



# TB Infection Control

Seattle TB Intensive - July 14, 2023

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## Overview

### Inpatient Setting

1. Transmission
2. Hierarchy of controls
3. Ventilation
4. Inpatient isolation precautions

### Outpatient and Community

1. Hospital Discharge
2. Home-based isolation
3. Contact investigation

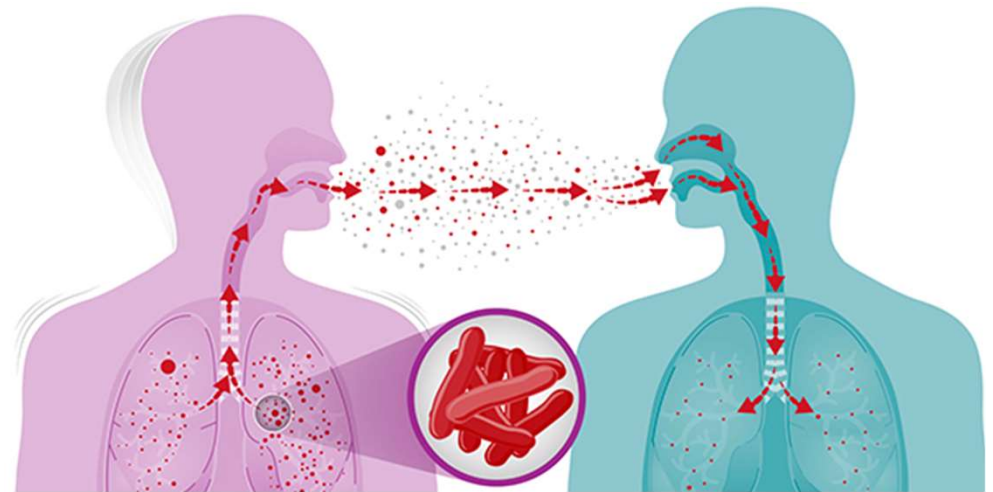
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**Part 1:**

# **TB Infection Control in Inpatient Settings**

## Transmission basics

- TB spreads from **person-to-person** through the air
- **Droplet nuclei** (1-5 microns) remain suspended in air
- **Infection** occurs when a susceptible host inhales droplet nuclei containing *M. tuberculosis*, bacilli establish in lungs and other areas



1. CDC, TB Infection Control
2. Fennelly, Kevin. Lancet Respir Med, 2020.
3. Wang et al. Science 2021.

## Breathing matters

- Coughing is widely thought to be the primary mechanism of TB transmission
- Newer data show that simple tidal breathing may be a significant contributor to transmission
- Dinkele et al (2022): performed bioaerosol evaluation of 38 people with untreated pulmonary TB

"Although a single cough produced approximately threefold more *Mtb* than a single breath, we estimated each individual makes around 22,000 breaths per day compared to an upper quartile of 550 coughs in the same period. **This suggests breathing is likely to contribute more than 90% of the daily aerosolized *Mtb* from symptomatic patients with TB irrespective of cough frequency.**"





## What factors impact transmission risk?

**Bacillary burden** of index case - concentration of infectious particles in the air

- Cavitory lesion, presence of cough, smear-positivity

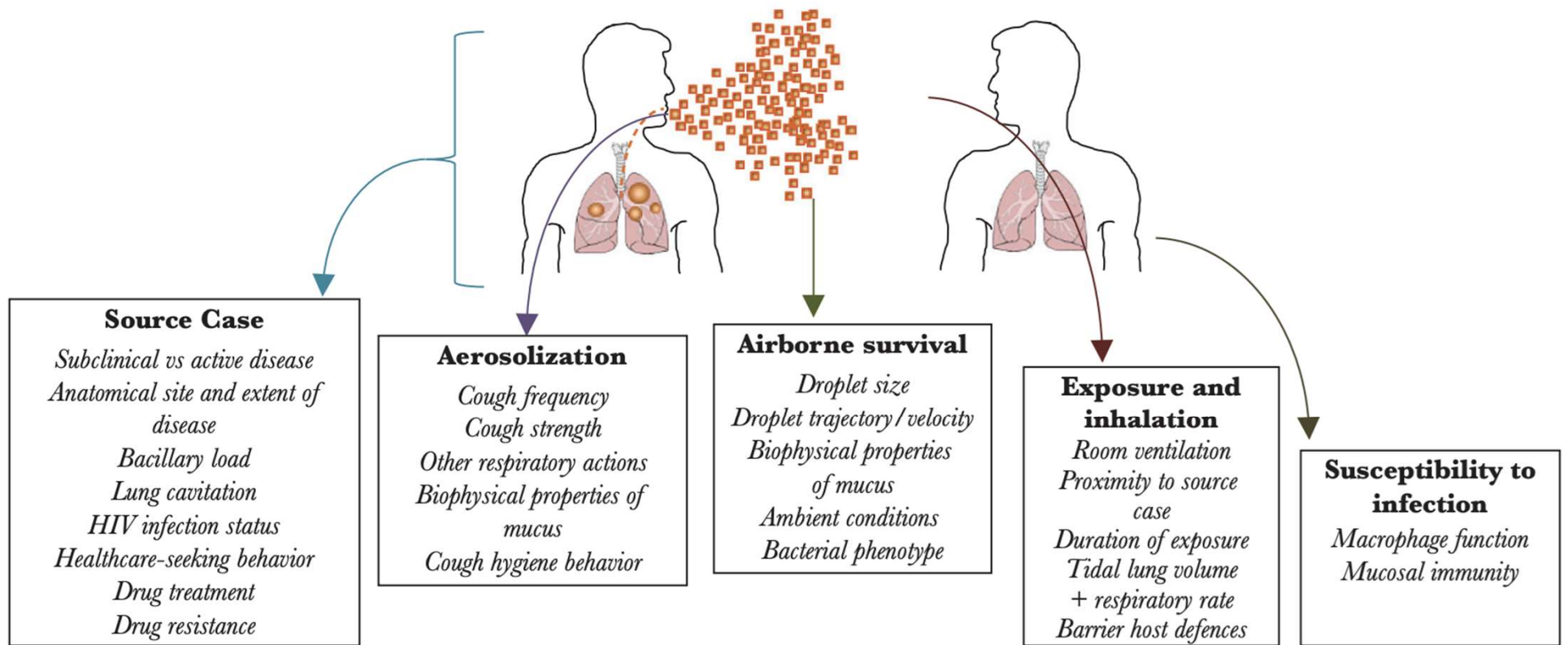
**Environmental factors** - ventilation, air circulation

**Exposure** - proximity, frequency, duration of exposure

**Host factors** - immune status of exposed person, genetics, co-morbidities e.g. silicosis, tobacco use

**Structural factors** - crowding, poor access to healthcare, socioeconomic status

1. CDC, TB Infection Control
2. Turner et al. JID 2017.



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**How can we stop transmission?**



Early

- ★ **identification**
- ★ **isolation**
- ★ **treatment**

of patients with TB





## Hierarchy of controls



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## (1) Administrative controls



- Conducting TB risk assessment of the setting
- Implementing work practice controls
- Educating employees about TB
- Screening employees for TB infection
- Using appropriate signage
- Training employees on cough etiquette
- Develop a written TB infection control plan
- Adjusting patient flow

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## (2) Environmental controls

- Natural and mechanical **ventilation**
- **Dilute and remove** contaminated air
- **Ultraviolet** germicidal irradiation
- Facility **design**, construction, renovation



# Types of ventilation



## Natural ventilation

**Pros:** low cost; in the right conditions, can have great ventilation

**Cons:** difficult to control amount and direction; weather-dependent; no filtration of other pathogens, dust, or pollutants

1. CDC, TB Infection Control
2. MSF



## Fans

**Pros:** low cost; can control direction and air mixing

**Cons:** no air cleaning; needs careful airflow mapping to prevent staff exposures

## Types of ventilation, cont'd



### HEPA filters

**Pros:** fast; 99.97% efficiency with 0.3 micron particles; can be portable

**Cons:** needs careful placement; power consumption; maintenance



### Mechanical ventilation/HVAC

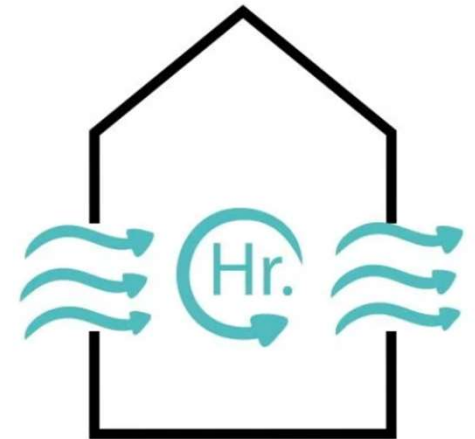
**Pros:** very effective

**Cons:** \$\$\$; maintenance; improperly configured systems can spread infection

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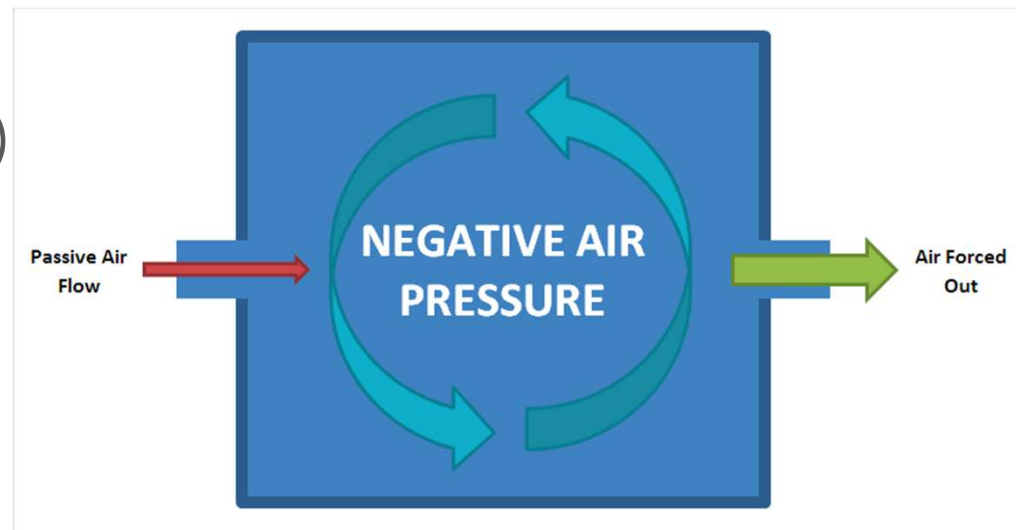
## Dilution ventilation

- Adds fresh, clean air into contaminated air
- Air changes per hour (ACH) measures the dilution ventilation rate - how many times per hour is the air in the room being replaced?
- Minimum ACH for most patient care areas = 6 but can vary widely



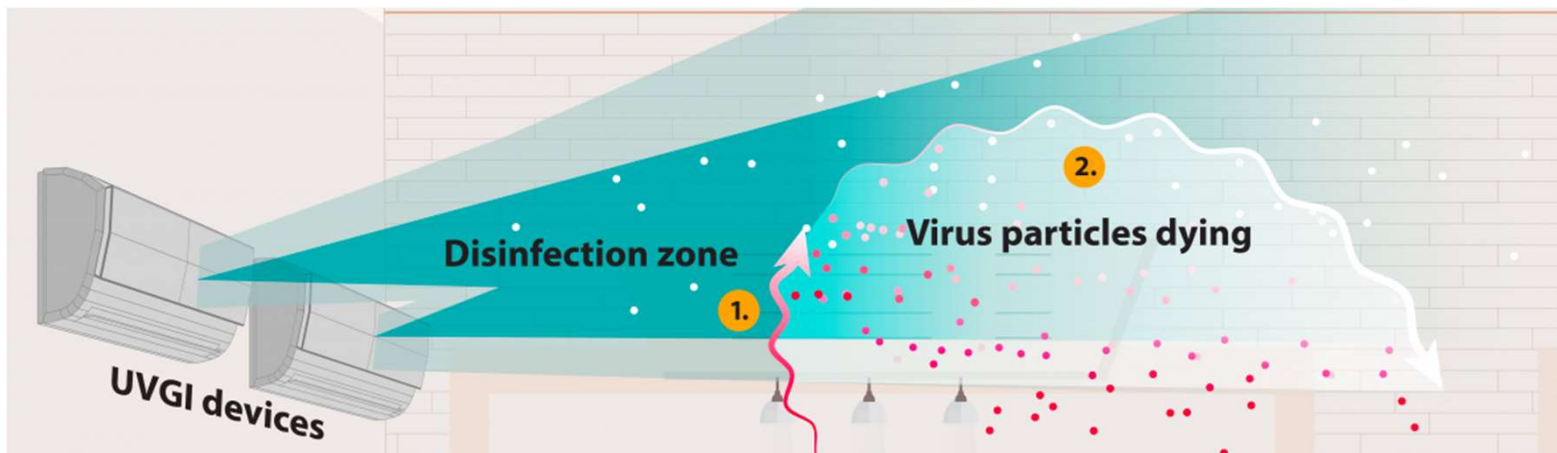
## Airborne infection isolation room (AIIR)

- Air pressure in room is **lower** than outside room (“negative pressure”)
- Air pressure is **monitored regularly**
- Prioritized for **isolation of an infectious patient** with airborne disease
- Minimum ACH for AIIR = **12**



# Ultraviolet germicidal irradiation (UVGI)

- Disinfecting technology consisting of radiation that kills or inactivates TB bacilli
- Complementary when used with other measures
- How does it work? Air flows from HVAC, fans, or windows through disinfection zone and pathogens are killed by UV-C energy





### (3) Respiratory protection/PPE



- **Particulate respirators** protect against inhalation of pathogens; filters large and small particles
- With proper fit, filters up to **95% of particles**
- Needs to be **fit-tested** to the healthcare worker
- **Powered air-purifying respirator (PAPR)**: portable, battery-operated, uses a blower to pass contaminated air through a filter to a facepiece
- PAPR can be used if **N95 doesn't fit** or employee has facial hair that interferes with N95 seal

# Patients with TB

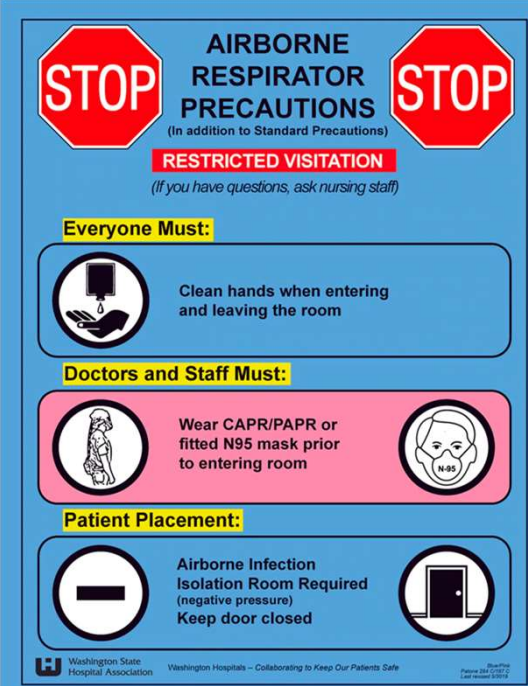
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# When to initiate airborne precautions

## 1. Patient has signs or symptoms concerning for TB

- Persistent cough (>3 weeks)
- Bloody sputum
- Weight loss
- Fever
- Night sweats
- Chest imaging suggestive of TB


## 2. Patient has confirmed, infectious TB





**STOP** AIRBORNE RESPIRATOR PRECAUTIONS **STOP**  
(In addition to Standard Precautions)

**RESTRICTED VISITATION**  
(If you have questions, ask nursing staff)



**Everyone Must:**

-  Clean hands when entering and leaving the room

**Doctors and Staff Must:**

-  Wear CAPR/PAPR or fitted N95 mask prior to entering room
-  N95

**Patient Placement:**

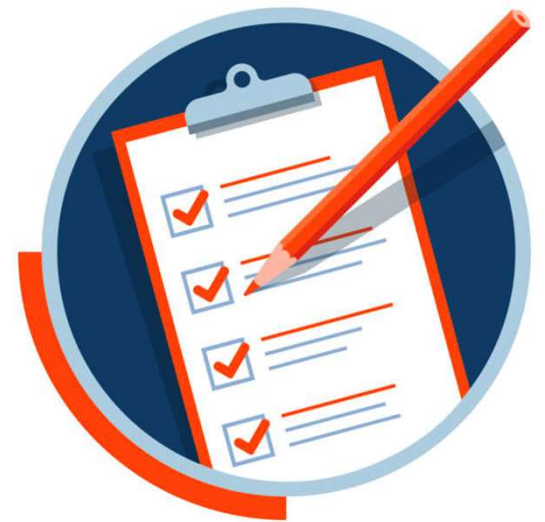
-  Airborne Infection Isolation Room Required (negative pressure)
-  Keep door closed

Washington State Hospital Association | Washington Hospitals - Collaborating to Keep Our Patients Safe | Patient 204 (01/12) Last revised 03/12

## When to discontinue isolation precautions - CDC

TB is **unlikely** and an **alternate diagnosis** is made **OR**

- 1) **3 consecutive, negative AFB sputum smears** collected >8 hours apart (at least one is morning specimen)
- 2) Patient has received at least **2 weeks of standard anti-TB treatment**
- 3) Patient has demonstrated **clinical improvement**



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## Releasing suspected TB patients from isolation - UWMC

**Two** negative sputum AFB smears

AND

One negative **Xpert** (rapid nucleic acid amplification test)



**What role does the Xpert play  
in TB infection prevention?**

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## Smear vs Xpert

- Xpert detects M. TB and mutations associated with rifampin resistance in <2 hours
- 2016 study compared Xpert to sputum AFB in low-prevalence setting

*Clinical Infectious Diseases*

MAJOR ARTICLE

 IDSA  
Infectious Diseases Society of America

 hivma  
hiv medicine association

 OXFORD

### Evaluation of Xpert MTB/RIF Versus AFB Smear and Culture to Identify Pulmonary Tuberculosis in Patients With Suspected Tuberculosis From Low and Higher Prevalence Settings

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#### Findings:

- One Xpert predicted the absence of culture-positive TB with NPV of 97.6%, and predicted the absence of smear-positive TB with NPV of 99.7%
- 1 Xpert was significantly more sensitive than 3 AFB smears
- 1 Xpert identified more than half of smear-negative, culture-positive TB (all missed by smear alone)

## Xpert MTB/RIF Assay as a Substitute for Smear Microscopy in an Intermediate-Burden Setting

Hyun-Seung Lee<sup>1</sup>, Seung-Jung Kee<sup>2\*</sup>, Ju-Hyeon Shin<sup>2</sup>, Yong-Soo Kwon<sup>3</sup>, Sejong Chun<sup>2</sup>, Jun Hyung Lee<sup>4</sup>, Eun Jeong Won<sup>2,5</sup>, Hyun-Jung Choi<sup>4</sup>, Soo Hyun Kim<sup>4</sup>, Myung-Geun Shin<sup>4</sup>, Jong-Hee Shin<sup>2</sup>, and Soon-Pal Suh<sup>2\*</sup>

<sup>1</sup>Department of Laboratory Medicine, Chonbuk National University Hospital, Jeonju, Republic of Korea; <sup>2</sup>Department of Laboratory Medicine and <sup>3</sup>Department of Pulmonary and Critical Care Medicine, Chonnam National University Medical School and Hospital, Gwangju, Republic of Korea; <sup>4</sup>Department of Laboratory Medicine, Chonnam National University Medical School and Hwasun Hospital, Hwasun, Republic of Korea; and <sup>5</sup>Department of Parasitology, Chonnam National University Medical School, Gwangju, Republic of Korea

- Lee et al (2019) - compared one Xpert vs. one AFB smear in South Korea
- Sensitivity and specificity were 74.1% and 97.5% for Xpert versus 38.8% and 96.7% for smear microscopy, respectively
- Concluded that Xpert provided **faster, more stable, and superior** results compared to smear
- Found a strong correlation between **cycle threshold** and **smear grade**
- More reliable detection of true-negative samples is important to avoid unnecessary treatment and All (especially in areas with higher NTM prevalence than MTB)
- 24% of smear-negative, Xpert-positive patients had a pulmonary cavity (risk of transmission)



## Xpert Only Strategy

- 2016 consensus statement by National TB Controllers Association (NTCA) and the Association of Public Health Laboratories (APHL) after revised FDA labeling in 2015 for Xpert
- Can use 2 negative Xpert tests to release suspected patient from airborne isolation



Consensus statement on the use of  
**Cepheid Xpert MTB/RIF®** assay in making  
decisions to discontinue **airborne infection  
isolation** in healthcare settings

### PURPOSE

The purpose of this consensus statement is to provide guidance for clinicians, nurses, and hospital infection preventionists on the use of the FDA-approved Cepheid Xpert MTB/RIF® (Xpert) Nucleic Acid Amplification (NAA) test when making decisions to discontinue airborne infection isolation (A.I.I.) for persons with suspected, infectious pulmonary tuberculosis (TB).

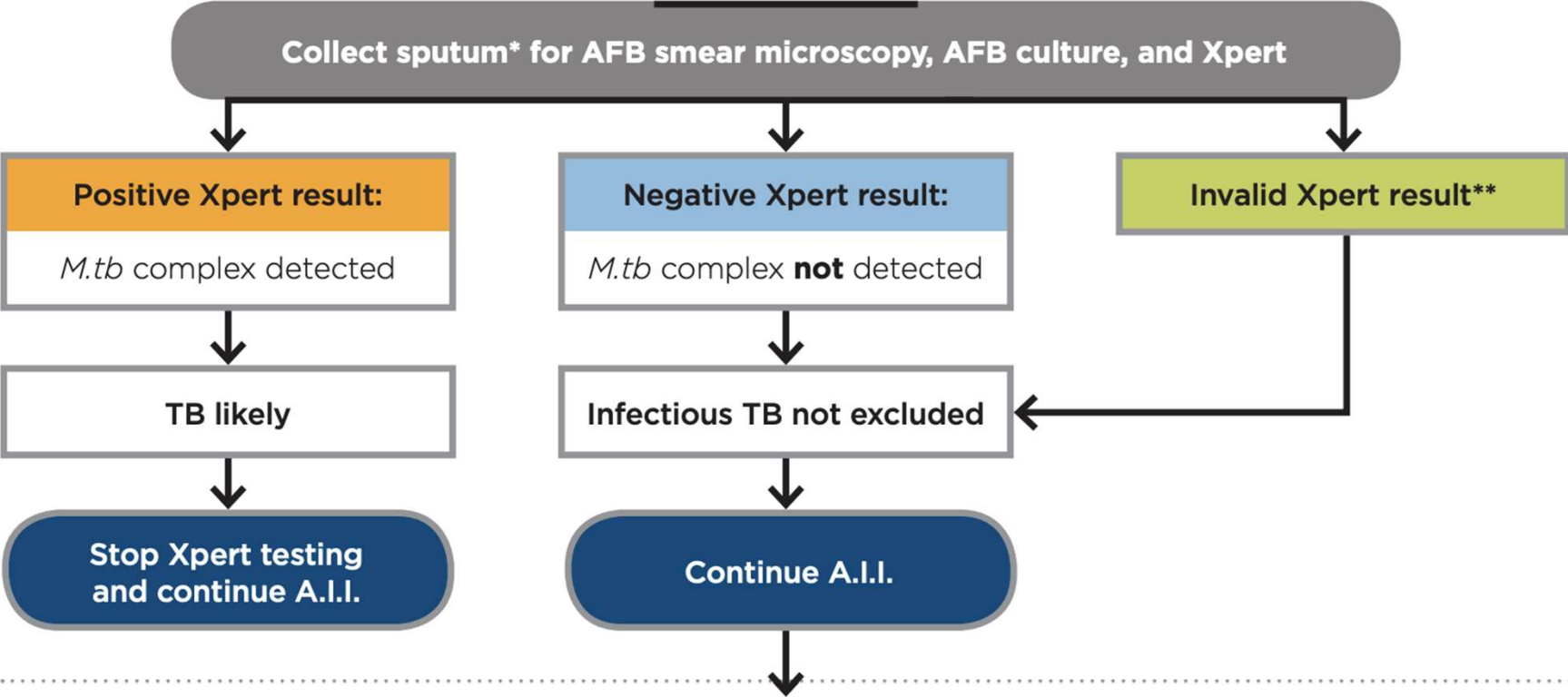
- It is important to note that the process described herein **is not to be used alone to rule out TB**; Xpert negative or acid-fast bacilli (AFB) smear-negative sputum may contain viable organisms and represent infectious tuberculosis.
- Furthermore, NAA testing should **not be used to monitor response to treatment or to release a newly confirmed TB patient from A.I.I.**

**Note:** FDA-approved labeling (and this document) applies for this instrument and this purpose **only**.

See Appendix I for Definition of Terms

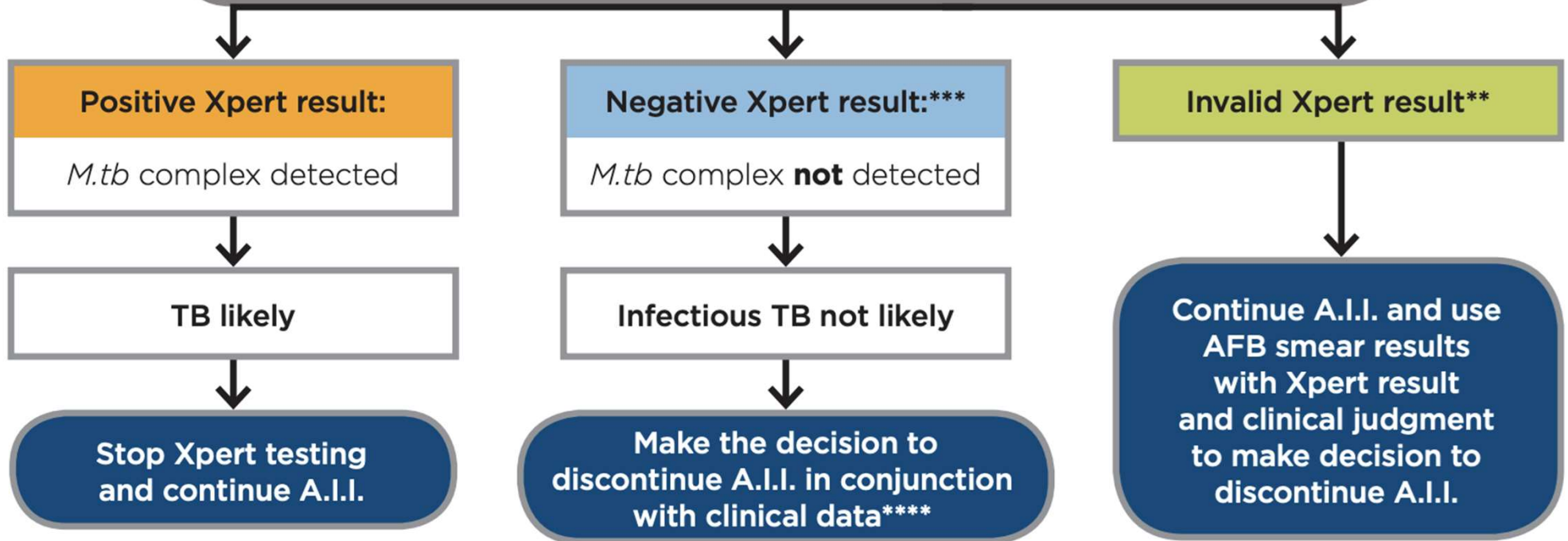
# USE OF GENEXPERT IN DISCONTINUING AIRBORNE INFECTION ISOLATION

## STEP 1.



## STEP 2.

Collect second sputum specimen at least 8 hours after first specimen for AFB smear microscopy, AFB culture, and Xpert



**M. tb:** *Mycobacterium tuberculosis* **A.I.I.:** Airborne infection isolation



## Key points on diagnostic testing and isolation decisions

- Different institutions have different protocols
- Collection and quality of sputum are critical
- Negative AFB or Xpert do not “**rule out**” TB - they decrease the likelihood of having *transmissible* TB
- **Use your clinical judgment!**
- Tests are interpreted in the context of clinical and radiographic presentation, and clinical suspicion for TB

# Extrapulmonary TB

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## Extrapulmonary TB



- Clinical presentation depends on the site of disease - e.g. meningitis, pleural TB, bone/joint TB
- Pulmonary TB must be “ruled out!”
- Up to 10% of extrapulmonary TB patients have unexpected infectious pulmonary TB, not reliably identified by chest X-ray (Parimon et al, 2008)
- UWMC protocol - all patients with extrapulmonary TB must undergo pulmonary TB workup
- Even if pulmonary TB workup is negative, AIR needed if risk of aerosolization: use of saws or electrical devices on bone, high-pressure irrigation of infected areas; aspiration of chest tube for TB empyema

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## Part 2

# TB Infection Control in Outpatient and Community Settings

# Discharging from the hospital

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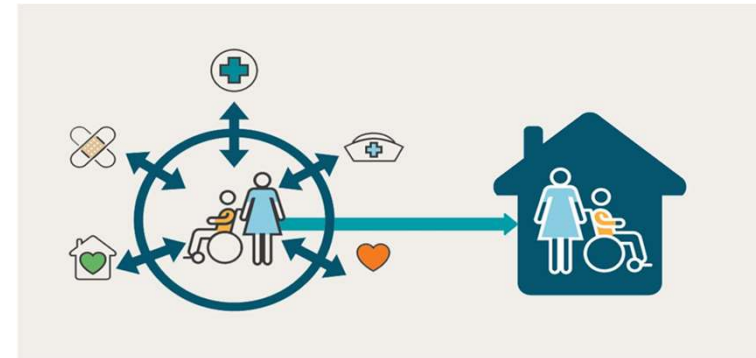


# Transitioning from Inpatient to Home



- ❖ Assessing clinical improvement/stability and completion of diagnostic testing and treatment initiation
- ❖ Assessing the safety of discharge to home for infectious patients admitted to hospital:
  - Living alone or w/ immunocompetent household members
  - Congregate setting (i.e shelter, nursing home, jail, etc)
  - High risk individuals at home (i.e infants, immunosuppressed)
- ❖ Assessing barriers to medication adherence

## Discharge Home



- ❖ Per the CDC, there is no minimum number of treatment days required prior to discharge home IF:
  - Patient lives alone or w/ immunocompetent household members who have already been exposed
  - No infant less than the age 5 years in the home
  - Patient is on appropriate treatment
  - There is a follow up plan in place
  - Patient willing to stay home until cleared
- ❖ If patient lives with high risk individuals, they should be evaluated and **treated as needed\*\*\***



## Congregate settings

Patients w/ confirmed or suspected TB should not be discharged to congregate setting until they:

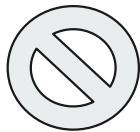
- Produce **3 consecutive, negative AFB sputum smears collected >8 hours apart** (at least one is morning specimen)
  - Received at least **2 weeks of standard anti-TB treatment**
  - Demonstrated **clinical improvement**
- ★ *Of note, some patients may continue to produce dead mycobacteria resulting in positive smears so in these cases, if cultures are negative twice consecutively, they may discontinue isolation*

# Home Based Isolation

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# Home/Community Based Isolation

**\*Protocols will vary by program!\***



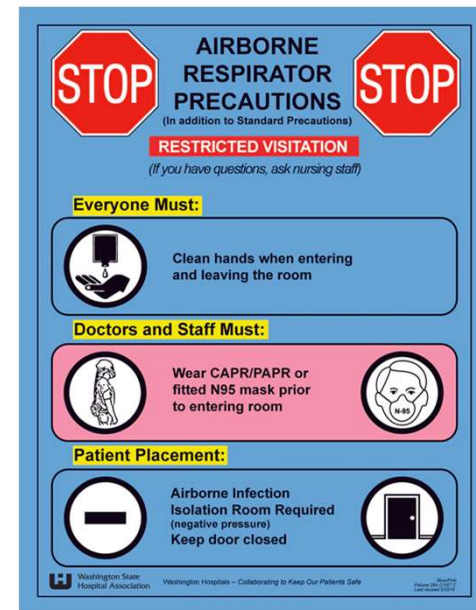
- No new visitors
- No visiting indoor/closed spaces
- No public transportation



- Walking outside
- Short taxi (w/ mask and windows open)
- Healthcare appts

# Seeing TB patients in clinic

- ❖ Must wear masks when entering clinic
- ❖ Should be placed in airborne infection isolation room
  - If none available, place in single room with door closed and mask on
- ❖ Staff seeing patient must be in appropriate PPE (N-95, PAPR)
- ❖ Allow appropriate downtime depending on ACH



# Contact Evaluation

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## Healthcare transmission



- Generally lower risk
  - Better ventilation, less time spent in close contact (i.e., >8hrs), universal masking
- Large exposures with contact tracing have not led to conversions
- High risk areas include emergency rooms, waiting rooms, AGPs, etc.





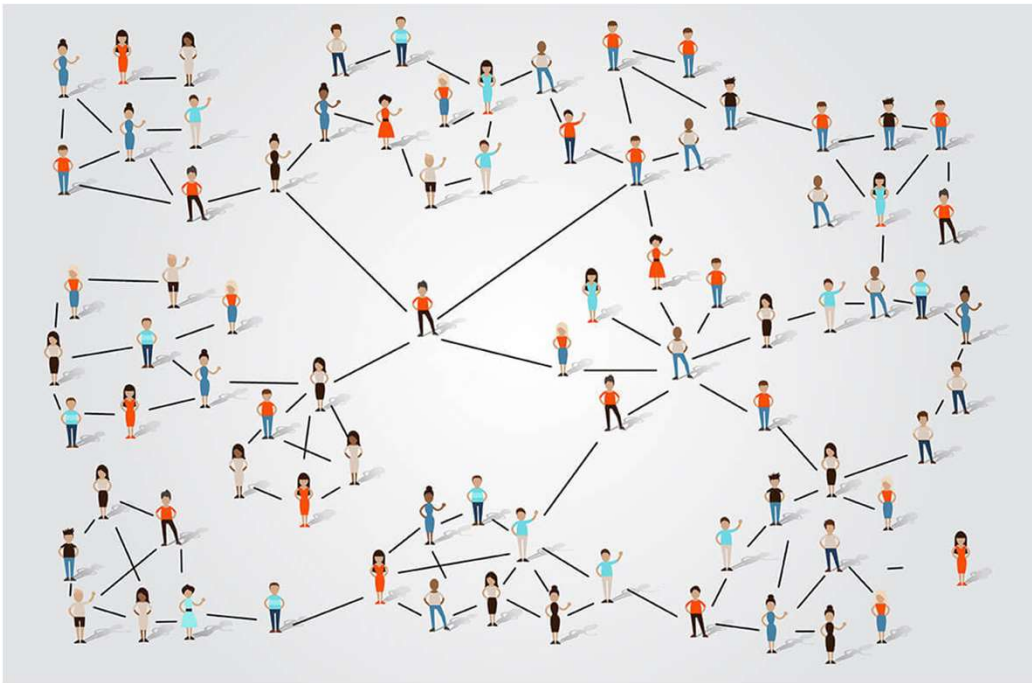
## Contact investigation

### Goals:

- ★ To identify other active cases
- ★ To identify people at risk for progression to active disease

- ❖ Start with inner circle first (based on proximity, duration of exposure, etc.)
- ❖ The infectious period is typically considered 3 months prior to symptom onset or diagnosis
- ❖ If there is a high infection rate among that first group, contact tracing will be expanded further

## Evaluation of contacts



- ❖ All close contacts should be evaluated for LTBI or active TB with symptom check and TST/IGRA (1st round of evaluation)
- ❖ CXR is recommended for:
  - Anyone with symptoms
  - Asymptomatic individuals who are highly immunocompromised or under the age of 5
  - Anyone whose initial TST/IGRA was positive
- ❖ If initial results are negative, repeat TST/IGRA should be done 8 weeks after last exposure

Thank  
you!

