

*“...the Nation was lost,
and all for the want of a hospital bed.”*

Making the Case for an Interoperable, Multi-scale Hospital/Healthcare Knowledge Domain

by

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“This is not our world as we once knew it. It is no longer sufficient to develop disaster plans and dust them off if a threat appears imminent. Rather, a system of preparedness across communities must be in place everyday. Such systems make effective responses to emergencies possible, and they also serve as deterrents to actual attacks. And, they are needed – whatever the level of our sense of security – to facilitate the management of crises that seem to be becoming everyday occurrences” (JCAHO 2003).

Current Status of Healthcare Planning, Preparedness, Response and Recovery

The healthcare system and its many key components (public and private hospitals, medical supplies & equipment, pharmaceuticals, medical practitioners, healthcare professionals, and support staff) represent one of the most multi-disciplinary information producing and information demanding environments in the world. Hospitals, for example, are well prepared to handle a wide array of diseases and

medical events, most of which present in a reasonably structured and somewhat predictable fashion. Hospital organizations are constantly constructing and reusing protocols for injury and disease management and case management in order to facilitate and optimize daily work of hospital personnel. In addition, these protocols help to minimize medical errors and maximize patient throughput. Well-functioning hospitals are, therefore, designed to handle

high volumes of elective and emergency admissions and even local small-scale disasters. Hospitals, and the healthcare systems to which they belong, however, are not well prepared to respond to large scale “assaults” (e.g., World Trade Center collapse; Hurricane Katrina; H5N1 avian influenza) which over-tax their resources (i.e., medical, administrative and ancillary personnel, beds, medical supplies & equipment, food, ambulances, etc.).

The private healthcare sector:

- *More than 6,600 hospitals*
- *More than 492,000 ambulatory healthcare facilities*
- *Nearly 70,000 nursing and residential care facilities*
- *Nearly 175,000 individual or group medical practices*
- *Nearly 100 health insurance companies*
- *More than 40,000 pharmacies*
- *Approximately 2,500 pharmaceutical manufacturers*
- *A medical devices and supplies industry*
- *More than 500 blood and organ bank establishments*

Source: Harrington, 2005

Many hospitals are fairly adept at scaling up (“flexing up”) for a relatively small and anticipated protracted event (e.g., flu season) and rescheduling a very large and diverse work

*For want of a nail, the shoe was lost;
For want of a shoe, the horse was lost;
For want of a horse, the rider was lost;
For want of a rider, the battle was lost;
For want of a battle, the kingdom was lost;
And all for the want of a horseshoe nail.*

**-- Attributed to Benjamin Franklin, Poor
Richard's Almanac of 1757**

force. However, with the major reductions in bed numbers in recent years, compounded by the closing of many hospitals, and coupled with the advent of just-in-time purchasing practices intended to lower operating costs, the healthcare system now finds itself unable to quickly identify sources and procure many different resources (people, supplies, food, drugs, etc.) in sufficient quantities needed for response to massive acute or even smaller, prolonged mass casualty events. It is very unlikely that current business practices, directed toward conserving resources, would be significantly changed in order to increase preparedness for what most hospitals consider a statistically unlikely event such as local terrorist actions or a Category 5 hurricane. One need only look at the examples set by hundreds of hospitals in close proximity to large airports, most of which are totally unprepared for the mass casualties that might be the product of a major airline accident. Thus it is apparent that a different, more effective planning, management and martialling process is required to minimize the impact of large scale “assaults” on thinly-stretched healthcare resources.

In the absence of essential real-time information about the potential demand for health services in relationship to resource availability and capacity, hospitals and healthcare systems represent a major weakness in the overall preparedness and defense of the community, and therefore the nation. As of February 14, 2006, nearly six months after Hurricane Katrina devastated the New Orleans area; the Louisiana Hospital Assn. still lists six acute care hospitals in Orleans Parish as “closed/evacuated” (LHA, 2006). Before Katrina, “Big Charity” Hospital alone handled 144,000 emergency visits annually and many now believe it will be torn down as a result of the damage sustained in Hurricanes Katrina and Rita (KFF, 2005). The practical implication is that the healthcare sector and its hospital systems will be required to create new types of information and information systems that essentially reduce the “cycle time” of ramping up for large scale emergencies.

Because of events like Hurricanes Katrina and Rita, and other devastating events, there is considerable and well-justified concern over the capacity of the hospital community and even the Federal Government to respond to the unexpected impact of large-scale traumas and/or contagious disease outbreaks and epidemics.

This concern has been documented in the press and is the topic of considerable debate in congress and among the national public health community. The Director of the CDC, Julie Gerberding, MD, has cautioned that the “weak link” in America’s response to something like SARS or H5N1 avian influenza is the inadequate capacity of hospitals to respond to

large-scale traumatic events and epidemics (Yee, 2003). In this sense, hospitals and regional healthcare systems need to develop mechanisms by which the surge of patients (including critically injured or deathly ill patients, the “walking wounded”, exposed but well individuals, “worried well”) are routed and tracked through the healthcare system in the event of a major

Federal Bioterrorism and Public Health Preparedness:

“While the experts clearly acknowledged that significant progress has been made in federal efforts since September 11, 2001, overall, the experts give the federal public health and bioterrorism preparedness performance a grade of D+.”

Source: Trust for America’s Health, 2005

Status of State Healthcare Emergency Preparedness:

- *Hospitals in nearly one-third of states and D.C. are not sufficiently prepared, through planning or coordination with local health agencies, to care for a surge of extra patients ...*
- *Hospitals in only two states have sufficient plans, incentives, or provisions to encourage healthcare workers to continue to come to work during a major infectious disease outbreak.*
- *Hospitals in nearly one-third of states lack sufficient capabilities to consistently and rapidly consult with infection control experts about possible or suspected disease outbreaks.*
- *Hospitals in nearly one-third of states have not sufficiently planned for prioritizing distribution of vaccines or antiviral medications to hospital workers.*
- *Hospitals in over 40 percent of states do not have sufficient backup supplies of medical equipment to meet surge capacity needs during a pandemic flu or other major infectious disease outbreak.*

Source: Trust for America’s Health, 2005.

catastrophic event. Barbera, et al. (2002) concluded that neither the medical nor the public health sectors are prepared and organized to adequately deal with mass casualty incidents. “Without prompt action, the nation carries the risk that victims of a mass casualty disaster might end up in ‘ambulances to nowhere’.” Nearly six months

after Hurricane Katrina made landfall, more than 2,000 persons are still officially listed as missing (Witt 2006).

Surge Capacity. Hospital surge capacity is a significant and critical concern in terms of healthcare planning, preparedness, response, and recovery in mass casualty situations and other public health events. Considerable thought is being applied to surge capacity at the international, national, state, regional, local, and hospital scales as well as within healthcare sector organizations.

*For want of a bed, a hospital was lost
For want of a hospital a community was lost
For want of a community a region was lost
For want of a region a Nation was lost.
... And all for the want of a hospital bed.*

-- Ric Skinner, "Healthcare Preparedness Infosphere", 2003

One of the Dept. of Health & Human Services' responsibilities is Hospital Preparedness, with Hospital Surge Capacity being a critical component. While this is not specifically mentioned in the National Response Plan (NRP, 2003) or the National Incident Management System it is clearly implied in Policy #15 of Homeland Security Presidential Directive 5 (HSPD-5, 2003):

"The Secretary shall develop, submit for review to the Homeland Security Council, and administer a National Incident Management System (NIMS). This system will provide a consistent nationwide approach for Federal, State, and local governments to work effectively and efficiently together to prepare for, respond to, and recover from domestic incidents, regardless of cause, size, or complexity. To provide for interoperability and compatibility among Federal, State, and local capabilities, the NIMS will include a core set of concepts, principles, terminology, and technologies covering the incident command system; multi-agency coordination systems; unified command; training; identification and management of resources (including systems for classifying types of resources); qualifications and certification; and the collection, tracking, and reporting of incident information and incident resources." (HSPD-5, 2005)

Furthermore, under the NRP interim implementation guidance, the Secretary's designation of primary federal agencies by functional area tasks the DHHS with infrastructure protection of the individual pieces and interconnecting systems that make up our nation's critical infrastructure. These activities are intended to improve "... public health and safety..." Also, DHHS's National Bioterrorism Hospital Preparedness Program Cooperative Agreement (US

DHHS, 2003) has been funding states that in turn fund local hospitals for development of Regional Surge Capacity.

Steps in the Right Direction

The Agency for Healthcare Research and Quality efforts to develop evidence-based information aimed at improving the quality of the U.S. health care system is a critical component of the larger initiative of the U.S. Department of Health and Human Services to develop public health programs to combat bioterrorism which easily can be conceived as supporting all-hazards response. Projects and activities comprising AHRQ's comprehensive bioterrorism preparedness portfolio are designed to assess and enhance the interface between the clinical care delivery system and public health infrastructure.

The HAvBED project, recently completed with funding from AHRQ, examined the effects of regional care models and their impact on resource allocation and capacity in the event of a bioterrorist event, as well as the effect of such an event on hospital and health care systems' costs, outcomes, and staffing. Characteristics of exportable models to regional, state, and local policymakers were identified (AHRQ 2005).

“The goal of HAvBED was to determine the feasibility of bringing together common data elements (and/or easily adapted data elements) from within each of these systems through an interface, after the specific useful data elements and their definitions were identified (including geographic information systems - GIS) and display formats were developed through collaborative input. “

Source: AHRQ 2005

HavBED (Hospital Available Beds for Emergencies and Disasters) is an information technology proof-of-concept project to demonstrate a standardized “real-time” hospital bed and resource availability information system that can be used by decision makers, planners and emergency personnel at the local, state, regional and federal levels.

The HAvBED prototype has demonstrated the feasibility and utility of a system that captures and integrates currently accessible bed availability data from disparate systems in use with hospital and healthcare organizations and across the country and coupling those data with data from organizations that do not currently participate in these systems to produce a large-scale picture of patient bed availability and hospital status across the country. These amalgamated data would be of assistance at a local, regional or national level in dispositioning patients from one

(or more) large-scale multi-casualty events from either natural causes or from the use of weapons of mass destruction.

Important recommendations from the HAvBED project are the basis for what is needed in a fully implemented interoperable, multi-scale hospital/healthcare information and decision support system. The system should be scalable so that it meets the needs of individual hospital and healthcare organizations as well as regional, state and National decision makers. Being able to link to existing hospital status and bed capacity reporting systems is considered a critical success factor in assuring system acceptability. Hospitals and organizations that don't have electronic reporting systems should be provided a means for manual data entry via web interface.

A single system that functions at the individual hospital level as well the National level, and at all scales in between is essential. The concepts and operation of the National system should remain simple and user friendly and incentives for hospital adoption should be

The strongest foundation for National healthcare planning, preparedness, response, and recovery is knowledge about every single hospital bed.

developed and implemented. A crisis information management system that is flexible and robust so that it could also be used for daily hospital operations (e.g., patient assignment, bed availability, asset tracking, equipment status, vehicle assignments, security status, etc.) should find wide acceptability. Additionally, a system that is useful to field personnel in their day-to-day operations is considered important.

Recognizing the lack of uniformity and standardization in terminology (e.g. bed definitions) the system should handle multiple categories and potentially provide for a “translator” so that data categorized according to one set of definitions can be imported into different categories according to another set of definitions.

Patient tracking is an important consideration during mass casualty events because

AHRQ Patient Bed Definitions:

- **Adult Intensive Care (ICU):**
- **Medical/Surgical:**
- **Burn or Burn ICU:**
- **Pediatric ICU:**
- **Pediatrics:**
- **Psychiatric:**
- **Negative Pressure/Isolation:**
- **Operating Rooms:**

Source: AHRQ website

NDMS Patient Bed Definitions

- **Medical /Surgical**
- **Critical Care-Pediatrics**
- **Critical Care-Adult**
- **Pediatrics**
- **Psychiatric**
- **Burn**

Source: AHRQ 2005

in the inevitable confusion and chaos families need to know where their loved ones are. Patient tracking is initiated by the First Responder tagging (e.g., barcode, RFID) a victim before dispatch to the appropriate care facility. One such patient tracking initiative is COMCARE's Integrated Patient Tracking Initiative (Briz, 2006) which is seeking to develop a national framework for the planning and implementation of Integrated Patient Tracking Systems. While mass casualty incidents are placing the spotlight on patient tracking, patient tracking can be improved each day during every emergency response. Complementary to a Patient Tracking system is a Patient Locator system for those victims who may not enter the healthcare system via First Responder route i.e., they may self-refer or be transported by a stranger. An application such as the Sarasota-Manatee County "real-time" homeless shelter capacity website (United Way 2-1-1, 2006) could be modified for hospital use so that victims could be registered in a secure HIPAA-compliant database when they enter the healthcare system.

The Medical and Health Incident Management (MaHIM) System (Barbera & Macintyre, 2002) is an all-hazards operational model for mass casualty response based upon medical, public health, and emergency management. The authors recognized that healthcare facilities have traditionally planned for and responded to emergencies as individual entities, not as part of a

"...the more networked the hospitals in a region are, the more resilient the healthcare system will be during a crisis -- even in the absence of new capital investments to build excess capacity."

Source: R. Hatchett, former Senior Medical Advisor to the Asst. Sec. for Public Health Emergency Preparedness pers. comm.

larger system. The report points out that preparedness for all-hazard mass casualty response is complex because medical infrastructure resides predominantly in many disparate resources in the private sector. Preparedness is further complicated by the fact that adequate surge capacity and

specialized resources may not be organized locally to achieve maximum effectiveness. They concluded that adequate mass casualty management and response require a "systems" approach that achieves rapid, efficient expansion of capacity through local and regional coordination. The authors use the term "region" to describe adjoining geographic areas within a state as well as the more complex situation of adjoining interstate jurisdictions. It is at these levels where realistic

planning should be focused, with recognition that planning, preparedness, response and recovery must start at the individual hospital bed.

Where to from Here?

It is probably safe to say that post 9/11/01, virtually all hospitals have some form of emergency management plan – some better and more detailed than others -- that addresses

Too often the emergency plan can be an “illusion of preparedness”
Source: Auf der Heide, 1989

patient and bed management during peak demands and surge due to mass casualty events. According to Auf de Heide (1989), disaster planning is an illusion unless it is based on valid assumptions about human behavior, incorporates an inter-organizational perspective, is tied to resources, and is known and accepted by the participants. A critical factor is the recognition that the plan must not assume anything, but rather be prepared for the unexpected (e.g., communications failures, transportation obstacles, compromise of facilities capabilities, etc.). The process of planning is more important than the written document that results (Auf de Heide 1989).

A typical element in hospital plans is diversion which occurs when the individual hospital’s resources are over-taxed and it cannot provide adequate patient healthcare. This situation can occur as a result of very localized situations, such as a major traffic accident in a rural hospital’s service area, or more widely occurring natural (e.g., weather) or human-caused disasters. A hospital system that tracks patients and requisite healthcare resources in real-time can support diversion decisions during “routine” daily hospital operations or at times of surge demands (Dinan, 2003).

Hospitals that have well developed patient/bed management systems that operate daily during non-peak or non-surge periods are in a much better position to provide critical information to the local incident management organization during unanticipated disaster surges.

Source: Dinan, 2003

“Community-wide perspective and community-wide planning is essential for readiness.”
Source: AHA, 2003

The American Hospital Association (AHA, 2003) provided an overview of the needs of the nation’s hospitals related to mass casualty events. AHA concluded that what is ultimately needed for both short and long-term disaster

response is an “operationally effective response system and the integration of hospitals into the community-wide response for mass casualty event.”

The Joint Commission on Accreditation of Healthcare Organizations (JCAHO, 2003) defines “surge capacity” as all encompassing of patient beds, available space (triage, management, vaccination, and decontamination), and personnel of all types, necessary medications, supplies and equipment. JCAHO considers surge capacity – “the ability to expand care capabilities in response to sudden or more prolonged demand” -- the most fundamental component of an emergency preparedness program.

JCAHO testified before the House Committee on Energy and Commerce’s Subcommittee on Oversight and Investigations during its “Review of Federal Bioterrorism Preparedness Programs from a Public Health Perspective” (O’Leary, 2001). O’Leary offered a series of recommendations for upgrading the healthcare system’s capabilities and for “weaving together a tighter response fabric among responsible parties.” He stated that this “fabric” should be a pattern recognizable to all those who comprise the “cloth”, because its essential elements will be comprised of effective coordination, communication, cooperation, chain of command, and capacity building.

“It is essential that a single, integrated system of response be created that will be effective in addressing a full range of diseases and rare events whether of terrorist or natural origins. Because it will serve multiple purposes, a single system is less likely to wither from inattention or nonuse. This system should be a blueprint for action that is also scalable to the extent of the emergency and to the settings that are involved. The framework should be community-wide and utilize common concepts so that it is transportable. For example, we should be reliant upon a consensus-based "chain of command" construct that has interoperability common to all states. This would make emergency management plans quickly and easily understood by all who are engaged in emergency activities. The system should be periodically tested and evaluated for its currency and feasibility.” (O’Leary 2001).

Linking hospitals in local, statewide and multi-state systems will enable healthcare surge capacity capability to adequately prepare for and respond to mass-casualty events and other regional public health emergencies -- a capability which does not currently exist. The system will be robust, yet flexible to handle the real-time capacity needs for mass casualty events and other

public health emergencies as well as the day-to-day operational aspects of patient management and efficient utilization of hospital resources. When fully developed and implemented the system will provide users with unparalleled situational awareness for carrying out their functional responsibilities during crisis or conflict, as well as during daily non-crisis “routine” hospital functions surrounding direct patient care and facilities operations. A key design consideration is the recognition that at every scale “location” of the asset or resource, patient or victim is a primary attribute.

Mass casualty and other public health emergencies create a demand for information within hospitals, between hospitals, between hospitals and local incident command centers, and between local, statewide and multi-state incident command centers and agencies. Because of the variety of communications systems utilized by the variety of critical components in preparing for and responding to these events, Interoperability, or the ability of different entities to communicate with each other on demand and in real time is a critical success factor in assuring how well hospital surge capacity can be planned for and responded to.

The U. S. General Accounting Office (GAO, 2003) recognizes the importance of a number of emerging information technologies that can be used to enhance the ability to prepare for and respond to public health emergencies. Geographic Information Systems (GIS) is one of the key technologies recognized by GAO. While GIS technology has been around for more than 35 years, it is rapidly becoming a core technology in hospital/healthcare applications, including disaster planning, preparedness, response and recovery. GIS represents a well-developed technology for capturing, storing, checking, integrating, manipulating, analyzing, and displaying data related to location, or geography, at any scale from hospital beds to multi-state regional healthcare facilities. GIS is being used by local, state, and federal agencies to support disease and outbreak surveillance. GIS can be used to track the spread of infection through a community, to identify geographic areas of particular health concern, and to identify high-risk populations. The resulting information can be used in support of surveillance systems to help identify geographic clustering of abnormal events as the data are collected. GIS has been used in cancer investigations, violence prevention, population estimation for disaster preparedness, and to support CDC’s anthrax investigation in 2001 (Zubieta, Skinner, and Dean, 2003).

Design Attributes for an Effective and Appropriate Solution

The system must be **interoperable** so that hospital subsystems (e.g., hospitals divisions such as clinical, pharmacy, blood bank, etc., health clinics, ambulance service, Visiting Nurse Association, security, food services, etc.), multiple hospitals, healthcare organizations, regional healthcare, state emergency operations center, national command centers will all be able to share critical information in one **integrated** “system of systems.”

The system must be **dual-use**. It should be used in routine situations as well as in all-hazards emergencies and disasters. The integrated system supports management and decisions during "routine" peak demands (e.g., flu season, summer increases in injuries), as well as local emergencies and disasters. The system deployed at the local hospital and community level also establishes critical information resources and communications infrastructures that will be used for planning, preparedness, response and recovery from large-scale disasters resulting from terrorism, all-hazards, and other public health mass casualty events.

The system must be **flexible** to handle and integrate similar data from various systems that use differing categories and definitions of the same data (e.g., AHRQ and NDMS bed categories).

The system must be **multi-scale** for it to function when needed and to the extent needed, providing management and decision support at the individual hospital, local region, statewide, or multi-state regional and national scales.

The system must be **“real-time”** for situational awareness, resource allocation, and decision support. The system must also be able to link hospital data systems with local community systems, which in turn communicate interoperably with statewide systems, which in turn communicate with a multi-state regional system, and ultimately with national systems. As frequently as hospital data systems are updated, the other databases are also updated. This assures that relatively current data is available up to, during, and following the trigger event.

The solution will be:

- *Interoperable and Integratable*
- *Dual-use*
- *Flexible*
- *Multi-scale*
- *“Real-time”*
- *HIPAA-compliant*
- *Spatio-temporal (i.e., GIS)*
- *Intra/Internet-based*
- *Robust*
- *Affordable*
- *Easy to Use and Customize*

The system must be **HIPAA-compliant** yet decision-supportive. Security provisions must be incorporated to prevent horizontal access to each hospital's data by other hospitals or others without expressed permissions, yet allow vertical access to the data by those charged with local/regional/national command and management.

The system must enable dynamic **spatio-temporal** analysis by having integrated Geographic Information Systems (GIS) technology which enables analysis of temporal and spatial patterns, relationships, trends, and simulation modeling of routine and surge situations and events.

The system must be capable of functioning in an **Internet** as well as **intranet** architecture. There are rich Internet resources (e.g., weather, traffic, satellite photos) that can support critical situational awareness and decision making, however the system must also be able to function to meet an organization's needs should access to the Internet be compromised or blocked.

The system must be **robust** with high integrity. Parallel and redundant links between subsystems provide capacity and capability for load sharing and gap resolution should one or more sub-system components become overloaded or overextended (i.e., bogged down).

The system must be **affordable** to the smallest as well as the largest hospital/healthcare organization.

The system must be **easy to customize and use** so that *the right information is available to the right people in the right format and at the right time.*

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About Baystate Health's Health Geographics Program, Springfield, MA

(www.baystatehealth.com/gis). Baystate's GIS Program was initiated in 1998, and is believed to be the only hospital with a full time GIS staff having "GIS" written into their job descriptions. The HGP was recipient of ESRI "Special Achievement in GIS" Award, 2002 ESRI International Users Conference, San Diego, CA. The HGP was recipient of ESRI "Vision" Award, 2004 ESRI International Health GIS Conference, Washington, DC. HGP Staff has over 70 combined years GIS experience in health, environment, spatial statistics, spatial epidemiology, hospital GIS, "hospital-land" security, emergency/disaster planning, preparedness, response & recovery, census demographics, ESRI GIS software. Specific project-level GIS staff experience includes clinical medicine, demographics, cancer, injury prevention, hospital facilities, non-hospital facility siting, healthcare marketing, and bioterrorism (NJ anthrax investigation), GIS and database application development.

Personnel:

Dr. Richard Wait, Chairman, Dept. of Surgery and Director of the Health Geographics Program. Dr. Richard Wait serves as Director of Baystate's Health Geographics Program. He is also Chairman of the Department of Surgery at Baystate Medical Center. He maintains a practice in surgical oncology and a career-long interest in basic science research which includes several national grants and numerous academic honors. A strong advocate for new technologies in medical education, he was instrumental in establishing the Health Geographics Program at Baystate. His current clinical research centers on breast cancer in minority populations and the use of GIS in injury prevention, cancer screening, and emergency preparedness and response. A member of numerous medical and scientific societies, he has authored more than 70 articles in scientific journals, and serves as editorial reviewer for several. He has been an invited speaker on GIS and Homeland Security and GIS in health education at several international conferences.

Ric Skinner, Sr. GIS Coordinator. Ric Skinner, Sr. GIS Coordinator, has over 30 years experience in environmental management & assessment and in applying GIS in environmental, health, and hospital related areas. Prior to coming to Baystate Medical Center, Ric was employed by large electric utility companies in Michigan and Pennsylvania, provided private GIS consulting services to hospitals and health information companies, and most recently was Research Scientist/GIS Coordinator for the New Jersey Dept. of Health & Senior Services, Cancer Epidemiology Services program. Ric provided GIS to the NJ West Nile Virus program and in 2001 primary GIS support to CDC in its anthrax investigation of the Hamilton (NJ) Mail Processing Facility. In his current employment with Baystate Medical Center, he is responsible for overall coordination of the Health Geographics Program staff and is working on GIS applications in the hospital setting, including patient/bed management and "hospital-land" security and emergency preparedness. He recently completed the Federal Emergency Management Agency's Integrated Emergency Management Course. He initiated the International Health Geographics Conference and co-chaired the first two conferences (Baltimore, Washington DC); co-authored the book "Geographic Information Systems Applications in Health"; served on the Editorial Board of the online International Journal of Health Geographics; and has authored or co-authored over 100 publications, presentations and reports in health

geographics and environmental assessment. Ric holds a B.A. and an M.S. in Biology. Ric can be contacted at ric.skinner@bhs.org.

Jane Garb, Spatial Epidemiologist/Biostatistician. Jane L. Garb, Spatial Epidemiologist/Biostatistician. Jane holds a Master's degree in Public Health in Epidemiology and a Certificate in Geographic Information Systems. Her current focus is on GIS applications in healthcare, particularly the relationship of social and demographic factors to health as well as the use of census data in estimation of affected populations in the event of a terrorism event. In addition to GIS, her previous work encompasses extensive research in cancer, cardiovascular and trauma epidemiology and she continues to provide ongoing education and support for surgical residents and faculty in research methodology and statistical analysis. Jane has published over fifty references in the medical literature (also under Jane McCall), including a book entitled: "Understanding Medical Research: A Practitioner's Guide." Jane can be contacted at jane.garb@bhs.org.

Chris Boyd, GIS Programmer/Application Developer. Chris Boyd, GIS Programmer/Developer, is primarily responsible for developing internal and external desktop, server-based and web-based GIS applications for the healthcare hospital setting. He is the principle developer for two vehicle route management applications involving a combined 40 vehicles, a disaster patient tracking application, and other applications utilizing hospital floor plan "smart maps" for internal asset management, as well as database development to support "hospital-land" security. Employed for 10 years as a Product Specialist by ESRI, Inc., he has extensive software development experience with the ArcGIS product suite. He was directly involved with developing tools and applications for the Arc/Info 7.x, ArcGIS 8.0 and ArcGIS 9.0 releases. He has comprehensive knowledge of ESRI software design concepts and functionality which is a particular asset to Baystate's GIS resources. Chris has strong expertise in designing and building interfaces, test suites, and geoprocessing functions. Chris is adept in various programming resources including Visual Basic, C++, ArcGIS component objects, ActiveX, XML dialogs and AML, and is a Microsoft Certified Professional. Chris has designed geodatabases and has written many technical documents. Prior to joining ESRI, Chris was employed for several years by IBM where he was responsible for analysis of systems test data, testing systems solutions development, and instruction in systems procedures. Chris holds a B.A in Psychology and M.A. in Geography. Chris can be reached at chris.boyd@bhs.org.