Identification of Mycobacteria
1. Essentials for the Mycobacteriology Laboratory: Promoting Quality Practices

1.1 Introduction

Notes:
Welcome to the Association of Public Health Laboratories Essentials for the Mycobacteriology Laboratory: Promoting Quality Practices. This presentation is identification of mycobacteria. The goal of this module is to discuss the classical and emerging methods for identification of mycobacteria, advantages and limitations of the different methods, importance of quality, accurate identification results, clinical significance of mycobacteria, turnaround times and reporting considerations, testing algorithms, sending specimens to a reference lab. Future core curriculum modules will focus on mycobacteriology molecular methods in greater detail.
1.2 Importance of Identification

Notes:

Accurate and prompt identification is important for patient management and public health response. Culture results are used for diagnosis of clinically significant disease, both tuberculosis and non-tuberculosis mycobacteria infections, initiating or altering antimicrobial therapy, respiratory isolation decisions, and initiating contact investigations.
3. Background

Notes:

A few introductory remarks on identification of mycobacteria.
3.2 National TB Laboratory

**National TB Laboratory Services Survey**

- APHL and CDC developed and launched the National TB Laboratory Services Survey in 2010
- Purpose: To assess the overall capability and capacity of laboratories in the United States providing TB services
- 580 of the 656 respondents perform some level of TB testing

Notes:

First let's talk about a National TB Laboratory Services Survey that was launched by APHL and CDC in 2010. The purpose was to assess the overall capabilities and capacities of TB labs in the US. 580 labs that responded perform some level of TB testing. The respondents were from commercial, clinical, and public health laboratories.
3.3 National TB Laboratory

Notes:

This slide shows some data from the National TB Laboratory Services Survey. This diagram shows the number of labs providing different TB lab services. You can see by this diagram that 580 of the TB laboratories that responded perform AFB smear microscopy. Over 805 set up culture, but only 37% perform identification of cultures. Of the subset of labs that perform identification of mycobacteria a majority are public health laboratories. Only 16.2% of TB labs that responded, or 94 labs around the US, perform TB first line drug susceptibility testing.
3.4 National TB Laboratory

Notes:

This slide shows more data from the National TB Laboratory Services Survey. This figure shows the primary method for identification of MTBC from culture for 213 labs in the US. You can see that the most common method for identification is the GenProbe AccuProbe, with over 83% of respondents using this method; another 10% use HPLC. Since many of the participants in the laboratory survey were public health laboratories it's not surprising that the number of labs that use HPLC is relatively high. About 4% of labs use molecular methods such as sequencing for identification; biochemical and line probe assays were used by a small percentage of laboratories.
3.5 Biosafety Recommendations for Manipulations of Mycobacterial Cultures

- All procedures for tuberculosis (TB) culture propagation and subsequent manipulation of the cultures are performed in BSL-3 facilities.
- The use of respiratory protection, containment equipment (e.g., biosafety cabinet, centrifuge safety cups), and practices to minimize aerosol production are essential.

Notes:

A few comments on bio-safety. The BMBL recommends that all manipulation of cultures of mycobacterium tuberculosis complex be performed in a bio safety level three facility. The use of respiratory protection, containment equipment, and practices to reduce aerosols is very important.
3.6 Identification Methods

Notes:
Identification methods include growth characteristics which include growth rate, temperature of growth, colony morphology and pigment production, conventional biochemical reactions, high performance liquid chromatography, or HPLC, the GenProbe AccuProbe kits, line probe assays, MALDI-TOF and DNA sequencing.
4. Classical Methods

Notes:
Let's talk about some classical methods for identification of mycobacteria.
4.2 Growth Characteristics

**Growth Rate**

- Can be observed on the primary solid media, but dependent on appropriate incubation temperature and number of organisms in the primary specimen
- To perform a standardized growth test from subculture:
  - Inoculate a defined suspension of mycobacteria on solid media
  - Incubate at 30°C and 35-37°C
  - Observe for growth at 5-7 days and weekly thereafter
- Rapidly Growing Mycobacteria: form visible colonies within 7 days of incubation (usually 3-4 days)
- Slowly Growing Mycobacteria: require more than 7 days for visible colonies to form

**Notes:**

Growth rate is defined as the number of days until visible colonies form on solid media. You can get an estimate of growth rate from primary culture but primary culture growth is dependent on appropriate incubation temperature and the number of organisms present in the original specimen.

To get a true assessment of growth rate you want to perform a standardized growth test from subculture. So you would inoculate a defined suspension of mycobacteria on solid media, and incubate at optimal conditions and observe growth at five to seven days and then weekly. Rapid growers form visible colonies within seven days, usually three or four days. Slow growers require more than seven days for visible colonies to form.
4.3 Growth Characteristics (2)

Notes:

More about growth characteristics. For colony morphology you want to observe colonies on solid media. You can use a stereoscope or microscope with a low power objective to visualize small colonies. Look at colony texture. You want to look at things like whether the colony is rough, smooth, butter-like, dry, granular, mucoid, or even translucent. Then look at colony pigment. The color range for mycobacteria might be non-pigmented or they can be yellow, orange, or even pink. There are three classifications of organisms based on pigment production. Photochromogens require light to form pigment. Scotochromogens form pigment either in the light or dark. And non-photochromogens don't have any pigment so they appear buff or white.
Here are some images of two mycobacteria demonstrating growth characteristics. On the left you see *mycobacteria tuberculosis* complex. This is the classic colony morphology which is rough and buff. The colonies look dry and wrinkled and they don’t have any pigment. On the right you see *mycobacterium gordonae*, which is smooth and shiny and yellow.
## 4.5 Conventional Biochemical Testing

<table>
<thead>
<tr>
<th>Conventional Biochemical Testing</th>
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<tr>
<td>• Classical approach to identification</td>
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<tr>
<td>• Requires sufficient amount of bacterial cells and several weeks of incubation</td>
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<td>• New mycobacterial species cannot be reliably identified by biochemical and other phenotypic tests</td>
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<td>• Current recommendations are for rapid methods</td>
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### Notes:

Now we'll talk about some conventional biochemical testing. This is a classical approach to identification and requires a sufficient amount of colony growth and several weeks of incubation. Biochemical tests include tests which have historically been performed for identification of MTBC such as nitrate reduction and niacin production.

New mycobacteria species can't be reliably identified by biochemical tests, this is because the results are sometimes difficult to read and are not always reproducible. The tenth edition of the manual of clinical microbiology no longer includes a reference table of biochemical reactions. For identification, current recommendations are for rapid methods such as molecular methods instead of biochemicals.
4.6 High Performance Liquid Chromatography (HPLC)

Now we'll talk about high performance liquid chromatography, or HPLC. In this method, cell wall mycolic acids are extracted and derivative with fluorescent or UV-adsorbing esters and then separated by chromatography.

- A pattern of peaks (chromatogram) is generated as mycolic acids are detected.
- Identification is based on comparison of isolate's pattern to a database or library of chromatograms.

Notes:

Now we'll talk about high performance liquid chromatography, or HPLC. In this method, cell wall mycolic acids are extracted and derivative with fluorescent or UV absorbing esters and then separated by chromatography. A pattern of peaks called a chromatogram is generated as the mycolic acids are detected. Identification is based on comparison of the isolate's pattern to a database or library of chromatograms.
4.7 Considerations for HPLC

Notes:

Here are some considerations for HPLC. The advantages of HPLC are that you can identify TB and nontuberculosis mycobacteria from broth culture and sometimes directly from a smear positive patient specimen. The cost of testing is inexpensive once you have the equipment. There's an FDA cleared instrument which is commercially available.

The limitations of HPLC are that the initial equipment costs are high, some methods require a good amount of growth. It is problematic for identification of rapid growers. It's unable to resolve some of the nontuberculosis mycobacterial groups or complexes including TB complex. The extraction uses hazardous chemicals and hazardous waste is generated. This method is used in large reference labs and public health laboratories, but its use is declining with the advent of more molecular methods.
4.8 Fluorescence-HPLC Patterns

Notes:

These are examples of HPLC mycolic acid ester patterns of three common mycobacterium species, the classic MTBC pattern on the top has one late emerging cluster mycolic acids. *Mycobacterium kansasii* looks similar to TB but it has more peaks. *Mycobacterium avium* complex has one cluster of emerging mycolic acids and then two later clusters. You can see that *M. Avium* looks very different from MTBC.
Now we will talk about molecular and emerging methods.
5.2 GenProbe Accuprobe

Notes:

The GenProbe AccuProbe assay is an in-solution hybridization assay for identification of growth on solid or liquid media. Nucleic acids are extracted after organisms are lysed and made non-viable. Single-stranded labeled DNA probes (in tubes) are allowed to anneal to target RNA. If present, RNA:DNA hybrids are detected by chemiluminescence. Commercial kits are available for identification of MTBC, *M. avium* complex, *M. gordonae*, and *M. kansasii*. 
5.3 Considerations for Accuprobe

Notes:
Here are some considerations for the GenProbe Accuprobe test. The advantages are that it identifies four frequently isolated mycobacteria; three of these mycobacteria are clinically significant. It's performed routinely in many laboratories, it's relatively easy to use, and it's FDA cleared. Limitations are that there is no nucleic acid amplification that occurs within the assay, so sufficient culture growth is necessary for identification. Beware of relative light unit (RLU) values that are near the cutoff; “high negative” values could indicate that the target organism is present in low numbers.
Now let's talk about line probe assays. This platform uses a nitrocellulose strip for identification of MTBC and commonly isolated NTM by reverse hybridization. Sample DNA is hybridized to probes on a membrane strip. There are three commercially available line probe assays, two by HAIN and one by Innogenetics. Both identify TB and a variety of NTM.
5.5 Line Probe Assay (2)

Notes:

This schematic shows the steps involved in the line probe assay. First, DNA is extracted from the patient specimen. Second, PCR amplifies DNA, usually the 16S or RPOB genes. PCR products are hybridized to probes on the strip. Hybrids are labeled and detected using a color metric assay. Bands are compared to standard patterns.
This image shows the strips for the Innogenetics INNO-LiPA assay, which is a line probe assay. There are two positive controls on the top of the strip. The first is a conjugate control band and the second is a mycobacterium genus positive band. These strips have 13 species specific probes. Lane two is *mycobacterium avium* complex. Lane three is *mycobacterium gordonae*. Lane four is *mycobacterium chelonae*. Lane five is *mycobacterium kansasii*. Lane six is *mycobacterium avium*. Lane seven is MTBC. Lane eight is the conjugate control that's negative for mycobacteria.
5.7 Considerations for Line Probe Assay

Notes:

Here's some considerations for the line probe assay. Advantages are that nucleic acid amplification for the assay can increase sensitivity. Some assays detect mutations associated with MTBC drug resistance and the cost for implementation is relatively low. Limitations of the line probe assay are that the strips are not FDA approved. It can be difficult to differentiate bands with visual inspection. Also it is sometimes difficult to identify species within *Mycobacterium fortuitum* complex or within the *M. Chelonae/abscessus* group.
5.8 MALDI-TOF

Notes:

MALDI-TOF stands for Matrix-Assisted Laser Desorption Ionization Time-Of-Flight. This assay is a form of mass spectrometry. It's used to analyze proteins and other macromolecules. Recent advances have allowed application of this assay to the clinical laboratory. Charge particles are accelerated by a laser. Time of flight is proportional to the ion's mass, chromatogram are compared to a library for identification.
5.9 Considerations for MALDI-TOF

Here are some considerations for MALDI-TOF. The advantages are that a small sample size is needed. It is a rapid identification method. It can also be used to identify bacteria and fungi in the laboratory. Limitations are that the heat inactivation and cell disruption step are difficult for mycobacteria. There are database limitations, the initial investment cost may be high, and it cannot identify to the species level within the TB complex. Bruger and other companies are developing databases for mycobacteria, fungi, and other bacteria. These libraries are in their infancy right now.
**5.10 DNA Sequencing**

DNA sequencing is for identification of organisms by determining the precise order of nucleotides in DNA. The DNA sequence is compared to a database of sequences of known and characterized organisms. 16S rRNA, *rpoB* and *hsp65* genes are commonly sequenced for identification.

**Notes:**

DNA sequencing is for identification of organisms by determining the precise order of nucleotides in DNA. The DNA sequence is compared to a database of sequences of known and characterized organisms. 16S rRNA, *rpoB*, and heat shot protein 65 genes are commonly sequenced for identification. Despite the availability of commercial sequencing methods, sequencing remains a complex and often cost prohibitive procedure for a routine clinical laboratory. A high level of expertise is necessary for this testing.
5.11 Real-time PCR

Real-time PCR

- Detection of amplified target in real time by measuring fluorescence
- Primarily used for direct detection in clinical specimens, but can be used for identification from culture as well
  - Some assays detect mutations associated with MTBC drug resistance

Notes:

Real-time PCR is the detection of amplified target in real time by measuring fluorescence. We usually think of real-time PCR for direct detection in clinical specimens, but it can also be used for identification of cultures. Some assays detect mutations associated with TB drug resistance.
5.12 Considerations for Molecular and Emerging Methods

Notes:

Here are some considerations for molecular and emerging methods. Advantages are that it is a quicker turn-around time if the assay can be performed directly on patient specimens. For most molecular assays, growth on solid or liquid media can be used and sometimes clinical specimens can be analyzed. Molecular methods are able to recognize new strains and differentiate between mycobacteria complexes.

Some limitations for molecular and emerging methods might be cost, in particular the initial set up cost, managing, updating, or creating a database, which often requires advanced computer skills, specialized equipment and maintenance of that equipment, new expertise and training, and new methods do not always replace standard methods. So laboratories have the extra burden of running additional tests.
6. Clinical Significance

Notes:

Now we'll talk about the clinical significance of mycobacteria.
6.2 Clinical Significance of MTBC

Identification of MTBC is the most important finding in the laboratory and has serious clinical and public health consequences.

- Isolation almost always signifies disease

  Exception: A single positive patient specimen in the absence of clinical indications may be a false positive.

- MTBC is not found in the environment

Notes:

Identification of MTBC is the most important finding in a clinical mycobacteriology laboratory. The finding of this organism has vital epidemiologic and public health consequences; so its detection should be a primary focus in the lab. Isolation of TB almost always signifies disease. The rare exception would be a false positive culture result. MTBC is not found in the environment.
**6.3 MTBC Culture Results for Patient Management**

**MTBC Culture Results for Patient Management**

In culture-positive TB cases, clinical response is evaluated by culture conversion

- Recommend 2 negative cultures by the end of 2 months (initial treatment phase) to document culture conversion
  - 80% of drug-susceptible TB patients have negative cultures within 2 months of treatment initiation

- If cultures are still positive after 4 months, the patient is deemed to have treatment failure and patient management must be re-assessed

**Notes:**

MTBC culture results are used for patient management decisions. In culture positive TB cases, clinical response is evaluated by culture conversion. It is recommended that two negative cultures are seen by the end of two months of the initial phase of treatment to document culture conversion. 80% of drug susceptible TB patients have negative cultures within two months of treatment initiation. If cultures are still positive after four months, the patient is deemed to have treatment failure and patient management must be reassessed.
6.4 Clinical Significance of NTM

Not all NTM isolation is clinically significant as source of diseases in humans.

Considerations for clinical relevance:
- Clinical setting and host
- Organism species and its pathogenic potential
- Source of the culture isolate & likelihood for contamination/colonization
- Quantification of organisms detected both in culture and AFB smears
- Number of positive cultures

Notes:
Now we'll talk about the clinical significance of nontuberculosis mycobacteria, or NTM. Not all NTM isolation is clinically significant as source of diseases in humans. Here's some considerations to think about when determining the clinical significance of an organism. Does the patient have symptoms consistent with mycobacterial disease, what is the patient’s immune status, what mycobacterium species has been identified? Is it considered one of the pathogenic species? Was the specimen collected surgically or from a normally sterile site? Was there abundant growth on the primary media? Were multiple cultures positive?
Here are some laboratory considerations for determining the clinical significance of NTM. To consider an isolate clinically significant you want to see two culture positive sputum samples or one culture positive bronc wash or lavage. Or a lung biopsy showing granulomas, or AFB on histopathology, plus a culture that's positive for NTM from that biopsy, or a lung biopsy showing granulomas or AFB on histopathology, plus a culture that's positive for NTM from a sputum or a bronc wash.
6.6 Clinical Relevance of Mycobacteria Isolated from Respiratory Specimens

This schematic shows the clinical relevance of mycobacteria isolated from respiratory specimens with increasing relevance toward the top of the chart. MTBC is considered the most clinically relevant with *M. kansasii* and *M. avium* complex next. The clinically relevant NTM can cause NTM-associated syndromes that include chronic pulmonary disease, cervical lymphadenitis, and skin soft tissue disease.

You can see that *M. gordonae* is at the bottom of the list. It is very rarely considered clinically significant, and would usually be considered an incidental finding. As far as patient risk factors for clinically significant mycobacterial disease, the most important risk factors are immune status and underlying lung disease. Other risk factors that are less significant include age, cystic fibrosis, and diabetes.
6.7 Mixed Cultures

**Mixed Cultures**

- Mixed mycobacterial cultures may indicate significant mixed infection
- Mixed mycobacteria species?
  - Visual inspection of solid media for different colony types
  - HPLC or MALDI-TOF may show “extra peaks” (confusing for identification prediction software)
  - Molecular results may be “heterogeneous” (un-interpretable)
- Multiple specimens from a patient can help clarify whether a mixed culture is clinically significant
- Need pure culture growth for susceptibility testing

**Notes:**

Mixed mycobacterial cultures may indicate significant mixed infection. Some ways that you can tell that a culture is mixed would be if you see different colony types. HPLC would show extra peaks, or two patterns superimposed on each other. If using MALDI-TOF, the protein pattern would be mixed which may lead to poor matches in the database. Molecular results may be heterogenous or uninterpretable.

Multiple specimens from a patient can help clarify whether a mixed culture is clinically significant. For example, if three specimens were received from a TB patient and one culture is mixed with Mac you might not think that's clinically significant. However, if all three TB cultures were mixed with Mac this is more significant. Of course you want to report the TB growth as soon as possible and you will need a peer culture for susceptibility testing.
Notes:

This image shows an example of what a mixed culture looks like on solid media using a low powered microscope or stereoscope for visualization. The larger more translucent colonies are *M. avium* complex. The smaller, rough dark colonies are MTBC. There are fewer of the MTBC colonies and they could easily be missed without careful observation.
Now we'll talk about some additional recommendations and practices.
7.2 Recommended Turnaround Time

Identification of MTBC ≤ 21 days from specimen receipt

- Molecular methodologies have dramatically decreased the TAT for identification once culture has grown
- Laboratory workflow and testing practices affect TAT
- Referral of testing can lead to increased TAT

Notes:

First let’s talk about the amount of time it takes to report culture results or the turnaround time. The recommended turnaround time is that MTBC be identified within 21 days from specimen receipt. Molecular methods have improved turnaround times, especially once the culture has grown. Your laboratory workflow and testing practices will effect turnaround times. Sending an isolate to another lab can increase turnaround times.
7.3 Identification and Reporting Considerations

Notes:

Identification and reporting considerations. For patient management and public health purposes, report preliminary identification MTBC or not MTBC as soon as possible. Make sure that identification results correlate and make sense. Do the molecular results match the phenotypic results (e.g., colony morphology and growth rate) before issuing final report. Discordant results should be investigated. Repeat testing as necessary or try a different test method. Send an isolate to a reference laboratory if more expertise is necessary. All the pieces of the puzzle should fit together before a final identification is reported.
7.4 Differentiating Within the Complex

Differentiating within the Complex

- MTBC includes *M. tuberculosis*, *M. bovis*, *M. bovis BCG*, *M. caprae*, *M. microti*, *M. africanum*, *M. canetti*, *M. pinnipedii*, and *M. mungi*
- Laboratory should consult with healthcare providers and TB program to decide the necessity of separating members of MTBC.
- Due to unique epidemiology and inherent PZA drug resistance, *M. bovis* and BCG should always be differentiated from other members of MTBC.

Notes:

Differentiating members of a TB complex. The MTBC complex includes *mycobacterium tuberculosis*, *M. bovis*, *M. bovis BCG* and other species listed in this slide. The laboratory should consult with healthcare providers and the TB program to decide the necessity of separating members of the TB complex. Due to the unique epidemiology and inherent PZA drug resistance, *M. bovis* and *M. bovis BCG* should always be differentiated from other members of the TB complex. In particular, you’re looking at patients that may have risk factors for *M. bovis* or *M. bovis BCG* infection. Those risk factors include therapeutic use of *M. bovis BCG* for bladder cancer, BCG vaccination, and access to unpasteurized milk.
Now we'll talk about how far to go with identification of NTM. Clinically significant NTM isolates should routinely be identified to the species level. The exception would be the *M. avium* complex (MAC). Patient management and treatment are not different between *M. avium* and *M. intracellulare*. The level of service and choice of methods should be determined by patient population served and resources available. Communication between clinician and laboratorian is essential for determining importance and extent of analysis for a clinical NTM isolate.
7.6 Possible Algorithm for Identification with Accuprobe

This slide shows a possible testing algorithm or testing flowchart when the laboratory uses mainly or only GenProbe AccuProbe for identification. When there's a positive culture containing AFB the lab might perform TB probe alone, positive probe results are reported. If the TB probe is negative other AccuProbe testing might be performed or the isolate might be sent to a reference lab for additional testing. After probe testing the lab might send out a final report as mycobacteria species, not TB, Mac, gordonae or kansasii without sending on to a reference lab for further testing. This is perfectly acceptable as long as submitters understand the identification limitations of the laboratory.
7.7 Possible Algorithm for Identification with HPLC or MALDI-TOF

Notes:

This slide shows a possible testing algorithm when the lab uses a variety of test methods, including HPLC or MALDI-TOF. When there’s a positive culture containing AFB, HPLC or MALDI-TOF is performed first and conclusive results are reported. For inconclusive results, further testing would be performed based on growth characteristics. For slow growers, AccuProbe testing or 16S sequencing might be performed, biochemical reactions might be used. For rapid growers, rpoB sequencing might be performed.
Let's talk about referring isolates to another lab for identification. Reference facilities should be utilized by laboratories lacking appropriate technologies and resources. Any AFB isolate that is not identified in-house should be sent on the original media within one working day. Laboratories should monitor the TAT of the reference facility to which their specimens are sent.
7.9 Considerations for Referral of Isolates

Notes:

Here are some considerations for referring specimens to another laboratory. The advantages of sending isolates to a reference lab are that the reference lab can provide expertise that is not otherwise available, limited in-house resources or difficulty maintaining proficiency might be reasons to send isolates to another lab for identification. It might be more cost effective to send isolates to a reference lab as opposed to bringing the technology or instrumentation in-house.

The limitations to sending isolates to a reference lab are that there are additional shipping costs. You need personnel that are trained and certified to ship packages. Because you're not performing the testing in-house, there's some loss of internal knowledge or status of testing, or what's going on with the isolate.

Be aware that a referral of isolates may increase your turnaround times. There's always a delay due to time it takes to ship the isolate.
7.10 Transport of Category A and Category B Substances

- Isolates of MTBC (including broths known to be positive for MTBC) are considered Category A (Infectious Substances)
- Patient specimens (e.g., sputum) are considered Category B (Biological Substances)
- Transport of both isolates and patient specimens is regulated by the Department of Transportation (DOT) and the International Air Transport Association (IATA) rules

Notes:

Transport of Category A and Category B substances. Isolates of MTBC including broths known to be positive for MTBC are considered Category A or infectious substances. Patient specimens such as sputum are considered Category B, biological substances. Transport of both isolates and patient specimens is regulated by the Department of Transportation, DOT, and the international air transfer association, IATA rules.
7.11 Transport of Category A and Category B Substances (2)

- Persons involved in shipping Category A and Category B substances must be trained and certified
- Packaging, shipping, and transport is complex and all regulations must be followed completely
  - Infractions may result in fines by regulatory agencies
  - Onus for proper packaging and shipping falls on the shipper
- For details regarding these regulations, please see the information provided in the Reference section

Notes:

More on transport of Category A and Category B substances. Persons involved in shipping Category A and Category B substances must be trained and certified. Packaging, shipping, and transport is complex and all regulations must be followed completely. If packages aren't shipped properly, the laboratory could be fined by regulatory agencies. For details regarding these regulations please see the information provided in the reference section.
Notes:

Here's an example of a Category A shipping system. The specimen is placed in a leak-proof screw cap container. The primary tube is labelled with two unique identifiers; usually the patient name and date of birth. The tube is sealed with paraffin or tape. The primary tube is placed in a biohazard zip closure bag with absorbent material. The zip closure bag is placed in a rigid secondary container. The outer container has appropriate labeling and signage according to DOT and IATA regulations.
Conclusions

- Accurate and timely identification of mycobacteria is crucial.
- Healthcare providers and TB Control Programs should be consulted to determine the level of TB laboratory services provided in your jurisdiction.
- There are a growing number of newly identified NTM, including those that are clinically significant.
- For robust identification, use a multi-faceted approach that includes rapid identification and phenotypic assessment before issuing a final report.
- Refer samples if lacking technical proficiency, staff expertise, or resources necessary to provide high quality results and rapid TAT.
- Use appropriate biosafety measures when working with cultures of mycobacteria, especially MTBC.

Notes:

Conclusions. Accurate and timely identification of mycobacteria is crucial. Healthcare providers and TB Control Programs should be consulted to determine the level of TB laboratory services provided in your jurisdiction.

There are growing number of clinically significant NTM. For robust identification, use a multi-faceted approach which includes rapid identification and phenotypic assessment before issuing a final report.

Samples should be referred if laboratories lack sufficient testing volume to maintain technical proficiency, staff expertise, or resources necessary to provide high quality results and rapid turnaround time. Use appropriate biosafety measures when working with cultures of mycobacteria, especially with MTBC.
7.14 Thank You for Participating!

Notes:

This concludes the Identification of Mycobacteria presentation, which is part of the series from the Association of Public Health Laboratories Essentials for the Mycobacteriology Laboratory: Promoting Quality Practices. Please see the CDC and APHL web sites for more information on the topics presented here.