

Differences in Time to Detection and Recovery of *Mycobacterium tuberculosis* between the MGIT 960 and the BacT/Alert MB Automated Culture Systems.

Kim Dionne,¹ Annie Hedgepeth,¹ Karen C. Carroll,¹ James D. Dick,¹ and Nicole M. Parrish¹

¹The Johns Hopkins Medical Institutions • Baltimore, Maryland

ABSTRACT

Rapid diagnosis of mycobacterial infections is essential to provide appropriate antimicrobial therapy. Automated, non-radiometric culture detection systems have focused on maximizing mycobacterial recovery from clinical specimens and minimizing the time to detection. We compared mycobacterial recovery rates and the time required for detection between the MGIT 960 (MGIT) and the BacT/Alert MB (MB) automated culture systems. Both systems and an LJ slant were inoculated with aliquots from the same specimen in parallel and incubated 6 weeks. A total of 622 clinical specimens were tested in parallel: 376 from non-sterile body sites and 246 from sterile body sites.

Overall, the time to detection for all Mycobacterial species considered together was shorter in the MGIT (average 7.3 days) versus the MB (average 16.9 days). However, recovery times did vary by mycobacterial species. In the MGIT, detection of *Mycobacterium tuberculosis* required an average of 13.5 days (range 7.2 – 19.3 days) versus 25.0 days (range 11.3 – 38.8 days) for the MB. Similar differences were noted for some of the non-tuberculous mycobacterial species. Recovery of *M. abscessus* in the MGIT required an average of 4.2 days (range 3.7 – 5.2 days) versus an average of 14.1 days (range 4.7 – 29.7 days) for the MB.

Sensitivity also varied between the two systems and tended to be mycobacterial species-dependent. Overall sensitivity for mycobacterial recovery was 85% and 65% for the MGIT and the MB, respectively. However, the MGIT demonstrated greater sensitivity for *M. tuberculosis* (100%) than did the MB (66.6%). The MGIT was also 100% sensitive for *M. fortuitum*, whereas the MB failed to detect this mycobacterial species.

Both systems recovered all *M. parascrofulaceum*, *M. abscessus*, and *M. kansasii*. *M. mucogenicum* was the only mycobacterial species not detected by either system. In this study, the MGIT demonstrated shorter detection times and better recovery of *M. tuberculosis* than the MB. However, it is essential that standard, solid-based culture methods be used in conjunction with automated systems to ensure recovery of mycobacterial species such systems may not detect.

INTRODUCTION

Rapid diagnosis of mycobacterial infections is essential to provide appropriate antimicrobial therapy and in the case of *Mycobacterium tuberculosis*, to implement effective infection control or public health interventions. Thus, automated, culture detection systems have focused on maximizing mycobacterial recovery from clinical specimens while minimizing the time to detection (TTD). This study compared the performance of the MGIT 960 (MGIT) [Becton Dickinson, Sparks, Maryland] and the BacT/ALERT MB (MB) [bioMérieux, Durham, N.C.] in three areas:

- Mycobacterial recovery rates
- Contamination rates
- TTD between automated culture systems.

MATERIALS AND METHODS

In this controlled study, a total of 622 clinical specimens over 3 months were tested in parallel: 376 from non-sterile body sites and 246 from sterile body sites. Non-sterile specimens were digested and decontaminated using Snap 'N Digest (SDL, Inc., Des Plaines, Illinois) according to manufacturer's recommendations, spun down, and the pellets retained. Sterile fluids were spun down and the resulting pellets used for inoculation. Tissues were homogenized and inoculated directly.

Each specimen was divided into three aliquots. The first was inoculated into a BacT/Alert MB mycobacteria processing bottle. The second was inoculated into a MGIT tube. Each inoculation was performed according to manufacturer's recommendations. The third aliquot was inoculated onto a Lowenstein-Jensen slant. Inoculated specimens were then loaded onto their respective instruments and incubated for 42 days. LJ slants were loaded into a 35°C incubator with 5% CO₂ and also incubated for 42 days.

Speciation of positive cultures for *M. tuberculosis*, *M. avium-intracellulare* complex, *M. kansasii*, and *M. gordonae* was performed using Accuprobe probe kits (Gen-Probe, San Diego, California). Isolates testing negative for all probes were speciated by DNA sequencing.

For direct comparison, a seeded study was also performed on each instrument using a standardized, dilution series of *M. tuberculosis* (H37Rv). Briefly, a suspension of H37Rv was prepared using Middlebrook 7H9 broth and adjusted to a 0.5 McFarland standard.

Subsequently, ten-fold serial dilutions were made and an aliquot of each added to individual MGIT tubes or MB processing bottles. The number of organisms in each dilution was verified using traditional plate counts on Middlebrook 7H11 agar. Samples were loaded onto respective instruments and the TTD monitored until all dilutions registered a positive signal.

RESULTS

Table 1. Time to detection (TTD) comparison between the MGIT 960 versus BacT/ALERT MB in bottles spiked with known concentrations of *Mycobacterium tuberculosis* (MTB).

MTB (CFU/ml)	TTD (Days)	
	MGIT 960	BacT/ALERT MB
1 x 10 ⁴	6.50	8.25
1 X 10 ³	7.90	10.25
1 X 10 ²	9.70	12.2
1 X 10 ¹	10.85	13.3

Table 2. Comparison of mycobacteria recovered from clinical specimens (n = 41) using conventional LJ slants versus the MGIT 960 and BacT/ALERT MB systems.

Mycobacterial Species	Number Recovered		
	LJ slant	MGIT 960	BacT/ALERT
<i>M. tuberculosis</i>	9	9	6
<i>M. avium</i> complex	20	19	19
<i>M. abscessus</i>	3	3	3
<i>M. fortuitum</i>	5	5	0
<i>M. kansasii</i>	1	1	1
<i>M. parascrofulaceum</i>	1	1	1
<i>M. mucogenicum</i>	1	0	0
Nocardia species	1	1	1
TOTAL	41	39	31

Table 3. Comparative TTD by mycobacterial species between the MGIT 960 and the BacT/ALERT MB.

Mycobacterial Species	TTD (Days)			
	MGIT 960		BacT/ALERT	
	AVERAGE	RANGE	AVERAGE	RANGE
<i>M. tuberculosis</i>	13.5*	7.2-19.3	25.2	11.3-38.8
<i>M. avium</i> complex	12.1	3.3-27.8	14.8	5.0-25.8
<i>M. abscessus</i>	4.2	3.7-5.2	14.1	4.7-29.7
<i>M. fortuitum</i>	8.1	1.3-12.4	ND	
<i>M. kansasii</i>	24.4	single isolate	20.8	single isolate
<i>M. parascrofulaceum</i>	8.8	single isolate	20.5	single isolate
<i>M. mucogenicum</i>	ND		ND	
Nocardia species	4.9	single isolate	6.0	single isolate

ND = Not Detected

*Statistically Significant Difference (P=0.006)

Table 4. Comparative contamination rates in the MGIT 960 versus the BacT/ALERT MB.

Specimen Type	MGIT 960		BacT/ALERT MB	
	Percent	Number	Percent	Number
Digested	10.3	39/346	17.2	64/346
Undigested	5.6	14/246	4.4	11/246

SUMMARY

- In this study, a total of 622 clinical specimens were tested in parallel for the presence of mycobacteria using the MGIT 960 versus the BacT/ALERT MB automated culture systems.
- Overall, the MGIT 960 demonstrated shorter detection times, lower contamination rates and better recovery of MTB than the BacT/ALERT MB.

Time to Detection (TTD)

- TTD for all Mycobacterial species considered together varied between the 2 systems: MGIT 960 (average 7.3 days); BacT/ALERT MB (average 16.9 days).
- Recovery times also varied by mycobacterial species between the two systems:
 - *Mycobacterium tuberculosis*
Average TTD: MGIT 960 (13.5 days);
BacT/ALERT/MB (25.0 days)
This difference was statistically significant (P = 0.006).
 - *Mycobacterium avium* complex
Average TTD: MGIT 960 (12.1 days);
BacT/ALERT/MB (14.8 days)
 - Other Non-tuberculous Mycobacteria
Average TTD: MGIT 960 (11.4 days);
BacT/ALERT/MB (18.5 days)

Sensitivity

- Sensitivity varied between the two systems and tended to be mycobacterial species-dependent.
 - ALL Mycobacteria considered together
MGIT 960: 85% (39/41);
BacT/Alert MB: 65% (31/41)
 - *Mycobacterium tuberculosis*
MGIT 960: 100% (9/9);
BacT/Alert MB: 66.6% (6/9)
 - *Mycobacterium avium* complex
MGIT 960: 95% (19/20);
BacT/Alert MB: 95% (19/20)
 - *Mycobacterium fortuitum*
MGIT 960: 100% (5/5);
BacT/Alert MB: 0% (0/5)
- Both systems recovered all *M. parascrofulaceum*, *M. abscessus*, and *M. kansasii*.
- *M. mucogenicum* was the only mycobacterial species not detected by either system.

Contamination

- Contamination rates for digested specimens were lower in the MGIT 960 (10.3%) versus the BacT/ALERT (17.2%).

CONCLUSION

- The MGIT 960 is superior to the BacT/ALERT MB system. It is essential that standard, solid-based culture methods be used in conjunction with automated systems to ensure recovery of mycobacterial species such systems may not detect.

CORRESPONDING AUTHOR

Dr Nicole M. Parrish, nparrish@jhmi.edu
The Johns Hopkins Medical Institutions, Baltimore, Maryland