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# Burn Disaster Response Planning in New York City: Updated Recommendations for Best Practices

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Nicole E. Leahy, RN, MPH,\* Roger W. Yurt, MD, FACS,†  
Eliot J. Lazar, MD, MBA,‡ Alfred A. Villacara, DMD,‡  
Angela C. Rabbitts, RN, MS,† Laurence Berger, MHA,‡ Carri Chan, PhD,§||  
Laurence Chertoff, MS,§|| Kathe M. Conlon, RN, MSHS,¶  
Arthur Cooper, MD, MS, FACS, FAAP, FCCM, FAHA,# Linda V. Green, PhD,§||  
Bruce Greenstein, MD, FACS,\*\* Yina Lu,§|| Susan Miller, MS,§||  
Frank P. Mineo, PhD, EMT-P,†† Darrin Pruitt, PhD,§|| Daniel S. Ribaldo, EMT-P,\*  
Chris Ruhren, RN, MAS, CCRN,¶|| Steven H. Silber, DO, SCM,‡‡ Lewis Soloff, MD§||

Since its inception in 2006, the New York City (NYC) Task Force for Patients with Burns has continued to develop a city-wide and regional response plan that addressed the triage, treatment, transportation of 50/million (400) adult and pediatric victims for 3 to 5 days after a large-scale burn disaster within NYC until such time that a burn center bed and transportation could be secured. The following presents updated recommendations on these planning efforts. Previously published literature, project deliverables, and meeting documents for the period of 2009–2010 were reviewed. A numerical simulation was designed to evaluate the triage algorithm developed for this plan. A new, secondary triage scoring algorithm, based on comorbidities and predicted outcomes, was created to prioritize multiple patients within a given acuity and predicted survivability cohort. Recommendations for a centralized patient and resource tracking database, plan operations, activation thresholds, mass triage, communications, data flow, staffing, resource utilization, provider indemnification, and stakeholder roles and responsibilities were specified. Educational modules for prehospital providers and nonburn center nurses and physicians who would provide interim care to burn injured disaster victims were created and pilot tested. These updated best practice recommendations provide a strong foundation for further planning efforts, and as of February 2011, serve as the frame work for the NYC Burn Surge Response Plan that has been incorporated into the New York State Burn Plan. (*J Burn Care Res* 2012;X:000–000)

Beginning in 2005, the New York City Department of Health and Mental Hygiene (NYCDOHMH) released a request for a proposal, based on federal guidelines, to create a Hospital Preparedness Task Force For Patients with Burns.<sup>1</sup> The goal was to develop best practice guidelines for providing care to at least 50 severely burn injured adult or pediatric patients per million population (400 patients within

New York City [NYC]) for 3 to 5 days after a large-scale burn disaster until such time that a burn center bed and requisite transportation could be secured.<sup>2</sup> Plan elements included:

- Tiered triage, treatment, and transportation guidelines to support care of the burn injured

*From the \*New York-Presbyterian Hospital/Weill Cornell Medical Center; †Weill Cornell Medical College of Cornell University, New York, New York; ‡New York-Presbyterian Healthcare System; §New York City Department of Health & Mental Hygiene, Office of Emergency Preparedness & Response; ||Decision, Risk and Operations Division, Columbia Business School, Columbia University, New York, New York; ¶Saint Barnabas Medical Center, Livingston, New Jersey; #Harlem Hospital Center, New York, New York; \*\*Jacobi Hospital, New York, New York; ††New York Hospital Queens; and ‡‡New York Methodist Hospital.*

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patients in nonburn center hospitals until such time that a burn center bed is available.

- Educational modules and practice guidelines for providers within the prehospital EMS, emergency department (ED), and intensive care unit (ICU).
- Recommendations for burn care equipment and supply caches for distribution to nonburn center hospitals and stored throughout NYC for deployment as needed.
- Communication and operational pathways between EMS, hospitals, and all stakeholders to facilitate consultations, care, outcomes, and resource utilization.
- Review of the impact of existing regulatory, legal and financial constraints on burn care under normal operations.

In response, NewYork-Presbyterian Hospital and Healthcare System assembled a working group to address the request. Ultimately, this team was awarded the project and became the NYC Task Force for Patients with Burns.<sup>3-5</sup> The “Task Force” convened in 2006 and included experts in EMS, emergency medicine, burn/trauma and pediatric critical care, hospital administration, public health policy, operations research, education, emergency management, and regulatory compliance. Since inception, this team has grown to include 21 members representing 11 institutions. The following report presents updated recommendations to these burn disaster planning efforts which, while created to meet the specific needs of a large metropolitan community, may provide guidance to other geopolitical areas pursuing similar planning efforts. These disaster response planning recommendations were based on the following premises:

- The healthcare infrastructure of NYC and the surrounding region remains intact.<sup>6</sup>
- Casualties are limited to those with burn injuries and will present for medical treatment by EMS and self-referral.
- The four recognized burn centers within NYC and five regional designated burn centers would operate at 150% of capacity in response to a burn disaster, as per the recommendations of the American Burn Association (ABA).<sup>7</sup>

## METHODS

Previously published literature, project deliverables, and meeting documents for the period of 2009–2010 were reviewed. A numerical simulation was also designed to evaluate the triage algorithm developed for this plan.

## RESULTS

A review of and update to each of the plan’s main elements are presented below.

### Primary Triage

EMS field triage uses the Simple Triage and Rapid Treatment algorithm per current standards of care.<sup>8</sup> In the event of a disaster that may potentially overwhelm existing burn care resources within NYC, this plan recommends that the EMS incident commander on scene may activate phase I, which allows ambulances to transport burn-injured victims directly from the scene to designated Burn Disaster Receiving Hospitals as below<sup>3,9</sup>:

- Tier 1 BDRH (NYC): New York State Department of Health (NYSDOH) designated burn centers within NYC (4 hospitals/71 burn center beds).
- Tier 1 BDRH (Regional): ABA recognized burn center hospitals within 70 miles of NYC (5 hospitals/69 beds).
- Tier 2 BDRH: 17 NYSDOH designated trauma centers within NYC.
- Tier 3 BDRH: 13 specified nonburn/non-trauma center 911 receiving (as per NYSDOH) community hospitals that elected to participate in exchange for the receipt of burn care supplies and supplemental burn care training for its staff.
- Tier 4 BDRH: Specified nonburn/nontrauma center 911 receiving (as per NYSDOH) community hospitals, which opted out of plan participation would not be considered as an EMS transport destination for burn injured patients (unless the patient was unstable and such a facility was the closest 911 receiving hospital).

Unstable patients would be transported to the closest 911 receiving hospital for stabilization then prioritized for transfer (Table 1).

### Secondary Triage

To prevent overloading a small number of hospitals with large numbers of casualties, patients will be triaged from the initial hospital to a BDRH until such time that a burn center bed within the city, region, or country and transportation could be secured. During this anticipated 3- to 5-day period, the tiered BDRH facilities would be expected to care for either up to 150% of normal operating capacity (Tier 1 BDRHs) or a maximum of 10 burn injured disaster victims per facility (Tier 2/3 BDRH).<sup>3</sup> BDRH hospitals will accept or transfer patients only if the patient has been entered into the Virtual Burn Consultation Center

**Table 1.** Glossary of terms

NYCDOHMH	New York City Department of Health and Mental Hygiene
NYSDOH	New York State Department of Health
FDNY	Fire Department City of New York
EMS	Emergency Medical System
VBCC	Virtual Burn Consultation Center
BDRH	Burn Disaster Receiving Hospital
ED	Emergency Department
ICU	Intensive care unit
START	Simple Triage and Rapid Treatment
ABA	American Burn Association
OR	Odds ratio
TC	Transform Coefficient
TIMM	Thermal Injury Mortality Model
BLCC	Burn Logistics Coordinating Center
LMS	Learning management system

(VBCC) tracking system to maximize bed, transport, and other resource utilization.

**Triage Algorithm**

Patients are initially assigned to a priority group according to age (years), burn size (percent TBSA), and presence of inhalation injury using the BDRH Decision Matrix (Figure 1), which is based on an analysis of predicted outcomes of patients included in the National Burn Repository of the ABA.<sup>3,7,10</sup> Tier 1 (indicated in red as those with a medium or high predicted survivability) are prioritized to receive a burn center bed first. Yellow Tier 2/3 (very high or low/expectant survivability) is the second priority

group, and gray Tier 2/3 (very low predicted survivability) is the third priority group. The green group, who might normally be treated as inpatients in a burn center, would be treated as outpatients.<sup>3</sup>

Priority ranking within any group, ie, with similar acuity and predicted survivability, is determined by estimating patients' mortality probability and expected length of stay (LOS) in a burn bed. The goal is to maximize the expected number of surviving patients. Age, TBSA, and inhalation injury are used to predict a patient's likelihood of survival ( $S_{likelihood}$ ) according to the TIMM model, which uses a nonlinear regression with coefficients of the function estimated from the National Burn Repository Data Set (39,888 patients).<sup>10</sup> TBSA is used to predict LOS based on the data from the National Burn Repository.<sup>11</sup> Comorbidities are used to adjust predicted survivability and LOS depending on the odds ratio and transform coefficient for each comorbidity.<sup>12</sup> Comorbidities can reduce the likelihood of survival and extend LOS. The triage score (below) gives preference to patients with higher likelihood of survival and shorter LOS. Treating patients with similar survival probabilities but shorter LOS allows for more patients to be treated.

$$Score = \frac{S_{likelihood}}{LOS \times TC} \times \frac{OR}{S_{likelihood} + (1 - S_{likelihood}) \times OR}$$

Simulation studies suggest that excluding patient LOS from the triage score can result in up to 5% fewer survivors. In addition, simulation studies suggest that

**BDRH Decision Matrix**

			0-10% + IHI	11-20% + IHI	21-30% + IHI	31-40% + IHI	41-50% + IHI	51-60% + IHI	61-70% + IHI	>71% + IHI
	Burn Size		OR	OR	OR	OR	OR	OR	OR	OR
Age	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	90+
0-1	Tier 2/3	Tier 2/3	Tier 1	Tier 1	Tier 1	Tier 1	Tier 2/3	Tier 2/3	Tier 2/3	Tier 2/3
2-4	Outpatient	Tier 2/3	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 2/3	Tier 2/3	Tier 2/3
5-19	Outpatient	Tier 2/3	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 2/3
20-29	Outpatient	Tier 2/3	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 2/3	Tier 2/3
30-39	Outpatient	Tier 2/3	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 2/3	Tier 2/3
40-49	Outpatient	Tier 2/3	Tier 1	Tier 1	Tier 1	Tier 1	Tier 1	Tier 2/3	Tier 2/3	Tier 2/3
50-59	Outpatient	Tier 2/3	Tier 1	Tier 1	Tier 1	Tier 1	Tier 2/3	Tier 2/3	Tier 2/3	Tier 2/3
60-69	Tier 2/3	Tier 2/3	Tier 1	Tier 1	Tier 1	Tier 2/3	Tier 2/3	Tier 2/3	Tier 2/3	Tier 2/3
70+	Tier 2/3	Tier 2/3	Tier 1	Tier 2/3	Tier 2/3					

Table based on ABA Board of Trustees and the Committee on Organization and Delivery of Burn Care. Disaster Management and the ABA Plan. *J Burn Care Rehabil.* 2005 ;26: 102-6. Reprinted with the permission of Wolters Kluwer Health and the Copyright Clearance Center License #2664901156167. 2011 May 9.

**Figure 1.** Burn disaster receiving hospital (BDRH) matrix.

for most comorbidities, the presence of the condition would not significantly affect the expected number of survivors. The only comorbidity that was identified as having a potentially significant impact if incorporated into the triage score was renal disease. In addition, clinician judgment may be invoked after the triage prioritization is made using the algorithm to limit a patient's ranking in the queue should certain conditions apply: patient/family wishes to limit end of life care, medical history inclusive of an imminently terminal disease, or a Glasgow Coma Score of <6 at the disaster scene.

## VIRTUAL BURN CONSULTATION CENTER

Once the incident commander on scene determines that the scope of the event will overwhelm existing burn care resources within NYC and the surrounding region, the NY State Commissioner of Health will be immediately contacted to activate phase II. This activation mobilizes the VBCC and necessary resources and allows hospitals and providers to operate at an alternate standard of care critical to response success.

The VBCC, staffed by burn care clinicians, will provide the centralized triage and tracking of all burn disaster victims, regardless of patient source (EMS transport or self-referral) or hospital location. All hospitals that receive burn disaster victims will provide patient case details to the VBCC clinicians who in turn then review the clinical data. On receiving such referrals, the VBCC assigns a unique patient tracking number to each patient required for interfacility transport and BDRH and burn center bed assignment. The VBCC collects and enters a predefined minimum patient information dataset into the patient tracking database, assigns the patient to a Tier 1 to 3 BDRH, and then prioritizes patients within the group using the equation above. Such steps are taken to maximize clinical outcomes and resources and ensure appropriate prioritization for patient care.

Once this triage scheme is finalized, VBCC staff periodically "lock" and hand off the triage prioritization to the Burn Logistics Coordinating Center (BLCC) responsible for the coordination of regional assets and matching of patients to available treatment and transportation resources. Revisions to the patient triage queue may only be made by the VBCC clinicians based on updated patient information or changes in the course of disaster events (ie, secondary event(s), subsequent building collapse).

In the event that referring hospital staff requires consultative assistance, the VBCC team will provide clinical support to the requesting provider. This de-

viates from current protocols that limit direct burn care consultation to cases where the burn center has already accepted a patient transfer from the hospital requesting guidance.

Recommendations for VBCC staffing and responsibilities include:

- Burn care clinicians including attending and resident physicians, nurses, and licensed independent providers who operate under and report to the designated chief triage officer (attending burn physician).
- Clinicians divide responsibilities between collecting, organizing, and entering patient information into the triage system and providing consultative support to requesting nonburn centers.
- Chief triage officer to review, approve, and adjust the triage list generated by the above algorithm as needed and direct the clinical operations of the VBCC team.
- Administrative, information technology and communications staff, and EMS personnel would also participate in team operations to provide clerical and technical support and situational awareness updates as needed.

The physical site for the VBCC has yet to be determined but would likely be selected from a small group of predetermined facilities, optimally remote to the event.<sup>13</sup> Specific technology requirements for the VBCC have yet to be specified but would be expected to include internet service, multiple computers, dedicated phone lines/phones/printers/copier and fax machines, a dedicated VBCC phone number exclusively for patient referrals, access to continuous media updates, back-up communications equipment, and other equipment as needed.

## Burn Logistics Coordinating Center

The BLCC, located at the Fire Department, City of New York, will interface with local public safety agencies, hospitals, and others as needed and will be charged to collate and manage information on resource availability and patient location, and match patients in need of care to available resources. Specific responsibilities include:

- Communicate with NYC hospitals and regional burn centers to ascertain bed and other key resource availability in Tier 1 to 3 BDRHs.
- Receipt of prioritized patient queues from VBCC and assignment of patients from initial receiving hospitals to available Tier 1 to 3

BDRH beds utilizing the VBCC tracking system.

- Assignment of Fire Department, City of New York (or other designated interfacility transport teams per activation of mutual aid agreements) resources for interhospital transport.
- Notification to referring hospitals and receiving BDRHs of patient identity and tracking number, transfer arrangements (ie, receiving hospital information and transport vehicle specifics), and contact information for clinical exchange between hospital providers.

To maximize resource utilization and minimize miscommunications, all patient transfers are approved and coordinated by this centralized entity, thereby obviating previously established interfacility transfer agreements and EMS transport mechanisms.

### Patient Tracking Database

To create and maintain accuracy and efficiency of patient and resource data management, the Task Force considered several database models and recommended the Burn Center Transfer Network<sup>®</sup> (Live Process, Nutley, NJ) due to the ease of use, abilities to support bi-directional communications between all entities, organizational capabilities, confidentiality, and compatibility with an adjacent state's systems. Database use allows participating hospitals to log in to precreated sites, upload and manage patient data, submit or accept burn transfer requests, and track the patients as they move throughout the triage and transport processes.

This tool also provides the VBCC and BLCC with the capabilities to view and manage all patients in the system to facilitate triage, resource matching, and utilization. This software can host the triage algorithm software to allow VBCC clinicians to develop a triage queue that will then be maintained by this program and provide a platform to match and track patients and resources. "Read only" capabilities can be assigned to any participating entity as appropriate to facilitate communication of patient and resource status.

In the event that Internet connections are not available, a manual backup plan was also recommended and developed.

### Legal Implications

As this plan anticipates deviations from standard clinical procedures and that the demand for patient care resources may exceed available supplies, legal support for a burn disaster response has been strongly suggested. The Task Force recommended that the NYS

Health Code be amended not only to mandate plan participation by all institutions and agencies but also to provide legal indemnification to healthcare providers, institutions, support staff, and government agencies responding as part of the VBCC. In support of this, the Task Force recommended the following:

- Provider indemnification begins on plan activation.
- Provider indemnification extends to all staff performing triage and support services including clinical consultations, data management, administrative support, etc.
- Indemnification offers that all providers (as defined above) and staff be held harmless against all types of liabilities and damages as related to the patient care tasks performed by the VBCC including triage, consultative support, tracking, and information sharing between the specified plan stakeholders.

### EDUCATIONAL TRAINING

In light of the need to prepare EMS and Tier 2/3 ED and ICU providers to transport and care for burn injured patients during the initial 3 to 5 days postinjury, the Task Force developed and pilot tested self-learning educational modules built on a Breeze<sup>®</sup> platform and a web-based learning management system (LMS). Content included injury assessment and resuscitation, critical care management, wound care/rehabilitation, nutrition, and pediatric care as relevant to the specific practitioner. Each module presented a required posttest with self-scoring feedback. The first phase of the pilot testing of these modules was completed on local computers by surgical residents and local paramedic students completing clinical rotations at the Hearst Burn Center. Overall feedback supported the continued use of these programs.

During the second phase of pilot testing, both courses and posttests were loaded onto a LMS hosted by the regional emergency services working group. All local medical reservists (~9,000) were invited by email to enroll and given an 8-day period to complete the online courses, posttests, and a 10-item survey assessing acceptance of the course and its delivery through LMS.

In response, 176 practitioners registered and 58 (33%) completed the program. Of this group, 65% completed the EMS course. The posttest pass rate was higher for the EMS course (86%) than the ED/ICU course (71%); median scores were higher than mean scores for both courses (EMS mean: 88.9, median: 93.3; MD/RN mean: 83.3, median: 86.7).

Program format, including LMS efficacy and acceptance, was rated positive (>75%). Course content and usability ratings were high on all 10 items. Overall 89% of course ratings were positive.

### Supplemental Burn Care Supplies

In follow-up to the previously described distribution of burn care supplies to Tier 2 and 3 BDRH facilities to support the wound care of 10 adult patients who each sustained a 50% TBSA burn for the initial 24- to 36-hour s/p injury and the distribution of comparable support to Tier 1 NYC BDRH facilities, silver sulfadiazine was distributed to Tier 2/3 BDRHs for use in the event of a burn disaster.<sup>3</sup> In addition, the NYCDOHMH conducted an emergency preparedness drill in which participating hospitals were required to locate the burn cart within the facility and confirm accountability by providing the serial number of a specified item (ie, warming blanket) to the agency within a 2-hour window. Of the 28 participating BDRH facilities, 21 successfully completed the table top drill (Lewis Soloff, MD, NYCDOHMH, March 21, 2011, personal communication).

### Plan Operations

Phase I activation occurs when the incident commander determines that there are large numbers of burn casualties that will overwhelm existing burn care resources. Such activation permits EMS to transport victims to Tier 1 to 3 BDRH if stable but does not

affect systems beyond EMS providers. Phase II activation requires notification to and approval by the NYS Commissioner of Health and triggers the invocation of provider indemnification and mandatory plan participation and the activation of the VBCC, BLCC, tiered BDRH system, notification by the NYCDOHMH to EMS and Tier 1 to 3 BDRHs to prepare for the treatment and transport of multiple burn casualties. Although the arbitrary number of 50 burn casualties may serve as a guideline, activation threshold could be adjusted for situational awareness, estimated resource availability, status of city/regional “infrastructure,” and other circumstances TBD. Plan operations are summarized in Figure 2.

### DISCUSSION

These updated recommendations for best practices offer a detailed outline for plan operations, stakeholder roles and responsibilities, provider education, communications pathways, data management, legal protection, and public health policy in the event of a large-scale burn disaster. Although this plan is limited in scope to burn injured patients, it provides both specific steps and general operating principles for a city-wide and regional response plan that capitalizes on the multiagency cooperation required to coordinate resources and maximize patient outcomes that may be adapted to other disaster response planning efforts. Although this plan is the first of its kind for the

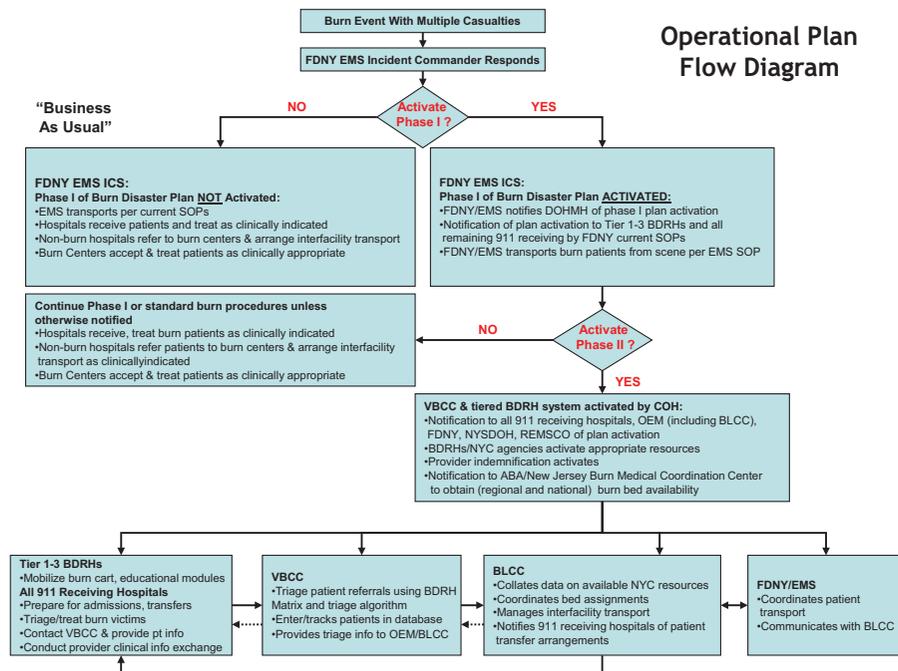


Figure 2. Operational plan overview.

NYC region and is limited in scope to a burn disaster response only, it offers guidance on operationalizing general principles that may pertain to other emergency preparedness planning groups both within NYC and outside jurisdictions. Such groups may consider modifying these principles to meet the unique population, resource, or geographic needs for a specific preparedness response or region.

## SUCCESSSES, BARRIERS, AND NEXT STEPS

Although further steps for implementation remain, the success of the plan development thus far can be attributed to several factors, which positively contributed to this effort. First and foremost, the resource density of NYC and the surrounding region lends itself to creating a solid disaster response plan. Within the 322 square miles of NYC lie 58 hospitals, including 4 burn centers, 17 trauma centers, and several large hospital networks. The city also has the country's largest centralized fire department and EMS system that serves the 8,008,000 residents and operates over or in close proximity to multiple resources that can be activated for mutual aid patient transport if needed. In addition, regional resources include five burn centers, which can be counted on to receive and treat patients as necessary. Finally, and perhaps most importantly, the preexisting collaborative relationships between and among the many City, State and private stakeholder agencies and institutions led to open and ongoing discussions regarding this planning process.

Although these efforts put forth comprehensive recommendations for a burn disaster response plan for the NYC metropolitan area, they must be considered in light of several limitations. According to the published data, NYC is considered to be vulnerable to natural and manmade disasters that could not only potentially generate mass casualties with multiple traumatic injuries but also decimate the local healthcare infrastructure.<sup>14</sup> Although future city-wide disaster planning efforts may be pursued to address these scenarios, this plan focuses on a response limited in scope to a single mechanism of injury and does not address a breakdown in existing healthcare infrastructure. This planning course was purposely chosen for its feasibility, given that this is the first city-wide and regional response plan to address the issues as outlined above. The Task Force accepts these limitations and anticipates that this plan can be modified and expanded as needed to address and accommodate these and other additional disaster response challenges.

As of the publication date of this article, several key issues including the specific location and mechanism for VBCC site designation, implementation of provider indemnification, selection of specific data management and communications tools, mandated plan participation, and institutional operations for continual staff training and education have not been finalized. As each of these issues is incredibly complex, far reaching in operational scope, and has wide medico-legal and regulatory implications for practitioners, agencies and institutions, extensive discussion between NYC, New York State, and institutional stakeholders is warranted to address the specific steps needed to implement these key pieces. Much of the force needed to move the plan forward is anticipated to require NYC and State executive and legislative amendments and approvals and lies beyond the scope of this planning group. This team, however, remains committed to this process and will continue to contribute to and provide recommendations and feedback for these planning efforts if requested to do so by the involved agencies.

As of January 2010, the Regional Emergency Medical Services Council of NYC altered the general operating procedures to reflect the tiered BDRH system in the event of a burn disaster.<sup>15</sup> On February 23, 2011, the NYC Office of Emergency Management released the NYC Burn Surge Response Plan, which is based on these recommendations and has been incorporated into the New York State Burn Plan.<sup>16</sup> Although further steps are required to finalize plan operations, these recommendations for best practices for a large scale response to an urban burn disaster provide a strong foundation from which additional efforts may be developed and implemented.

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