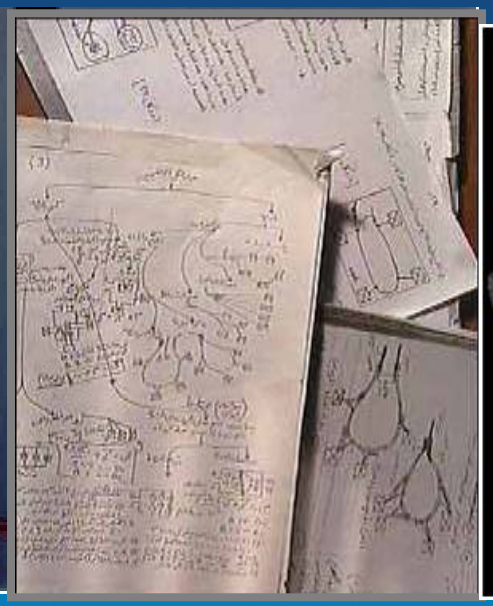
BTSafety LLC



Evaluating and Managing the Consequences of Terrorist Attacks via the Food Supply

Andrew M. Jaine Ph.D.

March 19 2008

BTSafety
Building Technologies for Safety LLC

The Requirements Are Specified in Policy:

HSPD 9, HSPD 10

It is the policy of the United States to protect the agriculture and food system from terrorist attacks, major disasters, and other emergencies by:

(a) identifying and prioritizing sector-critical infrastructure and key resources for establishing protection requirements;

. . . .

HSPD 18

It is not presently feasible to develop and stockpile medical countermeasures against every possible threat. . . This directive . . . to ensure that our Nation's medical countermeasure research, development, and acquisition efforts:

(a) Target threats that have potential for catastrophic impact on our public health and are subject to medical mitigation;

(b) Yield a rapidly deployable and flexible capability to address both existing and evolving threats;

(c) Are part of an integrated WMD consequence management approach informed by current risk assessments of threats, vulnerabilities, and capabilities; and

(d) Include the development of effective, feasible, and pragmatic concepts of operation for responding to and recovering from an attack.

BT Safety
Building Technologies for Safety LLC

Goal of Risk Assessment

For each defined threat, determine the range of possible consequences of terrorist attacks

Threat **-** ***Estimates of probabilities (or frequencies) of adversary acquisition, production, and dissemination of an agent.***

Vulnerability **–** ***Likelihood of success given an attack.***

Consequence **-** ***Estimated impact of terrorism events involving the agent.***

BT Safety
Building Technologies for Safety LLC

Goal of Risk Management

For each defined threat, determine the range of possible consequences of terrorist attacks and optimal approaches to their mitigation

Threat **-** ***Estimates of probabilities (or frequencies) of adversary acquisition, production, and dissemination of an agent.***

Vulnerability **–** ***Likelihood of success given an attack.***

Consequence **-** ***Estimated impact of terrorism events involving the agent.***

Mitigation **–** ***Appropriate locations and actions to reduce the consequence.***

BT Safety
Building Technologies for Safety LLC

Many Disparate Factors Contribute to the Potential Consequences

Characteristics of the Food Product

- Vulnerability – points of contamination
- Volume, speed, breadth of distribution
- Impact of processing and packaging
- Shelf life

Characteristics of the Agent

- Impact on organoleptic properties of food
- (Increasing) virulence
- Drug resistance
- Detectability
- Survivability

Many Disparate Factors Contribute to the Potential Consequences

Characteristics of the Consumption

- Demographics
- Preparation (Cooking)
- Serving size

Characteristics of the Response (e.g. Health System)

- Disease identification by medical community
- Medical mitigation
- Speed of reporting
- Event recognition processes
- Timing and effectiveness of response [recalls, announcements]

BT Safety
Building Technologies for Safety LLC

Number of Possible Scenarios is Vast

Foods

- Number of products > 320,000 (USDA ERS,1999)
- Average supermarket ~ 50,000 (USDA ERS,1999)
- ~ 10,000-20,000 New Products/Year (USDA, ERS)

Agents

- Number of Priority Pathogens > 250 (WA DOH)
- Number of Priority Chemicals > 70 (CDC)
- Radiological / Nuclear > 800 (ICRP)

BT Safety
Building Technologies for Safety LLC

Prioritization and Effective Mitigation Require Viewing Events at Two Different Levels

- **Broad** (Risk Ranking)
  - Prioritize the agent/food combinations of interest.
- **Focused** (Risk Mitigation)
  - Focus on the agent/food combinations of potentially highest risk
  - Analyze each scenario to determine optimal stages and ways to mitigate and respond

BT Safety
Building Technologies for Safety LLC

Risk Mitigation Requires Detailed Analysis of All Stages of each Attack Scenario (specific food + agent)

- Model all stages that could have a significant impact on the consequences, to assess:
  - Vulnerability to contamination
  - Contribution to total consequence
  - Relative importance
  - Potential effects of mitigation
- Decompose each scenario into elemental stages
- As scenarios are mitigated, iterate to address the new priorities that emerge

BT Safety
Building Technologies for Safety LLC

Outbreak Pathway Analysis

Model the evolution of food contaminations involving specific products & agents geographically **and** temporally

Production → Processing → Distribution → Contamination → Consumption → Illness → Medical Attn → Public Health → Intervention → Endpoints

Timing
Changes in Volume
Effects of Processing
Changes in Agent
Effects of People and Actions

Quantify the timing and consequences of events and interventions on Public Health.

BT Safety
Building Technologies for Safety LLC

Pathway Modeling Informs Three of the Four Phases of Risk Management

Threat **-** ***Estimates of probabilities (or frequencies) of adversary acquisition, production, and dissemination of an agent.***

Vulnerability **–** ***Likelihood of success given an attack.***

Consequence **-** ***Estimated impact of terrorism events involving the agent.***

Mitigation **–** ***Appropriate locations and actions to reduce the consequence.***

Pathway Modeling

BT Safety
Building Technologies for Safety LLC

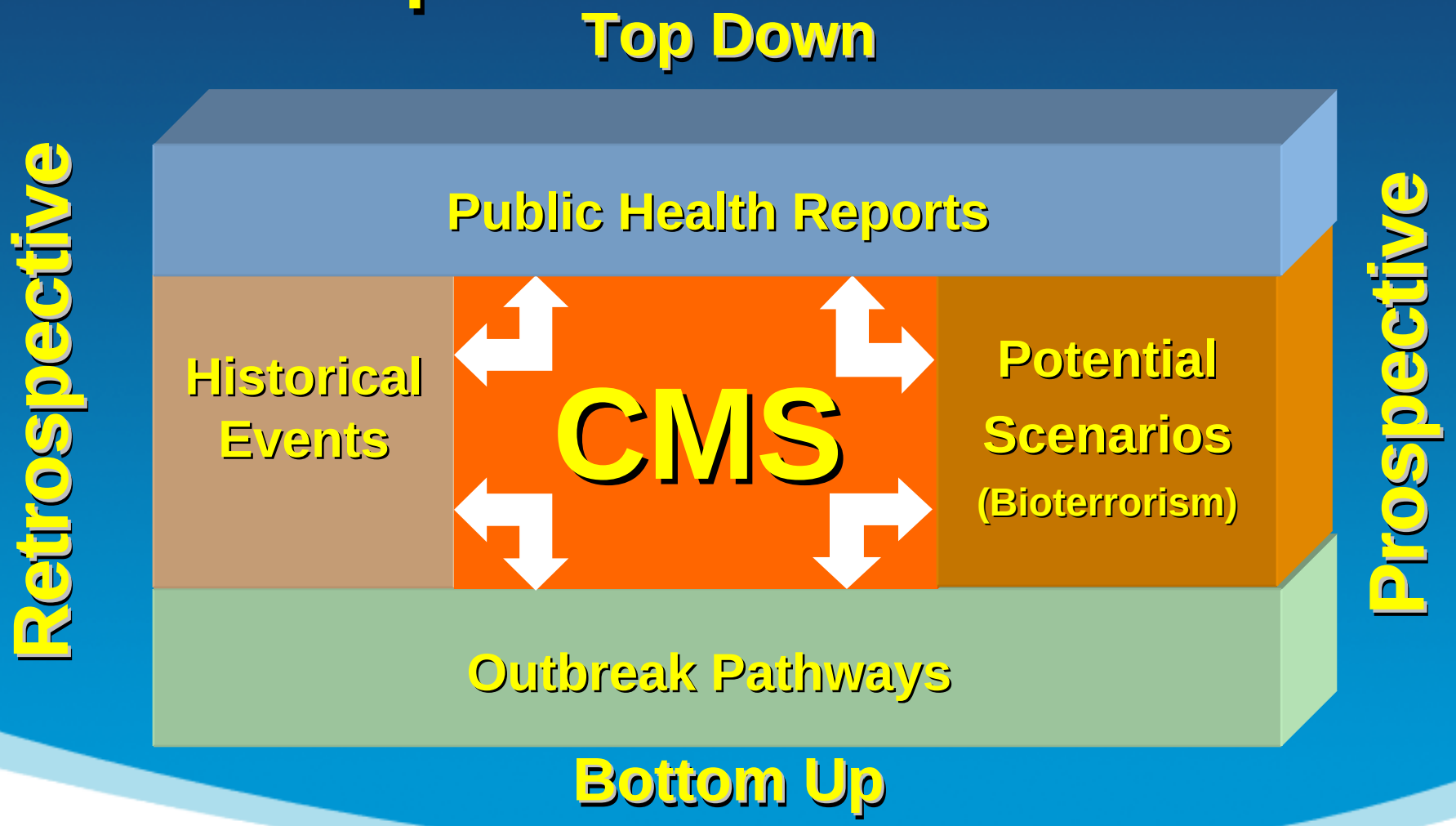
Consequence Management System (CMS)

Data-centric, science-based predictive model of the pathway of potential attack scenarios that quantifies the speed and consequences of foodborne attacks and interventions

- In two distinct forms, that share algorithms and data:
  1. Visual Consequence Model, an easy-to-use desktop model that visually demonstrates the results
  2. Risk Assessment Consequence Library that performs statistical analysis of the results

BT Safety
Building Technologies for Safety LLC

CMS Integrates Four Perspectives of Outbreaks



BT Safety
Building Technologies for Safety LLC

Optimizing the Modeling / Data Collection

- **Product/agent data collection are relatively independent:**
  - Food pathway (to consumption) is largely independent of agent.
  - Illness pathway (following consumption) is largely independent of product
  - Interdependencies include:
    - Product Effects
      - Organoleptic interactions (taste, smell, etc.); Spoilage
    - Agent Effects
      - Feasibility of contamination; agent inactivation, stability or modification (standard testing, storage conditions, lipid solubility, food processing, etc.)
- **Detection and Mitigation have complex dependencies**

BT Safety
Building Technologies for Safety LLC

Dependencies of Food Event Stages

Phase of the outbreak		Dependencies of the processes		
		Depend on product, agent and PHS		
		Depend on product and agent		
			Depend on agent and PHS	
		Depend on product	Depend on agent	Depend on PHS
Feas-ibility	Feasibility	Feasibility of contamination		
		Agent-Food Interaction		
Outbreak Development	Food distribution and consumption	Sourcing		
		Processing		
		Distribution		
		Consumer demographics		
		Food handling practices		
		Consumption patterns		
	Infection / intoxication and disease progression		Agent characteristics	
			Dose response	
			Secondary Transmission	
			Symptom presentation	
			Illness evolution	
			Clinical outcomes	
Outbreak Mitigation	Public/health system response		Patient decision making	
			Medical mitigation processes	
			Reporting systems	
				Organization structure
	Intervention and impact	Outbreak detection processes		
		Intervention availability		
		Intervention effectiveness		
		Impact metrics		

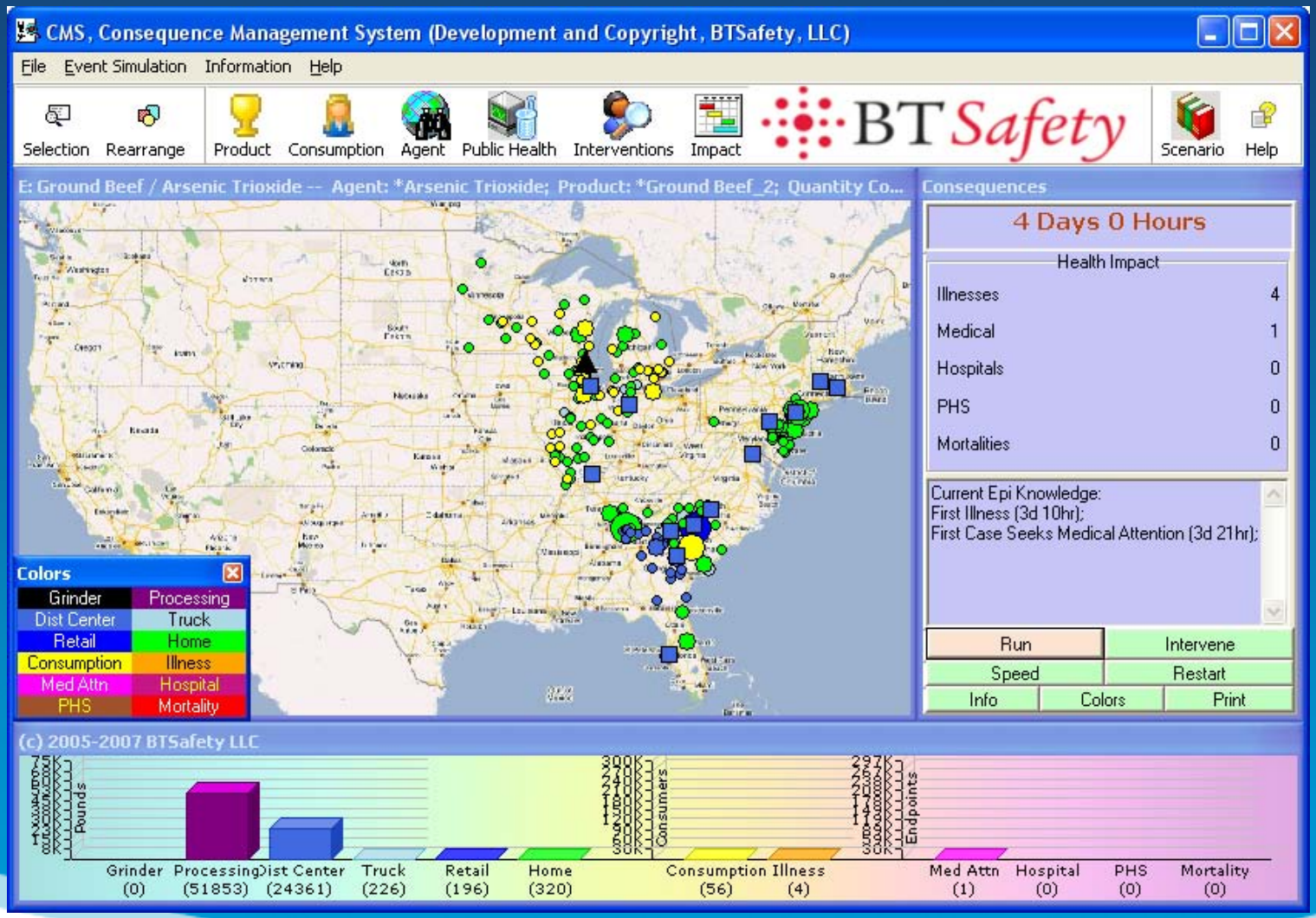
BT Safety
Building Technologies for Safety LLC

CMS
Models the Evolution, Consequences and Effectiveness of Interventions in Food Contamination Events

- Quantifies and visually demonstrates the *speed* and *consequences* of events
- Quantifies the effect on consequences of contamination at any point along the pathway
- Evaluates the *impact* of interventions on event mitigation
- Implemented with a form that can be used by untrained users, in advance of an event for *planning*, during an event for *assessment*, and as a *training* tool

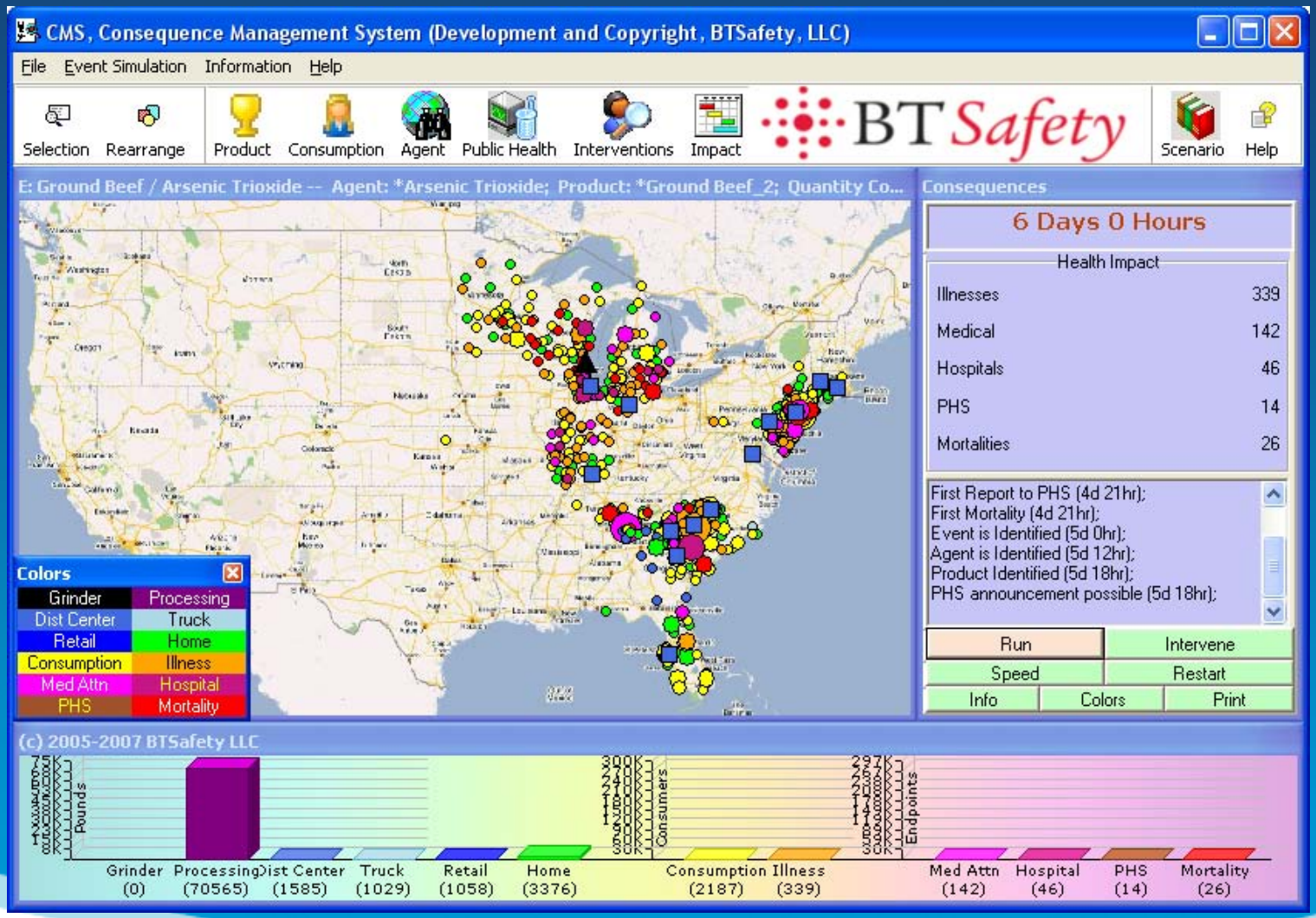
BT Safety
Building Technologies for Safety LLC

Consequences of Contamination of 100,000 lbs of Ground Beef with Arsenic Trioxide (4 days)



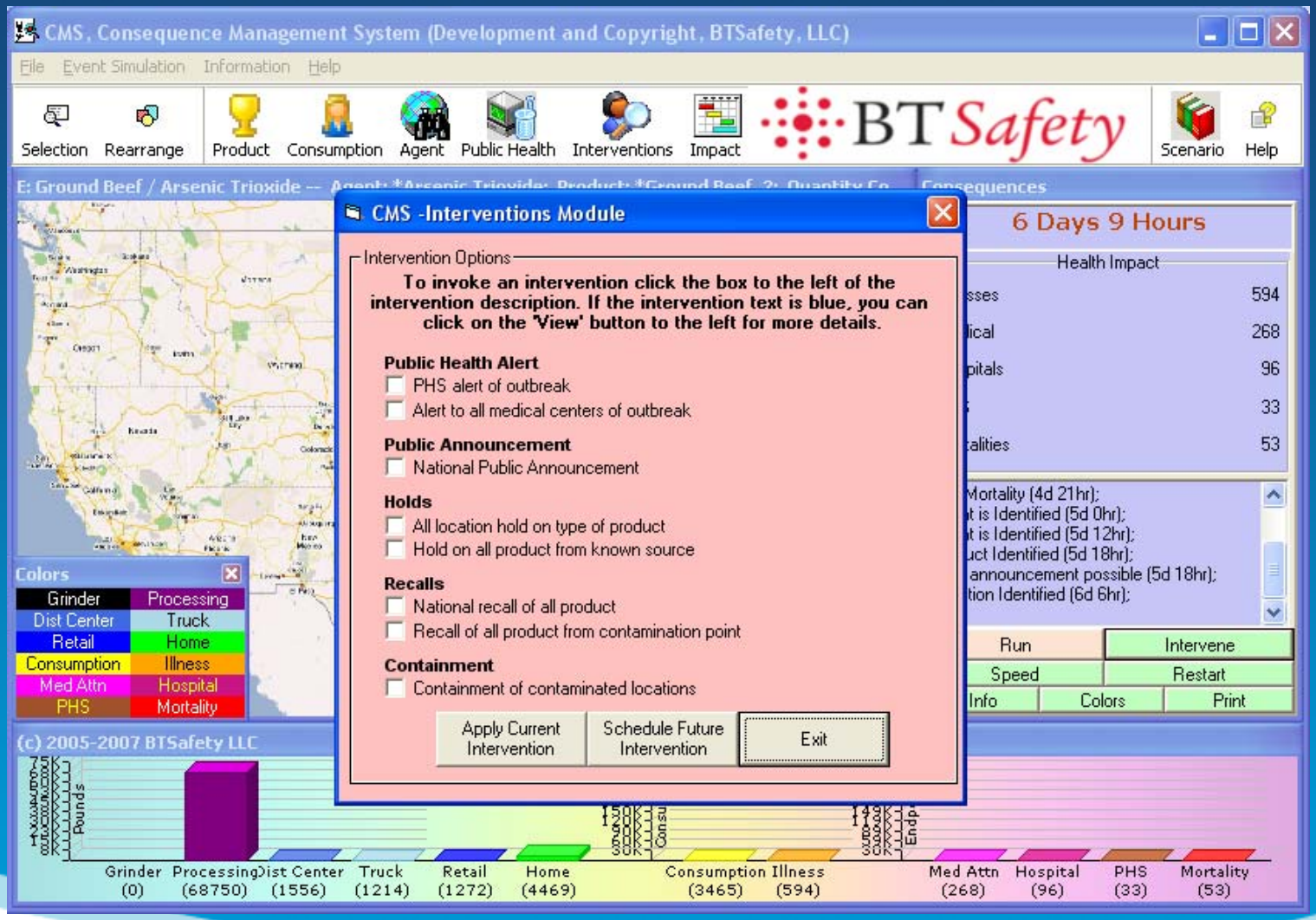
BT Safety
Building Technologies for Safety LLC

Consequences of Contamination of 100,000 lbs of Ground Beef with Arsenic Trioxide (6 days)



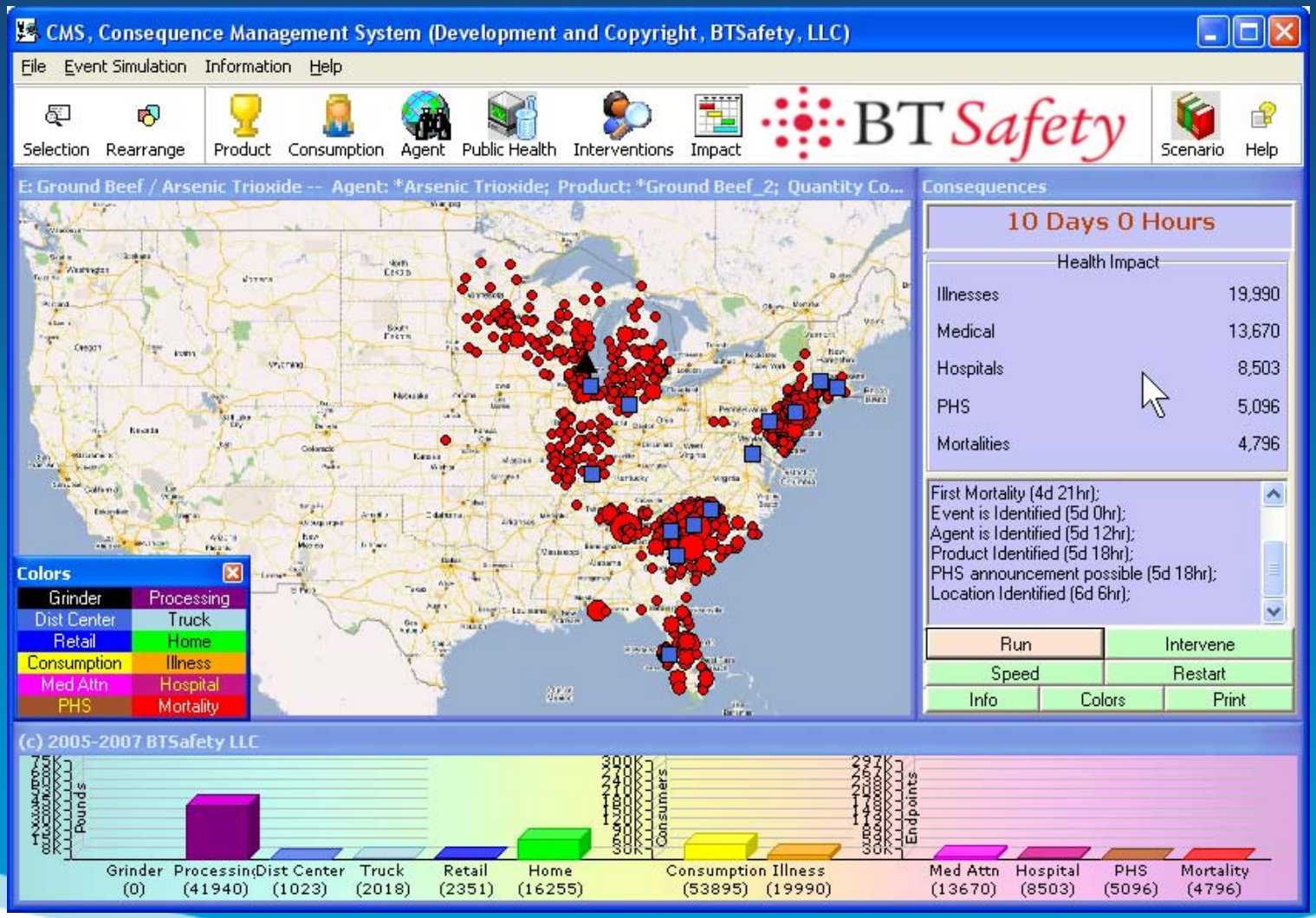
BT Safety
Building Technologies for Safety LLC

Consequences of Contamination of 100,000 lbs of Ground Beef with Arsenic Trioxide (with Intervention)



BT Safety
Building Technologies for Safety LLC

Consequences of Contamination of 100,000 lbs of Ground Beef with Arsenic Trioxide (at 10 Days)



BT Safety
Building Technologies for Safety LLC

Consequence Management System Risk Ranking Library

A software system that implements the food pathway algorithms of CMS as a library:

- Called from an external program with a threat definition,
- Returns a profile of the range of consequences that would result from many (thousands) of different scenarios of contamination with those characteristics

BT Safety
Building Technologies for Safety LLC

CMS Uses

Risk Assessment Policy Decisions:

- National Biodefense Analysis and Countermeasures Center / Battelle
  - 2008 Biological Risk Assessment for Food
  - 2008 Radiological and Nuclear Risk Assessments for Food

Bioterrorism Event Planning:

- Planned: State-level exercises

Training in Event Planning and Mitigation:

- FDA/Institute of Food Technologists (18 Food Defense Awareness Training Courses in last 2 years)
- USDA/FSIS table-top exercise for the meat industry
- Universities (Courses on supply chain logistics, food defense, public health)
- Food companies (Staff training)
- DOD training for food safety inspectors

BT Safety
Building Technologies for Safety LLC

CMS +
CMS Risk Ranking Library

Integrates Risk Ranking and Risk Management in a model that is:

- Consequence-Based
- Flexible to support all agents and products
- Data-centric
- Enables statistical ranking AND detailed examination
- Enables Iterative Evaluation of Risks and Responses

BT Safety
Building Technologies for Safety LLC

Extensive agency involvement

FDA U.S. Food and Drug Administration
CENTER FOR FOOD SAFETY AND APPLIED NUTRITION

Homeland Security

USDA United States Department of Agriculture

CDC Department of Health and Human Services
Centers for Disease Control and Prevention

Minnesota Department of Health
Protecting, maintaining and improving the health of all Minnesotans

MINNESOTA DEPARTMENT OF AGRICULTURE
FROM THE FARM TO YOUR FAMILY

ERS ECONOMIC RESEARCH SERVICE
United States Department of Agriculture
The Economics of Food, Farming, Natural Resources, and Rural America

Health Services
LOS ANGELES COUNTY

USDA ars Agricultural Research Service
the in-house research arm of the U.S. Department of Agriculture

CSREES Cooperative State
Research, Education, and Extension Service

USDA United States Department of Agriculture
Food Safety and Inspection Service

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

North Carolina Department of Agriculture & Consumer Services

Iowa Department of Agriculture

aphis.usda.gov

Kansas Department of Agriculture

BT Safety
Building Technologies for Safety LLC

Considerable Support from the Food Industry

- Multiple sectors
- Major multinationals through to small, local companies
- Collecting data
- Developing and maintaining confidential working relationships

BT Safety
Building Technologies for Safety LLC

We gratefully acknowledge funding from:

Homeland Security

NATIONAL CENTER FOR
FOOD PROTECTION AND DEFENSE
A HOMELAND SECURITY CENTER OF EXCELLENCE

FDA U.S. Food and Drug Administration Department of Health and Human Services

BT Safety
Building Technologies for Safety LLC