Infection Control After Major Flood: Lessons Learnt From Thailand

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Outlines

- IC issues during and after flood
- Lessons learned

Infection Control Issues After Flood

Infection Control Issues During and After Flood

- Environmental cleaning and air quality
- Mould Remediation Protocol
- Waste Management & Water quality
- Surveillance for ID
- Administrative control, Environmental control and Use of PPE

After Flood-ID only part of the problems

Life After Flood

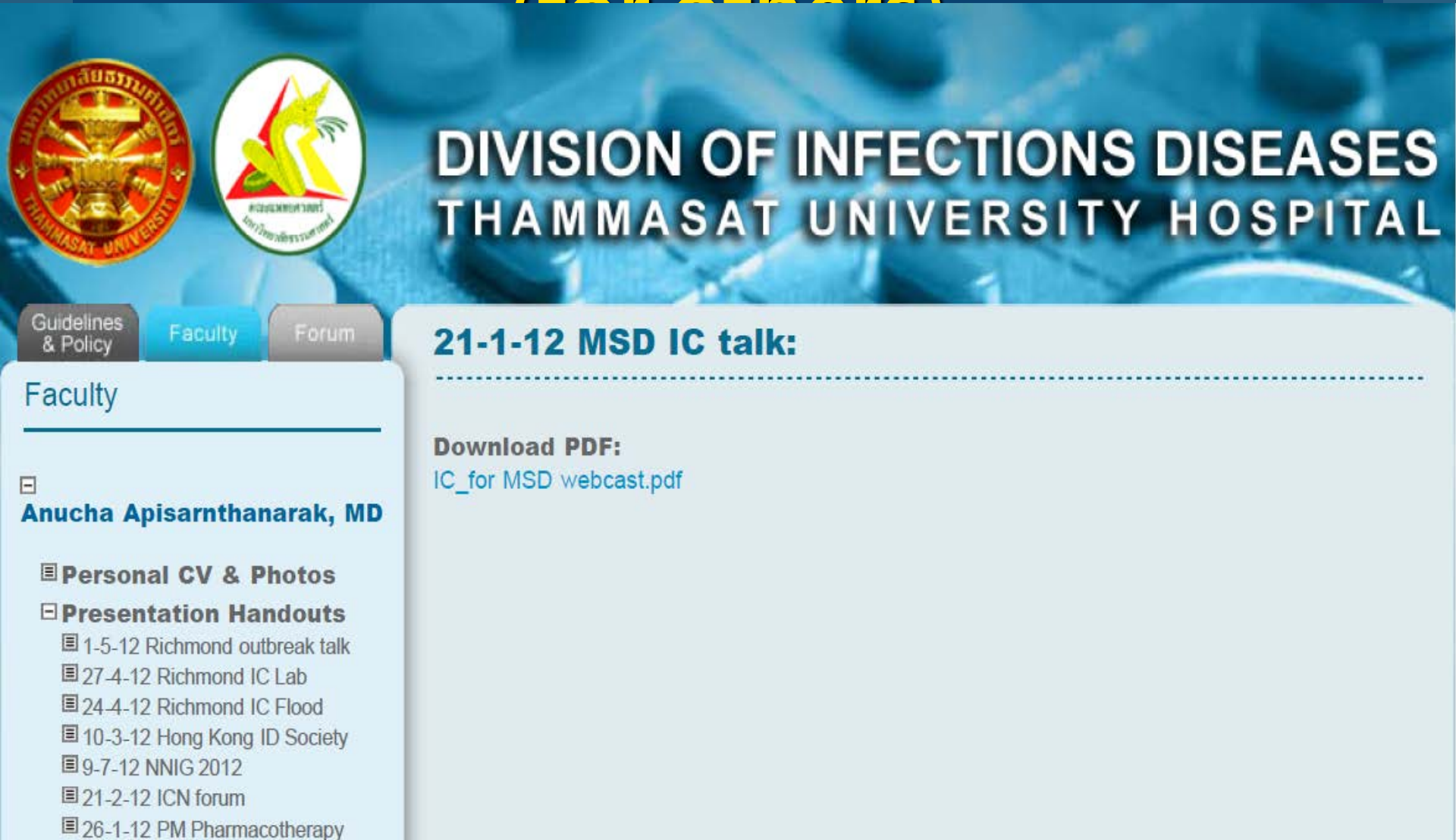
Renovation Post-flood

Ensure-All equipments function properly

Good that we have that flood (for me)

Good that our hospital have flood (for others during New Year)

Good that our hospital have flood (for others)



Environmental Cleaning and Air Quality

Specific Indication For Fungal Abatement

"Non-medical" Devices and Surfaces

- Even items that do not come into patient contact still require cleaning and disinfection if they had contact with flood water
- Same general process as with noncritical devices
  1. Soap/detergent and water
  2. Clean water rinse
  3. Bleach water disinfection (1:100)
  4. Air dry

"Non-medical" Devices and Surfaces (cont.)

- Can be used for non-damaged food cans
  - Remove labels first, then re-label after dry
- Porous food-preparation surfaces such as wooden cutting board must be discarded
  - Cannot be reliably disinfected

Bleach Water

- May be convenient to make 1:10 dilution centrally
  - Prepare in well ventilated area
  - Distinctive labels for 1:10 and 1:100 dilutions
  - Good lid
- Can then make 1:100 near point of use
  - Pre-marked containers or small container to count 9 parts water, 1 part 1:10 bleach solution
- If you can’ t smell chlorine, then no longer strong enough
- Prepare daily

Air sampling after flooding

- When can air sampling be done?
  - Monitor demolition and construction sites
  - Assess for contamination of HVAC system
  - Consider in cases of outbreaks

- UTMB experience after Hurricane Ike
  - Set up air sampling in high-risk patient care areas, ORs, other patient areas, lobby
  - Used results in when to resume patient care in various areas

Helwett A *et al*. Fifth Decennial: International Conference on Healthcare-Associated Infections, 2010

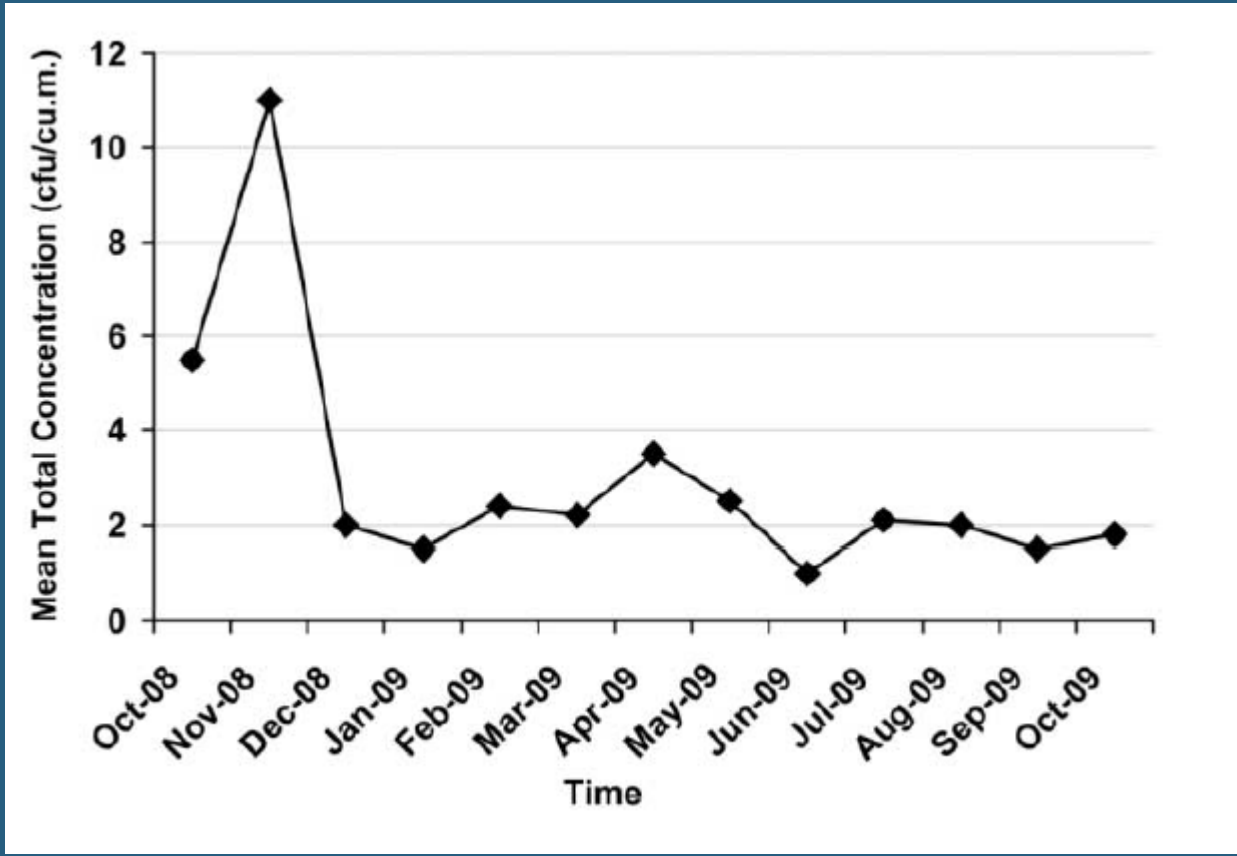
Role for air sampling after flood?

- Done to detect particulates (dust) or organisms (aspergillus spores)

- Particulate sampling (dust)
  - Evaluates efficiency of air filtration
  - Compare to outdoor air
    - "Dirty" = outdoor air
    - "Clean" = 90-95% filtration
    - "Cleanest" = HEPA filtration (>99.9%)

Detection of Fungal in the Air by Non-standard Method

FIGURE 2. Line graph measurement of the mean air concentrations of fungal spores in the operating rooms at the University of Texas Medical Branch at Galveston, Texas, after Hurricane Ike on September 13, 2008.



Air Quality Standards Used by UTMB Healthcare Epidemiology

Location	Air Quality Standard
High-risk patient care areas (transplant floor, ICU)	≤15 total colonies/m^3,and no pathogens present
Operating Room	≤3 colonies/m^3 of any fungi, and no pathogens present
Other patient care areas	≤15 total colonies/m^3, and ≤5 pathogens present
Lobby	≤25 colonies/m^3

Helwett A *et al*. Fifth Decennial: International Conference on Healthcare-Associated Infections, 2010

Mould Remediation Protocol

www.prakit.com/idtu
(Major Flood & Minor Flood)

Example of Site Specific Post-Flood Check List for Selected Areas of the Hospital

Area	Question	Yes	No	Comments
Laboratory Services	Can essential laboratory testing be provided? • Blood-gases and co-oximetry • Electrolytes • Hepatic and basic metabolic • Hemograms and coagulation studies			
	Can microbiological, toxicological, and serologic testing be performed or sent to a referral laboratory?			
	Is emergency power available to operate equipment and safety systems and/or provide necessary ambient conditions?			
	Has essential equipment been inspected for damage and heat/humidity exposure and manufacturers contacted for guidance on repair, cleaning, and disinfection?			
	Have damaged or contaminated reagents and supplies been replaced?			
	Have biologic safety cabinets been cleaned, disinfected and recertified?			
Central sterile processing area	Have all autoclaves been inspected for damage and manufacturers contacted for guidance on repair, cleaning, and disinfection?			
	Does the steam system meet published standards?			
	Have mechanical and biological indicator tests been performed on sterilization equipment?			
	Were stored sterile supplies compromised? Have they been reprocessed or replaced?			
	Have the washers, instrument disinfection, and ultrasonic equipment been tested for performance?			
Operating Suite	Has there been any damage to the sealed flooring and ceilings?			
	Do sterile supplies need reprocessing?			
	Have the autoclaves been inspected and undergone mechanical and biological indicator testing?			
	Has an evaluation for electrical hazards been conducted?			
	Are the scrub sinks functioning properly?			
	Are there enough air exchanges per hour?			
	Have all air filters been changed?			
Pharmacy	Have damaged or contaminated medications and solutions been replaced?			

Flood Checklist

Post outside flood containment area.

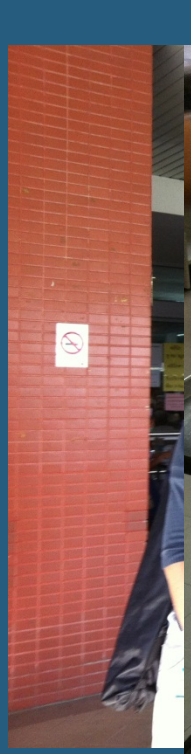
Task	Date Completed	Name/Dept
Call the Security Department at 362-0911 immediately to report the flood.		
Verify Housekeeping has posted the flood checklist		
Remove patient(s) from the area		
Identify area manager/point of contact. The Nursing Supervisor will contact areas not open at the time of the flood (i.e. areas not open on weekends or after normal business hours).		
Close flooded area to procedures and patient care during cleanup and disinfection. OR team will decide whether patient will be moved If floodwater penetrates ceiling tiles, plaster or drywall, place HEPA filter inside contaminated area. HEPA filter remains on until 1 hr after completion of cleanup.		
Seal off flooded area/Security to secure area Close door to affected room If large flood in open area, use ceiling to floor plastic barriers for containment.		
Contact Environmental Health and Safety Emergency Pager at 790-7968 for life safety issues regarding plastic barriers and fire safety access		
Affected areas are disinfected with a 1:10 bleach solution with a 10 min. Contact time: Walls and lateral surfaces disinfected by Housekeeping Ceilings disinfected by Carpentry Fans/dehumidifiers may be used to speed drying **if it is determined the area is asbestos free.**		
Affected areas remain closed until wall and/or ceiling completely dried		
Plumbing repair completed		
Walls dry		
Walls replaced if needed		
Painting finished		
Ceiling dry		
Ceiling/Insulation replaced if needed		
Wall covering dry		
Wall covering replaced if needed		
Final Housekeeping performed		
HEPA filter left on 1 hour (minimum) after clean-up		
BJH EH&S will perform and document preliminary assessments and follow-up in the BJH EH&S flood log.		
BJH Nurse Manager / Area manager or designee reviews checklist for completion of tasks and re-opens to patient(s).		

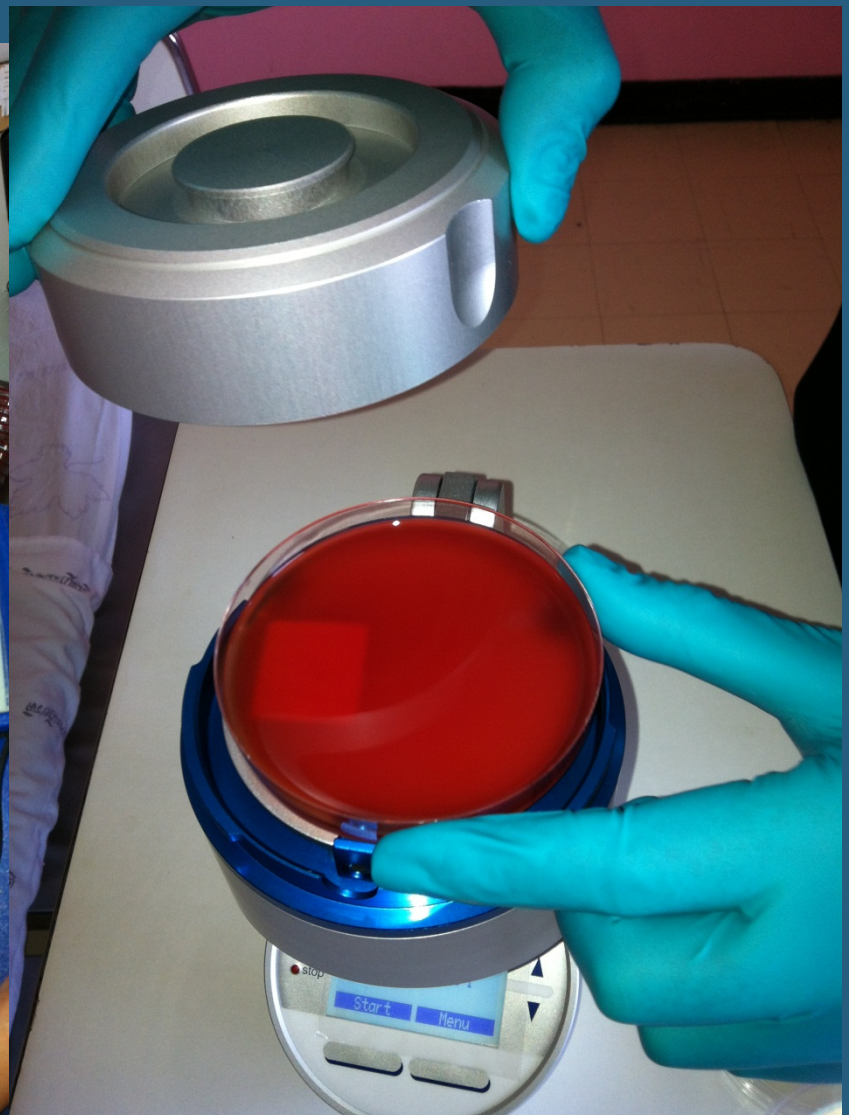
EH&S will pick-up flood checklist after final follow-up of the flooded space.

Examples (can be used post-hurricane)

Emergency Department	Have stretchers and exam tables been inspected, repaired, and disinfected?			
	Have cardiac monitors been recertified?			
	Has the trauma room flooring been damaged? Has it been repaired or replaced?			
	Have support service areas in the ED (radiology, lab) been inspected in the same manner as the larger department?			

New Strategy: Use Air Sampling to Determine Units to be Cleaned





Outcomes

- Air sampling was performed in all hospital units to determine units that need special attention for room decontamination
- 65 rooms from 18 patient units were visited for air sampling
- Only 15 of 65 rooms (23%) from 6 unit (30%) had air sampling for fungus more than the recommended standard (<500 CFU/cc^3)

Lessons Learned

- All investment in infection control need big capital cost, but we gain indirect cost
- Having hospital administration who understand and value cost appropriately will result in successful IC outcomes
- Standard method may seem expensive at beginning, it can help you safe money later on

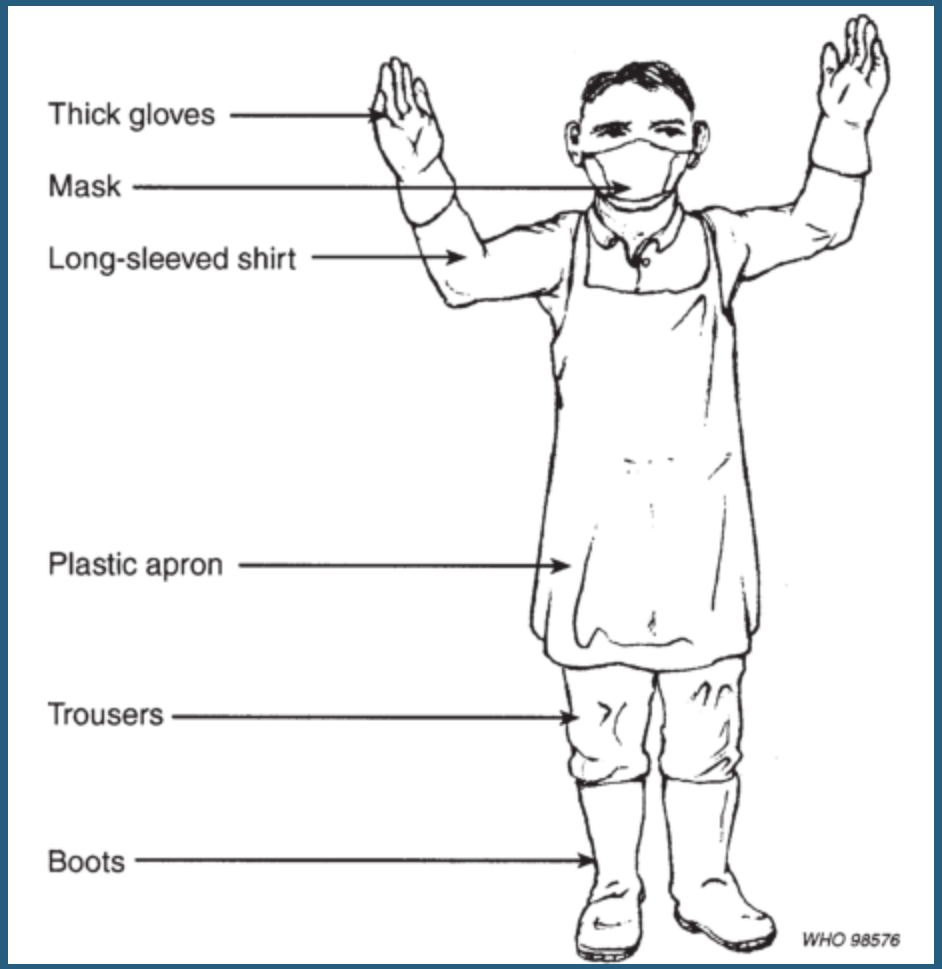
Waste Management and Water Quality

Moldy Waste

- Materials contaminated with environmental mold are not considered infectious waste
- Can be included with general wasted
- Should be put into plastic bags or covered with plastic to prevent spreading spores
- Workers may want to wear protective equipment to avoid inhaling spores to protect against lung irritation or hypersensitivity

Mandatory Personal Protective Equipment

- Overalls (coveralls)
- Industrial aprons
- Leg protectors and /or industrial boots
- Heavy-duty gloves
- No need for air sampling inside construction zone for fungal spore



Surface Culture for Fungus: A Waste of Money

- Environmental fungus is already there at the beginning
- There was no standard interpretation

Infection control surveillance after recovery

- Active surveillance for healthcare-acquired infections related to water/ mold contamination
  - Invasive fungal infections due to *Aspergillus* spp. or other fungi
  - Non-tuberculous mycobacterium
  - *Legionella* spp.

Occupational Health Issues

From Initial Survey

- 53% had humidity within normal limit
- 67% had temperature within normal limit
- 11% had both bacterial and fungal bioburden more than 500 CFU/mm3

Several Occupational Health Issues Associated with Poor Air Quality

- Exposure particle <10 micron: exacerbate wheezing, asthma, respiratory infections
- High CO: Tachypnea, reduce oxygen delivery to key organs in developing fetus
- High humidity: fungus & bacterial growth (sick building syndrome)

Initial Air Quality Check After Flood

Air quality characteristics	All rooms (N =68)	Open-ventilation patient care areas[1]	Closed-ventilation patient care areas[2]	*P* Value
Rel				
Ter				
Car				
Tot				
Total fungal bioburden (CFU/m^3, median, range)[3]	590 (160-4,400)	775 (200-4,400)	430 (160-2680)	0.05

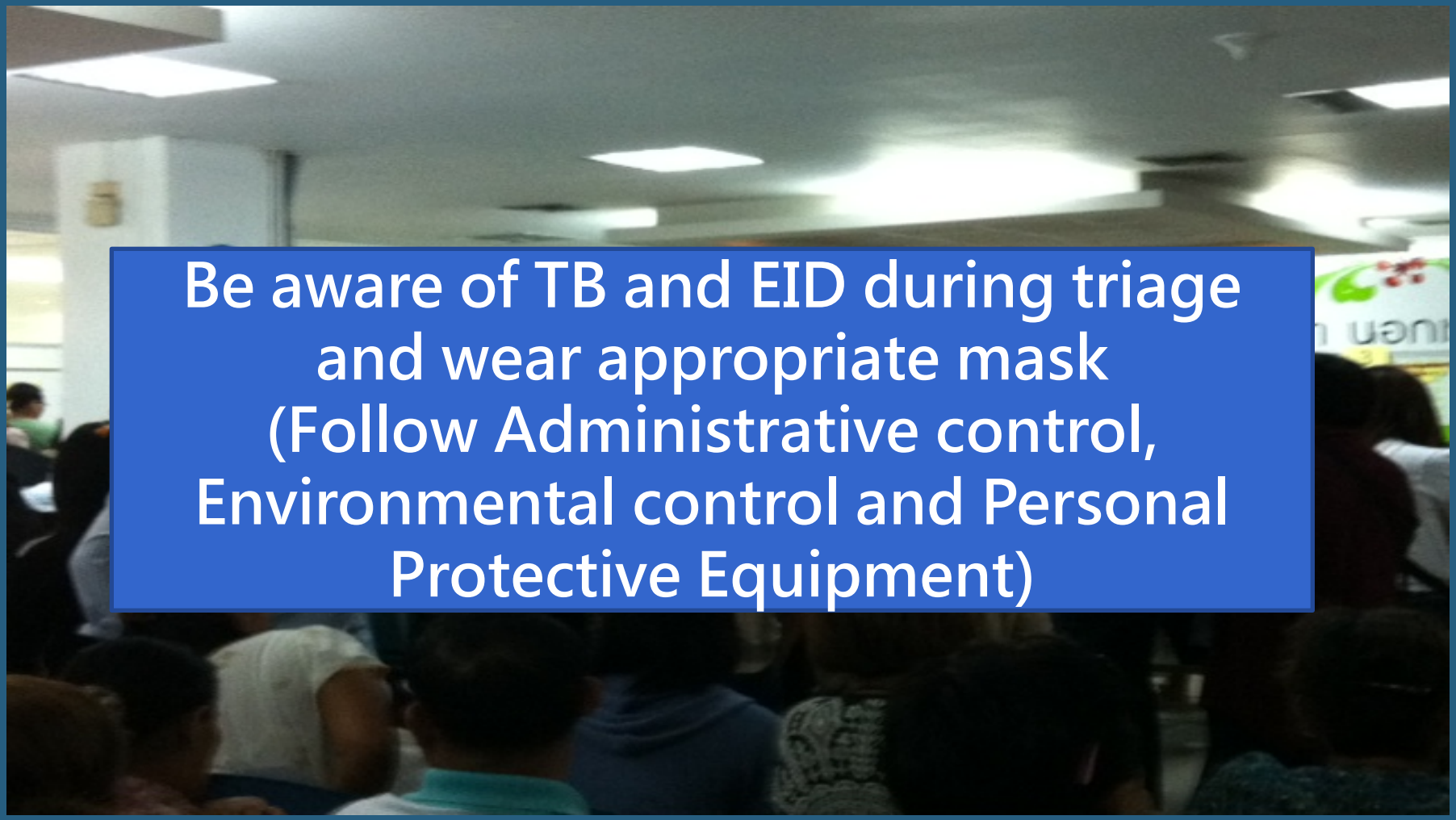
High bacterial and fungal bioburden >500 CFU/mm3 were detected only in units with excess humidity (100% vs. 0%; *P*<0.001)

All areas with fungal pseudo-outbreak had excess humidity

By multivariate analysis, first floor units were associated with excess fungal and bacterial bioburden (aOR = 1.16; *P*<0.001)

Administrative Issues

Triage in Crowded Area (2,000 visit at OPD and ER)



Natural Ventilation

Separation of Immunocompromised Host (using natural air ventilation)

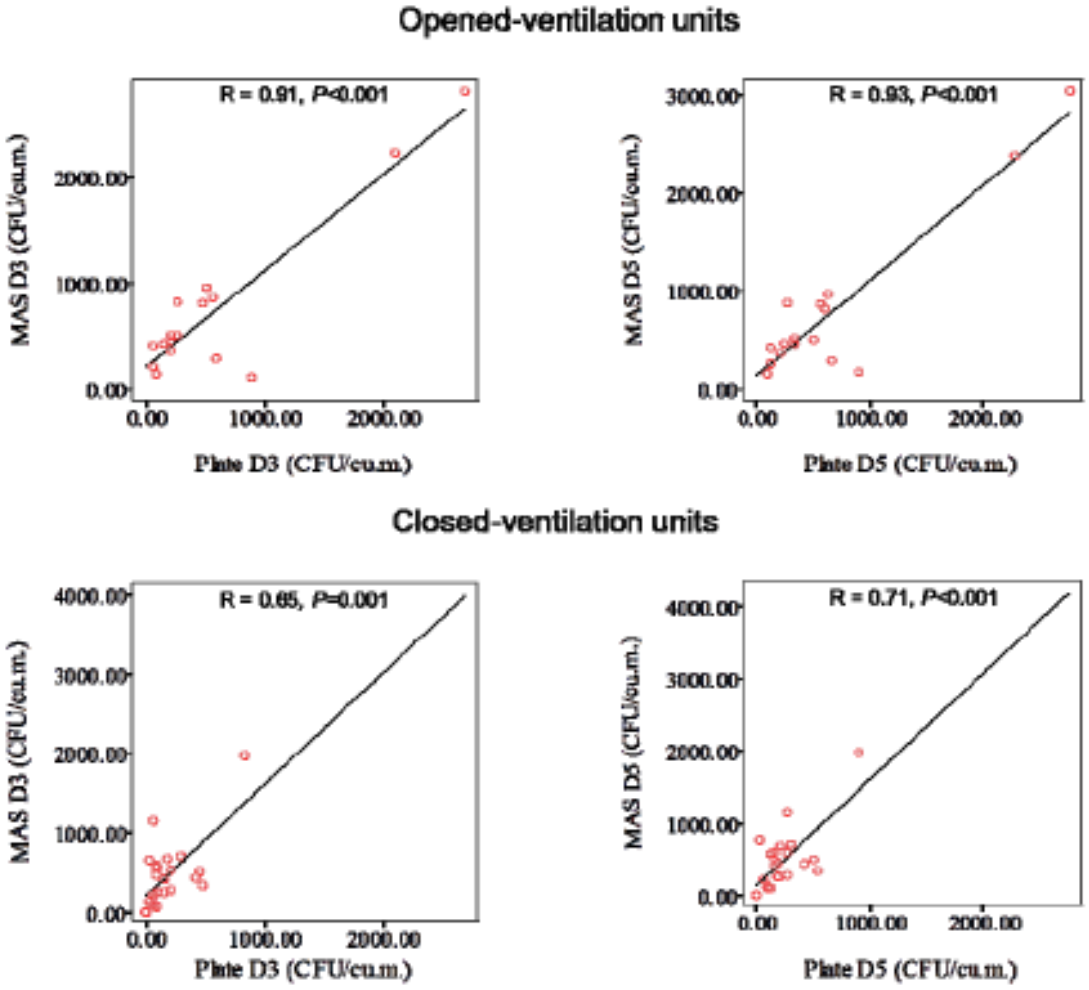
Things to Consider: Always Test for Efficacy

Detection of Fungal in the Air by Non-standard Method

Because Administrative Levels Cannot Invest for Evidence-Based Practices.

So, can settle plate be used after flood?

Figure 1



Khawcharoenporn T, et al. Post-flood measurement of fungal bio-burden: Can setlte plate be used? J Hosp Infect 2013

Other Administrative Issues

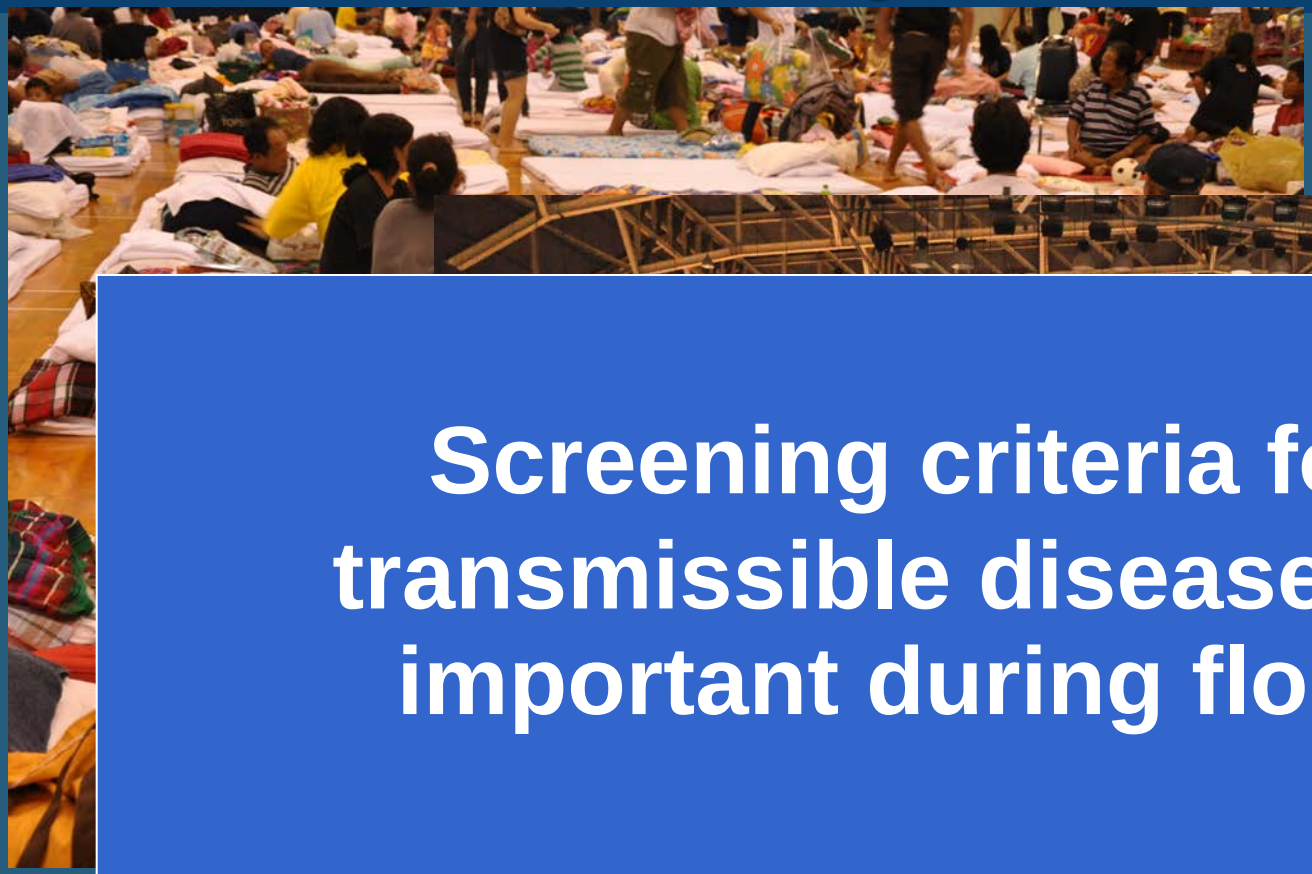
Evidence-Based Intervention for Disaster Preparedness

- Health agency need EM plan
- Most agencies have a plan
- 100% of US hospitals have plan
- Niska 2011
- 92% of Canadian hospitals have plan
- Zouliman 2010
- 93% of Chinese hospitals have plan
- Hui 2007
- 87% of US home health agencies have a pandemic plan
- Rebmann 2011

Need to move Beyond Having a Plan: Exercise Drill

- Only 58% of US hospital use scenarios in drills (Niska 2011)
- 30% test med distribution to staff
- 50% test their plan
- 16% of Canadian hospitals test their pandemic influenza plan (Zoutman 2010)

Talk to Staff about Having a Personal/Family Disaster Plan



Screening criteria for transmissible diseases is important during flood

"Unknown for c countries"

Table 2: *Risk assessment for possible commuicable disease outbreaks*

	Sri Lanka	Indonesia	Maldives	Thailand	India
Cholera	+	+	–	+	+
Typhoid	+	+	–	+	+
Shigellosis	+	+	–	+	+
Hepatitis A & E	+	+	+	+	+
Dengue fever	+	+	+	+	+
Malaria	+	+	–	Unlikely in south	+
Scrub typhus	+	+	+	+	+
Leptospirosis	+	+	?	+	+

What are we doing in Thailand?

Hospital Preparedness for Flood

Flood-related Infection Control Problems	N = 27
Meeting and updating flood problems by hospital administration	
No meeting or updating flood problems	10 (37)
Mold contamination and decontamination in the hospital	
No mold decontamination protocol	15 (56)
No air sampling for mold bioaerosols in flooded units	18 (67)
No HEPA use before opening flooded units	17 (63)
No containment policy for mold contaminated areas	23 (85)
Inappropriate mold decontamination procedures	12 (45)
Inappropriate method of equipment sterilization and disinfection	8 (30)
Personal protection equipment (PPE)	
Inadequate PPE	4 (15)
Inappropriate use of PPE	4 (15)
Air conditioning ventilating and air filtration system evaluation	
Unavailable specialist to inspect the systems	11 (41)
Bad odor before and/or after demolition and repairs	9 (34)
Waste management	
No waste picking up by the designated authority	6 (22)
No separation of infectious waste from general waste	3 (11)
Administration support	
Lack of understanding of mold-related problems	3 (11)
Lack of prioritization of the problems	2 (7)

What are predictors for plan?

Flood preparedness	Characteristics	Adjusted odds ratio (95% confidence interval)	*P*
Have flood protocol	Tertiary care (vs. secondary care)	10.07 (0.93-108.43)	0.05
Ever practiced exercise drill for flood protocol	Safety score of 10 (vs. <10)	6.77 (1.72-26.65)	0.006
Adequate stockpile of personal protection equipment for use during/after flood	Safety score of 10 (vs. <10)	9.01 (1.02-7.69)	0.007
Have plans for opening flood-unaffected units for use during/after flood	Tertiary care (vs. secondary care)	4.26 (0.92-19.70)	0.05
Have environmental cleaning and fungal decontamination protocols after flood	Safety score of 10 (vs. <10)	3.01 (0.95-9.60)	0.05
Have plans for operating isolation units during/after flood	Have a hospital engineer	2.57 (0.93-7.15)	0.07
Have plans for operating laboratory units during/after flood	Safety score of 10 (vs. <10)	5.00 (1.04-24.06)	0.04

[a] Score ranges from 2-10 for the agreement to the two statements about safety ("Leadership is driving us to be a safety-centered institution" and "I would feel safe being treated here as a patient").

What should we do after flood?

REVIEW ARTICLE

Hospital Infection Prevention and Control Issues Relevant to Extensive Floods

Anucha Apisarnthanarak, MD;[1] Linda M. Mundy, MD, PhD;[2] Thana Khawcharoenporn, MD, MSc;[1]
C. Glen Mayhall, MD[3]

The devastating clinical and economic implications of floods exemplify the need for effective global infection prevention and control (IPC) strategies for natural disasters. Reopening of hospitals after excessive flooding requires a balance between meeting the medical needs of the surrounding communities and restoration of a safe hospital environment. Postflood hospital preparedness plans are a key issue for infection control epidemiologists, healthcare providers, patients, and hospital administrators. We provide recent IPC experiences related to reopening of a hospital after extensive black-water floods necessitated hospital closures in Thailand and the United States. These experiences provide a foundation for the future design, execution, and analysis of black-water flood preparedness plans by IPC stakeholders.

Infect Control Hosp Epidemiol 2013;34(2):200-206


1A


1B


1C

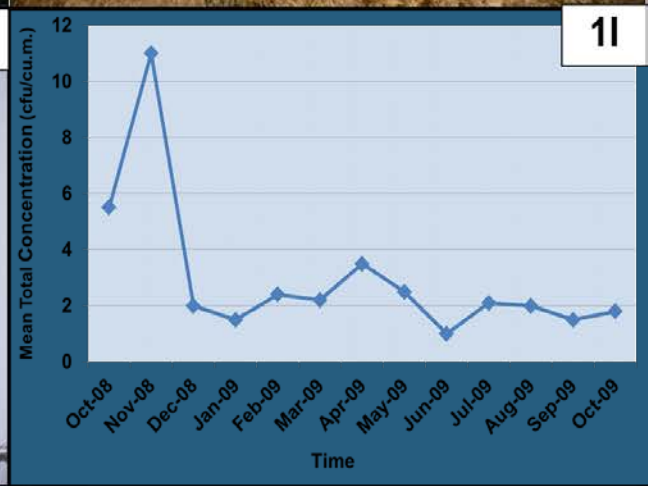

1D


1E


1F


1G


1H


1I
Mean Total Concentration (cfu/cu.m.)
0
2
4
6
8
10
12
Oct-08
Nov-08
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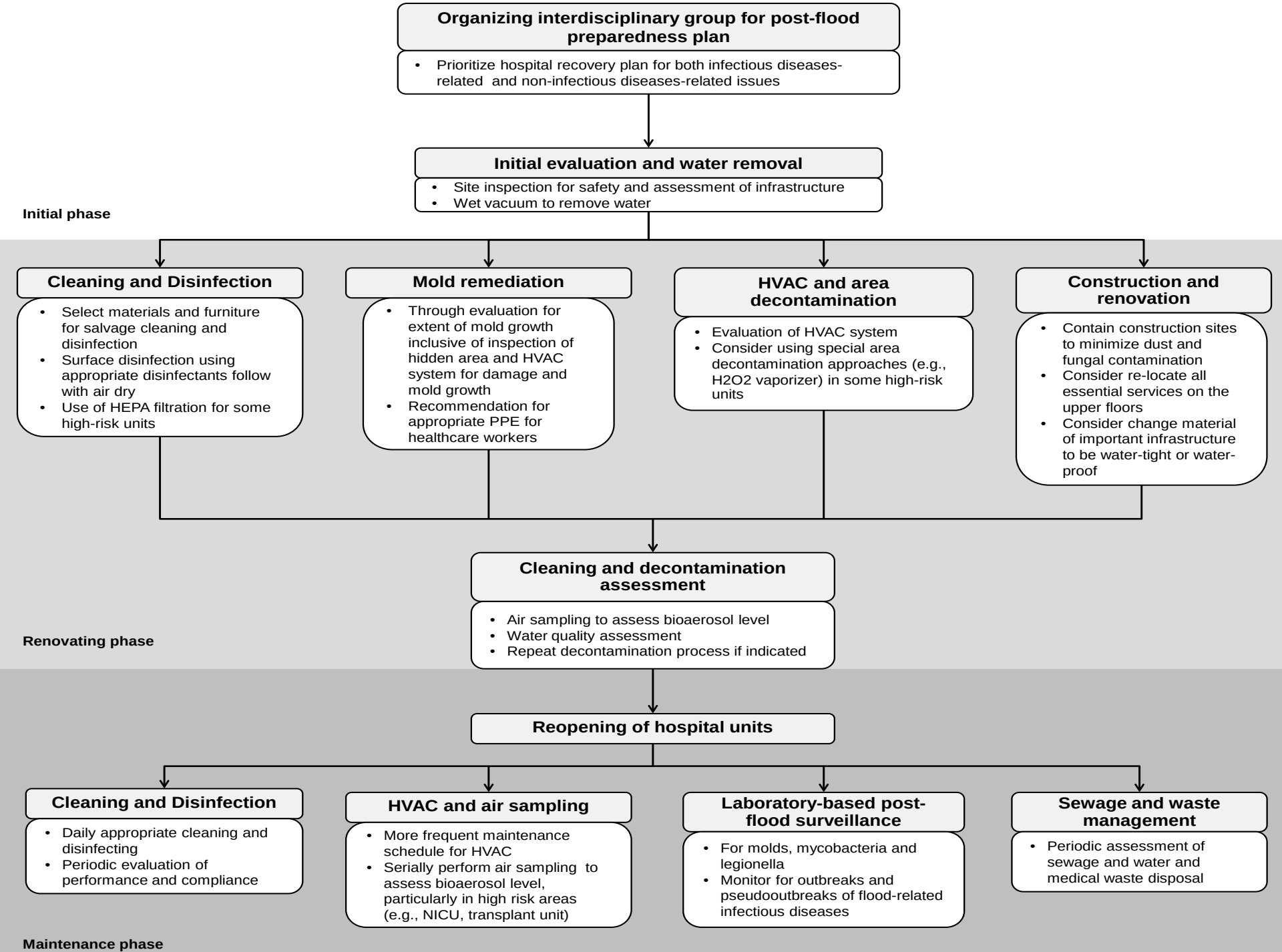
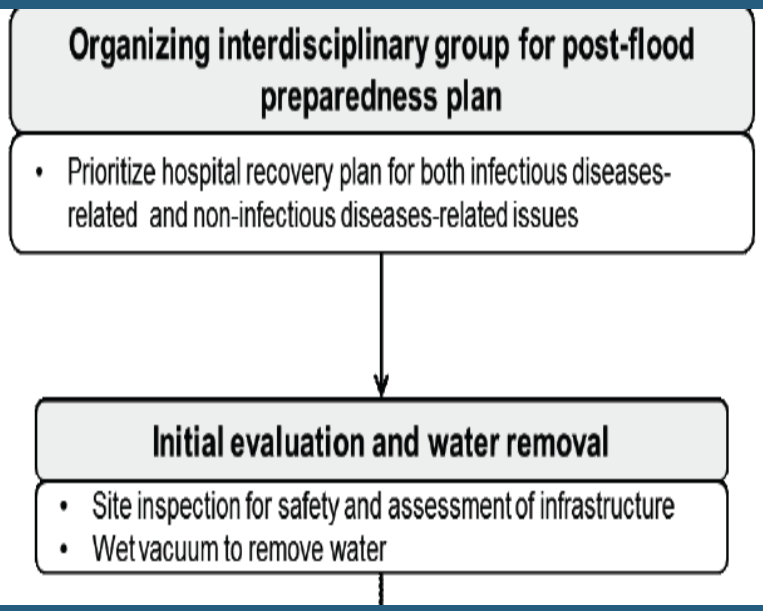
Oct-09
Time

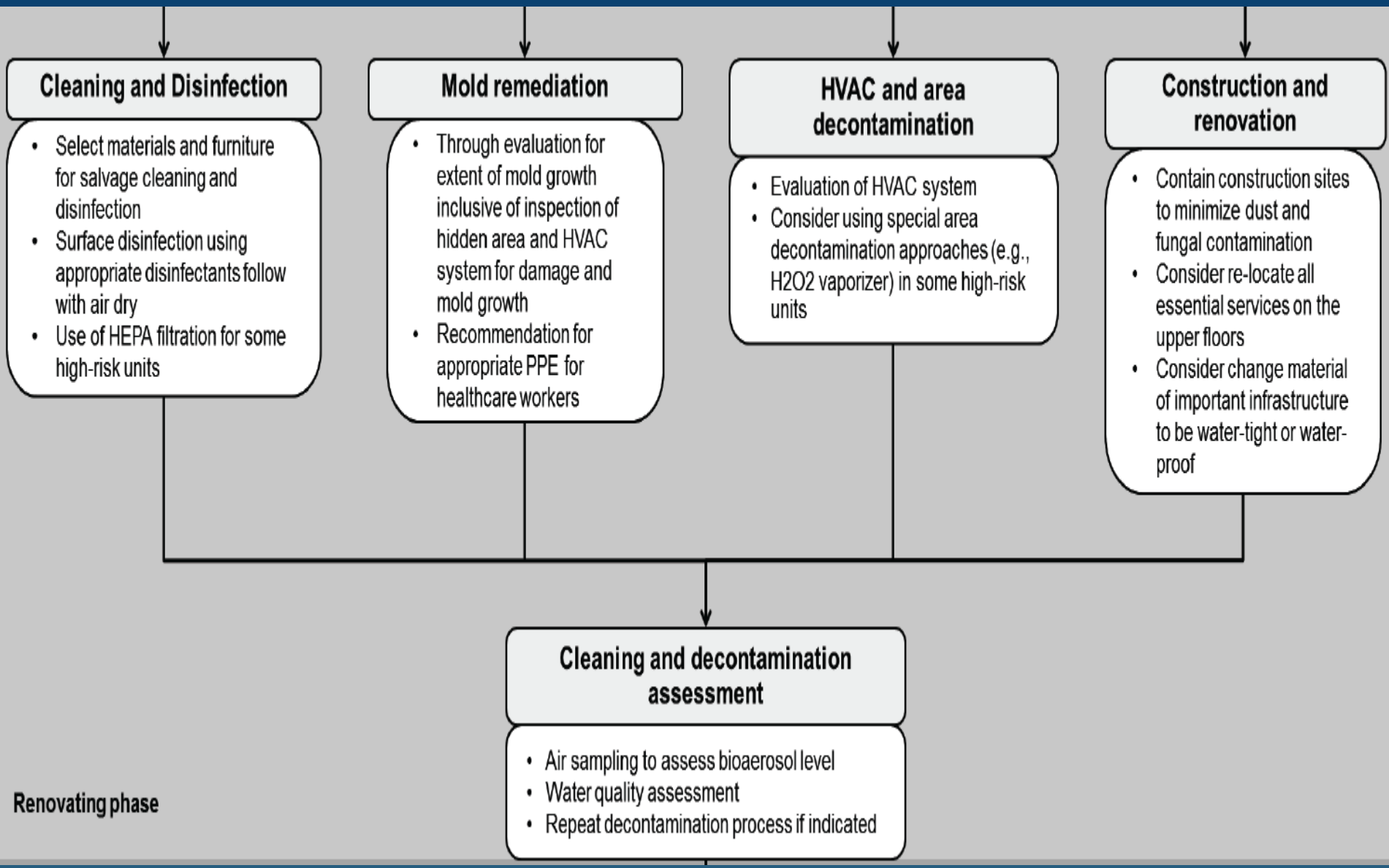

Organizing interdisciplinary group for post-flood preparedness plan
• Prioritize hospital recovery plan for both infectious diseases-related and non-infectious diseases-related issues
Initial evaluation and water removal
• Site inspection for safety and assessment of infrastructure
• Wet vacuum to remove water
Initial phase
Cleaning and Disinfection
• Select materials and furniture for salvage cleaning and disinfection
• Surface disinfection using appropriate disinfectants follow with air dry
• Use of HEPA filtration for some high-risk units
Mold remediation
• Through evaluation for extent of mold growth inclusive of inspection of hidden area and HVAC system for damage and mold growth
• Recommendation for appropriate PPE for healthcare workers
HVAC and area decontamination
• Evaluation of HVAC system
• Consider using special area decontamination approaches (e.g., H2O2 vaporizer) in some high-risk units
Construction and renovation
• Contain construction sites to minimize dust and fungal contamination
• Consider re-locate all essential services on the upper floors
• Consider change material of important infrastructure to be water-tight or water-proof
Cleaning and decontamination assessment
• Air sampling to assess bioaerosol level
• Water quality assessment
• Repeat decontamination process if indicated
Renovating phase
Reopening of hospital units
Cleaning and Disinfection
• Daily appropriate cleaning and disinfecting
• Periodic evaluation of performance and compliance
HVAC and air sampling
• More frequent maintenance schedule for HVAC
• Serially perform air sampling to assess bioaerosol level, particularly in high risk areas (e.g., NICU, transplant unit)
Laboratory-based post-flood surveillance
• For molds, mycobacteria and legionella
• Monitor for outbreaks and pseudooutbreaks of flood-related infectious diseases
Sewage and waste management
• Periodic assessment of sewage and water and medical waste disposal
Maintenance phase

Initial Phase

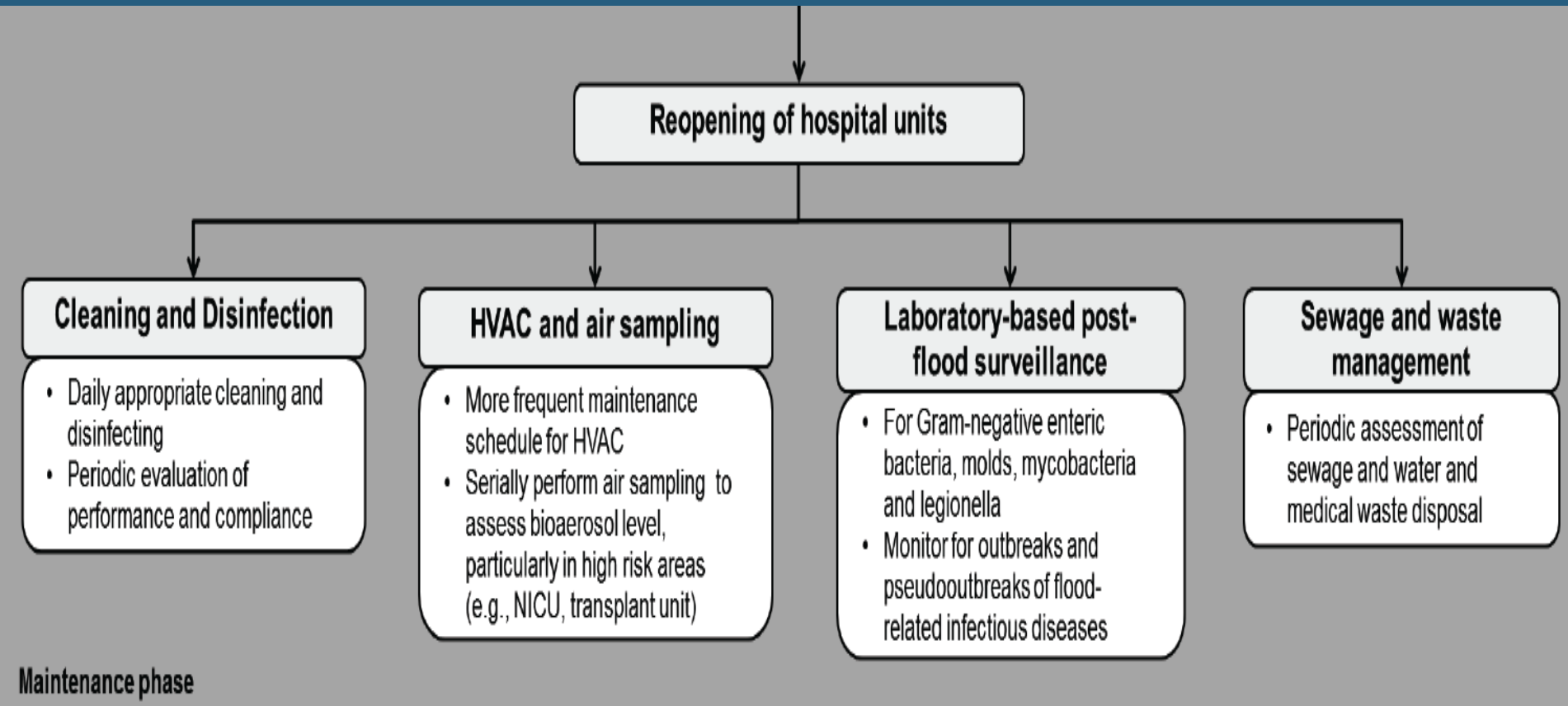


Initial phase

Renovating Phase



Maintenance Phase



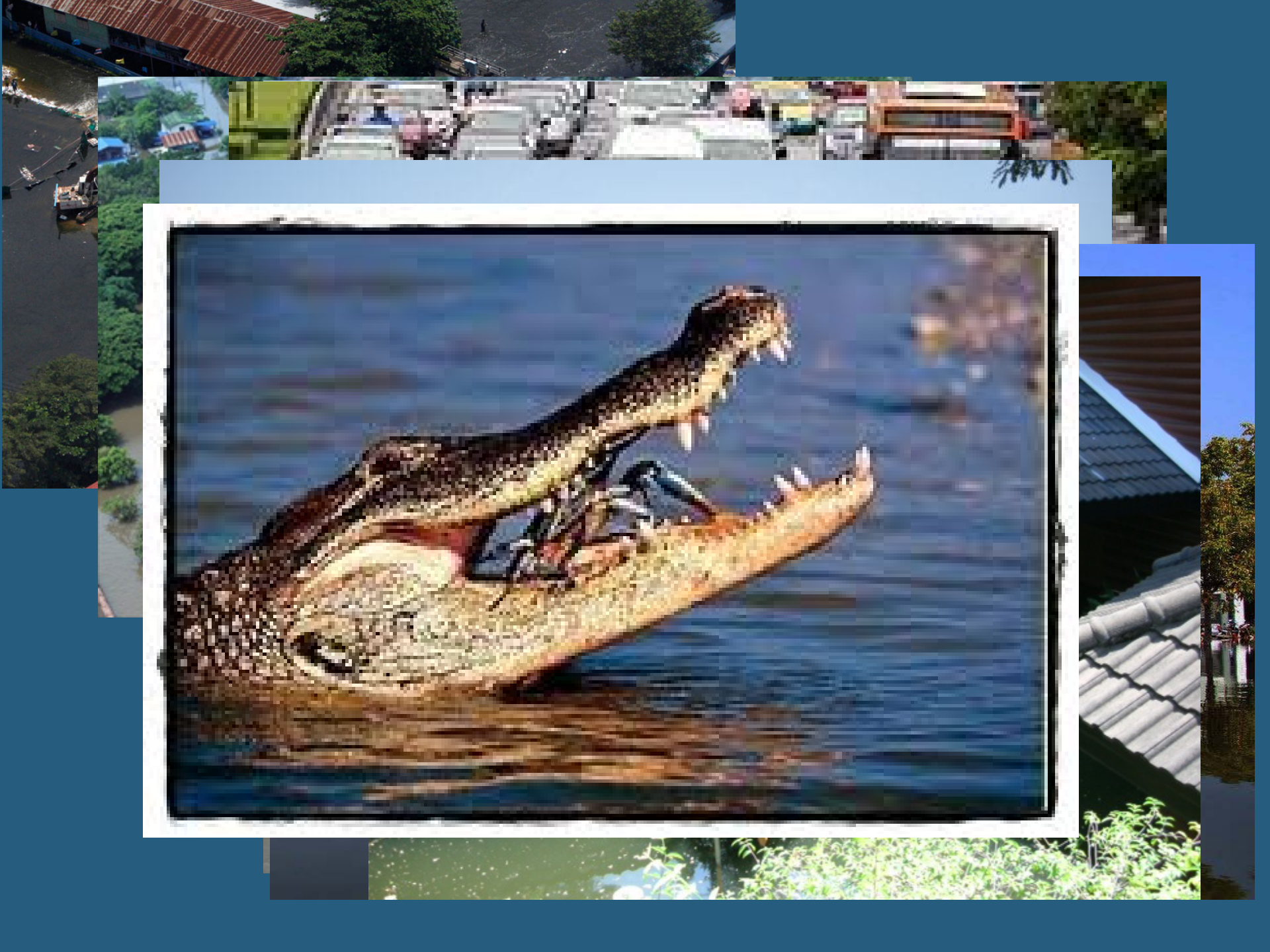
The basic principle is to "Do no Harm"

Florence Nightingale, RN, PhD

The hospitals must have at-least the standard safety for patients, even hospitals for poor people, to be called hospital.

Thank you for your attention

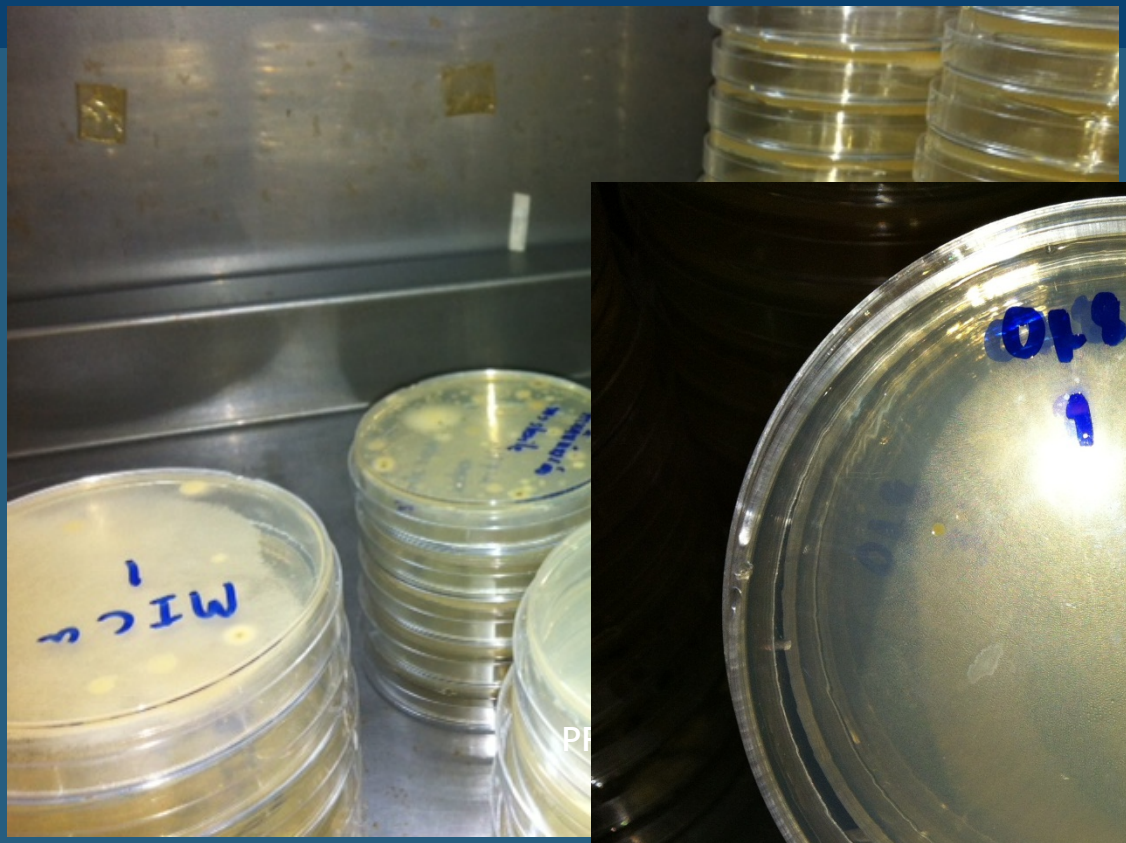
But we can learn from mistake

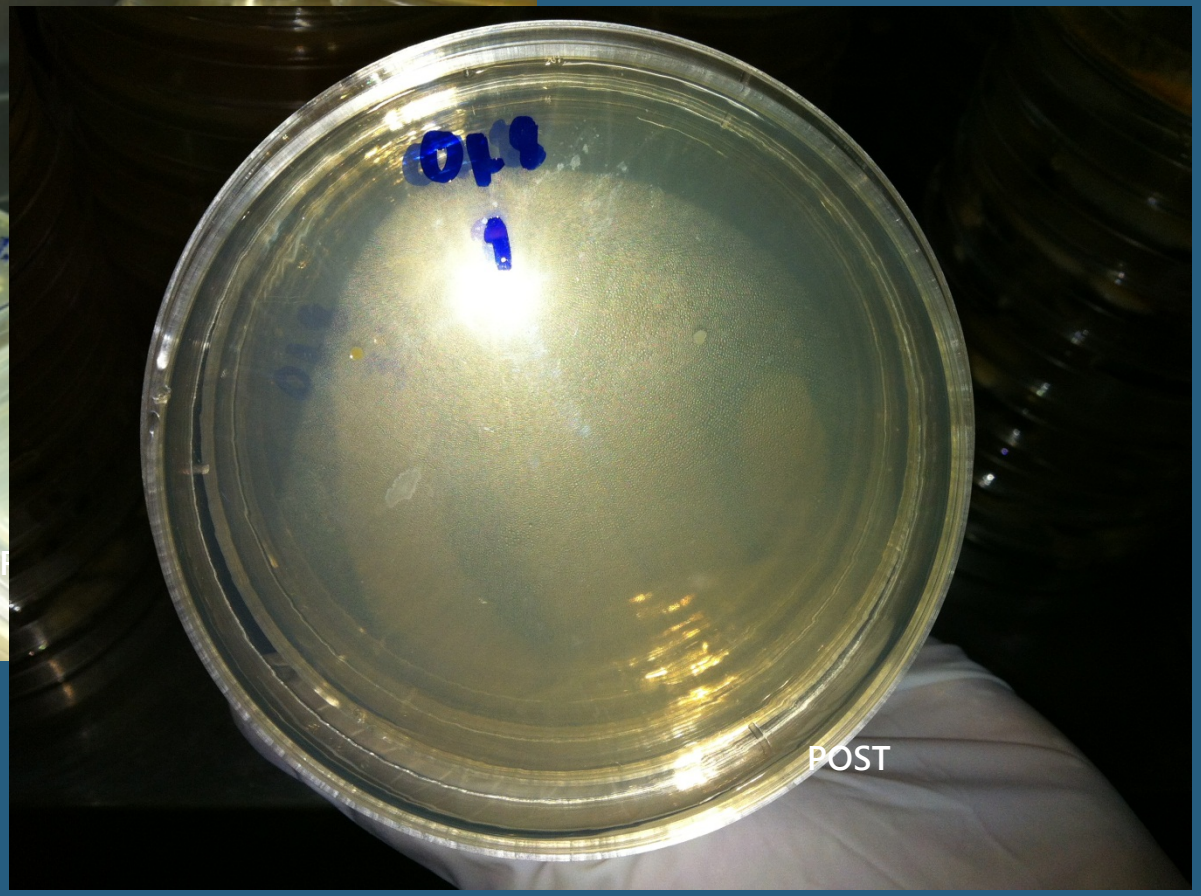


Medical issues related to mold exposure

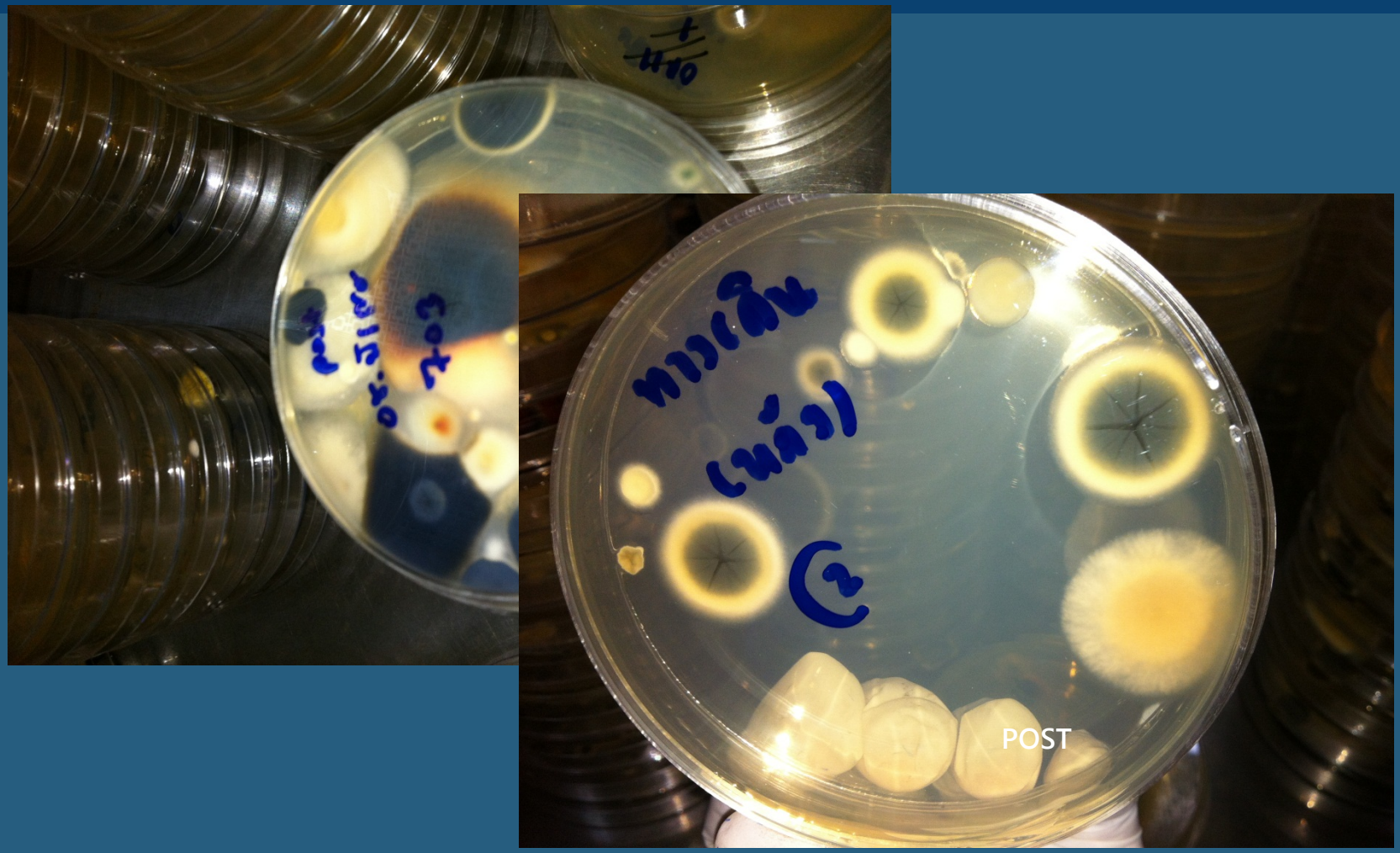
- Exposure to inhaled spores, fungal fragments, and mycotoxins
- Diseases
  - Allergic reactions
  - Toxic effects
  - Invasive infections (immunocompromised)
- Reactions more likely to occur with either high fungal load or chronic exposure

Outcomes (close units)





Outcomes (open units)



This finding is not surprising

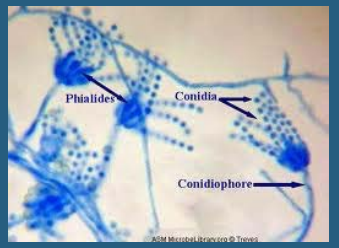
Lessons Learned

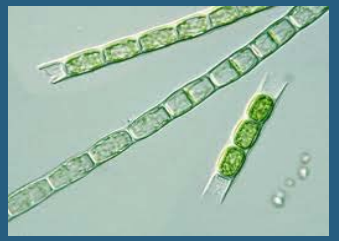
- Air decontamination using vapor/aerosolize is only a part of room decontamination and cannot be used as stand-alone intervention

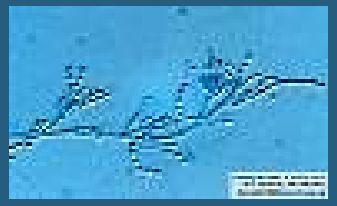
- Other interventions that might help include through cleaning, use of filter/HEPA filter/UV light

Predominant Fungus

- *Aspergillus spp.*
- *Pennicillium spp.*
- *Microspora spp.*
- *Paecilomyces spp.*







Surface Culture for Fungus: A Waste of Money

- Environmental fungus is already there at the beginning
- There was no standard interpretation