RUTGERS
Global Tuberculosis Institute
NEW JERSEY MEDICAL SCHOOL

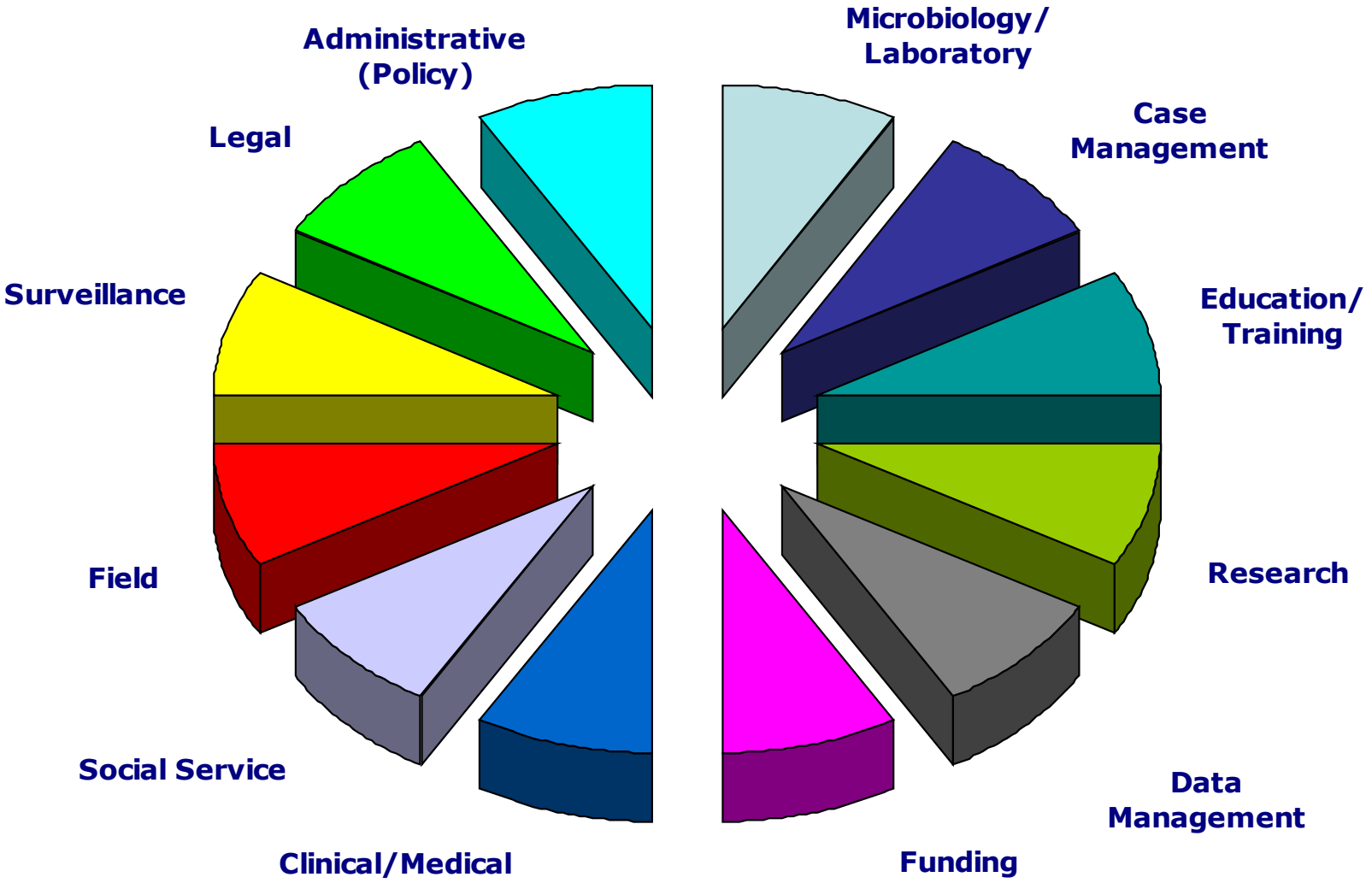
Fundamentals of Contact Investigation

Mark Wolman

August 30, 2024

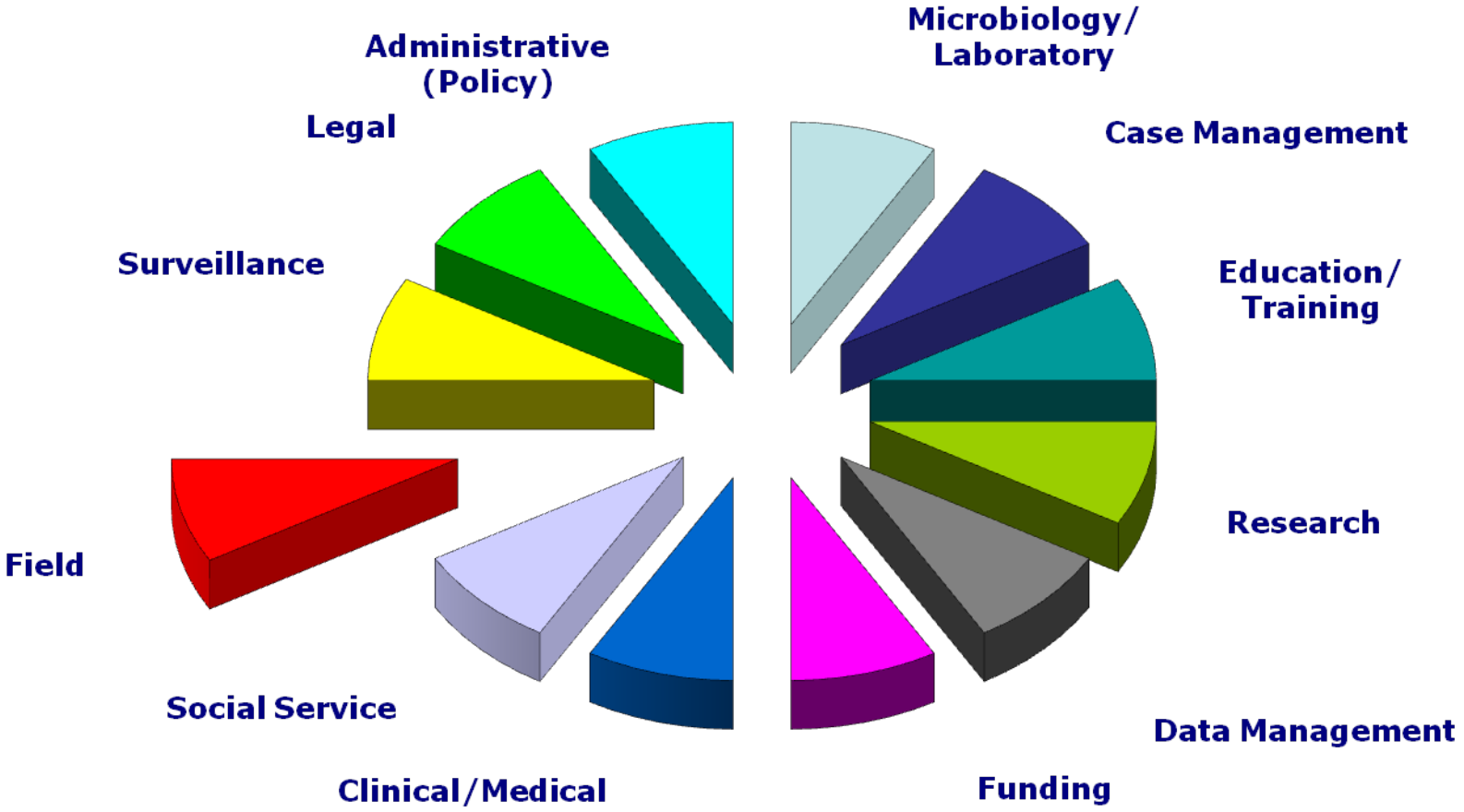
Essential Components of a TB Program

The Whole is Equal to the Sum of its Parts



Essential Components of a TB Program

The Whole is Equal to the Sum of its Parts



Priority TB Control and Prevention Activities

1. Identify and treat persons who have TB disease
2. Locate and evaluate persons who have been in contact with infectious or potentially infectious patients to determine if they are diagnosed with latent TB infection (LTBI) or TB disease and provide them with appropriate treatment to completion of therapy
3. Use targeted testing strategies to identify and treat persons with LTBI at risk for developing TB disease including close contacts, persons with medical risk factors and or social risk factors, recently arrived immigrants within 5 years from TB endemic countries and healthcare workers serving high risk clients
4. Identify settings that have a high risk for transmission of *M. tuberculosis* and apply infection prevention measures including congregate settings such as correctional institutions, long term care facilities and shelters for the homeless

[1]Centers for Disease Control and Prevention. Self-Study Modules on Tuberculosis: Module 6– Managing Tuberculosis Patients and Improving Adherence. 2014.

Purpose of the Contact Investigation

- Identify all high and low risk contacts who were **recently** exposed to an infectious or potentially infectious TB patient
  - A contact investigation should not be regarded as a general screening activity where large numbers of people are unnecessarily tested but rather an activity focused only on the testing of contacts identified during an infectious period

    The wider the net is cast for testing the more likely remote infection will be found

Objectives of the Contact Investigation

- Medically evaluate all appropriate contacts who were **recently** exposed
- Identify contacts **recently** infected and diagnosed with LTBI and provide appropriate treatment to completion of therapy thus *preventing future disease*
  - All TB cases began as TB contacts and all TB cases began as LTBI
- Identify contacts diagnosed with TB disease and provide appropriate treatment to completion of therapy thus *preventing further transmission*
- Identify contacts at high risk of developing TB disease (e.g., children, immunocompromised) and provide appropriate treatment until infection and disease is ruled out

Summarizing Importance of Conducting TB Contact Investigations

- Identify new cases of TB disease or LTBI
- Ensure appropriate initiation of treatment for TB disease or LTBI to completion of therapy
- Interrupt the spread of TB
- Prevent TB outbreaks

Responsibility For Conducting TB Contact Investigations

- State and local health departments have legal responsibility in their respective jurisdictions to
  - Oversee and monitor TB surveillance activities
  - Conduct contact investigations
  - Evaluate effectiveness of TB investigations
- Some contact investigation activities may be delegated
- CDC only provides guidance and recommendations to TB programs and may if requested provide an on-site presence during an investigation

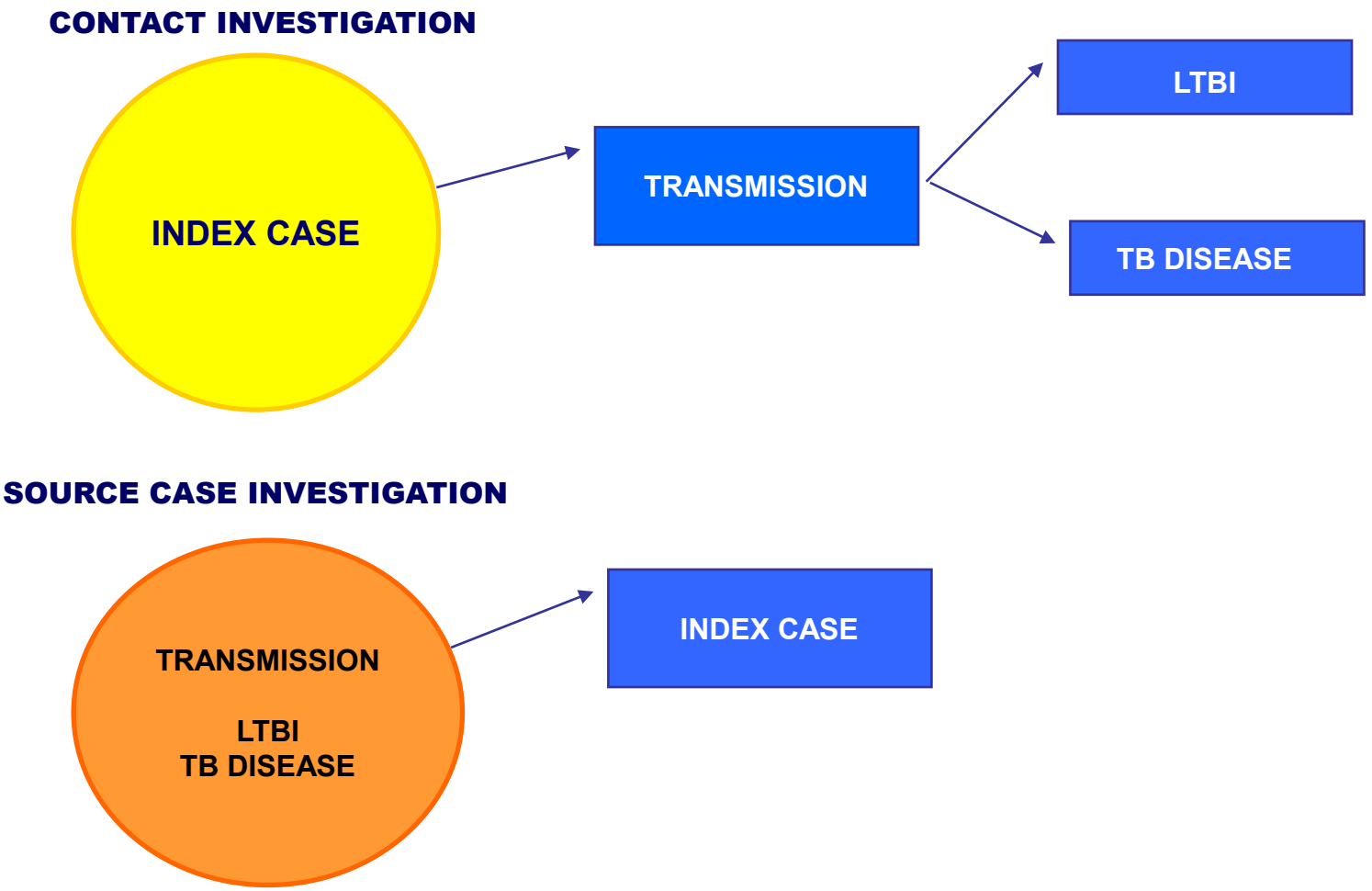
Definitions - 1

- Index case – Represents the first instance or initial report of TB disease
- Source case – Represents the original source of infection or disease
- Contact – An individual exposed to Mycobacterium tuberculosis by sharing air space with a person with infectious or potentially infectious TB

Definitions - 2

- Contact Investigation
  - An activity for identifying people exposed to an individual with infectious or potentially infectious TB, locating and evaluating them for latent TB infection (LTBI) and TB disease and providing appropriate treatment to completion of therapy
- Source Case Investigation
  - A contact investigation in reverse

Contact vs. Source Case Investigation



Who Are TB Contacts?

How Do You Think We're Doing In Contact Investigations In The United States?

US Contact Investigation Outcomes:
Sputum Smear Positive - Culture Positive

Year	2011	2012	2013	2014	2015	2011	2012	2013	2019	2020	
# Cases	10517	9951	9550	9406	9557	9272	8920	9020	8920	7174	
Sputum sm (+)	3417	3687	3648	3609	3714	3364	3364	3399	3465	2858	
# Contacts ID	72050	73677	69063	64148	64509	54620	51392	53780	51013	35718	
Evaluation Indices											*National Objective*
Contact index	21.1	20.0	18.9	17.8	17.4	15.4	15.1	15.8	14.7	12.5	
No contacts ID	5%	5%	6%	6%	6%	12%	7%	5%	5%	204 7%	
Evaluated	58785	60189	56464	52029	59294	41975	41246	42075	38536	27678	**93%**
Not evaluated	13265	13488	12599	12119	13215	12645	10146	11705	12477	8040	
TB disease	<1%	<1%	<1%	<1%	<1%	2%	<1%	<1%	2%	313 1%	
Infected	19%	19%	19%	17%	16%	16%	15%	14%	14%	4221 15%	
LTBI treatment initiated	70%	68%	71%	72%	73%	71%	76%	75%	76%	3265 76%	**91%**
LTBI treatment completed	66%	66%	71%	74%	75%	77%	77%	79%	79%	2580 79%	**81%**

US Contact Investigation Outcomes: Sputum Smear Negative - Culture Positive

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Cases reported	10517	9951	9950	9406	9557	9272	8920	9029	8920	7174	
Sputum smear negative	1726	1841	1767	1763	1848	1939	1827	1903	1783	1333	
Contacts ID	15933	18241	16063	14731	17680	13871	14100	13589	12674	8795	
Evaluation Indices											*National Objective***
Contact index	9.2	9.9	9.1	8.4	9.6	7.2	7.7	7.1	7.1	6.6	
No contacts ID	12%	15%	13%	14%	14%	21%	18%	14%	14%	205 15%	
Evaluated	12899	14357	13573	12288	13235	11421	11627	10702	9900	6893	**93%**
Not evaluated	3034	3884	2490	2443	4445	2450	2473	2887	2774	1902	
TB disease	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	66 <1%	
Infected	18%	16%	16%	13%	12%	13%	11%	13%	17%	896 13%	
LTBI treatment initiated	60%	59%	64%	65%	63%	64%	67%	67%	65%	562 63%	**91%**
LTBI treatment completed	66%	68%	71%	71%	72%	79%	79%	78%	81%	407 72%	**81%**

Investigation Priorities - 1

- Initial interviews
  - Initiated and conducted within one business 1 day of case report for infectious persons
  - Initiated and conducted within 3 days of case report for those considered non-infectious
- Re-interview
  - 7-14 days post initial interview
  - Ideally one interview should be conducted in the living space of the index patient

Investigation Priorities - 2

- Infectious period
  - Establishes probable start and end point of potential transmission
  - Not determined with precision/an estimation
  - Brings focus to the interview
  - Unable to conduct a quality investigation without it

Guidelines for Estimating the On-Set of the Infectious Period

Characteristic of Index Patient				
TB symptoms	AFB sputum smear or NAAT positive	Abnormal or cavitary CXR	Culture	Likely period of infectiousness
Yes	No	No	Pending	3 months before symptom onset or first finding consistent with TB disease, whichever is longer
Yes	Yes	Yes	Pending	3 months before symptom onset or first finding consistent with TB disease, whichever is longer
No	Yes	Yes	Pending	3 months before finding consistent with TB disease
No	No	No	*M.tb*	1 month (4 weeks) before date of presumed diagnosis

Ending the Infectious Period

- Historically a patient's infectious period ends with:
  - Effective treatment for ≥ 2 weeks and
  - Improved symptoms (i.e., cough), and
  - Mycobacteriologic response
    - For CI purposes, effective isolation can end the exposure period
    - Biologically the infectious period officially ends with three negative smears

- End date for *purposes of contact investigation* can be when community exposure is terminated (index patient is isolated) versus *biological end date* (3 negative AFB sputum smears)

- A patient returning to a congregate setting should have 3 or more consecutive negative sputum smears

Investigation Priorities - 3

- Assessing and prioritizing the probability of transmission
  - Contact tracing priorities based on the following characteristics
    - Person
    - Place
    - Time
    - Contact

Investigation A

- Index case
  - Sputum smear positive (4+)
    - PCR/Final AFB culture pending
  - Cough x 2 months
  - Chest x-ray cavitary disease
  - Diagnosed with presumed pulmonary TB/RIPE
  - During infectious period
    - Employed full time (40 hours)
    - Warehouse laborer
    - Multiple tasks
    - 20 coworkers
    - Warehouse 240,000 sq. ft.
    - Ceiling height 75 ft.
    - Adequate ventilation
    - All breaks inside/outside warehouse
      - Patient did not use break room

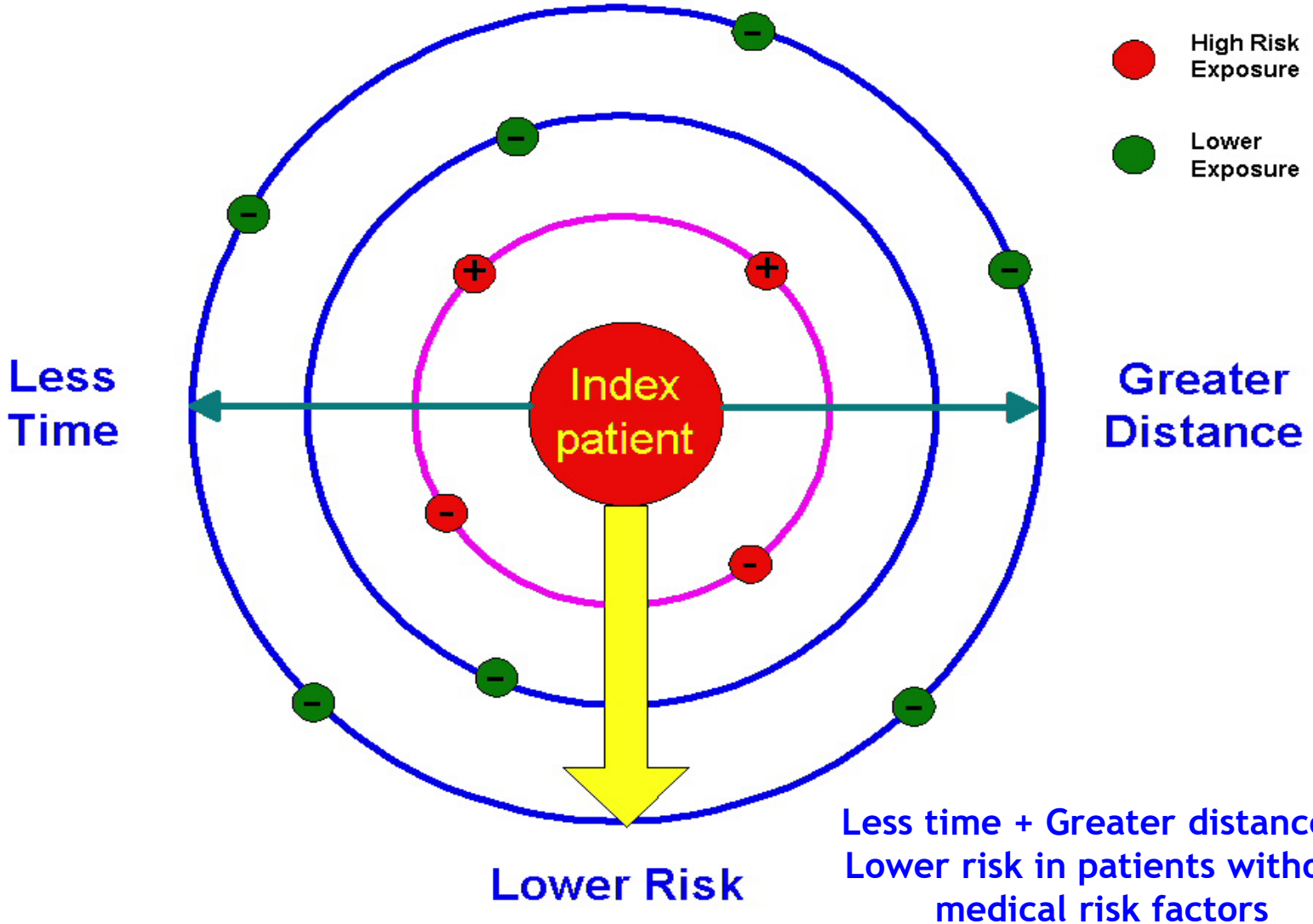
Investigation B

- Index case
  - Sputum smear positive (2+)
    - PCR/Final AFB culture pending
  - Cough x 2 weeks
  - Chest x-ray non-cavitary disease
  - Diagnosed with presumed pulmonary TB/RIPE
  - During infectious period
    - Employed part time (20 hours)
    - Office worker
    - Multiple tasks
    - 5 coworkers
    - Office measure 600 sq. ft.
    - Ceiling height 10 ft.
    - Adequate ventilation
    - All breaks inside/outside office

Investigation Priorities - 4

- Concentric circle model
  - Sets parameters of the investigation
  - Defines limits of investigation
  - Allows interview to proceed in an orderly fashion
  - A methodology designed to assist in visualizing the work that has been done by investigators in the prioritizing of information collected of identified contacts at risk of exposure which includes
    - Probability of transmission (person, place and time characteristics)
    - Risk for progression to TB disease (contact risk factors)

Concentric Circle Model in TB Control
Identifying Contacts at Risk of Exposure



Less time + Greater distance = Lower risk in patients without medical risk factors

Contact Investigations and Beyond

- Congregate setting investigations
- Expanding contact investigations
- Outbreaks

Definition

- A congregate setting is an environment where a number of people meet or gather and share the same space for either a *limited* or *extended* period of time.

Common Congregate Setting Sites

- Schools
  - Elementary
  - Secondary
  - Colleges and universities
- Day care centers
- Houses of worship
- Hospitals and other health care settings
- Shelters
- Correctional facilities
- Workplace settings
- Social settings

Congregate Settings of Interest by Age Group During the Infectious Period

Adolescents	Adults	Elderly
House of Worship	House of Worship	House of Worship
Travel	Travel	Travel
Medical Hospital	Medical Hospital	Medical Hospital
Work	Work	Work
School	School	
Juvenile DC		
	Shelters	Shelters
	Prisons	Prisons
		Long-term Care
	Drug Tx Center	

Determining When to Expand a Contact Investigation

- Consideration of the following factors is recommended
  - Achievement of program objectives with high-risk contacts
  - Extent of recent transmission in identified contacts
    - Unexpected high rate of positive TSTs/IGRAs or
    - Evidence of secondary cases or
    - Transmission to contacts aged <5 or
    - Documented TST/IGRA conversions or
    - Change in TST status from negative to positive
      - In absence of recent transmission investigation should not be expanded

Challenges in Congregate Setting Investigations

- Depending on the setting, the following can be associated with large-scale contact investigations
  - Potential for a large number of identified contacts
  - Potential for vague information for determining contact priorities
  - Potential for incomplete identity and locating information
  - Challenges in maintaining patient confidentiality
  - Collaboration with officials and administrators who are unfamiliar with TB
  - Media coverage

Outbreaks

- An outbreak is defined as meeting the following criteria:
  - 2 or more contacts are identified as being diagnosed with active TB or
  - Any 2 or more cases occurring <1 year of each other are discovered to be linked and genotypic linkage is established
- A TB outbreak is indicative of potential extensive transmission and implies that
  - An undiagnosed, untreated contagious patient may be in the community
  - Index patient may have multiple exposure sites
  - Environments of exposure may be promoting transmission
  - A substandard contact investigation and follow-up may be responsible

From Theory To Practice

A Congregate Setting Investigation on a University Campus

Test **all** or test small?

Test **everyone** or test no one?

Background - 1

- Index case: A 20 y/o US born male medically supervised by a primary care physician
  - 4-month history, diagnosis and treatment of allergies, asthma, and pneumonia
  - Cough x 4 months
  - March 30th x-ray abnormal with cavitary disease
    - April 4th referred to TB clinic
    - On initial clinic visit sputum collected and reported as AFB smear positive (4+)
    - Diagnosis: Suspected pulmonary TB
    - Index case placed in home isolation
    - Treatment with RIPE initiated via DOT
      - Final culture subsequently identified as MTB
      - Pansensitive

Background - 2

- TB interview findings:
  - **Infectious period** onset date August 1st
    - End date to be determined pending treatment outcome/response to therapy and or 3 negative smears
      - Index case identified 3 household and 2 social high-risk contacts
    - During infectious period index case attended a local university as a full-time undergraduate student
      - **Exposure period** for potential contacts at university setting established from September 1 (first day of classes) to March 31st (last day index case attended classes)

The Thinking Investigator - 1

- If you are conducting this investigation, what are you thinking at this particular point?
  - Are you concerned about potential exposure and transmission to students and faculty?
    - If no please explain
    - If yes what is your plan of action?
      - delay a congregate setting school investigation pending outcomes of TST/IGRA/CXR results of household and social contacts?
      - don’t delay and initiate a simultaneous congregate setting investigation while contacts are being evaluated?

Background - 3

- As identified contacts are being evaluated, a congregate setting investigation is initiated at the university
- April 11th management meeting and on-site assessment of the potential exposure environment was conducted with appropriate university and local health department staff in attendance

The Thinking Investigator - 2

- As the lead person during this meeting what specific information are you interested in collecting from university officials? Please explain

On-Site Assessment - 1

- University is a public institution with a total undergraduate enrollment of 13,462
- Index case attended 11 classes during the infectious period (Fall and Spring semesters)
  - Total 265 students and 10 faculty potentially exposed
  - Typical class met 2 times per week for 1.25 hours per day
  - Total 2.5 hours per week

The Thinking Investigator - 3

- What are you thinking at this particular point now that specific information has been collected about the index case?
  - please explain
- Would you request additional information to better determine extent of exposure and recommendations for medical evaluations?
  - If not please provide your rationale
  - If yes what additional information would you like to collect?

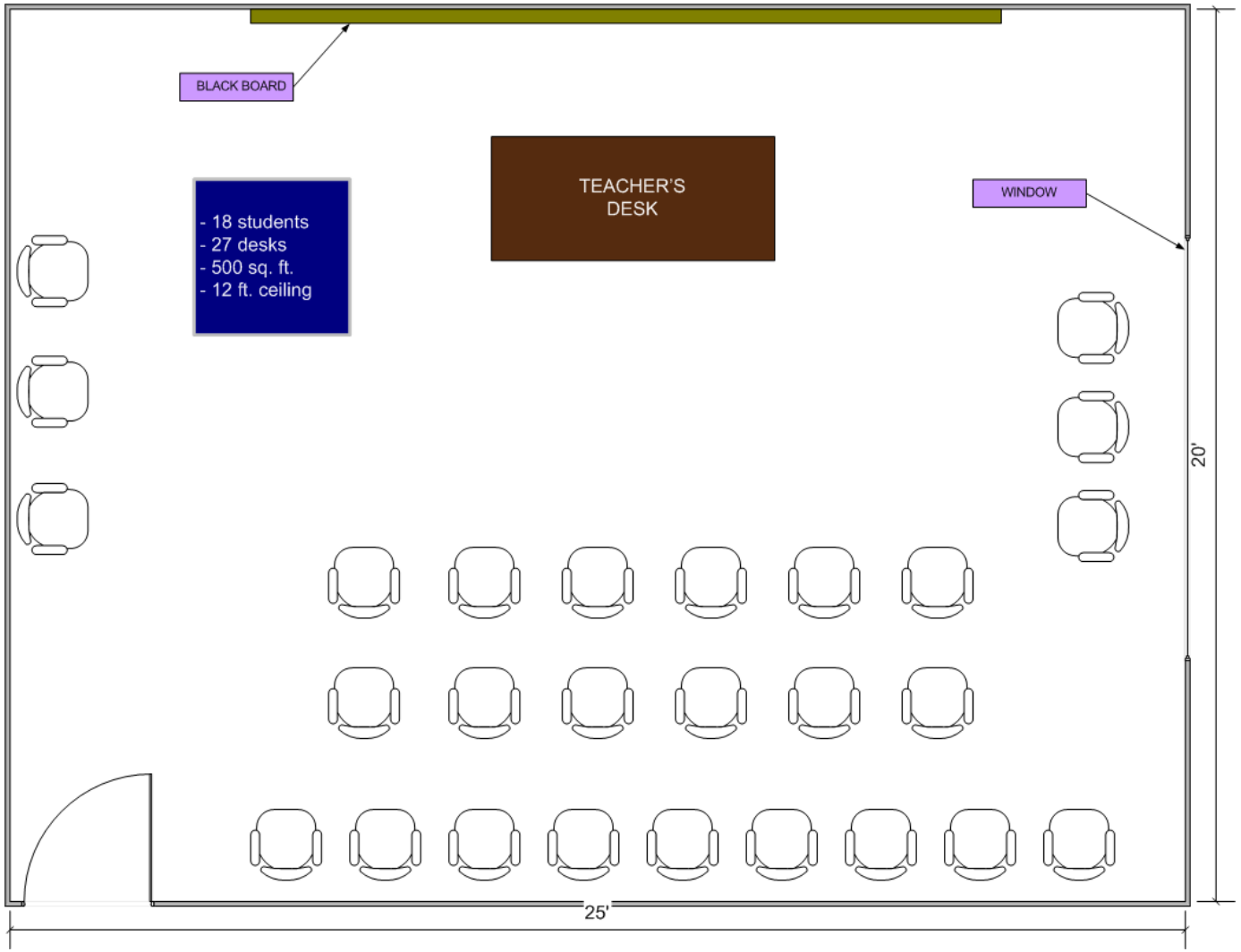
On-Site Assessment - 2

- Requested printout of all 11 classes with students and faculty names
  - Review of class rosters revealed the names of students and faculty sharing multiple classes with index case during the infectious period

On-Site Assessment - 3

- Exposure hours during both Fall and Spring semesters ranged from 108-80-68-60-40-22-20 classroom hours per student
- Measurement of classrooms ranged from 396-1196 square feet
  - Average classroom 400-500 square feet
  - Ceiling height typically 10-12 feet
  - During Fall semester several classrooms were identified as measuring 400 square feet and presented as crowded with unsatisfactory ventilation

Typical Classroom



The Thinking Investigator - 4

- What are your thoughts now that you have this additional information?
- Is there any other information that you feel needs to be asked and collected that would help you in determining the identification of high-risk contacts?
  - If no, please provide your rational
  - If yes, please explain

The Thinking Investigator - 5

- At this point in the investigation do you feel that you have collected enough information?
- What are your thoughts now?
- What recommendations do you plan to provide to university officials regarding the identification of high and low risk contacts?
  - Please explain

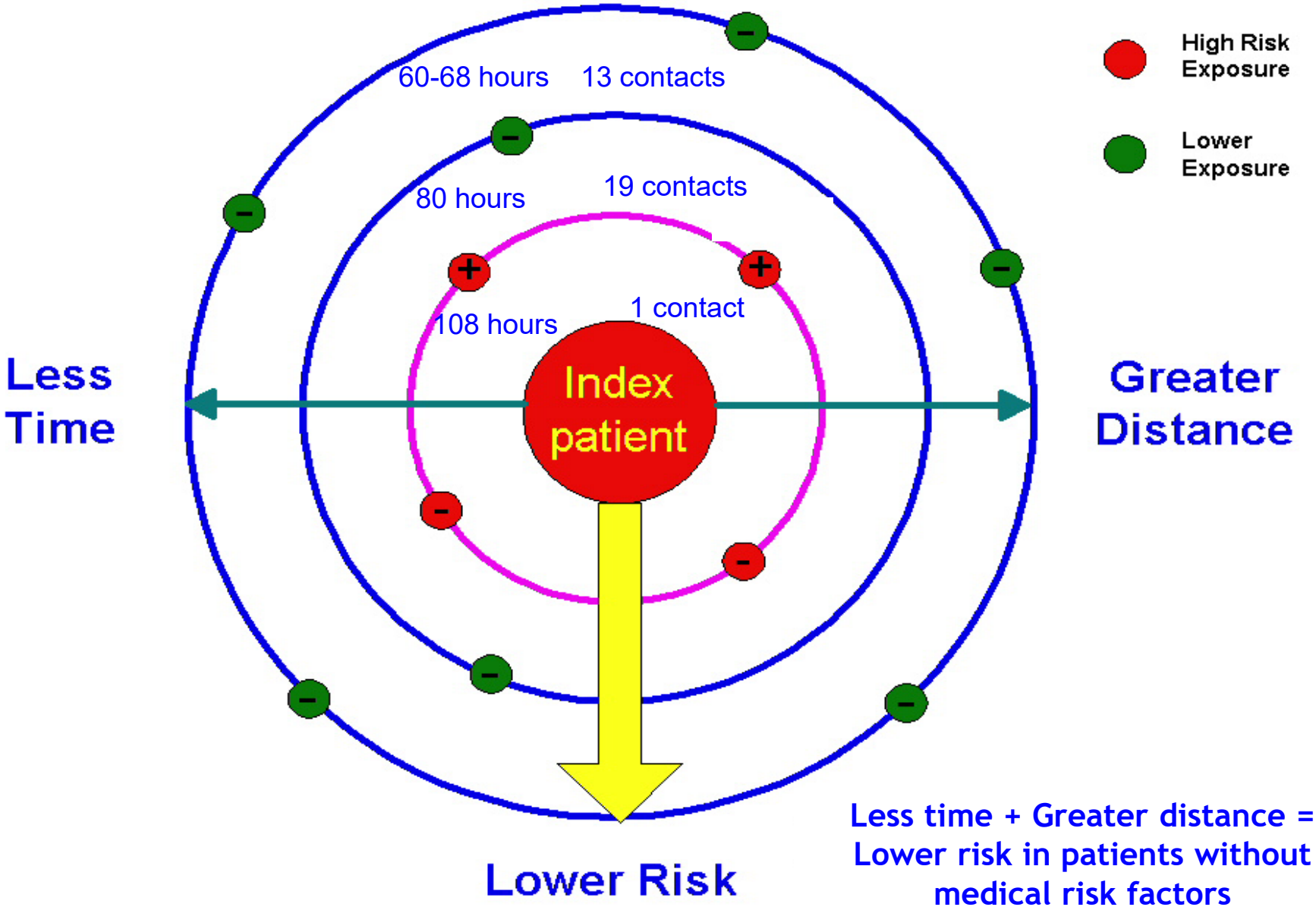
Findings of On-Site Assessment

- A review of class rosters, hours of exposure and classroom environments during the infectious period allowed for the configuration of a concentric circle
  - Identified layers and exposure hours of students ranging from most to least hours exposed during the entire infectious period

- Contact identification initially focused primarily on the Fall semester (16 weeks) versus the Spring Semester (8 weeks)

- 20 students and one faculty member representing 80-108 exposure hours identified as high risk contacts during the Fall semester

Concentric Circle Model in TB Control
Identifying Contacts at Risk of Exposure

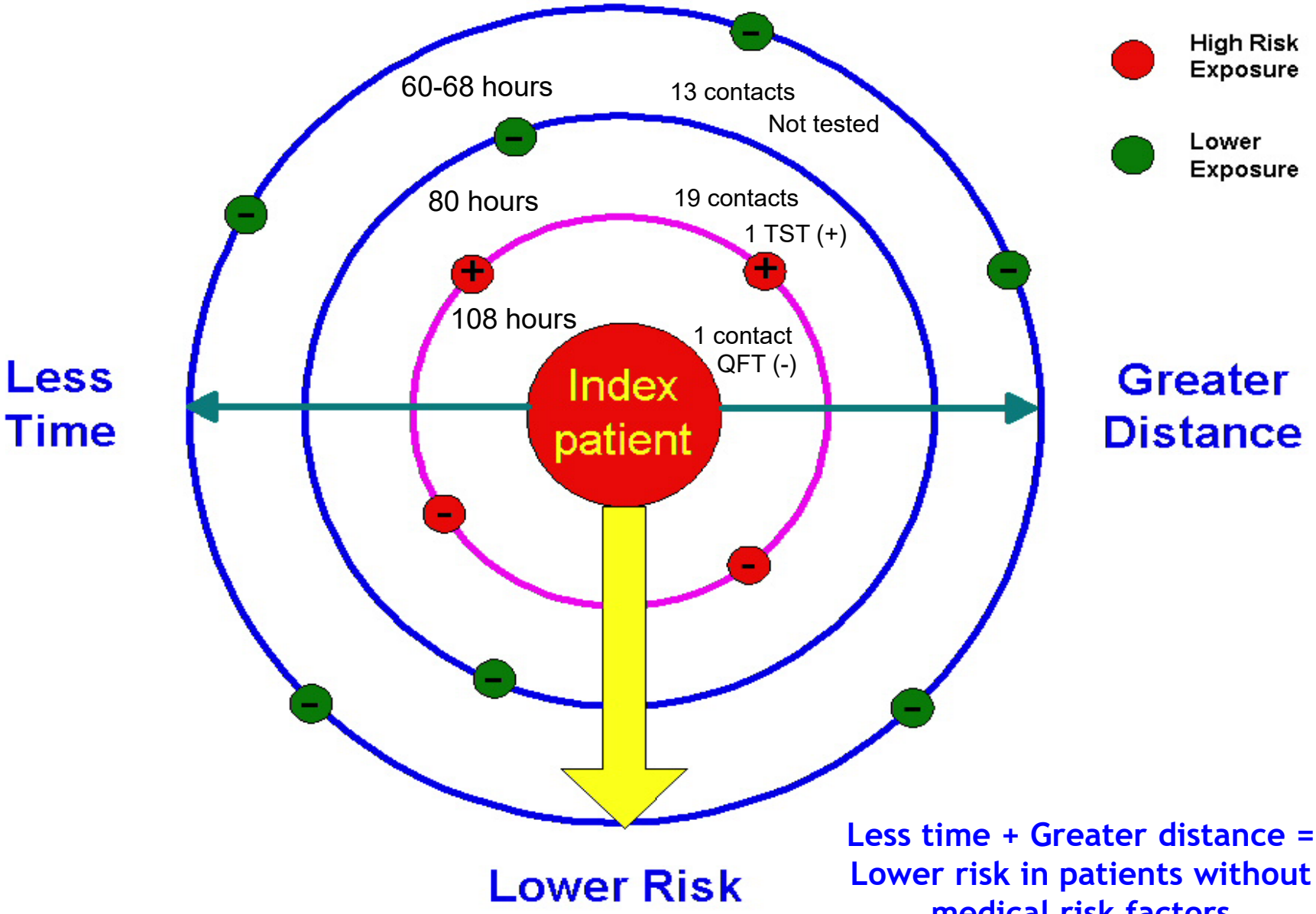


Less time + Greater distance = Lower risk in patients without medical risk factors

Investigation Outcomes

- Total of 25 high risk contacts identified
  - 3 household
    - 2/3 initial IGRA (+)
    - LTBI treatment
  - 2 social
    - Initial/post exposure IGRA (-)
  - 21 school
    - 8 initial/post exposure IGRA (-)
    - 10 initial/post exposure TST 0mm
    - 1 initial TST 13mm
      - LTBI treatment
    - 1 unable to locate
    - 1 documented previous TST (+)
      - LTBI treatment previously completed

Concentric Circle Model in TB Control
Identifying Contacts at Risk of Exposure



Less time + Greater distance = Lower risk in patients without medical risk factors

Congregate Setting Investigation Results

- 1/18 tested or 5.5% transmission rate in school setting
- Congregate setting investigation closed with no expansion of concentric circle for contact identification

Notes from the Field:

A Supermarket

A Shopper

and TB

Background - 1

- Index case is a 49 y/o female admitted to a local hospital on July 31 with complaints of cough, weight loss and fever x 1 month
- Admission chest x-ray reported as abnormal with non-cavitary disease consistent with TB
- Sputum collected on August 1 is AFB smear positive (3+)
  - PCR *M.tb*
- Treatment with RIPE started on August 2
- TB interview and contact investigation initiated at hospital on August 3

Background-2

- TB interview findings
  - Infectious period onset date March 1
    - End date to be determined pending treatment outcomes
  - Exposure period for any identified community contacts established from March 1 to July 31 (hospital admission)
    - Index case identified 1 household and 8 social contacts
  - During infectious period index case employed by major supermarket chain
    - Exposure period for potential contacts at supermarket established from March 1 through last day at work (June 30) prior to hospitalization

Thinking Investigator - 1

As the lead person in this investigation what would be your initial step after interviewing the index case?

A) Immediately begin testing identified household and social contacts
B) Immediately schedule a meeting with supermarket management
C) Both A&B

Thinking Investigator - 2

Which of the following topics must be included during the management meeting?

A) Providing TB education to management
B) Issues surrounding patient confidentiality
C) Collecting information specific to the job responsibilities of the index case
D) On-site assessment of the potential exposure environment
E) All of the above

On-Site Assessment

- Meeting and on-site assessment of exposure environment conducted with supermarket managerial staff on August 11
  - During infectious period index case assigned to internet shopping department
  - Worked part-time 5 days per week x 5 hours per day
  - Total 12-18 employees in same department

On-Site Assessment-2

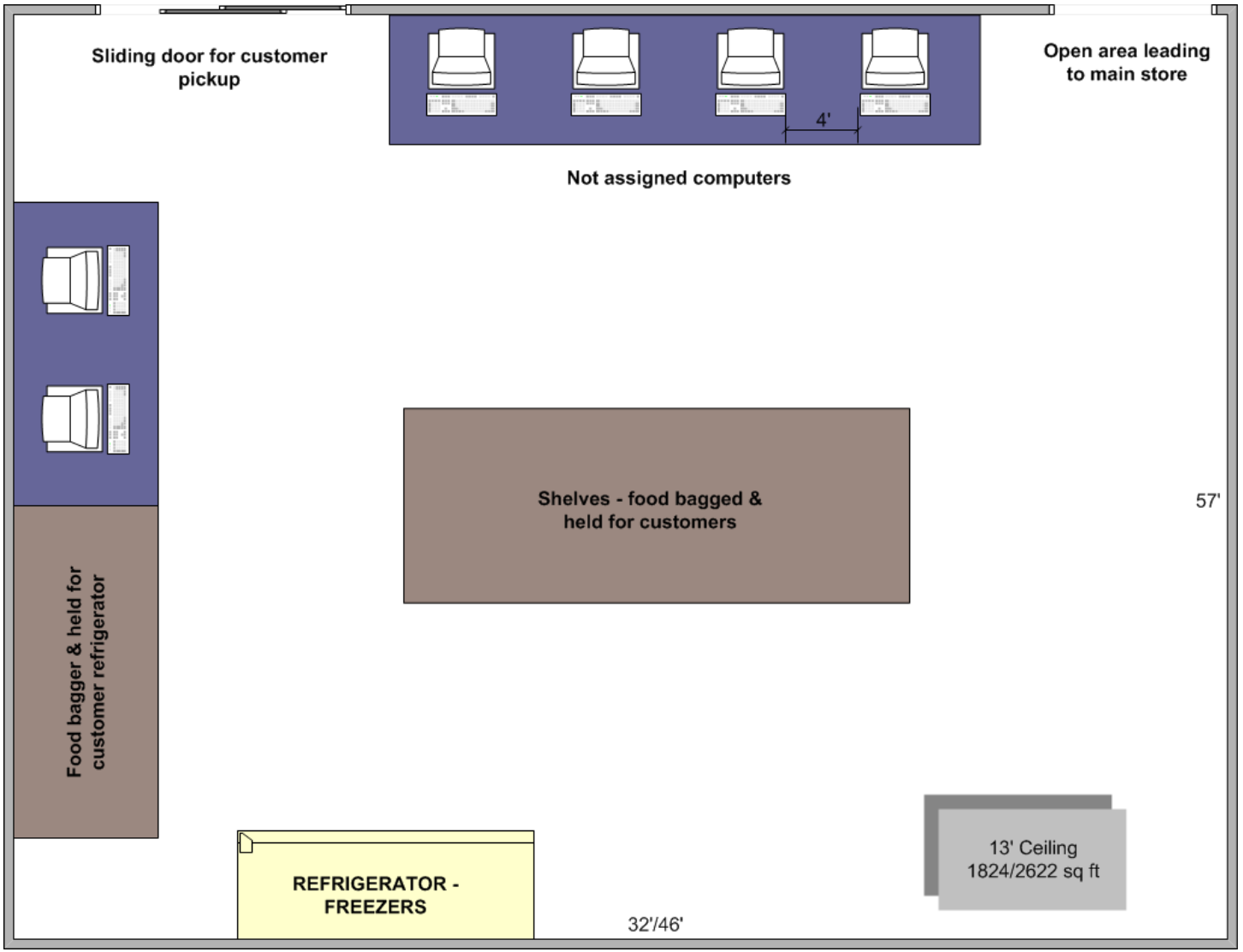
- Index case responsibilities included
  - Accessing internet shopping lists submitted from customers
  - Downloading lists to hand-held computer
  - Shopping for customers in main store
    - Main store measured approximately 100,000 sq. ft. with a 20 ft. ceiling

On-Site Assessment-3

- Index case spent most of work hours in main store
  - Time in computer room approximately 2 hours per day

- As a result of construction during infectious period computer room measured between 1,824 – 2,622 square ft with a 13 ft ceiling
  - Open, airy workplace with adequate ventilation
  - Room not self-enclosed with open hallway leading to main store
  - Sliding doors open and close in computer room for customer pick-up

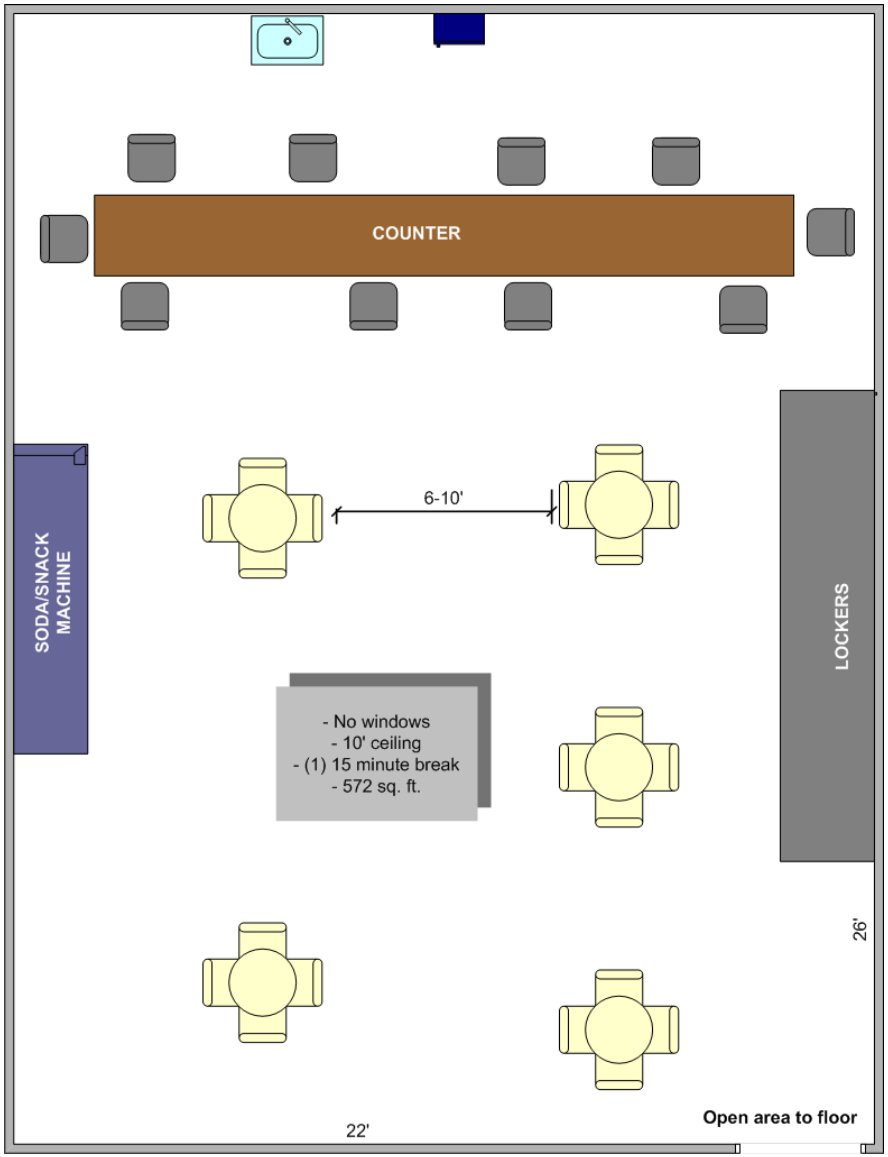
Computer Room



On-Site Assessment-4

- Index case permitted one 15-minute break per day with no lunch break
- Break room measured 572 sq. ft. with a 10 ft. ceiling and no windows
- 5 tables in room spaced approximately 6-10 ft. apart
- Maximum capacity 25 people
- Index case claims sat alone during all breaks taken indoors
    - Weather permitting breaks taken outdoors

Break Room


COUNTER
6-10'
SODA/SNACK MACHINE
LOCKERS
- No windows
- 10' ceiling
- (1) 15 minute break
- 572 sq. ft.
26'
22'
Open area to floor

On-Site Assessment - 5

- 3 hour daily round-trip commute by index case to and from work via public transportation (bus)
- 1.5 hours of commute shared with supermarket employee who works in different department

Thinking Investigator-3

At this point in the investigation do you feel enough information has been collected to make a decision regarding potential exposure at the supermarket?

A) Yes
B) No
C) Not sure

Thinking Investigator - 4

What recommendations do you plan to provide to supermarket management regarding the identification of high-risk contacts?

A) Identify and test 12-18 co-workers who shared the internet room
B) Identify and test co-workers who shared the break room
C) Identify and test any customers who regularly interfaced with the index case
D) Identify and test the co-worker who shared the bus commute
E) Identify all co-workers as low risk

On-Site Assessment - 6

- No high-risk contacts identified in the computer room
- One contact from another department was identified in need of a medical evaluation
  - Worker who shared public transportation

Investigation Outcomes

- 10 high risk contacts identified with initial test results
  - **1 household**
    - TST 0mm
  - **8 social**
    - 1 TST 0mm
    - 5 IGRA negative
    - 2 TST positive (17mm & 12mm)
      - Chest x-ray negative/LTBI treatment
  - **1 workplace**
    - Verbal history of previous positive TST and completion of LTBI treatment
      - Patient unable to provide documentation
    - IGRA positive/chest x-ray negative
    - Patient refused treatment for LTBI

"No Matter How Hard The Winds Howl—Don't Panic—Take Things One Step At A Time"