Information Needs and Decision Support in Health and Medical Disasters

Geoffrey Hoare PhD
Florida Department of Health
Geoff_Hoare@doh.state.fl.us

Jeffrey Nield
ESS Group
jnield@essgroup.com

Tom Belcuore
Florida Department of Health
Tom_Belcuore@doh.state.fl.us

Tom Rich
Abt Associates
tom_rich@abtassoc.com

ABSTRACT

During a disaster, health and medical decision makers need accurate, timely information. However, it is seldom readily available to the right decision makers, at the right time. Quite a number of databases currently exist with information about health and medical organizations which decision makers need during a disaster. Some of these databases have functions that facilitate decision-making and communication before, during and after a disaster. In theory, linking several existing databases will supply this information. Also, other functions can be provided in one package for incident management and monitoring of the preparedness capacity of a State's health and medical systems. But, this has not happened yet in Florida. This research assessed the different users needs, defined the information required to make good decisions and is testing a pilot decision support system of linked databases.

Keywords

information overload, health and medical, disaster management, decision support system, incident command system

INTRODUCTION

During a disaster, health and medical decision makers need accurate, timely information. However, it is seldom readily available to the right decision makers, at the right time. Quite a number of databases currently exist in Florida with information about health and medical organizations which decision makers need during a disaster. Some of these databases have functions that facilitate decision-making and communication before, during and after a disaster. In theory, several existing databases could be linked in order to supply this information. Also, other functions can be provided in one package for incident management and monitoring of the preparedness capacity of the State's health and medical systems. But, this has not happened yet.

Clearly this is not a new idea. Many are attacking this problem and much good work has been done. A number of these initiatives were reviewed in this pilot project. But the health care sector that ESF-8 supports during disasters is very large, complex and fragmented. It encompasses more than 10% of the economy. So clearly, more work can be done. A clearer understanding of the information system needs of health and medical decision makers during a disaster must begin with an analysis of the inter-related tasks and decisions they complete.

A Public Health Preparedness Decision Support System

This Pilot Project developed and evaluated a real-time, electronic health and medical decision support system that could enhance the county-level Health and Medical Emergency Support Function's (ESF-8) ability to maintain situational awareness of health and medical facilities, equipment and supplies. This system's design was based on an analysis of existing disaster decision support systems.

The scope of this project was the 13 county, NE Florida Regional Domestic Security Task Force, and more specifically, Alachua County's emergency response system health and medical emergency support function (ESF-8). The decision support system was designed to serve ESF-8, especially the Situation and Resource Units in the Planning Section, during an incident. During the next phase of this pilot project, we will explore integration across multiple counties and with the State Emergency Operations Center (SEOC).

THE DECISION MAKING TASKS AND INFORMATION NEEDS OF DISASTER RESPONSE

All steps in incident management decision making require information. Incident command staff use information about facilities and response assets to:

- assess the status of health sector organizations and response assets,
- create situation reports from multiple sources of information,
- formulate incident objectives for the incident action plan (IAP),
- supply different information to specific units,
- track the implementation of objectives and tie them to mission numbers.[1]

Usually, the better the information, the better the quality of the decisions made.

Ideally, status information is needed once every operations period to meet the demands of the planning, decision-making and briefing cycle in Figure 1. This planning cycle is described in more detail in the incident command system (ICS) literature.

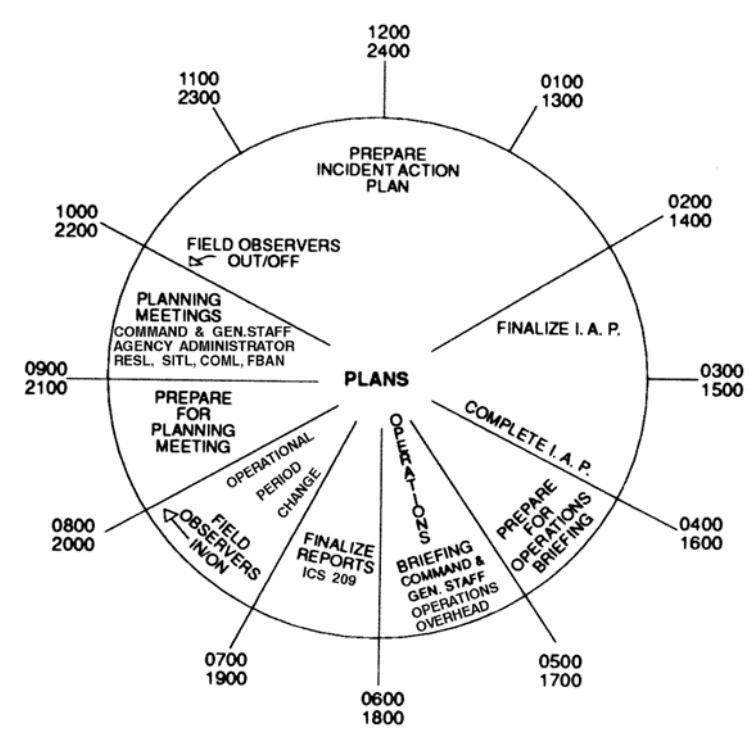

Figure 1: Operational Period Planning Cycle and Information Needs

Given the complexity of the health and medical sector which Emergency Support Function 8 is expected to support, the amount of information needed can quickly become overwhelming. For example, a metropolitan area of 2 million can have 35 hospitals, 600 nursing home and 100 dialysis centers. Better ways to access, store and communicate this information are needed. With a more integrated system the healthcare system's capacity and capability can be modeled. These models can filter out unimportant data to reduce the information processing demands on the decision maker. This is the job of the Situation and Resource Units in the Planning Section of the Incident Command System.

The Situation Unit

The Situation Unit's primary responsibility is to collect and report information to various ICS decision makers and responders. The Situation Unit could use field observers – Regional Emergency Response Advisors (RERAs), or subject matter experts (SME) –technical specialists like epidemiologists or industry associations' staff.

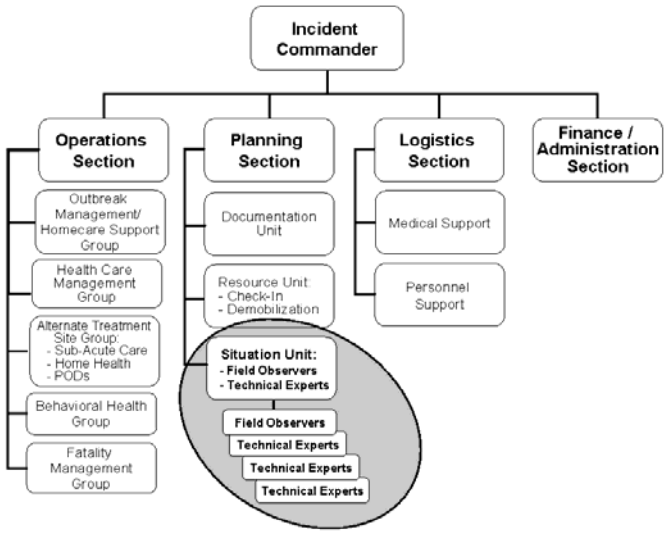

Figure 2: The Health/Medical Situation Unit in a Pandemic Incident Command System

The situation unit staff need to:

- **Access baseline inventories of health and medical resources:** (e.g. essential facility elements -- bed capacity, patient census, or infrastructure – transportation, water supply, equipment, food).
- **Report field observations and damage assessments:** During site visits, field observers and assessment teams gather status information about the location. Upon return to the command post, they need to enter data into the database.
- **Support mission assignments:** Responders would be given current information about impacted organizations from the database. These reports would describe specific facilities, including resource inventories and contact information.

Assessment and Reporting Processes

It is important to understand the workflow of this planning cycle to design a system that supplies the right information, at the right time, to different positions in the incident command structure.

Currently information is gathered and processed through:

- assessment forms – "DOH Critical Facilities Assessment Form,"
- spreadsheets,
- situation reports – ICS 209, 215 and 216 forms,
- conference calls,
- email,
- internet accessible notification and reporting services – Tracker, EMSystems, Emergency Status System (ESS) developed by the FL Agency for Health Care Administration (AHCA).[2]

Except for the web applications, the information storage and transmitting media, while robust, are low tech. For example, information on spreadsheets is easy for many to enter and read, but difficult to sort and display in a very sophisticated format. Also, it is more difficult to ensure the quality of the spreadsheet data than a database, as response personnel update it from a number of locations.

Further, given the sophistication of Florida's emergency management system, the information flows from an incident, to a county emergency operations center (CEOC) to the State Emergency Operations Center (SEOC) and back down again. An area command post or a multi-agency coordinating center may be stood up if regional situation assessment and/or response coordination is needed. There are generally upwards requests for resources and downward requests for the status of facilities and response missions, as diagrammed in Figure 3.

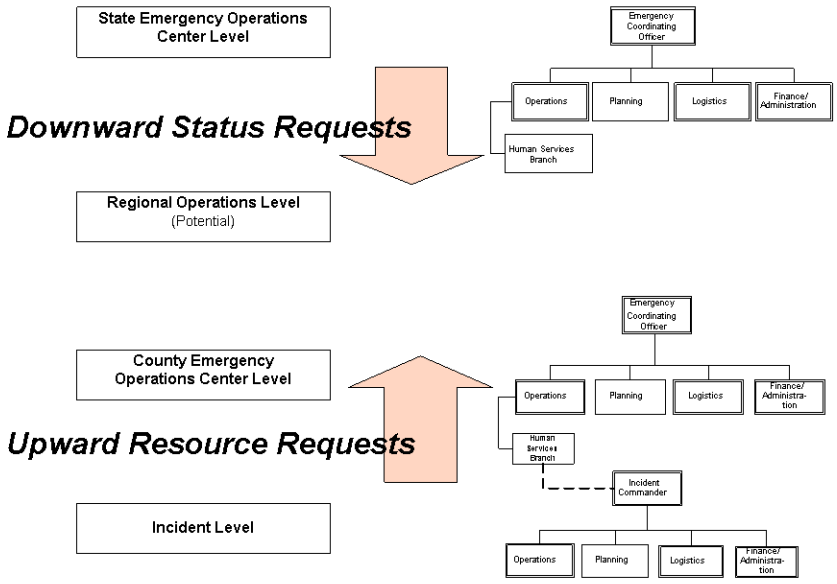

Figure 3: County and State Disaster Information Flow

So, the incident management team (IMT) and emergency operations centers' (EOC) staff need to generate and use information at multiple levels and locations – the incident, county, area command and state levels.

THE NEED FOR AN INTEGRATED DECISION SUPPORT SYSTEM

These information gathering and exchange arrangements are simple decision support systems (DSSs).[3] DSSs can be based on communication tools, documents, databases, models or any combination of these functions. A more robust DSS will enhance the information gathering, sorting and modeling needed to improve situational awareness.

Decision Support Systems Compared

A number of relevant decision support systems were assessed and compared. Two comparisons informed ongoing DSS development.

- First, the different functions performed with the various DSSs provided benchmarks for system improvements.
- Second, and probably more important, the actual data elements stored in each database were collated and compared. Besides suggesting what information is needed, this comprehensive Data Dictionary was developed to provide a starting point to coordinate data from these different legacy systems. With standard definitions, we could at least exchange accurate information. And, if it proves mutually advantageous, we could migrate to a common database that many response organizations could use.

Functionality

Our functional review was conducted, in most cases, by "test driving" each system. When we were unable to actually use the software, demonstrations and/or written descriptions of the software were obtained from the developers' websites.

All of the systems reviewed enhance emergency management with a similar variety of functions. However, based on what we considered the systems' "core" functions, we separated the DSSs into two categories – ***Asset Inventory and Tracking*** versus ***Incident Management***.[4] The systems listed under the Incident Management category were differentiated from the others because of functions catering to "live" incident management. For example, some could output queries to ICS forms, which the other systems do not do.

Several of the applications combine inventory and reporting functions designed specifically for medical facilities and emergency management agencies. Applications such as AIMS, EPRI, EMSystems, ESS, LiveProcess and SMARTT are designed to report resource status for hospitals, nursing homes and other facilities. In practice, health and medical facilities may utilize these applications from a local computer, connected to the internet. They can

enter status reports about facility condition, bed census or resource needs before and after an incident. This information can then be easily viewed by emergency managers at other locations. EMSystems is slightly specialized because it primarily serves the emergency medical system, to communicate emergency department status and surge capacity for mass casualty incidents. Otherwise, these DSSs perform similar core functions with variation resulting from different built-in features.

System functions were evaluated on a relative scale and assigned a score according to their performance. It is important to note that the score received is based on the version that was reviewed at the time of the study. Also, as is the case with any software solution, frequent software updates and the availability of extensions for applications, expand the functionality of a system. Our study did not consider hypothetical versions of the software even though we realized that many of the systems have available "add-ons" or modules that expand their functionality.

A Comprehensive Data Set

The most valuable contribution of this project to date is to compare the different data gathered in databases developed by different ESF-8 stakeholders. Clearly no one database used in Florida is comprehensive enough to store all of the information needed by ESF-8 in every type of disaster. This is understandable, given the complexity of a health and medical system that encompasses 7-10 percent of the economy. But a basic tenet of control systems is that they need to map and capture the complexity of the system they are trying to control.[5] A 30 page list of data elements captured in the databases listed above demonstrates the breadth of information a situation unit may need to process. The fact that no database included all of this information demonstrates the fragmented nature of the current system. It is important to note that although a comprehensive data set might be used in the decision support system being developed, it would not show all of that information to any one user. For example, those managing the recovery of the environmental health system would be interested in different information than those concerned about hospitals.

INTEGRATING ACROSS RESPONSE SYSTEM LEVELS

While it is often stated that "all disasters are local", the accumulating demands of local incidents are what strain county and state response systems to the breaking point. Clarifying the information needs of the different response organizations helped identify where an integrated decision support system could most effectively leverage performance improvements. Figure 4 illustrates how these organizations attempt to coordinate efforts from many local agencies to an integrated statewide response. In figure 4, each row of the diagrams represents a different component of the incident management system. Over time – pre-event through subsequent operational periods – there is interaction between these work environments as the situation is assessed, resource requests are made and response missions are assigned and tracked. Just querying the same database to create different reports relevant to different Situation Units – local, county EOC, area command or State EOC – would greatly speed up the decision making process. It would even be feasible for other states or Federal partners to access the information, without putting an additional burden on situation units or field assessment personnel. Further programming could automate mission tracking as needs are filled.

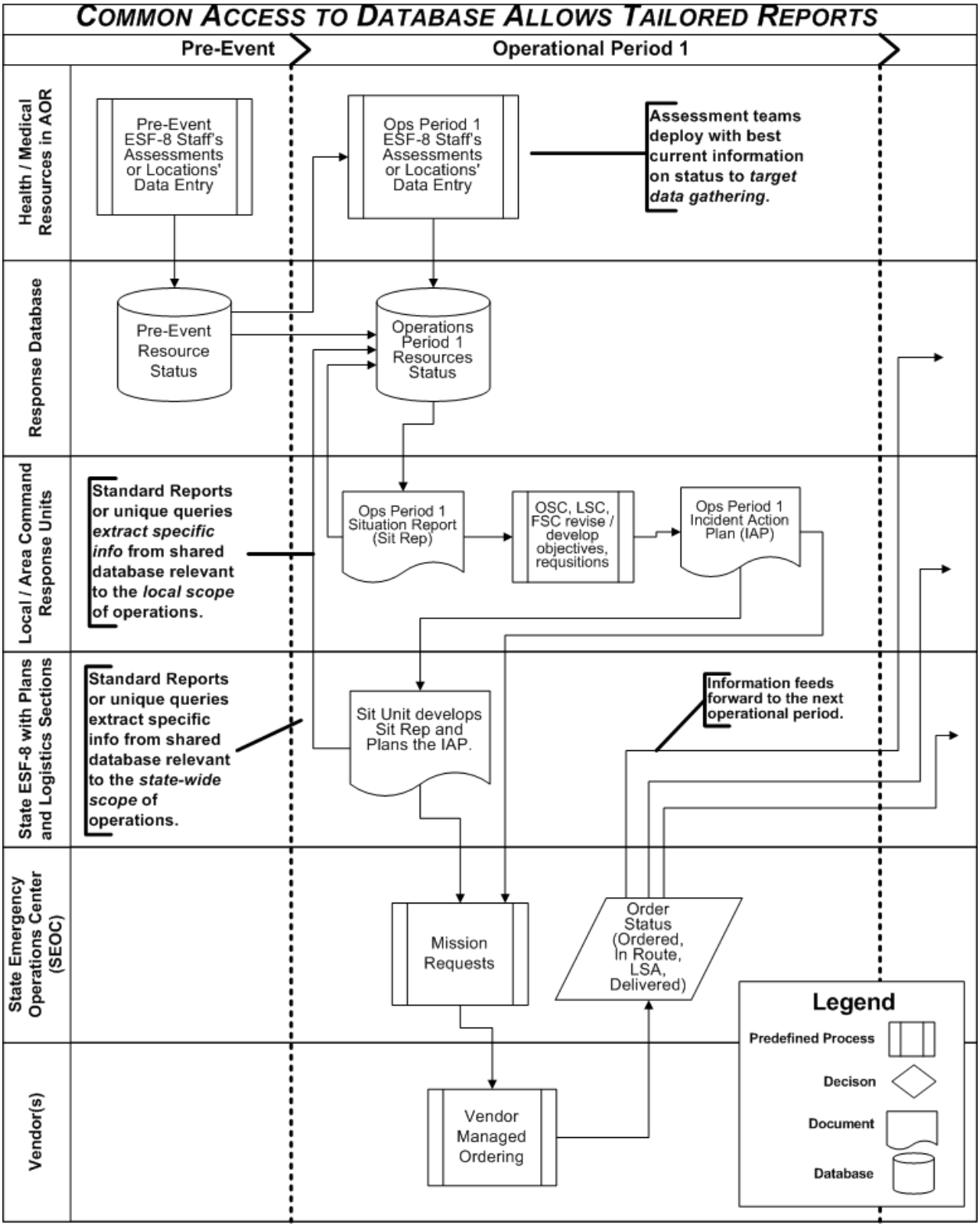

Figure 3: County and State Disaster Information Flow

THE PILOT DECISION SUPPORT SYSTEM

The Pilot DSS has a three-tiered architecture – user, process application, database. A web interface will provide access to multiple, pre-existing databases. The interoperability and translation between databases would occur behind the scene using interfaces with legacy databases. This interface would control exchanges with the various databases, especially if translation of data is required. This program would manage the data from other sources using a standardized Data Dictionary. A draft of this was assembled, as described above. The Pilot DSS using this model is illustrated in Figure 5.

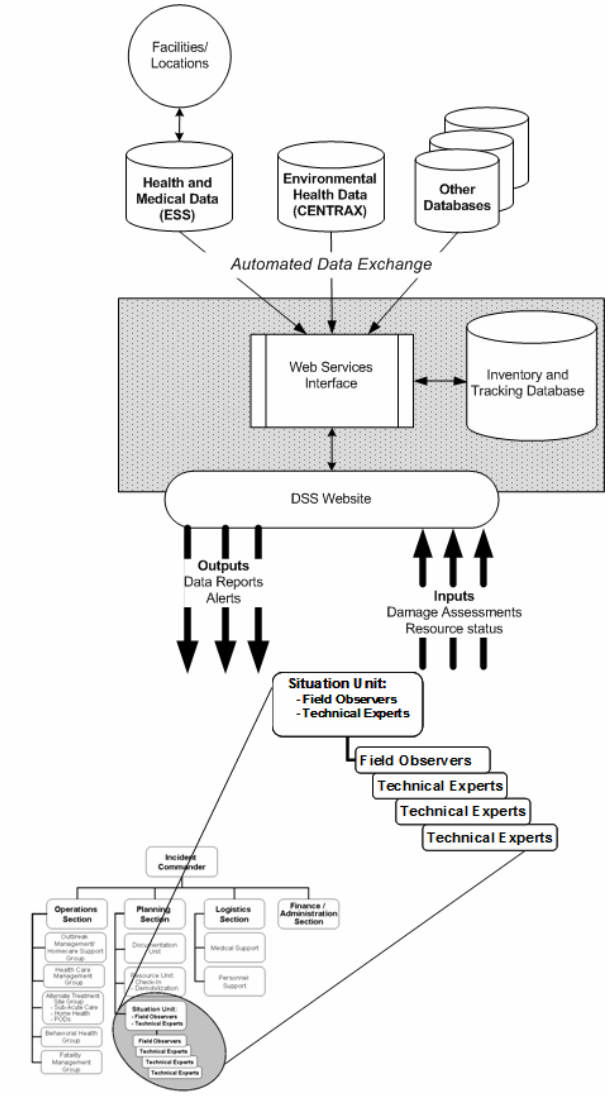

Figure 5: An Integrated System Architecture for the Alachua County Pilot

Demonstrating the Use of a DSS Pilot

The pilot DSS was built using a non-proprietary software package called, Emergency Preparedness Resource Inventory (EPRI).[6] EPRI consists of a web-enabled SQL database. Figure 6 gives and example of the kinds of data can be stored and searched about hospitals in the Region. This interface allows the information to be sorted in a number of ways. The web output of queries can be saved to a spreadsheet.

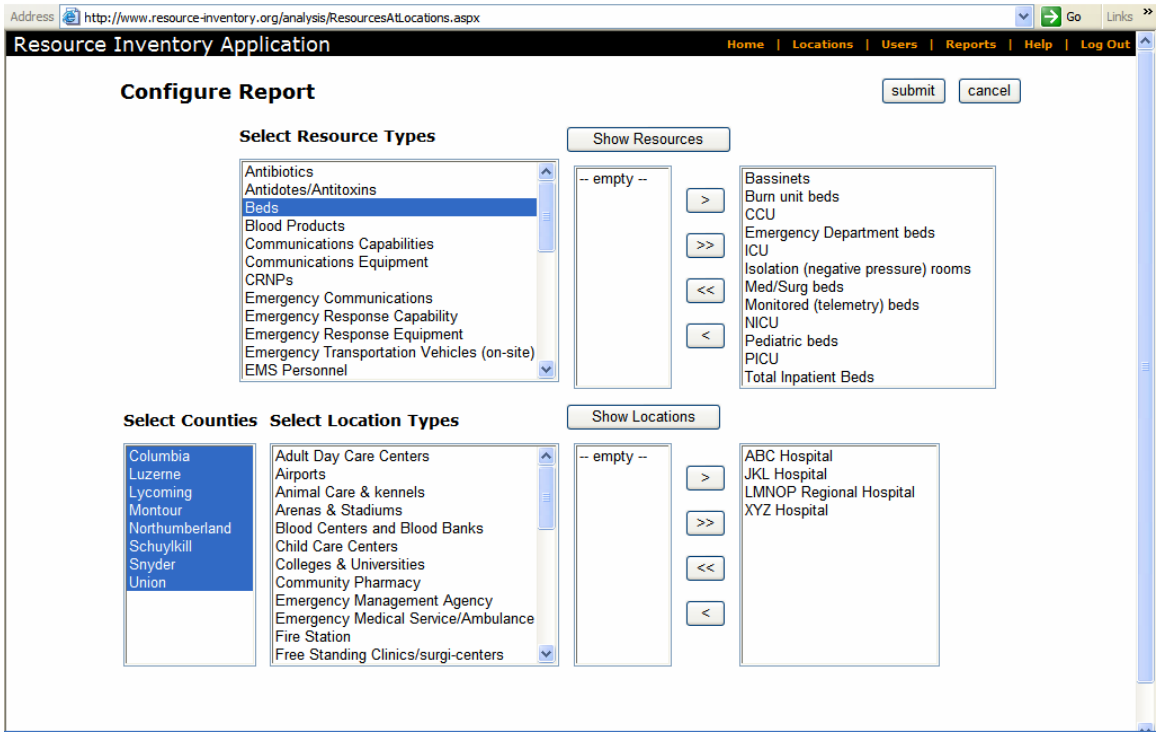

Figure 6: Example of EPRI Web-Based Reporting Interface

EPRI allows definition of new location and resource types if they were not included in the pre-existing database. ***Locations*** are defined by their ***location type*** (e.g. hospitals, clinics, nursing homes) and their unique descriptive information (e.g. address, contact information). ***Resources*** are defined by ***resource class*** (e.g. facilities/equipment, personnel, supplies, exists – yes/no) and ***resource types*** (e.g. beds, antibiotics, nurses, facility power supply) within these classes. The EPRI database was set up and customized to accommodate Region 3 data. Customization required manipulation of the database to reflect regional locations and resources associated with them. Further populating the database will require data loads from AHCA's ESS and FL DOH databases. These data transfers are still being developed. Phase 2 of the pilot will complete the automatic data transfer with these legacy systems.

PILOT PROJECT RESULTS

The pilot project allowed us to document a number of issues – training, human factors, IT support requirements, equipment and personnel costs and security associated with developing and implementing an integrated DSS. These are summarized in Table 1 below and more extensively in the complete report. The EPRI software proved to be a useful application to pilot the DSS although it was determined that the current version of the application has limitations.[7] Based on an extensive review of other similar decision support systems mentioned above, a number of functions to design into the production system will be detailed in Phase 2 of this project.

Design Area	Issues
Training	Significant training of project personnel, who are planners, was needed to understand the, sometimes arcane, process of information system design and prototyping.
Human Factors	It was hard to get responders used to one mode of information gathering/reporting to try out a new system that wasn't completely designed and implemented. Loyalties to legacy systems impeded experimentation.
Prototyping Difficulties	A related problem involved the need to develop and test different components of the system before the whole system could demonstrate its value. For example, you couldn't develop a dashboard-like capacity measure, if you didn't already have consistent, comparable numerator and denominator data.
IT Support	The requirements for installing and maintaining a SQL database with web interface software strained the capabilities of a mid sized public health department. Support staff costs were underestimated in Phase One.
Equipment Costs	While modest, equipment costs were significant.
Security	While the database had sufficient security features, it triggered enterprise IT governance scrutiny, which added cost and significant development delays.
EPRI Limitations	EPRI's structure limited the level of detailed information that could be used to describe different resources. Making changes to the database were beyond the capabilities of the IT staff.

Table 1: Pilot Project Issues

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[1] Florida uses a statewide incident tracking system that allows decision makers to request resources. These are then assigned a mission number to track their deployment and reimbursement.

[2] Information about these different systems is available in the complete project report.

[3] "An interactive computer-based system intended to help decision makers use communications technologies, data, documents, knowledge and/or models to identify and solve problems, complete decision process tasks and make decisions." Dan Power, Decision Support System Resources at DSSResource.com, accessed 11/12/06.

[4] Comparison information is available in the complete project report.

[5] This is Ross Ashby's "law of requisite variety".

[6] EPRI is available to the public at no cost through AHRQ (http://www.ahrq.gov/research/epri/). AHRQ worked with a team of consultants and hospitals to develop EPRI to assist public health planners and medical care managers with management of a bioterrorism attack. The AHRQ project chose an area in Pennsylvania to pilot and test the first version of EPRI (Hassol *et al*, 2005).

[7] Throughout this study, we have been in contact with AHRQ and Abt Associates to keep them abreast of our efforts. A list of improvements to EPRI was sent to Abt during this project to use in the revised version...