Public Health Surveillance After Disasters

Disaster Epidemiology Workshop

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Objectives

- By the end of this lecture, participants will be able:
  - To define the steps for setting up a surveillance system for emergency situations;
  - To develop a case definition;
  - To describe the operational issues in setting up a surveillance system post-disaster.

Outline

- Background
- Case Examples

Steps in Surveillance

- Setting up a surveillance system post-disaster
  - Establish objectives
  - Developing case definitions
  - Determining data sources
  - Field test methods (if possible)
  - Data collection
  - Analysis
  - Dissemination of results

Surveillance after Disasters

- To respond appropriately and effectively to the threats of disasters, relief efforts rely on timely and accurate information.
- Public health surveillance can:
  - identify health problems,
  - establish priorities for decision-makers, and
  - evaluate the effectiveness of relief efforts.

Objectives of a Surveillance System

Wetterhall SF and Noji EK. Surveillance and Epidemiology.
In: Noji E. Public Health Consequences of Disasters, 1997.

- Estimate the magnitude of a health problem.
- Identify groups at increased risk for adverse health outcomes.
- Detect epidemics or other outbreaks
- Generate and test hypotheses regarding etiology
- Monitor changes in infectious agents/environmental agents
- Detect changes in health practices
- Identify research needs
- Evaluate control strategies.

The Role of the Epidemiologist

- Epidemiologists can:
  - Define rapidly the nature and extent of health problems;
  - Identify groups in the population at risk for adverse health events;
  - Optimize relief response;
  - Monitor the effectiveness of the relief effort; and
  - Recommend ways of decreasing the consequences of future disasters.

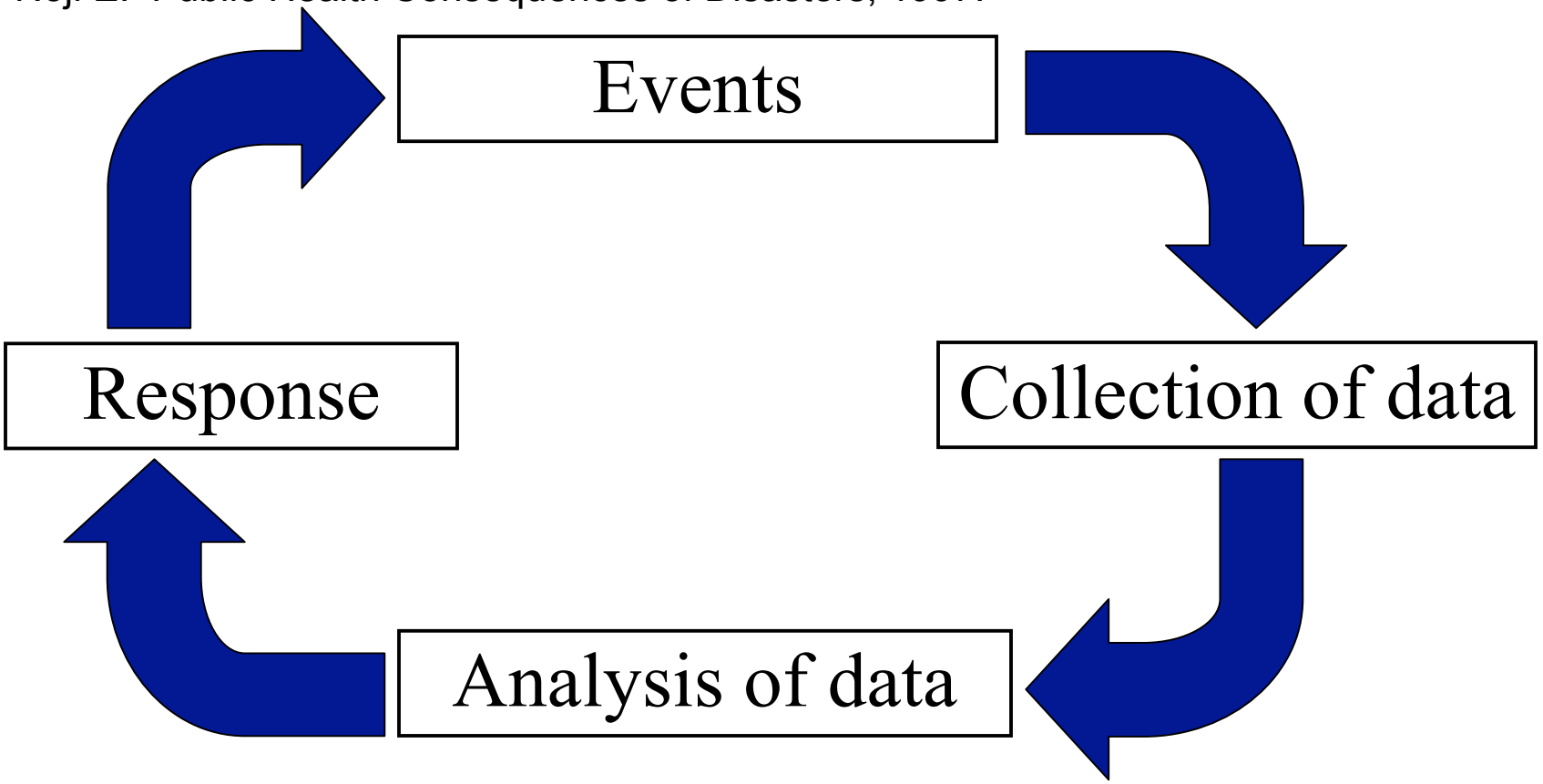
Elements of a good surveillance system

MMWR 2001;50(RR-13).

- Simplicity (structure and ease of operation)
- Flexibility (adapt to changing information needs)
- Data quality (completeness and validity)
- Acceptability (willingness of reporting entities)
- Sensitivity and specificity (case definition or OB detection)
- Predictive value positive (PV+) or negative (PV-)
- Representativeness (of target population over time)
- Timeliness
- Stability (reliability and availability)

The surveillance cycle

Adapted from: Wetterhall SF and Noji EK. Surveillance and Epidemiology.
In: Noji E. Public Health Consequences of Disasters, 1997.



Challenges Post-Disaster

Wetterhall SF and Noji EK. Surveillance and Epidemiology.
In: Noji E. Public Health Consequences of Disasters, 1997.

- Data must be collected rapidly under adverse conditions.
- Multiple sources of information must be integrated quickly and cohesively.
- Circumstances may impede information "flow".
- Cycle from information to action must be rapid, accurate and repeated.

Developing Case Definitions

- Case definitions enable the “case” (adverse health event) to be characterized by different data:
  - Clinical
  - Epidemiologic
  - Laboratory

Developing Case Definitions

- The elements of a case definition can include the degree of certainty in the diagnosis:
  - "suspected"
  - "probable"
  - "confirmed"

Sensitivity and specificity of case definition or outbreak detection

		DISEASE: Present	DISEASE: Absent
TEST*	Positive	TP	FP
	Negative	FN	TN

$$Sensitivity = Pr(T+|D+) = \frac{TP}{TP+FN} = Useful\ for\ "ruling\ out"$$

$$Specificity = Pr(T-|D-) = \frac{TN}{TN+FP} = Useful\ for\ "ruling\ in"$$

*TEST is case definition or outbreak detection

Bayes theorem and predictive value positive (PV+)

TEST*	DISEASE: Present	DISEASE: Absent
Positive	TP	FP
Negative	FN	TN

$$Sensitivity = P(T+|D+) = \frac{TP}{TP+FN}$$

$$Specificity = P(T-|D-) = \frac{TN}{TN+FP}$$

$$P(D+|T+) = Predictive\ Value\ Positive = PV+ = \frac{TP}{TP+FP}$$

$$PV+ = \frac{(Sensitivity)(Prior\ probability)}{(Sensitivity)(Prior\ probability)+(1-Specificity)(1-Prior\ probability)}$$

*TEST is case definition or outbreak detection

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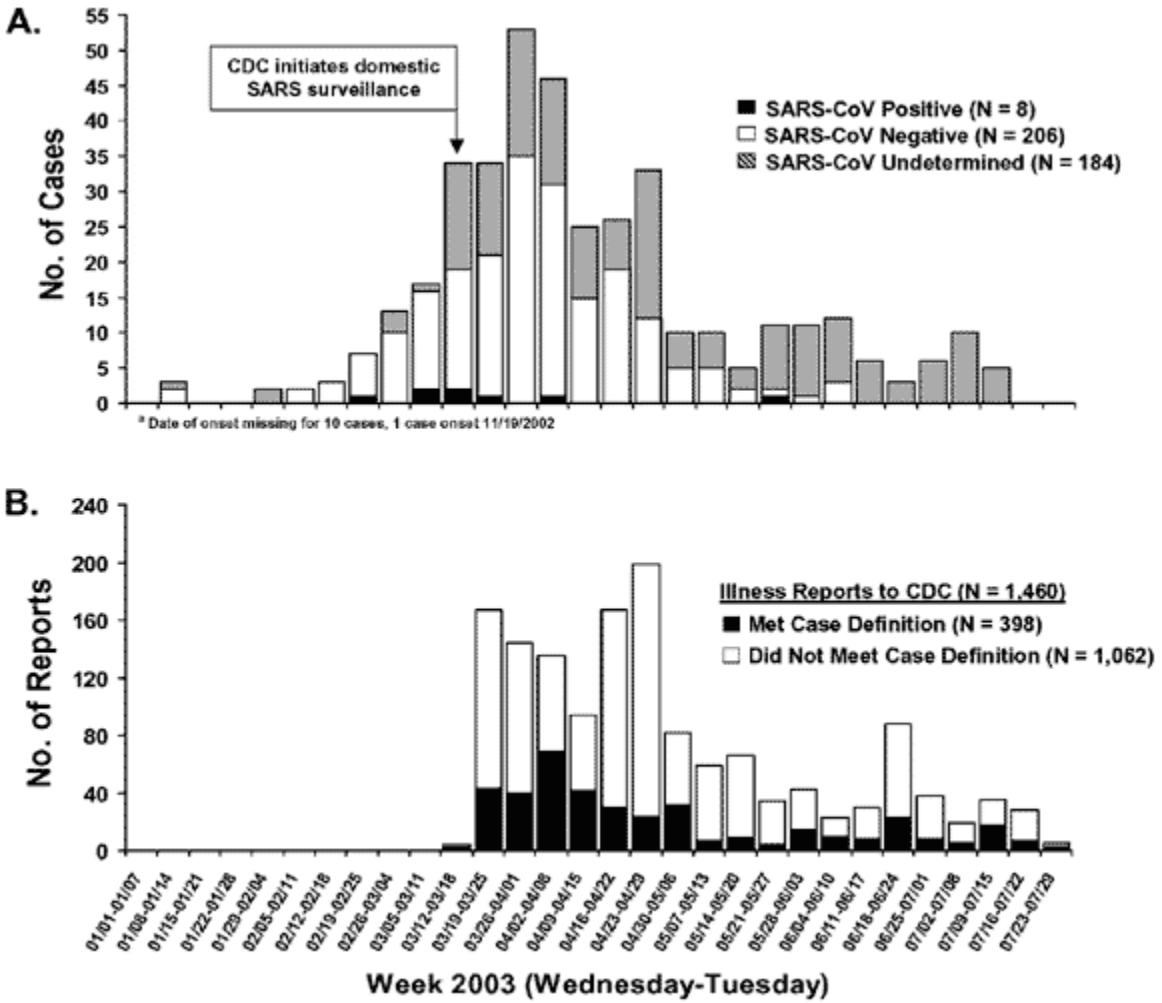
SARS Example

Displayed in Figure B is the number of unexplained respiratory illness reports received by CDC by week of illness report (N = 1,460). However, only 398 met the U.S. SARS case definition and is displayed by week of illness onset in Figure A.



Emerg Infect Dis 2004 Feb;10(2):185-194.

Determine Data Sources

- Objectives drive data sources
- Consider nontraditional sources of information post-disaster
  - eg, police, humanitarian aid agencies, civil defense organizations, religious officials, pharmacies, etc.

Active Surveillance Using Existing Medical Facilities

Surveillance for illness and injury after hurricane Katrina -- New Orleans, Louisiana, September 8-25, 2005. MMWR 2005 Oct;54(40):1018-1021.

- On September 9, 2005, Louisiana Dept. of Health and Hospitals, CDC, and functioning emergency treatment resources established active surveillance.
- The target population was persons living or working in four parishes in and around New Orleans (Jefferson, Orleans, Plaquermines, and St. Bernard)
- Active surveillance was initiated in:
  - Four hospitals
  - Ten nonhospital facilities

Active Surveillance Using Existing Medical Facilities

Surveillance for illness and injury after hurricane Katrina -- New Orleans, Louisiana, September 8-25, 2005. MMWR 2005 Oct;54(40):1018-1021.

- The facilities used a standardized reporting form
  - Demographics
  - Symptoms
  - Clinical impressions (eg, dehydration, ARI, diarrhea)
  - Mechanism of injury
- Different modes of data collection
  - Healthcare provider or surveillance team members

Active Surveillance Using Existing Medical Facilities

Surveillance for illness and injury after hurricane Katrina -- New Orleans, Louisiana, September 8-25, 2005. MMWR 2005 Oct;54(40):1018-1021.

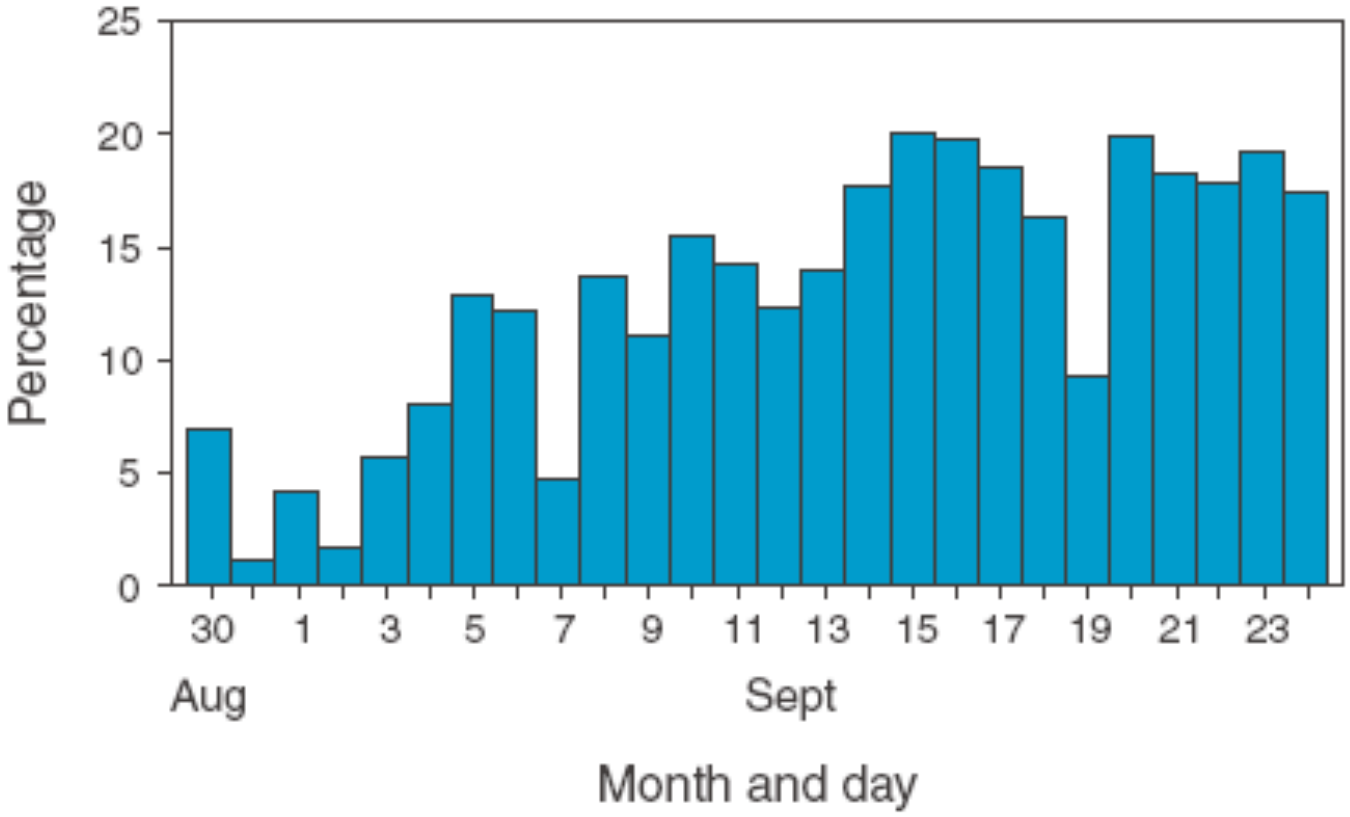
- All data were gathered and entered into a computer database manually.
- Analyses were completed daily.
- Illness and injury trends or individual cases of selected illness were communicated to health authorities.
  - Investigated by health teams as appropriate

Active Surveillance Using Existing Medical Facilities

Surveillance for illness and injury after hurricane Katrina -- New Orleans, Louisiana, September 8-25, 2005. MMWR 2005 Oct;54(40):1018-1021.

- As of September 25, the system monitored 7,508 reports of health-related events.
- This system prompted investigations of respiratory and rash illnesses, but no major outbreaks were detected.
- These data were used to identify post-hurricane injury patterns and to guide prevention messages.

FIGURE. Proportion of acute respiratory infections among reported illnesses after Hurricane Katrina — New Orleans, Louisiana area, August 30–September 24, 2005



Source: Surveillance for illness and injury after hurricane Katrina -- New Orleans, Louisiana, September 8-25, 2005. MMWR 2005 Oct;54(40):1018-1021.

TABLE 1. Number and percentage of persons with selected illnesses after Hurricane Katrina, by residency status — New Orleans, Louisiana area, September 8–25, 2005

Selected illnesses	Relief workers		Residents		Unknown		Total	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Infectious-disease–related								
Skin or wound infection	101	(19.1)	192	(12.8)	347	(16.2)	**640**	**(15.4)**
Acute respiratory infection	119	(22.5)	158	(10.5)	228	(10.6)	**505**	**(12.1)**
Diarrhea	11	(2.1)	52	(3.5)	83	(3.9)	**146**	**(3.5)**
Other infectious disease	36	(6.8)	109	(7.3)	143	(6.7)	**288**	**(6.9)**
Noninfectious-disease–related								
Rash	67	(12.7)	87	(5.8)	146	(6.8)	**300**	**(7.2)**
Heat-related	34	(6.4)	80	(5.3)	93	(4.3)	**207**	**(5.0)**
Nondiarrhea gastrointestinal	23	(4.4)	77	(5.1)	108	(5.0)	**208**	**(5.0)**
Renal*	8	(1.5)	44	(2.9)	35	(1.6)	**87**	**(2.1)**
Other classifiable illness†	22	(4.2)	52	(3.5)	88	(4.1)	**162**	**(3.9)**
Other illnesses	107	(20.3)	649	(43.3)	870	(40.6)	**1,626**	**(39.0)**
Total	**528**	**(100.0)**	**1,500**	**(100.0)**	**2,141**	**(100.0)**	**4,169**	**(100.0)**

* Includes kidney stones and renal failure (i.e., chronic and acute).
† Includes diabetes, cardiovascular conditions, obstetric/gynecologic conditions, and dental problems.

Source: Surveillance for illness and injury after hurricane Katrina -- New Orleans, Louisiana, September 8-25, 2005. MMWR 2005 Oct;54(40):1018-1021.

TABLE 2. Number and percentage of persons with selected injuries and exposures after Hurricane Katrina, by residency status — New Orleans, Louisiana area, September 8–25, 2005

Selected injuries and exposures	Relief workers		Residents		Unknown		Total	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Injuries								
Falls	46	(13.6)	196	(27.4)	222	(23.0)	**464**	**(23.0)**
Bites/Stings	67	(19.8)	92	(12.8)	152	(15.8)	**311**	**(15.4)**
Motor vehicle crash	16	(4.7)	65	(9.1)	64	(6.6)	**145**	**(7.2)**
Intentional injury	4	(1.2)	20	(2.8)	18	(1.9)	**42**	**(2.1)**
Other unintentional injuries*	117	(34.6)	237	(33.1)	362	(37.6)	**716**	**(35.5)**
Undetermined etiology	72	(21.3)	99	(13.8)	128	(13.3)	**299**	**(14.8)**
Toxic exposure/Poisoning								
Carbon monoxide poisoning	5	(1.5)	3	(0.4)	6	(0.6)	**14**	**(0.7)**
Other toxic exposure	11	(3.3)	4	(0.6)	12	(1.2)	**27**	**(1.3)**
Total	**338**	**(100.0)**	**716**	**(100.0)**	**964**	**(100.0)**	**2,018**	**(100.0)**

* Includes cuts, blunt trauma, burns, and environmental exposures.

Source: Surveillance for illness and injury after hurricane Katrina -- New Orleans, Louisiana, September 8-25, 2005. MMWR 2005 Oct;54(40):1018-1021.

Updated Results

TABLE 1. Number and percentage of persons with selected illnesses after Hurricane Rita, by residency status — New Orleans, Louisiana area, September 25–October 15, 2005

Illness	Relief worker		Resident		Unknown status		Total	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Infectious-disease–related								
Skin or wound infection	62	(8.8)	361	(9.9)	459	(9.9)	**882**	**(9.8)**
Acute respiratory infection	179	(25.5)	538	(14.8)	587	(12.6)	**1,304**	**(14.5)**
Diarrhea	18	(2.6)	92	(2.5)	123	(2.6)	**233**	**(2.6)**
Other infectious disease	28	(4.0)	219	(6.0)	223	(4.8)	**470**	**(5.2)**
Noninfectious-disease–related								
Rash	59	(8.4)	170	(4.7)	290	(6.2)	**519**	**(5.8)**
Heat-related	28	(4.0)	86	(2.4)	118	(2.5)	**232**	**(2.6)**
Nondiarrheal gastrointestinal	24	(3.4)	200	(5.5)	253	(5.4)	**477**	**(5.3)**
Renal	11	(1.6)	49	(1.3)	104	(2.2)	**164**	**(1.8)**
Other classifiable illness*	76	(10.8)	758	(20.8)	1,030	(22.1)	**1,864**	**(20.7)**
Other illness†	217	(30.9)	1,166	(32.0)	1,469	(31.6)	**2,852**	**(31.7)**
Total	**702**	**(100.0)**	**3,639**	**(100.0)**	**4,656**	**(100.0)**	**8,997**	**(100.0)**

* Includes diabetes, cardiovascular conditions, obstetric/gynecologic conditions, and dental problems.
† Includes other nonclassifiable illness.

Source: Injury and illness surveillance in hospitals and acute-care facilities after hurricanes Katrina and Rita -- New Orleans Area, Louisiana, September 25 - October15, 2005. MMWR 2006 Jan;55(02):35-38.

Updated Results

TABLE 2. Number and percentage of persons with selected injuries and exposures after Hurricane Rita, by residency status — New Orleans, Louisiana area, September 25–October 15, 2005

Injury/Exposure	Relief worker No.	Relief worker (%)	Resident No.	Resident (%)	Unknown status No.	Unknown status (%)	Total No.	Total (%)
Injury								
Fall	64	(12.0)	449	(25.0)	479	(21.3)	992	(21.7)
Bite/Sting	52	(9.8)	114	(6.3)	173	(7.7)	339	(7.4)
Motor-vehicle crash	20	(3.8)	161	(9.0)	235	(10.5)	416	(9.1)
Intentional injury	11	(2.1)	32	(1.8)	46	(2.0)	89	(1.9)
Other unintentional injury*	334	(62.7)	934	(51.9)	1,143	(50.8)	2,411	(52.7)
Undetermined etiology	44	(8.3)	96	(5.3)	158	(7.0)	298	(6.5)
Toxic exposure/Poisoning								
Carbon monoxide poisoning	1	(0.2)	1	(0.1)	3	(0.1)	5	(0.1)
Other toxic exposure	7	(1.3)	11	(0.6)	11	(0.5)	29	(0.6)
Total	**533**	**(100.0)**	**1,798**	**(100.0)**	**2,248**	**(100.0)**	**4,579**	**(100.0)**

* Includes cuts, blunt trauma, burns, and environmental exposures.

Source: Injury and illness surveillance in hospitals and acute-care facilities after hurricanes Katrina and Rita -- New Orleans Area, Louisiana, September 25 - October15, 2005. MMWR 2006 Jan;55(02):35-38.

Results of Field Investigations

Surveillance for illness and injury after hurricane Katrina -- New Orleans, Louisiana, September 8-25, 2005. MMWR 2005 Oct;54(40):1018-1021.

- The increase in ARI cases over time was only observed in nonhospital facilities.
  - One facility that identified multiple ARI cases among members of a National Guard battalion.
- Rash illnesses were deemed noninfectious; they were classified as prickly heat, arthropod bites, and the abrasive effects of wet clothing on moist skin.

Limitations

Surveillance for illness and injury after hurricane Katrina -- New Orleans, Louisiana, September 8-25, 2005. MMWR 2005 Oct;54(40):1018-1021.

- The enumeration of illnesses and injuries is incomplete.
- Misclassification of illnesses or injuries on the standardized form was possible.
- Prehurricane baseline data were not available to assess the magnitude of any increase in illnesses or injuries.

Active Surveillance Using Evacuation Centers

MMWR 2006 Jan;55(02):32-35.

- Any facility that housed displaced persons overnight was considered an evacuation center (EC).
- A one-page surveillance form was designed to record the number of patient encounters at an EC for selected communicable disease signs and syndromes.
- The form was designed to record the number of patient encounters during a 24-hour period.
- Instructions for recording and returning the completed forms were distributed along with the forms to all identified ECs.

Active Surveillance Using Evacuation Centers

MMWR 2006 Jan;55(02):32-35.

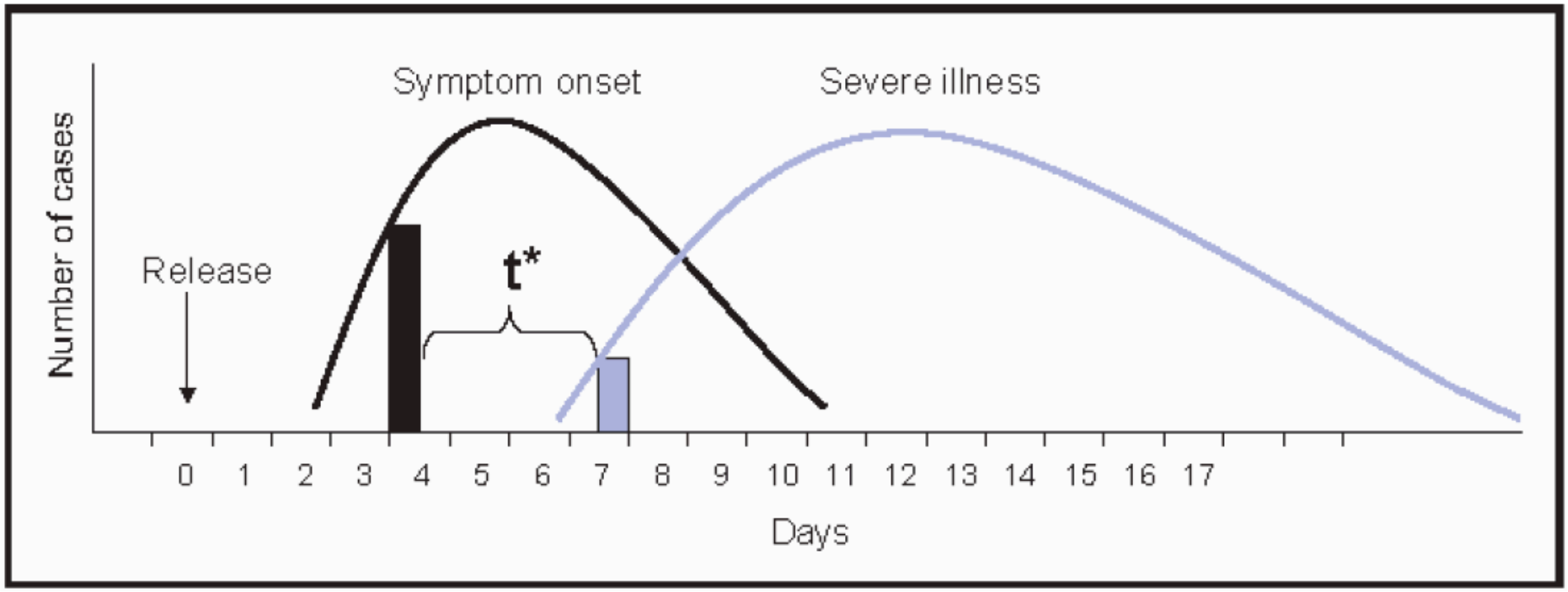
- Completed forms were reported by fax, email, or telephone to the American Red Cross disaster headquarters.
- ECs were called if they did not report by 11am each day.
- Individual forms were reviewed by medical epidemiologists for further investigation.

Data Analysis

MMWR 2006 Jan;55(02):32-35.

- Data were entered into a database.
- Syndromic data were analyzed using the Early Aberration Reporting System (EARS).
- Elevated cumulative sum scores and suspicious cases and clusters were investigated by telephone.

Syndromic Surveillance



*t = time between detection by syndromic (prediagnostic) surveillance and detection by traditional (diagnosis-based) surveillance.

Centers for Disease Control and Prevention. Syndromic Surveillance: Reports from a National Conference, 2003. MMWR 2004;53(Suppl).

Results

MMWR **TABLE. Average daily incidence* of communicable disease signs and syndromes among persons in hurricane evacuation centers (ECs), by selected conditions — Louisiana, September–October 2005**

Condition	Average daily incidence	Range	Largest reported cluster (no. of cases)
Fever only (>100.4°F [>38°C])	0.5	(0–1.9)	10
Bloody diarrhea	0.1	(0–0.7)	6
Watery diarrhea with or without vomiting	1.8	(0–4.0)	22
Vomiting only (one episode or more)	1.3	(0–6.0)	13
Influenza-like illness	4.7	(0–8.8)	47
Rash	2.7	(0–13.8)	35
Scabies, lice, or other infestation	0.6	(0–3.8)	60
Wound infection	1.6	(0–8.5)	34
Conjunctivitis	0.4	(0–1.8)	10

* Per 1,000 persons.

Results

MMWR 2006 Jan;55(02):32-35.

- Influenza-like illness and rash were the most commonly reported communicable disease syndromes.
- The majority of large clusters were attributed to overreporting.
  - A skin infestation of 60 cases was determined to be four confirmed cases of scabies with the remainder being EC residents treated prophylactically.

Limitations

- The syndromic surveillance system assumed that fax, email, and/or telephone were functional.
- EARS technology is quite sophisticated to apply.

Investigation of Rumors

- Rumors should be investigated fully and rapidly.
- By investigating significant rumors, health officials can assess accurately an evolving situation.

Effective Rumor Control

Wetterhall SF and Noji EK. Surveillance and Epidemiology.
In: Noji E. Public Health Consequences of Disasters, 1997.

- Establish a clear chain of command for disaster-relief efforts.
- Designate a spokesperson for responding to inquiries and providing updates.
- Use surveillance and epidemiologic methods to investigate each rumor.
  - Same stepwise approach for investigating an outbreak

In Summary

- Case definitions of disaster-related illnesses and injuries should be developed.
  - Simple and understandable
- Reporting procedures and easily modifiable standardized forms that can be used in a variety of settings should be developed.
- When available, collect baseline information.

Methodological Problems

Wetterhall SF and Noji EK. Surveillance and Epidemiology.
In: Noji E. Public Health Consequences of Disasters, 1997.

- Compromise between timeliness and accuracy
- Competing priorities for information
- Logistical constraints
- Absence of baseline information
- Denominator data unavailable
- Underreporting of health events
- Lack of representativeness
- Resource costs of collecting and analyzing data
- Lack of standardized reporting mechanism