

Patient-Driven Resource Planning of a Health Care Facility Evacuation

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Abbreviations:

CPAP: continuous positive airway pressure
EM: emergency management
ED: emergency department
HCF: health care facility
ICU: intensive care unit
IMT: Incident Management Team
NICU: neonatal intensive care unit
OR: operating room
TCP: total care patients

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Abstract

Introduction: The evacuation of a health care facility is a complex undertaking, especially if done in an immediate fashion, ie, within minutes. Patient factors, such as continuous medical care needs, mobility, and comprehension, will affect the efficiency of the evacuation and translate into evacuation resource needs. Prior evacuation resource estimates are 30 years old.

Methods: Utilizing a cross-sectional survey of charge nurses of the clinical units in an urban, academic, adult trauma health care facility (HCF), the evacuation needs of hospitalized patients were assessed periodically over a two-year period.

Results: Survey data were collected on 2,050 patients. Units with patients having low continuous medical care needs during an emergency evacuation were the postpartum, psychiatry, rehabilitation medicine, surgical, and preoperative anesthesia care units, the Emergency Department, and Labor and Delivery Department (with the exception of patients in Stage II labor). Units with patients having high continuous medical care needs during an evacuation included the neonatal and adult intensive care units, special procedures unit, and operating and post-anesthesia care units. With the exception of the neonate group, 908 (47%) of the patients would be able to walk out of the facility, 492 (25.5%) would require a wheelchair, and 530 (27.5%) would require a stretcher to exit the HCF. A total of 1,639 patients (84.9%) were deemed able to comprehend the need to evacuate and to follow directions; the remainder were sedated, blind, or deaf. The charge nurses also determined that 17 (6.9%) of the 248 adult intensive care unit patients were too ill to survive an evacuation, and that in 10 (16.4%) of the 61 ongoing surgery cases, stopping the case was not considered to be safe.

Conclusion: Health care facilities can utilize the results of this study to model their anticipated resource requirements for an emergency evacuation. This will permit the Incident Management Team to mobilize the necessary resources both within the facility and the community to provide for the safest evacuation of patients.

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Introduction

Health care facilities (HCF) have had to evacuate due to fire,¹⁻⁴ weather-related events,⁵⁻⁹ security threats,¹⁰ loss of utilities,¹¹ and other hazards/events.¹²⁻¹⁶ Such evacuations represent major undertakings for any facility, as patients include a myriad of vulnerable populations that generate unique difficulties and pose special logistical challenges when being evacuated.¹⁷ A review of HCF evacuations reported in the medical literature between 1971-1999 noted that of 275 HCF evacuations, 23% were due to fire, 18% internal hazardous material incident, 14% hurricane, 13% human threats, 9% earthquake, 6% external fire, 6% flooding, 5% utility failures, and 4% external hazardous material event. Of these evacuations, 11% reported at least one casualty. Of the 43 HCFs that reported the duration of the evacuation, only 16% were completed in <2 hours.¹⁸ The complex and lengthy process of an HCF evacuation^{19,20} can be improved using specific patient evacuation devices.²¹ Although evacuation planning strategies²²⁻²⁵ are available for HCFs, they do not provide resourcing estimates for Emergency Managers (EMs) and Incident Management Teams (IMTs).²³ Some of the required resources may be readily available to the HCF (staff, wheelchairs, oxygen tanks, etc.), yet the demands of the patient population may quickly outstrip an HCF's resources, often causing an HCF to require outside assistance.

Evacuation resource estimates identified in the literature are at least 30 years old. In a 1981 article describing the threat of a fire to an HCF, it was estimated that about one-third of the patients would be able to walk out of the hospital on their own, one-third would require assistance, and one-third would need to be carried out of a hospital.²⁴ A 1978 article reported that up to 70% of patients may be able to walk with or without assistance.²⁵ In light of changes in HCF environments since the 1970s, this study was undertaken for the purpose of determining current patient-driven evacuation resource needs for an HCF, as well as the perceived risk of an evacuation of such a population.

Methods

This study was approved by The George Washington University Medical Center Institutional Review Board. During the study period from October 2007 through March 2009, all patient care areas of the HCF were surveyed six times by the lead author using a standardized survey tool. The surveys were conducted at least 28 days apart to minimize the overlap of patient populations. Three surveys were conducted during traditional business hours of 8 AM to 5 PM, and three surveys were done during “after hours” (5 PM to 8 AM, and on weekends). The HCF is an academic urban inner-city trauma center with 339 beds, of which the majority (n = 246) are medical/surgical beds. In addition, there are 48 beds in the intensive care unit (ICU), 18 in psychiatry, and eight in labor and delivery. The hospital also is an Acute Stroke Center with a 16-bed acute rehabilitation unit. The facility does not have any pediatric services, but does have a neonatal intensive care unit (NICU), interventional radiology, interventional cardiology, endoscopy suites, and 14 operating rooms.

The charge nurse of each clinical area was asked to participate in the survey. Participants were given the setting that the HCF had to be immediately evacuated over the next few minutes regardless of the hazard leading up to the evacuation. For purposes of the study, it was assumed that all patients had to be moved, regardless of diagnosis or prognosis.

Survey questions included the patients’ demographics and evacuation factors, which were defined as: (1) continuous medical needs; (2) mobility; and (3) comprehension (Table 1). In addition, the charge nurses in the ICU were asked to estimate the number of patients who possibly could die due to their overall medical condition or continuous medical support needs that could not be interrupted during a vertical evacuation. Charge nurses also were asked to estimate the number of staff members required to assist in evacuating each nonambulatory patient.

Results

A total of 2,050 patients were included in this study; the majority (n = 1654, 80.7%) were 18 through 75 years of age. Of the remaining patients, 265 (2.9%) were >75 years of age; 120 (5.8%) were neonates; and 11 (0.5%) were <18 years of age. Five prisoners were included during the study period. Specific data regarding continuous medical care needs, nursing care needs, mobility, and comprehension of the patients according to hospital unit are presented in Tables 2-4. The NICU and term nursery population (n = 120) was analyzed separately. Data are reported in aggregate, except as noted where significant variations exist between regular hours and “after hours” or weekends. Note that the total number of patients surveyed may exceed the bed capacity, as hospital capacity does not include emergency department (ED) patients.

Continuous Care Requirements	Continuous infusion
	Infusion pump (include PCA)
	Life support-dependent ^a
	Dialysis-dependent
	CPAP-dependent
	Oxygen dependent
	Intraaortic balloon pump
	Intracranial pressure monitor
	Cardiac monitor
	Incubator-dependent
	Seclusion patient
	Restraint Patient
	Intraoperative; can be stopped
	Intraoperative; cannot be stopped
	Isolation patient
Stage II of labor	
Fetal monitor	
Prisoner	
Mobility	Could walk out
	Needs wheelchair
	Needs stretcher
Comprehension	Understands English
	Can follow directions
	Deaf
	Blind
	Demented
	Delirious
	Under medication effect

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Table 1. Evacuation Factors

^aMechanical ventilation
Abbreviations: CPAP, continuous positive airway pressure; PCA, patient-controlled analgesia.

Continuous Care Requirements

Among a total of 62 patients in the neonatal intensive care unit, 33 (53.2%) were considered by the charge nurses to be incubator-dependent. During the study period, only one (1.6%) of the NICU patients required mechanical ventilation, although 25 (40.3%) required continuous positive airway pressure (CPAP), and 51 (82.3%) required cardiac monitoring.

Continuous medical care needs among the 248 adult patients in the ICU during the study period included: continuous

Unit	Total n (%)	Continuous Infusion n (%)	Life Support Dependent n (%)	Oxygen Dependent n (%)	Cardiac Monitor n (%)
Intensive Care Unit	248 (12.9)	83 (33.5)	96 (38.7)	227 (91.5)	216 (87.1)
Medical	668 (34.6)	18 (2.7)		80 (12.0)	258 (38.6)
Surgical	367 (19.0)	7 (1.9)		19 (5.2)	24 (6.5)
Peanesthesia Care	41 (2.1)	2 (4.9)			3 (7.3)
Operating Room	61 (3.2)	20 (32.8)	49 (80.3)	26 (42.6)	47 (77.1)
Postanesthesia Care	37 (1.9)			15 (40.5)	22 (59.5)
ED	212 (11.0)	3 (1.4)	1 (0.5)	8 (3.8)	34 (16.0)
L & D ^a	43 (2.2)	1 (2.3)			
Special Procedure	37 (1.9)			6 (16.2)	19 (51.3)
Women's	87 (4.5)				
Psychiatry	48 (2.5)				
Rehab	67 (3.5)				
Hemodialysis	14 (0.7)			1 (7.1)	2 (14.2)
Total	1,930 (100)	134 (6.9)	146 (7.6)	382 (19.8)	625 (32.4)

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Table 2. Unit-Specific Patient Care Needs and Considerations During an Evacuation—Continuous Care Requirements^a2 patients were in Stage II of labor.

Abbreviations: ED, Emergency Department; ICU, Intensive Care Unit; OR, operating room; L&D, Labor and Delivery

intracranial monitoring (n = 15, 6%); intra-aortic balloon pump (n = 1, <1%); continuous venous dialysis (n = 9, 3.6%); and CPAP (n = 9, 0.4%).

Among adult non-ICU patients, infusion pumps (including patient-controlled analgesia) were required for 45 (2.7%) of the patients. In the Labor and Delivery Department, nine of the 43 patients (21%) included during the study period were connected to fetal monitors, and two patients (4.6%) were in active Stage II labor at the time of the survey. In the operating room (OR), the charge nurse considered 51 of the 61 (83.6%) ongoing cases able to be stopped rapidly if an emergency evacuation would be necessary. Of the 10 cases considered “unsafe to stop,” eight (80%) occurred during “after hours” or on weekends. Isolation patients consisted of 146 (7.6%) with contact precautions, and 16 (<1%) with respiratory precautions.

Nursing Care

With the exception of the neonate group, the charge nurses deemed that 457 (23.7%) of all the patients were considered total care patients (TCP) as they were bedridden, and required help with all activities.

Mobility

With the exception of the neonate group, 908 (47%) of the patients would be able to walk out of the HCF, 492 (25.5%) would require a wheelchair, and 530 (27.5%) would require a stretcher to exit the facility. All neonates (NICU and full-term nursery patients) required transportation via stretcher, as defined in the study. Charge nurses estimated that one staff member was

required to push a wheelchair. The number of staff members designated to transport a stretcher varied from one to two staff members for most medical/surgery patients, and three to four staff members for most ICU and bariatric patients.

Comprehension

A total of 1,893 of adult patients (98.1%) understood the English language, and 1,639 (84.9%) were deemed capable of both comprehending the need to evacuate and of following directions.

One “seclusion patient” was reported; this patient was secluded in the Emergency Department, rather than the psychiatric unit. Restraints were being used on 110 patients (5.7%) during the study period; 94 of these patients were in the ICU, and for the most part, were sedated and on mechanical life support machines. Patients with other barriers to self-evacuation included five patients who were deaf, and 10 were blind. These patients represented <1% of the adult patients in the study.

Mortality

Seventeen of all 248 adult ICU patients (6.9%) were deemed by the charge nurses to be too ill to survive an evacuation. The OR charge nurse also considered that 10 (16.4%) of the ongoing operations were at points where stopping the case was not considered a safe possibility.

Discussion

The lead author of this study was involved in an HCF emergency evacuation in October 2003. Due to a ruptured, burning gas line immediately next to the hospital, the local fire department

Unit	Total n (%)	Total Care Patient n(%)	Non Total Care Patient n (%)	Could Walk Out n (%)	Needs Wheelchair n (%)	Needs Stretcher n (%)
Intensive Care Unit	248 (12.9)	170 (68.5)	78 (31.5)	18 (7.3)	45 (18.1)	185 (74.6)
Medical	668 (34.6)	155 (23.2)	513 (76.8)	327 (49.0)	181 (27.1)	161 (24.1)
Surgical	367 (19.0)	34 (9.3)	333 (90.7)	200 (54.5)	109 (29.7)	58 (15.8)
Preanesthesia Care	41 (2.1)	1 (2.4)	40 (97.6)	22 (53.7)	15 (36.6)	4 (9.7)
Operating Room	61 (3.2)	61 (100)				61 (100)
Postanesthesia Care	37 (1.9)	5 (13.5)	32 (86.5)	26 (70.3)	5 (13.5)	6 (16.2)
ED	212 (11.0)	5 (2.4)	207 (97.5)	154 (72.6)	41 (19.3)	17 (8.0)
L & D ^a	43 (2.2)	5 (11.6)	38 (88.4)	22 (51.2)	13 (30.2)	8 (18.6)
Special Procedure	37 (1.9)	11 (29.7)	26 (70.3)	13 (35.1)	6 (16.2)	18 (48.7)
Women's	87 (4.5)	2 (2.3)	85 (97.7)	62 (71.3)	20 (23.0)	5 (5.7)
Psychiatry	48 (2.5)	1 (2.1)	47 (97.9)	44 (91.7)	4 (8.3)	
Rehab	67 (3.5)	7 (10.5)	60 (89.5)	14 (20.9)	48 (71.6)	4 (6.0)
Hemodialysis	14 (0.7)		14 (100)	6 (42.9)	5 (35.7)	3 (21.4)
Total	1,930 (100)	457 (23.7)	1473 (76.3)	908 (47.0)	492 (25.5)	530 (27.5)

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Table 3. Unit-Specific Patient Care Needs and Considerations During an Evacuation—Nursing Care and Mobility^a2 patients were in Stage II of labor.

Abbreviations: ED, Emergency Department; ICU, Intensive Care Unit; OR, operating room; L&D, Labor and Delivery

ordered an evacuation of the HCF. This resulted in the evacuation of 120 patients (<50% of all patients) within approximately 20 minutes.²⁶ The HCF utilized its Incident Management Team under the direction of the hospital's Incident Commander. A liaison was established quickly with the local responding fire department, and notifications of the need to evacuate the HCF were made regionally to other HCFs. Evacuation resource issues quickly arose due to the urgency of the evacuation and existing patient needs. To assist the IMT for future evacuations, the authors sought to determine updated, patient-driven evacuation resourcing needs for an HCF, and to identify the perceived risks to patients.

Typically, hospitals have ready access to their daily census on all clinical units and operating room schedules. Using findings from this study, HCF Emergency Managers and Incident Management Teams can model their own evacuation resource needs (Tables 2-6). Although the acuity and patient populations may vary, utilizing the data from this study regarding individual unit needs can aid in a rapid determination of evacuation needs. Based upon these evacuation resource needs, evacuation planning considerations can be developed to align needs, as much as possible, with available resources.

Intensive Care Patients

Given that approximately one-third of the patients in the ICU and OR require continuous infusions, the availability of battery-powered infusions is essential. With today's reliance on technology, manual adjustments of critical medications, such as

sedatives or vasopressors, requires a skill that is no longer common for many clinicians. Drip infusion calculations should be readily available for such medications.

A large number of ICU patients are under medication effects and/or are restrained; the ability to maintain a stable state during evacuation is key to ensuring a safe transfer for both the patient and staff. If possible, it may be best to temporarily remove from the patient bulky medical equipment, such as balloon pumps, intracranial pressure monitors, and continuous dialysis machines, then move the equipment separately, and re-connect it to the patient in a staging or definitive care area.

Overall, in light of the substantial estimated risk of mortality for critical care patients during an evacuation, the IMT may consider undertaking maximum efforts to shelter this population in place, or possibly evacuating them to unaffected portions of the HCF. In addition, the great resource needs during an evacuation may necessitate that this vulnerable population be evacuated last, thereby allowing the staff to move the greater number of less resource-intensive patients first, as well as minimizing the time these critical care patients will be in transition to definitive care.

Operating Room Patients

Ethical and moral questions arise when planning for patients whose operative procedures cannot be interrupted safely at the time of the evacuation. Developing emergency procedures for staff members with clear guidance is essential. Anecdotally, during the emergency evacuation in the lead author's HCF, staff members remained in a high-risk operating room (OR)

Unit	Total n (%)	Can Follow Directions n (%)	Altered Sensorium n (%)	Under Medication Effect n (%)
Intensive Care Unit	248 (12.9)	122 (49.2)	9 (3.6)	115 (46.4)
Medical	668 (34.6)	604 (90.4)	58 (8.7)	3 (0.5)
Surgical	367 (19.0)	350 (95.4)	17 (4.6)	
Preanesthesia Care	41 (2.1)	40 (97.6)	1 (2.4)	
Operating Room	61 (3.2)	61 (100)		61 (100)
Postanesthesia Care	37 (1.9)	35 (94.6)	1 (2.7)	1 (2.7)
ED	212 (11.0)	200 (94.3)	11 (5.2)	1 (0.5)
L & D ^a	43 (2.2)	43 (100)		
Special Procedures	37 (1.9)	32 (86.5)		5 (13.5)
Women's	87 (4.5)	87 (100)		
Psychiatry	48 (2.5)	44 (91.7)		2 (4.2)
Rehabilitation	67 (3.5)	67 (100)		
Hemodialysis	14 (0.7)	14 (100)		
Total	1,930 (100)	1,699 (88.0)	97 (5.0)	188 (9.7)

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Table 4. Unit-Specific Patient Care Needs and Considerations During an Evacuation—Comprehension

^a2 patients were in Stage II of labor.

Abbreviations: ED, Emergency Department; ICU, Intensive Care Unit; OR, operating room; L&D, Labor and Delivery

1. Adults: ~50% can walk out; ~25% require a wheelchair and ~25% require a stretcher;
2. Post-operative areas, such as the surgical, labor and delivery, and post-anesthesia care units require a stretcher for 17% of the patients;
3. Postpartum, psychiatry, rehabilitation, preoperative anesthesia care units, and the ED have low need for stretchers and continuous medical care;
4. Of ICU patients, 25% would be able to walk or be evacuated via a wheelchair;
5. On medical units, the percentage of stretcher evacuations correlates directly with the number of total care patients >20%;
6. Of adult ICU patients, <7% will be too ill to survive an evacuation;
7. Of surgeries, ~10% will not be able to be stopped for reasons of safety; the majority of these occur during “after hours” and weekends;
8. Most restraint utilization occurs in the ICU on patients on life support;
9. Of ICU patients, ~50% can comprehend that an evacuation is taking place;
10. Of patients in labor, ~5% may be in stage II labor;
11. One staff member is required to evacuate each patient in a wheelchair;
12. One to two staff members are required to transport each patient via stretcher;
13. Three to four staff members are required to transport a bariatric or ICU patient;
14. Heavy dependency on CPAP, cardiac monitoring, and incubators among NICU patients; and
15. Contact (7.6%) and respiratory isolation issues (1%) need to be considered during an evacuation.

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Table 5. Summary of Health Care Facility Emergency Evacuation Resource Needs

Abbreviations: CPAP, continuous positive airway pressure; ED, emergency department; ICU, intensive care unit; NICU, neonatal intensive care unit.

1. Consider manual management of infusions;
2. Develop strategies to rotate cardiac monitors among multiple patients;
3. Provide sufficient equipment for the manual measurement of vital signs;
4. Consider and plan for emergency interventions during the evacuation, eg, delivery of a newborn, dislodgement of an endotracheal tube on a mechanically ventilated patient, and fatal cardiac dysrhythmias;
5. Provide elevator management for efficient patient movement;
6. Develop intraoperative patient evacuation care guidelines to quickly halt ongoing surgeries;
7. Develop an intraoperative patient evacuation decision plan with organizational delineation of decision making;
8. Plan for the management of patients with communicable infectious diseases;
9. Plan for the management of the nursery and pediatric patients;
10. Plan for the management of prisoners;
11. Plan for the management of emergency resource utilization (durable and nondurable medical equipment, pharmaceuticals, and blood products);
12. Consider ways to shelter the most vulnerable populations in place, unless absolutely necessary to evacuate; and
13. Plan for the management of evacuation equipment (stretchers, wheelchairs, etc.)

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Table 6. Health Care Facility Emergency Evacuation Planning Recommendations

environment to continue caring for a patient on cardiac bypass. This proved to be a very difficult decision made by the OR staff. Developing institutional and OR-specific evacuation instructions for the staff could prove beneficial. In addition, special training for the IMT to make such difficult determinations should be part of preparedness.

Medical Patients

The IMT should understand that a controlled degradation of routine procedures, medical care, and resource utilization may become necessary in order to achieve an effective evacuation. For example, in this study, the charge nurses on the cardiac telemetry unit felt that all patients on that unit would have to be evacuated with a portable cardiac monitor. Without a sufficient number of portable monitors, the IMT may request that clinicians triage this limited resource to determine who truly must be monitored continuously during the evacuation process. Perhaps a portable cardiac monitor could be rotated among a number of patients for periodic assessments of their rhythm, rather than provide continuous monitoring. Other automated processes, such as blood pressure measurement, may need to be performed manually, necessitating a sufficient supply of manual equipment.

Maternity and Newborn Patients

All neonatal patients were considered by the charge nurses to be stretcher-dependent. However, this may not be entirely correct, as mothers could hold their babies on their laps in a wheelchair. In addition, multiple infants in bassinets could be transported on one stretcher. By moving these patients first, multiple patients with low resource needs could be evacuated at one time.

Other Considerations

Units that were determined to have low evacuation resource needs were the postpartum, psychiatric, rehabilitation medicine,

surgical, labor and delivery, and the preoperative units, as well as the Emergency Department. The reallocation of resources such as portable oxygen, cardiac monitors, and battery infusion pumps from these units may help alleviate some shortages in areas with greater needs. In addition, clinical and non-clinical staff may be shifted to units that require increased personnel to move patients, such as the intensive care and bariatric units which require at least twice the number of staff members to move one patient. Charge nurses also noted that some hospital beds would be very cumbersome to move. Some units had small stretchers that would be preferable for evacuation; typically, a hospital elevator can accommodate two such stretchers but only one hospital bed.

Even though the psychiatric unit, postpartum unit, and the ED had a high number of patients who could walk out of the facility, the evacuation of these patients may still be labor-intensive; the condition of psychiatric patients may deteriorate under the additional stress or require one-on-one supervision, postpartum patients may have their infants with them, and medically undifferentiated patients from the ED may become unexpectedly ill. Planning should anticipate changes in the patient's medical conditions during any evacuation. Being able to deliver an infant, reestablish an airway in a patient whose endotracheal tube becomes dislodged, and treat potentially fatal cardiac arrhythmias are just some of the daily hospital emergencies that become more complicated during an evacuation. The evacuation plans for clinical support departments, such as pharmacy, blood bank, materials management, biomedical engineering, and sterile processing, should address patient needs for supplies and equipment both during an evacuation and at the staging area.

The IMT also should consider taking control of the elevator system to facilitate an organized and structured evacuation of the hospital. Scripting the evacuation sequence of a hospital may save time in the execution of the evacuation of the HCF, assuming that preplanned evacuation routes and exits are operational and safe.

Resources should not be viewed as belonging to any one patient. Upon placement of a patient in a wheelchair in the staging area or area of definitive care, the patient should be transferred to a chair or the floor in order that the wheelchair can be utilized for the evacuation of another patient.

Limitations

This survey was dependent on the charge nurses having accurate knowledge of the evacuation factors of their patients. The charge nurses were confronted with the decision that an immediate evacuation was necessary. The complex decision making necessary to authorize such an operation in response to a hazard was not studied. The charge nurses also were not confronted with the need to prioritize the evacuation order of the patients. As each unit was surveyed separately, overall patient evacuation priorities were not addressed.

It is possible that some patients were counted twice if they were in a department undergoing a procedure during the beginning of the study, and were back on the unit by the time they were counted there.

The services offered at an HCF can vary greatly in size, scope, and complexity. To illustrate the institution-specific data in a more generalized fashion, the data collected from different component units are reported as numbers and proportions (Tables 2-4). Despite such details, the data provided in this study are from a single, urban, adult-service-oriented, academic trauma center, and may not represent other HCFs. The assumed

destination of evacuated patients in this study was considered to be out of the hospital, ie, past the hospital doors. Staging area considerations and horizontal evacuations to other sides of the building or other attached structures, such as a connected medical office building or parking garage, were not considered in this study. Future work may focus on these complex components of a HCF evacuation.

Conclusion

An updated survey of hospital patient needs during an emergency evacuation allows emergency planning for resource requirements. By understanding population of an HCF, preparation for immediate evacuation, specifically patient resource needs, can be made. Less than half of the patients can be anticipated to be able to walk out of the HCF during an immediate evacuation. With the increased risk of mortality associated with the evacuation of ICU patients, a shelter-in-place strategy may need to be adopted for the sickest and most resource-intensive patients, keeping in mind the safety of staff and patient alike. Finally, the IMT may require that scarce resources, such as portable cardiac monitors and oxygen, be triaged to patients that truly require them during the emergency evacuation process.

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