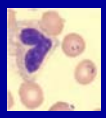




Infectious Disease in Disaster

Michelle McDonald, MD
Chief Medical Officer
Pima County Health Department
Michelle.McDonald@pima.gov

Risk for Infectious Disease Outbreak after Disaster associated with:

- Population displacement
- Availability of safe water and sanitation facilities
- Degree of crowding
- Underlying health status of the population, including level of immunity to VPDs and malnutrition
- Availability of healthcare services
- Local disease ecology
- Degree of disruption of public health infrastructure

Population Displacement

- Natural disasters, regardless of type, that do not result in population displacement rarely associated with outbreaks
- Conflict affected populations that have been displaced have been more commonly reported to have outbreaks of infectious disease. Up to 2/3 of deaths in these populations may be due to communicable disease.
- Risk for outbreak after disaster is often exaggerated by health officials and by media.

http://www.globalissues.eu/additional.html

Endemic Organisms Predominate

- Northridge Earthquake 1994
  nine fold increase in coccidiomycosis from Jan-March, risk factor of being in dust cloud
- Mount St. Helen's eruption 1980
  giardiasis outbreak after increased run off in Red Lodge, Montana from increased ash
- Would be rare in US to see outbreak of Hepatitis A, typhoid, cholera, malaria, measles, etc.

http://www.nasa.gov/centers/goddard/images/content/95249main_theb13651.jpg

Epidemics after Disaster
Influence of Public Health Infrastructure

SF 1907	Fire	Plague	Quarantine failure
Duluth, MN 1918	Forest Fire	Influenza	Crowding, pandemic
Haiti, 1963	Hurricane	Malaria	Vector control stopped
Italy, 1976	Earthquake	Salmonella carriers	Water sanitation stopped

Sandrock C. Infectious Diseases and Natural Disasters (1)

http://www.consrv.ca.gov/cgs/geologic_hazards/earthquakes/PublishingImages/SFEq06_03.jpg

Influence of Phase of Disaster

- Impact Phase (day 0-4)
  *extrication
  *immediate soft tissue infections
- Post Impact Phase (4d – 4 weeks)
  *airborne, foodborne, waterborne and vector borne/zoonotic infections
- Recovery Phase (>4 weeks)
  *infections with long incubation, vector borne or zoonotic

Impact Phase

- Skin and soft tissue disruption
  *infected wounds, inc. from staph and MRSA, vibrio species if exposure to sea/brackish water
  *tetanus prevention

Vaccination history	Clean, minor wounds	All other wounds
Unknown or <3 doses	Td or Tdap (Tdap preferred for ages 11-64 if not previously received)	Td or Tdap PLUS TIG
≥3 doses and 6-10 years since last dose		Td or Tdap
≥3 doses and >10 years since last dose	Td or Tdap	Td or Tdap

http://emergency.cdc.gov/disasters/disease/tetanus.asp

Post Impact Phase – Water borne and/or Food borne (Disruption of Sanitation)

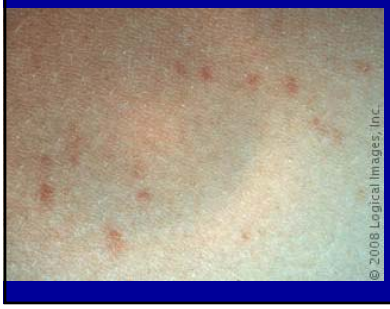
- Gastroenteritis (nonspecific) – hydration and improved hygiene
- Gastroenteritis – viral: Norovirus, Rotavirus, Hepatitis A, E – hydration and improved hygiene
- Gastroenterities – bacterial: shigellosis, salmonellosis, cholera; cholera more likely in developing world, relatively rare in developed world; hydration mainstay of therapy

Bacterial Gastroenteritis

Agent	Sx/course	Incub	Infect	Exclude	Rx
Shigella	Diarrhea (may be bloody), fever, abd cramps	1-3 d	onset to up to 4 wks out	Ill/ill contacts from food handling, pt care, infant care	If severe, immunocomp, to protect contacts; local R trends
Salmonella	Diarrhea, fever, abd cramps, H/A, N, occ V	12-36 hrs	Through sx, variable if carrier	"	<2 mo, elderly, debilitated, sickle cell, HIV, xtra intestinal; quinalone or amp
Salmonella enterica subs *enterica* serovar *typhi*	Systemic, fever, H/a, malaise, cough, rash, bradycardia, constipation	8-14d 1-10 d for *S. Paratyphi*	1st week through convalescence, more if carrier	"	Carriers, <2mo, elderly, debilitated, HIV; quinalone local R trends

Typhoid Fever Rash

- "rose spots" – flat red spots



http://www.visualdxhealth.com/atlas/typhoidFever-self/Care.htm

Bacterial Gastroenteritis and other Post Impact Phase Infections

Agent	Sx/course	Incub	Infect	Exclude	Rx
Vibrio cholera Serogroup 01 & 0139 FLOODS NEAR SEA	Mild-severe watery diarrhea; sepsis in immunocomp or w liver disease Occ wound infections	2-3d	Few d after recov but carriers	May prophy contacts who share food/drink; tetracyclines	If severe, antibiotics may shorten course of diarrhea; tetracyclines
Leptospirosis (contact w water, food or soil contaminated w urine of infected animals) FLOODS	1st phase: fever, chills, myalgia, V, D, jaundice, conjunctival suffusion, abd pain, transient rash 2nd phase: renal failure, liver failure, meningoencephalitis, pulmonary hemorrahage w resp failure	5-14 d	n/a	n/a	Penicillin, amoxicillin, doxycycline Dx w serology

Hogs on a Hot Tin Roof: Stranded on a roof in flooded Oakville, Iowa these hogs try to stay high and dry. Expect livestock prices to be on the rise too.

Source: Wall Street Journal 6/20/08

http://burnickblog.sovereignsociety.com/images/2008/06/26/hogs.png

http://www.who.int/zoonoses/diseases/Leptospirosis1_ok.jpg

Conjunctival suffusion

Post Impact Phase – Vector borne Infections

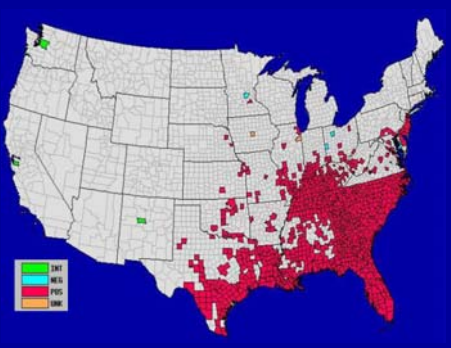
- West Nile Virus, SLE endemic in US
- Malaria very significant worldwide; regularly see introduced cases in US – theoretically could get to effective vector (*Anopheles*), especially if disrupted vector control activities and increased mosquito breeding habitat
- Dengue – endemic cases in Texas and is at increased rates in northern Mexico; vector (*Aedes aegypti* and *albopictus*) widespread in S. United States
- Yellow Fever – rare in US; vector *Aedes aegypti present*
- Typhus – endemic in mountainous Mexico, Central and S. America, central and eastern Africa, Asia (cooler areas where lice are common); zoonosis of flying squirrels in US

2005

Distribution of *Aedes aegypti*

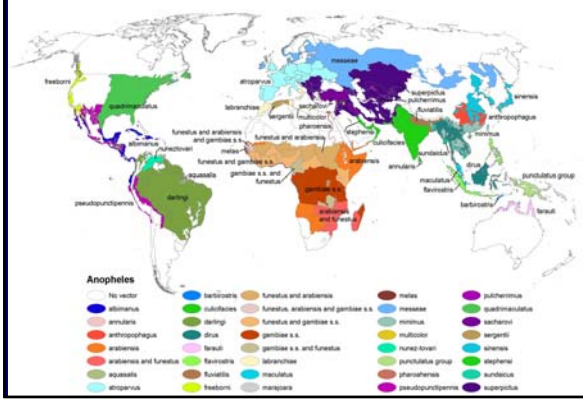
1970 2002

http://www.cdc.gov/ncidod/dvbid/dengue/map-ae-aegypti-distribution.htm



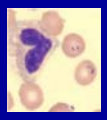
Distributoin of *Aedes albopictus* in the US by County, 2000, http://www.cdc.gov/ncidod/dvbid/arbor/albopic_97_sm.htm

Global distribution (Robinson projection) of dominant or potentially important malaria vectors. From Kiszewksi et al., 2004. American Journal of Tropical Medicine and Hygiene 70(5):486-498.



Malaria

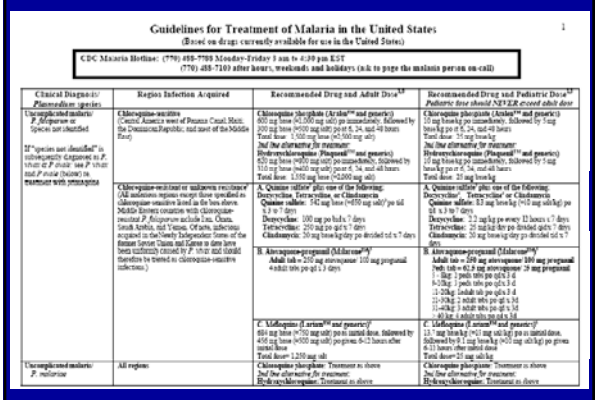
- 1,337 cases in US in 2002, >50% *P. falciparum*
- Sx (uncomplicated) non specific: fever, chills, sweats, H/A, GI sx, body aches, malaise; complicated (*P. falciparum*): jaundice, hepatomegaly, respiratory distress, neurologic sx
- Dx: microscopy – identify parasite, quantify degree of parasitemia
- Rapid antigen tests (not in US)
- PCR



http://www.cdc.gov/malaria/diagnosis_treatment/diagnosis.htm

Malaria continued

- Severe illness w *P. falciparum* with multiple organ failure: CNS (impaired consciousness, coma), severe hemolytic anemia, hemoglobinuria, pulmonary edema, ARDS, thrombocytopenia, abnormal coags, acute renal failure, hyperparasitemia (>5% RBCs w parasites), metabolic acidosis, hypoglycemia.
- *P. vivax* and *P. ovale* must treat dormant hypnozoites in liver after completing primary therapy to prevent relapses
- *P. falciparum* and *P. vivax* species have different drug sensitivities dependent on geography
- Treat uncomplicated malaria w oral meds, complicated malaria w parenteral meds



Guidelines for Treatment of Malaria in the United States 1

(Based on drugs currently available for use in the United States)

CDC Malaria Hotline: (770) 488-7788 Monday-Friday 9 am to 4:30 pm EST
(770) 488-7100 after hours, weekends and holidays (ask to page the malaria person on-call)

Clinical Diagnosis/ *Plasmodium* species	Region Infection Acquired	Recommended Drug and Adult Dose[17]	Recommended Drug and Pediatric Dose[17] *Pediatric dose should NEVER exceed adult dose*
Uncomplicated malaria/ *P. falciparum* or species not identified If "species not identified" is subsequently diagnosed as *P. vivax* or *P. ovale* use *P vivax* and *P ovale* (below) in manner with youngers	Chloroquine-sensitive (Central America west of Panama Canal Main, the Dominican Republic, and most of the Middle East)	Chloroquine phosphate (Aralen™ and generic): 600 mg base (=1,000 mg salt) po immediately, followed by 300 mg base (=500 mg salt) po at 6, 24, and 48 hours Total dose: 1,500 mg base (=2,500 mg salt) *2nd line alternative for treatment:* Hydroxychloroquine (Plaquenil™ and generic): 620 mg base (=800 mg salt) po immediately, followed by 310 mg base (=400 mg salt) po at 6, 24, and 48 hours Total dose: 1,550 mg base (=2,000 mg salt)	Chloroquine phosphate (Aralen™ and generic): 10 mg base/kg po immediately, followed by 5 mg base/kg po at 6, 24, and 48 hours Total dose: 25 mg base/kg *2nd line alternative for treatment:* Hydroxychloroquine (Plaquenil™ and generic): 10 mg base/kg po immediately, followed by 5 mg base/kg po at 6, 24, and 48 hours Total dose: 25 mg base/kg
	Chloroquine-resistant or unknown resistance[2] (All malarious regions except those specified as chloroquine-sensitive listed in the box above. Middle Eastern countries with chloroquine-resistant *P. falciparum* include Iran, Oman, Saudi Arabia, and Yemen. Others, infections acquired in the Newly Independent States of the former Soviet Union and Korea to date have been uniformly caused by *P. vivax* and should therefore be treated as chloroquine-sensitive infections.)	A. Quinine sulfate[3] plus one of the following: Doxycycline, Tetracycline, or Clindamycin Quinine sulfate: 542 mg base (=650 mg salt)[3] po tid x 3 to 7 days Doxycycline: 100 mg po bid x 7 days Tetracycline: 250 mg po qid x 7 days Clindamycin: 20 mg base/kg/day po divided tid x 7 days	A. Quinine sulfate[3] plus one of the following: Doxycycline,[4] Tetracycline[5] or Clindamycin Quinine sulfate: 8.3 mg base/kg (=10 mg salt/kg) po q8 x 3 to 7 days Doxycycline: 2.2 mg/kg po every 12 hours x 7 days Tetracycline: 25 mg/kg/day po divided qid x 7 days Clindamycin: 20 mg base/kg/day po divided tid x 7 days
		B. Atovaquone-proguanil (Malarone™)[6] Adult tab = 250 mg atovaquone/100 mg proguanil 4 adult tabs po qd x 3 days	B. Atovaquone-proguanil (Malarone™)[6] Adult tab = 250 mg atovaquone/100 mg proguanil Peds tab = 62.5 mg atovaquone/25 mg proguanil 11-20kg: 2 peds tabs po qd x 3 d 21-30kg: 3 peds tabs po qd x 3 d 31-40kg: 4 peds tabs po qd x 3 d >40 kg: 1 adult tab po qd x 3 d
		C. Mefloquine (Lariam™ and generic)[7] 684 mg base (=750 mg salt) po as initial dose, followed by 456 mg base (=500 mg salt) po given 6-12 hours after initial dose Total dose= 1,250 mg salt	C. Mefloquine (Lariam™ and generic)[7] 13.7 mg base/kg (=15 mg salt/kg) po as initial dose, followed by 9.1 mg base/kg (=10 mg salt/kg) po given 6-12 hours after initial dose Total dose= 25 mg salt/kg
Uncomplicated malaria/ *P. malariae*	All regions	Chloroquine phosphate: Treatment as above *2nd line alternative for treatment:* Hydroxychloroquine: Treatment as above	Chloroquine phosphate: Treatment as above *2nd line alternative for treatment:* Hydroxychloroquine: Treatment as above

Guidelines for Treatment of Malaria in the United States

(Based on drugs currently available for use in the United States)

2

CDC Malaria Hotline: (770) 488-7788 Monday-Friday 8 am to 4:30 pm EST
(770) 488-7100 after hours, weekends and holidays (ask to page the malaria person on-call)

Clinical Diagnosis/ *Plasmodium* species	Region Infection Acquired	Recommended Drug and Adult Dose[1,2]	Recommended Drug and Pediatric Dose[1,2] *Pediatric dose should NEVER exceed adult dose*
Uncomplicated malaria/ *P. vivax* or *P. ovale*	All regions[7] Note: for suspected chloroquine-resistant *P. vivax*, see row below	Chloroquine phosphate plus Primaquine phosphate[7] Chloroquine phosphate: Treatment as above Primaquine phosphate: 30 mg base po qd x 14 days *2nd line alternative for treatment:* Hydroxychloroquine plus Primaquine phosphate[7] Hydroxychloroquine: Treatment as above Primaquine phosphate: 30 mg base po qd x 14 days	Chloroquine phosphate plus Primaquine phosphate[7] Chloroquine phosphate: Treatment as above Primaquine phosphate: 0.5 mg base/kg po qd x 14 days *2nd line alternative for treatment:* Hydroxychloroquine plus Primaquine phosphate[7] Hydroxychloroquine: Treatment as above Primaquine phosphate: 30 mg base po qd x 14 days
Uncomplicated malaria/ *P. vivax*	Chloroquine-resistant[8] (Papua New Guinea and Indonesia)	A. Quinine sulfate[7] plus either Doxycycline or Tetracycline plus Primaquine phosphate[7] Quinine sulfate: Treatment as above Doxycycline or Tetracycline: Treatment as above Primaquine phosphate: Treatment as above	A. Quinine sulfate[7] plus either Doxycycline[7] or Tetracycline[7] plus Primaquine phosphate[7] Quinine sulfate: Treatment as above Doxycycline or Tetracycline: Treatment as above Primaquine phosphate: Treatment as above
		B. Mefloquine plus Primaquine phosphate[7] Mefloquine: Treatment as above Primaquine phosphate: Treatment as above	B. Mefloquine plus Primaquine phosphate[7] Mefloquine: Treatment as above Primaquine phosphate: Treatment as above
Uncomplicated malaria: alternatives for pregnant women[9,10,11]	Chloroquine-sensitive[12] (see uncomplicated malaria sections above for chloroquine-sensitive *Plasmodium* species by region)	Chloroquine phosphate: Treatment as above *2nd line alternative for treatment:* Hydroxychloroquine: Treatment as above	Not applicable
	Chloroquine resistant *P. falciparum*[[illegible]] (see uncomplicated malaria sections above for regions with known chloroquine resistant *P. falciparum*)	Quinine sulfate[7] plus Clindamycin Quinine sulfate: Treatment as above Clindamycin: Treatment as above	Not applicable
	Chloroquine-resistant *P. vivax*[[illegible]] (see uncomplicated malaria sections above for	Quinine sulfate Quinine sulfate: 650 mg[7] salt po tid x 7 days	Not applicable

Guidelines for Treatment of Malaria in the United States

(Based on drugs currently available for use in the United States)

3

CDC Malaria Hotline: (770) 488-7788 Monday-Friday 8 am to 4:30 pm EST
(770) 488-7100 after hours, weekends and holidays (ask to page the malaria person on-call)

	regions with chloroquine-resistant *P. vivax*)		
Severe malaria[[illegible]]	All regions	Quinidine gluconate[7] plus one of the following: Doxycycline, Tetracycline, or Clindamycin Quinidine gluconate: 6.25 mg base/kg (=10 mg salt/kg) loading dose IV over 1-2 hrs, then 0.0125 mg base/kg/min (=0.02 mg salt/kg/min) continuous infusion for at least 24 hours. An alternative regimen is 15 mg base/kg (=24 mg salt/kg) loading dose IV infused over 4 hours, followed by 7.5 mg base/kg (=12 mg salt/kg) infused over 4 hours every 8 hours, starting 8 hours after the loading dose (see package insert). Once parasite density <1% and patient can take oral medication, complete treatment with oral quinine, dose as above. Quinidine/quinine course = 7 days in Southeast Asia; = 3 days in Africa or South America. Doxycycline: Treatment as above. If patient not able to take oral medication, give 100 mg IV every 12 hours and then switch to oral doxycycline (as above) as soon as patient can take oral medication. For IV use, avoid rapid administration. Treatment course = 7 days. Tetracycline: Treatment as above Clindamycin: Treatment as above. If patient not able to take oral medication, give 10 mg base/kg loading dose IV followed by 5 mg base/kg IV every 8 hours. Switch to oral clindamycin (oral dose as above) as soon as patient can take oral medication. For IV use, avoid rapid administration. Treatment course = 7 days.	Quinidine gluconate[7] plus one of the following: Doxycycline[7], Tetracycline[7], or Clindamycin Quinidine gluconate: Same mg/kg dosing and recommendations as for adults. Doxycycline: Treatment as above. If patient not able to take oral medication, may give IV. For children <45 kg, give 2.2 mg/kg IV every 12 hours and then switch to oral doxycycline (dose as above) as soon as patient can take oral medication. For children >45 kg, use same dosing as for adults. For IV use, avoid rapid administration. Treatment course = 7 days. Tetracycline: Treatment as above Clindamycin: Treatment as above. If patient not able to take oral medication, give 10 mg base/kg loading dose IV followed by 5 mg base/kg IV every 8 hours. Switch to oral clindamycin (oral dose as above) as soon as patient can take oral medication. For IV use, avoid rapid administration. Treatment course = 7 days

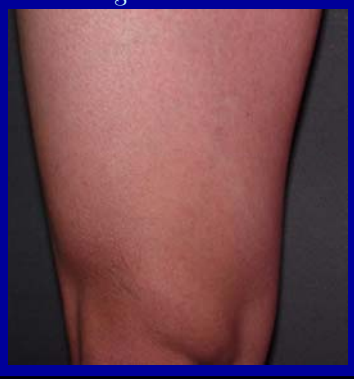
http://www.cdc.gov/malaria/pdf/treatmenttable.pdf

CDC Malaria Hotline: (770) 488-7788 M-F 8-4:30 EST, (770) 488-7100 after hours

Dengue

- 4 serotypes, no cross immunity; severity of clinical disease increases w each infection
- Undifferentiated fever or no sx in up to 87%, esp kids
- Classic Dengue Fever ("break bone fever")
  Sx: fever (3-14 d after mosquito bite), frontal H/A, retro-orbital pain, myalgias, arthralgias, N, V, maculopapular rash. Acute sx last ~1 week; weakness, malaise, anorexia may persist several weeks.
  Rx: symptomatic with emphasis on oral hydration. Avoid ASA/NSAIDS.

Rash of Dengue Fever

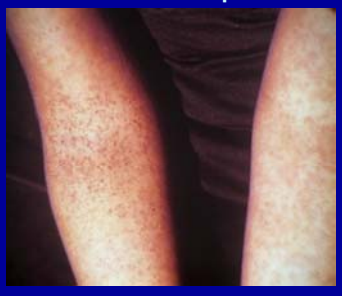


http://bepast.org/dataman.pl?c=lib&frame_nav=1&dir=docs/photos/dengue/

Dengue continued

- Dengue Hemorrhagic Fever (DHF)
  As fever from DF decreases, pt develops increased restlessness or lethargy, mild signs of circulatory failure and hemorrhagic sx – commonly mild such as petechiae, microscopic hematuria, but may progress to epistaxis, bleeding gums, hematemesis, melena.
  May see thrombocytopenia and hemoconcentration.
  May rapidly progress to Dengue Shock Syndrome (DSS), which has ~10% mortality if not treated.

Positive Tourniquet Test



■Inflate blood pressure cuff to a point midway between systolic and diastolic pressure for 5 minutes. Positive result if >20 petechiae in 1 square inch.

http://www.cdc.gov/ncidod/dvbid/dengue/slideset/set1/pps/slides-vi.pps#318,9,Tourniquet Test

Dengue continued

- Dengue Shock Syndrome (DSS)
  Shock caused by loss of intravascular volume from leaky capillaries rather than from hemorrhagic causes. Early warning signs: severe abd pain, protracted V, marked change in temp (↑ or ↓), change in mental status. May progress to shock - restlessness, cold clammy skin, rapid weak pulse, narrow pulse pressure, hypotension.
  Rx of DHS and DSS – mainstay is IV fluid replacement – can reduce fatality to <1%. Use acetaminophen based pain/fever control meds (ASA, NSAIDS may increase bleeding or cause Reyes syndrome in children).
- Dx: acute serum w/in 5 d onset fever for virus isolation or "convalescent" specimen ≥6 d after onset sx for serology.

Post Impact Phase Infections - Respiratory

- Viral, especially URI's, especially in children under 5
- CAP

pro.corbis.com/images/42-16531240.jpg?size=57...

Recovery Phase Infections

Need longer incubation period

- Tuberculosis – may need to consider at earlier phases due to disruption of care for those in treatment
- Coccidioidomycosis
- Leptospirosis

Nature of the Disaster

- Earthquakes → crush injuries, soft tissue infections
- Floods → disruption of water and sanitation systems, will see more water borne and vector borne/zoonotic infections
- Famines, refugee generating armed conflicts → airborne and waterborne infections (measles, diarrheal illnesses and acute respiratory illnesses most common cause of infection related deaths)

General Disaster Reminders

- Vaccinations are the mainstay of outbreak control in many situations (less so in US).
- Dead bodies pose little to no infectious disease risk Workers handling dead bodies should use universal precautions for blood/body fluids, use/correctly dispose of glove, use body bags if available, hand washing w soap after handling bodies and before eating, disinfect vehicles and equipment.
- Early surveillance and hygiene can stem outbreaks.

Measures to Reduce risk of Communicable Diseases after Disaster

- Early dx/rx of diarrheal disease and ARI, esp in <5 yrs
- Availability/use of treatment protocols for the main communicable disease threats, based on what is endemic
- Proper wound cleaning/care inc. appropriate tetanus proph
- Availability of meds/supplies such as oral/IV rehydration solutions, antimicrobials, etc
- Distribution of health education messages emphasizing good hand hygiene practices, safe food preparation techniques, boiling/chlorination of water, seek Rx early if fever, vector control adapted to local context/epi, mass vaccination if measles vax rate low

References

1. Sandrock C. Infectious Diseases and Natural Disasters. California Preparedness Education Network. 2006. http://phs.ucdavis.edu/Intl/media/IHConf2006/11-10 accessed 10/31/08
2. Watson JT, Gayer M, Connolly MA. Epidemics after natural disasters. EmergInfectDis. 2007 Jan. http://www.cdc.gov/ncidod/EID/13/1/1.htm accessed 10/31/08
3. www.CDC.gov multiple sites