Leadership Training: A New Application of Crisis Resource Management and Distance Education in a Large Group Format at a Medical Simulation Facility

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Abstract

Introduction: Leadership and teamwork skills must be practiced to gain full value from a leadership course. The leadership role is one of the main points highlighted during a Crisis Resource Management (CRM) session. While a typical CRM session offered in a medical simulation laboratory uses a medical crisis to elicit behaviors for videotaping and debriefing, the CRM principles are generic and applicable to leadership training outside medical practice.
Methods: The Simulation Development and Cognitive Science Laboratory of the Pennsylvania State University College of Medicine offered a CRM course to high school students using a pediatric full human simulator (M.E.T.I.) The students rotated through two sessions: as hands-on participants in the Simulation Laboratory, and in a remote education mode. During the remote session, they viewed their peers via a video link, discussed the crisis and were able to assist their peers.
Results: The 17 students valued the overall session at a high level (4.9 ± 0.2 on a five-point scale; mean ± SD). The majority of students (n=10) indicated that they felt involved in both the hands-on and remote sessions (³7 on a ten-point scale).
Conclusion: Based on the results, all participants believed the session was of great value and that they could use CRM principles in everyday situations. We believe that the participants found significant value in the CRM session as a leadership skills resource. Most students also felt involved in the remote sessions, thereby enabling a larger group of trainees to learn about and experience CRM principles.

Key words: Simulation, distance education, Crisis Resource Management, CRM, ACRM, leadership, full human simulator, large group, high school students

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Introduction

Leadership and teamwork skills need to be practiced to gain full value from any leadership training course. While some theoretical background and understanding can be learned during a classroom lecture, skills can only be acquired from practical implementation. In "real life", building leadership and teamwork skills includes the possibility for failure, which can be dangerous to others and detrimental to the student's self image. Transporting learning sessions to a simulated environment enables the participants to learn in a safe and less-threatening environment.

Realistic human simulators have only recently become available[1]. In the medical field, sophisticated simulators are available to teach Anesthesia Crisis Resource Management (ACRM)[2] and Crisis Resource Management (CRM)[3]. During CRM sessions, groups of trainees try to resolve a problem. After the simulation is over, trainees watch a video of themselves and examine leadership (or lack thereof) exhibited during the simulation. In this way, the CRM session is a starting point for discussion of leadership and can also provide examples of desirable leadership attributes.

CRM differs from crisis management (see table 1). The knowledge gained from CRM is not specific to a given discipline, i.e., any one of several crises (medical, First Aid, non-medical, etc.) can be presented and the resulting drama still be used for teaching and debriefing. However, the participants should have the knowledge and skills to manage the simulated crisis before any attempt is made to teach the higher level skills of CRM. Hands-on training (familiarization) with equipment and techniques is therefore necessary prior to a CRM session. Typical CRM sessions are usually limited to one or two 'hot seat' participants[2,3,4]. The cost of training large numbers of participants in such small groups can become prohibitive[5].

The primary objective of this education project was to demonstrate the feasibility of using full-scale simulation for leadership training of larger groups. To accomplish this we offered a CRM course featuring hands-on as well as remote sessions to high school students, and compared self-reported involvement. Furthermore, we assessed participants' satisfaction and the perceived value of large group CRM training.

Materials and Methods

With institutional review board approval, a group of 17 high school seniors and four teachers from Bedford, PA, volunteered to attend a four-hour CRM session at the Pennsylvania State University College of Medicine Simulation Lab. All had previously taken cardiopulmonary resuscitation (CPR) courses at school. The session consisted of a familiarization session (simulator, 3 medications, and monitoring equipment), a first crisis event, a lecture on CRM principles emphasizing leadership, a debriefing of the first session with emphasis on examples of desirable leadership. A second crisis session was followed by a second debriefing that again focused on leadership roles and a questionnaire. These steps are discussed in detail below.

The students were given a 60-minute hands-on introduction to the Simulation Laboratory and the pediatric full human simulator (Medical Education Technologies, Inc., M.E.T.I., Sarasota, FL). They were introduced to the monitoring equipment (electro-cardiogram, pulse oxygen monitor and capnogram) and taught how to do a basic clinical examination and administer medication. The use and dosage of oxygen, atropine, epinephrine, and lidocaine was explained. The students were also given training in several basic medical skills (bag and mask ventilation, intubation, and CPR).

The whole group gathered in a room adjacent to the Simulation Laboratory and were given the problem for the first scenario (see appendix A for the scenario). Based on their seating positions, half of the students were selected to return to the Simulation Laboratory to treat the victim while the other half watched them via a live video feed from the adjacent room.

There were three instructors in the Simulation Laboratory: a technician in charge of the computer controlling the simulator, an actor playing the role of a paramedic, and a director in charge of the overall flow of the scenario. At the remote site, one of the teachers acted as the remote director and was in charge of the group discussion. The teacher also supervised the "runner" who would bring information and help (if and when needed) to the hands-on group. All the instructors were in continuous communication with one another via wireless sets (microphone and speaker headsets).

In the Simulation Laboratory, students used the knowledge learned during the introductory session to treat the victim to the best of their abilities. They also had the option of asking for help from their peers. The students were expected to institute therapy without any adult help, although an adult actor (Emergency Medical Technician - EMT) was available to help them should unanticipated procedures be required. The remote participants in the adjacent room were encouraged to discuss the events they were watching over the video feed. They also had the option of sending advice to the hands-on group via a runner.

After the simulation, a 15 minute lecture was given to the whole group outlining the principles of Crisis Resource Management with emphasis on leadership principles (see tables 1 and 3). Examples of CRM principles from a non-medical crisis (a re-enactment of an aircraft accident in a flight simulator showing a lack of leadership) were given.

The whole group then viewed the video of scenario 1 and discussed the CRM principles with emphasis on leadership and teamwork (see table 2). The facilitator limited discussion of medical management (Crisis Management – facts and details). This allowed the majority of the time to be spent discussing the higher levels (concepts) of CRM (see table 1). In an interactive, constructive and non-judgmental environment, the participants were encouraged to point out areas where they could have acted differently and applied CRM principles. The facilitator aimed to avoid labeling actions as "good" and "bad", instead using statements such as "Where is it possible to do it differently next time?"

After this discussion, the second group was given an opportunity to manage scenario 2 (see appendix A) and apply the CRM principles they had just discussed. They were again encouraged to ask for help from the remote group watching events via video. The remote group was also

encouraged to discuss events and send a "runner" with advice when they thought it would be necessary (i.e. indecision on the part of the group in the Simulation Lab). Events progressed so rapidly that, although the remote group was ready to (and decided to) send help, the group in the Simulation Lab came to the same conclusion and instituted the therapy before the runner was sent.

Following the successful outcome of scenario 2, the whole group viewed the video of the second scenario, and discussed points of leadership and team communication which could be approached "differently" in the future. Examples of leadership behaviors were pointed out during the video replay and parallels were drawn with the first video (where less leadership was exhibited). Consequences of a lack of leadership were highlighted.

The students and their teachers completed questionnaires (table 3) exploring their perceptions of the course's value as applicable to leadership and team work (CRM) skills in contrast to learning medical principles. The results are presented as mean ± standard deviation (SD). Results of question 10 (involvement in remote session) were compared with question 11 (involvement in hands-on session) using a Wilcoxon's Signed Rank Test. A value of $p<0.05$ was considered significant.

Results

The training course was attended by 17 twelfth grade students and four adults (teachers) from biology and other science classes. The students chose to attend the session based on a description by their teachers.

During the scenarios in the Simulation Lab, therapy was instituted rapidly, initiated by individuals rather than by discussion and team effort. Both groups (hands-on and remote) seemed to be involved in the simulation and worked actively to achieve a successful outcome. Following the conclusion of the session, all attendees completed the questionnaires (100% return rate). Students attributed an overall high level of value to the training session (see table 3). Teachers rated the session at a high level, uniformly giving 5 out of 5 ratings to the question on overall value (see table 3). Students rated their level of involvement during the hands-on scenario significantly higher than during the remote session ($p < 0.001$, Wilcoxon's Signed Rank Test).

Free text written comments were invited from the students as well as the teachers (see Appendix B). Following the students' return home, each student wrote a thank-you note indicating what they believed they had gained from the session (see Appendix C for examples of comments).

Discussion

Leadership skills are generic across disciplines. The underlying principles are equally applicable in business, medicine, and in high school. Opportunities to practice leadership and teamwork skills in a safe environment (where failure does not lead to embarrassment) are few and far between. Leaders should understand and apply the CRM principles of standing back and of

getting help by allowing others to be involved. The leader's task is to delegate, i.e. manage and direct other members of the team, rather than to perform the task.

In a chapter entitled "Delegation and Team Building: No solo acts please", Thomas R. Horton[6] describes the importance of delegation: "…[leaders] must abandon the attitude of 'If I want anything done I have to do it myself.' [Those] who fail to learn this lesson limit their ability to lead." By delegating, the leader avoids becoming fixated and can stand back to see the big picture. Horton also describes the consequences of not delegating. "Those [leaders] who fail to delegate through fear of failure increase their probability of failure. Those who fail to delegate through arrogance will become humbled…" since there are often team members who can perform certain tasks better than the leader.

When this project was designed, we expected that students might feel less involved during the remote monitoring sessions. The participants' continuous animated discussions as they were viewing the events via the video link, suggested that they were fully engaged in the scenario. However, the results of survey questions #10 and #11 confirm our original suspicion (see table 3). The lower ratings of the remote session were likely the result of a sub-set of five students who felt involved with the hands-on but not the remote session. Nevertheless, all participants stated they would strongly advise their friends to attend a similar session. We speculate that the remote sessions contributed to the learning and satisfaction of the majority of the students, by affording trainees a second opportunity to experience (and learn from) another crisis.

These results suggest that there may be a subgroup of students who must either become more accustomed to remote learning in order to appreciate it, or who seem to find value only in hands-on sessions. An alternative explanation could be that these students were in the group that did the remote session first and consequently felt removed from the action. A third explanation is that a "let-down" phenomenon occurred: after the exciting hands-on environment the remote location paled in comparison. Finally, the nature of the scenarios themselves could have influenced the perceived involvement, some of whom could have promoted greater involvement in a remote session. The surveys we collected were anonymous and did not indicate which session students attended first; therefore we cannot determine which explanation or combination of explanations is the most likely. This issue may be fertile ground for future investigation.

It was interesting to note that one of the students felt more involved in the remote session than in the hands-on scenario. This student may have felt more comfortable giving advice during the remote session than actively participating during the hands-on session. Our high school students may therefore have approached the simulation with different learning styles. This may also be true of medical personnel. The matching of participation level in remote and hands-on sessions with various learning styles could also be the subject of a future study. Studying and understanding the relationship between different learning styles and CRM in non-medical trainees could help tailor future CRM sessions more closely to the needs of individual medical trainees. These basic educational studies could first be performed with non-medical trainees, whose availability for CRM training is often not as severely limited as that of medical trainees.
Another important area for further study is the development of validated measurement tools that are capable of assessing the growth of skills resulting from simulation exercises such as the one presented here. As simulations are incorporated in leadership development courses,

measurement of leadership and teamwork skills need to be available to teachers and learners so that progress toward skills acquisition can be monitored and feedback provided.

Aside from presenting our data on self assessment of simulation participants, we also wish to call attention to several design issues we encountered in constructing and running this simulation exercise. For example, in our simulation, a leader was not appointed before the group was presented with the crisis scenario. This has a tendency to make the reaction to the crisis more chaotic, with duplication tasks and miscommunication. During the debriefing this observation was highlighted to underline the importance of clear leadership. An alternative approach, used when teaching leadership skills to a specific individual, is to appoint the leader before the crisis begins. If time is not a constraint, it may be useful to use both approaches during a series of sessions. This could perhaps allow students who tend to be leaders as well as those who tend to be followers, to develop their teamwork skills.

Because of time limitations, all group members in our simulation entered each scenario simultaneously. Another option is to send students in sequentially[5]. In our previous work[5], a few trainees start and 'discover' the problem. As the scenario progresses, these trainees summon help or the director sends in more trainees. This teaches trainees how leadership can shift between individuals as the demands of the crisis change. It also demonstrates that requesting help is often necessary and constitutes an essential element of CRM principles.

Realistic simulation sessions can be quite stressful to participants since mistakes do occur and are an integral part of the experience. It is important not to embarrass "hot seat" participants. When participants are physically present in the Simulation Lab, they are all participants in the making of decisions and mistakes. When a remote group is observing the action, they could criticize the hands-on group (potentially causing embarrassment) if the remote participants notice something that the hands-on group misses. Through the remote group's interaction with the hands-on group (by sending a runner), they become part of the decision making process. Likewise, they become part of any error and cannot unduly criticize the hot seat group[7].

Adequate background knowledge is very important for participants to be able to manage the scenario. In our simulation, all the skills necessary for the two scenarios were demonstrated and practiced during the familiarization sessions. Thus the students were stimulated rather than intimidated by the scenarios. They could also advance beyond the basic factual details of the crisis and concentrate on learning the higher leadership principles.

The conclusion of the scenario is an important part of the session design. The session should have a satisfactory ending so that the students do not feel that they have wasted their time or that they failed. Because the students have invested so much in the experience, the simulator cannot simply be switched off. We believe that it is essential for an actor (paramedic or physician) to take over the management of the patient before the students leave the simulation environment.

There were several potential secondary gains for the students. In addition to the CRM skills taught during the simulation, the students' CPR and other basic medical skills (First Aid) were refreshed. They could see applications of chemistry (soda lime absorber) and physics (pulse oximeter and capnograph), stimulating their interest in science. Simulations such as these can

make science more interesting than conventional lectures, when used as an exciting adjunct to such lectures.

Conclusions

High school seniors and simulation teachers, who participated in a large group CRM simulation exercise intended to highlight leadership skills, rated the session highly and deemed skills learned as applicable to areas other than medicine. This suggests that participants found significant value in the CRM session as a leadership skills resource.
Our project demonstrates the feasibility of using full-scale simulation with hands-on and remote participation for leadership training. Although students reported higher involvement during the hands-on than remote sessions, the majority of felt involved during both sessions. Even those students who felt less involved during the remote sessions seemed to gain some value from the overall experience. Our observations suggest that large group CRM sessions can be valuable and useful even to non-medical participants.

Table 1: Differences Between Crisis Management and Crisis Resource Management as Applied in Medical Simulation

Crisis Management	Crisis Resource Management
Teaches medical management of the crisis: e.g. asthma, allergy, shock/bleeding - pathophysiology - diagnosis - grading of severity - immediate therapy - drugs, dosages - - complications	Teaches "administration" and team skills: - leadership - communication - using all resources - avoiding fixations - calling for help - being a good follower/contributor (team work)
Knowledge used and taught is based on the specific needs of the actual crisis.	Knowledge used and taught is independent of the actual crisis.
Each specialty/discipline uses a different simulated crisis and learns different aspects of management: e.g. nurse's role in a crisis is different from a physician's role.	Multiple disciplines work together in a team structure. All members of the team learn the same "skills" irrespective of underlying crisis e.g. the nurse is the leader until the physician arrives.

Table 2: Key Concepts of Crisis Resource Management (CRM)

A. ROLES

1. What is a leader?

Steps back and manages an event
Sets clear goals
Organizes the team
Delegates responsibility
Distributes work appropriately

2. What is a follower?

Assumes assigned responsibility
Feeds back event management data
Provides task and cognitive support
"Owns" delegated problems
Roles can be exchanged

B. COMMINICATION

Address people directly – introduce yourself
Declare an emergency – urgency, not panic
Establish your communication paths
Use non judgmental comments
Close the loop - give feedback

C. GLOBAL ASSESSMENT

Step back - physically and mentally
Enables overview of the whole picture
Verbally review patient and situational information
Provide clarity of ideas
Generate new ideas
Avoid fixation errors

D. SUPPORT

Asking for help when needed is a sign of maturity, not of weakness
Incremental help may be called
What sources of help available?
When and who to call for help
Type of help - advice, hands-on, specialized

E. RESOURCES

Prepare for anticipated needs - special carts, memo sheets, first aid sets
Understand the infrastructure
Know how support systems work
Internal and external resources

Table 3: Questionnaire Results of Simulation Training Session Participants (10 point scale; 1=low value, 10=high value).

	Students (n=17)				**Teachers** (n=4)			
How much will these principles that you learned today help you in the future to :	**AVG**	**STD**	**min**	**max**	**AVG**	**STD**	**min**	**max**
1. better deal with people (helpers/bystanders) during a First Aid emergency?	8.8	1.13	7	10	9.5	0.58	9	10
2. better deal with people (helpers/bystanders) during a non-medical problem?	8.2	1.07	6	10	9.3	0.50	9	10
3. understand how a leader should act?	8.6	1.62	5	10	9.8	0.50	9	10
4. apply your leadership skills?	8.2	1.25	6	10	9.0	0.82	8	10
5. analyze a crisis and develop a plan that you, as a leader, can implement?	8.3	0.99	7	10	9.3	0.96	8	10
6. be a better follower?	8.3	1.61	4	10	7.8	3.20	3	10
7. use all the resources available?	8.9	1.00	7	10	8.5	0.58	8	10
8. avoid fixations?	8.6	1.58	6	10	9.5	0.58	9	10
9. call for help?	9.3	0.92	7	10	8.3	3.50	3	10
10. Consider the scenario when you were in the library and watching your friends in the Lab. How much did you feel involved with the scenario?	5.8*	2.59	1	10	7.5	0.71	7	10
11. Consider the scenario when you were in the Simulation Lab (hands-on). How much did you feel involved with the scenario?	8.3	1.55	5	10	n/a	n/a	n/a	n/a
12. Would you advise your friends to attend a session like this?	9.8	0.44	9	10	9.3	0.93	8	10
Please rate this session overall. (5 highest, 0 lowest)	4.9	0.24	4	5	5	0.00	5	5
The following questions were addressed only to the teachers . To what extent do you think this session was useful to:					**AVG**	**STD**	**min**	**max**
13. demonstrate leadership skills ?					9.5	1.00	8	10
14. teach leadership skills ?					8.3	2.22	5	10
15. practice leadership skills ?					9.0	0.82	8	10
16. give a framework for students to further develop leadership skills?					8.5	1.29	7	10

* $p<0.001$ vs. hands-on involvement (question#11).

APPENDIX A: Description of Simulation Scenarios

Scenario 1: A Tired Child

A group of 5 and 6 year old children are on a Wilderness camping trip.
Groups of 4 went on a short orienteering hike on an enclosed farm. One group wandered off through a fence, got lost and used up all their food and water. They drank some river water and ate some plants that they had identified as edible.

After finding a known path again, one of them tripped and fell, severely twisted an ankle and was unconscious for a brief time.

Another one of them, Robin, ran back to call for help while 2 stayed with their injured friend. Robin was quite dehydrated and weak on arrival in the Camp to give the bad news.

An Emergency Medical Technician (EMT) arrived with medical equipment and placed an I/V in Robin's arm. The EMT, adults and children went off to help at the site of injury. One child stayed with Robin.

Robin started to feel even worse and the friend decided to call for help.
Robin can give some of his medical history if the helpers ask:

- 6 years old
- weighs 44 lbs. (20 kg)
- allergic to many pollens, plants (poison ivy), and bee stings
- often gets asthma with severe exercise
- history of epileptic fits (convulsions) with exposure to bright light
- the "edible" plants were some mushrooms
- the river water used to quench their thirst was in a field with cattle

Running of the scenario

- speaking becomes progressively less clear
- pulse becomes slow
- develops bronchospasm and low saturation
- eyes stop blinking (stay open and pupils become fixed and dilated)
- end scenario—with therapy, Robin recovers, adult returns and takes over

Scenario 2: An Unwell Child

5-year-old child named Pat

Story Line:

- group of children on a choir tour to a neighboring town
- many children have influenza (flu)

- Adults at a planning meeting in another building
- Pat says: “I am not feeling too well!”
- messenger comes to the remote site and calls for help

History available from Pat if students ask:

- 5 year old
- 40 lbs.
- vomiting the whole day
- real bad flu with headache and coughing
- could feel the heart skipping beats
- took a friend’s “heart tablet”, does not know what it is
- paramedics were there, placed an I/V. called an ambulance, went to another emergency, left some equipment, left a helper who went to search for the adults

Sequence of events:

- gradually loses consciousness (voice softer and fades away), eyes close
- slow heart rate (bradycardia)
- heart stops (cardiac arrest)
- with appropriate treatment, pulse beat back but irregular rhythm
  rapid atrial fibrillation
- with further treatment, Pat recovers
- end scenario - EMT comes back and takes over

APPENDIX B: Free Text Comments from Survey Forms

Comments by students*

- This session was really informative and can be applied to outside experiences. I'm glad that I chose to come.
- The session gave very useful information for everyday activities and dealing with situations and people.
- The hands on really helped me understand the multiple roles in crisis resource management.
- It was a great experience for me and I feel other students would benefit from it.
- Great program. It helped me to understand crises and how to handle them better. Good simulation of emergency.
- A great learning experience and it was exciting to know you can now help someone in the future.
- I learned a great deal. Very enjoyable trip. Feel privileged to have been able to practice using the simulator. Thank you for sharing.
- I loved how we had the opportunity to interact with the equipment and real-life crisis situation simulations. It was great.
- It was a great experience for us and I'm sure everyone enjoyed it.
- I thought it was very good and informative. It wasn't boring at all.

- I thought it was helpful.
- The dummy was very high tech and fun to use.
- I think that after today's scenario I want to be an OR nurse / doctor.

*There were no negative comments.

Comments by adults on the first part of the questionnaire—Questions 1-12

- Demonstrated leadership skills in multiple situations to make kids think about this in everyday life situations.
- Students learned a lot of medical techniques through 2 situations – first as a learner, second as role-player to reinforce what they learned. It was a great way to become involved in crisis resource management and in the simulation lab.
- Fantastic hands-on with mannequins. Good role-play to develop skills.
- The Dr. was very good with the kids.

Comments by Adults on the leadership section of the questionnaire—Questions 13-17

- It was great for leadership skills and also informative for those that might be thinking of a medical field with situations - to act on their feet.
- I strongly recommend it and will discuss the activities with the students in more detail
- Leadership skills can be taught to an extent but still need to be natural or at times useless without common sense. Book Smart versus Brain Dead

APPENDIX C: Selected Comments From Students' Thank-you Notes.

- I thought the crisis resource management was an excellent idea to present, and your program was a great way to present it. I remembered most everything that was said because of the opportunity to experience an emergency and learn from my mistakes.
- I will remember this experience for the rest of my life. The simulations we did showed me how it is so easy to focus on one event and have something else go wrong without other people's knowledge.
- I can honestly say that this experience was the most interesting field trip I've ever been on. And the best part was that I actually learned something…This [field trip] was different because we actually got to think for ourselves…I feel that this experience will help me later on in my further education and career [nursing].
- The leadership seminar was also very informative and educational. The information I acquired will be helpful in college and my future profession [public relations].
- After watching our taped performance and discussing it, I felt that I better understood the importance of all guidelines involving crisis management, especially communication and leadership. Now, I feel that I am better equipped to work through a crisis or just as part of a team with a task at hand.

- I learned by crisis resource management that I am a follower. I don't want to give the directions…What I learned will help me a little in my [future] career. As an elementary school teacher, it will probably help me more than I realize.
- I thought it was interesting how much better you do when you have a leader and followers.
- Thanks to the program, I've realized that I need to get used to being a follower when speaking with a superior in the fashion industry after college.
- The leadership skills showed me that if I am the leader I need to stand back and be the leader. I shouldn't try to do everything. I also know that if I am in an emergency crisis I will know what to do first and how to keep control.
- The presentation about emergency management crisis was well presented, giving me more insight for managing crises that may arise in my future. I now realize that there is a strict hierarchy, for these instances, that needs followed, or the situation will not resolve with a positive outcome.
- Your information on crisis management, and communication was very helpful and informative. It gave me a better understanding of what the roles of a leader, and follower are. I would like to be a restaurant manager someday. I feel that the skills you taught our class that day will be very helpful to each of us in our own career.
- I wanted to do everything and be involved in everyone else's duties. You really tried to show us the various roles that needed to be filled by one person.
- While doing the emergency procedures, I learned communicating is very important.

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