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COMPUTER SIMULATION IN MASS EMERGENCY AND DISASTER RESPONSE: AN EVALUATION OF ITS EFFECTIVENESS AS A TOOL FOR DEMONSTRATING STRATEGIC COMPETENCY IN EMERGENCY DEPARTMENT MEDICAL RESPONDERS

by

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DISSERTATION

Submitted to the Graduate School

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for the degree of

DOCTOR OF PHILOSOPHY

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MAJOR: INSTRUCTIONAL TECHNOLOGY

Approved by:

Advisor Date

DEDICATION

This work is dedicated to all the colleagues, friends, acquaintances and mentors who provided support, inspiration and motivation to help me achieve what was once only a dream.

This is especially dedicated to
Thomas, William, James, Robert, John, Mary, Terrence, David, Richard, Sharon, Susan, Fran and Nan O'Reilly.

"It matters not how straight the gate,
How charged with punishment the scroll,
I am the Master of my Fate,
I am the Captain of My Soul."

William Ernest Henley

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CHAPTER 1

INTRODUCTION and STATEMENT of PROBLEM

This study is an examination of the effectiveness of computer simulation as a tool for demonstrating the strategic competency of personnel to interactively respond to simulated emergency and disaster events. Computer simulation has been and continues to be an emergent instructional strategy of interest being used in an increasing variety of learning contexts. In the same way, preparedness of personnel to effectively respond to emergency and disaster events has become an increasingly critical 21st century training priority.

After the 9/11/2001 terrorist attack on the U.S. World Trade Center, and later, the 2005 Katrina hurricane and flood disaster, questions have been raised as to the adequacy of the overall preparedness that exists in this country to respond to serious, unanticipated mass emergency events, natural or human-caused. Evaluations of Federal, State, and Local emergency first response agencies after 9/11 have revealed serious deficiencies in preparedness and severe problems of coordination. Ironically, on September 23, 1996, five years prior to the 9/11 terrorist attack, the U.S. Congress passed Public Law 104-201, *the Defense Against Weapons of Mass Destruction Act.* In it, the Act acknowledged:

"…State and local emergency response personnel are not adequately prepared or trained for incidents involving nuclear, radiological, biological, and chemical materials (and) Exercises of the Federal, State, and local response to (these threats of) terrorism have revealed serious deficiencies in preparedness and severe problems of coordination." (Public Law 104-201, 1996).

A thorough thematic literature review (DeGraffenreid, 1999) has revealed, of all domestic jurisdictions, local preparedness is the weakest link in the emergency response chain. To ensure an acceptable level of preparedness, local emergency responders will require training, formalization of learned emergency responses, and practical experience through drills/exercises to demonstrate competency in response.

There is evidence that authenticity in realism (termed *fidelity*) to the mass emergency experience is integral to the instruction necessary to produce competency in emergency response personnel (Lebow & Wager, 1994). First-hand experience gained solely within live but infrequent emergency events cannot guarantee competent and consistent performance in future incidents and would be an unreasonable expectation. To approximate the type of fidelity necessary to mirror an actual mass emergency event through full-scale role-plays or drills are impractical due to the considerable time, money, and personnel that would be required. To find an instructional medium whereby costs are maintained at a feasible limit without compromise to experience fidelity, computerized simulations are being tried in preparedness training. To date, results of their effectiveness have been mixed.

Remarkably, with the exception of several “no significant difference” (NSD) findings, research on computer simulations has been lacking empirical evidence of an optimal learning outcome with simulations over conventional, classroom methods (Kim, 2002; Lee, 1999). This seems to be in stark contrast to what may be anticipated. Computer simulations offer the advantage of exercise repetition without the consequence of physical or personal harm. It is anticipated that the opportunity for practice with simulations would reinforce learned skills. The reported NSD results with simulated instruction, therefore, pose a conundrum when considering the generally held belief in the importance of skill *practice* as an essential component of Instructional Systems Design theory (Seels & Richey, 1994).

The literature reviewed for this study and cited in this paper suggests the major difficulty in validation of computer simulated training effectiveness appears to be the lack of a valid measurement tool. Much of the evaluation has involved surveys or qualitative assessments and not quantitative measurement (Lee, 1999). True transfer of learning is most evident in observation of the learned tasks/procedures being applied within the proper context (Kirkpatrick, 1998). Where a specific procedure or task is consistently defined and easily observable, application can be confirmed. In an emergency scenario, however, there may be several ways to address a single problem or procedure, complicating the observation of a “correct” learned application. Events can occur simultaneously, randomly, and in no particular sequence, further hindering a systematic evaluation approach, even by experienced evaluators.
It may be that the process of learning achieved through instructional simulation has not yet been accurately defined. There appear to be some constructivist theory characteristics, but because of its multi-sensory affective nature and cognitive problem-solving aspect, behavioral or cognitive learning theories may apply as well. To compare simulation to conventional classroom instruction, however, may be fundamentally inappropriate. It may be no better than comparing the proverbial apples to oranges. As such, the measurable learning/performance outcomes are not likely to be the same. It has been further suggested that researchers of computer simulations perhaps should refrain from comparison studies and focus on the value of simulation alone, as an

independent learning strategy, subject to its own possibly unique nuances (Yildiz and Atkins, 1992).

The interest in disaster preparedness clearly has come to the forefront since the 9/11 terrorist attacks. Certainly, the focus of effort properly is directed towards prevention of a recurrence. However, the National Commission on Terrorist Attacks Upon the United States (also known as the 9/11 Commission) rightly acknowledges that protective measures against attacks also must prepare for any that may get through, to contain damage and save lives (Kean & Hamilton, 2004). The commission identified a series of weaknesses in the domestic arena ranging from faulty pre-incident intelligence to a general lack of preparedness to coordinate and respond to the incident. Regarding the latter, the commission concluded:

"…even the most robust emergency response capabilities can be overwhelmed if an attack is large enough. Teamwork, collaboration, and cooperation at an incident site are critical to a successful response…..Regular joint training at all levels is, moreover, essential to ensuring close coordination during an actual incident." (Kean & Hamilton, 2004. p. 396.).

With this in mind, and in recognition of the often considerable logistical constraints of full-scale practice drills, the following proposal is made. *Computer simulations offer an equivalent alternative to hands-on, full-scale drills for effective skills practice and competency demonstration in emergency and disaster response within authentically-represented learning situations.*

To evaluate this proposal, three research questions were investigated:

1.) Can performance competency be adequately measured and assessed through the use of a computer simulated exercise?

2.) What is the relative impact of computer experience vs. experience in the Emergency Department on demonstrated performance competency in a computer simulation exercise?

3.) What is the perceived value of the learning experience expressed by participants using the computer simulation exercise vs. a comparable full-scale drill?

Bottom line, do computer simulations offer a reliable means to evaluate responder competence? To determine this, an off-the-shelf computer simulation of case studies depicting patients with potential biohazard exposures was field tested in a hospital emergency department using competency criteria developed and assessed by experienced emergency medicine physicians. Responder performances were assessed by those same emergency medicine physicians. Results were analyzed, compared and summarized and the findings are presented in this paper.

Significance of Study

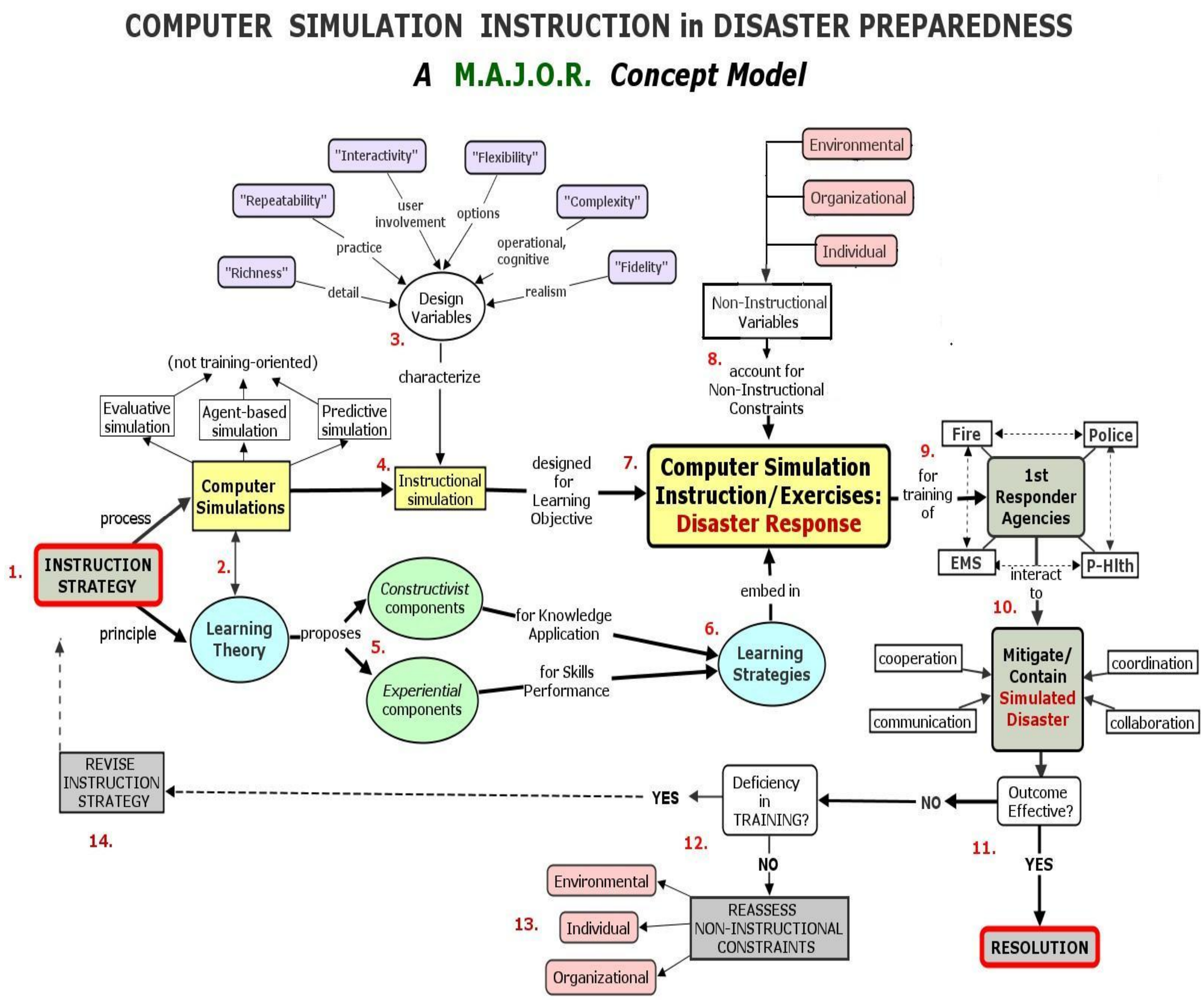
With the exception of several "no significant difference" (NSD) findings, research on computer simulations has been lacking in field studies for evidence whether an optimal learning outcome can be achieved with simulations vs. conventional classroom or role-plays/drills. Further, extraordinary patient surge capacity in healthcare units due to biohazard and bioterrorism events is among the top five "*Research Priorities*" identified by the Society for Academic Emergency Medicine (Rothman, et al. 2006). This study adds useful information relevant to that priority and contributes to the documentation of research findings collected from users in the field. The information can assist in identifying current or future instructional needs for biohazard disaster preparedness in localized disaster situations with a potential for extrapolation to large-scale incidents. In addition, it provides empirical data where there was little previously documented involving analysis of effectiveness of biohazard preparedness training. The study is specifically relevant to Instructional Technology and Human Performance Improvement in its focus on the use of computer simulation as a valid training and evaluation tool and a supplement, or a substitute, for the more resource-consuming full-scale exercises that have been the conventional approach for disaster preparedness training.

Computer simulations have the potential to become a standard component in instruction where competent performance is a primary objective vs. mastery of knowledge content alone. At the very least, computer simulations likely will become common instructional supplements. When one considers time and resource savings after development, and ever-increasing improvements in technology, computer simulations have the potential to become the instructional tool of choice in a wide range of disciplines (Marietta, 2002).

Computer Simulations in Mass Emergency Response – A Model

The effective use of computer simulation in disaster preparedness instruction requires exploitation of the advantages offered via simulation technology coupled with a determined adherence to recognized learning theory. It is through a melding of the two that optimal learning and knowledge transfer may be accomplished within the practical physical and operational constraints that exist. To understand the factors that need to be considered and where they may apply in any training method, it is useful to develop a model. The Multiple Area Jurisdiction Organized Response (M.A.J.O.R.) research group at Wayne State University is evaluating the use of computer simulation as an analytical tool for assessing First Responder disaster response. Figure 1 presents the M.A.J.O.R. instructional concept model (O'Reilly & Brandenburg, 2006). A key to interpretation follows the model.

Figure 1.



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Key to Model

Moving from left to right in the model, the most effective instruction strategy (1.) requires the blending (2.) of the presentation vehicle/process (*computer simulation*) with established principles derived from current *learning theory*. In this way, the instructional simulation goes beyond being purely an attractive, engaging visual aid to include meaningful instructional information to achieve a specific learning objective. While there are multiple intended uses of computer simulation (e.g. evaluative, agent-based, predictive), this model focuses specifically on the simulation characteristics or *variables* (3.) that impact simulation as used in an *instructional* context (4.).

The *design variables* (3.) previously mentioned are all critical, to a greater or lesser extent, depending on the instructional objective. “Richness” refers to the amount of detail in the simulation. For novice learners, too much richness may be confusing while too little richness may be too simplified for experienced learners. The amount of richness should be a function of the audience experience. “Repeatability” is important to allow for practice of response, presuming that more practice leads to refining and improvement of response speed and accuracy. “Interactivity” is one of the most valuable aspects necessary in simulation instruction, active involvement in a simulated exercise arguably being second only to practical experience gained in a live drill or incident with regard to immediacy of feedback to participants. “Flexibility” is the feature allowing for introduction of varying interventions in simulated exercises that would call for responses that are reactively spontaneous vs. those responses acclimated to a predicted simulation sequence. Unexpected event sequences promote “deep” understanding of the specific situation encountered to facilitate an immediate and fluid individual reaction.

"Complexity", like "richness", refers to the degree of difficulty in the simulation itself. Here, the difficulty may be *operational* such that the computer software or hardware may not be "user friendly". The simulation exercise may also lack in *cognitive* clarity, whereby the direct objective of the exercise is unclear to the learner. Again, the particular learning audience will determine the level of complexity that is appropriate. "Fidelity" is a reference to the degree of simulation realism, audio-visual and/or contextual. Audio-visual fidelity can add authenticity to the learning experience. It is also important to utilize relevant and recognizable examples/scenarios to make the instruction most meaningful to learners/responders.

Specific Learning Theory components (5.) help ensure that the actual desired learning transfer will be accomplished. This model has focused on two particular theoretical strengths that computer simulations can provide. Quite simply, *Constructivist* theory holds that the learner "constructs" meaningful conceptual understanding that is most useful to him/herself in lieu of rote memorization of factual information which may have little directly applicable value or relevance. Knowledge for application is most often constructed internally by the learner rather than being adopted 'as is' from information provided by an external source. Experiential learning theory holds that learning is most profound when it is accomplished by "doing" or when it can be related to previous experiences with which the learner is already familiar. Simulated "doing" allows for fine tuning of performance skills. When accomplished repetitively, it is akin to the kind of skills practice performed by an athlete or musician to maintain and/or improve performance.

Both constructive knowledge application and experientially-honed skills performance represent learning objectives for disaster response that can be enhanced when *learning strategies* (6.) are embedded in the computer simulation instruction (7). However, learning can be impeded by various non-instructional constraints (8.) whose presence can negatively impact effective instruction but none-the-less need to be accounted for. Such constraints include *Environmental* (non-responder-related*)* such as adequacy or availability of equipment and resources, *Individual* (responder-related) such as personal physical/behavioral/motivational limitations, and *Organizational* (responding group/agency-related) such as problems in interactions within or between groups.

Thus, preferred computer simulation instruction and learning exercises (7.) will include appropriate attention to the design variables (3.) of instructional computer simulations, inclusion of learning strategies (6.) into the instructional design with full acknowledgment of and provisions for contingencies regarding constraints (8.) that may impede learning effectiveness in 1st Responder Agencies (9.). The four primary 1st Responder Agencies are *Fire*, *Police*, *EMS* (emergency medical service) and *Public Health*. Their unrestricted/unrestrained mutual interaction through *cooperation, communication, coordination and collaboration* is necessary to lead to mitigation and containment of the simulated disaster emergency (10.). The indicator of a successful learning outcome from the designed instruction is, ultimately, achievement of the learning objective, which is *efficacious disaster Resolution* (11).

What if resolution is not efficacious, or otherwise does not meet set standard criteria? An assessment must then be made regarding the quality of the instructional strategy/ methodology vs. the impact of the non-instructional constraints (12.). Where deficiencies are identified due to non-instructional constraints (13.) possible contingencies must be decided on. Where there is a deficiency in training identified, instruction strategy needs to be revised (14). In certain cases, the use of *cost-benefit analysis* (the benefit gained warrants the costs of modification) and *risk/benefit analysis* (the risk is significantly high such that modification is imperative regardless of cost) is indicated. Such analyses should lead to adjustment(s) in instructional design which will optimize the effectiveness of computer simulation instruction in the context of disaster preparation.

Operational Terms. The following terms are specific to this research:

Authentic: as computer simulations are not actual experiences, authentic implies a reasonably faithful representation of the actual experience**.**

Blended Instruction: the dual use of both conventional and online strategies to achieve a particular pre-determined learning outcome.

Computer Simulation: an (interactive) open-ended and evolving experiential exercise in (response to) a given situation (or event/incident) with many interacting variables which is facilitated and enhanced through the use of specific computerized multi-media tools and/or technological processes.

CSCL: *Computer Supported Collaborative Learning*: A process in which groups working together for a common purpose utilize computer support to enhance the group interaction and group dynamics. It is based on the perspective that computer-supported systems can facilitate learning in ways that are not achievable by conventional face-to-face instruction.

Discovery Learning: learning through interacting with the environment, exploring and handling objects, raising relevant questions, resolving apparent controversies, and possibly experimenting within the immediate context.

Experiential learning: knowledge that is gained as a result of the interaction of past experiences with current situations. A learning process whereby the learner questions, tests and draws conclusions that are based on their subjective past and present experiences.

Functional simulation: a simulation intended to result in predetermined performance outcomes Realism (fidelity) needs to be higher than in instructional to measure performance.

Fidelity: The relative degree of realism of a simulated experience as compared to a live "real" experience.

Game: an activity or exercise, similar to a simulation, but with as an identifying characteristic the element of competition (Coombs, P., Prosser, R. and Ahmed, H. (1973). Where it involves the use of computer technology, it is a ***Computer Game***.

Hands-on training: training involving active participation of the learner in performance of a specific learning activity vs. hearing a lecture, reading text or observing simple visuals or demonstrations.

Ill-structured problem: one or more of problem elements are unknown or not clearly understood. They are typically situated in and emergent from a specific context.

Instructional simulation: a simulation intended to result in predetermined learning outcomes.

Simulation: a non-linear and interactive model, representing a real or imagined phenomena, that has the ability to present, either visually or textually, the current state of the model and that allows the user to track his/her progress within the model, providing feedback in realistic forms (Hargrave & Kenton, 2000).

Situated Learning: learning process whereby content is presented in an authentic context, i.e. using settings and applications where that knowledge would normally be applied.

Synchronous: real-time (live) interaction and exchange between instructor and learners.

Table-top exercise: an exercise method in which participants review and discuss the actions they would take given a contrived scenario (per their developed plans) but they do not perform any of these actions. The exercise can be conducted with a single team, or multiple teams, typically under the guidance of exercise facilitators.

Summary

Preparedness of personnel to effectively respond to emergency and disaster events has become an increasingly critical 21st century training priority. Computer simulation is an emergent instructional strategy being used to facilitate responder preparedness training. The need for effective disaster preparedness training is readily apparent. Whether computer simulation provides the means of achieving competent preparedness requires an examination of its actual use in the field. A model has been presented here describing how computer simulation may be used for biohazard preparedness of emergency responders. Specific terminology is defined. Reference will be made in Chapter 2 to related literature which presents fundamental, background information about computer simulations and how the technology has impacted or may be used to impact learner performance, particularly in biohazard response preparedness.

CHAPTER 2

REVIEW of RELATED LITERATURE

Having identified a training need and a model of a means to fulfill that need through computer simulation, this chapter will review the related literature on computer simulation instruction.

THEORETICAL BASE

No single learning theory can be advocated for the overall effectiveness of computer simulation in learning. Rather, several theories lend validity to its application. According to a review of the literature, learning theories that have been consistently applied to the computer simulation learning context include:

- Experiential Learning
- Situated Learning
- Problem-Based Learning
- Discovery Learning and
- Computer Supported Collaborative Learning (CSCL)

The fundamental similarity in these theories is that learning is an active process, best experienced within a realistic context, to allow for application and use (transfer) of knowledge to realistically the same, or similar, situations. Several of these theories are, or can be, related to a constructivist perspective. Constructivism is a "view of learning in which learners use their own experiences to "construct" understanding that makes sense to them, rather than having understanding delivered to them in already organized form. "...learning activities based on constructivism put learners in the context of what they already know, and apply their understanding to authentic situations." (Kauchak & Eggan, 1998, p. 184). The literature review pertinent to the study includes reference to

1) simulation as it is used in instruction,

2) factors involved in mass emergency response and

3) an examination of computer simulation as it is used for emergency preparedness.

A brief description of pertinent elements in these five learning theories follows.

Experiential Learning Theory. Experiential learning refers to knowledge that is gained as a result of the interaction of past experiences with current situations (Dewey, 1938/1997). It is the result of engaging the mind and body in activity, reflection, and application (Kolb, 1984). This learning process allows that the learner will question, test and draw conclusions that are based on their subjective past and present experiences. It has often been related to a “hands-on” approach. One could presume that experiential learning would be enhanced where the learning context authenticity is high. That is, where the participant is involved in practice and application of activities that are analogous to what would actually be performed in the field. Kolb describes experiential learning as a cycle consisting of:

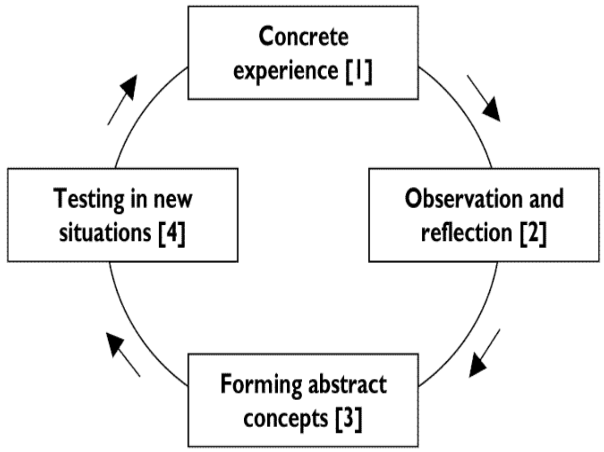
1) a concrete experience with the tangible qualities of an immediate experience,

2) reflective observation, which includes critical thought,

3) abstract conceptualization through analysis, and

4) active experimentation, with the implication of future application (see Figure 2).

Figure 2. Kolb's Experiential Learning Cycle



In the Kolb model, with each experience, the cycle is repeated.

Situated Learning Theory. In situated learning, knowledge needs to be presented and learned in an authentic context, i.e., using settings and applications where that knowledge would normally be applied (Lave and Wenger, 1990). This need not require training onsite but the onsite environment needs to be replicated as closely as practical (e.g., flight simulators for pilot training). Lave and Wenger argue that learning is a function of the activity, context and culture in which it occurs (i.e., it is situated) vs. classroom learning, where knowledge is often presented abstractly and out of context. There are social interaction and collaboration components whereby learners become involved in a `community of practice' which share certain beliefs, values and acquired behaviors. Considering the commonality of purpose in mass emergency response, collaborating responders would operate within such a 'community of practice' domain.

Problem-based Learning Theory. Problem-based learning involves, quite literally, knowledge gained as the result of problem solving. Mastery of knowledge content as the main focus of learning is replaced with the learner's ability to solve a given problem, present solutions and revise solutions as appropriate when presented with additional information. Focusing on a problem solution emphasizes learner *performance* rather than *memory* of factual pieces of information. Finkle and Torp (1995, p.1) state that "problem-based learning places individuals in the active role of problem solvers confronted with an ill-structured problem that mirrors real-world problems". Vygotsky (1978) further proposes that problems should be solved in a social context. Working together allows learners to solve problems at a synergized level usually not often possible when working alone. This supports the team-based approach to performance as well as the situated 'community of practice' concept.

Discovery Learning Theory. According to the Discovery Learning Theory, individuals are more likely to remember concepts that they encounter on their own (Bruner, 1966). They learn through interacting with their environment, exploring and handling objects, raising relevant questions, resolving apparent controversies, and possibly experimenting (Ormrod, 1995.) Research has found that discovery learning is most successful when learners have requisite prior knowledge and some structured experiences (Roblyer, Edwards, & Havriluk, 2004). While Rieber notes discovery learning within simulations can be difficult for some students, the learning can be effectively supported with creative simulation visuals, and possibly a scaffold or elaborated presentation style (Rieber, Roblyer, Edwards & Havriluk, 2004.)

Computer Supported Collaborative Learning (CSCL). Collaborative learning is demonstrated as groups working together for a common purpose (Resta & Laferrière, 2007.) CSCL, while not so much a theory as a process enhancement, adds a computer to support individuals in effectively learning together through technology. It is based on the paradigm that computer-supported systems can facilitate group process and group dynamics in ways that are not achievable by conventional face-to-face instruction (Koschmann, 1996). CSCL serves to support collaborative communicating of ideas and information, accessing new information, and providing feedback on problem-solving activities. Communication and conversation are recognized as among the keys to collaborative learning (Bonk, 2002). A matrix of these Learning Theories is presented in Table 1.

The learning theories presented propose different factors as being critical in instruction. Experiential and Situated theories place a premium on authenticity in the learning context. Discovery and Problem-Based learning emphasize critical thinking and problem-solving aspects necessary for a higher-order level of thinking, and presumably, the expectation of a higher order of performance. Computer Supported Collaborative Learning introduces the advantage of technology to efficaciously address a significant component of this investigation, namely, collaboration amongst responding units. Based on these factors, and considering the variables that can affect outcomes, disaster preparedness instruction should:

- be appropriately authentic, but show only important, critical features of the problem scene/situation
- be appropriate for the person; minimally rich for novice simulation-learners; moderately rich for experienced simulation-learners
- present a problem situation relevant to the objective (i.e., an emergency situation requiring competent, fluid action.)
- allow for practice in critical thinking and problem-solving, and be collaborative.

Table 1. Learning Theory Matrix

THEORY (theorist)	**PRINCIPLE**	**GOAL**	**STRATEGY**
EXPERIENTIAL LEARNING (D. Kolb)	Learning is a cycle involving experiencing, reflecting, thinking, and acting.	To make use of knowledge created through transformation of experiences.	Simulated exercises, Role Plays, Coaching, Action learning
SITUATED LEARNING (J. Lave)	Learning is a function of the activity, context, & culture in which it occurs.	To apply learned knowledge in similar (not necessarily same) context	Knowledge must be presented in an authentic context. It requires social interaction and collaboration.
PROBLEM-BASED LEARNING (L. Vygotsky)	Learning is focused on problem to be solved vs. content to be mastered	To develop reasoning skills, self-directed strategies	Present learners with “ill-structured” problem situation to be mitigated.
DISCOVERY LEARNING (J. Bruner)	Learners explore a problem to discover and retain solution concepts, aided by prior knowledge	To independently solve problems through informed decisions	Use virtual simulated exercises, role plays, concept mapping.
COMPUTER-SUPPORTED COLLABORATIVE LEARNING (CSCL) (T. Koschmann)	Learning occurs through knowledge-sharing and collaboration among multiple participants.	To facilitate & optimize collaborative understanding through computer-assisted learning.	Computer simulations and games providing authentic learning scenarios for multiple participants.

A thorough consideration of these components allows for a proposed framework for instructional design. Ultimately, the objective is to incorporate these design components into a computer simulation format that will facilitate the learning process.

Use of Computer Simulation in Instruction

As a brief overview, computer simulations designed for informational purposes can be categorized according to certain commonalities: they can be symbolic-based or experiential-based. Both provide opportunities to learn through near-real situational experiences. In symbolic simulations, the scene or object of interest is external to the participant; individuals interact with the information in the role of an objective evaluator rather than a participant. A NASA design engineer using a computer simulation to evaluate the aerodynamics of various booster rocket designs would be representative of the use of a symbolic-based simulation. In experiential simulations, individuals participate in a contrived event and take on specific roles which include particular responsibilities and constraints. They interact in an evolving situation. The computer simulated emergency event in this study wherein hospital personnel respond to a contrived biohazard incident is a clear example of an experiential-based simulation.

For training purposes, the following are basic characteristics shared by all instructional computer simulations:

- There exists an adequate model of the complex real world situation within which the participant interacts.
- There is a defined role for each participant that includes responsibilities and constraints.
- There is a data-rich environment that permits participants to exercise a range of strategies, from targeted to “shot-gun” decision-making.
- Feedback to participant actions is given in the form of changes (reactions) in the simulated situation (McManus, 2001).

By definition, then, simulations are controlled representations of real situations, calling for participants to respond, and which provide some form of feedback to those responses. Probably one of the most powerfully positive aspects of computer simulation instruction is in its reliance on interactivity between content and learner. It exemplifies active learning vs. a passive, lecture-type learning which has been the conventional approach.

Learning and Cognition with Computer Simulations. Potential for learning transfer to participants is a function of the degree of abstraction of information encountered by the learner. Edgar Dale (1946; 1969) posed a model describing a continuum of delivery methodologies based on varying degrees of abstraction. The model suggests the degree of abstraction in the delivery method will relate directly to the degree of cognitive support needed for effective comprehension by the learner.

The Cone of Experience (Figure 3) organizes learning experiences according to the degree of concreteness which each possesses (Table 2). At the bottom of the cone is hands-on experience. As one moves up the cone, concrete (authentic) experiences decrease and learning stimuli become more abstract requiring more skill on the part of the learner to interpret meaning. For certain types of learning (e.g., learning motor skills), experiences at the bottom of the cone may be more appropriate than those at the top. Learning experiences at the bottom of the cone involve active learner participation and would tend to hold attention longer. Media at the top of the cone are said to be more passive, with little to no learner participation, but are often suitable for transmitting large amounts of information quickly to groups (as in large lecture halls). Which degree of concreteness or abstraction is best depends upon intended outcomes and learning circumstances.

Figure 3. Cone of Experience (E. Dale, 1946).

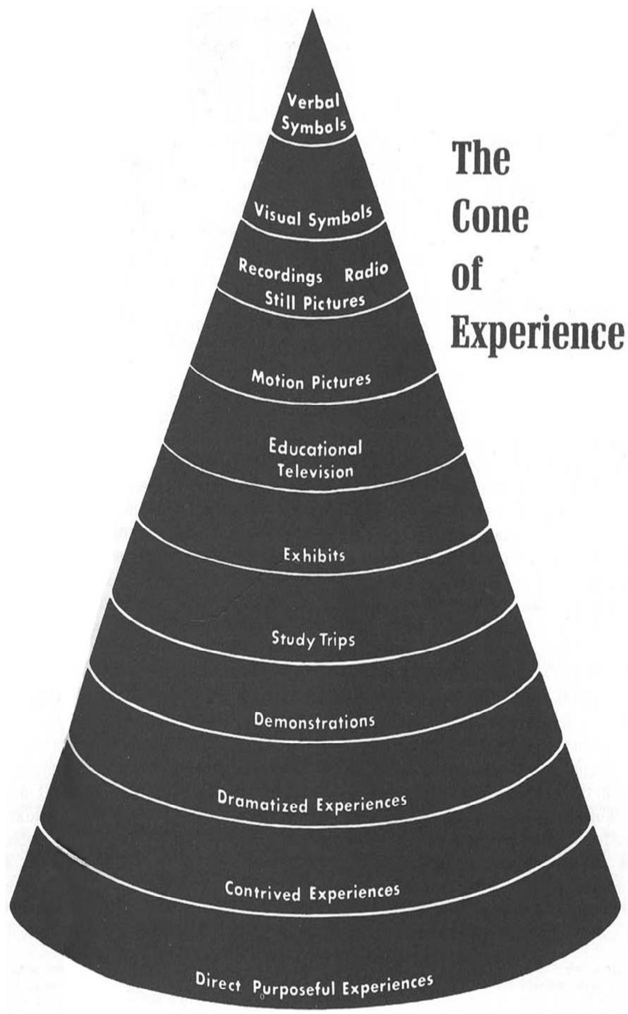


Table 2. Basic Aspects of the Cone of Experience

- Lower levels of the cone involve the learner as a participant and encourage active learning
- Lower levels include more action and stimuli and are richer in natural feedback
- Higher levels compress information providing more data faster for those able to process it.
- Pictures are remembered (recalled) better than verbal propositions.
- Pictures aid in recalling information that has been associated with them
- Upper levels of the cone need more instructional support than lower levels.

(Betrus and Januszewski, 2002)

As represented in Figure 3, for the appropriate application, learning from simulation-based instruction is second only to actual direct purposeful experience in its degree of concreteness (and lack of abstraction). Presumably, learner comprehension of performance tasks should be nearest to that gained from a learner's actual hands-on experience (i.e., doing the real thing). Where learning comprehension is high, there is the implication that learning retention is also high, but it cannot be assumed as given. Retention can be optimized, however, with continued "practice at retrieval" where the learner develops, through repetition and frequent quizzing, an ability to retrieve information and act based on minimal cues. Practice at retrieval appears to facilitate the retention needed in this context more so than extended, passive study of learning content. (Cull, 2000; Glover, 1989; Wheeler & Roediger, 1992.) More immediate and direct recall occurs without the need for prolonged critical reflection. Retention of learning has been consistently correlated with effectiveness in performance (Agrait, English, Evans, Hammell, Loughran & Stahl, 2004; Gredler, 2004; Lee, 1999; Marietta, 2002; Morgan, 2000; Smith, 1986; Tennyson, 1987; West, Snellen, Tong, and Murray, 1991; Yildiz and Atkins, 1992). It is this immediacy in recall, based on minimal cues, which would allow the medical responder to perform optimally under emergency conditions.

Other outcome measures which have been used to demonstrate the efficiencies of computer simulation instruction have related to reductions in training time and training-related costs. In a special report in *PC Week* (Janson, 1992), the U.S. Coast Guard realized a savings of over $11 million over a three year period on their computer-based helicopter flight simulator training. That same report indicated Federal Express estimated a savings of over $100 million on employee training that utilized a computer assisted (videodisc) program format. While ancillary to actual learning effectiveness, such non-instructional outcomes, nonetheless, add credibility to the use of simulated instruction in cases where there is not a compromise to instructional integrity.

Computer Simulation Advantages

Simulations can provide the learner with experiences that approximate authentic representations of reality and allow for interactive participation. They can be near-real processes, procedures or events whereby user actions result in consequences. Participants affect, or could be affected by, a response to a given problem situation. An advantage to this interactivity is errors would be immediately identified due to the relatively instant feedback received. Observed consequences to actions, pro or con, would provide important instructional reinforcement.

The capability for practice is an inherent quality of simulations. Simulations can allow for practice of the same, similar or a completely new simulated situation. Additional advantages to simulations would be in their *flexibility* for consistency or variability (random or controlled, depending on the instructional need) and in the complete avoidance of the physical consequences of real, catastrophic outcomes.

Computer Simulation Disadvantages

Disadvantages of computer simulations relate primarily to high initial cost in equipment and simulation program development, but that can be an upfront investment that is absorbed over time. There is limited opportunity to participate in actual hands-on activities and observation of the application of procedures by evaluators is not possible. There may be user resistance due to comfort levels with the technology or due to personal training preference. Whether these disadvantages outweigh the advantages is addressed by this study.

Variables Affecting Computer-Simulated Instruction Outcomes

Degree of Fidelity.

It has been proposed that, to be most effective as a learning tool, computer simulations need to provide learning experiences that are as close to the real experience as possible (Standen, 1996). This would include a realistic experience that occurs within a realistic learning environment. However, there is also indication that too much detail (also described as *richness*) in a simulation may introduce unnecessary complexity that can be distracting and disruptive to the learning process. Norman (1993) advises that ideal simulation model representations must essentially do three things:

1) Appropriately show critical features of a domain while ignoring the irrelevant
2) Be appropriate for the individual participant, and
3) Be appropriate for the task.

Accordingly, fidelity may be a variable that is relevant to the specific context and not to all simulations per se. The Simulation Interoperability Standards Organization (SISO) adopted the following formal definition of *simulation fidelity*:

1.) the degree to which a model or simulation reproduces the state and behavior of a real world object or the perception of a real world object, feature, condition, or chosen standard in a measurable or perceivable manner; a measure of the realism of a model or simulation; faithfulness. Fidelity should generally be described with respect to the measures, standards or perceptions used in assessing or stating it.

2.) the methods, metrics, and descriptions of models or simulations used to

> compare those models or simulations to their real world referents or to other simulations in such terms as accuracy, scope, resolution, level of detail, level of abstraction and repeatability. Fidelity can characterize the representations of a model, a simulation, the data used by a simulation (e.g. input, characteristic or parametric), or an exercise. Each of these fidelity types has different implications for the applications that employ these representations. (Gross, 1999.)

Measurement of Fidelity. It seems that defining the term 'simulation fidelity' has done little to improve on the ability to measure the effect it has on learning outcomes. Gross (1999) describes two obstacles to any standard for fidelity measurement:

1.) A definition must exist of the real or imagined world that is sufficient to measure the difference between it and the simulation.
2.) The simulation must be defined in terms similar to that definition.

Because any simulation is only a representation of some reality, most of the value is in its ability to *simplify the complexity* of the real world into a form that is comprehendible and usable. Simulation designers can seek to include as much fidelity as they can afford and lose consideration of the overload burden that is created that can reduce usability (Nance and Overstreet, 1995). A highly detailed and "over-engineered" training simulation may in its complexity obscure the real issues for which training is required. One of the real values of simulations (i.e. abstracting away irrelevant details) would be lost, inadvertently lowering the fidelity of the simulation and its effectiveness.

User Experience. Choice of simulation representations will depend not only on the application context, but on the level of experience of the user with computer simulations.

Novices learn best with lower level fidelity, while experienced learners do better with high fidelity (Chen, Fan & Macredie, 2004). The difference is due to the richness of the simulated presentation. For novices, high fidelity may provide too much information to process quickly, resulting in response delays. For learners experienced with simulation instruction, too simplistic a presentation may not engage the learner and concentration can drift or be lost. If novices are also lacking in prior emergency response experience, this will further impact computer simulated instruction and introduce delay. Also, acceptable individual competence in emergency response needs to be gained before initiating instruction in team preparedness.

Qualitative vs. Quantitative Evidence. A quantitative measure of simulation fidelity (as described in the SISO definition) is an objective measure and, therefore, it is a difficult one to obtain. While qualitative measures may be subjective and open to interpretation, their meaning can generally be understood (e.g., “spicy” food, “chilly” evening, etc.) Without resorting to various quantitative methods that may prove ambiguous with “no significant difference” measured, it is suggested that it may be possible to compare a simulation to other simulations meeting similar purposes in order to gauge its effectiveness for that purpose (Roza, Voogd, Jense and AndvanGool, 1999). In doing so, it is conceivable that the validity of the simulation can be determined. It may be that the validity of a simulation is more critical than its fidelity. Here, 'simulation validity' refers to the quality of being inferred, deduced, or calculated correctly enough to suit a specific application.

Mass Emergency Response

The literature here centers on assumed and/or observed human behavior exhibited in emergencies which, by nature, can occur without significant warning. In a number of cases, the assumed behavior may be based on incorrect beliefs and not on actual observations. Quarantelli’s research (1989) suggests human beings react remarkably well (without significant or “paralyzing” panic) in emergency/disaster incidents and that the source of most performance problems is in the organizations/agencies that are typically expected to respond to such incidents. He describes this and several other myths that are unsubstantiated by research and observation: a panic myth, a passivity myth, an antisocial myth, a traumatized myth, and a self-centered myth that are experienced by disaster victims. Quarantelli concludes that, overall, disaster victims do not panic, they are not passive, they do not become caught up in antisocial behavior, they are not behaviorally traumatized, and they are not appreciably affected by low morale.

Auf der Heide (1989) acknowledges and supports much of Quarantelli’s findings and further describes problems of inaccurate and unavailable information from disaster incidents which impede learning from these events. He also identifies a lag problem between research findings and demonstrable progress in improved response as well as complications sometimes stemming from over-response to lesser events. Auf der Heide is quick to add that existing problems do not appear to be due to incompetence on the part of first responders, but rather problems due to the response system as a whole. Emergency response organizations, including police, fire, medical and public health agencies, are developed and evolve to respond to common community emergencies. Disasters pose unique problems that can differ from routine emergencies that these emergency organizations face on a day-to-day basis. They are not always well adapted to handle large, non-routine disaster situations.

When a disaster event occurs, the fire, police, medical and public health agencies individually respond to employ the specific professional aid that each agency has been trained to provide. What these agencies are not always prepared for are the unique and unanticipated resource requirements and inter-agency interaction variables (cooperation, collaboration, communication, etc.) that may be called upon and which are necessary to effectively mitigate the emergency and extent of damage (response). Each agency has external (environmental) and internal (individual) factors which can affect the effectiveness of that agency's response and, in turn, the effectiveness of the total, four-agency (organization) emergency response. An example of a communications problem that occurred on 9/11 was poor interagency radio communication between responding units (police could not communicate well with the fire department, ambulances could not communicate with the police or fire department units.) A Federal investigation into the communications gap found the problem was not solely due to technical incompatibility of equipment but also due to human-related factors within the cultures of the agencies themselves (Tridata, 2003).

The response group that this study focused on was emergency medical responders, specifically Emergency Department nurses. The choice of this group was influenced by the relatively greater accessibility to a population of designated responders who perform emergency response on a regular vs. infrequent basis. Biohazard response would be an infrequent and unanticipated event for the other response agencies, but the Emergency Department of a trauma hospital would be the designated destination whenever an individual is suspected of having been exposed to a biohazard. Hospitals that are designated as area trauma-centers for mass emergency and disaster response are required to perform regular practice drills. All things considered, the ED emergency medical responders were deemed to be the test group of choice for this study. Chapter three describes the methodology that was used in the study to obtain findings to answer the posed research questions.

CHAPTER 3

STUDY METHODOLOGY

This chapter presents specific details on the study design and how it was conducted. There are a number of pertinent factors affecting incident response that warrant research and investigation if preparedness is to be optimized. This study examined the effectiveness of computer simulation to facilitate real-time learning through authentic computer-assisted training exercises. The objective was to examine whether a computer simulation exercise can provide a safe, manageable, and cost-effective alternative to the more involved, conventional, full-scale drill without compromise to training integrity of Emergency Department staff. Before any research data was collected, approval for this study was necessarily obtained from the Human Investigation Committee (HIC) of Wayne State University (Appendix A-1).

Hypothesis & Research Questions

The hypothesis and research questions given here are from Chapter 1.

> "Computer simulations offer an equivalent alternative to hands-on, full-scale drills for effective skills practice and competency demonstration in emergency and disaster response within authentically-represented learning situations. "

To determine the degree to which this hypothesis can be supported, a field-study of a computer simulation was conducted at a hospital emergency department and the following specific research questions were investigated:

1.) Can performance competency be adequately measured and assessed throughthe use of a computer simulated exercise?

2.) What is the relative impact of computer experience vs. experience in the

Emergency Department on demonstrated performance competency in a computer simulation exercise?

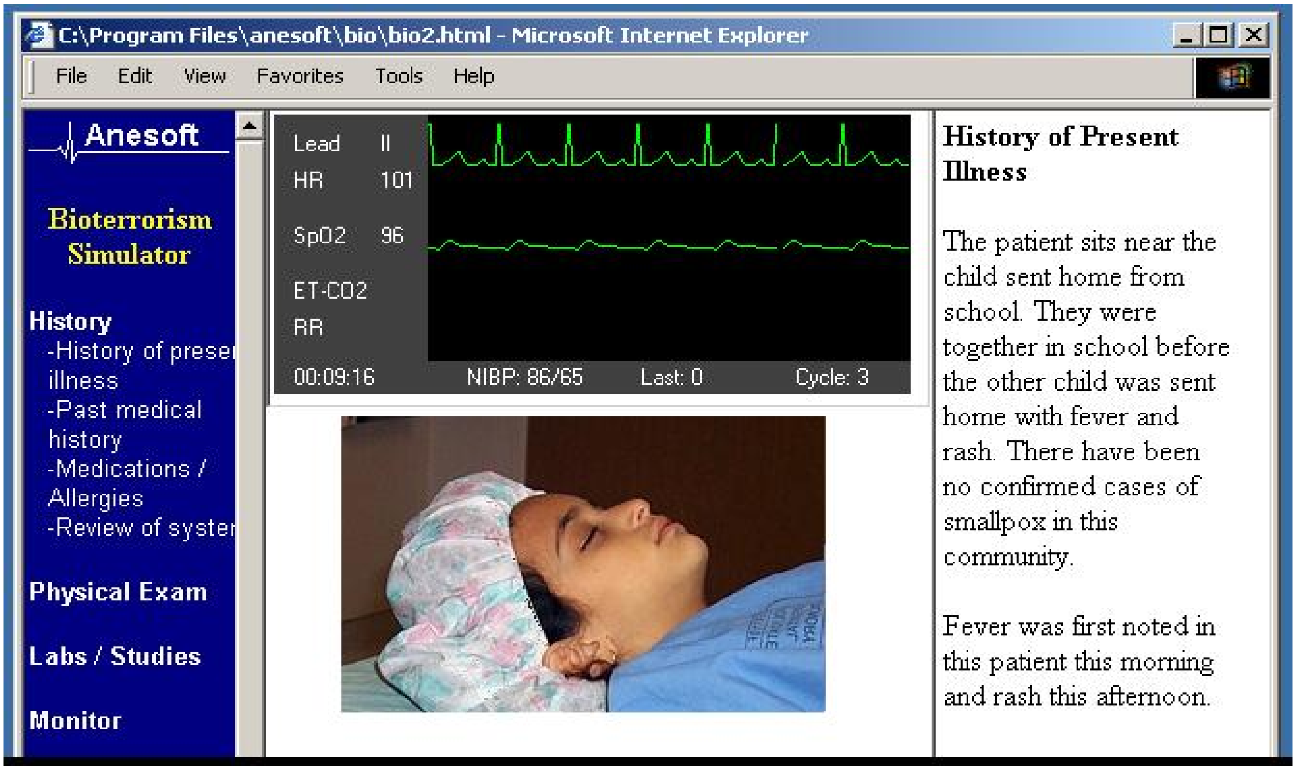
3.) What is the perceived value of the learning experience expressed by participants using the computer simulation exercise vs. a comparable full-scale drill?

Computer Simulation Instrument

The computer simulation used was a critical element of this study. It involved an on-line simulated triage scenario that participants responded to via a common lap-top computer. It did not involve actual 3-D virtual reality whereby participants typically don optical headgear to digitally “become” a part of an artificially-created computer environment as is experienced with more sophisticated experiential computer exercises and/or computer games. An objective of this study was to assess a training format that is accessible, affordable and representative of that which would be available to a majority of current end-users.

The computer-simulation instrument presented a scenario in which patients arrive at a hospital emergency department with unknown diagnoses due to the onset of health effects from a possible biohazard exposure. The software, an online Internet or CD-contained program, “Bioterrorism 2002” produced by *Anesoft Corporation* (Issaquah, Washington, USA), presents several individual cases of affected patients admitted with initially undiagnosed illnesses that must be triaged by Emergency Department (ED) medical first responders (Figure 4).

Figure 4. <u>The Computer Simulation</u>: *Bioterrorism Simulator 2002*



Sample frame from *Bioterrorism 2002* simulation screen

Betsy Gettig, Director, Genetic Counseling Program at the University of Pittsburgh, offers the following review of the Bioterrorism 2002 program as compared to currently recommended core competencies for emergency department response:

> "This CD is an excellent training module for emergency room staff and other first responders. The CD helps physicians, nurses, and other first responders review the latest guidelines for management of biological and chemical agent exposures. Users will learn to recognize the signs and symptoms of each illness, and order appropriate isolation, decontamination, diagnostic tests, and treatment in 24 different clinical scenarios. The agents presented in this CD are: anthrax, botulism, Ebola, plague, smallpox, tularemia, nerve agents, toxic gases, and vessicants. The 24 different scenarios expose the user to a wide variety of

> emergency room situations. The user must care for the patient and gains exposure to possible terrorist agents in a practice setting. Each module has specific learning objectives. "(Gettig, 2002, pp. 62-65).

Evaluation Criteria

Foremost in competent performance in an emergency response are appropriateness of strategy selection and fluidity in response. Consequently, measurement criteria included:

a.) response pathway chosen by the participant

b.) logical, sequential application of response and

c.) where applicable, elapsed response time.

Because of the complexity typical of an unanticipated emergency event, varied response options can be expected to be chosen by participants that, nevertheless, can yield results that are comparably the same. Considering this, effectiveness of performance was assessed by a trio of emergency care physicians who were selected based on their emergency department experience and expertise. These Subject Matter Experts (SMEs) independently reviewed computer print-outs of participant responses to each case study. To maintain confidentiality and objectivity, SMEs were not present at the exercise and were not provided any means, directly or by inference from demographic descriptions, to identify or associate any print-out to any particular participant. SMEs reviewed the print-outs to evaluate performance based on:

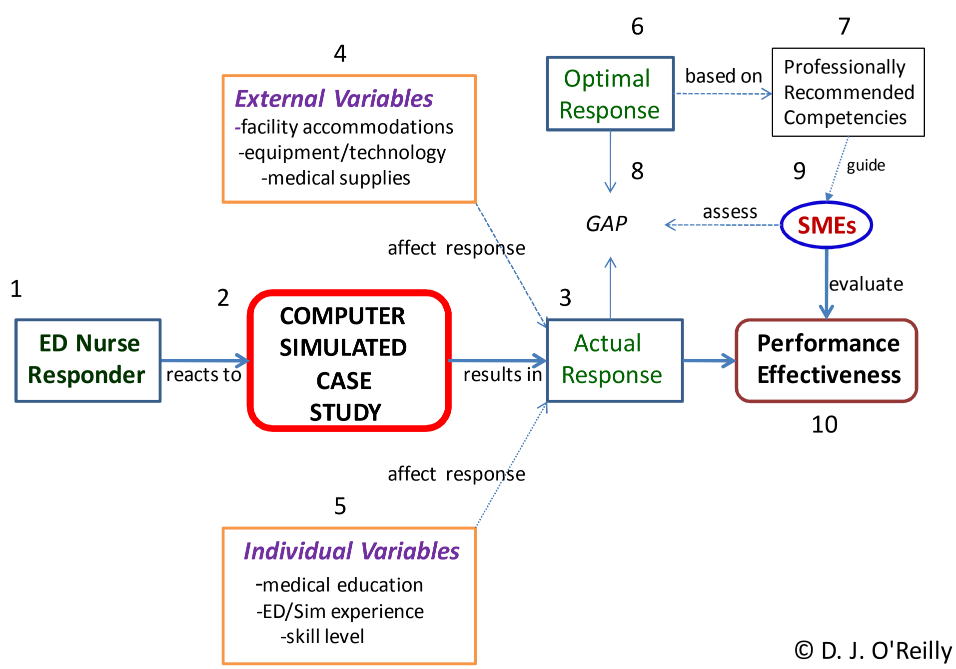
a.) current standardized protocol and/or recognized best practices

b.) the professional expert judgment of the evaluators, and

c.) situational critical choices made by the responder.

The response data collected was comparatively analyzed qualitatively and quantitatively. Comparisons between participants with different prior computer or ED experience were made to calculate a degree of significant difference in performance competency. A model of the evaluation process flow is provided in Figure 5.

Figure 5. Emergency Medical Responder Performance Evaluation Model



Key to Model

In this model, the medical responder is an emergency department nurse. The medical responder (1) engages in a computer simulated case study (2) of a patient demonstrating any of a number of symptoms indicative of a potential biohazard exposure. The medical responder is called upon to monitor and stabilize the patient's vital signs and overall medical status through initiation of proper respiratory support, medication, and any other supplemental treatment that may be indicated. The response provided (3) is contingent upon symptoms presented by the patient, the external variables (4) or *resources* available in the ED and medical facility, and the individual variables (5) or *capabilities* that the responder personally contributes (e.g., the responder's prior medical education, their emergency department and computer simulation experience and their current personal skills all contribute to the individual's capabilities.) There is an optimal level of response (6) that has been determined and recommended by public health organizations (i.e., the Center for Disease Control and Prevention) as well as the various "best practices" that continue to be identified through ongoing ED experiences (7). The net difference between a responder's performance in the computer simulation and that considered to be optimal performance in the ED represents the *gap* (8) between actual and preferred performance. The margin of the gap between actual and optimal is determined by Subject Matter Experts (9) consisting of three emergency medicine physicians with professional knowledge and experience within the medical emergency response field. The SMEs have established mutual criteria for competent case management of each of four case studies presented in the exercise. Referencing recommended core competencies and using their own professional judgment, they use these criteria to assess and evaluate the responder performance (10). With SME evaluation results and participant survey data and post-exercise interviews that were also collected in the study, comparative statistical analysis is then used to assess the relative effectiveness of the computer simulation as a viable instructional/training tool for biohazard response preparedness.

(The number of possible confounding factors in this study was presumed to be limited due to the homogeneity within the test exercise and among the study participants.)

Participant Demographics

The site for this study was a major city-hospital/trauma center that serves the basic and specialized needs of the Detroit community. This short-term care, 900+ bed hospital includes a 70-bed Emergency Department (ED) that can accommodate acute and critical patients and is identified as a major medical provider in Southeast Michigan for mass emergency and disaster incidents. Study participants were accepted for the study from the Registered Nurse ED staff if they met two criteria:

1. They would need to be currently active in the ED and
2. They should possess at least fundamental computer skills (defined as capable of sending/receiving/forwarding communications such as emails and performing basic word-processing functions.)

Because ED charting has been done routinely by computer in this hospital for a number of years to maintain an efficient and cost-effective paperless record-keeping system, all active staff RNs were able to meet or exceed the computer competency criteria. ED experience ranged from less than 1 year to greater than 5 years for this volunteer group of ED nurses (Table 3.)

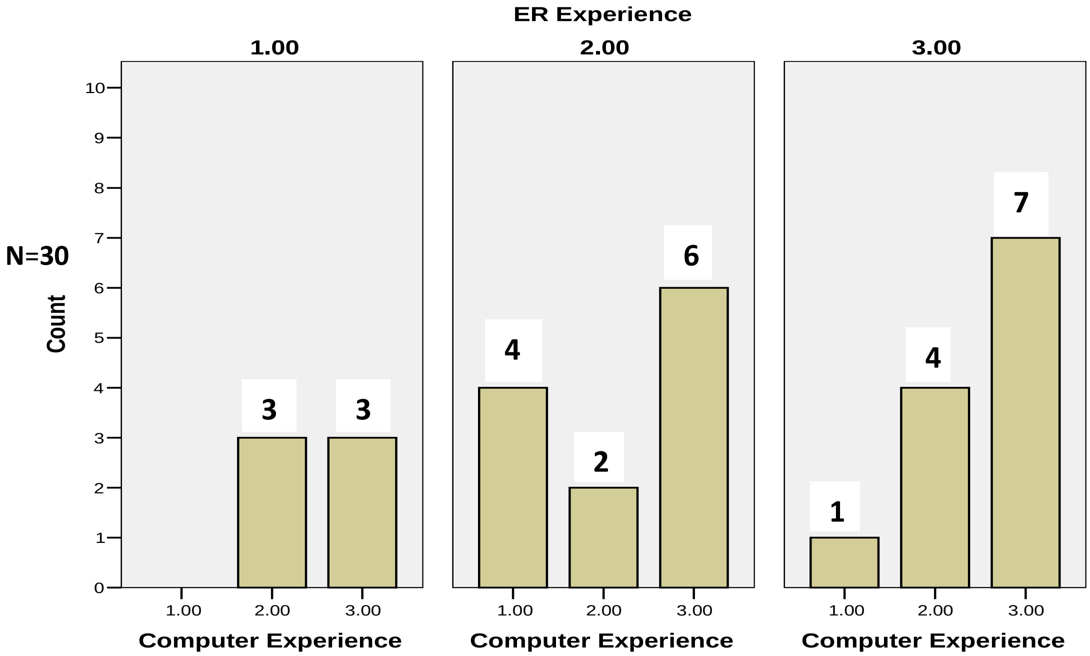
Table 3. Responder Demographics

Position:		Emergency Dept. Experience:	
- Staff RN	28	< 1 yr.	6
-Agency RN	1	1-5 yr.	12
-other (Supv./Coord.)	1	> 5 yr.	12
Education:		Computer Experience (reported):	
-Associate degree	13	-Low level	5
-Bachelor degree	11	-Moderate level	9
-post Bachelor	4	-High level	16
-Master degree	2		

A cross-reference between the variables of Emergence Department (ED) Experience and reported Computer Experience demonstrates a population of individuals with generally moderate to high emergency room experience and moderate to high reported computer experience (Figure 6.)

Participation in the study was voluntary. An initial incentive to participate was offered in the form of a meal ticket to a local coffee-house, but this did not generate any volunteers. Given that participation in the study involved actual active engagement of the participant in a specific task vs. simple completion of a questionnaire, that incentive was raised to a $25 cash award for an hour's time and effort. Still, individuals were slow to volunteer. With time, and increased staff familiarity with the project objective and actual time investment required, participation increased and the intended goal of 30 participants was eventually attained.

Figure 6. Cross Comparison: Responder ED Experience vs. Computer Experience



Emergency Room Experience (x)
1 = Low (<1 yr)
2 = Moderate (1-5 yrs)
3 = High (>5yrs)
Range = **1-3**
Mean = **2.20**

Computer Experience (*Reported*) **(y)**
1 = Low (email, basic word processing)
2 = Moderate (interactive computer exp.)
3 = High (advanced, computer test exp.)
Range = **1-3**
Mean = **2.44**

ER/Computer Combined Experience **(x.y)**
Range = **1.2 – 3.3**
Mean = **2.44**
(*Moderate-High*)

Exercise Process

The simulation was presented to participants via an Internet connection to the Anesoft *Biohazard 2002* website (Anesoft, 2002.) This proved to be particularly convenient, allowing for accessibility whenever needed. It was also very cost-effective since Anesoft authorized use of the simulation in this research without a fee. Because the testing was monitored and a single lap-top computer was used to present each exercise, data collection required onsite visits to the Hospital ED 3-4 times per week from late June through August 2010. Participants were tested individually in the ED break-room until the objective total of 30 was attained. The practical component of the exercise was comprised of four (4) separate case studies that, based on each case study scenario, could be related to a biohazard exposure and, possibly, a mass exposure event. A description of these four case studies is presented in Table 4.

Participants received a handout (Appendix B) with a description of the study objectives and instructions for navigating through the computer simulation program. Each participant was allowed a practice test or given a test demonstration (separate from the four designated case studies) so that they would be comfortable with the computer, the simulation program and the objectives that they would be asked to meet. For each case study, participants were instructed to:

1. Ensure decontamination and isolation of the exposed patient (if conditions warranted)
2. Achieve stabilization of the patient's condition, defined as ensuring vital signs are adequate to sustain life, with or without administration of drugs or life-support equipment (i.e., respiratory support.)
3. Notify Public Health of those cases that meet necessary reporting criteria.

Table 4. Biohazard Case Studies

Case Study **1**: a 64 year old female with fever and flu-like symptoms

This waitress works in a restaurant about 10 miles from the city where the smallpox outbreak occurred three weeks ago. Isolation and contact vaccination seem to be controlling the spread of the disease. There have been no reported cases in her area but she is worried that she may have contacted someone with smallpox at her restaurant. She heard that fever is an early sign of smallpox infection and wants to be vaccinated.

Case Study **2**: a 7 year old girl with fever and rash

This child is in the same first grade class as a child who was sent home from school with a fever and rash two days ago. There have not been any documented cases of smallpox in this community which is located about 200 miles from the site of the confirmed release of smallpox 25 days earlier. The patient has a fever of 101.6 and a rash on her abdomen. She denies sore throat. Her parents insist that every child in the school and their families should be vaccinated for smallpox

Case Study **3**: a 62 year old female with severe cough

This patient works downtown and is one of numerous persons who have developed a severe cough a few days after a terrorist group claims to have spread "a deadly curse" over the city. No release site has been identified and a specific toxin/organism is unknown. A sudden rise in the local incidence of pneumonias in previously healthy patients has been noted. For several days, this patient has had a fever, sweats, headache, stiff neck, muscle aches, nausea, vomiting, diarrhea, abdominal pain and lack of energy. She currently has a fever and shortness of breath.

Case Study **4**: a 71 year old female with respiratory failure and seizures

This patient is one of hundreds with sudden onset of burning eyes and nose, weakness and shortness of breath. She is struggling to breathe and was observed to have had a seizure a few minutes earlier. The cab driver that brought her to the hospital thought she had a seizure on the way to the hospital also. Hundreds of people have been suddenly affected by the same mysterious symptoms and are streaming into the emergency room. There has been no information concerning a possible cause.

Because RNs do not ordinarily administer medication without a physician's authorization, for the purposes of the exercise, RNs were advised they had such authorization to do whatever was medically necessary to achieve the prescribed objectives. In addition, a summary sheet of ten (10) standard ED medications and dosage recommendations (Appendix C) was supplied to each participant for reference as part of the instructional handout. Dosage information was also available as a "help" tab in the simulation program. As part of the computer simulation software, a real-time log was recorded as each case study proceeded. The log registered all actions initiated by the participant in the course of treating the case study patient. In addition to the computer simulation exercise, participants completed a pre- and post-exercise survey consisting of basic background information and exercise-related personal impressions. A post-exercise interview of each participant was also conducted.

A typical case study would run approximately 5-6 minutes from the time of initial patient presentation to completion of objectives. However, a small number of attempts ran as high as 22 minutes for the relatively more complex cases (e.g. Case Studies 3, 4). Due to the ongoing dynamics of the ED, participants usually could not complete all four case studies at a single sitting. It became necessary for nurse-participants to perform only one or two case studies at a time before returning to ED duties. The remaining studies were completed as time became available during the work-shift.

Each case study was introduced with a patient history along with information on the current physical condition of the patient and their vital signs. Based on that information, the nurse-participant needed to respond by entering their choice of appropriate emergency nursing care to insure the patient was decontaminated and/or isolated (if conditions warranted) and the patient's condition was ultimately medically stabilized. An on-screen side-menu was available from which the participant could choose from several protocol options (e.g., Past and Current Medical History, Vital Sign Monitors, Respiratory Support, Drugs, etc., as shown in Appendix B). It was up to the participant to select the proper option and initiate the appropriate actions needed in each case study. If there was a question regarding the recommended protocol, there is a help tab that can provide limited guidance. The Drugs tab can also provide limited guidance on drugs and dosage. However, these help tabs would not be sufficient to adequately substitute for basic knowledge of nursing practice. Based upon the nurse-participant's responses to the simulated patient as compared to the designated objectives assigned to each case, participant performance on each case study should provide a reasonably measurable approximation of their biohazard emergency medical response competency.

Performance Assessment

Each participant completed four case studies (one each, from case studies 1-4). Only one set of four case studies per participant was used in determining performance. Exercise performance was assessed and scored by comparing the results of each case study against two sets of objective criteria:

1. *Computer-Programmed Objectives*: These criteria were developed by Anesoft medical consultants/personnel and programmed into the computer simulation software and
2. *ED-Developed objectives*: These were developed specifically for this research study by the chief ED physician-SME at the hospital site in concurrence with two additional emergency physicians participating in the study.

Computer-Programmed Objective Criteria: These have been programmed into the computer software logic to recognize when a particular task has been performed which conforms to a designed objective. A "Heart" icon  appears on the computer screen when all programmed objectives of a case study have been met. All participants generating a heart icon in an exercise received full credit for the particular case study. Since conformance with objectives could be verified by a review of the case log, participants had the option to stop at any point they believed the critical objectives of the study had been met. If a participant elected to opt out of an exercise, they received credit for any objectives met prior to exiting the simulation based on a review of the computer-generated case log print-out. As long as the patient exhibited viable vital signs, an exercise continued until the heart icon was displayed or until the participant opted out. If, however, any of the vital signs drifted outside the range of viability for too long, the exercise would automatically terminate and an icon of a ghost  would be displayed (indicating the virtual patient had expired.) With the knowledge of this as a possible outcome, participants were observed to demonstrate an urgency to be successful in "saving" the patient despite the fact that they were engaged in a virtual computer-simulation rather than an actual "life or death" patient emergency. To aid in properly assigning credit when scoring was accomplished by a personal review of the case study logs, a rubric was developed for each case study based on objectives described in the case debriefs documented by Anesoft. The number of *computer-programmed objectives* ranged from 4 – 18 for individual cases, totaling 34 for all four case studies combined. Individual programmed rubrics are presented with descriptions of each case study in Appendices D-1 to D-4. A copy of a case study log is provided in Appendix E.

ED-Developed Objective Criteria: These emergency response criteria were developed for the study by the hospital Chief ED physician and reviewed by two additional ED physicians who each participated as SMEs in the study. While these criteria are consistent with and directly match much of the Computer-Programmed criteria, these ED-Developed criteria added sequence-dependent factors in some tasks (i.e., to receive full credit, certain procedures needed to be performed in a specified order, as in determining the need for decontamination or isolation as the *first* step, or with a particular course of medication, administration of one *before* another rather than after, etc.). The assessment of case studies against these criteria was accomplished by submitting the computer-generated case log data to each of the three (3) emergency room physicians for review and scoring. Using a performance objectives rubric and score key (Appendix F) points were awarded if, according to the judgment of the physician, objectives had been satisfactorily met according to the ED-Developed criteria. Twenty (20) points were available for each SME-assessed case study, for a total of 80 points for all four case studies combined.

The data collected in this study are presented in several formats. Because of the difference in total objectives for individual case studies, *Computer Test Results* are provided as Percent Objectives Met, with computer-programmed scores compared to SME-assessed scores. A statistical correlation between the two was determined. The data have also been analyzed to determine how well the computer and SME scores compare in assessing performance of participants with varying degrees of prior ED and Computer experience. The results of a series of ANOVA tests are given. Survey results and interview responses are tabulated to indicate trends. The *Research Findings* are provided in the next part, Chapter 4.

CHAPTER 4

RESEARCH FINDINGS

The research findings provided here were compiled from:

- Print-outs of real-time logs of 120 computer simulation exercises (four case studies each from a total population of 30 ED nurses).
- Pre and Post exercise surveys from these same nurse participants
- Post-exercise interviews of each study participant.

An SPSS computer program was used for statistical analyses of data.

The study focus was to assess the effectiveness and adequacy of computer simulation as a measurement tool for demonstrating competency in biohazard emergency medical response. It was not to determine the level of competency of any particular nurse or nursing staff. The data collected was used to answer the research questions posed. The findings are presented according to the data collection method used, with reference to the research questions addressed.

Computer Exercise Results

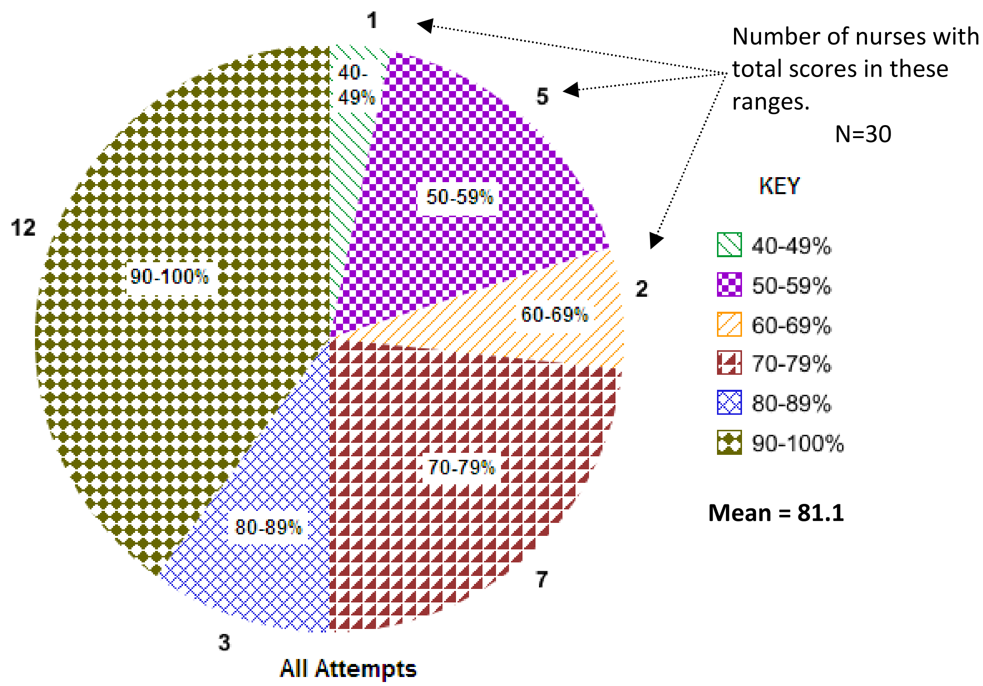
At its most basic, "*competency* "is simply defined as "the ability to perform a specific task in a manner that yields desirable outcomes" (Kak, Burkhalter, Cooper, 2001.) In this evaluation, designed case study objectives served to define the tasks required to reach a particular desirable outcome. Question 1 will be addressed first.

Research Question 1.) "*Can performance competency be adequately measured and assessed through the use of a computer simulated exercise?"*

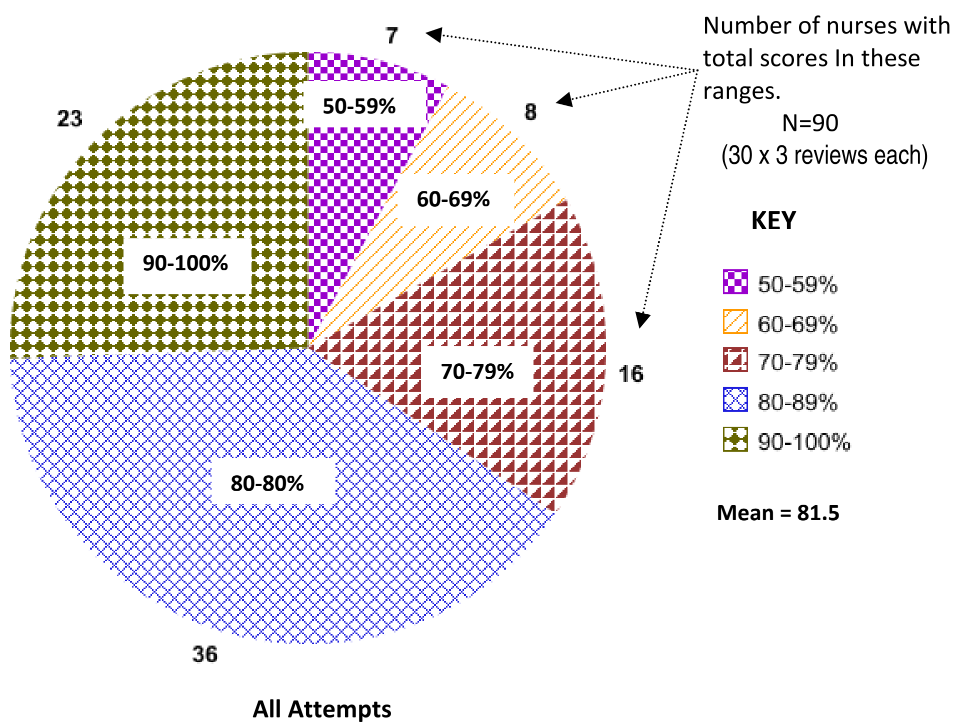
To determine the effectiveness of the computer simulation for competency assessment, data was collected on participant performance with the computer simulation, as is, with prior programmed objective criteria. The 30 nurse participants completed the same four designated computer-simulated case studies which were computer-assessed against programmed objective criteria. Print-out logs of the same simulated case study data were then assessed again by three ED physician/SMEs, but against modified, ED-developed objective criteria. The two sets of data were compared. Because of differences in total numbers of objectives in the two sets of objective criteria, a *percentage of objectives met* was used in making the comparison. The pie-chart in Figure 7 a.) shows the percentages of objectives met by participants when using the existing *Computer-Programmed Objectives* as scoring criteria. The pie-chart in 7 b.) shows the percentages of objectives met using the *ED-Developed Objectives Criteria* of the emergency physicians for scoring.

Figure 7. PERCENT TOTAL OBJECTIVES MET: Combined Scores - All 4 Cases

a.) Percent Objectives Met: Computer-Programmed



b.) Percent Objectives Met: SME-Assessed Scores



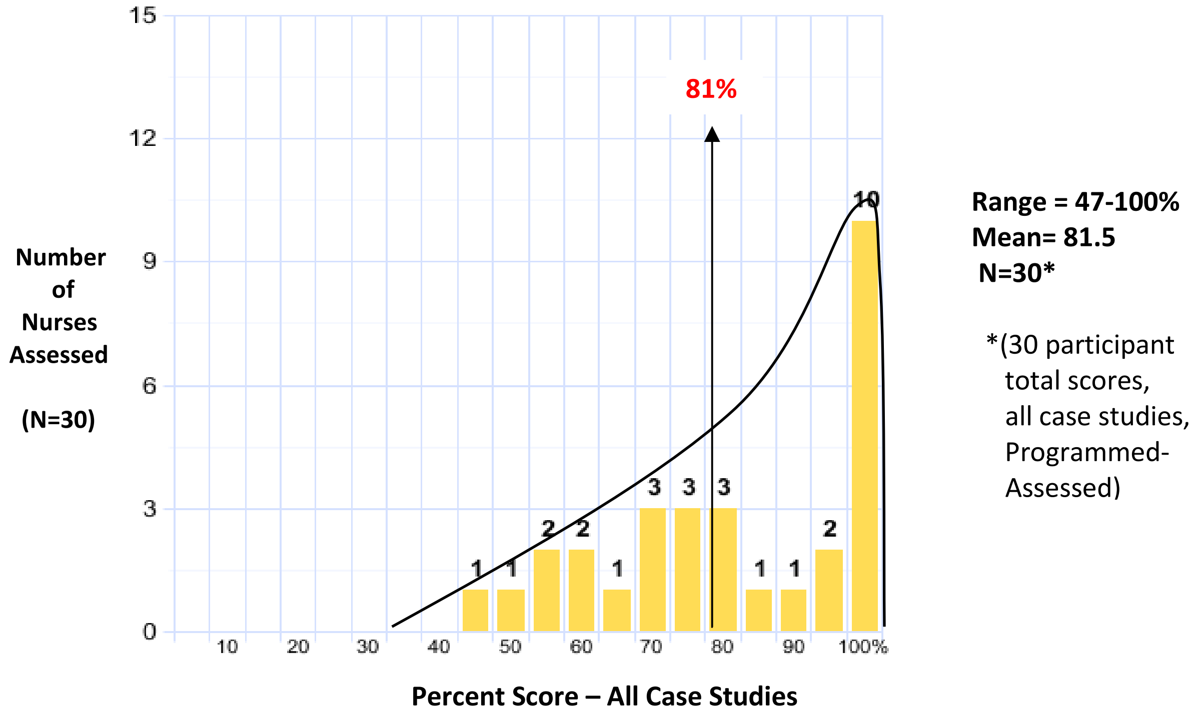
When an evaluation of competency is undertaken, it is usually necessary to use some form of standard criteria to compare against. Absent an established criterion for computer-simulated case studies for this particular study, an arbitrary standard was established for the purpose of demonstration. Consider, for example, a score of "80% objectives met" is set as the outcome standard (i.e., 80% of existing programmed objectives of the computer simulation must be met to meet the standard. *This figure approximates a relative "B" grade level for first-time users of the biohazard computer simulation. It is anticipated that a more stringent standard would be established for actual ED responder competency determinations in the field.*) With this arbitrarily-chosen standard, it is seen that half of the participants tested demonstrated they met this pre-determined standard (pie-chart 7 a.) An examination of pie-chart 7 b.), displaying the results of those same case studies assessed against *ED-Developed Objective Criteria* by the emergency medicine physicians, shows more than half of the participants were able to demonstrate they met the (arbitrary) 80% competency level for the pre-determined objectives. Figures 8 a.) and 8 b.) show the respective distribution curves for the pie chart data.

(Note: *N=30 in computer-programmed assessments since a total of 30 nurses participated in the study. That number is increased to N=90 for ED-assessed data because the 30 nurse participants were individually assessed by 3 SMEs (30 x 3 = 90*.)

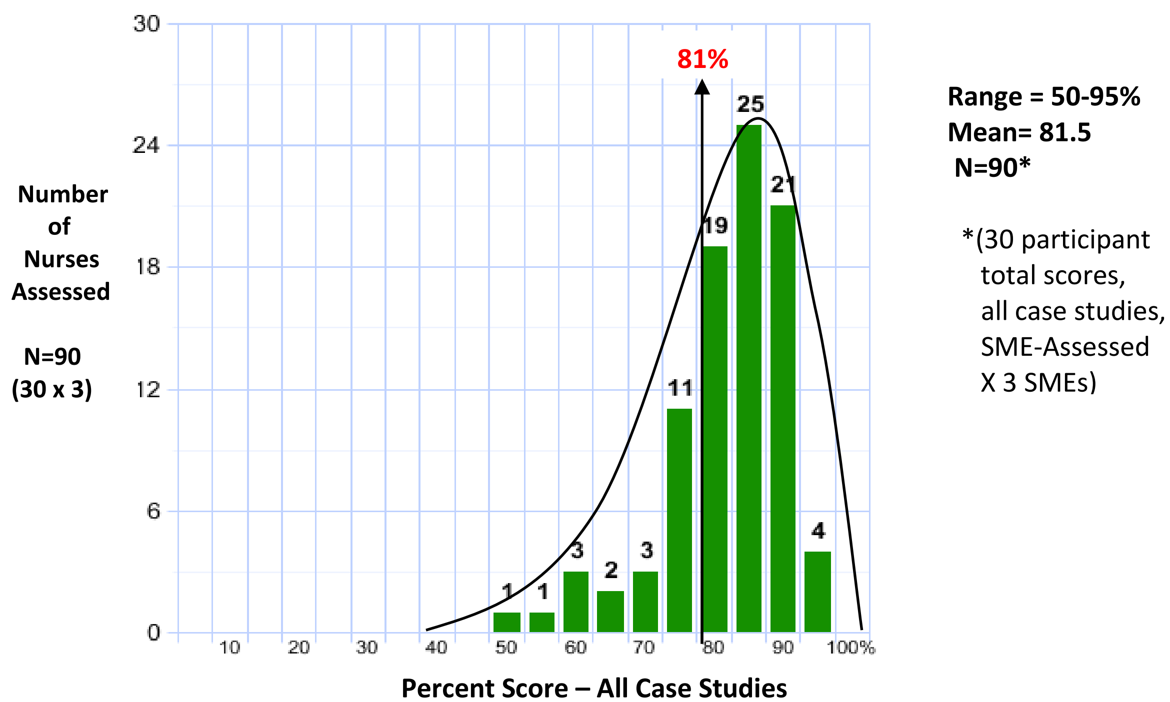
While more participants met the minimum 80% criteria for combined scores when assessed against ED-Developed objectives, fewer of these participants scored in the 90-100% range. This could be due to a difference in total number of criteria objectives of the case studies as well as to the effect of awarding partial credit. This would also

Figure 8. PERCENT TOTAL OBJECTIVES MET – Distribution Curves

a.) PERCENT ***COMPUTER-PROGRAMMED*** OBJECTIVES Met– All Cases



b.) PERCENT ***ED-DEVELOPED*** OBJECTIVES MET – All Cases



explain the differences in computer-assessed (8a.) vs. ED-assessed (8b.) distribution curves.

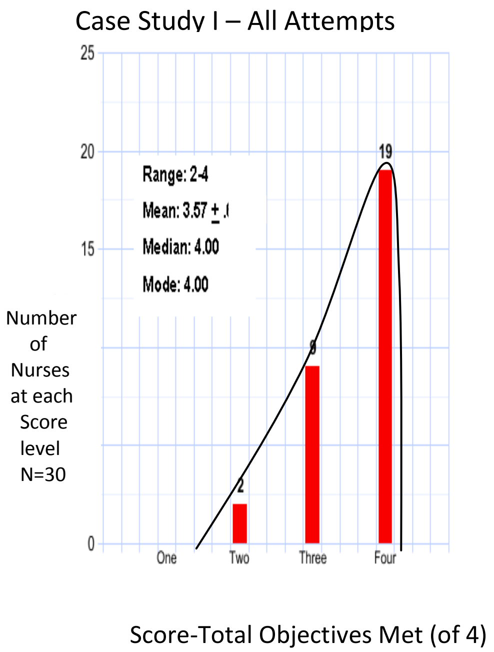
All figures demonstrate a consistency in computer-assessed vs. ED-assessed case study scores. These results support a positive finding for Research Question 1. When compared to professionally-assessed performance competency on simulated case studies, computer-assessed performance competency on those same simulated case studies was found to be measurable and comparable.

When score results of case studies 1-4 are individually displayed comparing computer-programmed objectives to ED-developed objectives (Figure 9.), a general negative skew is observed. It is noted that scores for Case Study 4 exhibit a wider range than the previous three case studies for both the computer-scored objectives and the SME-scored objectives (Figures 9 IVa & 9 IVb.) A primary reason for this may be due to the greater severity of the patient's condition in the last case study as opposed to the prior three.. Case Studies 1-3 involved patients who had been potentially exposed to a biohazard but who were not in a life-threatening state when they presented to the ED. Case Study 4 was of a patient who arrived at the ED in respiratory distress that required immediate attention and initiation of respiratory support procedures to prevent complete respiratory failure. If this was not recognized and dealt with immediately by the nurse participant, respiratory failure was imminent and the patient would expire (virtually). At that point, the exercise would automatically be terminated. In this group of 30 nurses, 10 exercise attempts ended automatically due to respiratory failure in the patient. Ten others were successfully stabilized and all objectives were met, as

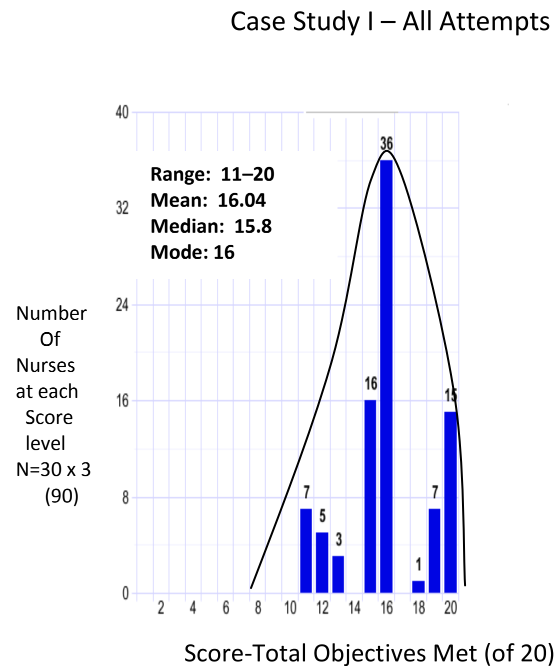
Figure 9. Individual Case Study Scoring Comparison

Comparison of scoring: **Computer-Programmed** vs. **ED-Developed** objectives.

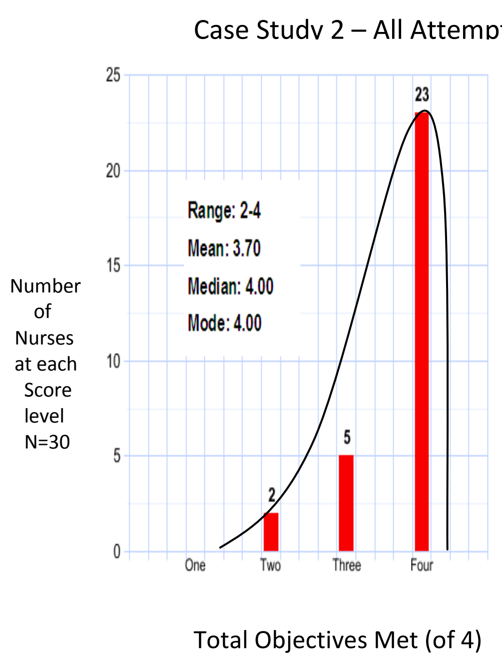
Ia. Computer-Programmed Objectives: Case Study 1



Ib. ED-Developed Objectives: Case Study 1



IIa. Computer-Programmed Objectives: Case Study 2



IIb. ED-Developed Objectives: Case Study 2

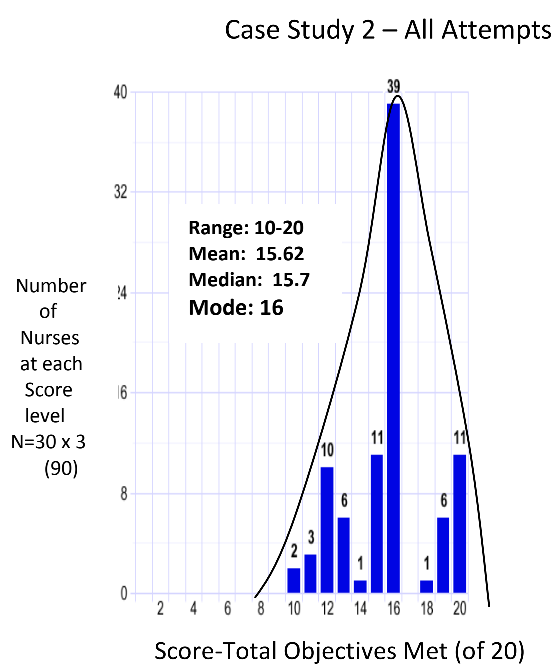
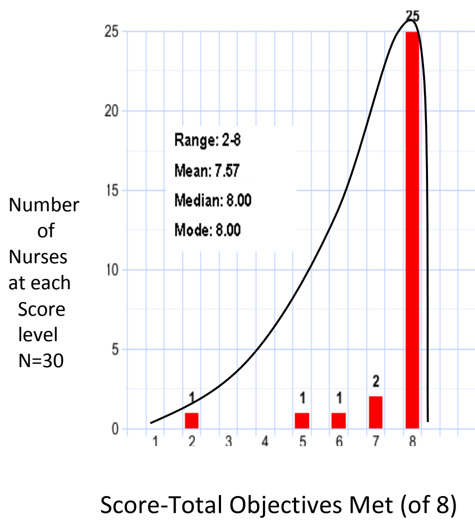


Figure 9. Individual Case Study Scoring Comparison (cont.)

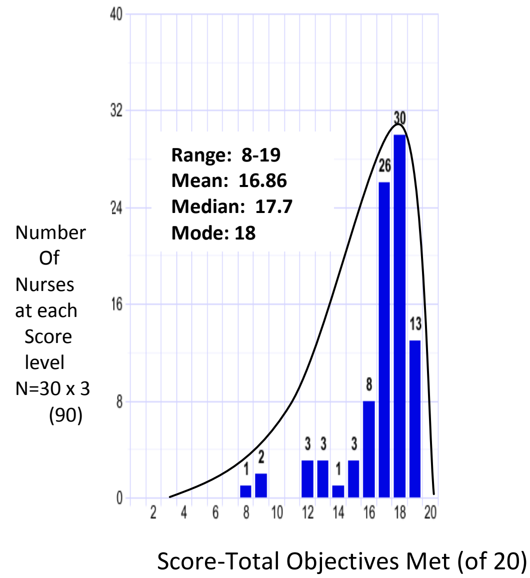
IIIa. Computer-programmed objectives: Case Study 3

Case Study 3 – All Attempts



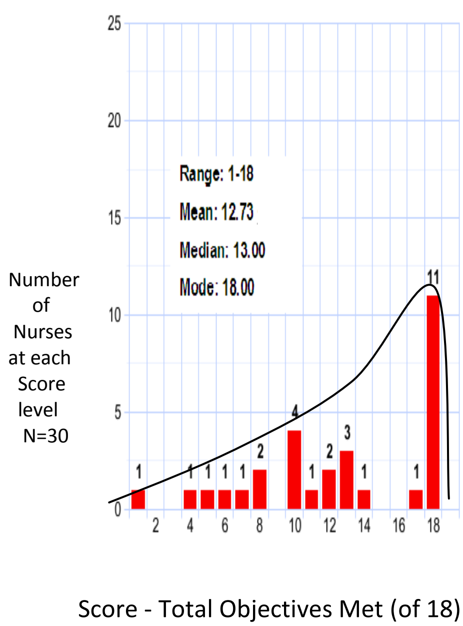
IIIb. ED-Developed Objectives: Case Study 3

Case Study 3– All Attempts



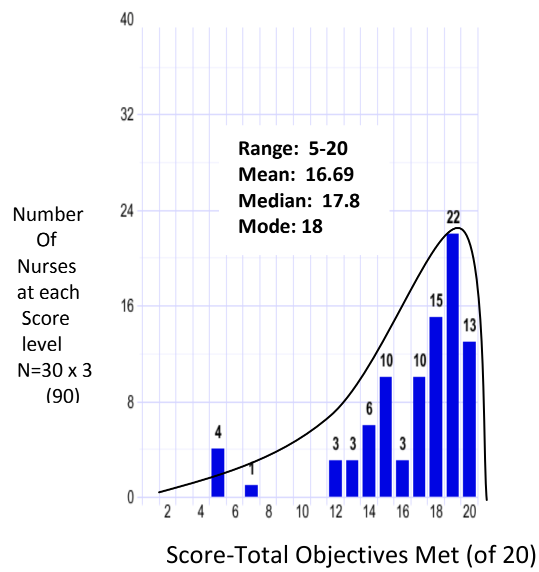
IVa. Computer-programmed objectives: Case Study 4

Case Study 4 – All Attempts



IVb. ED-Developed Objectives: Case Study 4

Case Study 4 – All Attempts



indicated by the display of the heart icon. The remaining 10 exercises ended with the participant choosing to opt out before receiving the heart icon. As long as the patient demonstrated life-sustaining vital signs, participants were allowed that option. All participants received credit for objectives met (as verified through the exercise log) whether they successfully completed the case study, were unsuccessfully terminated, or chose to opt out with the patient's vitals life-sustaining but without the heart icon display indicating completion of all objectives. The variability and range in scores that resulted was greater for this case study (4), as indicated.

The results of all individual case studies (Figures 9 Ia. – 9 IVb.) demonstrate a consistency in computer vs. ED assessed case study scores. Again, these results support a positive finding for Research Question 1 in that, compared to the SME assessments, performance competency has been comparably measured and assessed by use of a computer simulated exercise

To support the consistency in findings, a *correlation analysis* was performed on the individual SME scores for each case study assessed to determine the degree of inter-rater reliability among the three SMEs. Results indicated, with the exception of SME 1 in Case Study 2 where scores did not show significant correlation with the other scores for that case study, there was significant correlation found between SME scores for all remaining case studies 1-4 (Tables 5a. - 5d.) Figures 10a. - 10d. present the individual SME scores graphically.

Table 5. Correlations: SME Case Study Scoring

a.) Case Study 1.

		SME1	SME2	SME3	Mean (of 20)
Case1a (SME1)	Pearson Correlation Sig. (1-tailed)	•	.344(*) .031	.322(*) .041	15.97
Case1b (SME2)	Pearson Correlation Sig. (1-tailed)	.344(*) .031	•	.798(**) .000	16.17
Case1c (SME3)	Pearson Correlation Sig. (1-tailed)	.322(*) .041	.798(**) .000	•	15.97

*Correlation is significant at the 0.05 level (1-tailed).
**Correlation is significant at the 0.01 level (1-tailed)

As indicated in Table 5 a.), correlation of scoring with SME 1 and both SMEs 2 and 3 is significant at the .05 level. Correlation between SMEs 2 and 3 is significant at the .01 level. Figure 10 displays the SME scores graphically.

Figure 10. SME Case Study Score Comparison by Participant

a.) Case Study 1

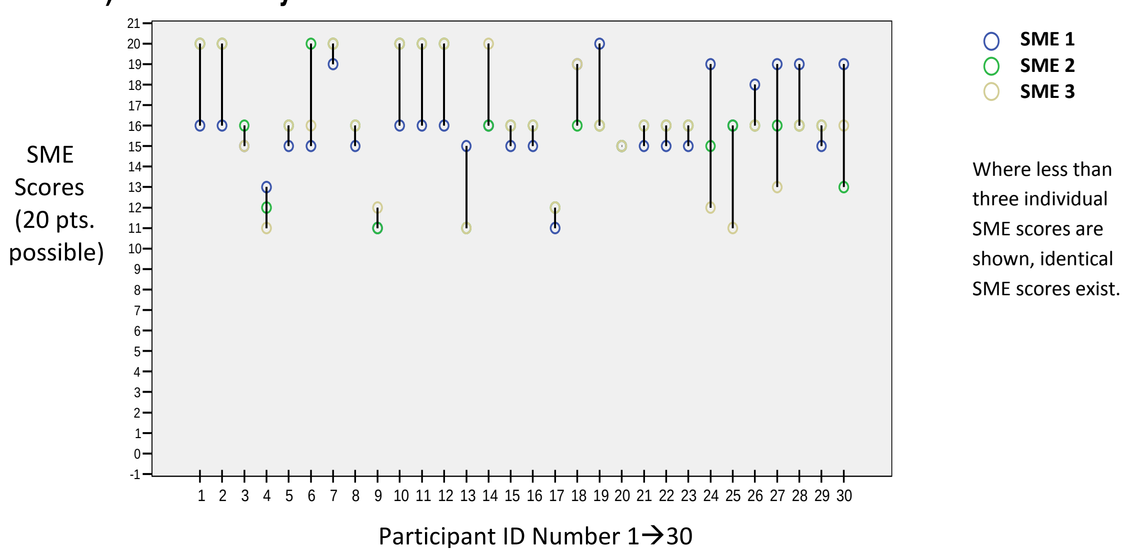


Table 5. Correlations: SME Case Study Scoring (cont.)

b.) Case Study 2.

		SME1	SME2	SME3	Mean (of 20)
Case2a (SME1)	Pearson Correlation Sig. (1-tailed)	•	-.131 .245	-.048 .401	14.77
Case2b (SME2)	Pearson Correlation Sig. (1-tailed)	-.131 .245	•	.815(**) .000	16.10
Case2c (SME3)	Pearson Correlation Sig. (1-tailed)	-.048 .401	.815(**) .000	•	16.00

** Correlation is significant at the 0.01 level (1-tailed).

Table 5b.) shows correlation of scoring between SME 2 and SME 3 is significant at the .01 level, but there is no significant correlation with SME 1 scoring.

Figure 10. SME Case Study Score Comparison by Participant (cont.)

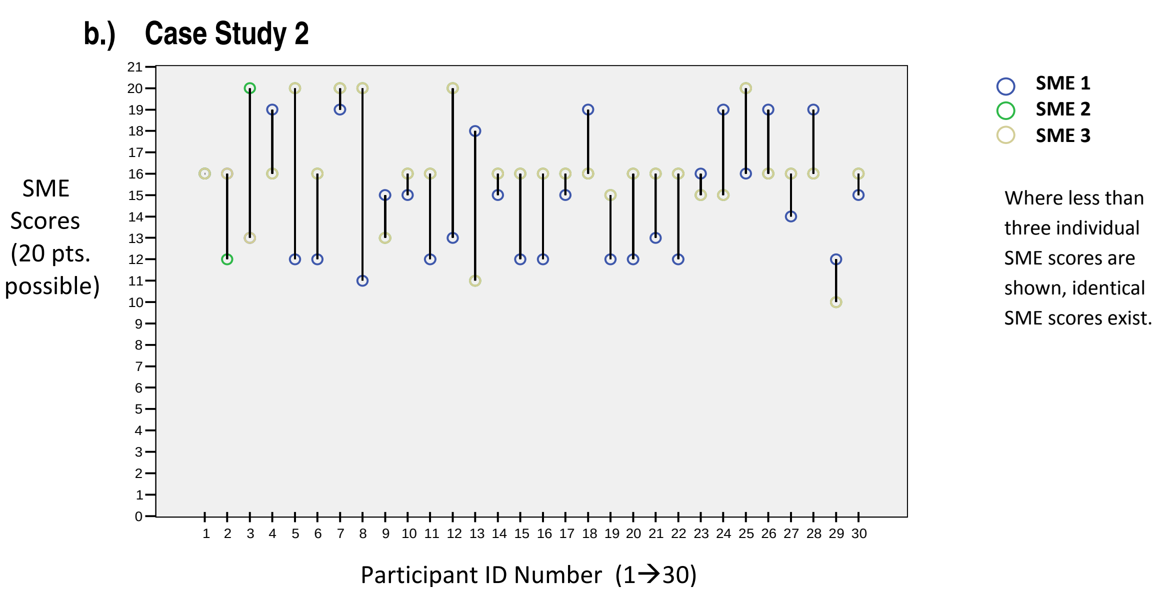


Table 5. Correlations: SME Case Study Scoring (cont.)

c.) Case Study 3.

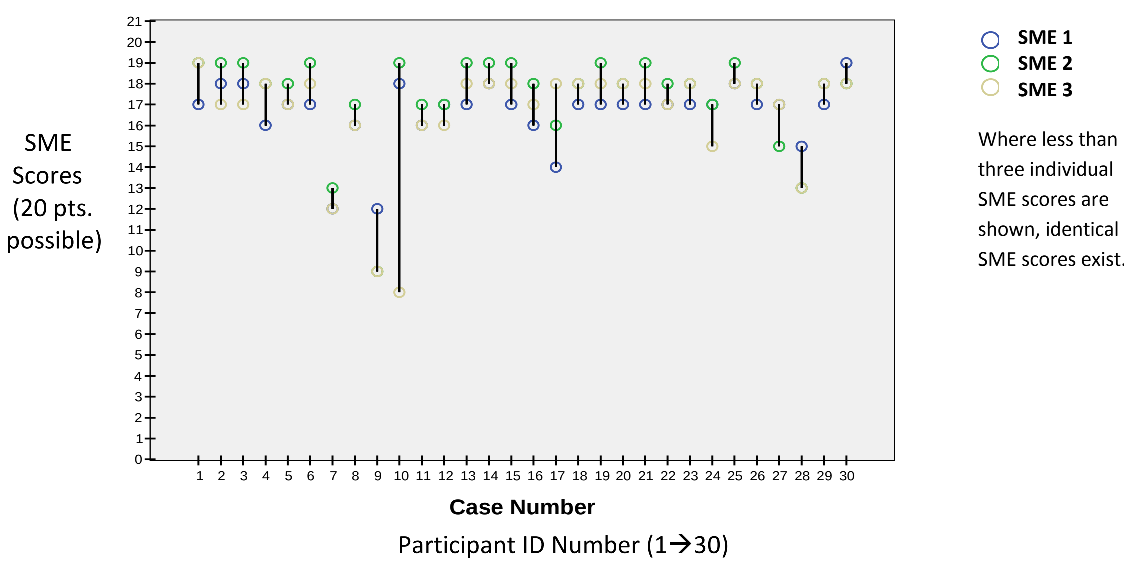
		SME1	SME2	SME3	Mean (of 20)
Case3a (SME1)	Pearson Correlation	•	.836(**)	.499(**)	16.60
	Sig. (1-tailed)		.000	.002	
Case3b (SME2)	Pearson Correlation	.836(**)	•	.640(**)	17.43
	Sig. (1-tailed)	.000		.000	
Case3c (SME3)	Pearson Correlation	.499(**)	.640(**)	•	16.53
	Sig. (1-tailed)	.002	.000		

**Correlation is significant at the 0.01 level (1-tailed).

Correlation of scoring between all three SMEs is significant at the .01 level.

Figure 10. SME Case Study Score Comparison by Participant (cont.)

c.) Case Study 3



(The SME3 score for participant 10 was unaccounted for and presumed an outlier.)

Table 5. Correlations: SME Case Study Scoring (cont.)

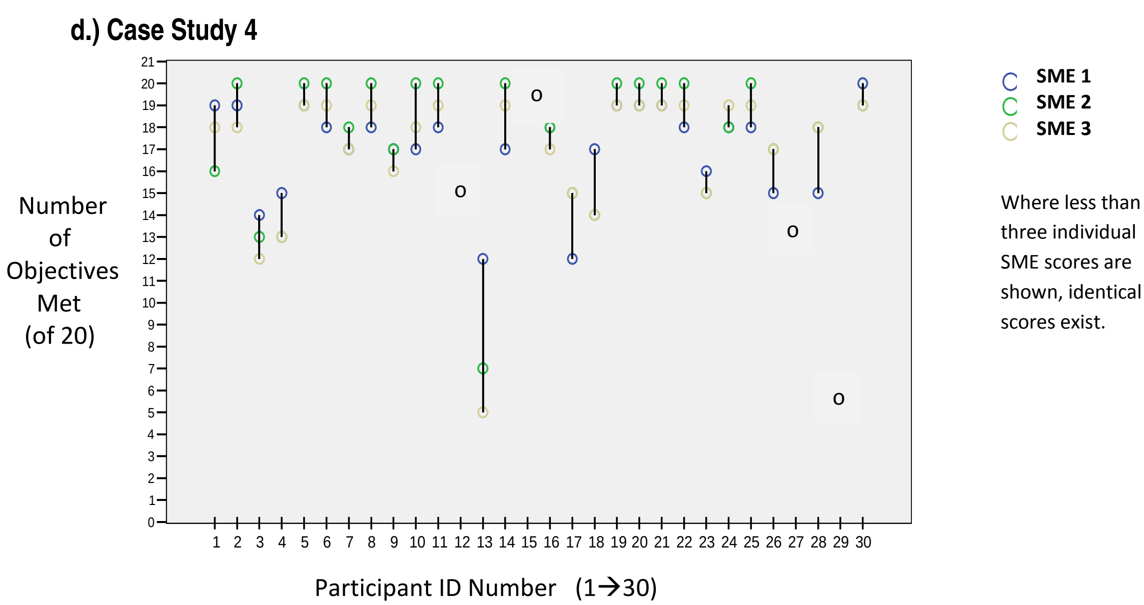
d.) Case Study 4.

		SME1	SME2	SME3	Mean (of 20)
Case4a (SME1)	Pearson Correlation Sig. (1-tailed)	1	.866(**) .000	.864(**) .000	16.57
Case4b (SME2)	Pearson Correlation Sig. (1-tailed)	.866(**) .000	1	.975(**) .000	17.03
Case4c (SME3)	Pearson Correlation Sig. (1-tailed)	.864(**) .000	.975(**) .000	1	16.47

**Correlation is significant at the 0.01 level (1-tailed).

Again, correlation of scoring between all three SMEs is significant at the .01 level.

Figure 10. SME Case Study Score Comparison by Participant (cont.)

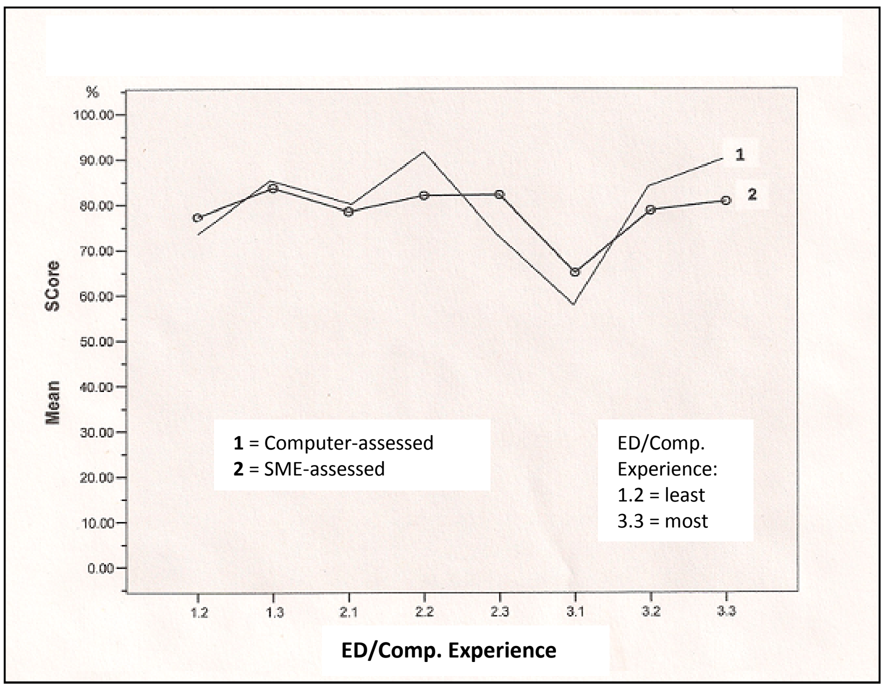


(Correlation of SME scores for participants 12, 15, 27 and 29 = 100%)

It is concluded that the three SMEs independently scored the case studies similarly, and assessment was consistent.

Statistically, there was also found to be a significant correlation (0.05 level) between Computer-assessed scoring and SME-assessed scoring of all case studies where combined Emergency Department experience and Computer experience levels (ED/Comp.) was used as a criterion (Figure 11).

Figure 11. Correlation of Mean Assessed Scores vs. Combined ED/Computer Experience



Correlation of Computer-Assessed and SME-Assessed Objectives Scores vs. Combined ED/Computer Participant Experience = **.438** (significant at the 0.05 level)

One of the objectives of this study was to evaluate whether prior experience of participants would have an impact on computer simulation performance. Prior experience was considered both in terms of ED "floor" experience as well as experience with a computer and was posed as the second research question:

Research Question 2.) "*What is the relative impact of computer experience vs. experience in the Emergency Department on demonstrated performance competency in a computer simulation exercise?"*

To answer this, an ANOVA was first conducted on the exercise results performed by individuals with varying levels of reported computer experience, from low experience (1) to high experience (3).

There was a significant difference found between groups with Case Study 1, but the other case studies 2-4 showed no significant difference (Figure 12, Table 6.)

Figure 12. ANOVA – Simulation Performance vs. Computer Experience

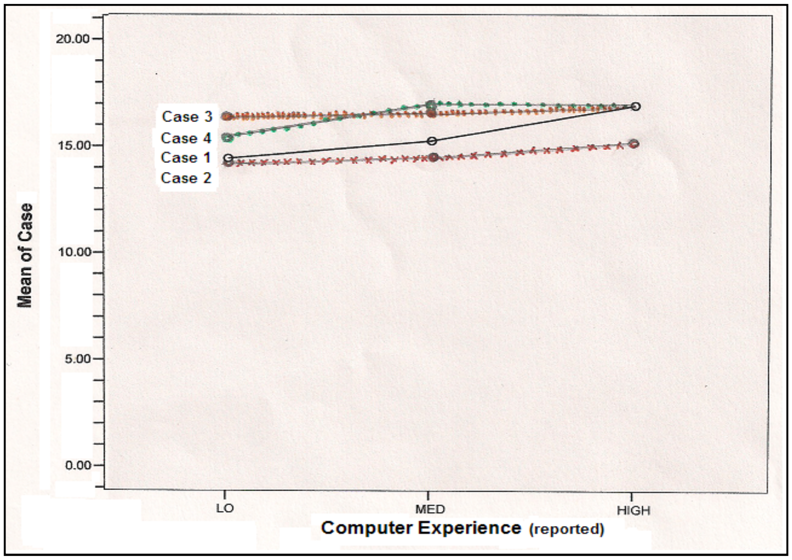


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Table 6. Sim Performance vs. Reported Computer Experience

ER-Developed Objectives		Sum of Squares	df	Mean Square	F	**Sig.**
Case 1 ERDesign	Between Groups	30.461	2	15.231	3.591	**.041***
	Within Groups	114.506	27	4.241		
Case 2 ERDesign	Between Groups	4.594	2	2.297	.292	.749
	Within Groups	212.772	27	7.880		
Case 3 ERDesign	Between Groups	.778	2	.389	.149	.862
	Within Groups	70.422	27	2.608		
Case 4 ERDesign	Between Groups	8.729	2	4.365	.456	.639
	Within Groups	258.638	27	9.579		

A second ANOVA was performed to explore the impact of Emergency Department experience and case study performance. While ANOVA results for Case Study 1 trended from the other three, no statistically significant differences were found among any of the case studies (Figure 13, Table 7.)

Figure 13. ANOVA – Simulation Performance vs. Emergency Dept. Experience

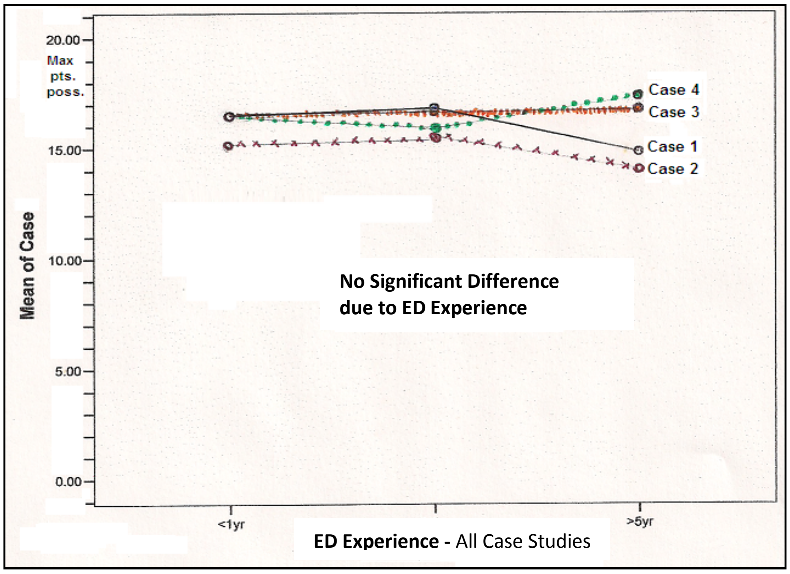

Table 7. Sim Performance vs. ED Experience

Sim Performance vs. ED Experience		Sum of Squares	df	Mean Square	F	**Sig.**
Case 1 ED-Developed	Between Groups	26.133	2	13.067	2.969	.068
	Within Groups	118.833	27	4.401		
Case 2 ED-Developed	Between Groups	11.867	2	5.933	.780	.469
	Within Groups	205.500	27	7.611		
Case 3 ED-Developed	Between Groups	.700	2	.350	.134	.875
	Within Groups	70.500	27	2.611		
Case 4 ED-Developed	Between Groups	12.450	2	6.225	.659	.525
	Within Groups	254.917	27	9.441		

Emergency Department and Computer experience were the primary variables specifically examined in this study. The findings indicate there does not appear to be a significant impact on performance with either variable, at least with the population of nurses tested. A possible explanation for differences in Case Study 1 performance may be initial lack of familiarity with the computer program and test design, which might present a learning curve for participants. This is not unanticipated with first-time performance of a new task. In the absence of evidence for any other contributing factors, other possible causes for differences would merely be speculative without the benefit of additional research. Differences may, of course, be random.

A final series of ANOVAs was performed on the computer simulation results to determine the impact of ED experience and Computer experience on the *Elapsed Completion Time* of a case study. The following tables provide the results for *Completion Time* vs. *Combined* *ED experience and Computer proficiency* (Table 8 a.), *Completion Time* vs. *Computer Proficiency* only (Table 8 b.), and *Completion Time* vs. *ED Experience* only (Table 8 c.) Referring to Table 8 a.) for the combined variables, there is nothing statistically significant at the 0.05 level. But trends in the data for the combination (i.e., Case Studies 3 and 4) warrant a second look at each variable independently. Table 8 b. (*Computer proficiency only*) shows no significant difference for all cases. Table 8 c. (*ED experience only)* shows statistical significance (0.05 level) for Case Study 3, and values trending towards significance for Case Studies 2 and 4. This would suggest a possible impact due to ED experience, but not Computer proficiency. The possibility is plausible. After the first case study has been completed,

Table 8 a. ANOVA: COMPLETION TIME and **COMBINED ED EXPERIENCE/COMPUTER PROFICIENCY**

ED/COMP Experience		Sum of Squares	df	Mean Square	F	**Sig.**
Case 1 Time	Between Groups	34.356	7	4.908	1.326	.285
	Within Groups	81.438	22	3.702		
	Total	115.794	29			
Case 2 Time	Between Groups	38.280	7	5.469	1.231	.328
	Within Groups	97.713	22	4.442		
	Total	135.994	29			
Case 3 Time	Between Groups	232.739	7	33.248	2.117	.085
	Within Groups	345.520	22	15.705		
	Total	578.259	29			
Case 4 Time	Between Groups	397.676	7	56.811	2.158	.080
	Within Groups	579.258	22	26.330		
	Total	976.935	29			

Table 8 b. ANOVA: COMPLETION TIME and **COMPUTER PROFICIENCY**

Comp. Exp.		Sum of Squares	df	Mean Square	F	**Sig.**
Case 1 Time	Between Groups	6.182	2	3.091	.761	.477
	Within Groups	109.612	27	4.060		
	Total	115.794	29			
Case 2 Time	Between Groups	.359	2	.180	.036	.965
	Within Groups	135.634	27	5.023		
	Total	135.994	29			
Case 3 Time	Between Groups	4.114	2	2.057	.097	.908
	Within Groups	574.145	27	21.265		
	Total	578.259	29			
Case 4 Time	Between Groups	104.647	2	52.323	1.620	.217
	Within Groups	872.288	27	32.307		
	Total	976.935	29			

Table 8 c. ANOVA: COMPLETION TIME and **ED EXPERIENCE**

ED.Exp	*(Significant 0.05 level)	Sum of Squares	df	Mean Square	F	**Sig.**
Case 1 Time	Between Groups	7.532	2	3.766	.939	.403
	Within Groups	108.262	27	4.010		
	Total	115.794	29			
Case 2 Time	Between Groups	23.415	2	11.707	2.808	.078
	Within Groups	112.579	27	4.170		
	Total	135.994	29			
Case 3 Time	Between Groups	164.165	2	82.083	5.352	**.011***
	Within Groups	414.093	27	15.337		
	Total	578.259	29			
Case 4 Time	Between Groups	181.711	2	90.856	3.085	.062
	Within Groups	795.223	27	29.453		
	Total	976.935	29			

it appears that computer proficiency becomes less of a factor in an individual's ability to complete the simulation. The participant has more familiarity with the computer and the simulation program. The more critical factor now becomes the ability to appropriately respond to the patient, where ED experience may be more advantageous.

Table 9 shows the number of participants that met the arbitrarily-designated "80% Objectives Met" criteria for Case Study 4, arguably the most complex of the four case studies, based on *ED experience level*.

Table 9. Case Study 4 Completed – Frequency of Participants

Case Study 4: 80% Objectives Met		
Experience Level		
1. < 1 yr.	**2.** 1-5 yrs.	**3.** > 5 yrs.
n=6	n=12	n=12
2	2	8
(33%)	(16%)	(67%)

The table shows a greater percentage of the most experienced nurses were successful in completing case study 4, suggesting that ED experience may have had a positive impact on performance with this computer simulation case study. Further research would be warranted to confirm a positive impact of ED experience on performance outcome on computer simulated case studies in general.

Summary

It was found that performance on computer-developed and assessed objectives correlated significantly with performance on objectives developed and assessed by ED physician/subject matter experts. Prior ED and Computer experience did not significantly impact participant performance on the case studies evaluated. Trends in the data suggest there may be some positive impact on performance related to increased years of experience in the ED. Confirmation of the significance of the trend, however, would require additional research.

Having quantified the data collected via the computer simulated case studies, the qualitative feedback from participant surveys and interviews represent the remaining study findings. This input was used to answer the final research question:

Research Question 3.) *"What is the perceived value of the learning experience expressed by participants using the computer simulation exercise vs. a comparable full-scale drill?"*

SURVEY RESULTS

Pre- and post-simulation surveys (Appendices G-1 and G-2) were used to obtain participant background data and to determine participant opinions and reactions to using a computer simulation exercise to practice biohazard emergency medical response. The pre-exercise survey was primarily for the purpose of obtaining demographic information, and that was presented earlier in Table 3. In the post-exercise survey, participant ratings were obtained on several aspects of the computer simulation exercise. Table 10. shows how participants rated 3 aspects of the simulation for difficulty, where a value of 1= *least difficult* and a value of 3 = *most difficult*:

Table 10. Task Difficulty Rating: Frequency of Responses (of 23 responses)

"For the computer simulation exercise, place the following in order of relative difficulty."

1 = *least difficult*
3 = *most difficult*

	Least **1**	**2**	*Most* **3**
A. Navigating the computer and/or the program	9	10	4
B. Individually participating in a monitored test	10	9	3
C. Responding to the case studies presented	4	3	16

The responses indicate *navigating the computer and/or program* rated low in terms of difficulty. While some participants stated they initially experienced some trouble in negotiating through the computer exercise and understanding with clarity the exercise options and overall objective, they also indicated they became more comfortable with the computer and the simulation with subsequent case studies. There was also a relatively low rating of difficulty given for "*participating in a monitored test."* Both ratings suggest that computer proficiency and "test anxiety" would not pose a significant hindrance to a participant's performance in the exercises.

"*Responding to case studies presented*" was listed as, relatively, the most difficult of the three choices offered. This is not an unexpected response considering the aim of such an exercise is to provide a challenging and purposeful problem-solving opportunity to practice medical emergency response. An effective computer simulation should allow for maximum focus on exercise performance without distractions introduced by difficulties in computer/program operation or from external disruptions that compromise one's ability to concentrate on the exercise itself.

Participants were then asked to rank (Table 11) the quality of basic aspects of the computer simulation using a five-point scale with 1 = lowest ranking and 5 = highest ranking.

Table 11. Computer Simulation Quality Ranking (from 30 surveys received.)

Relative Ratings	*Low*				*High*
On a scale of 1 to 5, with 5 being the highest	***1***	***2***	***3***	***4***	***5***
1. How do you rate the computer simulation?			5	13	12
2. How realistic was it?			1	10	18
3. How easy was it to use?		1	5	7	16
4. How challenging?			1	5	21
5. Was it relevant to your ED role?			3	8	18

A majority of participants gave 4 of 5 aspects the most favorable ranking (5). The one that did not get a 5 as the most frequent ranking (1. "How do you rate the computer simulation?") received the second highest value (4). High value ratings from participants suggest an acknowledgment that a computer simulation can provide many of the elements necessary for an effective training tool (e.g., reality, challenge, relevance and ease of use.) Whether these are sufficient for an effective learning experience will likely relate to practicality and how and where this training method is applied.

INTERVIEW RESPONSES

Having experienced the biohazard simulation exercise, the interview questions were designed to elicit participants' subjective opinions and impressions regarding the use of computer simulation in biohazard emergency preparedness. Where clarification of a question was requested or warranted, it was provided. The questions and responses were recorded as delivered. No conscious attempt was made to lead any participant in their answers. A selection of the more relevant inquiries is presented in Table 12.

Table 12. Interview Questions & Responses

. Question (total # responses)	**Not At All**	Not Much	**Undecided**	Some-what	**Very Much**
1. Were the patients in this exercise representative of those you might reasonably see in an actual biohazard incident? (20)			1	8	11
2. Do you think your current annual training prepares you for the types of biohazard exposed patients you encountered in this exercise? (20)		8	1	8	3
3. Do you think a computer simulation exercise like this would help you practice your biohazard response performance? (25)		2		9	14
4. Do you think a computer simulation exercise like this could be used to meet annual training requirements? (30)	2	5	2	10	11
5. Would a computer simulated exercise like this be effective for *sustaining your capability* (emphasis added) to respond to biohazard emergencies? (23)		1	1	6	15
	No		**Undecided**		Yes
6. Would it be more effective than a role-play simulation using actors? (25)	14		1		10

A review of the participant interview responses indicates there were several shared perceptions but also some that contrast. Most agreed (*Somewhat* to *Very Much*) that the patients presented in the computer simulation were representative of those they may see in a biohazard incident. But, when asked if their current annual training prepared them for those same types of patients, there was a near even split between those who agreed (*Somewhat*) and those who disagreed (*Not Much*). There was general agreement among participants that a biohazard computer simulation would help them practice biohazard response and even stronger agreement that a computer simulation like this would be effective in sustaining their biohazard response preparedness.

When asked if a computer simulation like the one they just completed could be used to meet current annual training requirements (for biohazard emergency preparedness), a majority responded *Somewhat* (10) to *Very Much* (11). However, that was not a unanimous impression as there were also responses of *Not Much* (5) and *Not at All* (2), with one undecided. When asked whether this computer simulation would be better for annual training than a role-play with actors, there was a clear split in opinion, with 10 responding "Yes" and 14 responding "No". There was one undecided. It should be noted that, at the time of this study, annual training was essentially comprised of suiting-up in HAZ-MAT protective gear and practicing decontamination procedures as well as patient triage which is unlike the patient-management focus of the computer simulation case studies. It is also worth noting that up to half the participants expressed at some point during the course of this study their clear preference for "hands-on" training (i.e., learning by personally handling patients, whether real or contrived in a role-play) over most other forms of training, including computer simulations. (The text of one participant's interview is provided in Appendix H.)

Summary

Participant feedback indicated, from a relative difficulty standpoint, the problem-solving of the case studies themselves posed the most challenge, with testing conditions and computer program navigation being less or least difficult. From a quality perspective, the computer simulation was ranked high in terms of realism, relevance, ease of use, and degree of challenge. There was strong agreement that the computer simulation would be helpful for sustaining personal biohazard preparedness. Despite the overall positive response to the computer simulation, there continues to be expressed the generalized impression by approximately half of the participants that computer simulation is not as effective as hands-on training, regardless the context and practical availability.

Having analyzed the bulk of data collected in this study, the research questions that were posed can be expanded upon, limitations encountered can be addressed and recommendations for further research can be made. These are presented in Chapter 5, *Conclusions and Summary*.

CHAPTER 5

CONCLUSIONS and SUMMARY

Responses to Research Questions

Restated simply, the objective of this study was to determine whether computer simulation can be used in training exercises to demonstrate learner competency for biohazard emergency response. The data generated were statistically analyzed both qualitatively and quantitatively and the results were used to answer these three research questions.

1. *Can performance competency be adequately measured and assessed through the use of a computer simulated exercise?*

If criteria for performance competency can be adequately deconstructed into specific tasks, it follows that it should be measurable, within the possible limits imposed by the measurement instrument. However, assessment will often be subject to interpretation.

It is impractical to seek to validate a given biohazard computer simulation by direct comparison to an actual biohazard incident of the same degree and dimensions. There would be logistic and design, and possibly ethical, constraints. Comparing a computer simulation to a full-scale drill would still be no more reliable than comparing one simulation to another. Understanding these limitations, this study gained information on situated training conditions in the field. Selected computer simulated case study results were evaluated against computer-programmed competency factors as well as criteria established for those same case studies by experienced emergency medicine physicians. Profiles of the emergency medicine physicians who participated as SMEs in this study are included at Appendix I.

The results were analyzed to determine whether a computer simulation could be used to effectively measure the level of response competency in emergency department nurse responders. In summary, the exercise results demonstrate:

- Significant correlations exist between computer-measured performance and SME-assessed performance suggesting each provides a similar capability for measurement and assessment in competency evaluations.
- A mean score for "*objectives met*" = 81.5% for all cases, whether computer-programmed and assessed or SME-developed and assessed, suggesting a high level of reliability in the measured test scores for each assessment method.
- Both assessment methods exhibit similar distributions. Results for all four of the case studies scored according to computer-programmed objectives present a longer negative skew and a wider range than those scored according to the ED-developed criteria. Results for Case Studies 1 and 2 using ED-developed criteria demonstrate more normal, bell-shaped curves. These characteristics could be related to the greater number of objectives set for ED-developed vs. Computer-programmed exercises, and the greater degree of specificity in the ED-developed objectives. A fewer number of "perfect scores" for ED-developed objectives would be anticipated, and was observed.
- An increase in the scores for "*objectives met*" with successive case studies, suggests an increasing familiarity with the computer program alone leads to improved overall test performance. Sufficient practice could reduce or even eliminate "computer experience" as a potential performance variable. At the same time, if used routinely, case studies would need to be adequately varied on

an ongoing basis to guard against redundancy or user prediction of programmed case study protocol.

It is concluded that these findings support the use of computer simulation as an effective measurement tool to assist in the measurement and assessment of biohazard emergency response competency.

2. *What is the relative impact of computer experience vs. experience in the emergency department on demonstrated performance competency in a computer simulation exercise?*

Analysis of the results of the case studies generally did not demonstrate significant influence of either computer experience or ED experience on exercise performance, but did suggest certain trends.

- There was a significant difference (0.04) due to reported (not verified) computer proficiency in Case Study 1 at the .05 level in a comparison of means analysis, but no significant difference was seen in subsequent case studies. That suggests the difference may be more due to lack of familiarity in the first encounter with the simulation program rather than to other apparent factors.
- An ANOVA performed to determine the impact on performance due to ED experience *combined* with computer proficiency did not show a statistically significant difference.

It is noted that a third of the participants (10) did not successfully complete Case study 4. In an ANOVA of test results of successful participants, computer proficiency did not show any significance. But ED experience trended toward significance and showed significance at Case Study 3, (.04). A check of ED experience level and successful completion of Case Study 4 indicated 8 participants (67%) with >5 years ED experience completed the case successfully, more than either of the less experienced levels. It may be that the more ED-experienced participants were able to parlay their experience and a closer adherence to the fundamental A, B, C's of First Aid (**A**irway, **B**reathing, **C**irculation) into success with that case study, the most complex of the group. Further research would be necessary to confirm this possibility.

3. *What is the perceived value of the learning experience expressed by participants using the computer simulation exercise vs. a comparable full-scale drill?*

Survey and interview responses indicate participants generally had a positive view of the potential for computer simulation use in biohazard emergency preparedness. To summarize:

- Participants rated the computer simulation high in regards to authenticity, the case studies being the most challenging aspect of the exercise (above navigating the computer or being personally monitored during the exercise). This is what a computer simulation exercise should provide if it is to be effective: allow the participant to focus on the problem to be solved while minimizing any extraneous distractions to that goal.
- Despite the positive view of computer simulation, hands-on exercises were indicated as *preferred* by at least half of the participants. There was, however, acknowledgement of the logistical limitations related to "hands-on" training specific to biohazard response preparedness. The likelihood of getting significant "hands-on" biohazard experience in the ED was also acknowledged to be low. At the time of the study, none of the 30 participants had treated or had any "hands-on" experience with an actual biohazard-exposed patient.

- There were mixed perceptions on the biohazard response training currently being received. Of participants who responded, there was a split between those who favored drills and role-plays (14) and those who favored computer simulations (10). Upon further probing, participants generally felt the two are not directly comparable in terms of experience gained. Participants generally expressed that each method provides practice in different aspects of biohazard response, for different skill sets. It was expressed that a preference for one over the other would not present a fair comparison. Several expressed that the hands-on practicing of donning Personal Protection Equipment/HAZMAT gear and of performing decontamination procedures which is currently practiced needs to be continued and recommended adding to that a computer-simulated module on patient care management. It was indicated that both would be useful for biohazard emergency preparedness.

Computer simulation competes with direct hands-on for preference in training method according to participant feedback. But the absence of opportunities to engage in direct hands-on training on a regular basis lends support to the use of computer simulation as a readily accessible alternate training method. The practical skill applications that need to be observed by evaluators currently eludes most computer simulations. However, it may be that these applications could practically be observed and measured in more routine ED procedures. All things considered, while the patients may differ, the skill application remains comparable and observable.

LEARNING THEORY APPLICATIONS

The following learning theories were examined in the literature review for this study and were revisited to assess how they may directly apply to the study findings:

1. Experiential Learning
2. Situated Learning
3. Problem-Based Learning
4. Discovery Learning and
5. Computer Supported Collaborative Learning (CSCL)

The fundamental similarity in these theories is that learning is an active process, best experienced within a realistic context, to allow for application and transfer of knowledge to the same, or similar, situations. In this respect, Experiential and Situated Learning theories (1, 2) may be closest to describing learning through (at least this) computer simulation. To the extent a simulation is realistic, and set in a familiar workplace setting with patients that participants have or reasonably could have direct contact with and participate in administering nursing care, the exercise will have experiential authenticity. Situated learning theory specifies that the setting need not be "on-site" but should approximate as close as possible the actual application situation. When they were surveyed and interviewed, participants responded in agreement that these conditions of realism were present. It is interesting that both of these theories are often associated with a "hands-on" learning technique. While a computer simulation usually does not allow for physical hands-on involvement, participants are none the less called upon to initiate an action that could constitute a vicarious hands-on activity. Still, perhaps the single most frequently voiced opinion from participants on the effectiveness of the computer simulation was "it's not hands-on". Further, the absence of hands-on activity does not allow evaluators to observe and gauge direct skills application. These are legitimate concerns. In an attempt to put these concerns into some perspective, it should be understood that military war-games, as well as jet-pilot training, constitute training that is essential but cannot be "hands-on". That training necessarily must be simulated. Nevertheless, these simulations allow for practice of skilled performance that will be called upon whenever the need arises, if at all. It would seem that disaster response preparedness also falls into this training category, where "hands-on" is impractical but practice is deemed essential for successful learning.

Problem-Based learning (3) emphasizes critical thinking, based on prior knowledge, to solve often unstructured problems. Evidence of the application of critical thinking could be inferred in many of the participant case study responses. In an emergency situation, response often must be made with immediacy based only on the possibly scant information available, and little else. There was a drug reference sheet and help tabs in the simulation program and participants checked dosage recommendations, and occasionally the help tab. They were observed, however, to rely primarily on prior knowledge in completing the exercises. As was noted, measurement of performance against an arbitrarily set standard was consistent whether computer-programmed or SME-assessed. Correlation between the two methods was significant. This supports the use of computer simulation as an effective tool for measuring problem-solving performance against a set standard, whether it be a generally recognized 'best practices" standard or one established for an individual location. What may be missing in the individually-completed simulations is the social context in which Vykotsky (1978) believed learning should take place. While not possible with the individually-completed simulation exercises, it may be this social context for learning could be provided at a debriefing session (After-Action Review/Report) which often follows these kinds of disaster preparedness drills/training exercises.

It would seem that Discovery learning theory (4) would have less relevance to emergency preparedness than the previous theories. In emergency response, action must be immediate and deliberate. There is not the luxury of time to deliberate on options. At least initially, participants may not have a large enough reservoir of established prior knowledge and experience in biohazard response to draw from in order to respond to these case studies immediately and deliberately. However, because the exercise is computer-simulated (virtual), there is not the same concern as with actual hands-on with live patients. Participants have the opportunity to practice trial and error in an authentic simulated emergency situation with an aim towards improving accuracy and response time. Practice is possible without the dire threat of virtual consequences being real ones.

Computer-Simulated Collaborative Learning theory (5) appears to have much to offer, but it could not be adequately evaluated here. Because the computer simulation exercises in this study were completed individually and not in teams, the collaboration component of this theory was not an option among participants. With continuing development in computer simulation for biohazard preparedness, a collaboration feature for multiple participants would be a significant and worthwhile enhancement.

RESEARCH SUMMARY

30 registered nurses from a city-hospital Emergency Department participated in and completed a computer simulation of four case studies of patients treated due to possible biohazard exposures. The instrument used for this study was an interactive computer

simulation of individual patients received undiagnosed at a hospital emergency department. Pertinent computer simulation program characteristics were assessed, including degree of complexity and fidelity (realism). Participant performance was evaluated against standardized computer-programmed objectives and ones specifically developed for the study by three pre-selected and active emergency medicine physicians acting as SMEs.

The results show these computer simulations are similar in effectiveness with many aspects of hands-on exercises and can fill a significant niche in emergency-care response preparedness that routine "hands-on" does not: that of frequent, diverse and readily accessible *practice* in biohazard case management. Further, they allow for more frequent, less-resource intensive assessments of responder preparedness to meet designated performance objectives with infrequently encountered biohazard patients.

These findings do not demonstrate that computer simulations replace "hands-on" as a preferred method of biohazard training for ED nurse responders. That was not an objective of this study. But, the findings demonstrate computer simulations provide an important training tool as an interactive virtual alternative to hands-on.

With the low probability of actually encountering biohazard-exposed patients in the normal day-to-day activity of the ED, computer simulations allow nurses the needed opportunity for *skills practice.* Practice allows nurses to remain current in their knowledge of procedures for the care of biohazard-exposed patients which they ordinarily would not see. Although virtual (simulated), the case studies used in this study were authentic enough that it was observed participants were motivated to be deliberate and precise in their efforts to stabilize each patient, much the same as would be expected in actual hands-on contact in the ED. There was a consistency in scoring seen among the three physicians acting as Subject Matter Experts (SMEs) indicating reliability in exercise assessment which, in turn, supports the reliability of the computer-assessed scores.

Probably the most notable advantage to computer simulation vs. role plays and drills may be in their overall availability. Easy availability can increase the frequency of use, to a greater number of responders, whenever access is sought (i.e., "24/7" availability). Computer simulations can provide for the practice of critical thinking in emergency response, unrestrained by the urgency of the moment or the life or death consequence of the "make-believe" (virtual) patient.

Still, while interactive, completing a computer simulation is not specifically "hands-on" and it currently may not fully meet what Edgar Dale describes as "purposeful, direct experience" (see Cone of Experience, Figure 3.) An additional limitation not currently possible with computer simulations is the inability of evaluators to directly observe and assess actual hands-on treatment procedures of responders. But, for the purposes of the hospital ED, sufficient biohazard preparedness cannot rely solely on what is the acknowledged limited availability for hands-on experience if it is to meet a biohazard response standard for competency and effectiveness.

This study supports adding computer simulation as an integral component within the repertoire of current biohazard response preparedness training tools, which include not only didactic methods, but also role plays and drills. Given the complexity of what constitutes sufficient preparedness, no single tool is completely effective. Feedback from study participants indicates users understand not only the limitations, but also the strengths that computer simulations contribute to practice in biohazard response.

As with any developed skill, mastering of competency in biohazard response requires practice. As has been often quoted and, by most measures of learning, is supported by the evidence: "Practice makes perfect." (Anon, ca.1550). In biohazard emergency preparedness, it is not perfection that is the goal, merely competency in performance.

Limitations of Study

Ultimately, the evaluation of effectiveness of the computer simulation will depend on an assessment of user performance. As such, possible limitations of the study tend to relate to the subjectivity or bias of the test subjects and expert evaluators. The study simulation appears to present a relatively high degree of authenticity, but simulation fidelity is only as high as the user perceives it to be. There may be highly competent individuals who perform purposefully and without hesitation in the Emergency Department but who may be distracted in the study due to a lack of familiarity with computer use or with simulated exercises in general. It was important to provide sufficient pre-test instruction and allow for adequate prior orientation time to computer operation to reduce these impacts relating to unfamiliarity with the computer and the simulation program. Evaluators must have their assessment scores compared to insure inter-rater reliability. The test sample (30) is a limitation based on practicality. Obtaining 30 test subjects posed some logistical limitations but the study did not require a single seating of 30 participants. Rather, testing was conducted over several individual sessions until the targeted number of test participants was attained. Participants needed to be reassured of the confidentiality of their exercise results and that their job was never at stake based on their performance on the case studies. Every possible and practical effort was taken to minimize confounding factors that may invalidate results. Throughout the study there remained among participants a preconception that hands-on training is the only truly effective training format for emergency response with other forms of training, including computer simulation, being of somewhat lesser value. To counter this, increased experience and familiarity through practice with authentic computer simulations would facilitate the acceptance and amenability of responders to their use for response preparedness. Computer simulations provide the benefit of "practice at retrieval" which facilitates retention and increases the responder's ability to retrieve information and act quickly with minimal cues (Cull, 2000), a key component of effective and competent ED emergency response.

Recommended Further Research

It has been offered that, because of their unique role in instruction, computer simulations should be evaluated based on their own merits and comparisons with other, conventional methods should not be the single measure of their value or effectiveness (Yildiz and Atkins, 1992). With this in mind, there are a number of areas for further research that can be recommended.

- There is a void in empirical evidence of the effectiveness of computer simulation in disaster and emergency response preparedness. Use of this study design can yield additional research to provide needed data to strengthen an understanding of the pros and cons and unrecognized potential for computer simulation, and other technologies, in disaster response as computer simulations take on an increased role as an instructional strategy.

- Studies on *team response* and *multiple responder collaboration* as described by the *Computer Supported Collaborative Learning Theory* (Koschmann, 1996) would broaden the ability to analyze group dynamics and synergies in disaster response. That would provide a truer representation of what transpires in multiple agency response to mass emergency and disaster events where collaboration is a critical factor.
- There was a trend in the statistics noted regarding the impact of experience in the ED and positive performance on the computer simulated case studies. Further research is recommended to determine whether the trend can be confirmed as statistically significant.
- Fidelity (realism) has been indicated as a critical aspect of computer simulation training and described as a major reason hands-on training is preferred. Because there necessarily is a limit to how "real" a simulation may be, it is recommended further research be conducted to determine minimal criterion required for the amount of fidelity needed for effective computer simulation instruction before a level of diminishing returns is reached. There is every indication that the use of computer simulation in instruction will increase. It would do well to determine that criterion now as a guide in future computer simulation program development.

While these are some recommended areas for further research that would impact the use of computer simulation in biohazard preparedness, computer simulation in instruction in general is a fertile area wide-open with instructional technology research needs and, as of yet, unidentified exploration opportunities.

APPENDIX A-1

WAYNE STATE UNIVERSITY

HUMAN INVESTIGATION COMMITTEE
101 East Alexandrine Building
Detroit, Michigan 48201
Phone: (313) 577-1628
FAX: (313) 993-7122
http://hic.wayne.edu

Full AAHRPP Accreditation — Association for the Accreditation of Human Research Protection Programs, Inc.

NOTICE OF EXPEDITED APPROVAL

To: Daniel O'Reilly
College of Education
137 Manoogian Hall

From: Ellen Barton, Ph.D. E. Barton / G
Chairperson, Behavioral Institutional Review Board (B3)

Date: October 16, 2009

RE: HIC #: 095109B3E

Protocol Title: Computer Simulation in Mass Emergency Response: An Evaluation of its Effectiveness as a Tool for Demonstrating Strategic Competency in Emergency Department Responders

Sponsor:

Protocol #: 0909007519

Expiration Date: October 15, 2010

Risk Level / Category: Research not involving greater than minimal risk

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The above-referenced protocol and items listed below (if applicable) were **APPROVED** following *Expedited Review* (Category 7*) by the Chairperson/designee *for* the Wayne State University Behavioral Institutional Review Board (B3) for the period of 10/16/2009 through 10/15/2010. This approval does not replace any departmental or other approvals that may be required.

- Recruitment Notice
- Consent Form
- SME Consent Form

- Federal regulations require that all research be reviewed at least annually. You *may* receive a *"Continuation Renewal Reminder"* approximately two months prior to the expiration date; however, it is the Principal Investigator's responsibility to obtain review and continued approval ***before*** the expiration date. Data collected during a period of lapsed approval is unapproved research and can ***never*** be reported or published as research data.
- All changes or amendments to the above-referenced protocol require review and approval by the HIC **BEFORE** implementation.
- Adverse Reactions/Unexpected Events (AR/UE) must be submitted on the appropriate form within the timeframe specified in the HIC Policy (http://www.hic.wayne.edu/hicpol.html).

NOTE:

1. Upon notification of an impending regulatory site visit, hold notification, and/or external audit the HIC office must be contacted immediately.
2. Forms should be downloaded from the HIC website at ***each*** use.

*Based on the Expedited Review List, revised November 1998

APPENDIX A-2

Print Form

WAYNE STATE UNIVERSITY
GRADUATE SCHOOL

2010 DEC 1 PM 3 09

TIME EXTENSION REQUEST
Doctor of Philosophy

Ph.D. Office, 42 West Warren, Detroit, MI 48202
Phone: 313.577.3270 | phdstudents@wayne.edu

Name Daniel J. O'Reilly Date November 30, 2010

PID 003-46-2229 E-mail djoreilly@earthlink.net Telephone 313-590-6507

Address 555 Brush Street #2803, Detroit, Michigan 48226

CHECKLIST

(One semester time extension.)

- ☒ Proposed Deadline Date: MAY 31, 2011
- ☒ Letter of Support from Advisor is attached
- ☒ Student's Annual Progress Report is attached
- ☒ Detailed timeline to completion is attached

1. **Describe the student's progress toward completion of the dissertation** *(attach additional pages if necessary).*

The dissertation prospectus was approved in October 2009 and a continuation of the study approved by the HIC on October 20, 2010. The dissertation study has been completed as well as the statistical analysis. Chapters 4 and 5 are in final revision.

2. **How has the student remained current in his or her field?** *(Attach additional pages if necessary).*

The student regularly attends professional development workshops at Wayne County Community College, where he is employed as an instructor of Introductory Biology and Human Ecology. The dissertation study has consumed the last 12 months (a collaboration with on-site hospital emergency department physician and the coordination of 30 nurse participants with a computer simulated exercise for emergency response to simulated biohazard patients).

Paul W. Johnson — 11·30·2010
Departmental Graduate Director — Date

Mark Wardell — 12 December 2010
Dean, The Graduate School — Date

APPENDIX A-3 (cont.)

DMC
Sinai-Grace
Hospital

Department of Emergency Medicine
17 September 2009

6071 W. Outer Drive
Detroit, MI 48235-2624

Dan O'Reilly
Millender Cntr Apts. #2803
Detroit, MI 48226

Re: Simulation Proposal

Dear Dan,

Sinai-Grace Hospital's emergency department will help you in your simulation project. The department administrative director will support your approaching the ED nurses to participate in the study. Space will be provided to do the online testing.

I will also review and score the simulations along with some colleagues in providing a general score on the simulations.

Should you have any further questions please feel free to contact me.

Sincerely,

Marc S Rosenthal, PhD, DO, FACEP
Director, EMS Sinai-Grace Hospital/DMC
Director, WMD Detroit Medical Center
Asst. Prof of Emergency Medicine

Our Strength. Your Health.

www.dmc.org

APPENDIX B

COMPUTER SIMULATION EXERCISE INSTRUCTIONS

How to complete this computer simulation

This exercise is an important part of a research study to determine whether computer simulation can be used as an aid to emergency responder preparedness. Basically, it will follow the same format as a full-scale drill: patients will be received in the ED after being potentially exposed to a deliberate release of a biological hazard. They will demonstrate various symptoms that the ED will need to respond to in order to stabilize the patient. Affected patients will be presented in this computer program, much the same as in a video game. You'll see the patient on the computer screen and the symptoms will be described. You'll then enter instructions about what you would do, step by step, to respond to the symptoms and, ultimately, stabilize the patient. You may not be able to follow a pre-determined evaluation sequence. You must, however, ensure the standard "ABC's" of emergency response (***A****irway clear,* ***B****reathing sustained,* ***C****irculation evident)* are met.

From "*Bioterrorism 2002"* Computer simulation

You will be asked to do 4 case studies. You won't know exactly what or if the patient has been exposed to a particular hazard, but you'll recognize physical symptoms that require nursing intervention. You'll enter that information into the computer by referring to a _sidebar_ presented on-screen which consists of various triage protocol components. If the computer indicates the patient's condition is worsening, you'll need to enter instructions to counteract that trend. The objective of the exercise is to practice ***first***

(cont.)

response and achieve ***patient stabilization***. *Remedy and recovery is outside the scope of this exercise.*

For the purposes of this exercise, you have received *Standing Orders* from the emergency physician in charge to administer treatment as needed. You'll be given some information upfront and some you will recognize according to the patient's ongoing status.

Only do what is necessary to stabilize the patient. Time elapsed to attain stability will be considered where it is a critical factor in the emergency response. Do not prolong or second-guess your decision-making in an effort to maximize performance in this desk-top exercise. Try to act as if you are responding to a real emergency in the real ED with a real patient in real-time. Your performance is not being evaluated individually, nor can the results of the exercise be linked to you directly. However, any unnecessary delay or unnecessary actions taken will be considered "*errors in response"* and detract from the overall *group performance*, which is being measured.

Bioterrorism Simulator Instructions:

1. Read the brief description of the case.
2. Take a few minutes to familiarize yourself with the main simulator screen. There is a patient, monitor, and clock. Control the simulation using the sidebar menu on the left side of the screen.
3. Begin the case by taking/reviewing the history of the present illness using the History menu.
4. Examine the patient using the Physical Exam menu.
5. Use the Monitor menu to monitor electrocardiogram, blood pressure, and oxygen saturation if the patient appears to be unstable.
6. Control the Airway and Ventilation if necessary. If ventilation is not *spontaneous*, suction and bag the patient (use *anesthetic mask*). If ventilation continues to be difficult, intubation will be necessary to provide *controlled* ventilation.
7. Start IV fluids by selecting the IV option in the Drugs/IV menu. *Type* the desired rate in the rate field, then select OK.
8. Administer vasoactive drugs if needed to resuscitate the patient. Refer to Drugs menu for agent and dosage.
9. Order labs or other studies using the Labs/Studies menu
10. If it is necessary, Decontaminate and Isolate the patient as soon as feasible.
11. For many cases it may be appropriate to contact the local *public health agency*.

(cont.)

12. Help information and recommended dosage is available for each of the agents.
13. Administer antibiotics or other drugs using the Drugs menu.
14. Select Help/Debrief for comments on what to do next and what went wrong during the simulation.
15. The case simulation is completed and the learning objectives have been met when the 'Heart' icon appears.
16. Review the case record by selecting Simulation/Review Record.
17. **Enter "QUIT".** **DO NOT ENTER "EXIT" or your entire exercise will be DELETED!**

When you have completed each case study, enter "Quit" but **Do Not Enter "EXIT"!** Instead, alert the moderator that you have finished your exercise. The moderator will assist you in saving a copy of your work. As time permits, the moderator may assign another case study to complete until four (4) have been done. When all four case studies have been completed, set up a time with the moderator in about a week when you can meet for a brief, informal follow-up interview to provide feedback on the exercise. At that time, you can pick up your $25 reward.

Thank you very much for volunteering and participating in this research study.

APPENDIX C

DRUG REFERENCE CHART

DRUG	ACTION	DOSAGE	REMARKS
Albuterol	-Relax bronchospasm -Facilitate spontaneous Respiration	Adult: 2-3 puffs (mask) 8-10 puffs (intubated) Child: **	
Antibiotics **- *Cipro*** (Ciprofloxacin) **-Doxycycline** **-Streptomycin**	- infection prevention/ control	Adult: 500 mg PO BID Child: 15mg/kg PO BID Adult: 100mg PO BID Child: 2.2mg/kg PO BID Adult:1 gm IM /q 12 hrs. Child: 15 mg/kg/IM/q 12 hrs.	If infection is highly suspected, begin anti-biotic treatment prior to confirmation of diagnosis
Antihistamine *Zyrtec*	Allergic rx	Adult: ** 10 mg tab 1/day Child: **	
Atropine	-Ease lacrimation, Rhinorrhea -Stabilize Heart Rate,	Adult: 2-5 mg/IV/slow Child: .05 mg/Kg/IV/slow	Repeat dosage every 15 min
Diazepam	Seizure Control	Adult: 5-10 mg/IV q 5-10min Child: 0.2 -0.5 mg/Kg /IV q 5-10min	
Morphine **(Ibuprofen, at home)**	Pain reduction	Adult: 0.1 mg/Kg (Morphine) (1-2 tabs/4hr, Ibuprofen) Child: ** (Morphine) (81 mg tab/4hr , Ibuprofen)	Morphine can cause respiratory depression
Pralidoxime **(2PAM)**	- for Nerve agent, with atropine -Restore functional Muscle movement -Resuscitate	Adult: 1-2 gm/IV /30 min, normal saline Child: 25-50mg/Kg/IV/30 min	
Vaccine: **-Anthrax** **-Botulinum antitoxin** **-Small pox** **-Chicken pox** **- H1N1**	Immunization, Prophylaxis	Adult: as prescribed (see "*Drug Help*") Child:	Where *credible* exposure has been established; not for prophylaxis except in vulnerable populations.

APPENDIX D
CASE STUDIES

D-1

Nurse: __________

Case 1 64 year old female with fever and flu-like symptoms (Smallpox, Lesson 1)

Debrief: This patient has no known contact with smallpox and has no rash so most likely has a different cause for her fever. Do not isolate, but have patient monitor for fever and rash at home.

Diagnosis: No smallpox. Probably influenza.

Case Discussion

The signs and symptoms exhibited by this patient are most consistent with the influenza or influenza-like illness (ILI). Fever, chills, non-productive cough and malaise are common to both influenza and smallpox prodrome, but the fever tends to be much higher with smallpox. The throat must be carefully examined since the vesicular rash of smallpox often first appears on the mucosa of the mouth and pharynx. The runny nose points to ILI more than smallpox.

It is unlikely that this patient was exposed to an aerosol release of smallpox or had contact with a smallpox case. No one within miles has been identified with smallpox and none of her family members have been exposed.

The patient should be reassured that she does not exhibit signs of smallpox and has little risk that she has contacted the disease. She does not meet the criteria for receiving the smallpox vaccine at this time. She does not need to be isolated, but should be advised to monitor her temperature and watch for a rash.

Case 1 Programmed Objectives Rubric (1 pt. for each, 4 pts. Total)

1. History of Current Illness ___

2. Vital signs ___

3. Check Skin for Rash ___

4. Aerosol Precautions ___

D-2

NURSE: ____________

Case 2. 7 year old girl with fever and rash (Smallpox, Lesson 3)

Debrief:

This patient has rash and prodrome most consistent with chickenpox. Notify your local Public Health department if any suspicion of smallpox remains. If the patient had contact with a smallpox case, but doesn't have smallpox, she should get a vaccine immediately. Send home and monitor for a change in condition.

Diagnosis: No Smallpox. Probably chickenpox.

Case Discussion

This patient's signs and symptoms are most compatible with chickenpox, not smallpox. The other child sent home from school with fever and rash also has presentation most compatible with chickenpox. Assuming the other child did not have smallpox, our patient has not had a credible smallpox exposure. Therefore she should not receive smallpox vaccine at this time and should go home, drink fluids, rest and take ibuprofen for fever.

Currently, smallpox vaccine would likely be released for administration to:

- Persons exposed to intentional release of smallpox virus.
- Contacts of smallpox cases and household members of contacts of smallpox cases.
- Suspected cases of smallpox admitted to a facility for isolation and quarantine for protection in case they do not actually have smallpox.
- Persons involved in direct medical or public health management or transport of suspected or confirmed smallpox cases.
- Lab staff processing specimens from suspected or confirmed smallpox cases.
- Other persons at risk of contact with infectious materials (i.e. certain hospital workers).
- Persons whose unhindered function is essential to support response activities.

Persons with no confirmed exposure to the release of smallpox virus or to a smallpox case would not be a candidate for smallpox vaccine. Persons with smallpox should be under isolation precautions or quarantined from the time of fever until either all lesions have scabbed and separated or until the diagnosis of smallpox is ruled out.

Case 2 Programmed Objectives Rubric (1 pt. each, 4 pts. total)

1. History of Current Illness ___
2. Vital signs ___
3. Check Skin for Rash ___
4. Aerosol Precautions ___

D-3

Nurse: _________

Case 3. 62 year old female with severe cough
(Other Infectious Agents, Lesson 3)

Debrief: This patient has signs and symptoms consistent with tularemia. Notify your local Public Health department, send specimens for testing, and begin antibiotic treatment.

Diagnosis: Tularemia from inhalation of airborne bacteria (possible released biohazard?).

Case Discussion

The signs and symptoms exhibited by this patient are consistent with pleuropulmonary tularemia. Due to typically low incidence, the diagnosis of tularemia may not be initially suspected. A clustering of sudden, severe pneumonias in previously healthy patients should raise the possibility of intentional aerosolized release of tularemia.

Streptomycin and gentamicin are the drugs of choice to treat tularemia.

Tularemia is not transmitted person to person and isolation of cases is not required. Patients thought to be exposed to an aerosolized release of tularemia should receive prophylactic doxycycline or ciprofloxacin, but close contacts of patients with tularemia pneumonia do not need prophylactic antibiotics. Note that ciprofloxacin is not FDA approved for treatment or prophylaxis for tularemia, but it is recommended by the Working Group on Civilian Biodefense.

The patient should be hospitalized if the history and physical exam are suggestive for pleuropulmonary tularemia. Consultation with the local health department and an infectious disease specialist would be appropriate if tularemia is suspected and immediate notification of the hospital epidemiologist and health department are indicated for clusters of cases compatible with tularemia or sporadic cases without a natural explanation.

Case 3 Programmed Objectives Rubric (1 pt. each, 8 pts. Total)

1. Hx present illness ___
2. Vital signs ___
3. General Exam/Skin ___
4. Breath Sounds ___
5. Chest X-ray ___
6. Streptomycin ___
7. Public Health notified ___
8. Microbiology lab ___

D-4

Nurse: _______

Case 4 Possible Nerve Agent (SOMAN)

Debrief: The airway was controlled and adequate oxygenation provided. The seizures were treated. The patient was decontaminated, and atropine and pralidoxime were administered.

Diagnosis: Based on symptoms and single incident/multiple individuals affected, possible nerve agent exposure.

Case Discussion: Respiratory failure and seizures indicate severe exposure to the toxic agent. Cholinergic symptoms observed in other patients should raise suspicion of nerve agents. Miosis is a particularly prevalent sign, present in 90% of patients affected by the Tokyo Sarin incident. The patient in respiratory failure must be intubated promptly and mechanically ventilated. Treat bronchospasm with albuterol and other bronchodilators as needed. Suction the airway frequently to keep it clear of secretions. Decontamination should follow soon as possible. Then establish intravenous access and administer atropine and pralidoxime. Diazepam has been recommended for seizure control. Midazolam may be a useful substitute since it is less painful on injection and has faster onset.

Case 4 Programmed Objectives Rubric (1 pt. each, 18 pts. total)

A. Airway:

1. Intubate ___ or (mask with oxygen) ____

2. Suction ___

B. Decon:

3. Remove clothes/jewelry ___

4. Shower ___

C. Physical:

5. Hx of present illness ___

6. Vitals ___

7. Breath ___

8. Heart ___

9. Skin ___

10. Pupils ___

D. Treatment Plan

11. Labs/C. x-ray ___

12. IV ___

13. Diazepam ____

(Albuterol ____)

14. Atropine ____

15. Pralidoxime ____

E. Precautions:

16. Droplet___

17. Universal ___

18. Notify Pub Hlth ___

APPENDIX E

SAMPLE EXERCISE LOG

Nurse: (*anonymous*) - Case 4

71 year old female with respiratory failure and seizures
Nerve Agents, Lesson 4
Tue Jun 01 14:54:00 EDT 2010

00:00:00 **HR:**71 **BP:**116/65 **RR:**16 **TV:**350 **SpO2:**96 **EtCO2:**0.0
- Obtained history of present illness.
- Obtained history of present illness.
- Obtained history of present illness.
- Obtained past medical history.

00:00:32 **HR:**55 **BP:**104/52 **RR:**7 **TV:**48 **SpO2:**91 **EtCO2:**0.0
- Obtained meds/allergies.
- Obtained review of systems.
- Obtained review of systems.
- OAA/S Scale:1 - Unresponsive
- Checked vital signs.
- Pulse: strong
- Pulse: strong
- Breath sounds: absent
- Heart sounds: normal
- Examined abdomen.
- Examined abdomen.
- Examined skin.
- Examined skin.
- Examined pupils.
- Performed neuro exam.
- Suction: scant secretions

00:01:04 **HR:**55 **BP:**102/51 **RR:**5 **TV:**33 **SpO2:**85 **EtCO2:**0.0
- Laryngoscopy: vocal cords visible MAC 3 size 7.5
- Ventilation: bag controlled TV: 550 RR: 14
- Display ECG lead II

(continued)

00:01:36 **HR:**61 **BP:**102/51 **RR:**7 **TV:**41 **SpO2:**63 **EtCO2:**49.0
- Display ECG lead V5
- NIBP: cycle 3 min
- Display capnogram
- Train of 4: T1 - T4 % 88 55 22 0
- Connect pulse oximeter

00:02:08 **HR:**78 **BP:**108/65 **RR:**14 **TV:**313 **SpO2:**89 **EtCO2:**40.0
- IV 1: Ringers 1000 ml/hr, bolus: 1000 ml
- IV 2: Ringers 0 ml/hr

00:02:40 **HR:**71 **BP:**122/75 **RR:**14 **TV:**262 **SpO2:**90 **EtCO2:**42.0
- Obtained CBC
- Obtained Electrolytes
- Obtained ABG
- Obtained Glucose
- Obtained BUN, Cr
- Obtained Microbiology
- Obtained Chest x-ray

00:03:12 **HR:**69 **BP:**128/79 **RR:**14 **TV:**230 **SpO2:**91 **EtCO2:**44.0
- Diazepam Bolus : 5.0 mg
- Public health notified.

00:03:44 **HR:**70 **BP:**136/87 **RR:**14 **TV:**208 **SpO2:**90 **EtCO2:**46.0
- OAA/S Scale:1 - Unresponsive
- Checked vital signs.
- Pulse: strong
- Examined breath sounds.
- Heart sounds: normal
- Albuterol Bolus : 10.0 puffs
- Heart sounds: normal
- Examined abdomen.
- Examined skin.
- Examined pupils.

(continued)

00:04:16 **HR:**74 **BP:**152/103 **RR:**14 **TV:**190 **SpO2:**90 **EtCO2:**48.0
- Performed neuro exam.
- Obtained Head CT Scan

00:04:48 **HR:**74 **BP:**162/112 **RR:**14 **TV:**176 **SpO2:**89 **EtCO2:**51.0
- Obtained Electromyogram

00:05:20 **HR:**74 **BP:**168/117 **RR:**14 **TV:**167 **SpO2:**86 **EtCO2:**52.0
- Ventilation: bag controlled TV: 600 RR: 16

00:05:52 **HR:**74 **BP:**171/119 **RR:**16 **TV:**163 **SpO2:**83 **EtCO2:**54.0
- Morphine Bolus : 5.0 mg
- Suction: scant secretions

00:06:24 **HR:**74 **BP:**175/122 **RR:**16 **TV:**159 **SpO2:**81 **EtCO2:**55.0
- Tube position: 24 cm
- Suction: scant secretions
- Suction: scant secretions
- Suction: scant secretions

00:06:56 **HR:**75 **BP:**177/121 **RR:**16 **TV:**158 **SpO2:**77 **EtCO2:**57.0
- Tube position: 24 cm
- Pause simulation
- Ventilation: spontaneous
- Ventilation: spontaneous

00:07:28 **HR:**75 **BP:**179/122 **RR:**16 **TV:**157 **SpO2:**74 **EtCO2:**58.0
- Ventilation: spontaneous
- Anesthetic mask placed
- Oxygen : 5.0 lpm
- Anesthetic mask removed
- Anesthetic mask placed
- Oxygen : 5.0 lpm

(continued)

00:08:00 **HR:**72 **BP:**182/122 **RR:**22 **TV:**95 **SpO2:**52 **EtCO2:**64.0
- Laryngoscopy: vocal cords visible MAC 3 size 7.5
- Tube removed
- Face mask placed
- Anesthetic mask placed
- Oxygen : 5.0 lpm

00:08:32 **HR:**66 **BP:**174/117 **RR:**24 **TV:**116 **SpO2:**46 **EtCO2:**65.0
- Suction: scant secretions

00:09:04 **HR:**60 **BP:**166/106 **RR:**23 **TV:**120 **SpO2:**64 **EtCO2:**67.0
- Atropine Bolus : 5.0 mg

00:09:36 **HR:**60 **BP:**148/91 **RR:**23 **TV:**126 **SpO2:**78 **EtCO2:**69.0

00:10:08 **HR:**91 **BP:**141/91 **RR:**23 **TV:**131 **SpO2:**88 **EtCO2:**71.0

00:10:40 **HR:**101 **BP:**140/95 **RR:**24 **TV:**136 **SpO2:**91 **EtCO2:**71.0
- Laryngoscopy: only epiglottis visible Miller 4 size 8.0
- Laryngoscopy: vocal cords visible MAC 3 size 7.5
- Ventilation: bag controlled TV: 600 RR: 16

00:11:12 **HR:**102 **BP:**139/97 **RR:**24 **TV:**138 **SpO2:**92 **EtCO2:**72.0
- Obtained Chest x-ray

00:11:44 **HR:**110 **BP:**142/103 **RR:**16 **TV:**540 **SpO2:**94 **EtCO2:**49.0

00:12:16 **HR:**112 **BP:**159/118 **RR:**16 **TV:**540 **SpO2:**94 **EtCO2:**46.0
- Clothes removed
- Aerosol precautions established.

(continued)

00:12:48 **HR:**109 **BP:**177/128 **RR:**16 **TV:**540 **SpO2:**95 **EtCO2:**44.0
- Patient showered
- Universal precautions established
- Patient showered

00:13:20 **HR:**107 **BP:**185/128 **RR:**16 **TV:**540 **SpO2:**95 **EtCO2:**42.0
- Diazepam Bolus : 5.0 mg

00:13:52 **HR:**105 **BP:**191/128 **RR:**16 **TV:**540 **SpO2:**95 **EtCO2:**41.0
- Suction: scant secretions

00:14:24 **HR:**102 **BP:**191/128 **RR:**16 **TV:**540 **SpO2:**95 **EtCO2:**39.0
- Morphine Bolus : 5.0 mg

00:14:56 **HR:**98 **BP:**191/128 **RR:**16 **TV:**540 **SpO2:**95 **EtCO2:**37.0
- Pralidoxime Bolus : 2.0 grams

00:15:28 **HR:**95 **BP:**189/127 **RR:**16 **TV:**540 **SpO2:**95 **EtCO2:**36.0

00:16:00 **HR:**92 **BP:**186/123 **RR:**16 **TV:**540 **SpO2:**95 **EtCO2:**35.0

00:16:32 **HR:**89 **BP:**179/121 **RR:**16 **TV:**540 **SpO2:**95 **EtCO2:**34.0

00:17:04 **HR:**84 **BP:**171/118 **RR:**16 **TV:**540 **SpO2:**95 **EtCO2:**33.0
- Obtained ABG

00:17:36 **HR:**80 **BP:**161/108 **RR:**16 **TV:**540 **SpO2:**95 **EtCO2:**32.0
- Ventilation: bag controlled TV: 700 RR: 18

00:18:08 **HR:**77 **BP:**152/100 **RR:**16 **TV:**540 **SpO2:**95 **EtCO2:**31.0

(continued)

00:18:40 **HR:**74 **BP:**142/91 **RR:**18 **TV:**630 **SpO2:**95 **EtCO2:**28.0
- Pralidoxime Bolus : 1.0 grams
- Suction: scant secretions
- Tube position: 22 cm

00:19:12 **HR:**71 **BP:**137/86 **RR:**18 **TV:**630 **SpO2:**95 **EtCO2:**27.0
- Atropine Bolus : 5.0 mg

- You successfully fulfilled the learning objectives for this case.

00:19:44 **HR:**89 **BP:**132/83 **RR:**18 **TV:**630 **SpO2:**95 **EtCO2:**27.0

00:20:16 **HR:**108 **BP:**129/90 **RR:**18 **TV:**630 **SpO2:**95 **EtCO2:**27.0

END

APPENDIX F

Sample SME Score Sheet

SME-developed Objectives Rubric (20 pt. Total)

SCORING SYSTEM			Pts.	AAA	AAB	BAA	ABA	BBB
Case #1 - Small Pox								
History			5					
	Current Allergies			5	5	5	5	5
		12						
Vitals			4	4	4	4	4	4
Physical			3					
	derm (1)			1	1	1	0	1
	Pulmonary (1)			1	1	1	1	1
	general (1)			1	1	1	1	1
Plan								
	Notify physician	8	4	4	4	4	0	4
	Precautions		4	4	4	4	4	4
				20	20	20	15	20
Case #2 - Chicken Pox								
History			5	5	5	5	5	5
	Current Allergies	12						
Vitals			4	4	4	4	4	4
Physical			3					
	derm			1	1	1	0	1
	Pulmonary			1	1	1	0	1
	general			1	1	1	0	1
Plan								
	Notify physician	8	4	0	0	0	0	0
	Precautions, yes		4	4	4	4	4	4
				16	16	16	13	16

APPENDIX G-1

Computer Simulated ED Exercise
Participant Background

Instructions: Please answer **all questions** by checking the **single best response**.

1. What is your current job category?
   a) physician___
   b) physician assistant___
   c) nurse RN___
   d) nurse LPN___
   e) medical technician___
   f) other (please indicate) ______________________

2. How long have you been practicing in this role (from question 1)?
   a) less than 1 year_____
   b) 1-3 years____
   c) 3- 5 years_____
   d) more than 5 years_____

3. How many years of practice have been in the Emergency Department (ED)?
   a) less than 1 year_____
   b) 1-3 years____
   c) 3- 5 years_____
   d) more than 5 years_____

4. Have you ever had experience in any live (not drill) Biohazard incident?
   a) No___
   b) Yes____ Can you please describe the incident(s)?
   ____

   ____

   ____

5. Have you had specific training in ***preparedness*** for Biohazard or Mass Casualty Incidents (MCI)?
   a) No___
   b) Yes___ Can you briefly list the course name(s) or otherwise describe the type of training?
   ____

   ____

   ____

(continued)

6. How well can you perform basic computer functions (send emails, search internet, purchase items online, etc.)? Check one.
   a) I have minimal personal capability on the computer_____
   b) I can perform routine functions (emails, online searches/purchases) _____
   c) I have moderate experience beyond the basic functions_____
   d) I am reasonably experienced with most computer functions_____

7. Have you had ***any*** prior experience with ***computer simulations***?
   a) No___
   b) Yes: (check all that apply)
   1. Computer games ____
   2. Business-oriented applications _____
   3. Medically-oriented applications ______**<--** Can you name or describe these?
   ____

   ____

   ____

8. Based on your ***current*** emergency care, computer, and simulation capabilities, rank in relative order which will be easiest (#1) to hardest (#3) in this exercise.

   ____ responding to the specific patients presented in this exercise
   ____ navigating the computer program
   ____ participating in a monitored exercise/test

9. Do you think a computer simulated triage exercise like this could be effective in sustaining ***your*** preparedness to respond to biohazard emergencies?
a) very much b) somewhat c) no opinion d) not very much e) not at all

10**.** Do you think it would it be more effective than a role-play drill (using actors)?
a) very much b) somewhat c) no opinion d) not very much e) not at all

11. Could it be used in place of a full-scale, role-play drill to meet annual re-training requirements?
a) very much b) somewhat c) not very much d) not at all

Any Impressions? (add any comments you wish about this study)
____

____

____

____

APPENDIX G-2

Computer Simulated ED Exercise

Post-Exercise Survey

Instructions: Please answer these questions with a single best response.

NOTE: Provide any feedback you feel would be helpful in Post-Exercise Impressions.

1. Based on your ***current*** mass casualty, computer, and simulation capabilities, rank in relative order which was easiest (#1) to hardest (#3) in this exercise.

____ responding to the specific patients presented in this exercise
____ navigating the computer program
____ participating in a monitored exercise/test

2. Would a computer simulated triage exercise like this be effective in sustaining ***your*** preparedness to respond to biohazard emergencies?
a) very much b) somewhat c) no opinion d) not very much e) not at all

3. Would it be more effective than a role-play drill (using actors)?
a) very much b) somewhat c) no opinion d) not very much e) not at all

4. Could it be used in place of a full-scale/role-play drill to meet annual re-training requirements?
a) very much b) somewhat c) no opinion d) not very much e) not at all

POST-EXERCISE IMPRESSIONS, please:

____

____

____

____

____

____

APPENDIX H

"BIOHAZARD" **COMPUTER SIMULATION INTERVIEW**

Name**:** ____Anonymous_______________________________________ Date: 7/6/2010 9:00am

1. ***1.*** *What is your role/function in the emergency department (ED)?*
   (limited to "***RN***" in this write-up, for purposes of confidentiality)
2. How long have you been doing that?
   About 3 years. I've been an emergency room nurse for about 14 years.
3. *What were you doing before?*
   (*confidential*).
4. *What is the highest grade level that you have completed?*
   I'll be done with my Bachelor's in Nursing in October.
5. *Besides the RN, do you have any health provider certificates or registrations?*
   TNCC, ENPC, studying for my CEN right now. I'll be taking the test next week.
6. *Have you participated in any actual disaster incidents while working in the ED?*
   Not a real one, no.
7. *How often do you have specific training related to biohazard emergencies?*
   Miles, our Emergency Preparedness _________ does yearly competencies.
   (*What does that entail?)*
   Really, what our role would be in the ED as far as decontamination and care of the patient.
   (*Decontamination and care…..)*
   Decontamination and care…yeah.
   (*You just had a drill here last week?)*
   Yes, I wasn't here, I missed it.
   (*It's not required that you take the drill?)*
   It was or me but I had to leave town because my mom was sick and I had to take care of her.
   (*Well……..that's personal…….but is it usually required?)*
   It's not required….but for the Team Leaders it is. For the regular staff, they just look for volunteers to participate.
   (*But they have a classroom required training every year…….).*
   For your annual competency, Yes.
8. *Using a numerical range with #1 for "Definitely Not" to #5 for "Definitely" rate whether you liked the computer simulation and why.*
   I thought it was really good…I'd give it a 5 because it helps show where my weaknesses are, what more I have to anticipate with these types of patients because we don't see them, we don't see them at all.
   (*You don't see biohazard-type patients?)* ……………. *(continued)*

Very rarely, I can't even tell ya…so…
(*So this would fill a void?)*
Yes, not just myself, but with everybody…….newer nurses are probably more up to speed than more seasoned nurses are because this is part of their curriculum in school……..
(*It is?)*
I believe it is.
(*Did you have to take something……in your BSN courses?)*
We had Community Health, there were some classes in emergency preparedness, and that was a simulated-type program also and what you would do and we had a big paper on it.
(When you say simulated program, was it on the computer?)
It was on the computer, it gave you a city, and there was a problem going on, actually there was a fire, it caused a lot of smoke inhalation-type emergencies, it challenged the community, in how the community would respond, like the Health Department…..
(*So was this more Emergency Management……)*
Yeah, it was more like Emergency Management, what is the role of the community and how does everybody come together.

9. *Using the same numerical range (as question # 10) was the computer simulation:*

a.) *realistic?*
Yes I thought it was very realistic so I'd give it a **5.**

b.) *easy to use?*
I thought it was because I use computers all the time so I'd give it a **5.**

c.) *challenging?*
Yes, it was challenge, I'm going to give it a **5.**

d.) *relevant to your role?*
Yes, as an emergency room nurse, yes it was very relevant, because this is what we do when patients come in.
(What number would you give it?)
5.

10. *Based on your* ***__current__*** *mass casualty, computer, and simulation capabilities, rank in relative order which was easiest (#1) to hardest (#3) in this exercise.*

__3__ responding to the specific patients presented in this exercise
__1__ navigating on the computer
__2__ participating in a monitored exercise/test

12. *In what ways is a computer simulation drill better for your preparedness than a full-scale drill?* *…………………….(continued)*

The drill offers the actual hands-on. Because when they do the drill, they have volunteers. They put their swim suits on and they go through the whole washing down, they use the equipment we have.
(*Is once a year enough?)*
Yeah, I think it is.
(*Does it get redundant?)*
I don't think it does.

13. *In what ways is a full-scale drill better for your preparedness than a computer simulation?*

I would say taking care of patients, or taking care of a patient that we know has some kind of exposure, but we don't know what. And that's a thing we need to know…how to figure that out, and until you do figure it out, what are you going to do? Because we tell that to people and they say "OK" but until they internalize it and they use that information, I know it doesn't happen. I think this would help open up those doors.

14. *Do you think your current annual training adequately prepares for the types of biohazard exposures that you encountered in the computer simulation?*
a) very much b) **<u>somewhat</u>** c) no opinion d) not very much e) not at all

15. *Do you think an emergency response computer simulation exercise like this would help you practice your response performance and why?*
a**) <u>very much</u>** b) somewhat c) no opinion d) not very much e) not at all

Because it makes you think. You don't have somebody with you to tell you what to do or make that decision for you. A lot of nurses count on their colleagues to help them, especially the newer nurses. Even if you don't get it right, at least you're thinking critical you're thinking about it about it

16. *Do you think an emergency response computer simulation exercise could be used to meet annual training requirements? Why?*
a) very much **b) <u>somewhat</u>** c) no opinion d) not very much e) not at all
I think it would, probably be very helpful but it wouldn't substitute for HAZMAT training because there you have to know how to put on the equipment, how to actually put up the tent, and actually walk on through the whole decontamination process, where we're going to do it, and how the flow works, so……..
(Is once a year enough?)
Yes.
(*Is it redundant after…..)*
No, because we learn it once a year, but we don't use it and need to be reminded….and things change, so we need to know how to apply that as well.
(*So you're saying not a substitute…*..)
I would say it's not a substitute, but make it an addition.
(*A supplement?*) …………………. *(continued)*

A supplement, yep

(*One last, subjective question*)

17. *What is your overall impression of this computer simulation?*

I thought the program, or simulation, was very, very helpful. It helped me identify areas that I need to concentrate on, and you can see, it provides you the visual, you put a nasal _____ on, and it shows you the vital signs changing…….

(Is this something you could simulate in a hands-on drill?)

I don't think you could do it with the drill, but in the training, in the annual competencies, something like this would be helpful.

(*Let me try to ask this question differently…would you be able to do something like the computer simulation in a hands-on drill? You know what I mean?)*

I know what you're asking…I don't know if you could….unless you had someone standing there and telling you, "This is what you have" but, seeing as I did not participate in this drill, it's difficult for me to answer.

(**Interview completed**.)

APPENDIX I
Study Contributors:
Physician/SME Profiles

I-1. **Dr. Marc S Rosenthal**, PhD, DO, FACEP
EMS/WMD Director Sinai-Grace Hospital
Director, Tactical Medicine

Attending Physician: Sinai-Grace Hospital
Assistant Professor, Wayne State University, Department of Emergency Medicine, Sinai-Grace Hospital/DMC
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Education State University of New York at Albany, BS, Physics and Astronomy and Space Science 1977
Yale University, PhD, Nuclear Physics 1982
Michigan State University, College of Osteopathic Medicine, DO, 1998
Residency Ingham Regional Medical Center, Osteopathic Internship 1998-1999
Saginaw Cooperative Hospitals, Inc. Michigan State University, Emergency Medicine Residency, 1999-2002
Service • Member, Society for Academic Emergency Medicine Program Committee
• Member, Board of Directors, MCEP
• Member, State of Michigan Volunteer Registry Advisory Committee
• Chairman, Technology Task Force, Michigan College of Emergency Physicians
• Editorial Board, American Journal of Disaster Medicine
• Assistant Medical Director, Washtenaw County Regional Tactical EMS Team
• Senior Medical Officer, National Disaster Medical System
Research Interests
• Disaster Medicine • Tactical Medicine • Wilderness Medicine

(continued)

I-2. **Dr. Howard Klausner**, MD
Medical Director for EMS and Disaster Medicine
Henry Ford Hospital, Detroit

Board Certifications:
American Board of Emergency Medicine
Medical School Education:
University of Michigan Medical School
- **Graduation Date: 05/01/1995**
Providence Hospital (MI) – Transitional
Post GraduateTraining:
Henry Ford Hospital (MI)
– Emergency Medicine
Office Locations:
Henry Ford Hospital
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1-800-HENRYFORD
(1-800-436-7936)

Dr. Klausner has been an emergency physician at Henry Ford Hospital, since graduating from residency in 1999. He is also a Supervisory Medical Officer for the Michigan DMAT team and assistant clinical professor of Emergency Medicine at Wayne State University.

(continued)

I-3. **Dr. Robert Dunne**, MD
Vice Chief, Emergency Medicine
St. John Hospital and Detroit Medical Center (DMC)

Medical Education: University of Michigan Medical School
Residency: Henry Ford Hospital
Board Certification: ABMS Board of Emergency Medicine
Primary Specialty: Emergency Medicine
www.emspecialists.com

Profile:
He completed emergency medicine residency training at Henry Ford Hospital in Detroit, MI where he was chief resident. He has served as EMS coordinator, associate program director and research director. He has held faculty positions at the University of Michigan and Wayne State University.

He is the author of peer reviewed papers, book chapters and educational materials. He lectures extensively on EMS, preparedness and topics in trauma and emergency medicine. Dr Dunne has served as a tactical medical physician for the Detroit Metropolitan Airport Special Response Team and the Michigan FBI SWAT team. He has served as faculty for the basic SWAT course. Robert Dunne is a supervisory medical officer on MI-1 Disaster Medical Assistance team, a federal medical team. He has been deployed for many Hurricanes from 1997 to the present, including Katrina, the World Trade Center response and many special events.

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ABSTRACT

COMPUTER SIMULATION IN MASS EMERGENCY AND DISASTER RESPONSE: AN EVALUATION OF ITS EFFECTIVENESS AS A TOOL FOR DEMONSTRATING STRATEGIC COMPETENCY IN EMERGENCY DEPARTMENT MEDICAL RESPONDERS

by

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August 2011

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Assessment of biohazard emergency and disaster response preparedness has historically involved the use of hands-on simulated drills and role plays to observe and gauge the competency of responder performance. While useful, perhaps ideally so, the logistical constraints related to time, equipment, personnel and overall costs limit the number of opportunities to use these hands-on evaluative modalities to sometimes only one or two practice sessions a year. Can responders be expected to react fluidly and appropriately in a biohazard incident when hands-on practice is arguably infrequent? The limited opportunity for hands-on practice raises the question whether there may be alternatives to hands-on drills and role plays that can facilitate the retention of certain medical response skills that may seldom be called upon, if ever, in the normal day-to-day operations of the emergency department. This concern regarding sufficient

response competency comes when the preparedness of personnel to effectively respond to biohazard mass emergency and disaster events has become a critical 21st century training priority. In an increasing variety of learning contexts, computer simulation has become an emerging instructional strategy of interest. Is it possible for computer simulation to fill the need for a feasible alternative to hands-on drills and role plays in biohazard emergency response practice to effectively maintain the desired level of emergency medical responder preparedness?

This study examined the capability of computer simulation as a tool for assessing the strategic competency of emergency department (ED) nurses as they responded to authentically computer-simulated biohazard-exposed patient case studies. Thirty registered nurses from a large, urban hospital completed a series of computer-simulated case studies of virtual biohazard-exposed patients. The completed case studies were assessed by the host computer according to computer-programmed criteria. The same case studies were also assessed by a trio of emergency medicine physicians acting as subject matter experts according to their own criteria. The results of this study demonstrated a significant correlation between computer-assessed and physician-assessed simulation exercises against pre-determined performance objective criteria. The data suggest computer simulations can play a useful role in emergency and mass disaster preparedness that offers readily accessible, cost-effective training where the opportunity for hands-on practice is limited or impractical. Further, use of computer simulation can make an effective evaluation of emergency response preparedness possible at more frequent intervals and with greater efficiency.

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