

# Keynote: Disaster and infection

- 1 Risk of infectious diseases emerging after a disaster
- 2 Identify patients according to syndromes
- 3 How to determine the morbidity status in a disaster area
- 4 Control of infection outbreak in a shelter

Tokyo Metropolitan Government, January 29, 2019

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# A ○○ disaster of unprecedented magnitude hit ○○ district!

## [ Natural disasters ]

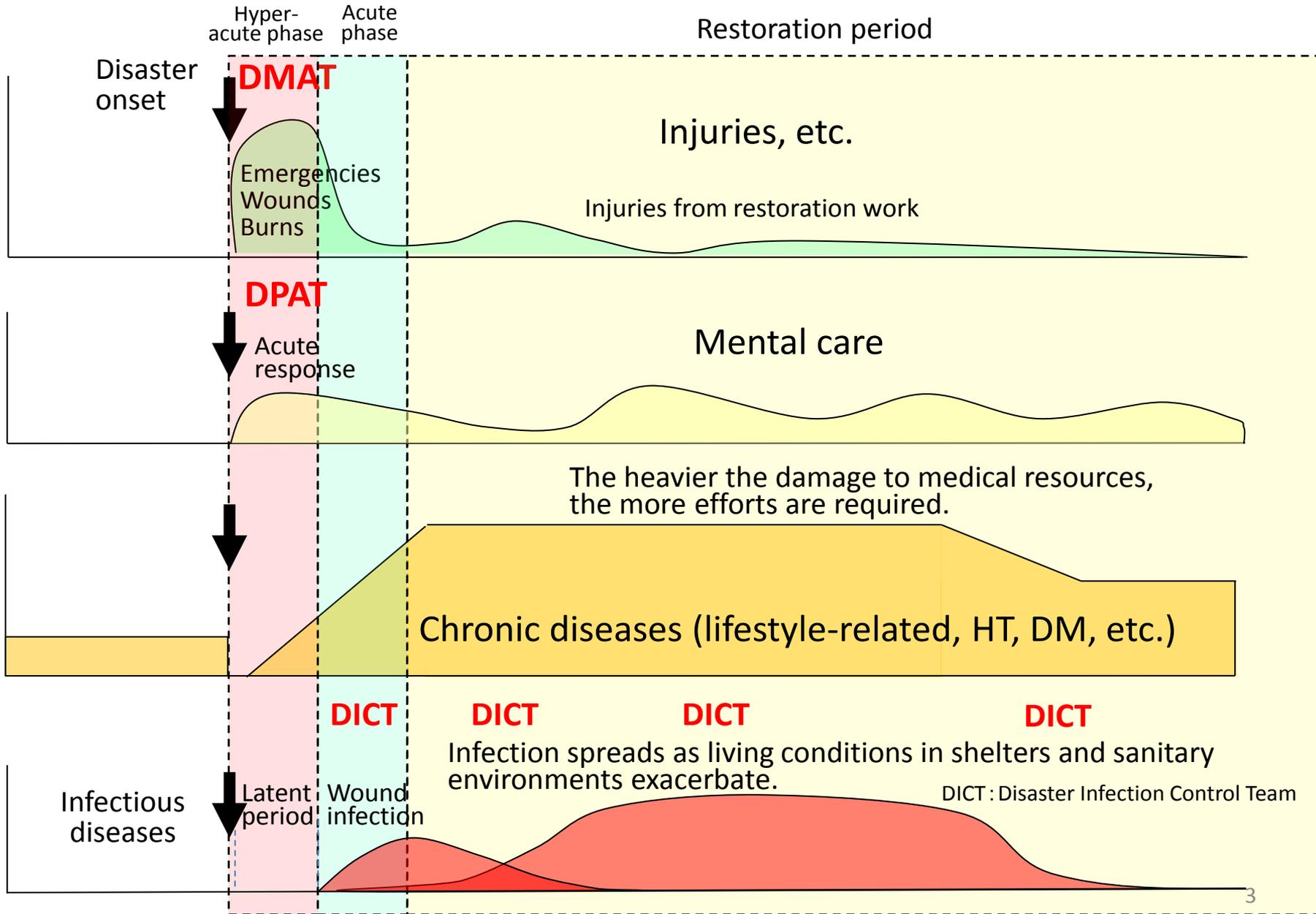
- Mt. Unzen's Fugen-dake Eruption (1991)
- Great Hanshin-Awaji Earthquake (1995)
- Great East Japan Earthquake (2011)
- Kinugawa River Floods in Joso (2015)
- Kumamoto Earthquake (2016)
- Northern Kyushu Heavy Rain (2017)
- Shinmoe-dake Eruption (2017)
- Western Japan Heavy Rain (2018)

## [ Human-made disasters ]

- Tokyo subway sarin attack (1995)
- Fukushima nuclear power plant accident (2011)
- VX attack in Malaysia (2017)



# Health-care efforts required after a disaster plotted over time



# Major natural disasters are occurring around the world!



- Are infectious diseases inevitable after every disaster?

- If not, when do they cause problems?

# 1 Considerations on the risk of infection after a disaster

# Factors affecting the risk of infection after a disaster

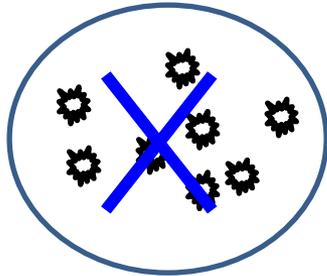
## Pre-disaster conditions

- Integrity of public health infrastructure
  - Water supply, sewage, electricity and gas
  - Housing
- Health of residents
  - Nutritional conditions
  - Prevalence of various infectious diseases
- Immunization rate
  - Routine vaccination
  - Voluntary vaccination

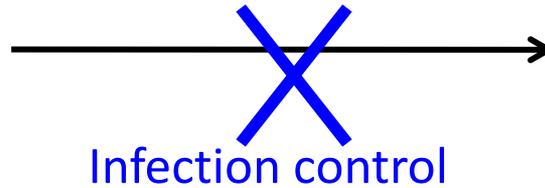
# Damage to public health infrastructure **increases** the risk of infection

Pre-disaster

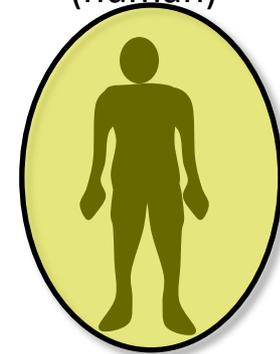
Source of infection



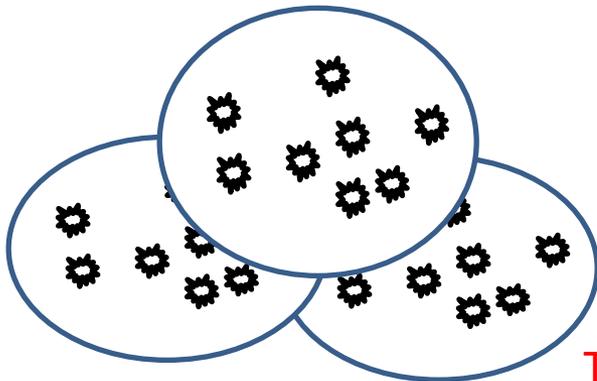
Route of infection



Susceptible population  
(human)



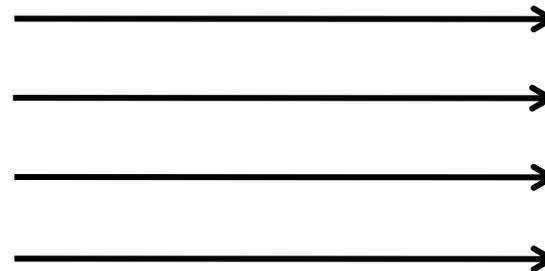
Post-disaster



**Pathogens proliferate.**

**The route of infection changes its quality and quantity.**

- Water supply and sewage integrity ×
- Residential environment ×
- Control of sanitary pests and vectors ×



**Emergence of disaster-vulnerable populations**

- Exhaustion
- Lack of sleep and malnutrition
- Mental stress
- Reduced natural immunity

# Factors affecting the risk of infection after a disaster

## Pre-disaster conditions

- Integrity of public health infrastructure
  - Water supply, sewage, electricity and gas
  - Housing
- Health of the residents
  - Nutritional conditions
  - Prevalence of various infectious diseases
- Immunization rate
  - Routine vaccination
  - Voluntary vaccination
- Region-specific infectious diseases
  - Malaria, dengue fever, leptospirosis, etc.
- Season-specific infectious diseases
  - Influenza, norovirus gastroenteritis, etc.

## Acute and chronic post-disaster conditions

- Disaster types and the extent of damage
  - Earthquake, tsunami, flood, eruption and forest fire
  - Presence or absence of a secondary/complex disaster

# If a major disaster hits the current Japan, people will likely ...

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1. suffer long-term **power shortages and planned outages**;
2. be **unable to communicate** due to long-term extensive blackouts;
3. be difficult to survive due to **lack of water, food and fuel**;
4. see **impacts on the international community and markets**;
5. be **unable to transport goods**;
6. go about **buying out of fear** induced by the media;
7. see high-rise buildings and skyscrapers **collapsing and catching fire**;
8. **unable to get home from work**;
9. have **fires spreading** due to traffic jam;
10. suffer damage to **radio and TV towers**;
11. unable to access the **Internet**;
12. see **fires at sea and industrial complexes**;
13. find quake-resistant **quay walls unusable**;
14. have **difficulty assembling** employees;
15. have **rail lines out of service** for a medium to long period of time;
16. have riots and disturbances (**deteriorated public security**);
17. have **difficulty transporting goods** due to lack of fuel;
18. suffer **a secondary disaster** due to aftershocks or heavy rains;
19. have **fires** in large-scale assembly facilities; and
20. have **panic** triggered by a false rumor.

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Source: The Cabinet Office Disaster Information [http://www.bousai.go.jp/jishin/syuto/taisaku\\_wg/](http://www.bousai.go.jp/jishin/syuto/taisaku_wg/)

Tokyo Metropolitan Government Disaster Prevention <http://www.bousai.metro.tokyo.jp/taisaku/1000902/1000422.html>

# Factors affecting the risk of infection after a disaster

## Pre-disaster conditions

- Integrity of public health infrastructure
  - Water supply, sewage, electricity and gas
  - Housing
- Health of the residents
  - Nutritional conditions
  - Prevalence of various infectious diseases
- Region-specific infectious diseases
  - Malaria, dengue fever, leptospirosis, etc.
- Season-specific infectious diseases
  - Influenza, norovirus gastroenteritis, etc.
- Immunization rate
  - Routine vaccination
  - Voluntary vaccination

## Acute and chronic post-disaster conditions

- Disaster types and the extent of damage
  - Earthquake, tsunami, flood, eruption, wildfire
  - Presence or absence of a secondary/complex disaster
- Time of disaster onset
  - Rainy/dry season
  - Typhoon/hurricane season
- Conditions of the affected population
  - Public health infrastructure (safe water/food)
  - Number of victims and proportion of those vulnerable to disaster
  - Availability of shelters and assistance
  - Availability of medical service
- Control of vectors, etc.
  - Arthropods (e.g., mosquitos, mites, flies)
  - Wild animals
- Infectious diseases imported from outside
  - Supporter-related infection (oral, respiratory, contact)
  - Food poisoning (*S. aureus*, *C. perfringens*)<sub>10</sub>

Risk factors change over time

# Infectious diseases triggered by major disasters

1996 Romania  
1997 Czech  
1998 Italy

**West Nile fever**

1990s Floods in North Korea

**Malaria in South Korea (re-emergence)**

2005 Hurricane in New Orleans

**Norovirus gastroenteritis, vibrio infection**

2010 Floods in Pakistan

**Cholera, malaria, Crimean-Congo hemorrhagic fever**

2011 Great East Japan Earthquake

**Influenza, norovirus, legionella**

2014 Gas explosion in Taiwan

**Dengue fever**

2009 Earthquake in Haiti

**Malaria, diphtheria, cholera**

2006 Floods in Somalia

**Rift Valley fever**

2008 Sichuan earthquake

**Gas gangrene**

1998 flood in Honduras

**Leptospirosis, dengue fever**

1998 Floods in Bangladesh

1998 Floods in India

2000 Floods in Mozambique

**Dysentery, cholera**

2013 Typhoon in Philippines

**Leptospirosis, measles**

1991 Costa Rica

2000 Dominican Republic

**Malaria**

1980 Cyclone in Mauritius

**Typhoid**

2004 Tsunami in Sumatra

**Tetanus, acute watery diarrhea  
malaria, dengue fever**

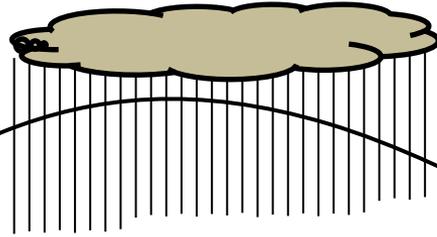
2010 Earthquake in Chile

**Hantavirus pulmonary syndrome**

Infection can be disaster-specific

# Overview of infectious diseases associated with floods

Typhoon, cyclone, and hurricane



## Wound infections

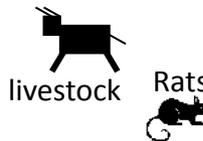
- Suppurative diseases
- Tetanus
- Leptospirosis
- Anthrax (endemic)

## Arthropod-borne infections

- dengue fever
- West Nile fever
- Rif Valley fever (endemic)
- yellow fever (endemic)
- Crimean-Congo hemorrhagic fever (endemic)
- Leishmania (endemic)
- scrub typhus and rickettsia (endemic)

Rural

**Animal-derived infection**  
- Leptospirosis, etc.



Restoration workers

Proliferation of mosquitoes and mites

Victims

River flooding  
(external water overflow)

Torrential rain

Urban

## Travel-related infections

- Malaria (movement from rural areas)

Traveling evacuees

## Shelter life-related infections

- Oral infection  
Cholera, dysentery, typhoid, hepatitis A and E, food poisoning, etc.
- Respiratory infection  
Common cold, influenza, measles
- Skin/eye diseases  
Conjunctivitis

Life in shelter

Water supply system

Sewage system

Sewer backflow  
(internal water overflow)

Swarm of mosquitoes

Rats

## Wound infections

- Suppurative disease
- Tetanus
- Leptospirosis

Sewage

Puddles

Coastal region

High tide blocks discharge

## Infections brought in by restoration workers and volunteers

- Food poisoning
- Measles, influenza, norovirus gastroenteritis, etc.

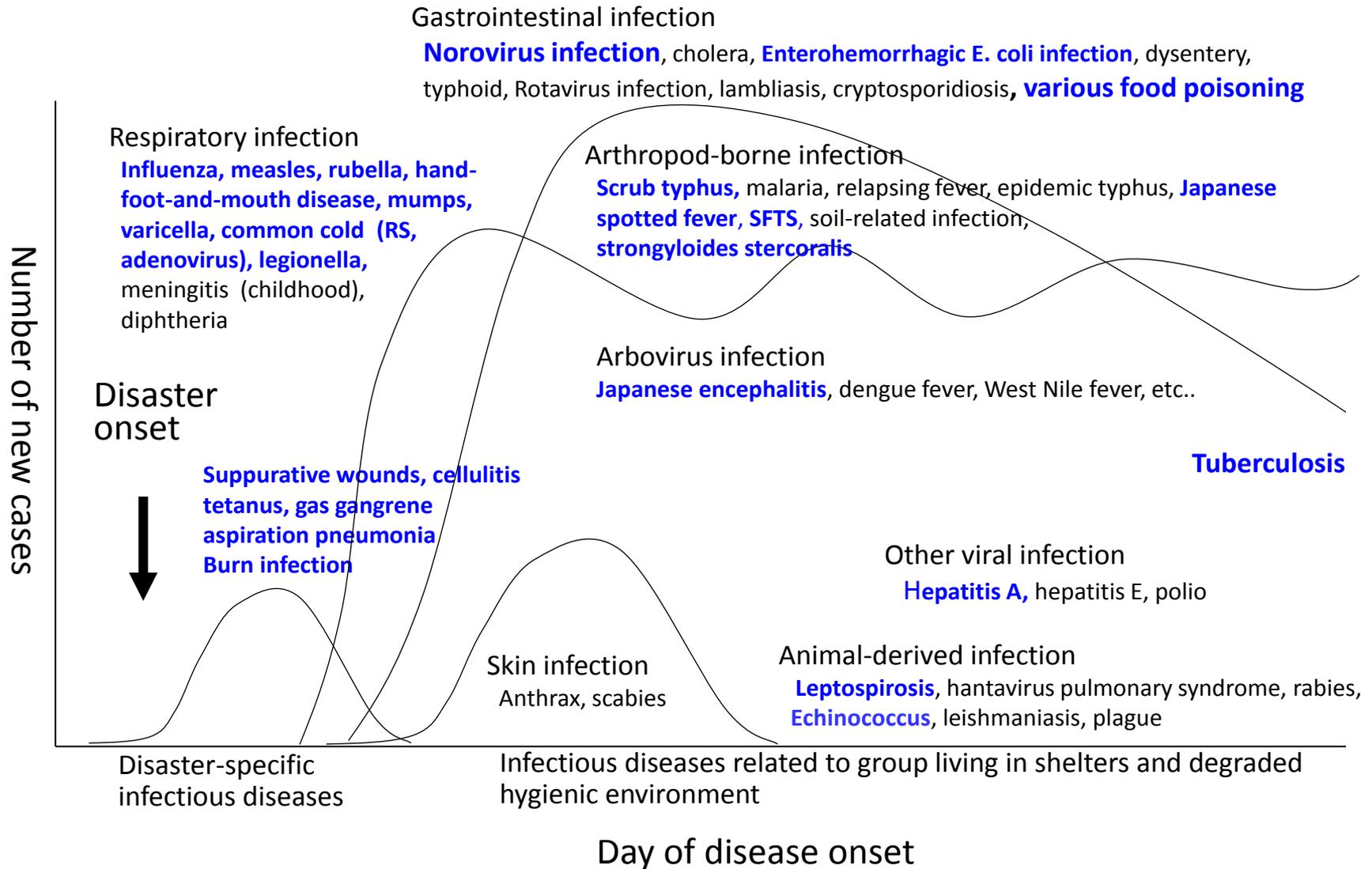
## Mosquito-borne infections

- Dengue fever
- West Nile fever, etc.

# Major infection outbreaks that occurred after floods

Year	Country	Infectious diseases	Oral	Skin/ mucous	Respiratory	Mosquito- borne
1980	Mauritius	Typhoid	○			
1983	Brazil	Leptospirosis		○		
1983	Ecuador	Malaria				○
1983	Peru	Malaria, gastroenteritis, typhoid				○
1988	Brazil	Leptospirosis		○		
1988	Bangladesh	Diarrhea, respiratory infection	○		○	
1988	Sudan (Khartoum)	Diarrhea (including dysentery ), hepatitis E, malaria	○			○
1990 to present	South Korea	malaria (re-emergence)				○
1992	Indonesia	Typhoid	○			
1993	U.S. (Iowa, Missouri)	Diarrhea, respiratory infection, leptospirosis	○	○	○	
1994	Nicaragua	Leptospirosis		○		
1996	Brazil (Rio de Janeiro)	Leptospirosis		○		
1996/1997	Romania	West Nile fever				○
1997	Czech Republic	West Nile fever				○
1997	Russia (Krasnodar)	Leptospirosis		○		
1997/1998	Kenia, Somalia	Lift Valley fever				○
1998	Italy	West Nile fever				○
1998	Bangladesh	Diarrhea, respiratory infection	○		○	
1998	India (West Bengal)	Watery diarrhea (cholera)	○			
1998	Argentina (Santa Fe)	Leptospirosis		○		
1998	Honduras	Leptospirosis		○		
1999	India (Orissa)	Leptospirosis		○		
1999/2000	Dominican Republic	Malaria				○
2000	India (Mumbai)	Leptospirosis		○		
2000	Thai	Leptospirosis		○		
2000	Mozambique	Cholera	○			
2001	Indonesia	Diarrhea	○			
2004	Bangladesh	Diarrhea	○			
2004	Dominican Republic	Malaria				○
2005	Pakistan	Hepatitis E	○			
2005	U.S. (New Orleans)	Vibrio infection, MRSA skin infection, norovirus gastroenteritis, conjunctivitis, etc.	○	○		
2005	Guyana	Leptospirosis		○		
2006/2007	Somalia, Kenia	Lift Valley fever				○
2008	Brazil	Dengue fever				○
2009	Haiti	Cholera (Nepal strain)				
2010	Pakistan	Cholera, leptospirosis, malaria, leishmania, respiratory infection, hepatitis, etc.	○	○	○	○
2010	Cote d'Ivoire	Dengue fever				○
2013	Philippines	Leptospirosis, measles		○	○	
2014	Mozambique, Malawi, Zimbabwe	Cholera	○			
2015	Taiwan	Dengue fever			13	○

# Infectious diseases that can cause problems after a disaster plotted over time



**Bold:** infectious diseases requiring special attention in Japan

Smaller font size: infectious diseases that often cause problems overseas

# Infectious diseases that can cause problems after a natural disaster

## Disaster-specific infectious diseases

### Flood /tsunami

#### Wound

Purulent wound, tetanus, gas gangrene, anthrax

#### Inhalation or aspiration of contaminated water

Melioidosis pneumonia, Pneumonia pseudomonas aeruginosa

#### Contaminated environments with patients' bodily fluid and waste

Cholera, bacterial dysentery, amoebic dysentery, typhoid, and other intestinal infections

#### Contact with infected animals and carcasses

Leptospirosis (Weil's disease), plague, hantavirus infection

#### Spread of vectors' habitats

Arbovirus infectious diseases (dengue fever, West Nile fever, Japanese encephalitis, yellow fever, chikungunya, Rift Valley fever, Crimean-Congo hemorrhagic fever, SFTS, etc.), malaria, filaria, tick-borne disease (scrub typhus, Japanese spotted fever, Lyme disease, etc.)

#### Spread of contaminated soil Anthrax, strongyloides

### Earthquake

**Wound-related infections**: similar to the case in floods and tsunami

**Scattering of fungi in the soil**: *Coccidioidomycosis*

### Wildfire

**Burn**: Skin infection

## Infectious diseases that can cause problems in shelter life and traveling

### Common to all types of disaster

#### Oral infection

Viral infection (norovirus, rotavirus, etc.), hepatitis A, hepatitis E, cholera, bacterial dysentery, typhoid, salmonellosis, amoebic dysentery, cryptosporidium, giardia lamblia, and others

#### Droplet infection

Common cold, influenza, meningococcal meningitis

#### airborne infection

Measles, tuberculosis

#### Percutaneous infection, contact with contaminated water

Schistosomiasis

#### Contact with wild animals

Leptospirosis, rabies, hantavirus infections, plague, toxoplasmosis, echinococcosis, angiostrongyliasis

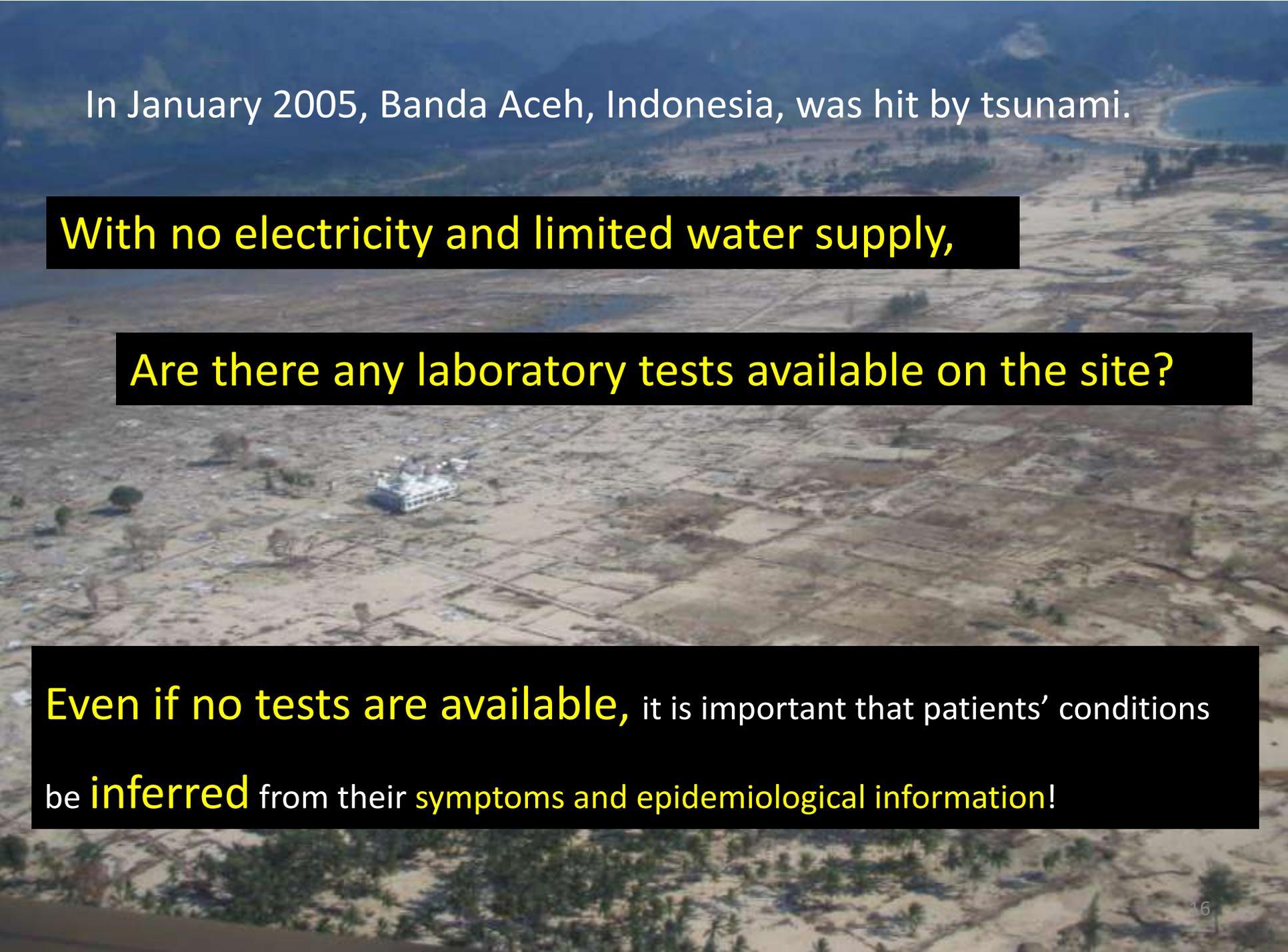
#### Mosquito-borne infections

Arbovirus infection, malaria, filaria

#### Infection caused by other hematophagous insects and animals

Plague, epidemic typhus, scrub typhus, leishmania, trypanosome

It is important, in peace time, to **assess the risk** of diseases likely to spread in each particular regions!



In January 2005, Banda Aceh, Indonesia, was hit by tsunami.

**With no electricity and limited water supply,**

**Are there any laboratory tests available on the site?**

**Even if no tests are available,** it is important that patients' conditions be **inferred** from their **symptoms and epidemiological information!**

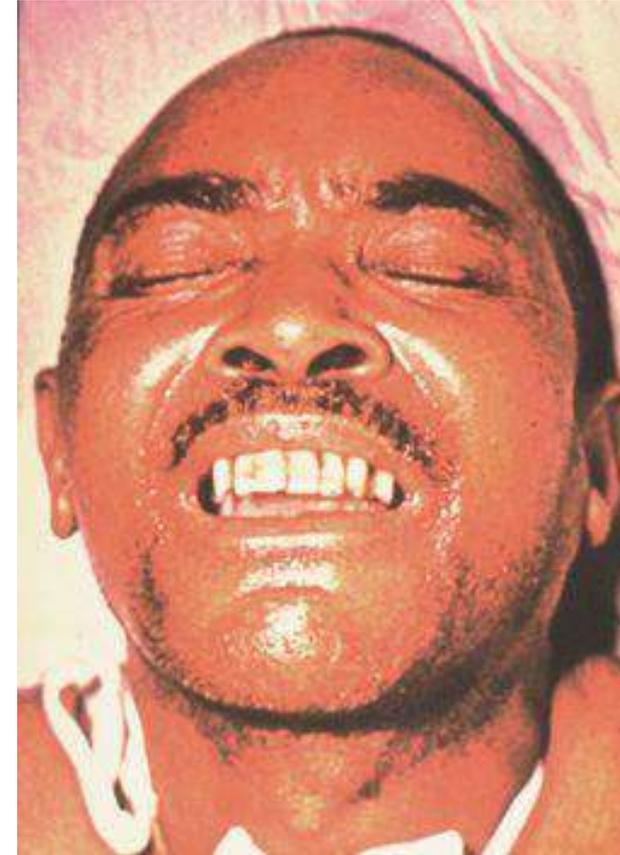
## 2 Identify patients according to syndromes

## Neurological syndromes

### Generalized convulsion and facial features



Risus sardonius



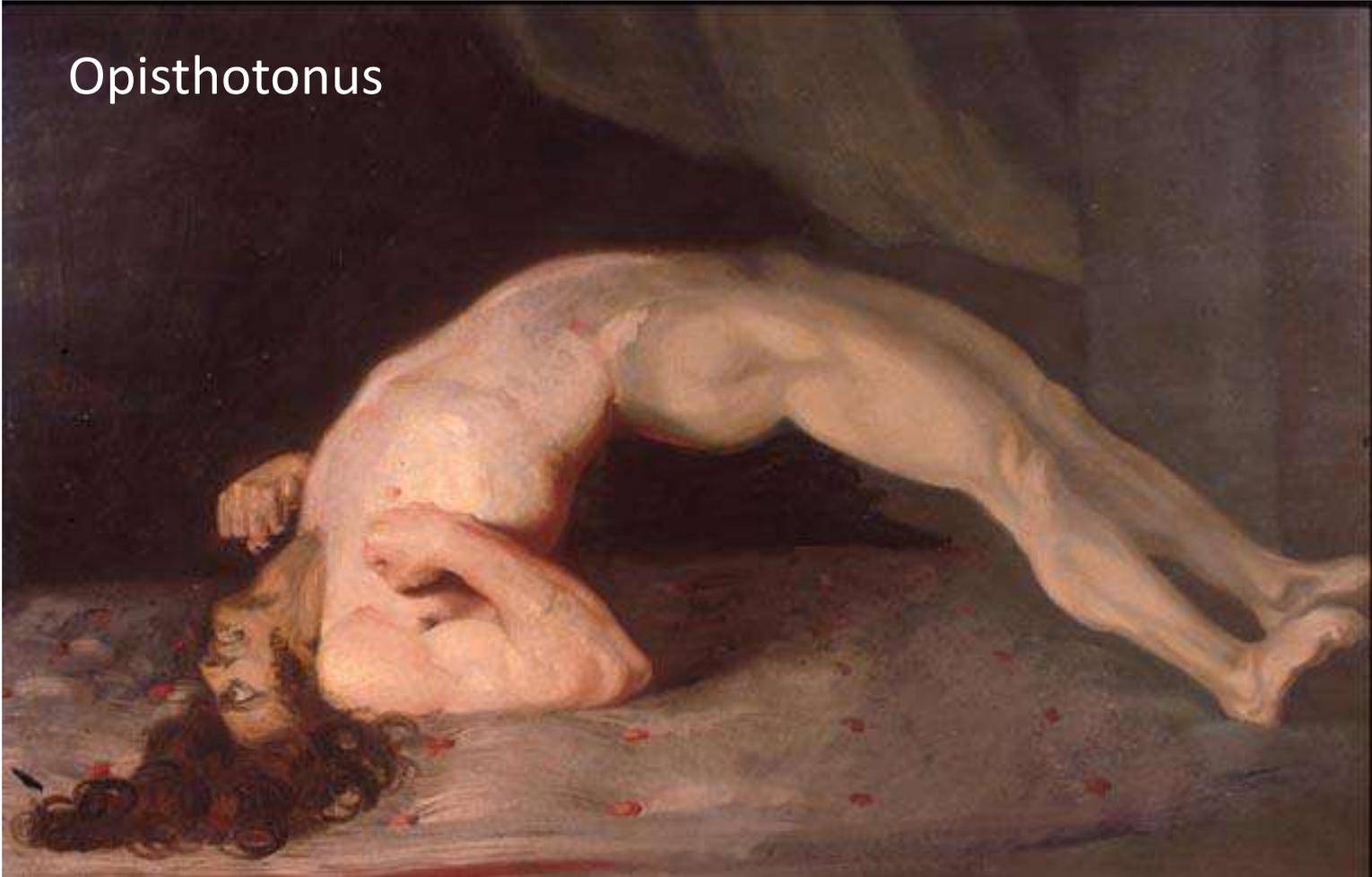
Trismus (lockjaw)

Symptoms consist of trigeminal palsy and rigidity masticatory.

## Neurological syndromes

Generalized convulsion and facial features

Opisthotonus



Tetanus

## Mucocutaneous syndrome

Gas and blisters form in infected wounds.



Pain, edema/swelling, and blistering



Gas formation and snow-ball crepitation

Patients susceptible to this syndrome often have underlying diseases such as diabetes, arteriosclerosis and colorectal cancer.

## Mucocutaneous syndrome

Gas and blisters form in infected wounds.



Clean wound

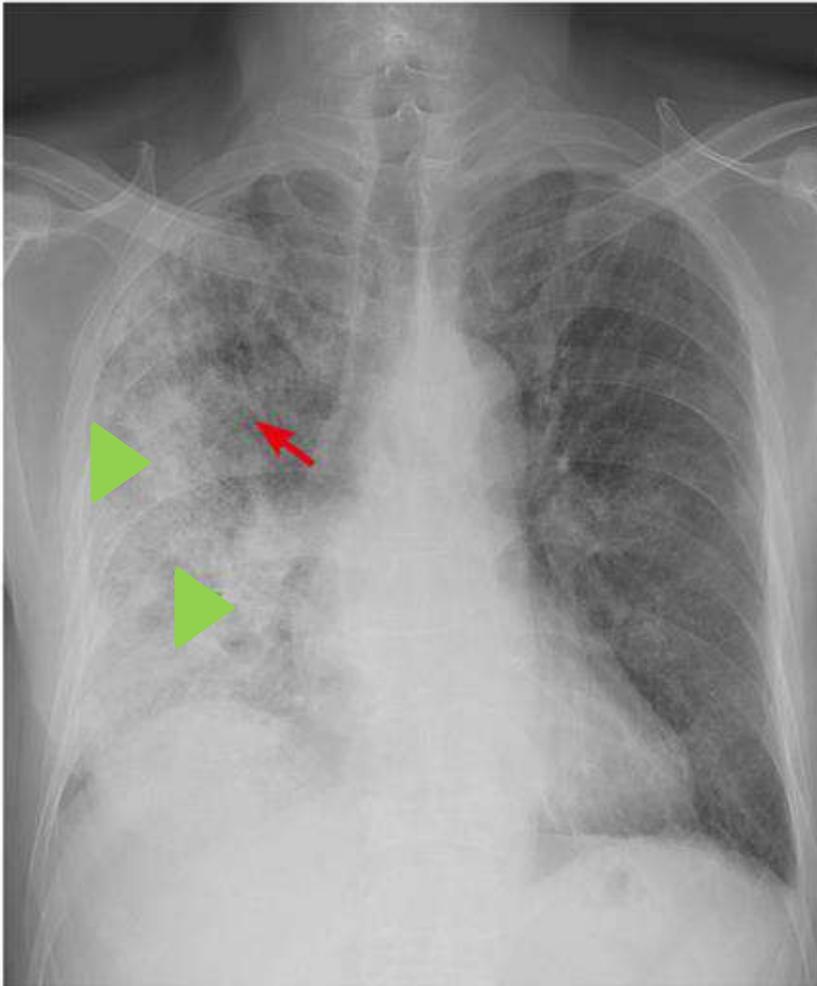


Gangrenous wound



## Acute respiratory syndrome

High fever, headache, chill, muscle pain + dry cough and chest pain



↑ : Ground-glass opacity; ▲ : Infiltrative shadow

Use of a humidifier can cause respiratory infection.



A nursing home in Kunisaki City, Oita, January 2018  
(Source: Nshinippon Shinbun)

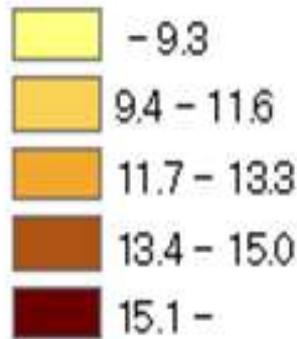
## Legionellosis

# Acute respiratory syndrome

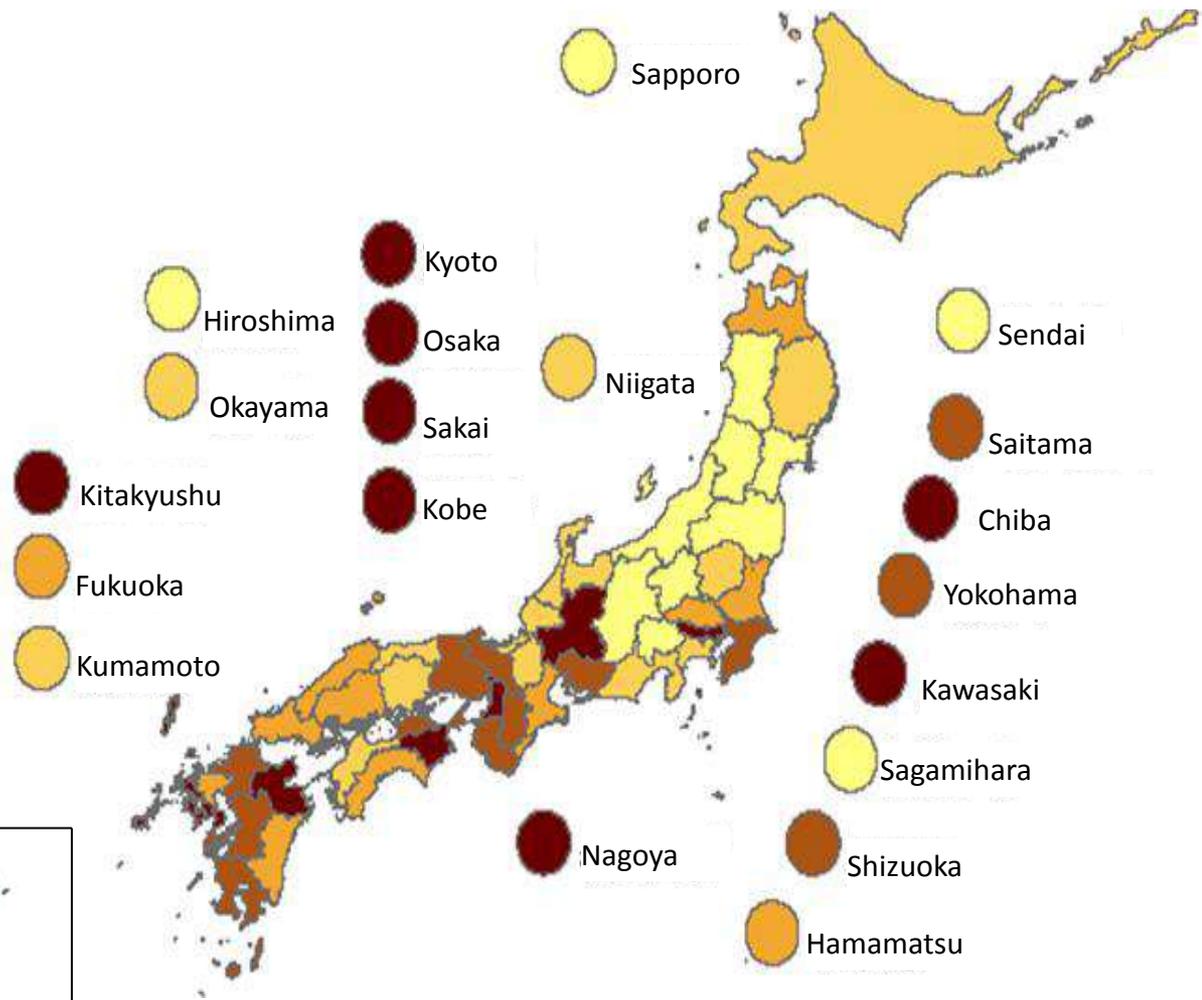
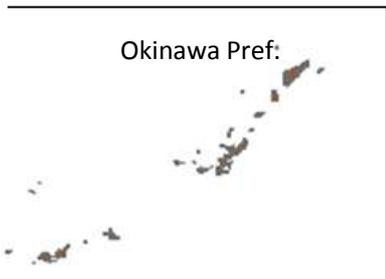
Cough, night sweats, bloody sputum, and slight fever lasting over 2 weeks

2016

Prevalence of ○○



13.9/100,000 people nationwide



Tuberculosis

## Acute gastrointestinal syndrome

Slight fever, vomiting, abdominal pain and diarrhea

YOU DON'T WANT IT.

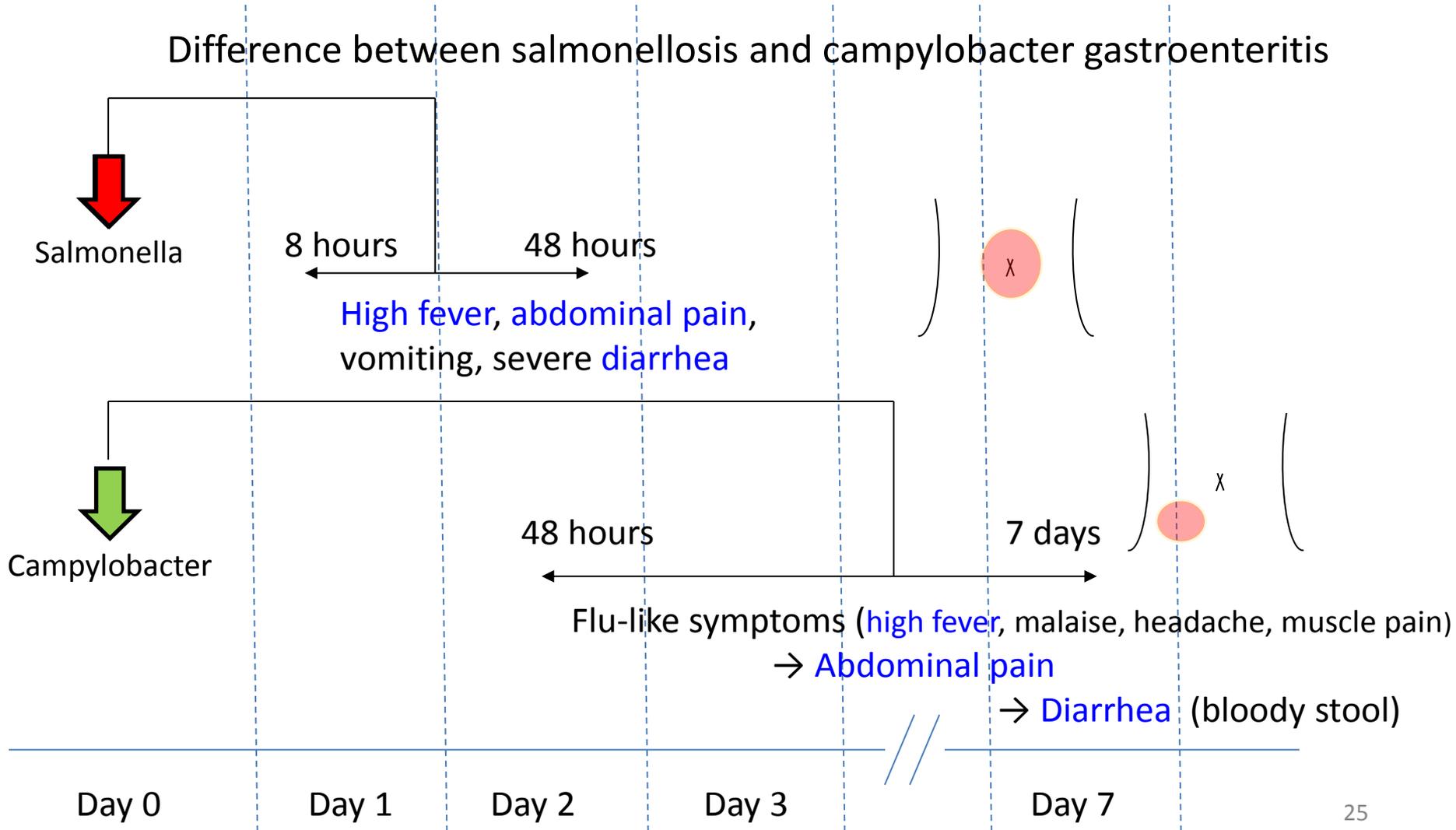


Norovirus gastroenteritis

# Acute gastrointestinal syndrome

## High fever, abdominal pain and diarrhea

Difference between salmonellosis and campylobacter gastroenteritis



## Acute gastrointestinal syndrome

Fever, abdominal pain and jelly-like bloody diarrhea



Delicious strawberry jelly



Mucus Bloody stool

Amoebic dysentery

## Acute gastrointestinal syndrome

Fever, abdominal pain and bloody stool



Delicious red wine



Bloody diarrhea

Bacterial dysentery

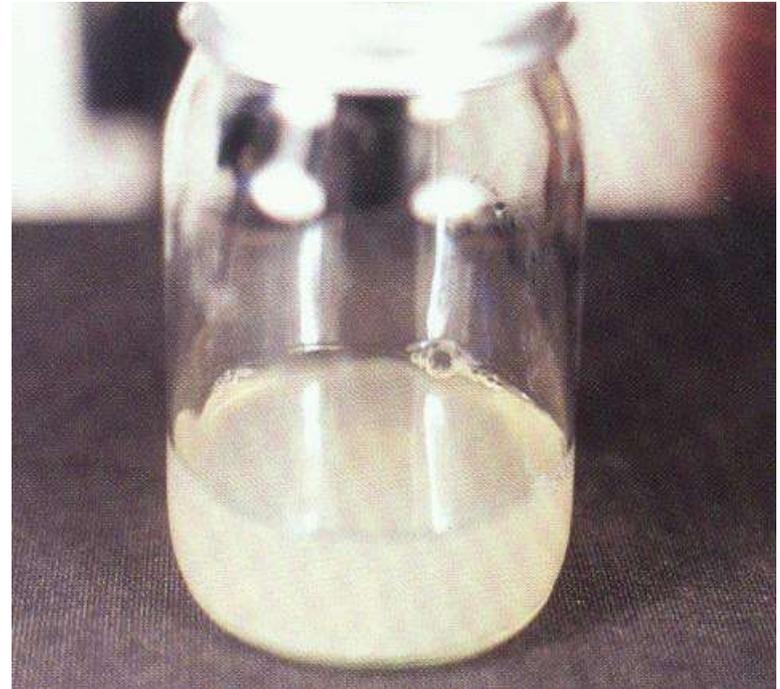
Enterohemorrhagic E. coli infection

# Acute gastrointestinal syndrome

Vomiting and watery diarrhea without abdominal pain  
(without fever)



Rice water



Rice water stool

## Acute gastrointestinal syndrome

Vomiting and watery diarrhea without abdominal pain  
(without fever)



Sunken eyes, high nose and cheekbones, lack of expression and facial pallor

Abnormal eye movement

Facial features characteristic to dehydration

Acute gastrointestinal syndrome

Vomiting and watery diarrhea without abdominal pain  
(without fever)



Skin tenting



Washer Woman's Hand

Skin findings for dehydration

Cholera

## Acute gastrointestinal syndrome

Abdominal pain and diarrhea without vomiting (**without fever**)

Are these safe to eat because they're boiled?



Curry



Stew

## Acute jaundice syndrome

High fever, jaundice, ocular hyperemia + difficulty walking



Gastrocnemius muscle pain

# Acute jaundice syndrome



Barefoot is a risk factor.



Wounds add to risk.



Risk increases after a flood.



Contact with brown rats

## Acute mucocutaneous syndrome

Redness, swelling and intense pain in dog and cat bite



- Intense pain, redness and swelling (30 min to 2-3 h after being bitten)
- Often results in cellulitis.

<https://www.bird-x.com/pasteurellosis--pages-355.php>

- Does not respond to Cefalexin therapy.
- Sepsis and arthritis will develop.

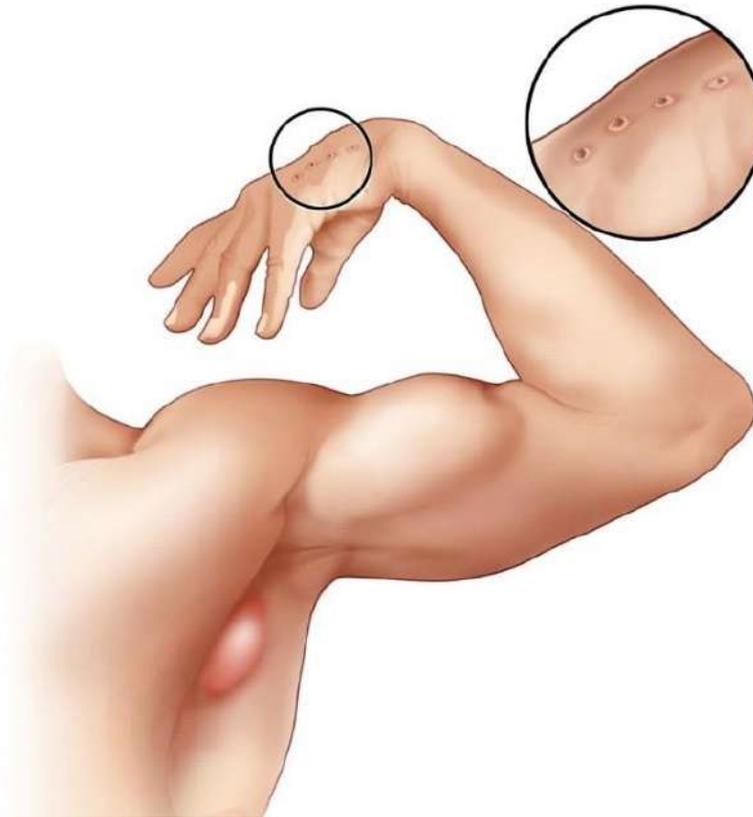
Lecture note Mammal and Human bite injuries, from Dr. Jim Holliman  
<http://www.slideshare.net/openmichigan/gemc-resident>

# Acute mucocutaneous syndrome

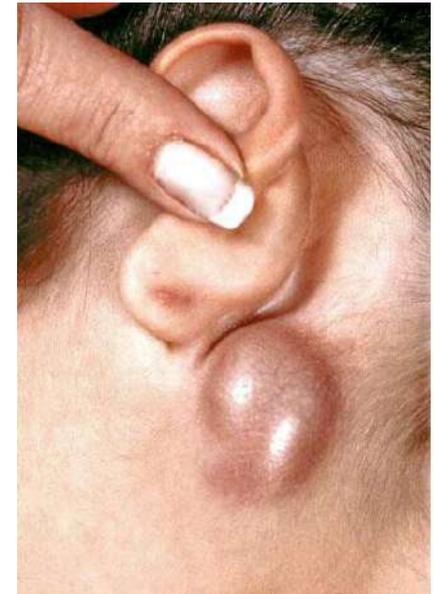
Blisters and lymph node swelling due to dog and cat bite wounds



Rash at a ruptured blister



1-3 weeks after being bitten.  
Swelling of regional lymph nodes with pain



Swelling of post-auricular lymph nodes

# Bartonellosis (cat scratch fever)

## Acute mucocutaneous syndrome

Rash on the hands, feet and mouth



- Blisters in the mouth, pain and fever ( $\pm$ )
- Gastrointestinal symptoms such as diarrhea
- Sometimes becomes severe
  - Encephalitis
  - Meningitis
  - Cerebellar ataxia

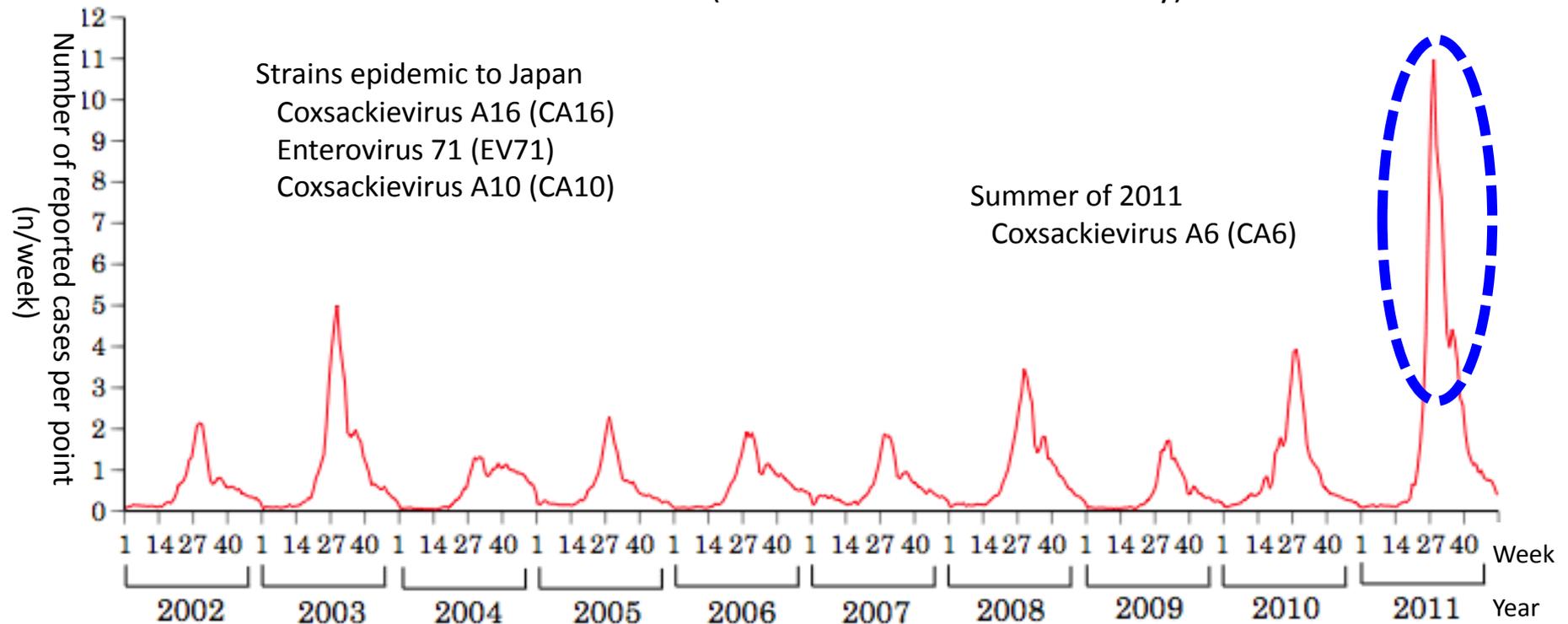
<http://xn--y8j2a2702e.com/teashikuchibyou/teashikuchibyou.html>

## Acute mucocutaneous syndrome

### Rash on the hands, feet and mouth



Figure 1. Changes in the number of reported patients with hand-foot-and-mouth disease from weeks 1 of 2002 to week 52 of 2011 (infectious disease trend survey)



Becoming epidemic nationwide in 2011, this infectious disease also did so later in the **disaster area**. It was **brought in** by volunteers.

Respiratory syndrome → rash

Cough, fever, catarrh symptoms + rash



Conjunctivitis, nasal discharge and cough



Buccal mucosa lesion (Koplik's spots)



Measles

**Acute neurological syndrome + mucocutaneous syndrome**

High fever, headache + rash + hemorrhagic purpura



Headache and stiff neck



Early rash



Purpura fulminans

**Meningococcal meningitis**

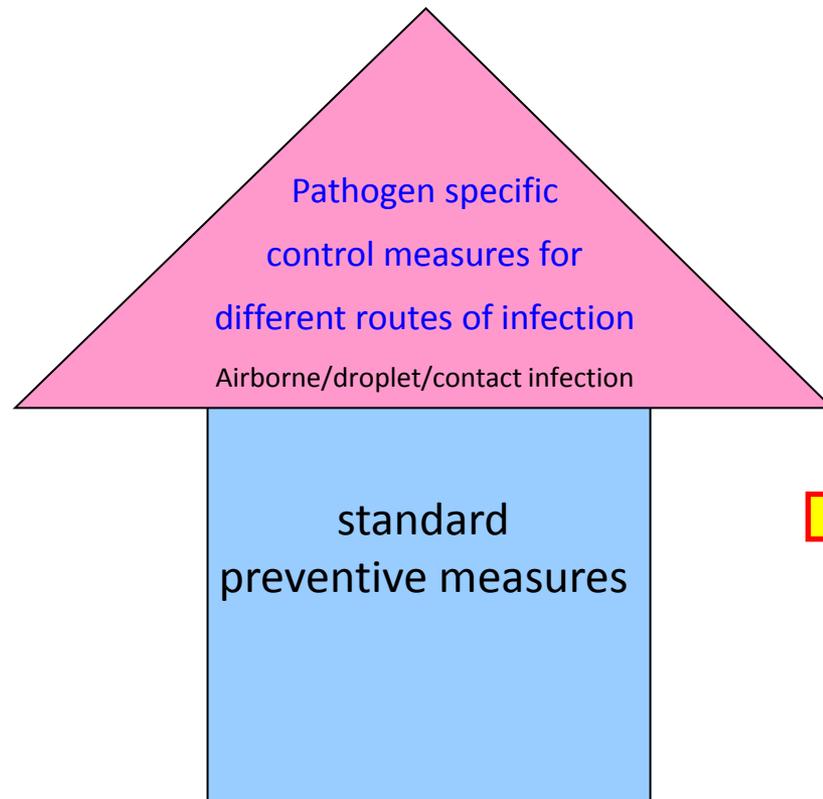
# 5 main syndromes likely to occur after a disaster

Syndrome	Clinical symptom	Expected infectious disease
Acute respiratory syndrome	Fever, headache, respiratory symptoms	Influenza
	General malaise, headache, muscle pain, chill, chest pain, dry cough	Legionella pneumonia
	Slight fever, cough, sputum (sometimes bloody)	Tuberculosis
Acute gastrointestinal syndrome	Bloody diarrhea, fever	Dysentery, EHEC, salmonella, campylobacter, etc.
	Watery diarrhea, no fever	Cholera
	Fever, abdominal pain, diarrhea	Norovirus gastroenteritis, etc.
	Abdominal pain, vomiting/diarrhea, etc., no fever	Toxin type food-poisoning (Staphylococcus aureus, Clostridium perfringens, etc.)
Acute respiratory syndrome → mucocutaneous syndrome	Fever, catarrh symptoms, late rash	Measles
Mucocutaneous syndrome	Pain, edema/swelling, snow-ball crepitation	Gas bacilli
	Fever, swollen lymph nodes, rash	Rubella
	Fever, swelling/pain in parotid lymph nodes	Mumps
	Fever, headache, rash	Meningococcal
	Blistering	Varicella, herpes simplex, hand-foot-and-mouth disease
Neurological syndrome	Trismus, dysphagia, convulsion	Clostridium tetani
acute jaundice syndrome	Fever, chill, conjunctival hyperemia, jaundice, difficulty walking, renal impairment	Leptospirosis

# Infection control measures differ between times of **peace** and **disaster**

## Peace time

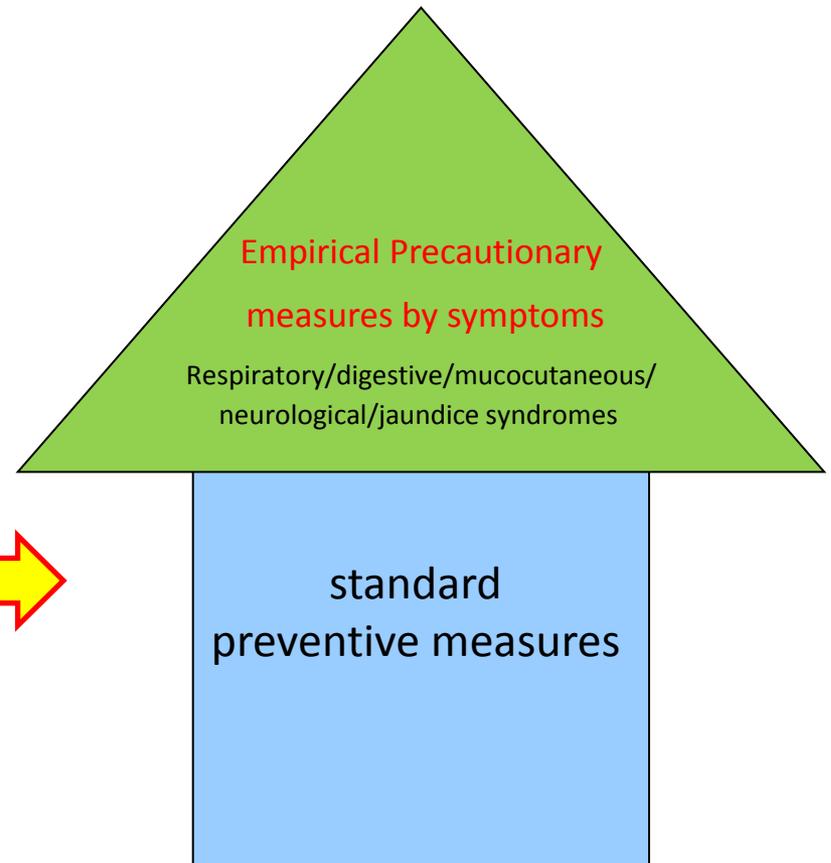
Just after the pathogen is confirmed by laboratory, **pathogen specific control measure** will be added.



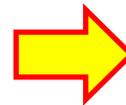
Applicable to all patients

## Disaster time

Pathogens are empirically predicted **based on syndromes** before confirmed by testing.



Applicable to all patients



# Syndromes likely to occur after a disaster

Syndrome	Clinical symptoms	Expected infectious disease	Treatment/procedure	Infection control measures	
				Standard precautionary measures	Empirical precautions
Acute respiratory syndrome	Fever, headache, respiratory symptoms	Influenza	Rapid test (influenza antigen)	○	Droplet infection Control + Contact infection control
	General malaise, headache, muscle pain, chill, chest pain, dry cough	Legionella pneumonia	Rapid test (urinary antigen)	○	Droplet infection Control + Contact infection Control
	Slight fever, cough, sputum (sometimes bloody)	Tuberculosis	PCR test	○	Air borne control measures
Acute gastrointestinal syndrome	Bloody diarrhea, fever	Dysentery, EHEC, salmonella, campylobacter, etc.	Antibacterial agent administration, symptomatic therapy	○	Contact infection Control
	Watery diarrhea, no fever	Cholera	Oral rehydration, symptomatic therapy	○	Contact infection Control
	Fever, abdominal pain, diarrhea	Norovirus gastroenteritis, etc.	Symptomatic therapy	○	Contact infection Control
	Abdominal pain, vomiting/diarrhea, etc., no fever	Toxin type food-poisoning (Staphylococcus aureus, Clostridium perfringens, etc.)	Symptomatic therapy	○	-
Mucocutaneous syndrome	Fever, catarrh symptoms, late rash	Measles	Symptomatic therapy	○	Air borne control
	Pain, edema/swelling, snow-ball crepitation	Gas gangrene	Wound management, administration of penicillium/Metronidazole	○	-
	Fever, swollen lymph nodes, rash	Rubella	Symptomatic therapy	○	Droplet infection Control + Contact infection Control
	Fever, swelling/pain in parotid lymph nodes	Mumps	Symptomatic therapy	○	Droplet infection Control + Contact infection Control
	Fever, headache, rash	Meningococcal	Antibacterial agents	○	Droplet infection Control
	Blistering	Varicella, herpes simplex, hand-foot-and-mouth disease	Symptomatic therapy	○	Air borne control + Contact infection Control
Neurological syndrome	Trismus, dysphagia, convulsion	Clostridium tetani	Wound management, bolus penicillium/Metronidazole injection, immune globulin, convulsion management, symptomatic therapy	○	-
acute jaundice syndrome	Fever, chill, conjunctival hyperemia, jaundice, difficulty walking, renal impairment	Leptospirosis	PCR test, etc., administration of antibacterial agents such as tetracycline	○	-