SPECIAL ARTICLE

JKMS

http://dx.doi.org/10.3346/jkms.2016.31.S1.S88 • J Korean Med Sci 2016; 31: S88-98

The Radiation Problem and Its Solution from a Health Communication Perspective

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Received: 22 June 2015
Accepted: 18 August 2015

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This paper observes both foreign and national discussions on preexisting radiation communication and attempts to find out what it takes to ensure that discussion concerning radiation leads to participation of and trust-building with members of society while considering cultural aspects. When analyzing Korean studies on health risk communication concerning radiation which utilize the frame of foreign literature, Korean studies can be categorized into one of the following themes: different risk perceptions between experts and the general public, discussion on the effects of the framing of radiation messages and media coverage, and research discussing the social implications of the dangers of radiation and the need for effective communication. These study results can be better explained when integrated with Korean social cultural dimensions. The "boiling pot effect" towards risk issues, egalitarian perceptions, escalation of ideological opposition and biased reasoning, and so on are especially major influences. Communication addressing radiological risks must foremost be open and able to mitigate distrust, must give the general public a chance to judge for themselves to prevent stigmatization, and, through the use of media and public education, must make efforts to prevent the proliferation of needless anxiety. Using literature research, this paper discusses possible ways to improve the effect of future health risk communication concerning radiation.

Keywords: Radiation; Health Communication; Risk Perception; Message Frame; Communication Strategy

INTRODUCTION

The fear that radiation affects the human body has much to do with people's perception of radiation. This perception stems from nuclear accidents which have transpired in everyday life. After the Japanese Fukushima nuclear reactor explosion in March 2011, the Korean public was shocked due to the close proximity of the accident and due to the fact that such an accident occurred in Japan, a state recognized for its nuclear advancement (1,2). Currently in Korea, nuclear and radiological problems are increasingly being stigmatized, and it has come to the point in which these problems require a massive amount of social effort and cost in order to be dealt with (3).

However, the fact that radiation exposure is dangerous does not mean all kinds of radiation are harmful. Though radiation discussion is focused on nuclear energy development due to people's exaggerated perception of nuclear accidents, radiation is currently being used in many fields, from food processing to health screening and medical treatment (4). These kinds of intentional exposure only exist because society agrees that the gains from radiation use outweigh the possible harm for the consumer and patient (5). Therefore, discussion on radiation should not stop at whether radiation is dangerous or not. It should try to reach a social consensus on the right usage of radiation by forming a public sphere which discusses the proper usage of radiation.

However, even in cases in which the uses of nuclear power and radiation are necessary, not only is fruitful discussion ruined due to stigmatization, this stigmatization also degrades the social willingness to even discuss nuclear power and radiation. For example, radioactively preserved foodstuffs are mistaken as radioactively contaminated foodstuffs due to this stigmatization (6). Anti-nuclear activists have risen up after the Fukushima accident in every part of society, and fear attributed to Japanese seafood (whether baseless or not) has also spread due to the same reason. Furthermore, this fear of radiation has made people anxious towards medical radiation used for diagnoses and therefore has created needless fear towards necessary medical treatments (5).

Media coverage is responsible for at least some of this fear (7,8). People who blame the media for nuclear fear-mongering generally say the public's fear towards nuclear energy increases due to media coverage, and this leads to the government wasting its budget to assuage the public's anxiety. However, since the harm radiation can cause the human body is a proven phenomenon, the media does not deserve all the blame for the public's fear. Before discussing the problems of media coverage, it

pISSN 1011-8934
eISSN 1598-6357

must be established that health communication of the government and other organizations which deal with scientific risk problems is at a pitiful level and is incapable of forming a consensus amongst the public or building trust with the public.

Health communication related to scientific risk problems has evolved from its basic function of solving the problem of knowledge deficiency towards formulating the public's understanding and attitude change. Nowadays, health communication is trying to encourage the participation of and build trust with the public (9-12). To eliminate misunderstanding such as the confusion between radioactively preserved foodstuffs and radioactively contaminated foodstuffs and the phenomenon of people not accepting x-ray chest examinations due to the anxiety of the amount of radiation involved during the examination, health communication must surpass the level of merely delivering knowledge about radiation. It must be able to change the general attitude towards radiation by trying to understand why the public misunderstands the difference between radioactively treated foodstuffs and radioactively contaminated foodstuffs and why the public thinks radiation is "risky." After that, health communication must evolve even further so that all of the public actively participates in the discussion of radiation problems and a social consensus is formed.

However, Korean scientific risk communication concerning radiation is only at the level of solving a lack of knowledge with simple persuasions or assertions. It is hard to say that Korean scientific risk communication is advancing towards the level of building trust by encouraging understanding among social members (13). Risk is a social concept, and, since risk perception is also a subjectively formed concept, trust and understanding among social members is crucial when deciding what is a risk or not (9). Therefore, this paper looks at existing foreign and domestic discussions on radiation communication in a comprehensive way and, while also considering cultural aspects, looks at what to consider for advancing discussions on radiological risk problems to a level that encourages the participation of and builds trust with social members.

EXISTING LITERATURE AND DISCUSSION ON HEALTH COMMUNICATION CONCERNING RADIATION

Foreign discussions on radiological risks can be divided into two categories: research on risk perception and communication, and research on media. Research on risk perception and communication can be further divided into the following categories: research on the characteristics of risk perception towards radiological risks and the influences of risk perception (14), research on the discrepancies between laymen's and experts' perceptions toward radiation risk (15-17), research on the effects of the message framing of radiation communication (18), research on the effects of reciprocal risk communication about radiological risks (19), research on the importance of trust when dealing with radiological risks (20), problems concerning social ethics relevant to radiological risks (21), and so on. The most noteworthy and well-studied categories are research on risk perception towards radiation and research on the effects of the message framing of radiation communication. The other categories are either directly or indirectly connected to risk perception research and message framing research.

The most important point in research on radiological risk perception and communication is that there is a noticeable difference between the perception of the public and the perception of experts. This difference affects perceptions about the causes of problems and the solutions to those problems. This difference has also been seen consistently. According to previous research, experts' level of radiation risk perception is lower compared to that of non-experts and experts are more accepting of technologies utilizing radiation (17,22). In a broad sense, it can be said that radiological risk perception is influenced by perception of the benefits of radiation, the amount of trust, and the amount of education received (17).

The problems coming from this difference of risk perceptions can be somewhat alleviated by closing this difference through communication and gathering clues needed to form a solution (15,19). However, the need for communication between experts and the general public should not be the only thing considered. Another problem is that risk perception towards radiation has already been stigmatized due to the social amplification of radiological risks (23). Social amplification of radiological risks and stigmatization is clearly seen, and the scope of stigmatization is spreading to organizations and areas related (24). Therefore, not only must the perceptional differences between experts and non-experts be closed, there is also a need to change the image people have of radiation. During these efforts, a form of communication which takes into account the fact that the level of stigmatization for each person is different depending on his or her perceptions, cultural disposition, and political ideology is needed (25).

The effects of the framing of radiation messages are often jointly discussed with the "Prospect Theory (26)." Most people, when dealing with health risks, are willing to accept risks involved in diagnoses such as physical examinations and treatments directly linked to survival. In these cases, message frames expressing negativity or losses are effective (27). However, when dealing with ways to prevent disease such as the use of sunscreen or when dealing with risks that have little to do with survival, people tried to avoid risk, and message frames expressing positivity and gains proved effective (28). Research on frames of messages addressing radiological risks yielded similar results. For radioactively treated foodstuffs, positive messages worked well (29), but for cancer treatment directly affecting survival

such as radiation treatment during lung cancer surgery, messages describing health risks in a negative light and messages conveying loss were more effective (30).

These results are consistent with the effects of the Prospect Theory. When facing a situation concerning gain, people tend to avoid risk. When facing a situation concerning loss, they tend to accept risk. Therefore, when promoting radioactively treated foodstuffs and food irradiation, it is effective to avoid the possible risks by emphasizing the benefits of such foodstuffs, and when promoting radiation treatment, emphasizing the dangers when such a treatment is not used makes people more accepting of the risks coming with the treatment (Table 1). The effects of message frames are affected not only by the type of risk but also by the expertise of the message receiver, the amount of education the public has received, the need for cognition, the level of involvement, the amount of information processing, and so on (15-17). To maximize the effect of frames of radiation messages, the most optimized message should be found using prior testing, which itself utilizes variables and the primary assumptions of the Prospect Theory.

Media research on radiation or nuclear power is similar to research on the role of media shown by general risks in technical environments. Media research on radiation is related to the manners of media coverage on radiation, the selective usage of information on radiological risks, the citation of information sources, media effect studies and so on (31). People's perception of radiation is closely linked to the manners of media coverage. The use of sensational vocabulary such as "deadly radiation," sensationalism, inaccurate citations, far-fetched deductions, and false reporting have especially played a huge role in forming a negative perspective towards nuclear energy and radiation (8,23,32). This trend has continued and has been reinforced ever since the Three Mile Island accident and the Chernobyl disaster. However, the media should not burden all the blame for its inaccurate coverage. Perceptions of inaccurate media coverage may result from biased interpretations based on scientists' self-protecting ideologies. Scientists are especially known to be very critical of their areas of expertise and to have high standards (33). Therefore, assessments of media coverage of radiation made by scientists can be biased. Media coverages about radiation generally have problems, but the media has yet to violate the boundaries society has set. There is a high possibility that the problem lies not solely in the manners of media coverage but also in scientists' ritualized bias towards the media and their lack of communication with others.

Table 1. The type of radiological risks and framing effects

Positive/gain framing	Negative/loss framing
Decisions on the use of radioactively preserved foodstuffs	Decisions on lung cancer surgery and radiation treatment
Decisions on the use of radiation that has nothing to do with the survival of a person	Decisions on the use of radiation that affects the survival of a person
Risk-avoiding situations	Risk-accepting situations

When using information on radiological risks, it is problematic to set people's perception by oversimplifying issues while ignoring various possibilities and by using frames readers can pay attention to and can easily understand (31,32). Furthermore, while the selection of an information source is important when dealing with radiological risks, it is hard to say that media select information sources fairly. Most experts are more optimistic of the risks of nuclear power than laymen and believe that safety is achievable. However, the media is more favorable of negative criticism towards nuclear power, and therefore, the media does not accurately portray the opinions of experts (34). There are two types of media effects nuclear energy coverage tends to have: agenda setting, in which the agenda of the media is reflected in the public's agenda, and the impersonalized effect of media coverage (35). Just because people get to understand nuclear energy issues from a social perspective via the media does not mean that they will take these issues personally. Therefore, research on media effects concerning radiation is increasingly trying to integrate effects of both personal and social variables.

DISCUSSION ON KOREAN PERCEPTIONS OF RADIATION AND RISK COMMUNICATION

Since Korean research on risk communication and health communication has only recently started being considered an area of expertise, it is hard to say that there are sufficient research results on radiation communication. However, research on health risk communication tends to develop from research on risk perception to research on risk communication. Therefore, it is safe to assume that research on radiation communication will also follow the same trend. According to this assumption, discussion on Korean radiation communication can be explained by and categorized into these three categories: 1) research on risk perception and the difference in risk perceptions between experts and laymen, 2) effects of the message frames of radiation communication and discussions on media coverages, and 3) social implications of radiological risks and research discussing the need for communication.

Research on radiological risk perception

The majority of research on Korean radiological risk perception has to do with research on radiological risk perception and variables affecting risk perception, and research on the relationships among risk perception, risk acceptance, and behavioral intention. According to previous research, Koreans on average have negative attitudes toward nuclear power (36). The attitude of the younger generations has especially changed negatively towards radiation and medical use of radiation after the 2011 Japanese Fukushima nuclear accident (37). The media has a lot to

http://dx.doi.org/10.3346/jkms.2016.31.S1.S88

do with this change in attitude. The way the media handles nuclear energy, such as coverage over the Japanese nuclear accident, affects radiological risk perception, and these influences are reinforced and enlarged when they interact with readers' comments on news articles (38). In a collectivistic society such as Korea, agreeing comments, a socially conformative phenomenon, can rapidly exacerbate the risks catalyzed by the media. This amplified risk perception can result in social stigmatization of nuclear risk.

The stigmatization of nuclear risks affects the overall perception of radiation. According to research on the stigmatization of scientific technology involving risk (39), stigmatization of nuclear energy has a negative influence on risk perception of both radiation technology and products of radiation technology. Unless the stigmatization on radiation itself is alleviated, the effects of radiation communication can only be limited.

With the general negativity of risk perception on radiation and nuclear power, another important result from research on risk perception is the discrepancy in perceptions between laymen and experts. According to research using the co-orientation model that tries to estimate both 1) the agreement of the two sides' opinions and 2) the accuracy between one side's estimation of the other's opinions and the other's real opinions, there is a stark difference between experts' radiological risk perception and that of laymen (36) (Table 2). Laymen tend to think more negatively of nuclear energy than nuclear energy experts, and the two do not share most risk perception categories. There was a definite perception discrepancy between laymen and experts in the categories of safety of nuclear energy, possibility of control, and amount of fear. Another result from the research on co-orientation is that people's estimate of the other side's perception (A's actual perception and B's estimate of A's perception) is statistically inaccurate. This low accuracy is worrisome since this implies that experts and laymen cannot anticipate each other's thoughts.

Laymen and experts also view the nuclear energy communication situation differently. Laymen are less confident in the effect of nuclear energy communication than experts are. However, when it comes to perceptions of nuclear energy communication, both laymen and experts are acutely aware of each other's perception of nuclear energy communication. This shows that improvement is possible since laymen and experts understand each other's perspective by applying similar risk communication standards. In another study, experts' perceptions toward radioactively preserved foodstuffs and cancer treatment using radiation were more positive and risk-accepting than laymen's (40).

Furthermore, perceptions of nuclear energy affect acceptance of nuclear and radiological risks. Koreans' acceptance of nuclear and radiological risks is affected by the level of trust in nuclear power plants, amount of risk perceived from nuclear energy, and the amount of benefits felt coming from nuclear energy (41). There are many variables affecting risk perception and risk acceptance, but the variable deserving the most attention recently is emotion. For residents in areas near nuclear power plants, their experiences living near the realities of nuclear risks and the emotions these experiences produce affect residents' perspectives towards potential benefits and risks and residents' acceptance towards risk (42). This shows that the perception towards nuclear and radiological risks is determined by how the public's emotions are handled.

Research on radiation message and media coverage frames

According to research on the frames of radiation messages, message frames had no effect on messages about cancer treatment using radiation but were effective with messages about radioactively preserved foodstuffs to some extent. In general, laymen perceived risks more than experts, but when discussing the benefits of radioactively preserved foodstuffs (Fig. 1), laymen exposed to a benefit/positive frame appreciated the foodstuffs more than those exposed to a loss/negative frame. On the other hand, experts exposed to a loss/negative frame appreciated the foodstuffs more than their counterparts who were exposed to a benefit/positive frame (40). These results are different from that of foreign research (which say that for promoting radioactively preserved foodstuffs positive messages are effective and for cancer treatment using radiation, negative messages), but these Korean results not only consider the effects of message frames but also take into calculation the expertise of the audience and

Table 2. Difference between laymen and experts on the perception of nuclear risks

Nuclear risk perception items	Average of laymen (n = 100)	Average of experts (n = 110)	Laymen's estimate of experts' perceptions	Experts' estimate of laymen's perceptions
Nuclear technologies are safe.	2.35	3.81	3.24	1.78
Individual will has nothing to do with the emergence of nuclear disasters.	4.28	3.55	4.02	4.28
The dangers of nuclear technologies can be controlled.	2.78	4.13	3.69	2.83
Nuclear technology disasters can kill many people in an instant.	4.45	3.74	4.27	4.29
I am afraid of the dangers of nuclear technologies.	4.09	2.85	3.50	4.04
It is hard to undo the damages caused by nuclear disasters.	4.54	3.94	4.05	4.25
The damages caused by nuclear disasters affect future generations.	4.62	4.09	4.26	4.25

A 5-point Likert scale, 1-not at all likely to 5-very likely.

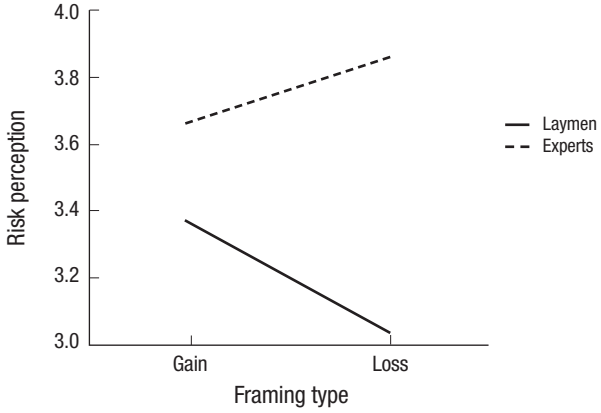

Fig. 1. The interaction effect of framing and expertise on the benefits of radiation sterilization.

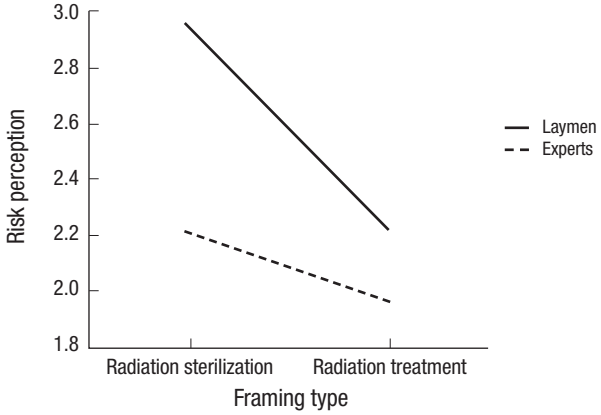

Fig. 2. The interaction effect of risk type and expertise on risk avoidance.

suggest that certain message frames can be more effective when paired with audiences of certain expertise.

Koreans feel more comfortable toward cancer treatment using radiation than radioactively preserved foodstuffs and feel that the former is more necessary than the latter (40). This trend was more pronounced in laymen than in experts (Fig. 2). Laymen were more avoidant of both radioactively preserved foodstuffs and cancer treatment using radiation than experts, but the difference in perception became much smaller in the case of cancer treatment using radiation. This phenomenon also appeared when measuring acceptance of risk. Laymen are thought to be more familiar with and more acceptive of cancer treatment using radiation than radioactively preserved foodstuffs since cancer treatment is directly connected to survival and therefore, the radiological risk coming from such treatment is acceptable. However, radioactively preserved foodstuffs are avoided if possible and thought not worth the risk. These results show that subjective judgments of risk affect subsequent perceptions and action variables.

Interaction between media forms and message frames affects risk perception and purchase intention for radioactively preserved foodstuffs (43). When delivering information using text and video, using positive message frames reduced risk perception and using negative frames increased risk perception. However, when using sound to deliver information, the results using positive frames did not differ from results using negative frames. This shows that the type of message frame used is not the sole variable. Different outcomes can come about by using different types of media. Therefore, not only the composition of the message but also the medium of the message is important when communication campaigns are designed.

Media frames on radiation are generally negative. Analysis on media coverage of the heavy water leakage accident in the Wolsong Nuclear Power Plant Unit 3 in 1999 shows that the media exaggerated the accident and raised baseless anxieties (44). Another problem with Korean media is that most coverage on accidents are sensational and have no interest in analyzing fundamental causes, in controlling processes nor in the execution of safety contingency plans.

The problem with Korean media coverage on radiation is that it is biased, especially after the Japanese Fukushima nuclear accident. The media is merely at the stage of exaggerating risk frames and delivering information on accidents. The media is incapable of producing future-oriented coverages while it focuses on political interpretations (45-47). It also turns out that press ideologies of Korean media companies affect the media frames concerning nuclear energy (48). Furthermore, when covering the construction of nuclear waste disposal facilities in Buan and Gyeongju, the media reproduced and enlarged social conflict and anxiety rather than encourage active risk communication among stakeholders (49). Media coverage on radiation needs to change. Its foundations lie on distrust. It should change and start to restore trust among social participants by allowing public participation. However, contemporary Korean coverage on radiation is incapable of such a productive role.

Research on effective communication strategies

It is important to provide a socially open and rational public sphere in order to facilitate a correct perception of radiological risk. However, with regards to radiological risk, there are many cases in which public opinion makes a judgment even before rational communication is given a chance. The influence media coverage can have on radiation is sizeable. The reason media coverage on radiation is important is that nuclear stigmatization through media affects perceptions on both radiological risk and radiation technology (39). Perceptions of radiation are hard to reset once they turn sour. Therefore, it is important to provide balanced information on radiation before radiation is stigmatized.

However, it is true that people already think negatively of radiation (50). The public's risk perception of nuclear energy is based not on any specific facts but by impressions given by ra-

http://dx.doi.org/10.3346/jkms.2016.31.S1.S88

diation (3). The public, which has witnessed the Fukushima nuclear accident nearby via the media, perceives the dangers of radiation greatly (51). Because negative impressions of radiation are subjectively formed, a couple of arguments against such an attitude will not change anything.

Then what communication strategy would ensure that the public has a balanced view of radiation? When scientific technology is presented as part of the solution to the public's problem, communication about scientific technology becomes more effective (3). If the public feels as though it is deeply connected to radiation issues, for example, if the public feels as though technologies using radiation are closely connected to everyday life, the public, which only thought negatively of radiation, will start to look at it in a comprehensive light. Therefore, in order for the public to consider both the positive and negative sides of radiation, it must be shown that radiation has a place in everyday life. This means going beyond both the society-oriented discussions and abstractness the media has provided and pursuing a more personal and specific approach to solve radiation problems.

If one observes reactions to communication covering radioactively contaminated foodstuffs, negative messages gathered a large amount of public confidence when targeted at people distrustful of the government (52). Furthermore, the more people debated about public issues, processed information about radioactively contaminated foodstuffs or felt ignorant about radioactively contaminated foodstuffs, the more their distrust of the government increased. These results show that social distrust is one of the biggest obstacles in solving the radiation problem.

This general distrust towards the government's risk communication also directly affects nuclear and radiological risk perceptions. When looking at previous research comparing Korean responses to the Chernobyl nuclear accident and the Fukushima nuclear accident, the Chernobyl accident did not lead to people pointing out nuclear risks within Korea while Fukushima did (1). Not only was the public worried by the close vicinity of a Japanese nuclear crisis, but they were also aware of its government's apparent lack of ability to manage crises, having experienced the government's ineptitudes several times beforehand. In other words, realizations that nuclear disasters might happen during their daily lives and doubt of the government's ability has incited people's anxiety of nuclear power and radiation. Therefore, communication that can reduce the public's distrust of the government and other related public agencies is required to curtail the public's anxiety of nuclear and radiological risks.

CONSIDERING RADIOLOGICAL RISKS FROM A KOREAN SOCIAL CULTURAL CONTEXT

According to research, 10th grade Korean students had a more positive perception of nuclear energy than their Japanese, Taiwanese, and Singaporean counterparts (53). This might be because Koreans have not had their own Fukushima and because Korean media is comparatively friendly towards nuclear energy. However, the general public opinion and reality are different. When the public encounters a radiological risk problem, perceptions and actions can be completely different than those anticipated (52). Therefore, to understand probable perceptions and actions that arise in actual situations, it is essential to observe Korean cultural aspects.

Radiation risk perception within Korea has rapidly proliferated after the Japanese Fukushima nuclear reactor explosion (38). This can be linked to the rapid social amplification of risk and stigmatization. However, this explosive propagation of anxiety might be more pronounced in a collectivistic culture such as Korea. Rapid social conformity, a well-known aspect of Korean culture, causes risk amplification (54). Unfortunately, this ripple effect of social conformity cannot be linked to a systematic solution since it cannot grab people's sustainable attention. This combination of extreme attention to an issue and a lack of attention permanence can be defined as the Korean "Boiling Pot Syndrome" (9). The Boiling Pot Syndrome is characterized by the incongruence between extreme social conformity and thereafter a lack of attention durability towards the situation. This syndrome disregards fundamental problem solving, ensuring that the problem can resurface in the future. Therefore it is necessary to establish a social dialogue system capable of eliciting sustainable solutions to risk problems.

According to the culture theory of risk (55,56), Korea is a hierarchical society with equalitarian concepts overflowing underneath (22). Hierarchical individuals see nature as something to be controlled and risk as something capable of being managed. Equalitarian individuals, on the other hand, see nature as a fragile thing. Once it has been destroyed, it can never be brought back. Therefore, equalitarian individuals say that nature must be protected from risks. Koreans once saw nuclear energy as something controllable, a tool which enabled economic growth. Nowadays, many Koreans view nuclear risks as uncontrollable nuisances. Furthermore, because there is widespread distrust of both governments and corporations, distrust of agents controlling nuclear energy is closely connected to negative perceptions of nuclear and radiological risks. Considering the change in Koreans' cultural tendencies towards risk, unilateral communication led by the government or corporations becomes ineffective.

Other main problems include ideological polarizations to radiation problems and extreme confrontations between ideological blocs. The nuclear energy and radiation issue can combine with the logic of ideological blocs to easily bring about extreme hostilities. The media also almost always encourages schisms between conservatives and liberals (9). This phenomenon

can be explained by the Terror Management Theory (57). According to the Terror Management Theory, when people feel terror or fear about mortality, they tend to establish a bond with people of similar beliefs and aggressively confront people with differing thoughts. People behave this way to nurture their cultural beliefs and to forget their fears. In view of this theory, extreme Korean ideological bloc logic might be a terror-managing attempt to solve the nuclear problem since nuclear and radiological risks, which are directly linked to death and survival, generate a massive amount of fear.

To lower fear and make reasonable judgments on nuclear energy and radiation, people need to have more self-esteem (57). People need to believe that they have the information necessary to make good judgments regarding nuclear energy and radiation issues and that they have the power to take measures. However, contemporary Korean attitudes towards nuclear energy and radiation issues are not based on self-esteem but on fatalism, which itself is based on distrust. Therefore, efforts to equip people with the will to solve nuclear energy and radiation problems with their own decisions are essential.

However, self-esteem does not solve all problems caused by extreme confrontations using fear. Currently there is a high probability that opposing stakeholders will fight over nuclear energy and radiation issues. The construction of a radioactive waste disposal facility is a typical example. It is essential to have a social system that can solve social conflicts and formulate a consensus for risk problems (22). To build a social consensus, advanced consensus building processes should be aggressively adopted. To solve social conflicts and form public spheres, alternative dispute resolutions techniques should also be utilized. The introduction of new ways to solve conflicts and encourage consensus building will catalyze dialogue and cooperation among interested parties, thereby enabling rational solutions to nuclear energy and radiation issues. However, when adopting these new risk communication processes based on consensus building, it is important to consider unique Korean cultural concepts such as *Chemyon*, *Jeong*, and collectivism since current alternative dispute resolution systems are customized mostly to solve risk problems in a Western hemisphere (9).

CONCLUSION AND RECOMMENDATIONS FOR HEALTH RISK COMMUNICATION ADDRESSING RADIATION

Korean society is a distrustful society, and the sooner it acknowledges its distrust and proceeds with radiation communication, the better. Korean perspectives toward nuclear energy and radiation resemble the Normal Accident Theory (NAT) more than the High Reliability Theory (HRT) (22). HRT states that the technologies and experiences Koreans have accumulated are enough to control nuclear energy. On the other hand, NAT states that the combination of complexity and subsystem coupling will result in inevitable accidents which, when combined with human error, might develop into a catastrophe. Examples include the Three Mile Island accident and the Chernobyl disaster. Until now, Koreans have established a safety reasoning based on HRT, but recent exposures of corruption and incidents involving nuclear power stations clearly show that nuclear risk is not as safely controlled as previously thought (51). This new thought pattern about the uncontrollable natures of nuclear and radiological risk is based on NAT and is strengthening distrust of the government and nuclear energy management organizations.

Dispelling distrust through effective communication

The most important form of radiation-related communication is communication which alleviates distrust. This kind of communication must ensure public participation in decision making processes concerning radiological risks, must be independent of special interest groups, and, above all, encourage the participation of the public. All communication must be open, and must show fast and transparent resolutions of problems. Organizations responsible for radiological risks must especially show that they are making authentic internal efforts when solving problems. A communication system capable of direct and rapid communication with the public is also necessary. Such systems include crisis communication models for handling crises, dispute systems designs for organizational conflicts, and mutual gain approaches for consensus building (22). Other alternative dispute resolution systems also can be utilized to encourage mutual understanding and public participation (9).

Preemptive communication to prevent stigmatization

Radiation communication must be preemptive in order to prevent stigmatization. It is hard to recover from stigmatization in Korea. Vocabulary that can bring about groundless fear and misunderstanding must be replaced, and efforts to enlarge mutual understanding with the public must be made through the open and accurate delivery of information, including negative information. Two-sided information is effective in high risk involvement situations. There is also a need to use some expressions more accurately, such as "radioactively exposed foodstuffs" and "nuclear waste dumping facilities (58)." Furthermore, delivering radiation information in advance, thereby using the so-called inoculation effect, can ensure that risk is not easily stigmatized through words of mouth and rumors. Ample discussion is needed to decide which risk message frame is needed during preemptive communication. The effects of risk message frames will change based on the speaker, the situation, the issue, and the public. The best way to predict the effects of a message frame is to put a frame under a simple test and confirm its effects before it is deployed, thereby reducing mistakes and maximizing effects.

http://dx.doi.org/10.3346/jkms.2016.31.S1.S88

Promoting understanding toward uncertainty and science

Radiation is ultimately linked to the problem of uncertainty and anxiety. To experts and scientists uncertainty is just something to be accepted, but to laymen uncertainty means anxiety. Experts try to control scientific matters, which are all based on some level of uncertainty, but laymen strive for zero uncertainty and want to avoid any amount of uncertainty. Therefore, health risk communication must enable laymen to make reasonable and independent judgments on scientific uncertainty (59).

For example, if the construction of the Gyeongju nuclear waste disposal facility fans anxiety toward earthquake dangers, it is important that laymen participate in decision making processes concerning uncertainty so that they themselves decide the amount of uncertainty they are willing to accept. During these processes, experts must acknowledge the public as a risk interpreting agent and not just an audience. The problem of accepting uncertainty is linked to the scientific belief of acknowledging uncertainty. Therefore, rather than eliminating uncertainty, changing people's assumptions of science is recommended. According to some research, people who view science as a subject of disputation and feel that some uncertainty is unavoidable turned out to understand and even accept a certain amount of risk (60). Therefore, a radiation communication campaign should be implemented to raise the public's understanding of science in order to solve the sensitivity problem of uncertainty.

Reinforcing communication between laymen and experts

There is a huge divide in perceptions towards radiation between experts and laymen. Experts include medical professionals, researchers, and policy decision makers who specialize in the field of nuclear energy and radiation. To close this divide, experts need to work more on their communication. Experts must have more active dialogue and reciprocal meaning-sharing efforts with laymen in order to change the public's attitudes on nuclear energy and radiation and to recover trust. Democratized science is needed to deal with radiological risk, and experts must go beyond laboratory knowledge and try to integrate existing knowledge with laymen's experiential knowledge (59). Another way to close the gap in perceptions between experts and laymen is to use the Mental Models Approach (61). The Mental Models Approach is comprised of four stages: 1) figure out the expert's normative model, 2) figure out the layman's descriptive model, 3) diagnose the difference in perceptions using communication models and find the most effective form of communication, and 4) gauge the effect of communication and reinforce it. Closing the difference in perceptions between experts and laymen makes it easier to form public spheres for radiation problems. Public spheres provide people a place or area to freely discuss social problems and to form public opinions through participatory democracy (22).

Improving the role of the media and forming public spheres

Laymen's perception of radiation is normally encountered via the media. Therefore, it is important for the media not to arbitrarily interpret uncertainty when covering radiation and not to focus on sensational aspects of radiological risks. When the media does interpret uncertainty arbitrarily, it focuses on disproportionate exemplification or anxiety. This attention-grabbing form of coverage manipulates people's risk perceptions (62). Furthermore, people's perceptions of risk and attitudes on science change depending on what media frame and what sources the media is using (63). If the media does not change its reporting orientation, establishing an effective public sphere for radiological risks will be difficult, and it will be very challenging to have sound debates. The media must publish fair coverage that relies on facts and not on sensationalism (44). Reporting guidelines for nuclear energy and radiation should be established and complied by reporters. Furthermore, regular opportunities for educating science reporters should be prepared by nuclear-related institutions to enhance reporters' general knowledge of nuclear energy and radiation. Another necessity for bringing about change in media coverage is related to a complete revelation of information by nuclear energy management agencies. Media coverage will be based on assumptions or biases if complete information is not disclosed. Furthermore, there is a need for enacting a universal self-regulating media coverage ethics to ensure that media coverage be made in an increasingly ethical manner. It is important to form a reasonable public sphere for nuclear energy and radiation by integrating complete revelation of information and conformity to the ethical norms of media coverage.

Radiation education for the public and science education through media

However, in order to create a rational public sphere, not only changes to nuclear energy management agencies' communication paradigms and active effort are required, but educating the public about the basic principles of nuclear energy and radiation is also necessary (37). Various means of communication must be mobilized. Examples are online and offline science cafés where experts and laymen would be able to discuss, and even solve, problems together, and utilize media, events, seminars, online classes, SNSs, and anything else capable of educating people on the elementary principles of nuclear energy and radiation. Without knowing the fundamentals of radiation such as half-life, amounts of exposure, and measurement units of nuclear energy, people will feel vaguely anxious, their self-esteem will fall, and they will very likely adopt a fatalistic view. Scientific education that media and public campaigns can provide is vital in stopping this from happening. The forms of media campaigns include all kinds of strategic communication

campaigns such as social marketing, advertising, and public relations campaigns.

Collaboration between medical professionals and communication experts

The recent MERS incident showed that during a crisis, medical knowledge alone is insufficient to calm the anxieties of the public. This lesson can be brought to nuclear crises. In order to assuage the fears of the public, expert medical knowledge must be explained in a way easily understood by the public. Efforts must also be made to gain the public's understanding. Since crisis communication assumes that uncertainty exists, forming consensuses through communication and gaining understanding are essential (9). On both accounts, cooperation between medical professionals and communication experts must be considered due to the need to deliver expert medical knowledge in a format comfortably approached by the public and the need to establish a cooperation system by gaining the understanding of the public. In order to format medical knowledge, preparatory efforts must be made to make messages in advance. These messages should consider appropriate risk comparisons, effective message framing, and efficient message deliverance methods by diverse media types. If a message has to be constructed once a crisis has already initiated, chances are that the efforts to construct such a message will worsen the situation (23). Such message mappings must be conducted before crises arise and through an intimate and regular cooperation system between medical professionals and communication experts. The second most important agenda is to estalblish a system that ensures the public's cooperation. Modern risk problems cannot be solved solely by medical professionals. A social system able to ensure the public's cooperation through information disclosure is needed. When a crisis occurs, medical professionals and communication experts must cooperate to form a public sphere in which the public can also participate. It is also imperative to establish a cooperation system in which all aspects of society can contribute to rationally overcome the current crisis. Furthermore, this problem is naturally linked to the issue of establishing social crisis management systems.

Timely and accurate crisis communication and crisis management

Nuclear energy and radiation issues inevitably cause crises. How an entity responsible for managing risk will communicate with the public during a crisis is an important communication issue. A key principle during a crisis is to deliver accurate information to the public as promptly as possible (22). Nuclear energy management agencies and governments have a duty to provide consistency in presented content by providing authentic information during a crisis. Superficial communication on symptoms and consequences during a radiological accident will only intensify public distrust. When an accident occurs, it is important to provide profound analyses and diagnoses following the Onion Model widely used in the field of crisis management. The Onion Model explains that technical accidents are associated with problems coming from the structure, personnel, and culture of an organization, not from seemingly technical malfunctions. The crisis should be analyzed in a multifacet and in-depth way to find out the authentic reason.

Furthermore, when looked at in detail, these problems are also linked to the organization's management philosophy and the ideology of the organization's leadership. Therefore, crisis communication which focuses only on technical problems will not gain the public's trust. It is important to assure the public that a similar accident will never happen again through profound investigations into the causes of the crisis. Relying on presentations of temporary solutions without providing trustworthy explanations about corrective actions will only increase distrust towards nuclear energy and radiation. Health risk communication concerning radiation can restore the public's trust gradually when open and preemptive communication aimed at prevention is combined with proper responses and effective crisis communication during crises.

DISCLOSURE

The author has no potential conflicts of interest to disclose.

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