010 (Amazon - \$13.60). This month I would like to introduce readers to another recent book by Daniel Kahneman (Nobel prize in economics) *“Thinking, Fast and Slow.”* Farrar, Straus, and Giroux, New York, 2011.

Beliefs about Decision Making

Kahneman’s book is intended to raise questions about our common beliefs in the ways we make judgments and choices. He notes that most of the thoughts and impressions which come to our conscious mind arise without our knowing where they came from. For example, can we trace the process of detecting irritation in our spouse’s voice or how we avoided an obstacle in the road before becoming consciously aware of it? The mental work that produces impressions and decisions is based on intuition which goes on in the silence of our minds. This book is about biases in intuition that affect our decisions.

Intuitive Biases

Kahneman notes that even after teaching and using statistics for years, he had not developed an intuitive sense of the reliability of statistical results. He found that he was too willing to believe research findings based on inadequate evidence and prone to collect too few observations in his own research. A survey showed that other expert colleagues also exaggerated the likelihood that experimental results would be confirmed, even with a small sample. One study conducted with a colleague showed that participants ignored relevant statistics and relied on *“resemblance”* as a simplifying rule of thumb (heuristic) for making a judgment. In other words, they ignored data in favor of information that resembled something they already knew about.

In another study they found that participants made judgments based on how easy they could *“recall”* certain events as a basis for generalizing a conclusion. People tend to assess the relative importance of issues based on how easily they can recall events, which may be largely determined by media coverage. This is an interesting paradox, because the media tends to report what seems to be currently in the public’s mind. Kahneman’s studies were to demonstrate possible flaws in our thinking which occur outside of our awareness. Our minds are susceptible to systematic errors of intuition.

Emotion as a Basis for Judgments

Studies are showing that emotion is a large factor in intuitive judgments and choices. Decisions are often guided by feelings of liking or disliking, with little deliberation or reasoning. When a question is difficult and a knowledgeable solution is not readily available, an answer may still

come quickly to mind. But, the answer may not specifically respond to the original question. Rather, in place of the difficult question we “*substitute*” an answer to an easier and related question (having to do with what we like or dislike). Since this substitution is outside of our conscious awareness, it will usually go unnoticed.

Two Systems of Thinking

Kahneman refers to earlier researchers who describe two systems for judgments characterized by fast thinking and slow thinking.

- **System 1**, *commonly called the subconscious mind*, operates automatically and **very fast** with little or no effort and no sense of voluntary control.
- **System 2**, *commonly called the conscious mind*, **slowly** and deliberately devotes attention to demanding mental activities that require effort. This system has beliefs, makes choices, and decides what to think about and what to do.

While we generally identify ourselves with System 2, the automatic System 1 is the basis for effortless origination of impressions and feelings that are the main source of explicit beliefs and deliberate choices of System 2. We are born with innate System 1 skills for perceiving our world, recognizing objects, orienting our attention, and avoiding danger. As we mature we also learn new skills, such as reading and interpreting nuances of social situations. All processes that become automatic, such as athletic or game skills, playing a musical instrument, driving a car, or knowing that $2 + 2 = 4$ are System 1 functions. “*System 1 is the secret author of most of our judgments and choices.*”

System 1

We are born with innate skills to perceive the world around us, recognize objects and people, and orient our attention to predict and avoid losses. As we mature we build on this innate resource through learning, impressions, and experience. Subsequently this knowledge is drawn upon by System 1 automatically without conscious intention or effort. Mental activities associated with skills derived from prolonged practice also become fast and automatic. Basically all of the actions, decisions, and functions which we perform without thinking about them are System 1 functions. System 1 or our subconscious mind is an enormous super computer which operates the machine which we call our body. This system is able to handle thousands of inputs simultaneously to regulate our hearts, breathing, digestion, healing of cells, etc, without any conscious or thinking effort.

System 2

Functions of this system have one feature in common. They require attention and these functions are disrupted when attention is diverted. In other words, System 2 can basically only do one thing at a time. The admonition to “pay attention” is appropriate for this system. We have a limited budget of attention and will fail if we try to go beyond our budget. A current example is what happens to a driver’s attention when he/she is talking on the cell phone or even worse if they are texting. We have all observed a car weaving over the lines in the road and then saw the driver engrossed in a cell phone conversation. The same inattention to surroundings applies to

persons walking and talking on their cell phones. Intense focusing on one task can essentially make us blind to other stimuli that would normally attract our attention. Thus, we can become blind to the obvious and blind to our blindness. People on cell phones do not realize that their attention has drifted away from driving or walking.

Conflict of Systems for Radiation Risk Decisions

Both systems function continuously while we are awake. System 1 runs automatically and System 2 is comfortable in a low-effort mode in which only a fraction of our thinking capacity is engaged. System 1 generates suggestions for System 2 such as impressions, intuitions, intentions, and feelings. If accepted by System 2, these impressions and intuitions turn into beliefs and impulses turn into voluntary actions. Thus, we normally believe our impressions and act accordingly. System 1 is usually very good at what it does, its models of situations and short term predictions are accurate, and its initial reactions are swift and generally appropriate. Such automatic assessments of radiation risks, however, may be far from appropriate for the circumstances. Since System 2 relies on sensory input to warn of dangers, and radiation provides no information for our senses, then System 2 has to rely on impressions from System 1. System 1 impressions may come from mythology perpetuated by the media and images of unacceptable consequences that could result from radiation exposures. Such impressions may have no relevance to technical reality as understood by specialists in radiation safety.

Since System 1 operates automatically and cannot be turned off, errors of intuition and impressions may be difficult to prevent. Biases cannot be avoided because System 1 has no clue to errors in radiation risk decisions. Even if cues to errors in response to radiation risks are evident, such errors can only be prevented by concentrated monitoring and significant effort by System 2. Thus, when a responder instinctively decides to run in response to a screaming Geiger counter, reversing that decision requires considerable effort on the part of System 2. Our conscious minds (System 2) are not intended to constantly monitor the decisions of System 1. System 2 is much too slow and inefficient for most routine decisions. Do we want to slowly analyze the potential of a striking snake before instinctively jumping back? In the mind of a first responder, running will seem like an appropriate response to a radiation signal.

This discussion of Systems 1 and 2 (subconscious vs conscious mind) will continue in a series of forthcoming articles, including more notes from Kahneman's book.

How We Make Decisions for Radiation Safety

Ray Johnson, MS, SE, PE, FHPS CHP
Director,
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Preview

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

Radiation Safety Counseling Institute 2

How Do We Make Safety Decisions?

- What information do we rely upon ?
- What observations ?
- What experience ?
- What others have told us ?
- How do we evaluate this information ?

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How Many of You Work with Radiation ?

- Is your source of radiation safe ?
 - What does Safe mean ?
- How do you know that ?
- 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. _____

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Share With Your Neighbor

- Was your decision on radiation safety Logical, rational, analytical?
- Quickly compare notes from previous slide
- What do you have in common?
- What is different?
- What is the single most important factor in making a decision on radiation risks

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What is the Most Important Factor ?

Radiation Safety Counseling Institute 7

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?

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Public Decisions for 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 radiation safety ?
- How long would it take to decide ?

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Fears vs Reality

- Origin of radiation 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 ?

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Is it OK to be Afraid ?

- What will you think of doing when the first responders are running ?



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What is Fear ?

- Psychologists define fear as a response to a specific stimulus
 - Such as pain or imminent danger
- Since radiation produces no sensation
 - Not a true fear based on imminent danger
 - Radiation fears are based on imagination
 - Manufactured fears are based on images of consequences
- Many radiation fears are also based on mythology
 - Something believed which is not technically true
 - Based on false premises and misunderstanding



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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

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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



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Fears and Imagination


- All fears are based on imagination
- Fears summon powerful predictive forces, anticipation
- 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



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The Gift of Fear

- Fear is a gift for our protection
 - True fear is part of our defense mechanism
- Worries or anxieties are based on our memories or imagination
 - Worry is not a true fear, but a choice
- Many fears are learned
- Does anyone have a true fear of radiation?




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Results of Worry

I've experienced a great many terrible things in my life, a few of which have actually happened.

Will Rogers



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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 radiation safety, 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%


- **Slow, deliberate, rational, thinks, reasons, and 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**



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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**



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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 ?**

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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 ?**



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Fears of Radiation are Involuntary

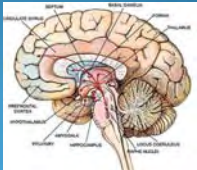
- **Instinctive fears of heights, snakes, spiders, closed spaces, submersion, public speaking,**
- **Repeated message “deadly radiation”**
 - **Transferred to subconscious mind for protection**
 - **Radiation is now an instinctive source of fear**
 - **Fear of radiation – not a conscious choice**
- **Subconscious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



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Fear First – Think Second

- **First - fear reactions are subconscious**
 - **Occur near top of spinal cord – amygdala**
- **Sensory data speeds from five senses**
 - **Through spinal cord to center of brain –thalamus**
 - **Thalamus acts as relay between midbrain and larger cerebral cortex**
- **Amygdala is closer**
 - **Recognizes danger first**
 - **Mobilizes body for Fight, Flight, or Freeze**
 - **Before thinking occurs**



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Amygdala on Guard

- Sensory system and amygdala constantly scanning for signs of danger
- Quickly leaps to action at first hint
- Amygdala takes control immediately
 - Fear response, overrides conscious thinking processes - OK for a striking snake
- Not a good way to decide on radiation safety
- Amygdala not programmed for radiation
 - Our subconscious has learned other shortcuts to process information quickly
 - Remembered impressions

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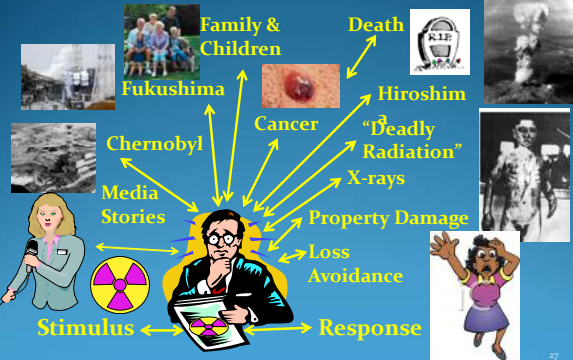
How We Make Quick Decisions

- 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
 - May not be best in the long term
 - Is running away the best answer?



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Subconscious Processing



27

Sources of Radiation Fears


- Perceptions of radiation risks
 - Related to images of unacceptable consequences
- Lack of information
 - Forces people to rely on what they already know or believe about radiation
 - Use of imagination, Anticipation of losses,
 - Worst case images of disaster



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Common Views Behind Radiation Fears

- Fearful images of consequences, such as cancer and death
- Dread and expectations of catastrophic consequences
- No way to know if you have been exposed
- If you know, it may be too late
- You do not know what will happen, but you know it will be bad
- Possible effects on children and future generations
- Possible long-term harm to property and property values
- You have no control and there is no escape - destiny



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Fear of Radiation

- Psychological effects may be equally, if not more, damaging than physical health effects
- Fear is created by the unconscious mind as a protective mechanism
- Result of linking radiation with emotional trauma
 - Real life injuries - not likely
 - Dramatized by the media - "Deadly Radiation"
- Powerful negative association, unconscious mind says this is very dangerous and to avoid radiation, I will attach terrible feelings to radiation, to assure that I will be safe

A radiophobia is born

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Radiation Phobia

Fears arise from the question, **"What if..?"**

- What if I am exposed to radiation?
- What if I get contaminated?
- What if my children are exposed?
- What if my property gets contaminated?

Basis of phobias (fears / images) ?

Beliefs of the subconscious mind



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Basis of Radiation Fears


- **When did radiation become fearsome?**
 - 1945 - Hiroshima / Nagasaki
 - 1979 - Three Mile Island
 - 1986 - Chernobyl
 - 2011 - Japan, Fukushima Daiichi Reactors
- **Is there a good basis for radiation fears?**
- **Is radiation deadly? What is the evidence?**
- **How many people in the US have died from radiation exposures? Where? When?**
- **How much radiation does it take to cause effects? Death?**



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Fears of Radiation


- **Perceptions of radiation risks**
 - Related to images of unacceptable consequences
- **Lack of information**
 - Forces people to rely on
 - What they already know or believe about radiation
 - Worst case images of disaster
 - Use of imagination
 - **Radiation Mythology**




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What is a Myth?

- **A collective opinion, belief, or perception that is based on false premises or the product of false reasoning**
- **A traditional story used to explain some natural phenomenon**
- **Unfortunately, what we consider myths, others may consider reality**



Jamie Hyneman
Adam Savage



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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**
- **Simple, direct, makes sense, credible**

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We are Most Afraid of What we Know the Least About

- **What do you know about radiation ?**
- **What have you heard ?**
- **Do you remember ever hearing anything good about radiation ?**
- **What does the news media tell you about radiation ?**

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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



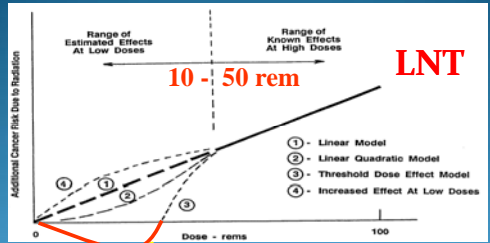
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"No Safe Level of Radiation" - Myth

- 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

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Myth of Models for Estimating Risk




Are small doses of radiation beneficial?

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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 harm someone with radiation!"



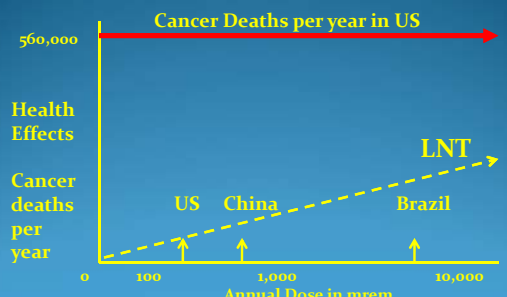
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What Does Zero Mean ?

- 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 - 8,000 mrem / yr in Guarapari, Brazil
 - 10,000 - 26,000 mrem / yr in Ramsar, Iran

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True Model for Estimating Cancer Risk



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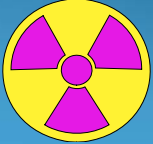
“Is it Safe?”

- Primary question for workers
 - When beginning to use radiation
- This question is what staff want answered
 - Basis for radiation safety awareness class
- Response to concerns hampered by LNT – risks down to zero dose
 - Difficult to conclude any level is inherently safe, without risk

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Acceptable Risk

- Typical levels of occupational exposures
 - Well within tolerable levels of risk
 - Especially compared to other everyday risks
- So, why can't we simply tell people – “It is safe!”
- Question “Is it safe?”
 - Either has no answer
 - Or, multiple answers



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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

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How can we Help a Frightened Person ?

- Rather than saying, “It is Safe”
- Let them know, “Its 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

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Steps from Cause to Effect

1. What are properties of RAM (α , β , γ , x-ray)?
 - form and quantity ?
2. Where is it located ?
3. How is it contained ?
4. How will it move in the environment ?
5. What are the exposure conditions ?
6. How much energy is deposited in body ?
7. What is the health risk ?

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Review

- How do we make decisions for radiation 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 (conscious mind)



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Review

- Its OK to be afraid
- Fears are natural for our protection
- How “afraid” - appropriate for the situation ?
 - Imminent harm is unlikely
 - We are very resistant to harm by radiation
- Fears (worry) can also be harmful
- How to answer question, “Is it safe?”
- Best answer determined by each person
- We can be a resource to demonstrate radiation and explain steps from cause to effect

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Misunderstandings About

- Common views on radiation based on mythology
- Myth - “Deadly Radiation” “Deadly Aspirin”
- Myth - “No safe level of radiation”
- Myth of LNT
 - Linear Non-Threshold dose model
- There is no zero radiation
 - 100s to 1,000s of mrem/yr around the world



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Where to Find Answers

- <http://hps.org/publicinformation/asktheexperts.cfm>
- <http://www.radiationanswers.org>
- <http://radiationcounseling.org/>

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Questions ?



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- MS, Sanitary Engineering (1963) Massachusetts Institute of Technology (MIT)
- SE, Professional Sanitary Engineer Degree (1963) MIT and Harvard University
- PhD Studies, Radio and Nuclear Chemistry (1966–1972), Rensselaer Polytechnic Institute
- Greater Washington Institute for Transactional Analysis - Counseling (1977–1979)
- American Board of Health Physics Certification (CHP) (1983–present)
- Licensed Professional Engineer (PE, Sanitary) in Vermont since 1965
- Johns Hopkins Fellow, Organizational Systems and Communications (1984–1985)
- Past President and Fellow of the Health Physics Society (FHPS) (2000)
- President-elect, American Academy of Health Physics (2012)
- Commissioned Stephen Minister – Counselor, United Methodist Church (2003–pres)

Experience

- 2010 – pres. Director, Radiation Safety Counseling Institute. Workshops, training, and counseling for individuals, companies, universities, or government agencies with concerns or questions about radiation safety. Specialist in helping people understand radiation, risk communication, worker counseling, psychology of radiation safety, and dealing with fears of radiation and nuclear terrorism for homeland security.
- 2007 – 2012 VP, Training Programs, Moeller Radiation Safety Academy, training and consulting in radiation safety.
- 1984 - 2007 Director, Radiation Safety Academy. Providing x-ray and radiation safety training, audits, and consulting to industry (nuclear gauges and x-ray), universities, research facilities, and professional organizations.
- 1988 - 2006 Manager and Contractor to National Institutes of Health (NIH) for radiation safety audits of 3,500 research laboratories and 2,500 instrument calibrations a year, along with environmental monitoring, hot lab and analytic lab operations, and three accelerators and over 100 x-ray machine inspections.
- 1990 - 2005 President of Key Technology, Inc. a manufacturer and primary laboratory for radon analysis with over 1,500,000 measurements since 1985. Primary instructor at Rutgers University 1990-1998 for radon, radon measurements, radiation risks, radiation instruments, and radon risk communication courses.
- 1986 - 1988 Laboratory Director, RSO, Inc. Directed analytical programs and Quality Assurance for samples from NIH, Aberdeen Proving Ground, radiopharmaceutical companies, and the nuclear industry.
- 1970 - 1985 Chief, Radiation Surveillance Branch, EPA, Office of Radiation Programs. Directed studies of radiological quality of US, coordinated 7 Federal agencies for nuclear fallout events, QA officer 8 years. Head of US delegations to I.A.E.A and N.E.A. on radioactive waste disposal. ANSI N-13, (1975-1985). Retired PHS Commissioned Officer (0-6) in 1985 with 29 years of service.
- 1963 - 1970 U.S.P.H.S. Directed development of radiation monitoring techniques at DOE National Labs, nuclear plants, and shipyards in the US and Chalk River Nuclear Laboratory in Canada.

Health Physics and Professional Activities

Health Physics Society (HPS) plenary member 1966; President-elect, President, Past President (1998-2001), Fellow (2000), Treasurer (1995-1998); Secretary (1992-1995); Executive Cmte. (1992-2001), Chair, Finance Cmte. (1996-1998); Head of U.S. delegation to IRPA X (2000). RSO Section Founder and Secretary/Treasurer (1997-2000); Co-founder and President, Radon Section (1995-1996). Co-Chair Local Arrangements Cmte. Annual Meeting in DC (1991); Public Info. Cmte. (1985-1988); Summer School Co-Chair (2004); Chair, President's Emeritus, Cmte (2006); Chair, Awards Cmte. (2002); Chair, History Cmte. (2005-Pres.); Continuing Education Cmte. (2005-Pres.). Academic Dean for HPS Professional Development School on Radiation Risk Communication (2010). PEP, CEL and AAHP Instructor; Journal Reviewer; Treasurer, AAHP (2008 – 2011). AAHP President-Elect (2012). Baltimore-Washington Chapter: President (1990-1991) and Honorary Life Member; Newsletter Editor (1983-2005); Public Info. Chair (1983-1991), Science Teacher Workshop Leader (1995 – Pres.). New England Chapter: Newsletter Editor, Board of Directors, Education Chair (1968-1972). Charter Member (1986), President, American Association of Radon Scientists and Technologists (1995-1998) and Honorary Life Member, Board of Directors; Newsletter Editor (1990-1993). Founder and first President, National Radon Safety Board (NRSB) (1997-1999). Member of American Industrial Hygiene Association (1997 – Pres.) (Secretary, Vice Chair, Chair, Ionizing Radiation Committee, 2009-2012), Conference of Radiation Control Program Directors (1997-Pres.), Studied H.P. communication styles and presented Myers-Briggs seminars to over 3500 H.P.s since 1984. Over 30 professional society awards. Registered Professional Engineer since 1965. Certified Health Physicist since 1983.

Publications

Authored over 500 book chapters, articles, professional papers, training manuals, technical reports, and presentations on radiation safety. Author of monthly column, "Insights in Communication" HPS Newsletter 1984 - 1989 and 1994 -2001.

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