Initial Test of Emergency Procedure Performance in Temporary Negative Pressure Isolation by Using Simulation Technologies

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Study objective: The potential of infectious disease spread in diseases such as tuberculosis, infectious disease epidemic such as avian flu and the threat of terrorism with agents capable of airborne transmission have focused attention on the need for increased surge capacity for patient isolation. Total negative pressure isolation using portable bioisolation tents may provide a solution. The study assesses the ability of health care workers to perform emergency procedures in this environment.

Methods: Physician performance in completing predetermined critical actions in 5 emergency care scenarios inside and outside of a bioisolation tent ("setting") was studied in an advanced medical simulation laboratory. By design, no pretraining of subjects about total negative pressure isolation use occurred. Impact of setting on time to completion of predetermined critical actions was the primary outcome measured. Secondary variables studied included impact of study groups, scenarios, and run order (inside or outside of the tent first). Subjective assessments were obtained through questionnaires.

Results: Four teams of 3 physicians completed 5 emergency patient care scenarios during 2 4-hour sessions. Mean time to completion of critical actions was for tent/no tent 298 seconds/284 seconds ($P=.69$, one way ANOVA), respectively. Mean time to completion for first versus second performance of a scenario in the crossover design was 338 versus 243 ($P=.01$). The mean score for self-assessed performance did not differ according to setting.

Conclusion: The ability of physicians naive to the total negative pressure isolation environment to perform emergency medical critical actions was not significantly degraded by a simulated bioisolation tent patient care environment. [Ann Emerg Med. 2008;51:420-425.]

INTRODUCTION
Background

Recent disasters have clearly demonstrated the need for increased surge capacity on the part of all elements of out-of-hospital, hospital, and emergency department (ED) systems.[1]

Although billions of dollars have been spent to improve local, regional, and national preparedness, the preparedness efforts have focused on systems issues, such as statewide planning and coordination, interagency communications, and scene management, triage, and transport. The severe acute respiratory

Editor's Capsule Summary Summary

What is already known on this topic
Most hospitals cannot provide adequate isolation facilities for large numbers of patients.

What question this study addressed
Medical simulation scenarios were used to determine whether the use of negative pressure portable bioisolation tents impaired physicians' ability to perform emergency procedures quickly.

What this study adds to our knowledge
Emergency physicians did not require more time to perform procedures when they were done inside a portable bioisolation tent.

How this might change clinical practice
Large but portable negative pressure bioisolation tents can be incorporated into infectious disease disaster planning without concern that ability to perform procedures is significantly impaired.

syndrome (SARS) outbreak raised the specter of entire hospitals becoming disabled because of quarantine and therefore unavailable to respond to the needs of the general public. SARS also introduced North American and other countries' governments and health care leaders to the modern concept of a massive population of acutely ill patients requiring high-level care during a short period, with the potential to overwhelm hospital ED and inpatient resources. More recently, concern about management options for possible human cases associated with H5N1 (avian) influenza is prompting a further reevaluation of our system capacities and infection control procedures.[2] The threat of an epidemic outbreak of an acute infectious disease or of a large population exposure to a biological or chemical agent also challenges current systems in terms of "surge capacity," the ability to rapidly increase capacity to provide effective, if limited, care to a significantly increased volume of acute care patients. The need to protect health care providers from possible infection, exposure, or contamination and to limit the potential for disease-causing agents to spread to other patients requires additional capacity. In addition, in case of mass casualty or epidemic in the community, effective containment systems in which suspected cases can be isolated are required even as patients are receiving lifesaving care. Currently, EDs in Canada, the United States, and elsewhere are challenged by large numbers of acutely ill patients and reduced numbers of inpatient beds, leading to ED crowding. Crowding is identified as a root cause of ambulance diversions, and even the relatively small increase in patient volume associated with the traditional influenza season increases the amount of time EDs are unable to accept patients.[3]

Little attention to date has been paid to the potential response for mass casualty caused by organisms capable of

human-to-human spread through airborne contact. Although the likelihood of such an epidemic is unknown, recent analyses related to possible human-to-human spread of the H5N1 influenza virus suggest catastrophic effects on individuals and the health care system. The Government Accounting Office has found that many hospitals lack the capacity to respond to large-scale infectious disease outbreaks and lack adequate equipment and isolation facilities.[4] EDs and hospitals generally have limited isolation capability, and much of this is concentrated in tertiary care facilities and major teaching hospitals. There exists no feasible contingency plan through which a large-scale escalation of ED and hospital isolation potential could be provided on short notice, and the construction of permanent, large-capacity isolation facilities is cost-prohibitive.

Portable bioisolation facilities with negative pressure airflow capability provide one potential affordable method to rapidly increase capacity for bioisolation at times of increased need both in and out of the hospital. Proponents of total negative pressure isolation systems argue that these portable structures are mobile and easily assembled and provide negative airflow and filter systems to prevent disease spread. Total negative pressure isolation is therefore proposed as a realistic alternative to hospital closure or quarantine at times of greatly increased need. Although there are some data assessing the technical performance of such systems,[5-7] no study to date has evaluated the potential impediments of this environment to the performance of critical medical procedures.

Transmission of infection within a hospital requires 3 elements: a source of infecting microorganisms, a susceptible host, and a means of transmission for the microorganism.[8] Transmission of disease can occur through direct contact (body surface to body surface), indirect contact (contact through intermediate object), airborne (small: 5 μm or smaller that can remain suspended for long periods) droplets (generated by coughing or sneezing of heavy particles that do not remain suspended), common vehicle (through contaminated items such as food and water), and vector-borne (mosquitos, flies, etc) mechanisms. Garner[8] reviewed the types of isolation precautions taken in hospitals: handwashing and gloving, patient placement, transport of infected patients, meals, respiratory protection, eye protection, face shields, gowns and protective apparel, patient care equipment and articles, linen and laundry, dishes, glasses, cups, and eating utensils. Standard precautions are used for all patients: airborne precautions for those infected with organisms of 5 μm or smaller size, droplet precautions when larger particles are involved and pose little risk of airborne transmission, and contact precautions when skin-to-skin transmission can occur. Precautions appropriate for common organisms are found in Figure E1 (available online at http://www.annemergmed.com), and a more complete listing is provided online by the Centers for Disease Control and Prevention.[8] Of the interventions implemented to reduce transmission of infection, handwashing and glove use are believed to be the most important interventions to help reduce

spread of infection in general hospital practice.[9-17] Airborne precautions require monitored negative air pressure, with 6 to 12 air changes per hour and safe discharge of air through filters to prevent contamination of the ambient environment.

Importance

Although the need for strict isolation is unclear, concerns about infectious organisms causing avian influenza ("bird flu") and SARS, particularly when combined with ED and hospital crowding, clearly demonstrate an urgent need to develop methods to quickly and effectively increase our ability to provide bioisolation, at least temporarily. Because of the great expense associated with building new or retrofitting existing patient care areas to provide adequate negative pressure environments, interest has turned to relatively inexpensive portable systems. Portable systems have potential additional advantages to fixed infrastructure because they can be rapidly deployed, quickly assembled, and expanded as needed. Medical isolation is distinct from quarantine. In quarantine, no particular medical interventions are implicit, whereas medical isolation includes the ability to deliver health care during the isolation phase.

Goals of This Investigation

As a first stage of evaluating use of a bioisolation system in patient care, we studied the ability of emergency physicians to perform lifesaving procedures within a portable bioisolation environment with advanced medical simulation technologies. We also studied the impact on patient care and the comfort level as experienced by providers in the total negative pressure isolation tent environment. By design, no advance training about how to work within the total negative pressure isolation environment was provided to subjects to emulate the actual deployment of these devices.

MATERIALS AND METHODS
Study Design

To test the impact that the bioisolation tent had on the performance of patient care procedures, test subjects were presented standardized simulated emergency medical scenarios in a standard resuscitation room containing a bioisolation tent and also in the adjacent standard resuscitation room without the tent. Identical critical care scenarios were presented to study subjects in a crossover design (Table E1, available online at http://www.annemergmed.com). With a high-fidelity human patient simulator, time to completion of predetermined critical actions was then tested (Table E2, available online at http://www.annemergmed.com). Thus, each team performed identical procedures in and out of the bioisolation tent consecutively. At the entrance to both the total negative pressure isolation and non–total negative pressure isolation rooms, standard personal isolation instruments (mask, gown, and gloves) were provided. Each team member evaluated his or her team's performance, their comfort level during each scenario, and the impact of the total negative pressure isolation tent.
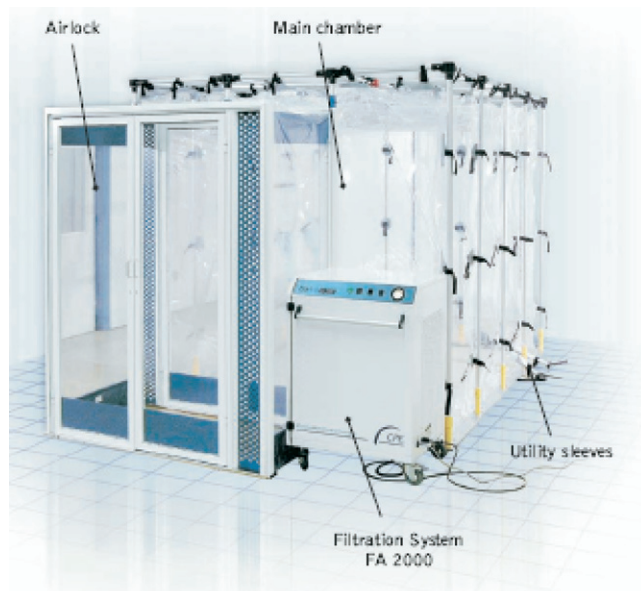

Figure. Isoark portable bioisolation unit.

Setting

The Simulation, Training, Research, and Technology Utilization System (STRATUS) Center for Medical Simulation, located within the Department of Emergency Medicine at Brigham and Women's Hospital, consists of 3 training laboratories. The Micro-Simulation Laboratory provides computer-based simulation training, the Steinberg Advanced Skills Laboratory is designed for task training in medical procedures, and the Human Patient Simulation Laboratory houses 2 high-fidelity human patient simulators (SimMan; Laerdal Medical AS, Stavanger, Norway) within identical rooms outfitted to reproduce, in exact detail, hospital emergency treatment rooms (Figure E2, available online at http://www.annemergmed.com). An Isoark Collapsible/Portable Negative Pressure Isolation Chamber (Collective Protection Engineering, Inc., Baltimore, MD) (Figure) produced by Collective Protection Engineering, Inc., was placed in one of the 2 adjoining simulation rooms. The IsoArk has a 90-by-90-inch chamber with an anteroom airlock. In the bioisolation study room, noninvasive monitors, oxygen, and suction ports remained outside of the tent. Access to these devices was through cables and tubes that traversed ports situated within the tent's walls. The tent and the door to the regular room were placarded with standard airborne isolation precaution signs as used in the hospital.

Selection of Participants

Study subjects were emergency medicine residents from the Harvard Affiliated Emergency Medicine Residency Program at Brigham and Women's and Massachusetts General Hospitals, Boston, MA. Emergency medicine faculty created, programmed, and ran the clinical scenarios that were used. Subjects were placed into 4 groups of 3 residents each, with distribution of experience (by duration of postgraduate training)

as evenly as possible among groups. Two groups participated in each of 2 separate sessions. Residents were familiar with the capabilities and physiologic characteristics of the simulators, to which they are regularly exposed as part of their training in emergency medicine.

Methods of Measurement

As each group managed the simulated patients, 2 skilled observers experienced with simulator experience observed their actions. Time to completion of predesignated critical actions was recorded by faculty running the patient simulators. The simulation software is programmed to capture the times when observers noted that critical actions were performed.

Each subject completed questionnaire 1 after each simulation run (Figure E3, available online at http://www.annemergmed.com) and questionnaire 2 (Figure E4, available online at http://www.annemergmed.com) after completing both simulation runs of a critical care scenario.

Primary Data Analysis

To compare performance, mean time to completion was calculated for each run of the study, which was the average time required to complete all critical actions performed within each scenario. In cases in which one or both groups did not perform a critical action, this critical action was not included in the analysis. The influence of setting (inside or outside of the total negative pressure isolation tent) on mean time to completion of critical actions was the primary study endpoint. Other variables calculated included the impact of the study group (first or second day of testing), critical care scenario, and order of run (ie, bioisolation first versus nonbioisolation first). The initial study protocols also called for measurement of the time between the decision to perform a procedure and its subsequent completion. To emulate as much as possible the actual resuscitative environment, however, the groups were not given specific instruction about to how to convey decisions or information. As a result, it became clear to the observers early in the study that it was not possible to accurately determine a definitive point in time about group "intent," and this data point frequently could not be recorded. Therefore, because of incomplete and potentially unreliable data, this data point was excluded from analysis.

Noise, temperature, and humidity were recorded on all runs inside and outside of the bioisolation tent.

This study was approved by the Brigham and Women's Hospital institutional review board.

RESULTS

Four teams of 3 physicians completed 5 scenarios inside and outside of a bioisolation tent during 2 4-hour sessions. The results of univariate comparison of mean times to critical action completion are shown in Table 1. The mean time for critical action completion within the total negative pressure isolation tent was 298 seconds and without the total negative pressure

Table 1. Univariate comparison of mean times to completion of critical actions by setting (in or out of temporary negative pressure isolation tent), experiment day (1 or 2), run order (first or second run by the same group of the same scenario), and scenario.

	Mean Times to Critical Action Completion (95% Confidence Intervals), s	P Values (1-Way ANOVA)
Setting		.69
Room	284 (221–347)	
Tent	298 (260–336)	
Run order		.01
1	338 (281–396)	
2	244 (211–277)	
Experiment day		.13
1	317 (255–379)	
2	264 (229–301)	
Scenario		.09
1	328 (178–479)	
2	303 (214–393)	
3	287 (254–322)	
4	336 (336–267)	
5	199 (173–225)	

isolation tent, 284 seconds. The mean critical action completion time for the first versus second experiment was 317 seconds and 264 seconds. The time to completion for scenarios 1 to 5 was 328 seconds, 303 seconds, 287 seconds, 336 seconds, and 199 seconds, respectively. The impact of run order (ie, time to completion of critical actions, depending on whether it was the first or second time a scenario was performed by a group) yielded times of 338 seconds for the first attempt and 243 seconds for the second attempt. The elapsed time variables showed a nearly normal distribution, with 1 outlier and a z score of 4. Excluding the outlier, the skewness became 0.521; kurtosis=0.009.

The presence of the tent had little effect on the average time to completion of critical actions. Because groups did not complete all critical actions, the proportion of procedures completed was compared for each variable. We observed that completion rates differed among scenarios but not by whether the tent was present (Table 2). Temperature and humidity in the total negative pressure isolation tent and in the adjoining room without the tent are shown in Figure E5 (available online at http://www.annemergmed.com).

Participants answered questionnaire 1 after the first and second run of each scenario (Tables E3 and E4, available online at http://www.annemergmed.com). The mean score for self-assessed performance (question 1a) did not differ between the setting outside of and within the total negative pressure isolation tent. Similarly, there was no statistical difference (when Bonferroni correction was applied) in the self-reported ability to perform procedures, though there was a strong trend toward greater ease outside of the tent. Significant differences were noted with regard to ease of access to equipment and patients, ease of communication, and level of comfort.

Table 2. Comparison of weighted estimates of mean proportion of critical actions completed by setting (in or out of temporary negative pressure isolation tent), experiment day (1 or 2), run order (first or second run by the same group of the same scenario), and scenario.

	Mean Proportion of Critical Actions Completed	P Values, χ^2
Setting		
Room	0.82 (0.75–0.88)	.15
Tent	0.76 (0.68–0.82)	
Run order		
1	0.76 (0.69–0.83)	.25
2	0.82 (0.75–0.87)	
Experiment day		
1	0.76 (0.68–0.82)	.15
2	0.82 (0.75–0.88)	
Scenario		
1	0.63 (0.49–0.74)	.001
2	0.93 (0.79,0.98)	
3	0.90 (0.77–0.96)	
4	0.75 (0.64–0.84)	
5	0.81 (0.71–0.88)	

In questionnaire 2 (administered after performance of the identical scenario inside and outside of the tent), 53% of participants (95% confidence interval 0.4% to 0.6%) believed that the total negative pressure isolation tent did not negatively affect patient treatment (Table E5, available online at http://www.annemergmed.com). Sixty-two percent of respondents indicated a positive or neutral response about their comfort level in the tent.

LIMITATIONS

This study has several limitations. With regard to internal validity, although there was no significant difference observed in the proportion of critical actions performed as shown in Table 2, each group did not complete every critical action. It is possible that the total negative pressure isolation tent deterred the decision by a group to perform certain procedures, which may have led to death in a real patient, though this was not observed to be the case by study personnel. Procedures performed were similar in the bioisolation scenarios and the normal environment, suggesting that the tent itself was not a factor in any decision to perform or not perform a procedure. In addition, comparison of the numbers of procedures completed did not indicate a significant difference between groups, other than those expected between differing scenarios. As far as data analysis for our crossover study design, although we observed no carryover effects by standard tests, such tests are not completely reliable.

It is also possible that emergency medicine faculty, nurses, or other personnel performed differently than emergency medicine residents who were the study subjects. The limited number of study subjects limits the power of the study with regard to statistical significance. For example, although univariate analysis demonstrated a nonsignificant *P* value when the impact of the total negative pressure isolation tent on time of critical procedures was compared, greater numbers of subjects may have increased the power of the study to demonstrate statistical significance. However, the difference of 14 seconds' average is unlikely to be of clinical significance.

Also, we chose not to provide training or exposure to the total negative pressure isolation tent before testing performance. It seems likely that previous training would improve performance and acceptance.

Finally, there are caveats with respect to the use of medical simulators for this type of analysis. Although medical patient simulation has become an important method for practitioner education, experience with its use as a research tool for performance is limited. It is possible, for example, that practitioners perform differently in a real patient care environment. In this study, subjects had great familiarity with the use of the simulators because they are used for educational purposes throughout residency training and the simulation rooms are designed to be nearly exact replicas of the clinical ED environment in which they work.

There are several important limitations to the external validity. This study used resident physicians associated with a training program at a tertiary care medical facility as test subjects. It is possible that medical staff in other institutions, medical staff who are not customarily in a "trainee" role, or nonphysicians react differently. It is also possible that medical personnel at other facilities have differing experience and procedures with regard to infection control that would make use of a total negative pressure isolation tent more or less effective.

DISCUSSION

Total negative pressure isolation with portable bioisolation tents is one potential method to improve surge capacity in infectious disease outbreak situations. Although these devices have undergone technical testing for filtration capacities, the ability of health practitioners to perform lifesaving interventions has not been studied. It is not known, for example, whether such devices may impede the ability of physicians to treat critically ill patients in initial phases of resuscitation. In this pilot study, the average time to completion of critical procedures by emergency medicine residents as measured in a medical simulation environment was not significantly altered by a total negative pressure isolation bioisolation tent. This experiment used a crossover design, so, as expected, groups showed improvement when performing a scenario for the second time whether inside or outside of the total negative pressure isolation tent.

In summary, in this pilot study of the total negative pressure isolation bioisolation environment, we did not identify significant delays in the performance of critical procedures in a simulated ED setting. Larger studies in diverse environments are needed to confirm these findings.

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Use standard precautions for the care of all patients

In addition to standard precautions, use airborne precautions for patients known or suspected to have serious illnesses transmitted by airborne droplet nuclei. Examples of such illnesses include the following:

    Measles

    Varicella (including disseminated zoster)[†]

    Tuberculosis[‡]

In addition to standard precautions, use droplet precautions for patients known or suspected to have serious illnesses transmitted by large particle droplets. Examples of such illnesses include the following:

    Invasive *Haemophilus influenzae* type b disease, including meningitis, pneumonia, epiglottitis, and sepsis

    Invasive *Neisseria meningitidis* disease, including meningitis, pneumonia, and sepsis

Other serious bacterial respiratory infections spread by droplet transmission, including the following:

    Diphtheria (pharyngeal)

    Mycoplasma pneumonia

    Pertussis

    Pneumonic plague

    Streptococcal (group A) pharyngitis, pneumonia, or scarlet fever in infants and young children

Serious viral infections spread by droplet transmission, including the following:

    Adenovirus[†]

    Influenza

    Mumps

    Parvovirus B19

    Rubella

Contact Precautions

In addition to standard precautions, use contact precautions for patients known or suspected to have serious illnesses easily transmitted by direct patient contact or by contact with items in the patient's environment. Examples of such illnesses include the following:

    Gastrointestinal, respiratory, skin, or wound infections or colonization with multidrug-resistant bacteria, judged by the infection control program according to current state, regional, or national recommendations to be of special clinical and epidemiologic significance

Enteric infections with a low infectious dose or prolonged environmental survival, including the following:

    Clostridium difficile

    For diapered or incontinent patients: enterohemorrhagic *Escherichia coli* O157:H7, *Shigella*, hepatitis A, or rotavirus

    Respiratory syncytial virus, parainfluenza virus, or enteroviral infections in infants and young children

Skin infections that are highly contagious or that may occur on dry skin, including the following:

    Diphtheria (cutaneous)

    Herpes simplex virus (neonatal or mucocutaneous)

    Impetigo

    Major (noncontained) abscesses, cellulitis, or decubitus

    Pediculosis

    Scabies

    Staphylococcal furunculosis in infants and young children

    Zoster (disseminated or in the immunocompromised host)[†]

From: Garner JS, Hospital Infection Control Practices Advisory Committee. Guideline for isolation precautions in hospitals [Centers for Disease Control and Prevention Web site]. *Infect Control Hosp Epidemiol.* 1996;17:53-80, and *Am J Infect Control.* 1996;24:24-52. Available at: http://www.cdc.gov/ncidod/hip/ISOLAT/isopart2.htm.

Figure E1. Synopsis of types of precautions and patients requiring the precautions.*

Figure E2. Simulation, Training, Research, and Technology Utilization System (STRATUS) megacode room.

Participant questionnaire: Each run/room
(to be completed after each scenario run in each room)
Date: _____
Group: A/B
Scenario: _____ Tent?: Y/N

	\<Poor\> \<Excellent\>
Please rate your team's overall performance in this scenario:	1 - 2 - 3 - 4 - 5

Please evaluate the following statements using the given scale of 1 through 5:

	\<Disagree Strongly\> \<Agree Strongly\>
1. I was able to perform necessary actions during the scenario:	1 - 2 - 3 - 4 - 5
2. It was easy to access and use needed equipment during the scenario:	1 - 2 - 3 - 4 - 5
3. It was easy to access the patient during the scenario:	1 - 2 - 3 - 4 - 5
4. It was easy to communicate with others during the scenario:	1 - 2 - 3 - 4 - 5
5. The noise level did not interfere with operations in the scenario:	1 - 2 - 3 - 4 - 5
6. I was physically comfortable during the scenario:	1 - 2 - 3 - 4 - 5
7. I found the ambient air too humid during the scenario:	1 - 2 - 3 - 4 - 5
8. I found the ambient air too warm during the scenario:	1 - 2 - 3 - 4 - 5

\<Over, please\>

Figure E3. Participant questionnaire I completed after each run of the scenario.

Participant questionnaire: Each scenario
(to be completed after *both* runs of each scenario)
Date: _____
Group: A/B
Scenario: _____
Tent: First/second

Please evaluate the following statements using the given scale of 1 through 5:

                                                                       <Negatively> <No clinically significant effect> <Positively>

1. The tent affected *team* performance in a clinically
    significant manner during the scenario: 1 - 2 - 3 - 4 - 5

Notes: _____

_____

2. The tent affected *my* performance in a clinically
    significant manner during the scenario: 1 - 2 - 3 - 4 - 5

Notes: _____

_____

3. The tent affected (simulated) patient outcome
    during the scenario: 1 - 2 - 3 - 4 - 5

Notes: _____

_____

                                                     <Disagree Strongly> <Agree Strongly>
4. I was comfortable inside the tent: 1 - 2 - 3 - 4 - 5

(How so?: _____)

Notes: _____

_____

Please write any notes or comments you wish to add:

_____

_____

<Over, please>

Figure E4. Participant questionnaire II: Each scenario (to be completed after *both* runs of each scenario)
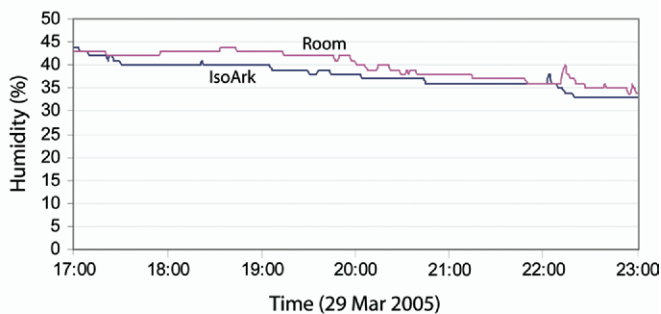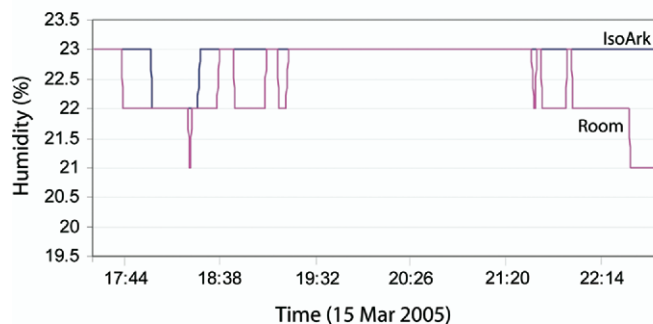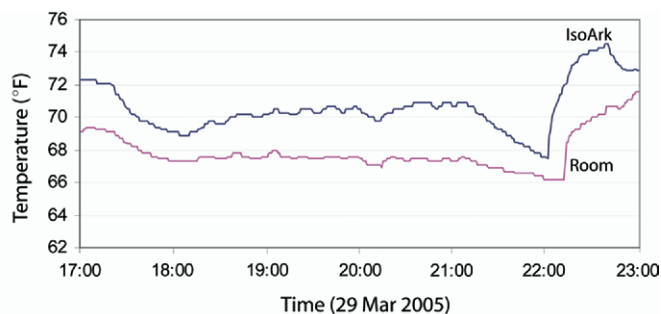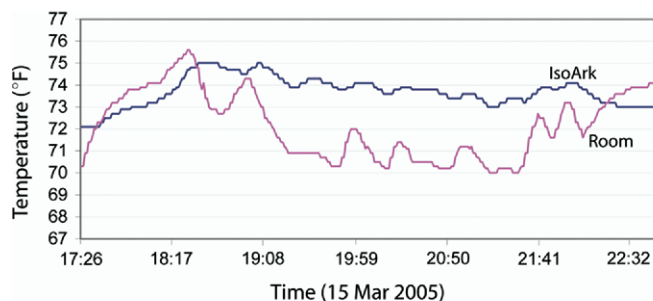
Figure E5. Temperature and humidity inside the temporary negative pressure isolation tent testing room and in the adjoining simulation testing room.

Table E1. Crossover design of critical-care scenarios.

Scenario	Run Number	Room 1 (Tent)	Room 2 (No Tent)
PEA	1.1	A	B
PEA	1.2	B	A
Anaphylaxis	2.1	B	A
Anaphylaxis	2.2	A	B
Third-degree AV block	3.1	A	B
Third-degree AV block	3.2	B	A
MVA trauma	4.1	B	A
MVA trauma	4.2	A	B
Chest pain to VF	5.1	A	B
Chest pain to VF	5.2	B	A

Each study group performed identical scenarios in and out of the total negative pressure isolation tent.

Table E2. Critical actions in patient-care scenarios.

Scenarios	Critical Actions
PEA	1, 3, 5, 6, 7
Anaphylaxis	1, 2, 8, 10, 11, 12
Third-degree AVB	1, 2, 5, 6, 13, 14
MVA trauma	1, 2, 5, 6, 7, 8, 9, 15, 18
Chest pain to VF	1, 4, 13.16, 5, 6, 17

Critical actions: 1: intravenous line; 2: oxygen; 3: monitor applied; 4: bag-valve-mask ventilation; 5: endotracheal intubation attempt; 6: endotracheal intubation completed; 7: needle thoracostomy; 8: tube thoracostomy initiated; 9: tube thoracostomy completed; 10: recognize obstructing airway; 11: cricothyroidotomy; 12: intravenous epinephrine; 13: apply transthoracic pacing/cardioversion pads; 14: cardiac electrical pacing; 15: blood transfusion; 16: defibrillation; 17: cardiopulmonary resuscitation; 18: call for blood.

Table E3. Questionnaire 1 results.

Question Number	Total Counts					Total
	1	2	3	4	5	
1a	2	4	14	43	57	120
1b	3	9	19	56	33	120
2	3	24	24	47	22	120
3	1	12	12	42	53	120
4		3	4	59	54	120
5		3	9	49	59	120
6		9	34	57	20	120
7	24	23	43	26	4	120
8	22	20	39	32	7	120

Self-evaluated overall performance: 1=poor, 5=excellent; questions 2-9 1=disagree strongly, 5=agree strongly (see Figure 5E, available online at http://www.annemergmed.com).

Table E4. Questionnaire results.

Question	Mean Scores*		Kruskal-Wallis	t Test
	Room	Tent	P Values	P Value
1a	4.23	4.25	.8127	.9204
1b	4.08	3.70	.0156	.0310
2	3.78	3.23	.0037	.0050
3	4.47	3.77	.0001	<.0001
4	4.60	4.13	<.0001	<.0001
5	4.48	4.25	.0404	.0810
6	4.07	3.40	<.0001	<.0001
7	2.47	2.92	.0188	.0273
8	2.63	3.07	.0343	.0436

*Mean scores and Kruskal-Wallis test (and t test) for tent/room (individual scores, not paired), N=60/60.

Table E5. Questionnaire 2 average participant responses after completion of run in and out of tent.

Impact of TNPI tent as judged by participants (numbers are total participant responses for each question)

	1	2	3	4	5	Total
Q1 Team performance	6	22	31	1	0	60
Q2 Personal performance	4	21	34	1	0	60
Q3 Simulated patient outcome	4	14	41	1	0	60
Q4 Comfortable in tent	0	23	20	12	5	60

Percentage of Participants Judging No or Positive Impact of TNPI Tent

	%	Confidence Interval Lower	Confidence Interval Upper
Q1	0.53	0.4	0.66
Q2	0.58	0.45	0.71
Q3	0.7	0.57	0.81
Q4	0.62	0.48	0.74

TNPI, Temporary negative pressure isolation.