Epidemiology Of Children In Disasters

"Disaster Management and Emergency Preparedness: The Pediatrician's Role"
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Definitions

- Infectious agent
  - Capable of causing infection
- Infectious disease
  - Illness caused by infectious agent
- Contagious disease (common term)
  - Transmissible by direct or indirect means (usually refers to actual transmissibility)
- Communicable disease (correct term)
  - Transmissible by direct or indirect means (usually refers to potential transmissibility)

Definitions

- Infectivity
  - How readily an agent infects host
- Infectiousness
  - How readily an agent infects others
- Pathogenicity
  - How readily an agent causes overt disease
- Virulence
  - How readily an agent causes severe disease

Definitions

- Incidence
  - "The number of instances of illness commencing . . . during a given period in a specified population"*
- Prevalence
  - "The number of . . . instances of a given disease . . . in a given population at a designated time"*
- Number
  - Actual number of patients afflicted with a given illness
- Rate
  - Crude, category-specific, age- and sex-adjusted
    - Usually stated per 100,000 population to yield whole number
    - May require calculation of "synthetic" estimates for localities

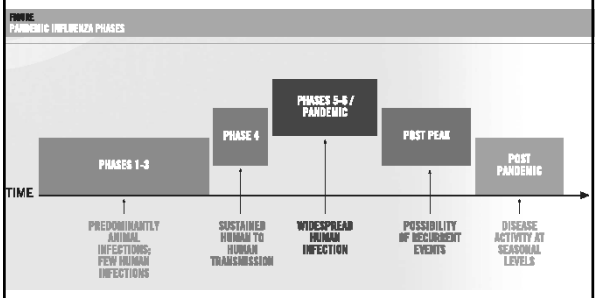
*Modified from Last JM, ed, *Dictionary of Epidemiology*

Definitions

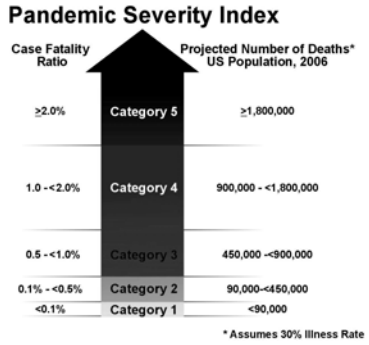
- Epidemic
  - "The occurrence . . . of cases of an illness . . . clearly in excess of normal expectancy"*
- Epizootic
  - "An outbreak . . . of disease in an animal population (. . . that may also affect human populations)"*
- Endemic
  - "The constant presence of a disease . . . within a given geographic area or population group"*
- Pandemic
  - "An epidemic occurring over a very wide area . . . and usually affecting a large number of people"*

*Modified from Last JM, ed, *Dictionary of Epidemiology*

Pandemic Influenza Phases



Pandemic Severity Index



Epidemiology 101

- Probability of Transmission
  - Chance of transmission of infection from one host to another given contact between them
- Secondary Attack Rate* (SAR)
  - Probability of illness among susceptible hosts following contact with primary (index) case
- Basic Reproductive Number (R_0†)
  - Expected number of new infections from an index case in a susceptible population

*Not a rate, but a proportion †Pronounced "R naught"

Epidemiology 102

- Generally speaking . . .
  - If $R_0 > 1$, the epidemic will progress
  - If $R_0 < 1$, the epidemic will regress
  - If $R_0 = 1$, illness will become endemic
- But it's not really that simple . . .
  - R_0 does not include 2° or asymptomatic cases
  - R_0 is an average, so local clusters will occur
  - R_0 has 4 subcomponents that affect its value
    - Duration of infectious period
    - Number of infectious contacts
    - Transmission probability
    - Infectiousness potential

Epidemiology 103

- Strategies for epidemic control modify R_0!
  - Decrease the contact rate
    - Social distancing
    - Sanitary etiquette*
    - Cohorting (quarantine)
  - (Pre)Treat the infected patient
    - Attenuate pathogenicity of agent
    - Shorten the infectious period
    - Reduce shedding of agent

*Respiratory (airborne droplet), handwashing (body fluids) ± masks, gloves

Epidemiology 104

- Counterintuitive goals of triage in bioevents
  - ***Primarily*** to **prevent** *secondary* infections
  - ***Secondarily*** to **control** *primary* infections
- "Minimum Qualifications for Survival" (MQS)*
- "SEIRV" Bioevent Triage Methodology
  - **S**usceptible but not exposed: info from media
  - **E**xposed but not infected: info from "PHAP†"
  - **I**nfected: PCP‡ → home; 911 → hospital
  - **R**emoved by death or recovery: info to relatives
  - **V**accinated or protected by medication: reassure

*Defined by regional Health Emergency Operations Center (HEOC) based on availability of resources immediately or readily deployable

†Public Health Answering Point ‡Primary Care Provider

H1N1

- United States, April 20-August 30, 2009
  - 9,079 proven hospital H1N1 cases, 593 deaths
- United States, August 30 - October 17, 2009
  - 21,823 hospital influenza cases, 2,416 deaths
- United States, April 20 - October 17, 2009
  - 102 pediatric deaths , 95 proven H1N1
  - 11 pediatric deaths this week, 9 proven H1N1

Most Pediatric Disasters Are Disasters Involving Physical Trauma And Burns

- 24/24 reports of disasters affecting children published to date in the English language pediatric literature involve physical trauma, burn, or chemical related injuries

Natural Disasters	*Human Disasters**
• 4 - earthquakes	• 6 - bomb blasts
• 2 - hurricanes*	• 1 - dynamite blast
• 1 - tsunami	• 1 - bus crash
• 1 - lightning strike	• 1 - airplane crash
• 1 - blizzard	• 1 - boating crash
	• 1 - hospital fire
	• 1 - mass shooting
	• 3 - gas poisonings

*Plus Hurricane Katrina

*Excluding war wounds

Hurricanes

Quinn B, Baker R, Pratt J, et al: *Ann Emerg Med* 1994;23:737-741
Damien F, Atkinson CC, Bouchard A, et al: *J Emerg Nurs* 1997;23:545-549
Johnston C, Redlener I, eds: *Pediatrics* 2006;117:S3358-S460

- First week following hurricane: 50% increase in volume
- Second week following hurricane: baseline volume
- Diagnoses significantly different during first week
  - AGE, impetigo, open wounds seen more often
  - GU problems, abdominal pain, ST injuries seen less often
- Diagnoses significantly different during second week
  - Dermatologic problems, cellulitis, injuries, open wounds seen more often
  - Respiratory problems including URIs seen less often
- Trend toward increased number of hydrocarbon or bleach poisonings
- Trend toward decreased number of behavioral complaints

Earthquakes

Iskit SH, Alpay H, Tugtepe H, et al: *J Pediatr Surg* 2001;36:368-372
Jain V, Nopronen R, Smith BM, et al: *J Pediatr Surg* 2003;38:663-667
Abolghasemi H, Sabzechian M, Radfar MH, et al: *Prehosp Disast Med* 2005;20:s11-s12
Radfar MH, Sabzechian M, Abolghasemi H, et al: *Prehosp Disast Med* 2005;20:s12

- Prolonged extrication and transport: hours, days
- Nearly half the survivors will have crush injuries
  - Two thirds of these have acute renal failure
  - No correlation between crush syndrome and time under rubble, time before admission, number of crushed limbs
- Over half the survivors will have other injuries
  - Soft tissue, CNS injuries
  - Extremity, spine, pelvic fractures

Asian Tsunami in Sri Lanka

Patabendi P: *Prehosp Disast Med* 2005;20:s125-s126

- Some ~50,000 lives were lost; ~20,000 were children
- Thousands lost homes, schools, and were displaced
- Many lost one or both parents, siblings, loved ones
- Most sustained immense, irreparable psychic trauma
- Many faced threats of sexual and other forms of child abuse, as well as unreported human trafficking
- Refugee camps were austere and dilapidated, despite vigorous actions by public health organizations

Lightning Strike

Myers GJ, Colgan MT, VanDyke DH: *JAMA* 1977;238:1045-1046

- Associated with group recreational activities outdoors
- Mostly occur in high summer due to thunderstorms
- Victims typically seek shelter fro rain under trees
- Approximately 25% of the children will be affected
- Common serious pathology includes the following:
  - VF/VT leading to cardiopulmonary arrest and sudden death or TBI and coma, with or without recovery
  - Severe burns leading to temporary or permanent paresis
  - Minor burns associated with complete recovery

Blizzard

Attia MW: *Prehosp Emerg Care* 1998;2:285-288

- 35% increase in pediatric ED visits before the storm
- 85% decrease in pediatric ED visits during the storm
- 40% decrease in pediatric ED visits after the storm
- 29% were considered urgent vs. 15% at other times
- 22% overall admission rate vs. 8% at other times
- Proportional increase in case types other than asthma

Fireworks Explosion

Knapp JF, Sharp RJ, Beatty R, et al: *Pediatr Emerg Care* 1990;6:122-126

- Typically involve illegal high energy firecracker
- Force of the blast often causes building collapse
- Injuries parallel those seen following bomb blasts
- Presentation often includes the following conditions:
  - Respiratory failure, decompensated shock, traumatic coma
  - Deformities and tissue loss of the head, face, and neck
  - Severe TBI with massive cerebral edema
  - Soft tissue avulsions involving upper body
  - Pulmonary and intestinal contusions
  - Traumatic amputation of upper > lower extremities
  - Multiple avulsions, lacerations, contusions of skin

Bus Crash

Wass AR, Williams MJ, Gibson MF: *Injury* 1994;25:371-374

- "Every emergency physician's nightmare"
- Prenotification is usually insufficient
- Disaster plan implementation delayed
- Most have minor injuries
  - Soft tissue injuries/lacerations to head and face, upper and lower limbs
- Some have major injuries
  - Most are TBIs, some may require neurosurgical intervention

Airplane Crash

vanAmerongen RH, Fine JS, Tunik MG, et al: *Pediatrics* 1993;92:105-110

- More children will survive than adults
- One third to one half will sustain high risk injuries
  - Severe TBI, typically with intracranial bleeding
  - Hypotensive shock with massive hemothorax or femur fractures
- Children are often mistriaged and transported to non-pediatric-capable facilities
- State, regional, and county disaster plans did not address pediatrics

Boating Crash

Vukmir RB, Paris PM: *Am J Emerg Med* 1991;9:64-71

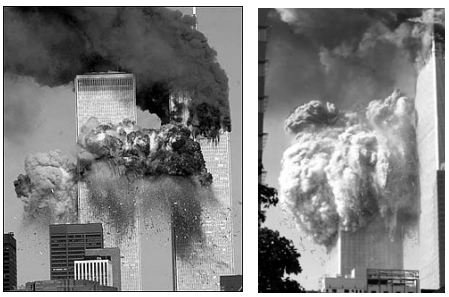
- 12 of 24 victims were children
- Majority were seriously injured
  - Pelvic herniation/gastrocnemius laceration - 1
  - Subdural hematoma/compartment syndrome - 1
  - Pancreatic transection/splenic laceration - 1
  - Bilateral intraarticular knee laceration - 1
  - Multiple long bone fractures - 1
  - Pulmonary contusion - 1
  - Traumatic brain injury

Bomb Blast in Oklahoma City, Oklahoma

Quintana DA, Jordan JB, Tuggle DW, et al: *J Pediatr Surg* 1997;32:307-311

- 66 of 816 casualties of the Alfred P. Murrah Federal Building bombing in Oklahoma City, Oklahoma on 4/19/95 were children
- 20 children were seated by window in day care center
- 19 children injured in bombing died, 16 in day care center
  - 90% had skull fractures, most with skull capping
  - Associated injuries: 37% trunk, 31% amputations, 47% arm fractures, 26% leg fractures, 21% burns, 100% soft tissue injuries
- 47 children injured in bombing survived
  - 15% required hospitalization
  - Documented injuries: 2 open depressed skull fractures with partially extruded brain, 2 closed head injuries, 3 arm fractures, 1 leg fracture, 1 arterial injury, 1 splenic injury, 5 tympanic membrane perforations, 4 burns (1 burn > 40% TBSA)

The Day The World Changed



Israeli Experience: Epidemiology

Aharonson-Daniel L, Waisman Y, Dannan YL, et al: *Pediatrics* 2003;112:e280

- Terror-related injuries constitute 1.5% of all traumatic injuries
  - Mean age: 12.3 yr terror vs. 6.9 yr non-terror
  - Body region: 0.5x fewer TBI, 2.5x greater other head and body injuries
- Terror-related injuries more severe, needed more acute care
  - Internal truncal injuries: 11% terror vs. 4% non-terror
  - Open head wounds: 13% terror vs. 6% non-terror
  - Critical injuries (ISS ≥25): 25% terror vs. 3% non-terror
  - Use of ICU: 33% terror vs. 8% non-terror
  - LOS: 5 days terror vs. 2 days non-terror
  - Need for rehabilitation: 17% terror vs. 1% non-terror

Israeli Experience: Prehospital

Waisman Y, Aharonson-Daniel L, Mor M, et al: *Prehosp Disast Med* 2003;18:242-248

- Based on 41 "limited" MCEs involving children 9/00 - 12/02
- Average 32 BLS, 9 ALS units; 93 EMT-Bs, 19 EMT-Ps, 8 MDs
- First responders, volunteer off duty professionals also helped
- "Scoop and run" on scene field management approach
- Evacuation time: 5-10 min, urban; 10-20 min, rural
- Victims were evacuated to multiple facilities in most cases
  - Most injuries caused by blasts and penetrations by foreign objects
  - Two thirds of children had multiple injuries
  - High proportion of critical to fatal injuries
  - Higher rate of surgical interventions than nonterror injuries
  - Longer hospital stays than nonterror injuries
  - Greater need for rehabilitation than nonterror injuries

Israeli Experience: Terror Injuries

Kluger Y, Peleg K, Daniel-Aharonson L, et al: *J Am Coll Surg* 2004;199:875-879

- Review of Israeli National Trauma Registry from 10/00 to 6/03
- 906 of 16,438 (1.6%) of injuries (all patients) were terror-related
- 62 of 16,438 (0.4%) of injuries (ped patients) were terror-related
- Terror injuries 3x (61% vs. 23%) more often multiple
- Terror injuries 3x (29% vs. 10%) more often severe (ISS >15)
- Terror injuries 3x (6% vs. 2%) more often lethal
- Terror injuries 4x (26% vs. 7%) more often needed ICU care
- Terror injuries 5x more often required surgical intervention

Israeli Experience: Civilian Injuries

Amir LD, Daniel-Aharonson L, Peleg K, et al: *Ann Surg* 2005;241:666-672

- Review of Israeli National Trauma Registry from 10/00 to 6/02
- 158 children hospitalized for acts against civilian populations
- 1.4% of injured children hospitalized, 10.9% of hospital deaths
- Explosions: 114 (72%); shootings: 34 (22%); other: 10 (6%)
- Older children more frequently injured by explosions
- Explosive injuries were more often critical or lethal
- Limbs: 63%; head/face: 47%; chest/belly: 37%; brain: 18%
- More than one body region injured in 63%
- Explosive injuries: 1/3 less belly trauma; 1/5 more limb trauma
- 7 inhospital deaths (6 2° TBI, all due to explosions in 15-18 yo)

Response to Pediatric Firearm Trauma: Firearm Terror in Beslan, Russia

Rozinov V, Goncharov CF, Vetlakh VI, et al. *Prehosp Disast Med* 2005;20:s12

- ~600 hostages taken by Chechyan separatists
- 311 of ~600 hostages were children
  - 5 were agonal, triaged as expectant
  - 52 were wounded, triaged as immediate
  - 199 were wounded, treated as delayed
- 256 were wounded, 47 needed operations
  - 7 on thorax or abdomen
- 55 admitted, needed no further assistance
- 385 ultimately hospitalized
- 146 transferred to Moscow or Rostov

Summary

- Data is all anecdotal
- Inaccurate numerators
- Unknown denominators
- Children are often injured
- Best information from Israel
- Disaster registry vitally needed