

# **TB Infection Control in Health Care Settings**

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# Objectives

- TB incidence in community & hospitals decreasing & Risk to health care workers is decreasing
- CDC Guidelines 2005 update reviewed
  - Administrative, Environmental, Respiratory Controls
  - Implementation
  - Extended to include many non-hospital settings
- Re-evaluation of TST screening
- New technology (eg, BAMT)

**What is the most dangerous  
type of TB to Health Care  
Workers?**

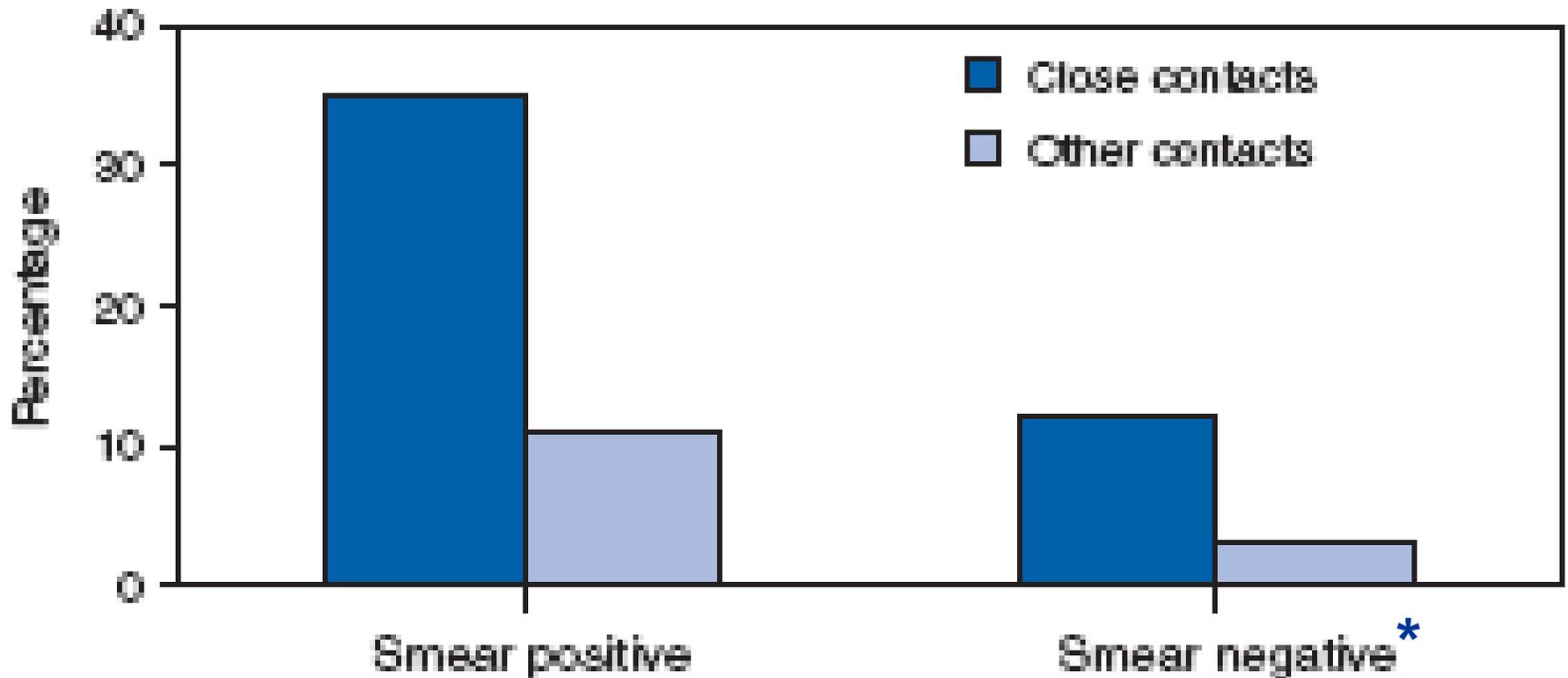
**The Unsuspected Case!!**

**What Factors Determine TB  
Infectiousness?**

# Transmission of Tuberculosis

- Aerosol (airborne droplet nuclei) only transmits infection
- 21-23% of close contacts become infected
- Patient factors
  - Disease in lung, airway, and/or larynx
  - Coughing or cough inducing procedure
  - Concentration of droplet nuclei (cavitary > non-cavitary)
    - Sputum smear:
      - Positive: transmission occurs
      - Negative, but culture positive: transmission less often (see Figure)
- Environment factors
  - Duration of contact
  - Small enclosed space
  - Poor ventilation or recirculation of room air
- Other factors
  - Susceptibility of the host
  - Poorly understood bacteria characteristics
- Infection rate drops rapidly with treatment initiation

# TB Transmission...Percent Infected Smear-Positive vs. -Negative Source Case Proximity to Source Case



**\*AFB smear negative cases account for 17% TB transmission**

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**How long should patients be  
isolated?**

# Traditional CDC Isolation Recommendations

Patients are not considered infectious if they meet the following criteria:

- Adequate therapy for 2 or 3 weeks
- Favorable clinical response
- Sputum smear *negative* x 3...

**Disconnect: Regulation vs. Reality**

# Prolonged Sputa/Culture Positivity = Reality (Smear + correlates w/ culture + duration)

Study	Culture Conversion	Rx Regimen	N	Cure Rate
Cohn et al: <i>AIM</i> 1990	1-19 wks	6 mos DOT (2x/wk)	125	98%
Combs et al: <i>AIM</i> 1990	50% (-) @ 7 wks 90% (-) @ 16 wks	6 mos daily	1451	97%
Dutt et al: <i>AJM</i> 1984	50% (-) @ 6.5 wks 90% (-) @ 13 wks	6 mos DOT (2x/wk)	751	95%

Data from studies in developed countries show:

- ~90% cases smear negative at 3 months
- Sputum persistently AFB positive more likely a/w negative culture results than with treatment failure (Al-Moamary et al, *Chest* 1999)

**If smear & culture still positive at 2 months: Re-evaluate susceptibilities, Adherence to Rx, & Plan to prolong Rx**

# Scientific/Common Sense Criteria for TB Non-Contagion

- TB chemotherapy rapidly reduces contagion
  - Viable TB bacilli w/in sputum reduced >90% in 1<sup>st</sup> 2 days
- Low likelihood of MDR TB
- Complete adherence to DOT multi-drug Rx x2-3 weeks
  - 5-7 days if AFB smear negative at onset
- Clinical improvement evident (eg, reduced cough frequency, ↓ AFB smear grade)
- Close contacts identified, evaluated, started on Rx (LTBI or even active TB)
- Most stringent criteria for congregate settings & suspect or proven MDR TB: 3 consecutive negative AFB smear results (8-24 hours apart)

# Amended

## CDC Isolation Recommendations

Patients are not considered infectious if they meet the following criteria:

- Adequate therapy for 2 or 3 weeks (susceptibility data helpful)
- Favorable clinical response
- Mycobacteriologic response (↓Smear Grade)....

**Many patients released from strict isolation  
after 2 – 3 weeks**

**(cough resolved, energy improved, smear  
grade↓, pan-susceptible organism)**

# Outpatient or Inpatient Therapy?

- Guiding principle: Minimize transmission risk
- Inpatient therapy guidelines:
  - Is it worth putting more people at risk?
  - Clinical indications (e.g., massive hemoptysis, concurrent disease complications)
  - High risk for poor adherence to therapy

# What are the Fundamentals of TB Infection Control?

- Early identification and isolation
- Effective Airborne Infection Isolation (AII)
- Rapid institution of effective treatment

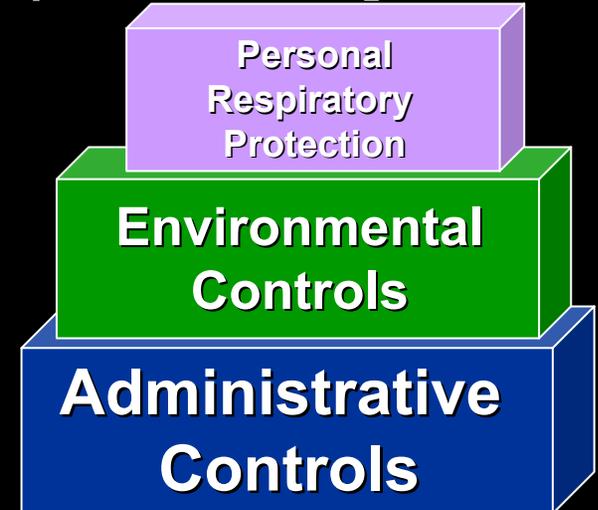
# What Agencies Oversee Infection Control?

- Advisory Recommendations (Toothless)
  - Center for Disease Control (CDC)
  - National Institute for Occupational Safety & Health (NIOSH): Certifies respirator design
- Regulatory (Teeth): Occupational Safety & Health Administration (OSHA)
  - Private employers
  - Federal agencies (certain restrictions)
  - States choose to participate (Local/state agencies)
    - ~50% states so choose
    - Iowa does not, but Iowa OSHA follows federal agency regulations closely

# 2005 CDC Guidelines

## Three Tier Control Hierarchy Continue

- Administrative controls: Decreases risk of exposure
- Engineering controls: Reduce [droplet nuclei]
- Personal Respiratory protection
  - Respirators, fit-testing
  - Last tier, back-up if 1 & 2 fail



**Guidelines for Preventing the Transmission of TB in Health-Care Settings, 2005**

***MMWR Recommendations & Reports 12/30/05***

# Overview of Differences

## 2005 Compared to 1994 Guidelines

- Applies to entire health care setting rather than selected areas
- Scope of settings broader: laboratories, more outpatient & non-traditional settings
- Terminology & abbreviations
  - Tuberculin skin test (TST) replaces purified protein derivative (PPD)
  - Airborne infection isolation (AII)
  - New technology breeds new abbreviations:
    - Blood analysis for *Mycobacterium tuberculosis* (BAMT)
    - QuantiFERON-TB Gold (QFT-G) [IGRA] substitutes for TST in HCW screen
- TB screening for HCW
  - Criteria change
  - Decreased frequency
  - Clearer definitions for which HCW need serial testing
- Expanded information:
  - UV germicidal irradiation (UVGI) & room air circulation
  - Dealing w/ MDRTB & HIV
  - Respirator training

# Administrative Controls

Infection Control strategy for reducing exposure risk

- Assess TB Risk
- Assigns responsibility for TB Infection Control
- Develops/installs written TB Infection Control plan
- Ensures timely lab availability
- Screen & Evaluate HCWs
- Train and educate HCWs
- Coordinate efforts w/ state/county public health departments



# TB Risk Assessment Worksheet...Appendix B

- Community rate of active TB
- Number of TB patients treated at your facility
- Screening for LTBI among workers
- TB infection control program in place
- Types of Environmental Controls in use
- Respiratory Protection Plan
- Level of laboratory support
- Annual risk re-assessment plan

# Screening for TB among HCWs

## Guidelines...Appendix C

- Baseline testing TST (two step)
- Screen for active TB
- Training & education about TB
- Serial testing

# Serial Testing of HCWs for LTBI

- Serial testing: administer, read & interpret TST according to guidelines...
- Rationale for decreased emphasis on serial testing:
  - Most hospitals: transmission of TB infection approaches a level (< 2%) which predicts that TST less likely to detect disease & more likely to be false positive
  - UIHC: TST screening data review suggests TST conversion rate (0.05%) most likely false positive rather than indicating TB transmission
- No serial testing for Low Risk classification (Appendix C).
- Exempt those HCWs w/ LTBI & Rx completed
  - Consider annual TB assessment in lieu of TST
- BAMT (eg, QFT-Gold) substitute for TST in serial testing...

# LTBI Testing Upgrade...Generalizations

## Interferon- $\gamma$ Release Assay (IGRA)

- Accurate blood testing is a reality; Substitute for TST
- QuantiFERON-TB Gold<sup>®</sup>, aka QFT-G (99, upgrade '05, '07\*)
  - Commercially available, costly
  - Measures Interferon- $\gamma$  production by sensitized lymphocytes (T-cells)
  - Does not cross-react with BCG or MAC (antigens: ESAT-6, CFP-10)
- Advantages/Indications
  - Patients in whom false positive TST likely (eg BCG, NTM)
  - F/u not necessary in 48-72 hours; Ideal for patients unlikely to return
  - Equal Sensitivity, Increased Specificity compared to TST
- Limitations: Blood must be processed w/in 12h\*; Multi-popn. data limited (HIV, Elderly, Children); Serial testing performance uncertain; Cost
- Does not distinguish latent from active disease
- New: \*QFT-GIT (in tube...↓time factor) & T-Spot.TB<sup>®</sup>

## Key Recent References

CDC. Updated Guidelines for Using IGRAs to detect M tuberculosis infection, US 2010. *MMWR Recommendations and Reports* June 25, 2010

Pai M et al. Systematic Review: T-Cell–based Assays for the Diagnosis of Latent TB Infection: An Update. *Ann Intern Med* 2008; 149:177-184.

# IGRA (QFT-G) for Screening

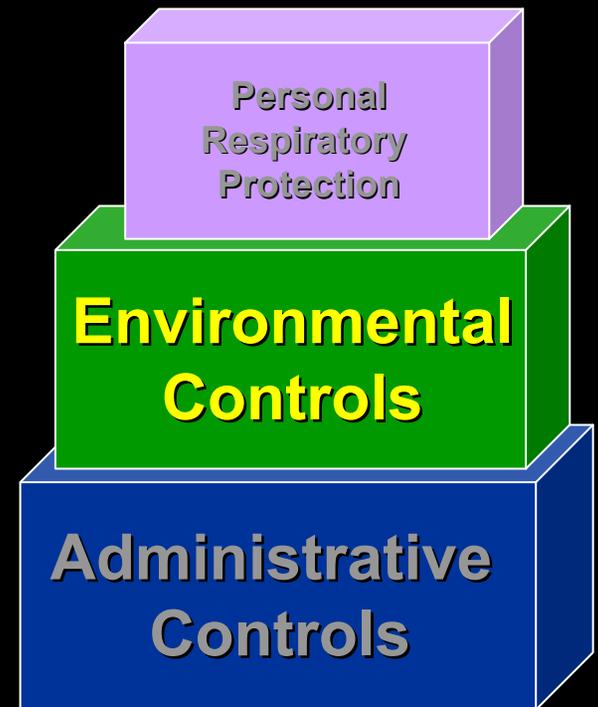
- Annually UI screens 300-500 students from high TB incidence nations (eg, SE Asia, Africa)
- TST positive 2002-2007: 31-49% positive
  - 2006 (N=313): 49% TST+, 149 CXRs, INH Rx 20%
  - 2007 (N=470): 37% TST+, 7% QFT-G+, 33 CXRs (↓ by 76%), INH Rx 50%
  - Other Big 10 Universities similar results using QFT-G (N > 3000 screened in 2007)
    - Several have switched from TST to QFT-G (CDC recommendation w/ little data)
    - LTBI infection rate reduced to 6-8% from 25-45%
    - One institution found 3 early active pulmonary cases

# Environmental Controls

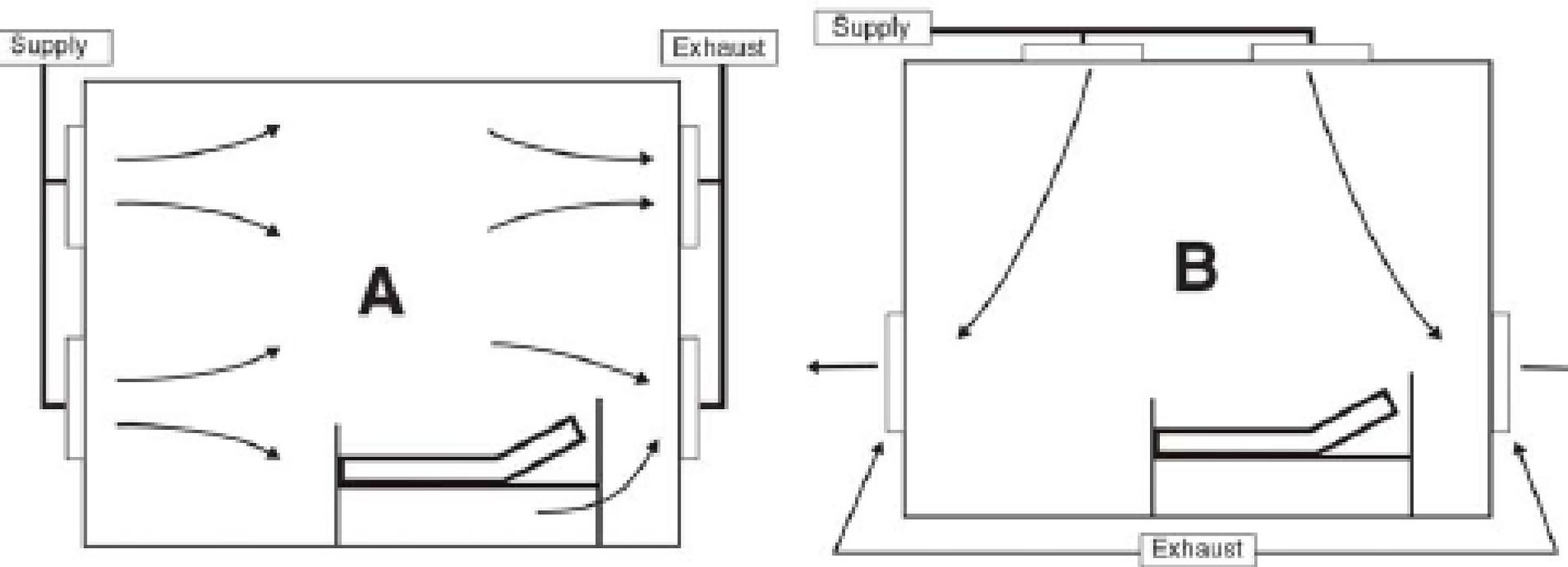
## Second Level

Control source of infection:

- Removing contaminated air by ventilation
- Preventing contamination in areas adjacent to source case (All rooms)
- Cleaning air by use of HEPA filtration (min efficiency:  $99.97\% \geq 0.3 \mu\text{m}$  particle)
- UV germicidal irradiation only w/ simultaneous use of HEPA filters & high rate of purge airflow



# General Ventilation Issues



## Air Flow Patterns for Mixing & Preventing Short Circuit Circulation

- Single pass (preferred)
- Recirculation (use of HEPA/UVGI)
- All: negative pressure  
(New facilities: 12 ACH; Existing facilities: 6ACH)

# General Ventilation Issues (2)

- Ante room preferred for All rooms
  - Helps maintain negative pressure
  - Limits impact of opening door/traffic in/out
- Monitoring room airflow recommended



**Breathe no evil!**

**Spe**

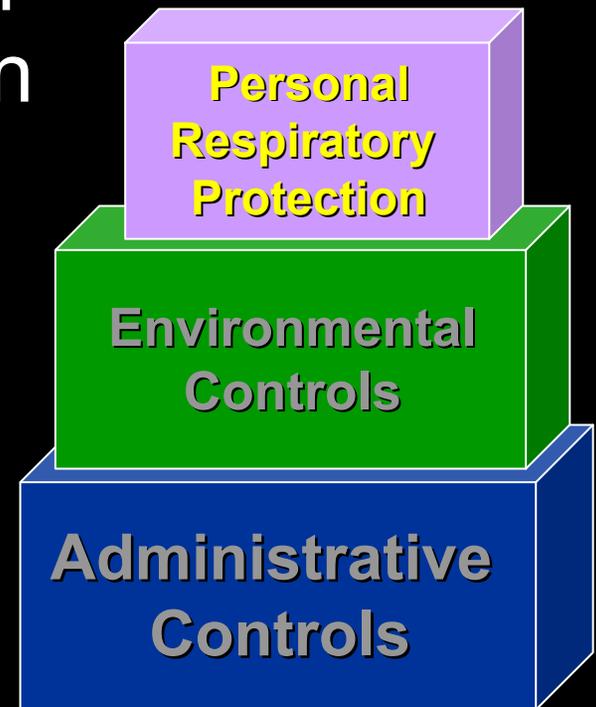
**evil.**



**...But NIOSH & OSHA say...**

# Personal Respiratory Protection Level Three

- Use in high risk situations
- Most of the benefit: Administrative & Environmental controls
- Epidemiologic data lacks power to support respiratory protection /fit-testing of minimal import
- Respiratory protection & particularly fit-testing remains contentious issue



# Evidence for Effectiveness of Respiratory Protection

Administrative and Engineering Measures Effectively Control Outbreaks of Nosocomial TB Transmission

Hospital	Control Measure(s) Used		
	Administrative Control	Engineering Control	RPD
Jackson Memorial, Miami	Extensive	Extensive	Submicron
Cabrini, NYC	Extensive	Exhaust fans	Molded Surgical
Grady Memorial, Atlanta	Extensive	Exhaust fans	Submicron

RPD=Respiratory protective device

Exhaust fans were placed in windows to produce negative pressure rooms

No fit-testing performed in any institution (predated 1994 CDC/NIOSH)

# Evidence for Effectiveness of Respiratory Protection

- Published surveys of hospitals (Columbia, St. Clares, UVa, SHEA) show that TST conversion rates fall or remain low more as a result of administrative & engineering controls vs. respiratory protection (Bangsberg et al: *ICHE* 1997; Fella et al: *AJIC* 1995, Jernigan et al: *AJIC* 1994; Fridkin et al: *ICHE* 1995)
- No data regarding effect of fit-testing
- No study that isolates and evaluates impact of respiratory protection program in the hierarchy of controls

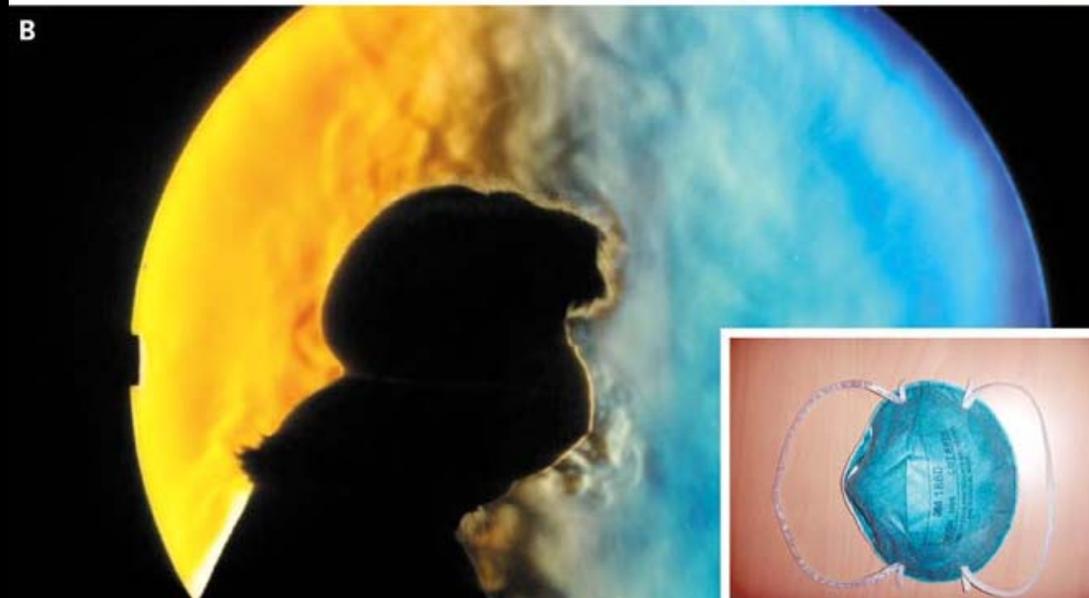
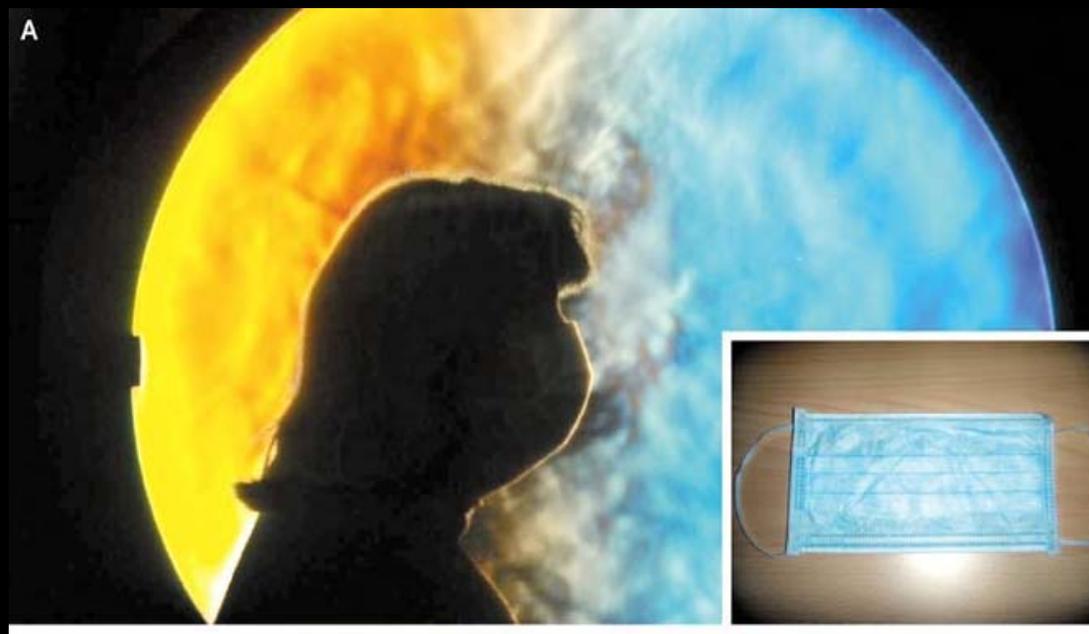
# Respiratory Protection Sequence of Events

- Respirator for entering isolation: N95 since 1995
- CDC/NIOSH: 1994, recommend initial fit-testing, periodic re-assessment, but annual fit-testing not mentioned
- OSHA: initial & annual assessment & fit-testing (qualitative & quantitative)
  - Must conform to 1987 OSHA respiratory protection standard (no annual fit-testing)...**No more!!!**
  - OSHA revised respiratory standard in 1998 (29 CFR 110.134) (requires annual fit-testing), but excluded TB ...**until 12/30/03**
  - Wicker amendment to 2005 Omnibus Spending Bill: **OSHA can't use tax dollars to enforce respiratory standard for TB**

# Respiratory Protection Measures

- Respiratory Protection Program
  - Select respirators
  - Write SOP
  - Medically screen users
  - Provide training: user seal-check
  - Fit testing
  - Evaluate program
- Training HCWs about respiratory protection & TB
- Use Respiratory Protection:
  - Entering All room
  - During cough/aerosol inducing procedures
  - Where Administrative &/or Environmental controls insufficient to protect you from inhaling droplet nuclei
- Training patients on respiratory hygiene & cough etiquette  
What mask should patient wear in room with visitors?

**Coughing propels & disperses a plume of TB droplet nuclei ~1-2 m outward**  
**Wearing any mask blocks forward momentum of cough plume**



# Respiratory Protection Devices

- NIOSH certifies respirator design
- Types of devices:
  - N95: inexpensive, simple, disposable (eg, duck bill)
  - APR/PAPR: greater protection; ([Powered] Air Purifying Resp)
  - Others: Air hood/helmet; Cartridge respirator; body suit
  - Surgical, DM; DMF vs. HEPA respirators... no longer in use



# Fit-Testing

- Quantitative: concentration of a marker material measured inside & outside; requires trained personnel & complex equipment
- Qualitative: pass/fail (saccharin, bitrex, irritant smoke)
- Seal-check: performed by user each time respirator put on (positive/negative).



# Special Situation: TB Infection Control in Resource Poor Setting (esp. ↑ HIV Incidence)

## Administrative Controls

- Proactive Planning
- Select individual responsible & encourage creative implementation (eg, change attitudes/stigma, eliminate cohorting in TB wards, ↓ LOS)

## Environmental Controls

- Open-Window Ventilation & Fans
- Inexpensive ceiling UV light/shield/fan set-up
- Continuous teaching patients proper cough hygiene

## Personal Respiratory Protection

- N95 respirator availability
- Model/teach proper use

# Special Situation: Operating Room

- Normal OR Airflow: OR  $\Rightarrow$  Hallway
  - $\Downarrow$  Bacterial contamination of surgical field
  - But... $\Uparrow$  Dissemination of TB from surgical field
- Measures to prevent TB dissemination in OR
  - Administrative: Schedule TB case during low-use period (few other patients/staff, extended time after case for air purification)
  - Environmental: OR w/ ante room; Ante room air flow pressure either positive or negative cp OR & hallway; >95% efficiency filter on expiratory port vent/anesthesia machine
  - Respiratory Protection: Staff wear N95 mask (no PAPRs)

# TB Control in Health-Care Setting

- Review of TB contagion
- TB incidence in community & hospitals is decreasing
- Risk to health care workers is decreasing (...Risk for increased complacency!)
- CDC Guidelines 2005 update reviewed
  - Applies to traditional & non-traditional settings
  - Implementation of 3 tiers of control: Administrative, Environmental & Respiratory
- Re-evaluation of TST screening
- New technology (eg, BAMT...IGRA)

# Pop Quiz #1

What is the recommended sequence for application of control measures in TB exposure program?

1. Administrative, Environmental, Respiratory Protection
2. Respiratory Protection, Administrative, Environmental
3. Environmental, Respiratory Protection, Administrative
4. It doesn't matter
5. None of the above

# Pop Quiz #2

Appropriate Administrative Measures include:

1. Conducting a TB risk assessment
2. Testing & evaluating HCWs who are at risk for TB or may be exposed to TB
3. Controlling the source of infection by use of general ventilation systems
4. Installing HEPA/UVGI for All rooms

# Pop Quiz #3

N95 respirators should be used in settings where Administrative & Environmental controls may not fully protect HCW from airborne droplet nuclei.

- True
- False