Training for Safety in Emergencies

Inoculating for Underground Coal Mine Emergencies

By Catherine Y. Kingsley Westerman, Katherine A. Margolis and Kathleen M. Kowalski-Trakofler

IN BRIEF

- **Emergency training for underground coal miners can be developed using inoculation theory, which has been used to explain how people may resist unwanted persuasion attempts by preparing counterarguments in advance.**
- **This theory is relevant in an emergency training context when used to help people react quickly and effectively to emergencies by preparing their responses in advance.**
- **The researchers used a NIOSH training module as an example of how the theory may be applied in a training context to prepare workers psychologically for emergencies in underground coal mines, but the concepts can be applied in other industries that require emergency safety training.**

The potential for emergencies is ever-present in coal mining. This is illustrated by statistics which show that "employees in coal mining are more likely to be killed or to incur a nonfatal injury or illness, and their injuries are more likely to be severe, than workers in private industry as a whole" (Rice & Jonocha, 2008, p. 1). As a result of this constant exposure to harm, coal miners must be highly trained to deal with various emergency scenarios. For example, all underground coal miners must learn how to operate lifesaving emergency equipment, how to navigate out of the mine through smoke or obstacles, and how to administer first aid. This knowledge can help save lives in the event of an emergency.

Some existing underground coal mine training focuses on rote performance of prescribed actions. For example, coal miners are taught when and how to put on self-contained self rescuers (SCSRs), which are respirators that provide 60 minutes of breathable air. More specifically, they learn a rote procedure for donning SCSRs that is reviewed each quarter (Vaught, Brnich, Wiehagen, et al., 1993). Such preparation provides a basic survival skill and gives miners a good rule of thumb for what to do in an emergency.

Unfortunately, it is impossible to prepare for every potential situation because emergencies are unpredictable. When escaping miners encounter a situation that requires them to make a difficult decision, they may waste precious time considering or discussing what to do. In addition, they may not know how to take action when working with a group of people who have various and potentially disturbing reactions to the emergency. One way to help miners react quickly and effectively in such situations is to have them think through possible situations and plan their likely responses in advance.

This article describes using inoculation theory principles to prepare miners for emergencies. This is a unique application in that, to the authors' knowledge, these principles have not previously been applied in emergency preparation training.

Preparation based on inoculation theory principles differs from more traditional training in that it involves teaching trainees to think for themselves rather than simply teaching them how to perform a task or use a safety device. The simplicity of inoculation theory lends itself to trainers with content-area expertise who may not have formal training in adult education. This is particularly important in the mining industry, which relies on the master/apprentice style of teaching (Camm & Cullen, 2002), with older, experienced workers pulled from the mine to be-

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come safety trainers. These workers' expertise is in mining, not teaching. Inoculation theory principles may be used by trainers to develop new materials or to modify existing training materials.

This article defines inoculation theory, briefly discusses its past use, and provides a brief example of how the theory can be applied when using a training module. In addition, it suggests how practitioners can apply the principles of this theory to their own emergency preparation training.

Inoculation Theory Explained

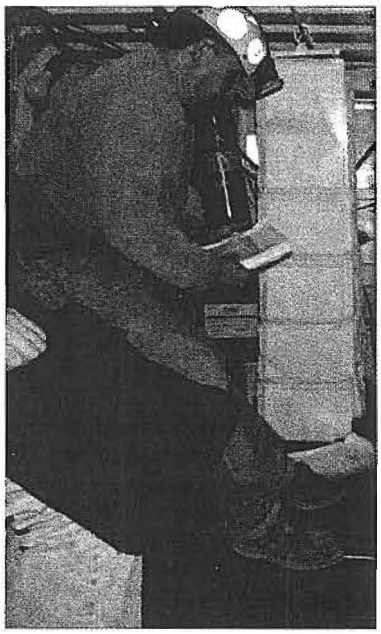
Inoculation theory was originally explicated by McGuire (1961), who uses a medical analogy to explain the use of persuasive messages to change attitudes. The medical analogy is straightforward: similar to inoculation for a disease, wherein a weakened version of the disease is injected to help the individual develop immunity to the disease, inoculation for persuasive messages involves exposing people to a weakened form of counterargument to their already held beliefs in order to enable them to resist counterarguments when their beliefs are attacked. Inoculation theory has been applied successfully in areas such as advertising (Bither, Dolich & Nell, 1971; Compton & Pfau, 2004); public relations (Burgoon, Pfau & Birk, 1995); political campaigns (An, 2003; An & Pfau, 2004); and adolescent health campaigns—particularly to help adolescents resist peer pressure to drink alcohol (Duryea, 1983; Godbold & Pfau, 2000).

McGuire (1961) suggests that people tend to avoid information that disagrees with their beliefs. As a result, when their beliefs are attacked, they are particularly vulnerable because they are not expecting the attack and are unprepared for the arguments against their beliefs. In the case of a mine emergency, it may be that miners believe it will not happen at their mine or, if it does, that their buddy Al will know what to do—they may avoid the idea that it could happen and that Al might not be there. Thus, they may feel confident that an emergency will not happen or, if it does, that someone else will make sure they are okay. When an emergency does occur, these individuals could be highly vulnerable because of a lack of preparation.

Inoculation theory requires that two elements be present: threat and refutational preemption (Compton & Pfau, 2005). Threat, defined as "a warning of possible future attacks on attitudes and the recognition of attitude vulnerability to change" (Szabo & Pfau, 2002, p. 235), is necessary to motivate an individual to prepare to defend his/her belief.

For example, let's assume that Jack believes it is important to follow the safety procedures at his manufacturing job exactly as written. A threat could be generated through a warning that some people think following safety procedures slows them down and that someone may try to convince Jack that it is not necessary to follow all the procedures as written. Refutational preemption, which Szabo and Pfau define as "the process of replying to counterarguments before they occur" (p. 235), gives individuals the tools (i.e., refutations) to use against future attacks as well as giving them practice in how to generate their own tools.

Relative to the cited example, a refutational preemption might occur when Jack is told a story about a person who was careless about safety procedures and was injured as a result. Jack could then use this anecdote (i.e., refutation) when he encounters those who do not believe safety procedures must be followed exactly. In addition, hearing this story might spur Jack to think of additional reasons why he wants to follow safety procedures as written. As a result of formulating his own reasons, he will be armed both with the refutation given to him (the anecdote) and his own personal refutations that he



In the case of the refuge chamber module used to test this application of the theory, the refutational preemption gives miners the knowledge that all the physiological and psychological reactions discussed in the training are normal and expected.

has now generated in advance of a confrontation.

Application of these principles in an emergency preparation setting is simple. Expose miners to the idea that an emergency can happen and what it will be like if it does (i.e., threat); then provide miners with some ways of dealing with the emergency (i.e., conduct a refutational preemption to provide tools) and engage them in thinking about how they would respond in an actual emergency. This should help miners deal with emergencies more efficiently and potentially more effectively than had they not thought through the possibilities and potential responses in advance. By exposing individuals to this weakened "emergency reality," inoculation training can increase their ability to survive emergencies in two ways: 1) by providing them with tools to counteract the emergency situation; and 2) by prompting them to come up with their own plans for such a situation.

Although inoculation theory has not previously been used to prepare for emergencies, researchers in emergency management research and training have suggested that advance preparation for emergencies is warranted (Colligan & Cohen, 2004). In an experiment, Boer (2002) observes that when drivers entered a tunnel and became stuck behind a smoking vehicle, they were slow to act (e.g., waited in cars or left cars but did not use emergency exit doors). Boer recommends that advance instruction for drivers in this area would improve their evacuation behavior during a real tunnel emergency.

Ockerby (2001) also recommends that people should be trained in forms of behavior under stress. He found that in past emergencies, the perception that warning people would cause a panic resulted in delayed evacuation efforts and worse consequences. If people are familiar with the situation and know what to do, they can carry out a behavior such as evacuation. A study by Harbst and Madsen (1993) shows that once people are properly warned of an emergency situation, 85% will take protective action and less than 3% will panic.

Klein (1989) also supports the importance of advance preparation. In his recognition-primed decision model of decision making, Klein suggests that if decision makers are already familiar with a given situation, then they immediately have available information specific to that situation, including plausible goals, critical cues and causal factors, expectancies and typical actions. These decision makers will immediately be able to select a workable course of action based on their experience. Applying the principles of inoculation theory in mining or similar industries would provide workers with this type of knowledge.

In the context of mine emergencies, familiarizing miners with potential situations and how they may handle them in advance will help them in a real emergency. Vaught, Brnich, Mallett, et al. (2000), provide an example of a mine emergency simulation. They suggest that although vicarious experience of a mine emergency is not enough preparation for a real emergency, it is superior to having had neither preparation nor advance discussion of decisions and issues that will undoubtedly arise in an emergency.

Inoculation theory can provide a basis for developing a store of information and responses to emergency situations. The mining industry in particular has relied "heavily on the mentor/learner (master/apprentice) relationship to train new miners" (Camm & Cullen, 2002, p. 37). Because of the technical nature of mining, trainers are often pulled from mining ranks and do not receive specialized training in education. Rather, they are content experts. The principles of inoculation theory are sufficiently basic that they can easily be understood and applied when developing new training or modifying existing training.

Sample Application: Refuge Chamber Expectations Training

The training used as an example was designed for underground coal miners. Refuge Chamber Expectations Training (Margolis, Kowalski-Trakofler & Kingsley Westerman, 2009) teaches miners about the physical and psychological conditions they may experience if they become trapped in a mine during an emergency and must enter a refuge chamber.

To clearly explain the example, a brief review of refuge chambers and the program itself is provided (for full details, see Margolis, et al., 2009). In short, refuge chambers are kept at specified intervals in an underground coal mine to provide a safe haven for trapped miners; chambers contain breathable air, food, water, waste disposal, first-aid supplies and other necessities that will support life for 96 hours. In the event of an emergency, miners are strongly advised to escape the mine if possible; however, if they are physically blocked from exiting the mine or cannot walk out of a mine, they may need to enter a refuge chamber to be protected from a potentially toxic and smoky atmosphere until they can be rescued. This program describes the physiological and psychological responses miners may have to being in a confined space for up to 4 days.

Based on inoculation theory principles, training should include two elements: threat and refutational preemption. Such training should also include practice at generating tools. Therefore, training should aim to provide enough exposure to the circumstances of a traumatic event to stimulate an individual's defenses (i.e., threat). Training also should include a refutational preemption; that is, miners should be given a refutation to the threat—a tool to help them deal with the situation. In addition, training should stimulate the miners to generate their own tools for potential emergencies. Table 1 provides examples of elements from using inoculation theory in a training program.

The training shows participants the potential

Table 1

Inoculation Theory Applied to Training

Elements needed for inoculation	Refuge chamber expectations training example	Sample of content
Threat	Content on disturbing physical and psychological symptoms	People may behave aggressively.
Refutation/tool	Content on "normal" responses	It is to be expected that some people will react in this way during a stressful situation.
Practice at generating tools	Post-viewing discussion questions on how trainees might handle different reactions	Did you know how people may respond emotionally? For example, some may get quiet? What might you do to handle this?

threat by discussing some physical and psychological responses they might experience in a refuge chamber, including responses such as sweating, body aches, and aggressive or withdrawn behavior. The refutational preemption gives miners the knowledge that all the physiological and psychological reactions discussed in the training are normal and expected. Another element to combat the threat of physiological and psychological responses is the information that contrary to popular knowledge, people do not tend to panic in an emergency (Ockerby, 2001; Harbst & Madsen, 1993). Simply possessing this knowledge can help a miner avoid panicking and concentrate on the situation at hand.

The training also provides some practice at generating solutions to the threat in the postviewing discussion questions. These questions specifically ask trainees to think about how they would handle the responses described in the program. The instructor is encouraged to generate more discussion targeted to the particular group and the potential issues at the specific mine where the training is being conducted.

Applying Inoculation Theory

To apply inoculation theory when developing new training or modifying existing training, one must remember three main components: generate threat, give tools and practice developing tools. One way to generate threat would be to discuss salient examples of emergencies. Research on adult education suggests that "adults are motivated to learn as they experience needs . . . that learning will satisfy" (Knowles, Holton III & Swanson, 2005, p. 39). Establishing a threat's existence by giving examples and scenarios demonstrates to trainees that they need to learn about these emergency situations and, thus, should enhance their learning.

For example, trainers could discuss injuries that have occurred or present real-life scenarios about people who were in emergency situations. Trainers in the mining industry can access real accident reports through MSHA's digital library (**www.msha.gov/training/library/mshaportal/index.html**). Other industries may have similar reports or existing training scenarios that would be applicable. In addition, some trainees may have experience with emergencies that they can share.

Providing tools to trainees simply involves teaching them some ways of dealing with the threat presented in training. These tools are likely already the main focus of existing training; they may be safety devices, such as refuge chambers or ear plugs, or they may be procedures, such as knowing the chain of command for reporting a mine emergency.

Finally, trainers must engage trainees in generating their own tools to use in emergencies by asking what they would do in an emergency. One technique for achieving this is role-play. Role-playing directly involves trainees (Lawson, 2009) and compels them to think about how they would react. Brainstorming as a group or working in teams to solve a problem may also help trainees.

For example, suppose decision making is one focus. Coal miners must decide what to do with an injured worker (e.g., leave him behind or stay together). It would be useful to role-play or generate ideas in teams to simulate the conditions of group decision making. Inoculation theory principles may be best suited to training that deals with situations which have uncertainty surrounding them, such as injured workers or other uncomfortable situations. They may not be as necessary or useful for rote training (e.g., operation of a refuge chamber), although they could be used to think through responses if a device does something unexpected.

Inoculation theory also could be applied to other fields that require quick responses to situations that involve uncertainty. For example, the theory could have been used in an attempt to avoid the *Challenger* explosion in 1986. This explosion was traced back to failed O-rings on the shuttle; it was determined the explosion was preventable. The problem was poor communication among engineers, their managers and high-level decision makers. Engineers knew the launch was not safe because of the low temperatures on the day of the launch; however, under pressure to produce, managers reversed their recommendation to halt the launch.

Training to address this issue remains key in industries where high-level officials with decision-making power may not be as familiar with the workings of products as those performing the work. In this case, workers in a training session would be presented with a threat that in a high-pressure product launch situation, decision makers may not listen

to expert advice if that advice is negative. Refutational preemption could be carried out by sharing the *Challenger* story as an anecdote about the results of overruling the advice of those most familiar with the product. Refutational preemption also could include providing the name of a high-level person with whom concerns about the product launch can be shared and who will then present them to high-level decision makers. During the training, workers also could be encouraged to generate ideas about what they would do if they urgently needed to stop a product launch for safety reasons but decision makers would not listen to their concerns.

Inoculation theory also may be useful for training workers in an industry such as steel, oil or nuclear power who must know how to respond on the spot if emergencies arise. For example, a steel worker may see an emergency developing and know that the best solution is to shut down the production line. However, s/he may believe the boss will disagree with that decision and, therefore, may hesitate to take action. Inoculation theory training would help demonstrate to the worker that a threat exists (e.g., supervisor's opinion that production should never be shut down) and provide a refutational preemption by giving the trainee some tools for dealing with the threat (e.g., pointing out the company's value statement that safety is number one and production is number two). Finally, trainees could be asked to devise their own solutions to the situations.

Conclusion

The principles of inoculation theory can be used for emergency safety training for miners as well as for workers in other high-risk industries. Trainers with content expertise should be able to apply these principles and practice using the tools. Although the main example focused on training miners for incidents involving refuge chambers at underground coal mines, other mine emergency response groups such as command center personnel and mine rescue teams, along with workers in high-risk industries, firefighters, police and other first responders, could benefit from using these principles to prepare for emergencies. **PS**

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