Tracking the Daily Availability of Burn Beds for National Emergencies

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Medical planning for Operation Iraqi Freedom included predictive models of expected number of burn casualties. In all but the best-case scenario, casualty estimates exceeded the capacity of the only Department of Defense burn center. Examination of existing federal–civilian disaster plans for military hospital augmentation revealed that bed availability data were neither timely nor accurate. Recognizing the need for accurate knowledge of burn bed availability, the Department of Defense requested assistance from the American Burn Association (ABA). Directors of burn centers in the United States were queried for interest in participation in a mass casualty plan to provide overflow burn bed capacity. A list of 70 participating burn centers was devised based upon proximity to planned military embarkation points. A computer tracking program was developed. Daily automated e-mail messages requesting bed status were sent to burn center directors at 6 AM Central time with responses requested before 11 AM. The collated list of national overflow burn bed capacity was e-mailed each day to the ABA Central Office and to federal and military agencies involved with burn patient triage and transportation. Once automated, this task required only 1-2 hours a day. Available burn-bed lists were generated daily between March 17 and May 2, 2003 and then every other day until May 9, 2003. A total of 2151 responses were received (mean, 43 burn centers per day). A system to track daily nationwide burn bed availability was successfully implemented. Although intended for military conflict, this system is equally applicable to civilian mass casualty situations. We advocate adoption of this or a similar bed tracking system by the ABA for use during burn mass casualty incidents. (J Burn Care Rehabil 2005;26:174–182)

Prior to the start of hostilities, a planning team was assembled at the US Army Institute of Surgical Research and tasked with the design of burn care support for impending military action in Iraq. The initial thought was to duplicate the successful burn care plan devised 12 years earlier for Operation Desert Storm.[1] It soon became apparent that the second Gulf War would be very different from the first. Compared with Operation Desert Storm, the team needed to anticipate different tactics, different doctrine, different weapons, a much shorter preparation and evacuation time, the possible enemy use of vesicant chemical weapons, and a military medical system that could marshal significantly fewer personnel resources than in previous conflicts.

The first Gulf War had a long aerial campaign followed by a brief ground war. The second conflict would have near simultaneous air and ground battles. Urban warfare was likely. The opposing force was known to have had and used chemical weapons (including sulfur mustard) in battle between 1980 and 1988. Chemical burns meet the American Burn Association (ABA) criteria for transfer to a burn center, and mustard gas exposure produces chemical burns of the skin and lungs.[2] In the interval between the two gulf wars, the rapid pace of battle had prompted a change in medical doctrine from the large field hospitals, with significant in-theater care and long-range

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Presented the meeting of the American Burn Association, Vancouver, British Columbia, Canada, March 24 to 27, 2004.
The opinions and assertions herein contained are the private opinions of the authors and do not represent official policy of the US Army or the Department of Defense.
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0273-8481/2005

DOI: 10.1097/01.BCR.0000155545.24253.45

transportation of the *stable* patient, to small mobile hospitals, limited in-theater care, and the long-range transportation of the *stabilized* patient.[3] This change meant that sicker patients would be arriving at tertiary care facilities sooner after injury than at any previous time.

Burn casualty predictions were made for best-case, worst-case, and chemical weapon-use scenarios. The best-case and chemical weapon-use scenarios predicted a casualty number that was within the capacity of military medical assets. The worst-case scenario predicted 750 to 1250 burn patients, including 150 to 250 patients with burns greater than 20% TBSA, a number that would overwhelm military medical resources. Therefore, planners looked for other options.

The National Disaster Medical System (NDMS) is designed for just such contingencies[4]; however, planners soon discovered inaccuracies in NDMS burn data. Several hospitals offering burn care to the NDMS had neither a burn center nor any experienced burn care providers. Some burn center hospitals either did not participate or did not have burn bed availability listed in NDMS data. Participating hospitals with true burn capacity did not have burn bed capacity differentiated from total bed capacity. Bed data was often several weeks old and did not reflect "real-time" availability.

A plan was devised to set up a system that would provide a daily report of burn bed availability throughout the United States in conjunction with the ABA. The Army Surgeon General, the Integrated CONUS Medical Operations Plan, the US Transportation Command, and the Global Patients Movement Requirements Center rapidly approved this plan.

METHODS

The Central Office and President of the ABA were contacted for assistance in February 2003. A request was made to use the nation's civilian burn centers as a reserve burn bed capacity in the event that military medical resources were overwhelmed. In February, 2003, a letter was drafted by the ABA President and sent to all burn center directors in the United States The letter solicited volunteers for this program, along with information on burn center size and surge capacity. A key point of this voluntary program was the intent to use the *reserve capacity* of each burn center. We did not wish to overwhelm any burn center with a large number or patients or to force any civilian burn center to expand to accommodate wartime patients. Centers interested in participating were asked to provide a contact person willing to answer daily e-mail messages 7 days a week to provide accurate information on daily burn bed capacity. The names, phone numbers, and e-mail addresses of the designated contact person from each burn center were recorded by the ABA and forwarded to the Army Burn Center.

Military planners established medical evacuation routes from the Middle East back to the Continental United States. The initial plan was to transport injured service members from the Middle East to Landstuhl Regional Medical Center, outside of Frankfurt, Germany. From Landstuhl, patients would be transferred through designated embarkation points in the United States and then sent to military medical facilities close to their home station. Those requiring burn care would be sent to the US Army Burn Center (Brooke Army Medical Center) or to civilian facilities close to embarkation points. All patients with vesicant (mustard gas) injury would be treated at the Army Burn Center or within military medical facilities. Just before start of hostilities, a second transfer point was established at a US Navy Fleet Hospital in Rota, Spain.

The primary embarkation points were designated as Andrews Air Force Base in Maryland, KellyBase/Lackland Air Force Base in San Antonio, Texas, and Scott Air Force Base in Belleville, Illinois. As necessary, secondary embarkation points would be added at Miramir Marine Corps Air Station in San Diego California; Fort Gordon, Georgia; Travis Air Force Base in Fairfield, California; and McChord Air Force Base in Tacoma, Washington (Figure 1). A list of 70 participating burn centers was developed based upon ABA verification status, proximity to planned military embarkation points, burn center size, and overflow capacity The total burn bed capacity of these centers was 1161 beds.

The US Army Burn Center sent one burn surgeon to Southwest Asia and a second burn surgeon to Landstuhl Regional Medical Center in Germany. One senior surgeon was mobilized from the Army Reserve and assigned to the Army Burn Center. The two deployed surgeons served as liaison and triage officers to direct appropriate patients with burn injury into the evacuation chain. The burn surgeon at Landstuhl would also function to distribute burn patients to appropriate embarkation points and civilian burn centers close to their home station when military facilities were full. Communications links were established between The Army Burn Center, Landstuhl Regional Medical Center, and the two liaison burn surgeons. The senior burn surgeon at the Army Burn Center carried a two-way pager with a special burn hotline e-mail account to provide field consultation 24 hours a day.

To gather data, a Burn/Vesicant Contingency Cell

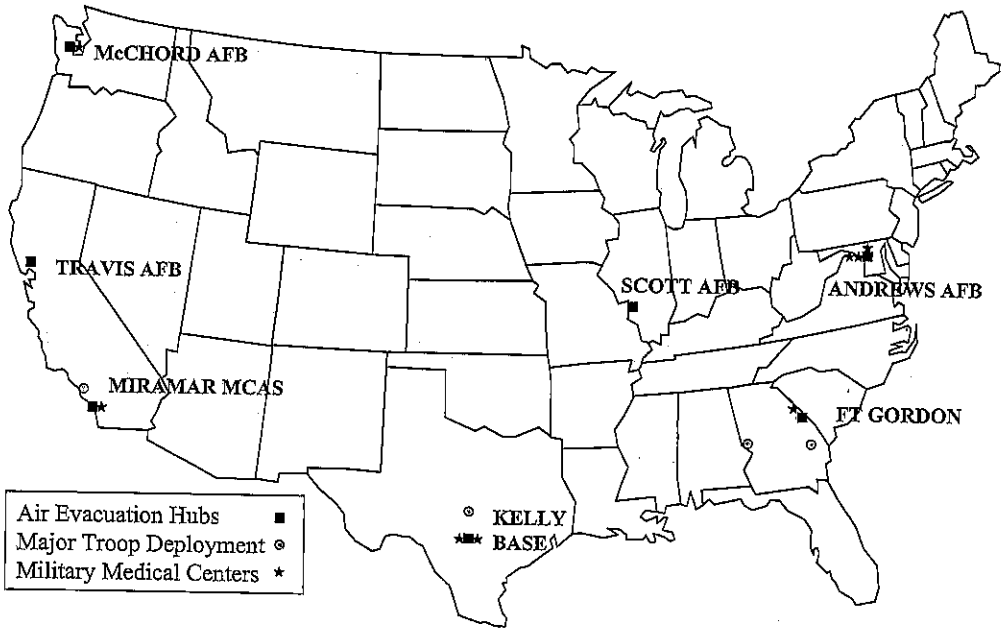

Figure 1. Embarkation points.

was established at the Institute of Surgical Research. A treatment plan for the burn center management of sulfur mustard injuries was jointly developed by the Army Burn Center and the US Army Research Institute of Chemical Defense. A computer tracking program was developed and implemented. The program was written in Microsoft Access™ (Redmond, WA) and run on the computer network of the Institute of Surgical Research.

Daily automated e-mail messages requesting bed status were sent out to participating burn centers at 6 AM Central time (Figure 2). The responses were tallied at 11 AM each day and a list of available burn beds generated (Figure 3). At 12 PM Central time, an updated burn bed list was delivered electronically to the ABA Central Office, the burn surgeon liaison at Landstuhl Regional Medical Center, to military agencies responsible for patient triage and transportation, and to the NDMS Federal Regional Coordinating Centers (Figure 4). Once automated, this task required only 1-2 hours per day.

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Good morning!  Today is Wednesday, March 19th, 2003.

Request you provide your current burn bed availability --

ICU =
NON-ICU =

Please reply before 11:00am (central time) to address above.

Thank you for your continued support in this effort.
USAISR OPERATIONS
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Figure 2. Daily e-mail message.

RESULTS

The first test query went out on March 12, 2003. After adding additional participants and correcting e-mail addresses, the second test query took place on March 14, 2003. The first Burn Availability Report was generated on March 14, 2003. The system was implemented full-time on March 17, 2003, and operated until May 9, 2003. Daily e-mail queries and bed availability lists were generated until May 2, 2003, at which point lists were generated 3 times a week for the final week.

A total of 2151 e-mail responses were received during full implementation. The mean number of burn centers responding each day was 43 burn centers (range, 21–56 burn centers; Figure 5). E-mail responses were less frequent on weekends with an average of 31 burn center responses per weekend day (range, 21–39) compared with 46.7 burn center responses on weekdays (range, 25–56).

Burn Bed Availability Report for Friday, May 09, 2003 Report prepared at 1615 (central time)

PAGE 3 of 4		*REGION / HUB / DISTANCE*	*LOCATION - POC - PHONE*
Oregon Burn Center			
Legacy Emanuel Hospital			**Portland, Oregon 97227**
ICU 1	**NON-ICU 1**	**4 / McChord / 134 miles**	**Nathan Kemalyan, MD - 503-204-4683/503-413-4232**
Arizona Burn Center			
Maricopa Medical Center			**Phoenix, Arizona 85008**
ICU 6	**NON-ICU 6**	**4 / Miramar / 362 miles**	**Daniel M. Caruso, MD - 602-344-5637**
University of Utah Health Center			
			Salt Lake City, Utah 84132
ICU 4	**NON-ICU 6**	**4 / Travis / 695 miles**	**Jeffery R. Saffle, MD, FACS - 801-581-2121**
US Army Institute of Surgical Research			
			Fort Sam Houston, Texas 78234
ICU 9	**NON-ICU 12**	**5 / Kelly / 12 miles**	**LTC David Barillo, MD - 210-222-2876**
Baton Rouge General Medical Center			
Burn Center			**Baton Rouge, Louisiana 70806**
ICU 1	**NON-ICU 1**	**5 / Kelly / 474 miles**	**Susan Dixon, RN - 225-387-7715**
Intregris Baptist Burn Center			
			Oklahoma City, Oklahoma 73112-4481
ICU 3	**NON-ICU 4**	**5 / Kelly / 481 miles**	**Paul Silverstein, MD - 405-842-9732**
St. John's Mercy Medical Center			
Burn Center			**St. Louis, Missouri 63141**
ICU 3	**NON-ICU 2**	**6 / Scott / 42 miles**	**Michael Smock, MD - 314-882-2231/314-663-4788**
University of Chicago Burn Center			
			Chicago, Illinois 60637
ICU 2	**NON-ICU 2**	**6 / Scott / 300 miles**	**Lawrence J, Gottlieb, MD - 847-452-4124**
Loyola University Medical Center			
Burn Center			**Maywood, Illinois 60153**
ICU 5	**NON-ICU 5**	**6 / Scott / 302 miles**	**Richard L. Gamelli, MD - 708-216-8000**
Stroger Hospital			
(New Cook County Hospital)			**Chicago, Illinois 60612**
ICU 3	**NON-ICU 8**	**6 / Scott / 309 miles**	**Barbara A. Latenser, MD - 312-333-4262**

Figure 3. Burn bed availability report.

Beds that could have been made available or converted to burn use for a national emergency ranged from 196 to 584 beds per day, with a mean of 407 beds. Intensive care unit beds that potentially could have been used ranged from 83 to 239 beds per day, with a mean of 167 beds. Reported daily bed availability, as a percentage of the total bed capacity of the 70 participating burn centers is presented in Figure 6. In presenting these data, centers not responding to the daily e-mail request had their beds assumed to be not available for the day in question.

The number of burn casualties resulting from military action matched the best-case predictions made by the planning team. There was sufficient capacity at

- American Burn Association (2)
- USAF Global Patient Movement Requirements Center (2)
- US Transportation Command (2)
- US JF Command (2)
- NDMS Federal Coordinating Centers (58)
- ISR Liaison Burn Surgeon (Germany) (1)
- Service Points of Contact (5)
- Others (4)

Figure 4. E-mail recipients of daily bed report.

the Army Burn Center to handle all military burn patients injured during the time of this study. One military burn patient became unstable during an overnight in-transit stay at Malcolm Grow Air Force Hospital at Andrews Air Force Base. This patient was admitted to the Washington Hospital Center Burn Center for several days. After stabilization and emergency surgery, he was transferred to the Institute of Surgical Research by the Army Burn Flight Team and subsequently was discharged. No other military burn patient was treated at the contingency civilian burn centers in this network.

DISCUSSION

Burn care capacity in the United States has decreased during the last decade. In the 12-year interval between the two desert wars, the number of burn beds in the United States listed in the ABA Burn Care Resources Guide has decreased from 1966 beds to 1897 beds. In the same timeframe, 16 burn centers have closed, and others (including the Army Burn Center) have downsized. More subtly, the remaining burn centers have lost surge capacity. In the current healthcare environment, no one has too many nurses or too many beds. Changes in inventory management to "just-in time" delivery means that the hospital warehouse now probably stores a 1-week supply of silver sulfadiazine instead of the several-months supply likely kept a few years ago.

At the same time, the possibility of a civilian burn mass casualty incident producing hundreds of patients has become more real. At the least, awareness of this possibility has increased on the part of burn care providers in the post September 11th environment. When such a disaster occurs, it may make more sense to spread the patients among multiple burn centers, rather than attempt to temporarily bring out-of-town

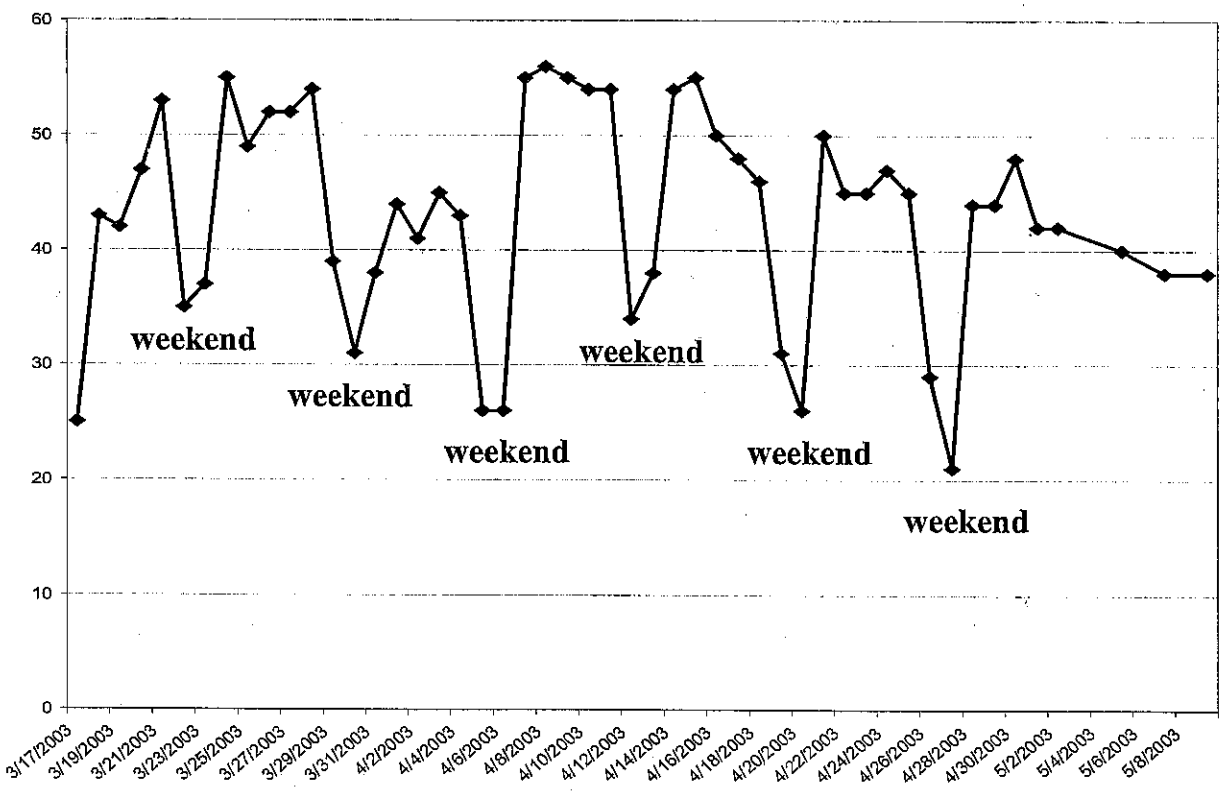

Figure 5. Number of burn centers reporting.

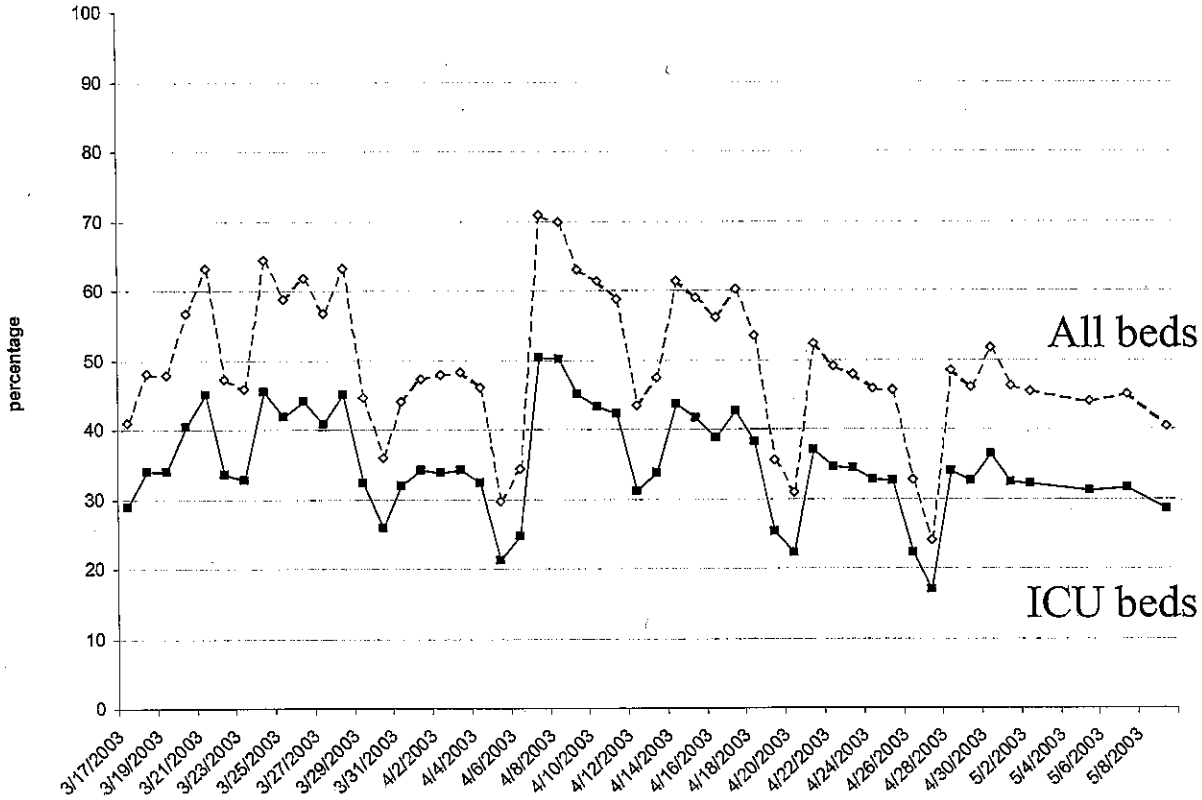

Figure 6. Burn beds available.

burn care providers to the burn center closest to the disaster.[4] The system herein described would be of great value in the regional or national distribution of burn patients resulting from a mass casualty incident.

The idea of organizing burn centers for military or civilian burn mass casualty incidents is not new. Wachtel, Robson, Meyer, and others[4,5] explored the possibilities of a national burn disaster plan and the role of the ABA in such plans in the 1980s and early 1990s.[5] Likewise, the idea of using a computer system to provide real-time bed availability data is not new. The Birmingham (Alabama) Regional Emergency Medical Services System presently links 10 hospitals via modem to a computer system located at a Trauma Communications Center (TCC). Hospital status is monitored and reported as available or unavailable. When paramedics contact the TCC, patient data are entered into the computer by the TCC communicator, allowing selection of the available hospital that best fits the needs of the patient.[6] Many other trauma systems use similar technology. As hospital burn resources become more constrained, a similar system could be used on a regional or statewide basis to match burn patients with open burn beds every day.

A caveat in the interpretation of data herein presented is that the daily number of available burn beds may or may not have been realistic, attainable, or sustainable. One is left with the impression that the country has substantial burn overflow capacity, which is obviously not the case. Clearly, the number of burn beds that civilian providers were reporting as potentially available reflected a strong willingness to help out during a time of national emergency and does not reflect normal peacetime burn center operation. Some of the beds reported as available were likely in use for other purposes, such as surgical intensive care unit or plastic surgery floor beds. Others were probably burn center beds currently occupied by patients who were transferable, such as wound care patients, postoperative flap patients, or overflow patients from other intensive care units. In addition, the bed-reporting system operated during the spring months, a time of year that traditionally is slow in terms of burn admissions in many burn centers. Had this system been operated during seasons of peak use, burn bed availability would have been lower. Future monthly testing of the bed reporting system during the course of several years might better reflect seasonal data. In the future, disaster planners may wish to calculate burn overflow capacity as a percentage of the normal

daily or annual census of each burn center. Whether this overflow percentage should be 20% or 200 % remains to be determined.

In summary, a voluntary system to track the daily availability of nationwide burn beds was rapidly and successfully implemented. Although intended for military conflict, this system is equally applicable to civilian mass casualty situations. We recommend adoption of this or a similar bed tracking system by the ABA for future burn mass casualty incidents. Such a system should be tested monthly to insure that e-mail and contact information remain current. During actual mass casualty incidents, natural disasters or elevated terrorism alert status (orange or above) the system should be activated and run on a more frequent basis until the event or alert has been resolved.

ACKNOWLEDGMENTS

The authors would like to thank Basil A. Pruitt, Jr, MD, the staff of the ABA Central Office, and the participating burn centers for much-needed assistance in the setup and operation of this system and for the overwhelming willingness to provide support during a time of national need. A list of participating centers is included in Appendix 1.

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APPENDIX
PARTICIPATING BURN CENTERS

Center	City	State
Arizona Burn Center Maricopa Medical Center	Phoenix	Arizona
Baltimore Regional Burn Center Johns Hopkins Bayview Medical Center	Baltimore	Maryland
Barnes Jewish Hospital Washington University Medical Center	St. Louis	Missouri
Baton Rouge General Medical Center Burn Center	Baton Rouge	Louisiana
Bridgeport Hospital Burn Center	Bridgeport	Connecticut
Brigham and Women's Burn Center	Boston	Massachusetts
Bronson Burn Center	Kalamazoo	Michigan
C.R. Boeckman Regional Burn Center	Akron	Ohio
Erlanger Health Systems Burn Unit	Chattanooga	Tennessee
Firefighter's Regional Burn Center	Memphis	Tennessee
Geo. W. Peak Memorial Burn Center	Columbia	Missouri
Grossman Burn Center	Sherman Oaks	California
Hennepin County Medical Center Burn Center	Minneapolis	Minnesota
Indiana University Medical Center Adult Burn Unit—Wishard Hospital	Indianapolis	Indiana
Integris Baptist Burn Center	Oklahoma City	Oklahoma
John S. Dunn Sr. Burn Center Hermann Medical Center	Houston	Texas
Lehigh Valley Hospital Burn Center	Allentown	Pennsylvania
Louisiana State University Medical Center Regional Burn Center	Shreveport	Louisiana
Loyola University Medical Center Burn Center	Maywood	Illinois
Maine Medical Center	Portland	Maine

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Center	City	State
MetroHealth Medical Center	Cleveland	Ohio
Comprehensive Burn Care Center		
Miami Valley Hospital	Dayton	Ohio
Regional Adult Burn Center		
Mississippi Firefighters Memorial Burn Center	Greenville	Mississippi
Nassau County Medical Center Burn Center	East Meadow	New York
Nebraska Health System	Omaha	Nebraska
Clarkson Hospital/University Hospital Burn Center		
New Mexico Regional Burn Center	Albuquerque	New Mexico
New York Presbyterian Hospital	New York	New York
Cornell Burn Center		
North Carolina Jaycee Burn Center	Chapel Hill	North Carolina
University of North Carolina Hospitals		
Oregon Burn Center	Portland	Oregon
Legacy Emanuel Hospital		
Parkland Memorial Hospital	Dallas	Texas
Regional Burn Center		
Regional Burn Center	Springfield	Illinois
Memorial Hospital Center		
Regions Hospital Burn Center	St. Paul	Minnesota
Saint Barnabas Medical Center	Livingston	New Jersey
San Francisco General Hospital	San Francisco	California
Burn Service—3A		
Sentara Norfolk General Hospital	Norfolk	Virginia
Eastern Virginia Medical School, Burn Trauma Unit		
Shands Burn Center at the University of Florida	Gainesville	Florida
Southern California Regional Burn Center at LAC	Los Angeles	California
USC Medical Center		
St. Agnes Burn Treatment Center	Philadelphia	Pennsylvania
St. John's Mercy Medical Center	St. Louis	Missouri
Burn Center		
St. Luke's Burn Center	Sioux City	Iowa
Stroger Hospital	Chicago	Illinois
Strong Regional Burn Center	Rochester	New York
Sumner Redstone Burn Center	Boston	Massachusetts
Massachusetts General Hospital		
Tampa Bay Regional Burn Center	Tampa	Florida
Tampa General Hospital		
Temple University Hospital	Philadelphia	Pennsylvania
Temple Burn Center		
The Burn and Wound Center at Doctor's Medical Center	San Pablo	California
The Burn Center at Washington Hospital Center	Washington	District of Columbia
Torrance Memorial Hospital	Torrance	California
UAB Burn Center	Birmingham	Alabama
University Hospital Burn Unit	Denver	Colorado
University of Colorado Health Sciences Center		
University Medical Center—Burn Center	Fresno	California
University of California Irvine Medical Center	Orange	California
Burn Center		
University of California San Diego	San Diego	California
Regional Burn Center		
University of Chicago Burn Center	Chicago	Illinois
University of Cincinnati Hospital	Cincinnati	Ohio
Burn Special Care Unit		
University of Iowa Burn Treatment Center	Iowa City	Iowa

continues

Center	City	State
University of Iowa Hospitals and Clinics		
University of Kentucky Hospital Burn Unit	Lexington	Kentucky
University of Louisville Hospital Burn Unit	Louisville	Kentucky
University of Michigan Health Systems	Ann Arbor	Michigan
University of South Alabama Burn Center	Mobile	Alabama
University of Texas Medical Branch Blocker Burn Center	Galveston	Texas
University of Utah Health Center	Salt Lake City	Utah
University of Washington Burn Center Harborview Medical Center	Seattle	Washington
University of Wisconsin Hospitals & Clinics	Madison	Wisconsin
U.S. Army Institute of Surgical Research	Fort Sam Houston	Texas
Vanderbilt Burn Center	Nashville	Tennessee
Wake Forest University Baptist Medical Center Burn Center	Winston-Salem	North Carolina
Westchester Burn Center Westchester Medical Center	Valhalla	New York
Western Pennsylvania Hospital Burn Trauma Center	Pittsburgh	Pennsylvania
Western States Burn Center	Greeley	Colorado