SUBJECT

RISK ANALYSIS

SESSION 10 Risk Communication

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Risk Communication

Crisis and Emergency Risk Communication is an approach to communicating effectively during emergencies. These principles are used by public health professionals and public information officers to provide information that helps individuals, stakeholders, and entire communities make the best possible decisions for themselves and their loved ones. CERC recognizes that during emergencies, we work under impossible time constraints and must accept the imperfect nature of our choices. CERC draws from lessons learned during public health emergencies and research in the fields of public health and emergency risk communication.

The CERC program consists of 1) training, 2) resources, and 3) shared learning.

Risk Communication: Working With Individuals and Communities To Weigh the Odds

Risk communication (RC) is a complex, multidisciplinary, multidimensional, and evolving process of increasing importance in protecting the public's health. Public health officials use RC to give citizens necessary and appropriate information and to involve them in making decisions that affect them-such as where to build waste disposal facilities.

In its most familiar form, RC is associated with dialogue in environmental health decision-making about such community issues as air pollution, hazardous waste sites, lead, pesticides, drinking water, and asbestos. Risk communication can also help promote changes in individual behavior such as in informing homeowners about the need to check for indoor radon or lead-based paint.

Principles of Risk Communication

The National Research Council (NRC) defines risk communication as "an interactive process of exchange of information and opinion among individuals, groups, and institutions." The definition includes "discussion about risk types and levels and about methods for managing risks." Specifically, this process is defined by levels of involvement in decisions, actions, or policies aimed at managing or controlling health or environmental risks. (See Figure 1 on page 2 for the seven RC principles.)

Risk communication theory and practice may include public participation and conflict resolution, and be intertwined with risk assessment and risk management-concepts usually not addressed by traditional health communication models. Traditional messages about health risk tend to flow one way to motivate individual behavioral change among stakeholders and policymakers. Effective risk communication is an exchange, a two-way process with participation seen as an individual's and a community's democratic right. Conflict resolution can be a goal because risk information often is controversial-community members, activists, government officials, scientists, and corporate executives may disagree about the nature, magnitude, or severity of the risk in question. RC can highlight more clearly the nature and size of the conflict, leading the way to a more informed dialogue. RC can support a consensus-building process but is not designed to eliminate dissent. Informed dialogue and consideration of community concerns facilitate effective policy- and decisionmaking if RC principles are applied.

According to the National Research Council, the RC "process can be considered successful only to the extent that it, first, improves or increases the base of accurate information that decision makers use, be they government officials, industry managers, or individual citizens, and, second, satisfies those involved that they are adequately informed within the limits of available knowledge." Ultimately, measurement of RC success depends on the purpose of the exchange. For example, an increase in the number of homeowners aware of radon as a problem is a different measure of RC accomplishment than the number of people who take action.

Foundation of Risk Communication

Risk communication is a relatively new field. In the mid-1980s RC became recognized as a necessary component in risk management and community decisionmaking in environmental and occupational health as the Nation faced mounting concern over toxic wastes, nuclear power plants, and hazardous materials. Since the first national conference on risk communication in 1986, the RC field has matured and gained greater interest and attention among agencies, policymakers, the media, and the public.

Risk communication has grown out of the work in methods for estimating risk to humans exposed to toxicants and in research directed to how individuals perceive risk. In 1983 the NRC's Risk Assessment in the Federal Government: Managing the Process provided the framework for improving risk assessment. In 1986, the U.S. Environmental Protection Agency (EPA) established its guidelines for carcinogen risk assessment, the first Federal agency to do so. Three years later the NRC published Improving Risk Communication, describing the basis for successful risk communication.

Benefits and Barriers

Risk communication benefits include improved decisionmaking, both individually and collectively. The purpose of the exchange and the nature of the information have an impact on the benefits. Depending on the situation, personal and community anxieties about environmental health risks can be reduced or increased. For example, a goal might be raising concern about radon and prompting action.

Other benefits of the RC process include a better educated public, an appreciation of limited resources and difficult choices, increased coordination between various levels of government, and the development of working relationships between diverse interest groups such as the Sierra Club and the Chemical Manufacturers Association, to name an example from a project in the State of Washington. As citizens become more involved as participants, they become part of and contribute to the solution.

Because the RC process is so deeply embedded in broader social issues, barriers and problems are many. A key barrier is the term 'risk' itself--how it is measured, described, and perceived: Interested parties perceive risk differently. People do not believe that all risks are of the same type and size. Many consumers do not understand probabilities--a .05 probability is less comprehensible than the statement, "5 of 100 people have an increased risk for a disease." Figure 2 on page 4 shows some of the factors influencing risk perception.

Conflicting risks and messages, difficulty of translating scientific information, and disagreement on what is the risk itself and how to assess it present other problems. Barriers also exist in agencies' lack of RC expertise and in organizational cultures unfamiliar or uncomfortable with two-way processes.

Public and Private Sector Activities

Public and private organizations are studying ways to overcome the problems and barriers to effective risk communication. Within the Public Health Service (PHS), U.S. Department of Health and Human Services (DHHS), the Environmental Health Policy Committee's new Subcommittee on Risk Communication and Education has set priorities for policies, training, and evaluation. In its 1994 report, "Recommendations To Improve Health Risk Communication," the subcommittee presented an analysis of RC policies and procedures across PHS agencies with the goal of helping public health professionals carry out RC activities. The subcommittee plans to publish the Health Risk Communicator, a quarterly newsletter that will provide a forum for the exchange of news and ideas about contemporary health risk communications.

Recently the subcommittee assessed agencies' RC interests and activities, including the National Aeronautics and Space Administration's hazards communication program and RC training in the Army, Navy, and Air Force. RC issues are on the agendas of the Peace Corps, U.S. Department of Energy (DOE), and National Institute of Occupational Safety and Health.

Within PHS, the Agency for Toxic Substances and Disease Registry (ATSDR) has funded workshops, developed materials, and increased its capabilities in RC. Most recently, ATSDR has published A Primer on Health Risk Communication Principles and Practices and expanded its electronic communications activities with a home page on the Internet.

Through its World Wide Web site, ATSDR provides Internet users with database access and other resources and promotes more universal access to risk information. Many government units have established electronic bulletin board systems, hotlines, and clearinghouses to make databases and all forms of information available. The National Institute of Environmental Health Sciences offers a toll-free number and other services through its ENVIRO-HEALTH Clearinghouse.

Last year, the former Subcommittee on Risk Communication and Education of the Committee To Coordinate Environmental Health and Related Programs sponsored a workshop on Applied Evaluation Methods for Health Risk Communications. Health and risk communicators from PHS and other Federal agencies discussed evaluation methods, strategies, and needs and reviewed case studies. Proceedings will be published this spring.

Rutgers' Center for Environmental Communication conducts research on how to improve communication about environmental issues and distributes a list of more than 100 publications available from the center, including a manual for government risk communicators. (Figure 3 displays questions from a popular center publication.)

Other universities and researchers are studying elements of RC. With funding from the National Science Foundation and the U.S. Department of Agriculture, Penn State University is investigating how people change their perceptions after receiving information about climate changes and threats. Carnegie Mellon University researchers are developing "mental models" or intuitive theories of how risks operate.

Organizations are putting RC theories into practice. The National Association of County and City Health Officials (NACCHO) provides training and materials and soon will release Don't Hazard a Guess: The Essential Guide to Communities, Hazardous Waste Sites, and Local Public Health. This handbook has a chapter

on RC principles and discusses the importance of community involvement and RC strategies. NACCHO is packaging for release this summer its 1-day training course for developing skills in RC and working with communities. NACCHO's sponsorship of such RC projects follows an assessment in which members ranked RC first in their educational needs for addressing environmental health problems.

Next Steps

Scheduled for publication in the April issue of the journal Risk Analysis are the proceedings of a national symposium on RC in 1994 where academics and practitioners explored next steps for agencies. Sponsors were DOE (through the National Conference of State Legislatures), EPA, National Cancer Institute, and the National Science Foundation. When describing the challenges of RC and their needs, participants described three priorities for research, training, and action. First is the how of public participation-how to begin and facilitate a dialogue given conflicts and issues related to relationships, data, interests, structure, and values-how to integrate outside concerns with agency decisionmaking. Second is the how of communicating with different social and cultural groups-a broad need with particular significance in the environmental justice movement (see Spotlight). Needed is guidance on language, format, and distribution of messages and materials. The third how concerns evaluation-measuring RC success and outcomes.

Effective RC is important to the accomplishment of many Healthy People 2000 objectives, including the 16 objectives for environmental health that cover a broad range of exposure media-air, water, soil, and groundwater-as well as a variety of pollutants such as radon, toxic chemicals, and lead. Also necessary is a clear and common vision of environmental risk communication's role in prevention. Ongoing public and private efforts in RC evaluation research, training, and technical assistance will help the Nation address environmental health as a continuing and serious public concern into the next century.

* From Jefferson's letter to William Charles Jarvis, Septemer 28, 1820, as quoted by EPA Administrator William Ruckelhaus in a 1983 speech before the National Academy of Sciences when he argued that government must accommodate the will of the people and called for a governmentwide process for managing risks that thoroughly involved the public.

Figure 1. Principles of Risk Communication

There are seven cardinal rules for the practice of risk communication, as first expressed by the U.S. Environmental Protection Agency and several of the field's founders:

1. Accept and involve the public as a legitimate partner.
2. Plan carefully and evaluate your efforts.
3. Listen to the public's specific concerns.
4. Be honest, frank, and open.
5. Coordinate and collaborate with other credible sources.
6. Meet the needs of the media.
7. Speak clearly and with compassion.

Source: Seven Cardinal Rules of Risk Communication. Pamphlet drafted by Vincent T. Covello and Frederick H. Allen. U.S. Environmental Protection Agency, Washington, DC, April 1988, OPA-87-020.

Figure 2. Factors Influencing Risk Perception

People's perceptions of the magnitude of risk are influenced by factors other than numerical data.

Risks perceived to ... are more accepted than risks perceived to ...

Be voluntary Be imposed

Be under an individual's control Be controlled by others

Have clear benefits Have little or no benefit

Be fairly distributed Be unfairly distributed

Be natural Be manmade

Be statistical Be catastrophic

Be generated by a trusted source Be generated by an untrusted source

Be familiar Be exotic

Affect adults Affect children

Source: A Primer on Health Risk Communication Principles and Practices. Prepared by Max R. Lum, Ed.D., M.P.A., and Tim L. Tinker, Dr.P.H., M.P.H. Washington, DC: U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry. 1994. Adapted from Acceptable Risk by Baruch Fischoff, Sarah Lichtenstein, Paul Slovic, Stephen Derby, and Ralph Keeney. New York: Cambridge University Press. 1981.

Figure 3. Communicating With the Public: 10 Questions To Ask

1. Why are we communicating?
2. Who is our audience?
3. What do our audiences want to know?
4. What do we want to get across?
5. How will we communicate?
6. How will we listen?
7. How will we respond?
8. Who will carry out the plans? When?
9. What problems or barriers have we planned for?
10. Have we succeeded?

11. **Risk Analysis Techniques**
12. **1. Brainstorming**
13. Is used extensively in formative project planning and can also be used to advantage to identify and postulate risk scenarios for a particular project. It is a simple but effective attempt to help people think creatively in a group setting without feeling inhibited or being criticized by others.
14. The rules are that each member must try to build on the ideas offered by preceding comments. No criticism or disapproving verbal or nonverbal behaviors are allowed. The intent is to encourage as many ideas as possible, which may in turn, trigger the ideas of others.
15. **2. Sensitivity Analysis**
16. Sensitivity analysis seeks to place a value on the effect of change of a single variable within a project by analyzing that effect on the project plan. It is the simplest form of risk analysis. Uncertainty and risk are reflected by defining a likely range of variation for each component of the original base case estimate. In practice such an analysis is only done for those variables which have a high impact on cost, time or economic return, and to which the project is most sensitive.
17. Some of the advantages of sensitivity analysis include impressing management that there is a range of possible outcomes, decision making is more realistic, though perhaps more complex. And the relative

importance of each variable examined is readily apparent. Some weaknesses are that variables are treated individually, limiting the extent to which combinations of variables can be assessed, and a sensitivity diagram gives no indication of anticipated probability of occurrence.

18. **3. Probability Analysis**
19. Probability analysis overcomes the limitations of sensitivity analysis by specifying a probability distribution for each variable, and then considering situations where any or all of these variables can be changed at the same time. Defining the probability of occurrence of any specific variable may be quite difficult, particularly as political or commercial environments can change quite rapidly.
20. As with sensitivity analysis, the range of variation is subjective, but ranges for many time and cost elements of a project estimate should be skewed toward overrun, due to the natural optimism or omission of the estimator.
21. **4. Delphi Method**
22. The basic concept is to derive a consensus using a panel of experts to arrive at a convergent solution to a specific problem. This is particularly useful in arriving at probability assessments relating to future events where the risk impacts are large and critical. The first and vital step is to select a panel of individuals who have experience in the area at issue. For best results, the panel members should not know each other identity and the process should be conducted with each at separate locations.
23. The responses, together with opinions and justifications, are evaluated and statistical feedback is furnished to each panel member in the next iteration. The process is continued until group responses converge to s specific solution.
24. **5. Monte Carlo**
25. The Monte Carlo method, simulation by means of random numbers, provides a powerful yet simple method of incorporating probabilistic data. Basic steps are:
26. a. Assess the range of the variables being considered and determine the probability distribution most suited to each.
27. b. For each variable within its specific range, select a value randomly chosen, taking account of the probability distribution for the occurrence of the variable.
28. c. Run a deterministic analysis using the combination of values selected for each one of the variables.
29. d. Repeat steps 2 and 3 a number of times to obtain the probability distribution of the result. Typically between 100 and 1000 iterations are required depending on the number of variables and the degree of confidence required.
30. **6. Decision Tree Analysis**
31. A feature of project work is that a number of options are typically available in the course of reaching the final results. An advantage of

decision tree analysis is that it forces consideration of the probability of each outcome. Thus, the likelihood of failure is quantified and some value is place on each decision. This form of risk analysis is usually applied to cost and time considerations, both in choosing between different early investment decisions, and later in considering major changes with uncertain outcomes during project implementation.

32. **7. Utility Theory**
33. Utility theory endeavors to formalize management's attitude towards risk, an approach that is appropriate to decision tree analysis for the calculation of expected values, and also for the assessment of results from sensitivity and probability analyses. However, in practical project work Utility Theory tends to be viewed as rather theoretical.
34. **8. Decision Theory**
35. Is a technique for assisting in reaching decisions under uncertainty and risk. All decisions are based to some extent on uncertain forecasts. Given the criteria selected by the decision-maker, Decision Theory points to the best possible course whether or not the forecasts are accurate.
36. **The Quality Risk**
37. This risk can best be expressed by the question: "What if the project fails to perform as expected during its operational life?" This may well be the result of less than satisfactory quality upon project completion, and is especially true if quality is not given due attention during the project life cycle. Since the in-service life of the resulting product is typically much longer than the period required to plan and produce that product, any quality shortcomings and their effects may surface over a prolonged period of time.
38. Consequently, of all the project objectives, conformance to quality requirement is the one most remembered long after cost and schedule performance have faded into the past. It follows that quality management can have the most impact on the long-term actual or perceived success of the project.
39. **Risk Perceptions**
40. 1. People do not, in fact, demand zero risk. They take risk every day, both consciously and subconsciously, and they are willing and able to take benefit/risk decisions, as in driving and speeding.
41. 2. Peoples' judgment of degrees of risk is not, however, coincident with most methodologies for measuring risk statistically. The public may greatly underestimate familiar risks (e.g. driving) while greatly overestimating unfamiliar risks (e.g. buying a home near a nuclear facility).
42. 3. A variety of emotional, not logical, factors control risk perceptions:
43. a. Primary is the sense of personal control and the ability to mange the risk
44. b. Secondary are qualities of familiarity and conversely, dread. The greater the unfamiliarity and potential for connection to gruesome, the more it is likely to be judged as highly risky and therefore unacceptable.

45. 4. Once established, risk perceptions are extremely hard to change. New information may be absorbed by the intellect, but it is not readily absorbed at an emotional level.
46. 5. Risk perceptions reside fundamentally at an emotional level.

Risk Factors

Uncertainty

Lack of knowledge of future events

Goals of PRM

To identify project risks and develop strategies which either significantly reduce them or take steps to avoid them.

Opportunity

The probability those outcomes will be favorable.

Risk

The probability those outcomes will be unfavorable.

Project Risk

Is the cumulative effect of the chances of uncertain occurrences adversely affecting project objectives.

Risk Factors

1. **Risk Event – Precisely what might happen to the detriment of the project**
2. Risk Probability – How likely the event is to occur
3. Amount at Stake – The severity of the consequences

Probability

Probability = Frequency of relevant events

Total number of possible events

Risk Event Status (criterion value or ranking)

Risk Event status = risk probability x amount at stake

Processes

1. Risk Identification

Determining which risks are likely to affect the project and documenting the characteristics of each. Can be classified as:

a. *Scope* – Risk associated with changes of scope or the subsequent need for "fixes" to achieve the required technical deliverables.

b. *Quality* – Failure to complete tasks to the required level of technical or quality performance

c. *Schedule* – Failure to complete tasks within the estimated time limits, or risks associated with dependency network logic

d. *Cost* – Failure to complete tasks within the estimated budget allowances

2. Risk Quantification

Evaluating risks and risk interactions to assess the range of possible project outcomes.

3. Risk Response Development

Defining enhancement steps for opportunities and responses to threats.

4. Risk Response Control

Responding to changes in risk over the course of the project.

<u>Identification</u>

1. Inputs

a. Product description

Risk depends on the nature of the product. Proven technology has less risk than products requiring innovation and invention.

b. Other Planning outputs

Review outputs from the processes for possible risks, e.g., WBS, cost estimates and schedule duration's, staffing plan, procurement management plan.

c. Historical information

2. Tools and Techniques

a. Checklists

b. Flowcharting

Helps understand the cause and effects of risks.

3. Outputs

a. Sources of Risks

This includes such items as stakeholder actions, unreliable estimates, team turnover, changes in requirements, insufficiently skilled staff.

b. Potential Risk Events

Precisely what might happen to the detriment of the project, such as natural disasters, requirement for development of new technology, etc.

c. Risk symptoms

These sometimes are called triggers, early warning of an impending event, etc.

d. Inputs to other processes

Risks can be inputs to other processes as constraints or assumptions.

Quantification

1. Inputs

a. Stakeholder risk tolerances

This provides a screen for both inputs and outputs to risk quantification.

b. Sources of risk

c. Potential risk events

d. Cost Estimates

e. Activity duration estimates

2. Tools and Techniques

a. *Expected Monetary value*

This is the product of risk event probability of occurring times the risk event value (could be a gain or loss).

b. Statistical sums

This calculates the range of alternative project budgets from the cost estimates for individual work items.

c. Simulation

The most common is Monte Carlo analysis, which is used to analyze the behavior or performance of the system. The results of a schedule simulation may be used to quantify the risk of various schedule alternatives, different project strategies, and different paths through the network or individual activities.

d. Decision Tree

e. Expert Judgment

3. Outputs

a. Opportunities to pursue, threats to respond to

This is a list of opportunities that should be pursued and threats that require attention.

b. Opportunities to ignore, threats to accept