Simulating the Impact of a Terrorist Attack on the US Food Supply Chain

The National Center for Food Protection and Defense has used SIMUL8 as a risk management tool to simulate the public health system's response in the event of a terrorist attack on the US food supply chain.

Intentional attacks on the food supply can have catastrophic impacts on the health of the population. In localized events the ability to expand health care to meet sudden, and potentially prolonged, demand is of great concern. Risk Sciences International (RSI), a global risk-management organization was funded by The National Center for Food Protection and Defense (NCFPD), a US Homeland Security Center of Excellence, to develop a simulation-based tool to enable the exploration of current surge capacity under various forms of attack on the US food supply. This would ensure adequate resources could be aligned in the event of attack. Designed for open-access, the Food Attack Response Exploration (FAREx) tool supports NCFPD, and other stakeholders including public health agencies, in the development of emergency preparedness plans for an attack on the food supply. This helps minimize the threat to human lives and prevent a possible public health disaster.

Simulation that Connects to the Web

SIMUL8's advanced features, including a unique ASP tool made it the system of choice for RSI. The ASP tool links the simulation to a website interface for data-entry and accessing live results. The software's flexibility to quickly run a multitude of scenarios, meant users could simulate a number of possible terrorist events. This enabled RSI to understand the outcomes of the events including; the impact of the attack, the response of the public health system, level of sickness, demand on lab testing, required resources and treatment.

The simulation tool could be effectively used by the planning team, without any prior knowledge of simulation software.

Application of the FAREx tool allows healthcare professionals to:

- predict the impact of an attack of varying magnitudes on the ability of the health care system to provide the necessary response,
- provide data that can be used directly in the decision-making process including:
    - number of extra resources required to meet the requirements of victims,
    - percentage of capacity used and percentage available with respect to the regional supply of reusable resources, day-by-day during the event, and
    - number of cases that fail to obtain a required primary or secondary resource.
- provide a better understanding of the interaction of factors associated with the threat agent, food vehicle, location and resource availability in determining the response of the health care system to surge requirements.

Simulating the Effects of Chemical Attacks on Public Health

The FAREx tool itself is generic, with application to almost any food-threat combination including chemical and microbial agents. Part of the project consisted of RSI developing simulations around two potential public health scenarios. The first was the effect of contamination of the milk supply with botulinum toxin in the state of Georgia, and distribution of the contaminated food through retail outlets. The second scenario simulated the effect of the neurotoxin TETS contaminating products of concession stands at a large sporting event in Baltimore.

For both scenarios, using simulation RSI could measure all angles of an attack including:

- overall impact of the terrorist attack
- length-of-time to inform the public
- time taken to withdraw implicated food
- number of people becoming sick
- severity of illness
- geographical locations of those who are sick
- hospital bed capacity & availability of medical resources
- laboratory testing
- time course of each stage.

The Challenge

As terrorist attacks can take many forms, the simulation tool had to be adaptable for a number of possible events involving different chemicals, locations and magnitudes. In addition, the unexpected nature of an attack meant the tool had to provide fast, accurate results that could easily be used by emergency planning teams.

It was important that the simulation tool could be used by the planning team with no prior simulation experience. Not only would this reduce training times, but would ensure the tool was as widely accessible by the planning team as possible. The ability to access the simulation remotely via the SIMUL8 ASP was vital. This meant the planning team would not be confined to an office and could access the tool anywhere on the ground.

The ASP Solution

Risk Sciences International developed an interactive, web-enabled, simulation tool. This allowed the user to enter scenario data via a website, that is then passed to SIMUL8 on a remote server to run the simulation via an SQL database. Once the simulation has run, the results are processed and returned to the website via the SQL database for the user to access. This streamlined process is made possible with SIMUL8's advanced ASP feature. The simulation considers all stages from; exposure of consumers to the contaminated food, becoming sick, seeking treatment, and (possibly) obtaining health care resources. Using SIMUL8's queuing and time-based features this process is analyzed for the whole time-course of the event, incorporating a feed-back loop when the attack is recognized by the local public health agency.

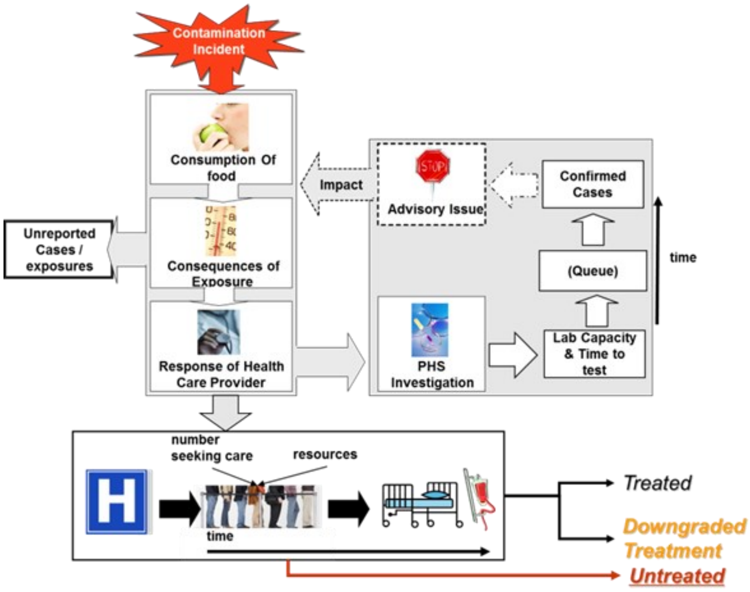

Figure 1: Schematic of the simulation exploring the effects of a chemical attack

The FAREx tool is designed so that each user has a unique password-protected account, with multiple users able to access the simulation tool at one time. RSI also made the decision not to limit the capacity of events to allow maximum flexibility. For example, it is possible to run a scenario involving 30,000 cases of exposure with 500 hospitals to treat cases. The simulation tool can run 3 scenarios concurrently, with the remaining scenarios held in a queue for processing.

...the simulation tool shows the number of people expected to develop symptoms and the timeline of these illnesses, when and where victims will seek treatment, and the overall duration of the event.

For each attack agent, the data entered included; the geographic location of the attack, the number of exposures to the threat, treatment centers - their bed capacity and availability of medical equipment, availability of resources to treat the symptoms, and lab testing information. Using graphs, the FAREx tool shows the number of people expected to develop symptoms and the timeline of these illnesses, when and where victims will seek treatment, and the overall duration of the event.

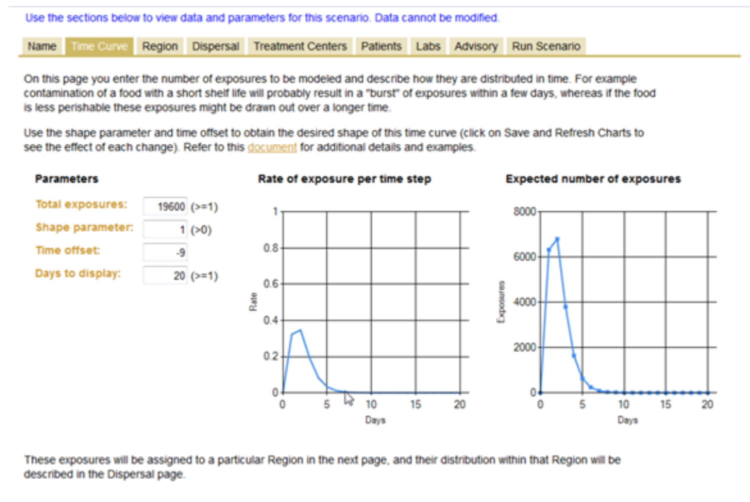

Figure 2: FAREx tool showing no. of exposures of Botulinum toxin & distribution over time.

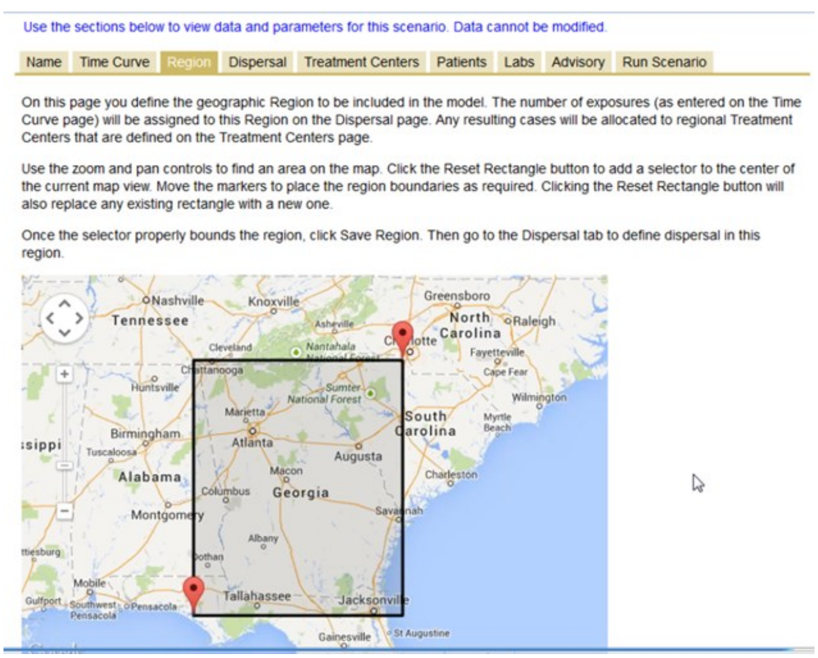

Figure 3: FAREx tool showing location of attack using Google Maps API.

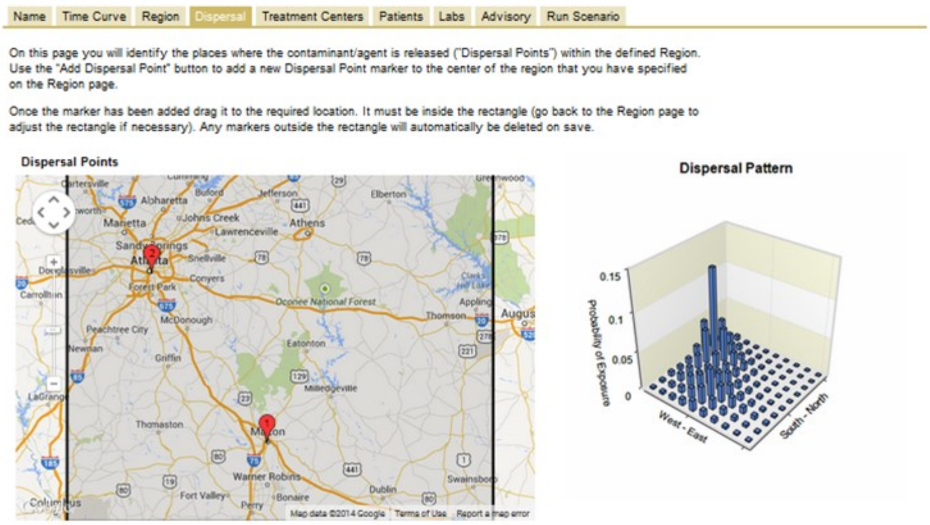

Figure 4: As before, showing dispersal pattern of contamination release.

The FAREx tool looks at the treatment centers in the affected area to track the availability of medical resources such as: ICU and Medical/surgical beds, medical equipment such as ventilators, and the volume of drugs to treat the effects of the attack agent. This data is entered by the user into the website, then passed into the simulation to run within the overall scenario.

By grouping patients by severity of sickness, the simulation also determines what medical resources are required to treat their conditions. For example, for those categorized as moderately ill, the simulation shows that a patient would require an ICU bed for 2.4 days and 1 unit of the antitoxin dose (see figure 5). The FAREx tool is then able to identify whether the availability of medical resources and drugs is relative to the number of people requiring treatment, or if there are bottlenecks to be addressed.

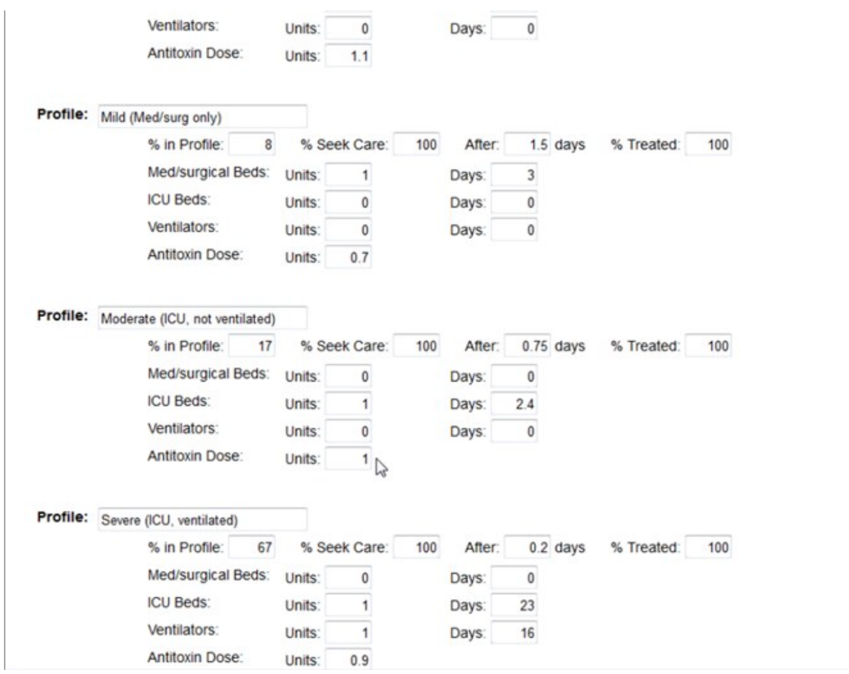

Figure 5: Simulation tool showing severity of Botulism cases & required healthcare resources

An important element of the simulation is the ability to measure the length of time to conduct lab testing to recognize the existence of the attack agent in the food supply. Using queuing in SIMUL8, the tool monitors when people would visit a practitioner to report symptoms and subsequently be referred to hospital, while in parallel their samples are sent for lab-testing.

The final element in the simulation is the advisory. Users of the FAREx tool can specify the minimum number of reported cases to trigger an investigation. The simulation measures the time to issue the advisory and withdraw the contaminated food from the market, and the expected time period for the public to comply.

Once the data is entered into the website, the user directs the simulation to run. A report is then generated and passed back to the website to be viewed by the user. The results are displayed in easily digestible graphs and tables and provide a wealth of information that can be used to effectively plan a response in the event of an attack.

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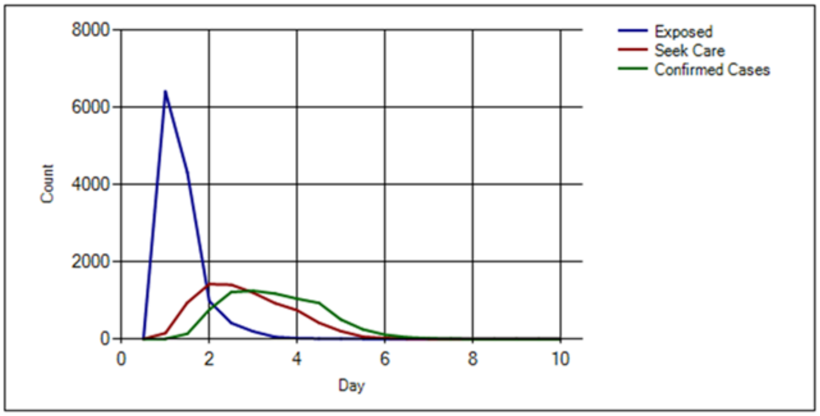
Result	Mean	5th Percentile	95th Percentile
Exposed	12200	12000	12400
Symptomatic	7590	7410	7800
Seek Treatment	7430	7270	7640
Investigated	7400	7240	7600
Confirmed	7360	7200	7580



Result	Mean	5th Percentile	95th Percentile
Time Advisory Issued	3.00	3.00	3.00
Number Averted	7380	7200	7580

Figure 6: Example Public Health Response Results.

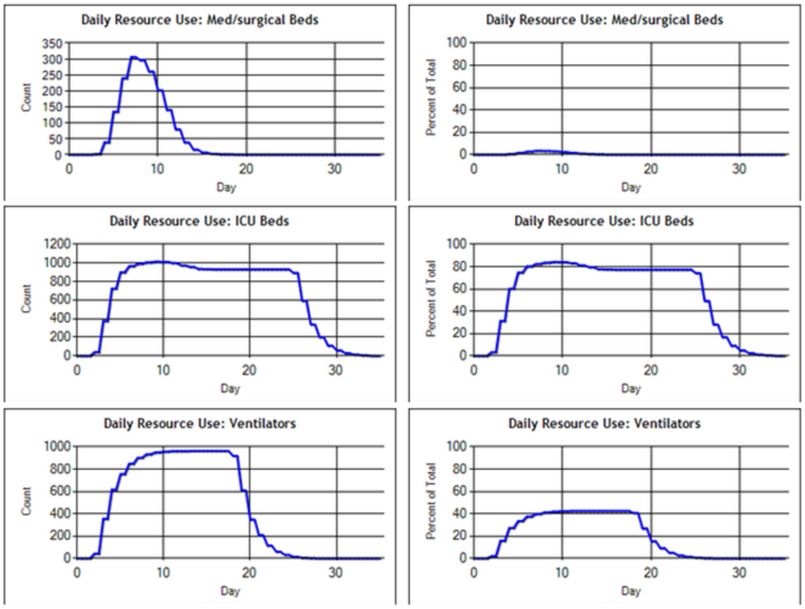


Figure 7: Treatment Capabilities.

Result	Mean	5th Percentile	95th Percentile
Require Treatment	6970	6810	7170
Untreated	0.00	0.00	0.00
Cases Downgraded (ICU Beds)	3970	3850	4080
Cases Downgraded (Ventilators)	804	770	839

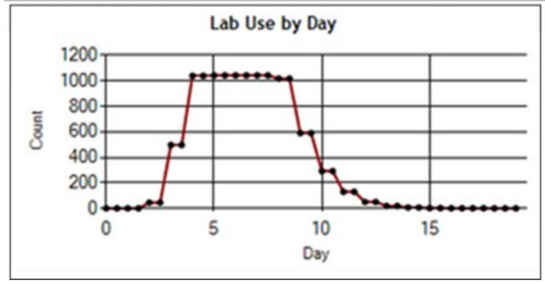


Figure 8: Surge Capacity Results.

The Result

The FAREx simulation tool enables The National Center for Food Protection and Defense to reduce risk in the event of a terrorist attack by effective planning of resources, potentially saving millions of lives.

In the Botulinum scenario, the simulation identified that in the event of an attack there would be a time delay in cases being confirmed, and therefore further lab testing capacity would be needed to prevent bottlenecks. From the simulation, RSI would also be able to identify the success of the advisory stage to inform the public and withdraw the milk from supply.

The simulation also provided details on the availability of resources and their usage over time. Using graphical data, RSI could see that they had a satisfactory level of medical /surgical beds, however ICU beds with ventilators were showing a limited level of availability and so action would be required to ensure adequate availability of beds.

From the results, RSI could also deduce how many patients would require treatment and who would be left untreated following an attack of the type simulated. From this, the simulation could determine how much anti-toxin would be needed to treat the effects of the botulinum.

Using SIMUL8 and its powerful ASP technology, RSI was able to create a highly robust risk management tool to inform decision making in the event of an attack. The flexibility of the FAREx simulation tool means that multiple scenarios can be simulated, from toxic chemicals in the food supply to more localized chemical attacks. This ensures that stakeholders and decision makers have practical science-based information and data that can be used in the development of emergency preparedness plans. This inevitably seeks to minimize the impact of an attack on the food supply and reduce the threat to public safety.

For more information on the FAREx tool, and how to discuss access, please contact Emma Hartnett at Risk Sciences International: ehartnett@risksciences.com