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Risk Communication and Information Dissemination

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In occupational and environmental health and safety, risk is the product of a hazard and exposure to the hazard. Risk communication is a form of preventive action intended to reduce morbidity and mortality. Risk communication in occupational and environmental health and safety includes dissemination of risk information among workers, employers, labor and environmental specialists, legislators and regulators, members of the general public, researchers, and other decision makers.[1-3] However, the *communication* part of risk communication implies a process broader than dissemination. It signifies an *exchange* of perceptions among stakeholders about workplace risks to worker health and safety. Or it signifies an *exchange* of perceptions among stakeholders about environmental risks to community health (Box 29-1).

There are three objectives for risk communication: autonomy, equity, and efficiency.[4] Under the Occupational Safety and Health Act, workers are guaranteed a safe workplace. However, without effective risk communication, workplace safety is not likely to be achieved. Before workers begin their jobs, they should have more information about the jobs than hours, wages, and benefits. They should also know the job-related risks to their health and safety and the necessary measures to control these risks. This type of information sharing is the only way to ensure that workers have complete information about the risks to which they are exposed. Unfortunately, economic pressures impinge on workers' autonomy to decide on what work they will do.

Concerning the objective of equity, labor-contract law presumes that parties to a contract (employer and employee) have equal information before they agree to the contract. Employer and employee agree on remuneration in return for labor under specific conditions. However, the employer often has more information about the risks associated with job-related materials and processes. The employer may also know more about the resources available to control or abate hazards. Therefore, there is a need for risk communication to balance the contract agreement as much as possible. Workers should understand what they face in their jobs.

Concerning the objective of efficacy, risk communication is necessary for having efficient social systems and economic markets. There are risks in every human endeavor. Deciding which risks are acceptable and which ones are not will be done most efficiently by a society when all stakeholders are engaged in communications about those risks. Risk communication helps to ensure that all expertise is considered and that agreed-upon practices will be widely accepted.

Box 29-1. Environmental Risk Communication

Craig W. Trumbo

Environmental risk communication can be broadly defined as all communicative activities within the information sphere relative to a given hazard that has diffuse boundaries in terms of its demographic, geographic, temporal, and outcome characteristics. Communications range from those that are from one person to another, to those that are generated by the mass media to the general public, and they range from casual communications to those that have a specific purpose. The information sphere encompasses domains of activity, such as news, advertising, policy, regulation, and entertainment.

Environmental risk communication often involves diffuse boundary characteristics that provide the contextualizing attributes of who (demographic), where (geographic), when (temporal), what (outcome), and why (cause and effect). The diffuse nature of these boundary characteristics separates environmental risk communication from occupational health and safety communication, which is typically associated with a narrowly defined population (workers), at a specific place (or specific class of places), within an identified time of exposure (while at work), and with a shared set of outcomes often derived from a single well-identified and casually linked hazard, such as asbestos or noise. In contrast, environmental risks may involve ill-defined or broad (and often shifting) demographics spread over equally ill-defined or broad areas, with no clear beginning or end to exposure times. Outcomes are often uncertain and rarely are they causally linked.

Examples of environmental hazards can be divided between those that are naturally occurring and those that are humanmade. Naturally occurring hazards involve chronic problems, such as solar ultraviolet radiation and radon exposure, and acute problems, such as fires, earthquakes, and extreme weather events. Humanmade environmental hazards include those that are voluntary—mainly risky behaviors, such as smoking, consuming an unhealthy diet, substance abuse, and unsafe sex, and those that are involuntary, such as air and water contamination by chemical or radioactive substances, food contamination, the consequences of new technologies, and climate change.

While the concept of risk is ancient, environmental risk communication has been scientifically studied only since the early 1980s. It has various disciplinary origins and ongoing threads, located in fields such as communication, public health, psychology, sociology, policy studies, and political science.

There are four most salient areas of research on environmental risk communication:

1. The various psychological mechanisms behind the perception of risk, which are relevant to understanding risk-communication audiences and how they process and understand risk messages
2. Sociology and anthropology research on environmental risk as a phenomenon occurring at the intersection of physical, social, and cultural processes
3. How the mass media transmit environmental risk messages to the general public
4. The pragmatic concerns of those charged with communicating risk

The complexity of environmental risk communication extends into practice. While risk communicators may also be individuals or groups engaged in informal or unofficial information transmission, many environmental risk communicators are professional practitioners. There are commonalities across these areas of practice.

Most of the prescribed steps for effective occupational risk communication are also applicable in environmental risk communication:

- Define the audience in terms of its receptivity to the communication, ability to process the information, and capacity to act on recommended behaviors.
- Understand the demographic characteristics of the audience, especially as risk messages can be understood differently, according to age, sex, and racial and ethnic group.
- Consider the language and style of the message.
- Pretest and evaluate the message.
- Consider transmission of message elements through textual, visual, or audio modes.
- Ensure that message content establishes and maintains the credibility of the source, while providing factual information or instructions—and often persuasion to act.
- Consider the channels through which environmental risk messages are sent.

Channel selection and management has become a major challenge for risk communicators because communication technologies have rapidly evolved and function in different ways for different populations or groups. The decline of the U.S. newspaper industry poses a considerable challenge because this avenue for community-level dissemination offered significant efficiencies of scale. The rapid growth of social media poses a considerable challenge since little is yet known about its efficacy in environmental risk communication.

To some degree, risk communication has been developed as a set of persuasive tools used by special interests to serve their needs. Political and economic interests have always had access to the strategies identified here, and they will always apply them toward their vested interests, sometimes risking public harm. Therefore, professional risk communicators should conduct their work with an unbending respect for the public good.

The objective of efficiency should also drive decisions about how much and what kind of risk communication is undertaken.

While the importance of risk communication may seem obvious today, legislated mandates for the creation and dissemination of risk information were necessary in the past. A range of federal legislation and regulations contains such stipulations concerning occupational and environmental health (Table 29-1). Requirements are included in the Occupational Safety and Health Act of 1970 and the Occupational Safety and Health Administration (OSHA) Hazard Communication Standard—perhaps the most direct regulatory expression of occupational risk communication objectives. The Environmental Protection Agency (EPA) also mandates training that encompasses risk communication (Fig. 29-1). In addition, voluntary consensus standards have called for risk communication, such as those of the American National Standards Institute (ANSI); corporate policies, such as those of Responsible Care; and labor and community-organization health and safety policies and practices.[5–7]

A RISK COMMUNICATION MODEL

A model for risk communication is depicted in Figure 29-2. Each stakeholder in the risk communication process is both a sender and a receiver of risk communications (risk-communication messages) as each takes in information, processes it, and sends it to others. Other preventive actions may take place as the understanding of risks and prevention methods increases. Risk communication is only effective if information is received and used by a significant number of stakeholders. The stakeholders in Figure 29-2 are usually engaged simultaneously in risk communication, each providing a unique perspective on new knowledge, attempting to make sense of it.[8,9] Figure 29-2 conceptualizes stakeholders at the individual level; however, at the organizational level there are also stakeholders, such as academic institutions, government agencies, insurance companies, labor unions, professional associations, and non-governmental organizations.

Figure 29-3, which depicts the risk communication process in greater detail, is based on general health-communication models.[10,11] New risk and prevention knowledge may be created by any stakeholder. That information creates a necessity for one or more stakeholders to consider taking—or not taking—preventive actions (top of Fig. 29-3).

Alternatively, and in reverse, the *need* for a preventive action may drive people to seek new information.[12] In these cases, the information is part of the store of information that resides in databases, books, periodicals, collections, certification criteria, training materials, and general understanding.[13] Information is then sought by people who have a specific need for a preventive action and are seeking change in behaviors. These behaviors are influenced by roles and contexts in which the seekers of information operate.[14,15]

If risks and prevention strategies are well-known and widely accepted, then new knowledge provides merely a refinement of prevention practices to make them more effective, requiring minimal additional risk communication. However, new knowledge about risks and controls generally leads to planning activities for risk communication.[16] These activities include an assessment of stakeholders, external factors, and available resources. The assessment of stakeholders involves determining which stakeholders should receive the new information based on their likelihood of contributing to prevention activities. Sometimes the information may be so compelling that employers and workers will take action upon receiving the information. Sometimes insurers, media representatives, government regulators, union officials, and others may be expected to play a role in stimulating preventive actions. External factors, such as the current economic and political climate, should be assessed to inform the rest of the process. These assessments, combined with the importance of the new risk information to the preservation of health and safety, should then be used to decide how many resources to devote to further risk communication. The process may then continue to development and production of risk-communication messages.

Design of messages includes an assessment of stakeholder audiences to ensure that their

Table 29-1. Examples of Legislative and Regulatory Requirements for Disseminating Occupational Health and Safety Information

Legislation	Requirements
Occupational Safety and Health Act	
Public Law 91-596 http://www.osha.gov/pls/oshaweb/ owadisp.show. document?p.table=OSHACT&p.id=2743 U.S. Code Citation: 29 U.S.C. 651 *et seq.* http://frwebgate.access.gpo.gov/cgi-bin/getdoc. cgi?dbname=browse.usc&docid=Cite:+29USC651 Section 20 (a)(7)(d) Research and related activities Section 21 (a) Training and employee education	Requires NIOSH to disseminate information obtained from this research and related activities to employers and employees. Requires the conduct or support of education programs to provide qualified personnel to carry out the purposes of the OSH Act, and information programs on the importance and proper use of safety and health equipment. Also provides for the establishment and supervision of programs for the educationand training of employers and employees in the recognition, avoidance, and prevention of unsafe or unhealthful working conditions in employments covered by the OSH Act.
OSHA regulations	
29 CFR 1910.1200 Hazard communication(e) Written hazard communication program http://trwebgate.access.gpo.gov/cgi-bin/get-cfr.cgi?TITLE=29&PART1910&SECTION=1200&TYPE=PDF	Requires employers to develop programs to make available information on hazardous substances and develop a written hazard communication program. Employers must also show how they will inform workers of hazardous chemicals and the hazards of nonroutine tasks.
Toxic Substances Control Act	
Public Law 94-469 http://www.epa.gov/region5/defs/html/tsca.htm U.S. Code Citation: 15 U.S.C. 2601 *et seq.* http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi? dbname=browse.usc&docid=Cite:+15USC2601 U.S. Code Citation: 15 U.S.C. 2603 http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi? dbname=browse.usc&docid=Cite:+15USC2603	Establishes and coordinates a structure for the exchange of research and development results on toxic chemicals among federal, state, and local authorities. Includes ways to facilitate and promote the development of standard data formats, analyses, and consistent testing procedures as part of the research and development exchange structure.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	
Public Law 95-510 http://www.epa.gov/superfund/action/law/cercla.htm U.S. Code Citation: 42 U.S.C. 9601 et seq. http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi? dbname=browse.usc&docid=Cite:+42USC9601	Training areas under this legislation include the safe packaging, loading, unloading, handling, storing, and transporting of hazardous material and emergency preparedness for responding to an incident involving the transportation of hazardous materials.
Superfund Amendments and Reauthorization Act (SARA)	
Public Law 99-499 http://www.epa.gov/superfund/action/law/sara.htm U.S. Code Citations: 26 U.S.C. 9601 *et seq.* http://frwebgate.access.gov/cgi-bin/getdoc.cgi? dbname=browse.usc&docid=Cite:+42USC9601 42 U.S.C. 9605 et seq. http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi? dbname=browse.usc&docid=Cite:+42USC9605	Title III of SARA provides a framework for emergency planning and preparedness and requires facilities to provide community groups with information on their inventories of hazardous chemicals and for manufacturers to report releases to the environment.

NIOSH, The National Institute for Occupational Safety and Health; OSHA, The Occupational Safety and Health Administration. (*Source*: Adapted from Reference #2 on page 637.)

Figure 29-1. Environmental Protection Agency–mandated pesticide training. (Photograph by Earl Dotter.)

Figure 29-2. Risk communication model.

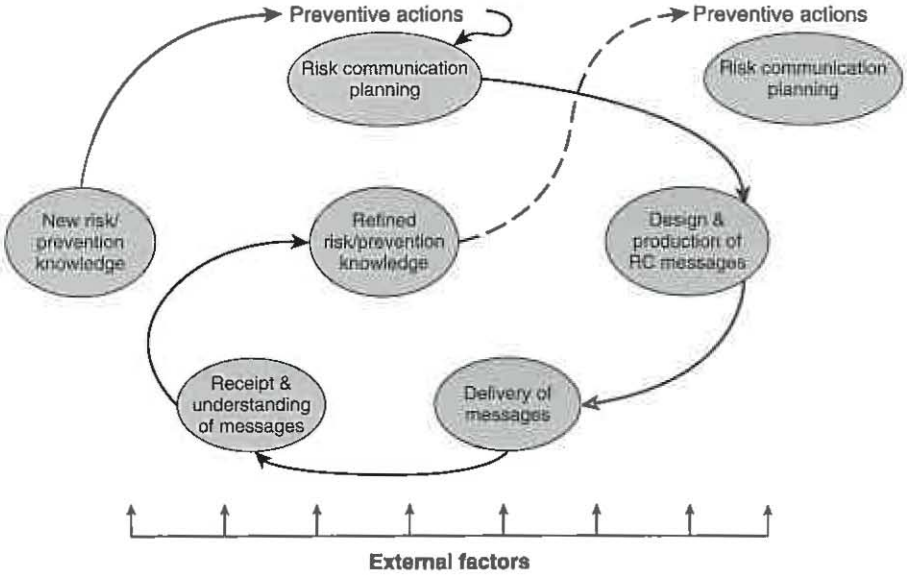

Figure 29-3. The risk communication process.

demographic characteristics, current knowledge, attitudes, biases, and behavior patterns influence the design (Fig. 29-3, right center). Design also includes the selection of message channels (methods to disseminate messages) and the frequency of message transmission through each channel. Message channels include training, print, video, and Internet-based methods.

Message production involves the writing of copy and the preparation of visual and aural elements appropriate to each selected channel. Message delivery involves the transmission of messages to the stakeholder targets. Message delivery should be guided by information about the media access and patterns of use of the intended recipients—which media they use to make decisions about risks and hazard protection, and when and how often they use these media.

The next stage in the process is the receipt and understanding of risk communications by stakeholder audiences (Fig. 29-3, lower left)—often unnecessarily left to chance in occupational and environmental health and safety. Audiences can be asked about the receipt and understanding of disseminated messages. Understanding the message is critical because it is the only basis for achieving the final step in the process: risk and prevention knowledge, which leads to further, and perhaps more tangible, prevention actions by stakeholders (indicated by the dashed-line arrow in Fig. 29-3).

Overall, the model demonstrates that risk communication is the development of a consensus for preventive action among stakeholders based on a shared or agreed-upon interpretation of new risk and prevention knowledge. If external factors are favorable, once information and knowledge is obtained, a process of use and impact occurs.[2,3,17]

Risk communication faces "real-world" barriers.[6,18,19] To understand the flow of risk information, one must also analyze the barriers or external factors that affect the process. For example, information on practices that reduce risks of noise-induced hearing loss has been widely disseminated, but these practices have not been adopted at an appreciable level by many industries. The need for effective programs to prevent hearing loss is not at issue. However, economic, social, and political barriers to the use of this information are significant.[20] Approaches to reducing occupational morbidity and mortality are often complex and often beyond the realm of risk communication. However, a stronger emphasis should be placed on determining additional types of information needed by stakeholders and how data are used by organizations and individuals in making decisions.[21,22]

In each of the stages, there is feedback. Every time information or knowledge is created or interacts with a person or situation, the validity or appropriateness of the information or knowledge can be tested and the possibility of feedback arises. This, in turn, can result in new or modified information and knowledge. This model builds on the one-way, linear, source-message-channel-receiver model.[23] However, it is more likely that all the stages are occurring simultaneously, or at least interacting with or influencing each other.[24] In practice, the boundaries of the science information process are permeable and information flows in all directions.

RISK COMMUNICATORS

Occupational and environmental health and safety communication lies at the nexus of diverse human and organizational interests and a vast array of workplaces and processes. Several types of risk communicators (senders and receivers of messages) are involved. Different audiences require different types of communication, tailored message content and formulations, and specialized means of delivery.[19,21,25] The approach of dividing mass audiences into smaller and more homogeneous segments is known as audience segmentation.[26] The following are observations about nine types of risk communicators in occupational health and safety. Environmental health involves a similar group of risk communicators (Box 29-1).

Workers

In occupational health and safety, workers are the primary focus of risk communication. They bear the risks of the hazards, suffer from exposure to hazards, and benefit from controls used to reduce or eliminate hazards. Workers care about their health and safety. They also care deeply about their families and being able to support them. Traditionally, workers are targeted as receivers of risk information since their understanding of the risks they face and the controls available to them is central to risk communication. Employers, union representatives, government officials, health professionals, journalists, and representatives of advocacy groups and other non-governmental organizations are common sources of risk communication for workers. The information workers receive should be timely, understandable, accurate, actionable, and reliable because the risks that they face are often significant and imminent.

Workers are also important senders of information. They may convey information about ways in which they are exposed and the symptoms that result. Since they often play a role in the development and use of control methods, workers can be sources for information about those controls for all other stakeholders. They may be especially effective sources of communication for co-workers. More experienced workers are often trusted sources of information for those with less experience, especially younger workers. Workers are often very effective communicators when they tell their stories about how they or their friends have been injured or escaped injury.

Employers

Employers are important risk communicators because they have some autonomy to direct or control what occurs in the workplace. They are also able to direct resources to health and safety programs and specific measures for hazard control. In addition, the law and the federal government generally hold them responsible for workplace health and safety (OSH Act of 1970). Because of their importance, employers receive risk information from all other stakeholder groups. Employed workers represent an important source of information for employers. Worker protection should be a partnership between employers and workers. Other important sources of information for employers are insurance companies, trade associations, health and safety professionals, and government officials, as well as conferences and meetings, and the Internet. Employers send risk communications to all stakeholder groups as they explain their policies and practices and share information on worker injuries and illnesses.

Government Agencies

Government agencies at the federal, state, and local level whose missions involve health, environment, and/or labor are senders and receivers

of occupational safety and health information in several ways. They are mandated to attend to the concerns of the public, especially workers and employers. For example, the National Institute for Occupational Safety and Health (NIOSH) is the federal agency responsible for performing research on occupational health and safety and recommending measures to reduce or eliminate workplace exposures and hazards. NIOSH has conducted many "town-hall" meetings across the United States to learn about workplace safety and health concerns and to use the information obtained to guide research. Government agencies receive reports from employers. For example, the Bureau of Labor Statistics receives information from employers on occupational illnesses, injuries, and deaths.

Government agencies are message senders, mainly to workers, employers, and the general public as well as other government agencies and branches of government. OSHA communicates, primarily to employers and workers, rules for workplace safety and health and information on risks and controls (http://www.osha.gov). NIOSH informs the public of its research projects and results through its Web site (http://www.cdc.gov/niosh).

Non-governmental Organizations

Many non-governmental organizations (NGOs), both for-profit and nonprofit, perform risk communication for occupational safety and health. They include unions, trade associations, workers' compensation insurance companies, safety councils, and advocacy groups as well as environmental non-governmental organizations. (See Chapters 32 and 33.) For example, committees on occupational safety and health (COSH groups) are coalitions of labor unions and individual health and safety professionals and activists who work on issues in a special geographic area. Other NGOs focus on health and safety problems in a specific sector, such as the Center for Construction Research and Training.

Non-governmental organizations receive risk information from workers, employers, researchers, government officials, and others. They also serve as message senders to these same stakeholders, adding their perspective or translating risk communications into other channels, such as translating regulations into training materials and research reports into policy proposals. Non-governmental organizations generally do not perform original research or literature reviews to make determinations about hazards and risks and generally do not issue risk management recommendations. However, there are some exceptions; for example, the Center for Construction Research and Training performs all of these activities.

Professional Organizations

Two types of professional organizations are engaged as senders and receivers of risk communications: those associated with particular occupations and those focused on occupational and environmental health and safety. The former—basically trade associations—focus on the health and safety needs of their members, such as in health care, where worker protection is often seen as a dimension of patient safety. For example, the Association of periOperative Registered Nurses provides training materials, position statements, and advocacy materials on issues such as patient lifting, fire safety, noise, and evacuation of surgical smoke. The Society for Mining, Metallurgy, and Exploration provides similar materials for its members, who are mining engineers.

Professional organizations that focus on occupational health and safety issues include, for example, the American Industrial Hygiene Association (AIHA), the American Society of Safety Engineers (ASSE), the American College of Occupational and Environmental Medicine (ACOEM), the American Association of Occupational Health Nurses (AAOHN), and the American Public Health Association (APHA). Members of these organizations include a mixture of academics, consultants, and practitioners who work on identifying and controlling health and safety problems, often within a specific industrial sector. They are interested in scientific research results and especially information on newly identified hazards and effective interventions for controlling these hazards. These organizations can significantly influence workplace conditions by providing information to their members and by issuing policy proposals. They also have committees of experts on specific topics who can act as resources for technical assistance

and development of policy positions for legislative and executive branches of government.

Researchers

Scientific endeavor is the source of much risk information. Researchers work for academic institutions, government agencies, NGOs, insurance companies, and other groups. Researchers communicate to their peers through scientific publications, using narrow, precise, and detailed messages that are grounded in rigorous scientific methods. Science makes progress through careful building of the general body of knowledge by replicable procedures and careful reporting of hypotheses, research methods, and results. Research communications are tailored to meet diverse needs, ranging from solving specific problems to attempting to obtain financial resources in the political arena.[27,28] Scientific publications are also the cornerstone for reviews of important occupational health and environmental safety topics by government agencies, advocacy groups, and other organizations. Other applied research outputs include methods, tests, technologies, and devices. The goal of all these research communications is to continuously improve and promote occupational and environmental health and safety.[18,29,30]

The General Public

Communications of occupational and environmental health and safety information to the general public come mostly from news media organizations, government agencies, and NGOs, and also from other sources (Fig. 29-4). However, information is also passed to the public in a multistage process in which community opinion leaders learn about an issue from news sources and then pass that information on to others—partly because opinion leaders are viewed as trusted sources in their communities.[31] The public participates in risk communication at the community level as message senders by participating in public meetings with government officials, employers, and others.

Journalists

Journalists include print and broadcast reporters, photographers, and videographers. They work for mass-market media, such as daily newspapers and television and radio networks. They also

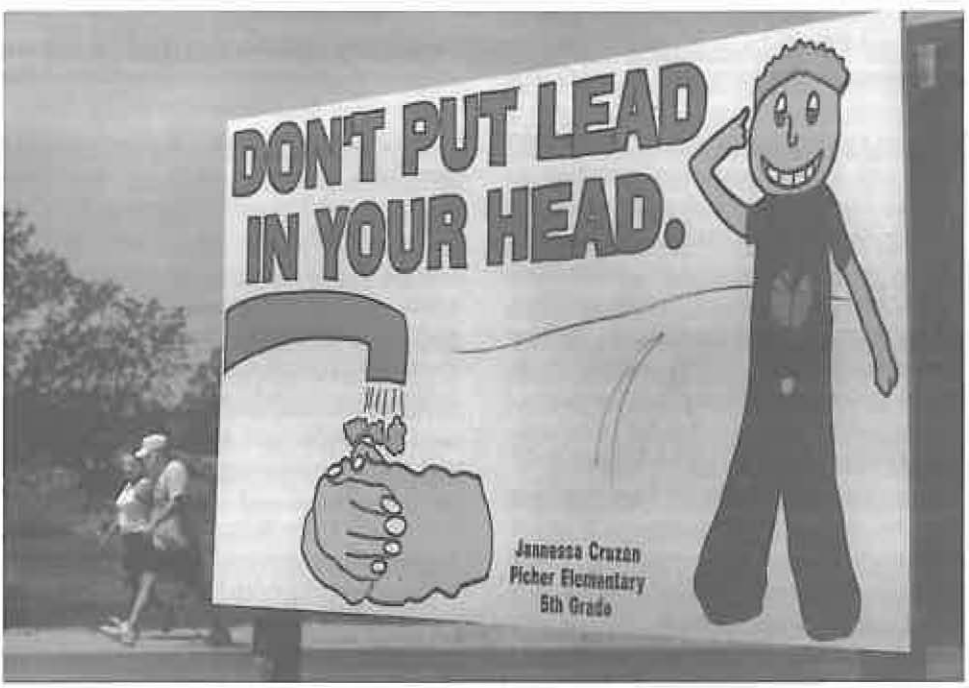

Figure 29-4. Billboard communicates to the general public the risks of lead exposure. (Photograph by Earl Dotter.)

(Drawing by Nick Thorkelson.)

work as freelance providers of content for other media, such as magazines, trade publications, and blogs.

Journalists can amplify risk information and stimulate action. For example, crane collapses in New York and Florida focused public attention on the problem of crane safety and forced OSHA to quickly plan new standards for crane safety (http://www.youtube.com/watch?v=kUVnbJ2Rf5I). In Las Vegas, newspaper attention to construction fatalities forced changes at Nevada OSHA, led to Congressional hearings, and brought nationwide attention to construction safety (http://www.pulitzer.org/archives/8381). Stories about fatalities and foundries in the *New York Times* and on *Frontline* on the Public Broadcasting System created public support for tougher enforcement of OSHA regulations at companies and other entities that often ignore them.

However, the news media infrequently pay attention to occupational health and safety issues. Reporters generally cover established "beats," such as crime, education, sports, and business. Their work is routinized, leaving little time and few resources to develop other sources and content. In addition, newspapers and other print media, which are suffering from drastically reduced revenues, have reduced investigative journalism, in which sufficient time and resources are allocated to study and report in depth on a subject like occupational health and safety.

Although journalists tend to focus on official sources for information, such as government officials and their press offices,[32] they also seek information from unofficial sources involved in an issue, such as workers and community members. Although there are a few journalists who specialize in science issues, many journalists often talk to scientists. However, journalists sometimes may have difficulty understanding scientific concepts and translating scientific information so that it is understandable to wide audiences, but they play a critical role communicating scientific information to wider audiences.[33]

Legislators

Legislators at the federal, state, and local level are targets of occupational health and safety and environmental health information from all other stakeholders. Since they pass laws and allocate public funds, they have a major impact on conditions in workplaces and the general environment. Legislators need accurate information on

risks and the methods and costs of prevention to allocate government resources wisely. Often with the help of aides and communications specialists, legislators communicate about risk issues to their constituents through many message channels.

MESSAGE DESIGN AND PRODUCTION

When risk communication follows routine or informal processes, such as regular reports to government agencies and discussions between employers and employees, little or no planning may be needed. However, in almost all other situations, planning is needed. Planning risk communication should include *(a)* setting objectives; *(b)* deciding which stakeholders should be addressed, depending on their understanding of risks and control measures and their role in prevention activities; *(c)* assessing current status, by in-depth interviews, focus groups, or surveys; and *(d)* determining the resources necessary to achieve the objectives.

When planning is completed, message design and production begins, with five important considerations: audience segmentation, design, style, content, and pretesting.

Audience Segmentation

The nine groups of risk communicators discussed in this chapter represent one level of audience segmentation. Within each group, smaller and more homogeneous segments can be identified. Each segment may require a different strategy and different types of information products. For example, workers may be divided by ethnicity, native language, age, gender, occupation, industry, work experience, and cognitive style. Each of these factors may affect how messages are received and sent. Employers may need to be segmented by these factors as well as the numbers of their employees. In general, the smaller the number of employees, the less expertise is present to evaluate risk information and implement control measures.[34]

Government agencies, NGOs, and professional organizations each have different types of leaders, constituents, missions, resources, and influences. These factors may affect the selection of targets during the segmentation process. Journalists may be segmented by such factors as experience preparing content on a specific topic, such as science, health, labor, business, and environment, as well as the media channels that have previously used their content. When preparing risk communication for peers, even researchers may need to be segmented into groups by their specialties. Occupational and environmental health and safety is an area where many specialties contribute, yet scientists are often so specialized that they have trouble understanding each other.

Message Design

All risk communication should have a compelling message that motivates audiences to listen to the message, understand it, learn from it, and take preventive actions—including passing the message to others. Strategies for communicating with all stakeholder groups should be guided by theories that explain how individuals and organizations receive, understand, and accept new information and how human attitudes and behaviors change.[35] Although much science-based risk information is based on mathematical probabilities, research on human perceptions indicates substantial presence of biases that cause people to assess risk in ways that are decidedly nonmathematical. These biases are stable across a range of situations and groups of people.[36] Perceptual biases exist between technical experts and members of the general public: experts usually underestimate risks, while others (generally with less information) usually overestimate them.[37] Emotional responses can be important too. In certain circumstances, risk communication that attempts to scare people can be effective.[38]

Message Style

Message style is most effective when it is adjusted for each audience segment addressed. For those with low literacy and/or English skills, direct and simple language should be used. Pictures can be used effectively to minimize the amount of text, especially for non-English speakers. "Before" and "after" (or "safe" and "unsafe") illustrations are often effective. Messages should resonate with

the experience of those addressed and have emotional appeal for them. Messages such as "You have a one-in-a-thousand chance of getting cancer from this chemical" lack the emotional impact that may be necessary to retain the audience's attention. The language used in most material safety data sheets (MSDSs), such as "use with adequate ventilation," is too technical and vague for most workers. To resonate with workers, risk communication should use real-world examples or cases studies of hazardous exposure situations that workers face regularly. A companion technique is the use of stories from individuals who have been injured or become ill on the job or who have experience with new health and safety procedures. Properly framed, these stories from peers can have high credibility.

Employers also need concise messages because of their generally heavy schedules and workloads. They trust and want to know about the practices of their peers and competitors. They want case studies with more detail than most workers want, and they want health and safety issues placed into context with all the other aspects of directing a company or some other entity. Messages should use language specific to the trade and industry that demonstrates familiarity with it.

In government, executive-branch officials and legislators need a variety of risk communications from all types of stakeholders to act in the public's interest. Although they will accept and use anecdotal or case-study information, they usually seek objective quantitative data about risk and control. The generalizability of such information helps them choose what appears best for those whom they serve. Communications to government agencies or officials should almost always be formal in tone. Sometimes brevity is essential, such as with legislators. For others, more extensive information is needed, such as reporting to government agencies on workplace injuries, illnesses, and deaths. Risk communication should be consistent with executive agency or legislative priorities—that is, in the right place at the right time. When communications include policy implications, they should be concise and logical, connecting risk and control information with viable policy options. The style used in communications to NGOs and professional associations should be similar to the style used in communicating with government agencies or officials. Such communications should demonstrate understanding of an organization's mission and the population or group served.

Risk communications to the public should be straightforward, simple, and brief. Like other audiences, the public needs to know what the hazards are, how and how many people are affected, and what experts recommend to control the problem. When data about risks of occupational and environmental diseases or injuries are presented, comparisons can be made to risks related to more common hazards, such as smoking or sedentary lifestyle. Stories of affected individuals are often critical to effectively communicating with the public. Journalists also need to use a similar style and have "hooks" with their stories to engage readers to attend to their messages. In communicating to journalists, one should provide them with contact information for stakeholders, especially researchers, workers, employers, community leaders, and government officials.

Message Content

Workers and community members need to know which conditions or exposures are dangerous, what the possible outcomes are, how likely it is that they may become injured or ill, and what preventive measures need to be taken. Messages should be succinct and meaningful. Messages such as "Be careful" lack sufficient specificity. For example, messages may need to tell workers how to report unsafe situations to peers and supervisors so that they will be addressed promptly, without negative consequences for their reporting these situations. Workers should be empowered to make or recommend changes. They should be informed of their rights under the Occupational Safety and Health Act, which include the rights to *(a)* refuse hazardous work until the hazard is corrected and *(b)* bring it to the attention of the supervisor or shop steward—without suffering negative consequences.

Like workers, employers also need reliable information on hazards, potential outcomes, and effective controls. Especially valuable are communications that feature practical controls for hazards and sources of additional information, such as databases containing solutions to health and safety problems. Risk alerts that give case studies, such as "fatal facts," can help

dramatize risks and motivate employer action (http://lni.wa.gov/Safety/Research/Face/Files/ConstructionFalls.pdf). Evaluation of safety controls, return on investment, and productivity impact may help persuade employers to adopt the appropriate controls,[39] especially as costs of interventions increase.

Some employers respond well to messages that view safety as essential for a well-run enterprise and good management practices. If workers believe that safety is only important to management because it saves the company money, then an entire safety program can be undermined. Safety should be integral to an employer's identity and culture, including encouraging workers to voice their concerns and suggestions on health and safety. Large employers, who rely on complex management systems, may find this reasoning to be persuasive; small employers may be more persuaded by evidence that "safety pays."

Researchers often communicate risk information in the style of scientific papers and presentations, following the sequence of background, hypotheses, methods, results, and discussion. Communications from researchers are generally judged to be scientifically acceptable by independent peers who carefully examine the content of these messages. This peer-review process gives other stakeholders some degree of confidence in the validity and reliability of the information, but it may not ensure its validity and reliability.[40]

To some extent, the nature, significance, and seriousness of some occupational and environmental health and safety issues make them compelling topics for journalists because they attract audiences. Occupational safety problems and resultant injuries are often relatively easy to report on because they are visible and because causes and effects are apparent. However, occupational and environmental diseases are infrequently covered in the news media because their causes appear to be unclear, complex, or uninteresting. In addition, with multiple stakeholders involved, journalists may not have access to necessary information or they may get conflicting information from multiple sources. Nevertheless, there have been many impactful stories, especially in newspapers, that have focused the public's attention on occupational and environmental diseases and injuries.

Pretesting

Before messages or informational materials are disseminated, they should be pretested, especially if they are intended for large or low-literacy audiences.[11,41,42] Pretests, which involve exposing a few members of an intended audience to a message and gauging their reactions, are done to identify ways to improve messages before they are broadly disseminated.[11,43,44] Messages may be tested to optimize their concept, clarity, credibility, length, or style. Sometimes different approaches to delivering the same risk information may be attempted. Pretests can reveal unexpected interpretations of a message and cultural or gender-based sensitivities about a message.

Messages may be tested by methods including interviews of individuals, focus groups, and surveys. After it is determined what should be tested, such as attention, motivation, recall, or cultural appropriateness, methods are designed to assess these qualities of the message. Test subjects should be drawn from the intended audience. Biases of those tested should be considered if they have not been randomly selected. Data from pretests should be analyzed to determine how tested messages can be improved.

MESSAGE CHANNELS

Risk messages reach audiences through message channels. For many purposes and audiences, communicators prefer electronic channels, which include television, radio, video, and the Internet, as well as e-mail, blogs, CD-ROMs, DVDs, podcasts, listservs, webinars, and social media, such as Facebook, MySpace, and Twitter. Social media are produced and distributed with an expectation of generating ongoing communications and interaction among pairs and groups of individuals. They are faster and cheaper than other channels, but they may be less reliable. Print channels, which include newspapers, magazines, books, scientific journals, and written reports and policies, are being increasingly adapted to the Internet. While comparatively expensive, live, face-to-face interaction through meetings, seminars, or training programs represents another channel, which can be very effective by facilitating the give-and-take of true communication.

Using the most appropriate channels involves understanding which channels work best for which audiences at which times. When making decisions about channels, risk communicators should also decide on the number of times each channel will be used for the same or a similar message. One use of a channel is almost never sufficient for positive results.

Messages to workers about hazards are best delivered in small brochures and training classes where workers are encouraged to ask questions and to discuss issues. "Toolbox talks," which are training sessions designed for and delivered in work settings – not training rooms, can be effective where training facilities are not available. They are short, practical, delivered by supervisors or peers, and have few or no written materials. Organized workers often highly trust messages that come from their unions.[45] Therefore, training sessions presented jointly by management and a labor union can be especially effective. Training and information dissemination at the worksite is very effective if workers are paid for the time they participate—which conveys respect for them and the importance of the message. Giving workers materials to take home and read on their own, which does not convey the importance of the information, is often ineffective in reaching them with messages. However, messages disseminated through union publications, before or after paid training, may reach family members who can help reinforce these messages.

Photographs and videos can be effective teaching tools, especially when time is allotted for discussion after viewing them. Merely showing a video without discussion is generally ineffective and may indicate to workers that management does not really want to know their opinions or concerns or to clarify issues raised. Video recordings of workers using their own words to describe workplace hazards, traumatic workplace events, or safety procedures that were or were not used can lend an unparalleled level of realism to training experiences. Video storytelling can help dramatize a problem and facilitate meaningful interactions about hazard control. Asking open-ended questions is an effective technique to help get workers talking about their experiences and concerns. Role playing is a useful technique in helping workers confront awkward situations, such as raising safety concerns with a boss. Health professionals can effectively deliver health messages to workers, such as helping them understand the importance of protective equipment, such as earplugs, respirators, and other personal protective equipment.

Employers obtain information from suppliers, trade journals, trade association meetings, and the Internet. Targeting health and safety information to purchasing agents is important since they are responsible for acquiring supplies and equipment with safety features.

Government agencies use official channels to disseminate occupational and environmental health and safety information to the general public, often with a fixed set of procedures. OSHA communicates with other agencies through various mechanisms, including notices of proposed rule making, which government agencies issue when they seek to add, remove, or change a regulation. These notices are published in the *Federal Register*, an official daily publication of federal regulatory activity that government agencies often use to communicate with stakeholders. Many other communications between agencies are done routinely, without notice. For example, state health departments regularly share injury and illness data with NIOSH. All government agencies provide "non-directed" information through postings on agency Web sites and other electronic media. For example, NIOSH has a monthly online newsletter known as *NIOSH eNews* (http://www.cdc.gov/niosh/enews/).

One official channel that NIOSH uses to provide comprehensive review of the scientific literature about a specific hazard, worker exposure to the hazard, risk of disease and injury associated with exposure, and methods to control the hazard is publication of criteria documents. These contain specific preventive recommendations so that, as far as practicable, no employee will suffer diminished function capacity or life expectancy as a result of work. The OSH Act presumes that OSHA will use criteria documents to help protect the lives and livelihoods of workers.

Researchers and members of professional organizations use scientific journals to provide and receive risk communication. One source estimated that at least 155 journals publish occupational health and safety papers. At least 35,000 papers, reports, pamphlets, fact sheets, and other occupational health and safety documents are released each year.[46] Many occupational health

and safety professionals also attend conferences, where they share information through formal presentations, interest group meetings, and networking events.

All stakeholders can be reached by mass-media channels, such as newspapers, magazines, books, and television. Some of the classic books in social criticism have raised concerns for occupational safety and health issues, including Upton Sinclair's *The Jungle*, Paul Brodeur's *Expendable Americans*, and Studs Terkel's *Working*. Fictional television programs have included plot or subplot lines that depict occupational and environmental hazards. Reality programs that focus on dirty, risky, or dangerous occupations can serve to communicate occupational health and safety information. However, they may also give the impression that the risk of work-related illnesses, injuries, and deaths are acceptable and inevitable.

Social Media

Social media, which combine technology, social interaction, and communication to form networks, establish business and personal relationships, and transmit information quickly, include e-mail, instant messaging, blogs, Wikis (collaborative Web sites), podcasts, Internet forums, microblogs (blogs with very short posts), social networking sites, and real simple syndication (RSS) feeds (syndicated Internet content). More information may be moving through social media than through traditional media. Organizational hierarchies and traditional channels of communication and information dissemination are evolving into faster and more complex interactions. The trend toward flatter (more horizontal or less hierarchical) organizations will likely promote use of social media for reaching the objectives of these organizations.

Social media may be used for occupational and environmental health and safety risk communication.[47] Social media can help achieve a socially constructed definition of risk through interactive, multipath communications in which all users are active generators and consumers of information. This can help focus opinions and move people to action. In addition, the use of social media may build communities of occupational and environmental health and safety practice through rapid communication among stakeholders. For example, social media could help government agencies obtain stakeholder views about new hazards or proposed policy changes. Social media may also be useful to researchers in soliciting stakeholder input and feedback on protocols. Because social media provide the real-time feedback on issues, they may be useful as surveillance tools. (See Chapter 3.). Used systematically, they could be used to identify prevalence or incidence of various work-related health conditions and possible control measures.[48]

All message channels have limitations. Use of social media may be problematic for large organizations that are accustomed to closely controlling their communications. Uses of social media must be monitored for adverse consequences, such as inaccurate information attributed to an organization, breached security of restricted information, and damage to an organization's credibility or reputation. Evaluations should be conducted to assess the capacity of social media to efficiently achieve the risk communication objectives of stakeholders.

EVALUATION

Risk communication should include evaluation of activities in the context of stated objectives and money spent. Process measures to consider include the following:

- Exposure of audience members: Did they have an opportunity to get the message?
- Attention to the message: Did they pay attention to it?
- Comprehension: Did they understand it?
- Involvement: Did it resonate with them?
- Acceptance: Did they recognize it as a valid message?
- Actions: What actions, if any, did they take?

If these process measures are positive, then changes in the knowledge, attitudes, skills, behavioral intentions, and/or behaviors of the audience members should be measured.

A larger focus of research in occupational and environmental health and safety should be on how people obtain and use risk information. There has not been sufficient research on the dissemination, adaptation, and use of occupational and environmental health and safety information. Senders of information often have

optimistic assumptions about dissemination of research findings in contrast and what is actually available to, and assimilated by, potential users of that information.[2] This mismatch especially applies to how employees, managers, and organizations obtain and use occupational health and safety information and the dynamics of decision making and stages of occupational change involving such information.[34,49] Nevertheless, promising examples of research on occupational safety and health risk communication and information dissemination can be cited, including approaches that are theory-based and rigorously designed.[50]

There are four output categories, or phases of output, that could be envisioned to track the flow of occupational and environmental health and safety research: immediate, intermediate, penultimate, and ultimate.[2,51,52] Each category is produced by government agencies, corporations, labor unions, trade associations, and NGOs. Each phase of output transforms the prior output to an input, and then disseminates this information as its own output. Various mechanisms exist to monitor and encourage these dissemination and transformation efforts. One method is to first identify representative organizations and institutions at each stage and then to monitor transformation activities and the number of outputs and inputs.[51,52] As outputs move downstream from immediate to ultimate and are absorbed and transformed by recipient organizations, a "dilution" effect may occur with respect to impact and the ability to measure contributions.[52] A one-to-one relationship rarely exists between receipt of an input at one level and a corresponding output at another level. Measuring inputs and outputs of various recipient organizations is potentially useful for monitoring the flow of safety and health research, but this approach does not necessarily indicate the full diffusion path or actual adoption of useful information. The diffusion of innovations theory is an alternative framework for monitoring dissemination of new ideas emanating from a research activity.[53]

ETHICS

Risk communicators are obliged to perform in compliance with ethical standards. A major issue is divided loyalty. Some risk communicators work for an organization, where they are expected to contribute both to the protection of workers and the financial status of the organization, which can create ethical dilemmas.

Other ethical issues concern the use of risk communications in lieu of other more costly or time-consuming interventions. For example, it is not acceptable to tell workers they have to continually avoid a hazard if methods exist to eliminate that hazard. The peer-review system used by researchers for risk communication helps to ensure that research findings are reported truthfully, with transparency about potential conflicts of interest among researchers. However, the system has limitations. The few examples of misconduct have included falsifying research results and plagiarizing the work of others. There are also cases in which peer reviews have not been thorough or critical enough to ensure the scientific rigor and quality of a publication. And, when conflicts of interest are not made clear, the peer-review system fails all of its stakeholders.[40]

CONCLUSION

Risk communication faces the following challenges:

1. Audiences are more diverse than ever before, making it difficult to reach many of them. In addition, today there are fewer intermediaries, such as labor unions and health and safety departments in large corporations, that can help communicators reach out and transmit timely, meaningful information.
2. Communicators and researchers must step outside their usual networks and address more diverse audiences. They must translate complex information so that it will be meaningful for lay audiences. This can be challenging for specialists who have spent years within their disciplines or realm of science.
3. It is increasingly difficult to get the attention of the public and the mass media, especially with downsizing and restructuring of traditional news outlets. Public health

communication competes for attention with economics, politics, sports, and entertainment. Even within public health, occupational and environmental health and safety competes for attention with consumer health, women's health, children's health, elder health, lifestyle health, prevention of infectious disease, and other sets of issues.

4. Occupational and environmental health and safety attracts public consciousness when there are catastrophes, such as mining disasters and crane collapses; scandals, such as flagrant violations of health and safety regulations; and emerging problems that have environmental or consumer health implications, such as hazards in the manufacture of flavorings. It is increasingly difficult to arouse indignation about the "quiet" toll of work-related injuries, illnesses, and deaths that occur throughout the year.
5. It is increasingly challenging to tailor risk communication to address the specific needs and learning styles of many different audiences.

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