A Multi-State Needs Assessment Consultation with State and Local Health Officials Concerning Use of Computer Modeling for Preparedness Activities

Executive Summary

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EXECUTIVE SUMMARY

I. Project Narrative

In August of 2007, the Centers for Disease Control and Prevention (CDC) approached the National Network of Public Health Institutes (NNPHI) to collaborate to conduct a rapid needs assessment that would gather information from state and local health officials regarding their needs and interests related to preparedness modeling. This information would help the newly developed CDC *Preparedness Modeling Unit* support health protection policy-making at the state/local level. NNPHI and its members have a proven track record of producing high-quality work and leveraging the power of their network to coordinate studies and policy initiatives of national interest that span multiple regions of the country. Public health institutes work closely with governmental public health agencies at state and local levels, private businesses, academia, and community organizations. The network also maintains strong relationships with national public health organizations such as the Association of State and Territorial Health Officials (ASTHO), the National Association of County and City Health Officials (NACCHO) and the American Public Health Association (APHA). In addition, several NNPHI members had considerable expertise in the particular substantive area of emergency preparedness and response. The institutes selected for participation in this project sought to provide an "on the ground", local understanding of the needs and use of policy preparedness modeling as well as gain valuable insights from experts in the field. The results of the assessment were intended to better inform the CDC when establishing the priorities for its new preparedness modeling investments. Opportunities exist for the NNPHI and its member institutions to continue to provide input to the *Preparedness Modeling Unit* and CDC involving response function and threat- specific computer modeling needs of local and state health officials from across the country.

The CDC, in collaboration with the NNPHI, engaged three institutes to conduct a series of focused consultations with a select sample of city, county and state health officials to determine their familiarity and utilization of formal, mathematical computer modeling tools for emergency preparedness activities associated with three specific threats: pandemic influenza; radiological release; and a series of severe heat waves. A needs assessment tool was created and was guided by the following key questions:

1. Are state and local health officials familiar with mathematical or other forms of preparedness modeling? What types of preparedness models are they familiar with?
2. Do state and local health officials use these tools in their regular practice? If so, how? If not, what are the opportunities to introduce, expand or enhance the use of preparedness modeling in local public health practice?
3. Have state and local health officials used models to influence health protection policy-making in their states?
4. If CDC were to provide assistance to state and local health officials in the use and development of preparedness modeling, what activities would be most helpful?

In order to accomplish this task, the NNPHI engaged the Florida Public Health Institute (FPHI) as the lead institute, with Michigan Public Health Institute (MPHI) and the Community Health Institute of New Hampshire (CHI) as supporting institutes, in order to:

- Create a rapid needs assessment tool
- Identify, recruit and carry out structured consultations using the tool with local and state officials at health departments and offices of emergency management
- Meet directly with health officials, or, when not possible to meet in-person, to perform telephone consultations
- Collect qualitative and quantitative data regarding use of computer modeling for preparedness activities associated with the three threats, with emphasis before, during and after the event or emergency
- Create a PowerPoint presentation, providing background information defining computer modeling and offering examples as applied to preparedness activities, to be used prior to each consultation
- Analyze and sort the data using techniques to quantify outcomes and demonstrate repeated themes from qualitative data
- Report findings to the NNPHI and to the CDC, and to provide guidance to the newly formed *Preparedness Modeling Unit* at the CDC, and prepare a manuscript for publication in journals and provide presentations at professional meetings

II. Introduction

Public health emergency preparedness has been defined as "the capability of the public health and health care systems, communities, and individuals, to prevent, protect against, quickly respond to, and recover from health emergencies, particularly those whose scale, timing, or unpredictability threatens to overwhelm routine capabilities." (Lurie, Nelson, Wasserman, Zakowski, APHA, 2007).

Since September 11, 2001, there has been substantial investment made to improve the nation's public health system's capacity to prevent, prepare and respond to natural and man-made emergencies and disasters. Simultaneously, there has been an expansion of information technology and use of computers to assist in this process. In 2006, at the request of the Department of Health and Human Services (DHHS) Assistant Secretary for Health, CDC strengthened its support of mathematical modeling to enhance public health preparedness and laid the foundation for the *Preparedness Modeling Unit*. According to the most recent CDC Preparedness Initiative report (January 2008), this Unit will "provide CDC staff and stakeholders with information about modeling options, scenario-based analysis, and policy guidance across a range of potential threat situations." The recruitment for a Director and staff for this Unit at CDC is well underway.

The CDC convened a workshop of 50 stakeholders in February 2007 to engage in dialogue concerning preparedness modeling efforts and further define CDC's role in the field. An outcome of this workshop was the decision to perform a study to better understand the needs and interests of health officials at the local and state level with regards to their use of formal modeling for health protection policy making decisions and provide such information to the new director of the unit.

Computer modeling as a tool for public health preparedness planning will improve health protection efforts before, during, and after an event by using modeling methods to:

- Reveal options
- Anticipate likely outcomes
- Support policy decisions

For the purposes of this study, modeling was defined as: a formal, quantitative representation of a real-world phenomenon that allows users to do one or more of the following:

- Define problems and negotiate boundaries around a system of interest
- Better understand changes within the system over time
- Anticipate the likely consequences of particular conditions
- Estimate the relative leverage of and trade-offs associated with different action scenarios

Disease transmission modeling had been first used by Daniel Bernouli in 1760 to characterize smallpox (Lipkowitz). He offered the first mathematical formulas of the propagation of the disease and made the case for universal inoculation. Infectious disease modeling has been used to study epidemics and to design treatment and control measures. The Rutgers University Center for Discrete Mathematics and Theoretical Computer Science (DIMACS) held a Working Group on Predictive Methodologies for Infectious Disease in 2005-2006 under the auspices of the Special Focus on Computational and Mathematical Epidemiology. They noted that disease transmission models have evolved to be used as predictive models by borrowing from other fields, as in the use of Monte Carlo sampling from the field of risk assessment and by linking with analytical approaches (Blower and Dowlatabadi- HIV model and Ferguson, Donnelly and Anderson- Foot and Mouth epidemic). The Working Group noted that "in order for the study of infectious diseases to become a predictive science two things are needed: 1) new prediction methodologies need to be developed or borrowed from other fields, and 2) more time and effort needs to be spent on model validation (i.e., the transmission models need to be tightly tied to data). The newer predictive computer models allow for the analysis of the impact of potential medical and public health interventions and strategies in the abstract prior to an event or outbreak. "

Modeling preparedness activities involving an influenza pandemic contain two major parts: disease transmissibility modeling and response modeling including mass vaccination clinics and Points of Distribution (PODS) for disseminating anti-virals and/or other medications. The majority of computer models for pandemic influenza examine two key factors—diagnosing the first case (identifying the index case as soon as possible) and slowing the rates of transmission by reducing social contact and limiting personal interactions whenever possible (in the workplace, schools and in the community). The influenza preparedness computer models in this study were primarily the CDC models FluAid 2.0 and FluSurge 2.0, and the transmissibility models by the MIDAS researchers. MIDAS is an acronym for Models of Infectious Disease Agent Study and is funded by the National Institute of General Medical Sciences of the National Institute of Health. In terms of preparedness modeling involving response planning, the most often cited was the Weill Medical College of Cornell model, created by researchers under contract to the United States Department of Health and Human Services, Agency for Healthcare Research and Quality, entitled the Bioterrorism and Epidemic Outbreak Response Model (BERM**)**, a capacity planning model. Another computer modeling application for evaluating a POD plan was developed by the Montgomery County Advanced Practice Center in partnership with the Institute for Systems Research at the University of Maryland and is called the Clinic Planning Model Generator (CPMG). The CPMG was built on data from a smallpox exercise and other biological POD exercises. Additionally computer modeling has been used in creating tabletop exercises for preparedness training and response. (Aaby, Abbey, et al)

III. Methodology

The FPHI, in collaboration with the MPHI and the CHI, created a needs assessment consultation tool designed to elicit quantitative and qualitative data from city, county and state health officials regarding their familiarity with and use of modeling for preparedness activities involving three threats:

- Pandemic influenza
- Radiological release in an urban setting
- Series of severe heat waves

The assessment consultation tool (attached at the end of this report) totals 35 main or topic questions (75 questions coded for analysis) and is divided into 5 sections:

1. Descriptive information- defining and describing the agency by number of employees, geography or setting and population size served, parameters of responsibility, etc;
2. Threat-specific probes- asking if the participant uses models for preparedness activities before, during or after the three threat-specific events, and if so what models, and if not, why. Other questions were designed to learn about the challenges and obstacles to using preparedness modeling for the specific threat;
3. Creating and sustaining partnerships- health department and emergency operations officials' community partners and their current use of preparedness modeling as well as future opportunities;
4. Training- level of proficiency and opportunities for future use of computer modeling for threat events and for hazard response functions; and
5. Future directions for the CDC to consider to promote preparedness modeling initiatives.

Respondents were invited to participate by email. Appointments were confirmed by telephone and subsequently by email. A consent form was read before all consultations and responses were kept confidential, not linking the reply with any specific official. Individual consultations lasted approximately one hour, including orientation and discussion, and were tape recorded for data collection and analysis purposes. There were some meetings with two or three health officials being consulted simultaneously. The CHI used one multi-hour intense focus group to elicit the responses from six respondents.

The three institutes developed a PowerPoint presentation defining and describing modeling, specifically regarding its application to public health issues and preparedness related activities. The PowerPoint was presented to each participant prior to in-person or telephone consultations, thereby providing a context for defining the topic and facilitating a common basic level of understanding regarding dynamic computer and formal modeling for public health. For telephone consultations, the assessment tool and PowerPoint presentation were emailed to the respondent in advance of the scheduled meeting.

A. Sampling

Participants were recruited based on their positions in a health department or office of emergency management. Experts in epidemiology, environmental health, and emergency preparedness at local and state levels were identified and contacted. Particular attention was given to recruit participants that have had considerable experience in the field, have direct responsibility for emergency preparedness functions, participate in training and drills or have other skills that would add to the diversity and richness of the data. NACCHO, ASTHO and CSTE (Council of State and Territorial Epidemiologists) were contacted for suggested participants for inclusion in the study. In addition to health officials and emergency management professionals, several modeling experts were included in the sample. These included: a university professor and chairman of the engineering department and a modeling expert; a university dean responsible for education and training of public health and allied health professionals; and a director of disaster services for an area medical society and hospital consortium.

This study used ***purposive sampling*** to identify participants in order to maximize information (Lincoln & Guba, 1985). By using purposive sampling, this "increases the scope or range of data as well as the likelihood that multiple realities will be uncovered." (Lincoln & Guba 1985). The choice of purposive sampling was made in order to reach a targeted sample quickly and where sampling for proportionality was not of concern. The interviewers selected the most prominent and articulate sample of leading local and state health officials to serve as a rich resource for structured interviews or consultations.

B. Data Collection

The three participating institutes conducted a total of forty (40) consultations during a six-week period from October 15 to November 30, 2007 as follows:

- Twenty-nine were conducted by the FPHI
- Six by the CHI
- Five by the MPHI

Of the 40 consultations, 63% (25) were conducted in-person and 37% (15) were conducted via telephone. There were 22 consultations or 55% conducted as one-on-one, three with two persons (5% each), two with three persons (7.5% each), and one consultation that was a six person focus group (15% of the total sample). During the consultations in which more than one individual was interviewed at a time, the interviewers found that the group dynamics served to elicit *more* information and the interaction led to additional prompting and richer responses. In the consultations that involved two or three persons simultaneously, in all cases, they were co-workers and the questioning served to remind each other of certain models or activities and therefore served to reinforce their remarks.

C. Data Analysis

The assessment results were analyzed using the *SurveyMonkey* on-line program which allowed for quantification of numerical data and the display of qualitative responses. Basic response frequencies were established for each question, and then sorted by a variety of criteria for additional in-depth analyses. Each individual in the multi-person consultations and the focus group were considered an individual respondent for the analysis. The open ended data was transcribed into the *SurveyMonkey* program and was available for analysis of common and repeated themes.

Summary Characteristics of Participants

	Local health official	State health official	Local EM*	State EM*	Other	Total
Florida	4	7	2	1	3	17
Michigan	1	3		1		5
Missouri	2		1			3
New Hampshire	2	3		1		6
New York	3		1			4
Texas	2					2
Utah		2				2
Washington**	1					1
TOTAL	15	15	4	3	3	**40**

* EM= emergency management ** Washington state

D. Local and State Health Departments

There were equal numbers of participating health officials from local health departments (cities or counties) and from state health departments (15 each). The roles for the local and state departments with respect to preparedness planning are different and thus it was important to include representation from both levels.

For all categories, the health officials included in this needs assessment were either division or department directors and have had considerable and lengthy experience in their positions.

E. Health Department, Emergency Management and Other

There were seven emergency management officials consulted and approximately half were from the local level and half were from the state level. In addition, two academic professors and a community leader proficient in use of modeling for health preparedness and response scenarios were included in the sample. Several business leaders and modeling experts were interviewed but their experience and responsibilities did not meet the criteria for this study and their responses were not included.

The emergency management officials, also seasoned in their job experience, were considered important to include, as in many cases, emergency managers are uniquely qualified and responsible for radiological releases and for weather-related events (heat, cold, storm, flooding, etc) and thus knowledgeable about modeling and preparedness activities.

F. Population Density

Representing a mix of urban and rural communities, participants were responsible for providing preparedness and response plans for a wide range of populations. New Hampshire had the smallest community, serving 88,000 people. The largest city included the health department and emergency management agency for New York City, serving five boroughs and 8.2 million people. The average local county health department was approximately 1.5 million people. The following tables summarize the populations of the areas served by study participants.

Populations of Study Areas

State Health Departments	**Population**
New Hampshire	1.3 million
Utah	2.5 million
Michigan	10.2 million
Florida	18 million
Local Health Departments	**Population**
New Hampshire-city	88,000
New Hampshire-city	110,000
Florida - rural counties-regional	122,000; 150,000; 270,000
Michigan - city	871,000
Missouri - county	1 million
Florida - county	1.3 million
Florida -county	1.5 million
Texas - county	1.6 million
Florida - county	1.8 million
Washington - county	1.8 million
Florida - city/county	2.4 million
Texas - city/county	2.4 million
New York - city/boroughs	8.2 million

IV. Key Findings

All participants were familiar with modeling for preparedness activities (100% indicated that they are familiar with models for preparedness functions). When probed, the models most recalled were in three categories:

- Natural disasters-hurricane, flood, earthquake models
- Disease transmission and syndromic surveillance models and
- Technological or terrorism-related models (chemical or radiological release plume models)

Overall, respondents mentioned familiarity with a broad range of models, protocols, and strategies using a diverse range of terminology. Effort was taken to determine the extent to which the terms they used were duplicative. There appears to be a need to utilize and promote a common glossary of terminology with respect to modeling.

Factors influencing the use of models:

Regarding each type of threat (pandemic flu, radiological release, and heat waves), each participant was asked, "What factors influence your use of models?" In response to this question, participants mentioned variations of two main factors - the **quality** of the models and the **applicability** of the models - and themes related to those factors as follows:

The quality of models and the ability of staff to use them

- Validity- of the assumptions used to create the model
- Reliability- confidence that the model is tested
- Authorship or source- a critical analysis of the source
- Accessibility- ability to download the model software
- Scalability- relevant to their unique location and population
- Relevance- current with mandates from state or federal planning initiatives
- Capacity- having qualified and trained staff to run the models

Below are some direct quotes from participating health officials:

"Accuracy and proven validity. Interested in evidence-based practices. Most interested in use of models in parallel applications. Must show proof by others of accuracy and then will consider their use."
Local health department official, medium population density (1.0–1.7million)

"(It is) challenging to find models that are considered proven and reliable and have impact on prevention and preparedness action steps. Models need to be disseminated to the local health

department by credible sources—the CDC, HHS and state health department…. We are also interested in models that are useful for the vulnerable populations- especially the elderly, chronically ill and homebound."
Local health department official, medium population density (1.0 -1.7 million)

"Availability and operational in nature, if they know there are models from reputable centers that have action plans associated with them, they will use the models."
Local health department official, medium population density (1.0-1.7 million)

"(I am) most influenced by who developed the model (authors of the model) and what was the objective when the model was developed. The other factor is if the model can be made adaptable to my field and area and interests."
State health department official, Environmental Health

"If the CDC or WHO are suggesting a model and promoting the outcome or action, then they would seriously consider this a valid and tested model. If not sure of the authors, then they are less likely to use the model or believe its recommendations."
State health department, Epidemiology

"Not every model can be applied at the sub-state level. It would be helpful to know what other models might be out there that can help with that. The overarching need is for different and scalable models that can be overlaid."
State health department official

Applicability to specific hazards, circumstances and populations

- Models for specific hazards (i.e., hurricane, flooding)
- All-hazard models
- Response function models- regardless of the hazard (i.e., evacuation)
- Political circumstances- models useful to convince political and elected leaders when to institute public health interventions
- Population characteristics- behavioral characteristics, vulnerable populations, population density, population mobility, elderly living "independently" or in nursing homes, language and cultural barriers.

Although the models mentioned were discreet, and the three threats that were the focus of this needs assessment were different in cause, scope and duration, the responses overlapped and had some repeated themes. Participants said they look to models as "tools" and they are looking for models to help support and guide policy decisions.

They were emphatic about using modeling, with a variety of other factors, including past experience, to make significant health protection decisions.

- State health officials considered having ***access*** to the models very important. Those with responsibility for making policy decisions wanted to be able to view all assumptions and have the ability to potentially adjust these boundaries for their area. Local health officials wanted ***access*** to the models to be able to download and input local population and source-specific data.

- ***Awareness***- additional efforts should be considered for disseminating and communicating with health officials regarding the availability, utilization, and potential benefits of modeling for emergency preparedness activities.

- ***Mandates***- another repeated theme was to have models mandated by the federal government for use by state health officials and then subsequently by local health departments. This would assure uniformity in preparedness planning.

    - A State health officer said that he/she expects the *"federal policy makers will dictate models and tools for states to use in their promulgated planning assumptions."*
    - A local health department director commented *"if models were disseminated by the state health department, all county health departments would adopt the same underlying guidelines for planning."*
    - The local health departments are directly responsible for preparedness planning and there is inherent variability due to variations for local settings. The use of models, especially if mandated by the state official, and simultaneously used by contiguous local departments could provide additional planning benefits

- ***All Hazard***- the health authorities were interested in models that support an all-hazard approach to preparedness and response activities.

- ***Opportunities*** exist to greater coordinate the understanding of the public health threats, as well as to document alternative solutions and strategies with city, county and state health and emergency management officials. Ways to share ***Best Practices***, both of knowledge and use of models, would be beneficial.

- ***Variability***-there is great variability in use of modeling and in the development of strategies at the local (county) level. There appears to be little cross-referencing or sharing between officials at the local level. States are responsible for general oversight and providing statewide guidelines and do not routinely promote sharing of planning initiatives.

- To assess whether there was a difference in practice between large and small communities, the data was sorted **by *population size*** served by local agencies. The categories were divided into small (population under 1 million), medium (population between 1 million and 1.7 million) and large (1.8 million people and greater).

    - Those in the small population density category most often cited geographic and demographic variables as influencing their use of models. They were more likely to cite the CDC FluAid and BERM POD as the models they used in planning. These health officials had received some training in models and are interested in all-hazard model training and use. For certain events needing sophisticated models, they assume the state will send in resources.
    - The medium sized city and county health officials reported model accuracy, validity and operational use as most important factors influencing their use. The challenges were related to accessibility of the models, trained staff, and adjusting models to meet their specific needs. These health officials had some training with models and were interested in modeling for natural disasters.
    - The large sized city, county and state health officials reported use of more sophisticated disease transmission models (MIDAS) and were interested in being able to make alterations to the models to serve their needs.

- ***Vulnerable and special populations***- health officials and emergency managers are interested in the use of modeling to assist in planning for the needs of vulnerable populations at times of emergency and disaster. Most often cited were the elderly, the disadvantaged, those with cultural and language barriers, and those living in nursing homes. The issues mentioned involve primarily communication (warning and alerts) and hazard response functions (evacuation, sheltering, quarantine, etc.).

- ***Political ramifications-*** health officials are looking to models to assist with the ability to convince local leaders to enact containment measures and other strategies at time of infectious disease spread. Local health agencies have to work with various authorities within their county, specifically multiple independent school boards and elected officials, and the use of models could help convince those responsible to "buy in" and support difficult public health measures.

- ***Long range effects-*** the environmental health officials were concerned that the models take into account the long range ramifications of present response actions. Also mentioned were the effects of global warming on the environment and health and the benefits of modeling for these issues.

- ***Future assistance***- Local and state health officials are anticipating CDC: to 1) create models to improve preparedness, 2) adapt models to make them more user-friendly and scalable to their area, and 3) translate models into actionable steps.

Challenges or Obstacles to Using Modeling for Preparedness Activities:
The most commonly repeated challenges or obstacles to using formal modeling for preparedness activities include:

- Not aware of existing models

- Inadequate training of staff and lack of time to advance understanding and skills associated with proper use and interpretation of the model. A county health official said "*One of the main reasons why I do not use models is because I do not have the staff, time or expertise to use the models- since these models do not allow us to change the assumptions. If CDC could make models easier by allowing us to put in our own variables, I think my staff will be more encouraged to use them."*

- Lack of funding to train staff.

- Scalability- relevance (both to small communities and to large urban areas)

- Limited utility- a city health official commented, "*the actual response is affected by political necessity. If the model says, if you don't do "X" in the first week, you are probably increasing your probability of "Y", what are the political ramifications of not being able to do "X"? For example, if a model recommends school closures at 1% infection rate, then how does that translate to a community in which it is typical to have 5% of the high school population out sick on any given day, without knowing the causes of the absences?"*

V. Conclusions

This multi-state sample of accomplished and experienced health officers from city, county, and state agencies strongly support the use of computer modeling as a tool for emergency and public health preparedness activities. These professionals have an enormous responsibility to promote and protect the health and safety of its residents, and are seeking new tools to achieve these goals. However, because of the high stakes, they have certain criteria that they want met in order to adopt strategies based on theoretical mathematical models. The validity, reliability, source, accessibility, and scalability were considered key factors in the use of models. Awareness, cost, staffing, and training were some repeated obstacles to use.

Health officials are looking towards the mandate of credible and "valid" models, with the ability to input and make adjustments at the local level. Emergency management officials are interested in models that have suggested action plans associated with them. They cited the hurricane models (SLOSH and HAZUS) that take storm information and convert them into evacuation plans which offer time and location-specific guidelines.

Additional work is needed to disseminate available models and share best practices with regards to knowledge and strategies. Additional ways to coordinate and communicate, across all levels and across states, would be beneficial. There is also the need to utilize and promote a common glossary of terminology with respect to modeling.

The use of computer modeling to assist and improve the preparedness planning for vulnerable populations was a repeated theme. Most often cited were references to improved communication, evacuation and sheltering strategies for the elderly, the disadvantaged, those with physical and mental handicaps and those facing language and cultural barriers.

Health and emergency management officials expressed interest to have models and their outcomes be translated into operational action plans. Scenario analyses, exercises and realistic drills that can evaluate the operational plans would be useful. The use of scenario analyses and game based modeling, with location specific population data, was a goal expressed by health officials. User-friendly, team based training in the use of models and in the interpretation of the outcome of models was a priority mentioned by participants.

The CDC, and its *Preparedness Modeling Unit*, has the opportunity to offer guidance and leadership in this developing field of public health preparedness. In particular, natural disasters involving wildfires, earthquakes and hurricanes were specifically mentioned. Computer modeling assistance with disaster response functions, including evacuation, sheltering and distributing needed medications and supplies, were often cited by the sample of city and county health officials. The vast topic of healthcare workforce and hospital readiness at times of disaster surge was frequently mentioned. Local and state health officials have a vast wealth of data and are interested in sharing and partnering with the CDC to assist in the creation of models and the adaptation and customization of the models to their specific location and jurisdiction.

Opportunities exist for NNPHI and its member institutes to continue to provide support to the *Preparedness Modeling Unit* and CDC. The CDC Preparedness Modeling Initiative has identified several future directions for year two of the development of the *Unit* which NNPHI has the topical knowledge and capacity to support. Through the Rapid Needs Assessment Project, NNPHI increased its own knowledge about the capacities in the network around the topic of emergency preparedness and health protection policy-making and has strengthened ties to state and local government focused in this area. The project demonstrated that emergency preparedness officials and state public health professionals are eager to work together to enhance the tools and resources used for health protection policy-making and are supportive of stronger collaboration with public health systems partners. Public Health Institutes can provide and promote linkages with local and state emergency preparedness and public health professionals, national partners and state health policy centers. The network can quickly leverage the capacity of the members to provide support to the CDC in the form of rapid data collection, information dissemination and training.

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Other suggested resources:
Center for Disease Control and Prevention (CDC) Influenza Software – FluAid 2.0 and FluSurge 2.0 at http://www.cdc.gov/flu/tools.

http://preparedness.asph.org CDC Centers for Public Health Preparedness, CPHP NEWSletter#20-May 29, 2007. Feature" Games and Simulations Collaboration Group. Retrieved 11/8/2007
http://asph.org/press/workforce/article_view.cfm?FLE_Index=305&FL_Index=29

Radiological Accident Modeling for Emergency Response (RASCAL) developed by the U.S. Nuclear Regulatory Commission (NRC).

Hazard Assessment System for Consequence Analysis (HASCAL) and Hazard Prediction and Assessment Capability (HPAC) developed by Defense Special Weapons Agency (DSWA) to support planning, forecasting and analysis of radiological, biological, and chemical incidents anywhere in the world.

National Atmospheric Release and Advisory Center (NARAC) real-time weather data, plume model predictions and expertise.
http://narac.llnl.gov/uploads/Sugiyama2002_AMSAirPollution_146205_qzcke.pdf

National Hurricane Center (NHC) and National Oceanographic and Atmospheric Agency (NOAA) www.nhc.noaa.gov for SLOSH and other models
National Library of Medicine (NLM) Radiation Event Medical Management web site at www.remm.nl.gov
www.naccho.org
www.astho.org
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