

The Impact of Comprehensive Laboratory Automation on Workflow Efficiency and Turnaround Time in the Analysis of Positive Blood Cultures and Urine Cultures in Taiwan



Tai-Fen Lee¹, Ming-Hui Hung², Hsueh-Wei Chu¹, Qiao-Ting Chao¹ and Yu-Tsung Huang¹



Departments of Laboratory Medicine¹, and Medical Education², National Taiwan University Hospital and National Taiwan University College of Medicine, Taipei, Taiwan

Background and Purpose:

Total Laboratory Automation (TLA) enhances specimen processing, streamlines workflow, and reduces turnaround time (TAT) for laboratory tests. This research evaluates TLA's effect on TAT for positive blood culture and urine culture results, focusing on workflow enhancement and efficiency to expedite result reporting.

Methods:

The effectiveness of the Copan TLA system was assessed by analyzing hospital data during two consecutive six-month periods: the pre-TLA implementation phase (January to June 2022) and the post-implementation phase (January to June 2023). Following TLA implementation, positive blood cultures were processed using sterile tubes and underwent automated inoculation, with an additional 6-hours of image interpretation step. Urine samples were directly inoculated using the WASP system. Turnaround time (TAT) was defined as the time elapsed from sample receipt to the issuance of final culture results.

Pre-TLA Process

- Inoculation**
 - Classification of culture specimens
 - Inoculate the culture medium by manually streaking
 - From 7:30 a.m. to 8:00 p.m. (2 shifts)
- Plates screening**
 - Manually reading plates
 - Positive cultures: perform subculturing, ID, and AST.
 - Negative cultures: reporting
 - From 8:00 a.m. to 5:00 p.m.
- Reports review**
 - Review all datas
 - Reporting all results
 - From 8:00 a.m. to 5:00 p.m.
- Blood cultures**
 - Positive cultures: grading reporting
 - Negative cultures: reporting
 - From 8:00 a.m. to 5:00 p.m.
- Night staff**
 - subculturing for positive blood and sterile site specimens
 - From 8:00 p.m. to 1:00 a.m.



Post-TLA Process

- Inoculation**
 - Classification of culture specimens
 - Inoculate the culture medium by COPAN WASPLab and manually streaking
 - From 7:30 a.m. to 8:00 p.m. (2 shifts)
- Screening/Reporting**
 - Reading plates through the computer
 - Positive cultures: perform subculturing, ID, and AST.
 - Review all datas and reporting
 - From 7:30 a.m. to 4:30 p.m.
- ID/AST**
 - Recheck the colonies
 - Positive cultures: perform subculturing, ID, and AST
 - From 8:00 a.m. to 5:00 p.m.
- Rapid cultures**
 - Positive blood cultures and sterile site specimens
 - The culture medium was inoculated for 6 hours for ID, and AST
 - From 11:30 a.m. to 8:00 p.m.
- Night staff**
 - Inoculation of urine samples using the COPAN WASPLab
 - Subculturing for positive blood and sterile site specimens
 - From 8:00 p.m. to 1:00 a.m.

Results:

During the period spanning January to June 2022, a total of 4,154 positive blood cultures were documented, exhibiting an average turnaround time (TAT) of 81.40 hours (SD 40.82). In the corresponding months of 2023, this number decreased to 3,883 cases, accompanied by a diminished mean TAT of 74.61 hours (SD 38.92). Regarding urine cultures, there were 31,772 cases recorded in 2022 with an average TAT of 54.99 hours (SD 20.46). In contrast, the year 2023 witnessed an increase in the number of cases to 37,120, with a slightly reduced mean TAT of 53.66 hours (SD 17.57). These findings highlight significant improvements in performance ($P < 0.001$). Furthermore, the average time required for reporting isolation of a single bacterial strain in urine cultures decreased from 51.1 to 50.93 hours, and for two strains, it dropped from 68.3 to 64.58 hours, signifying a notable reduction ($P < 0.001$).

Table 1 : Comparing the TAT and SD in positive blood culture reports from January to June in 2022 and 2023

Month	2022	2023	P-value
	Mean ± SD (N)	Mean ± SD (N)	
JAN	77.1 ± 34.6 (636)	90.4 ± 45.6 (633)	0.14
FEB	80.1 ± 42.0 (601)	73.0 ± 35.0 (584)	0.002
MAR	81.5 ± 37.3 (753)	72.0 ± 37.0 (697)	<0.001
APR	82.7 ± 54.3 (680)	74.0 ± 33.1 (619)	<0.001
MAY	83.3 ± 37.1 (726)	73.9 ± 43.9 (668)	<0.001
JUN	83.0 ± 37.1 (758)	74.5 ± 36.4 (682)	<0.001
Total	81.4 ± 40.8 (4154)	74.6 ± 36.4 (3883)	<0.001

Figure 1 : Box plots showing the median TAT to report positive blood cultures from January to June in 2022 and 2023

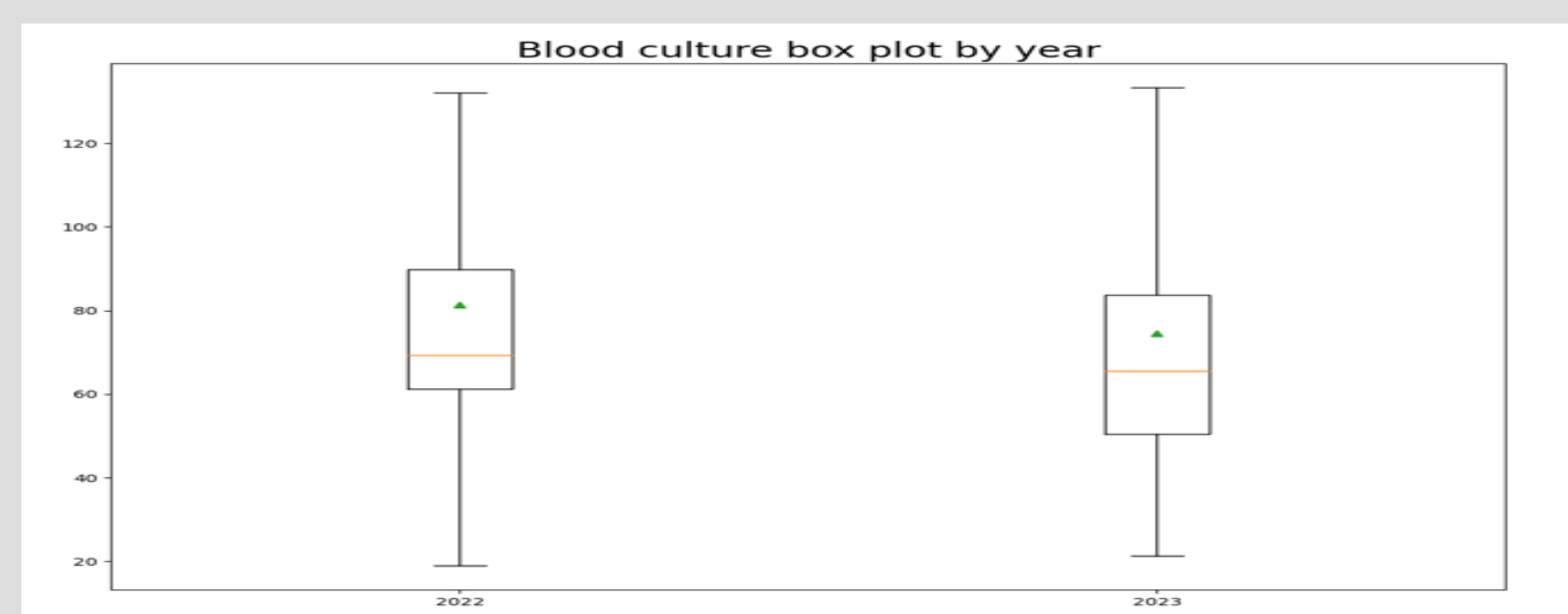
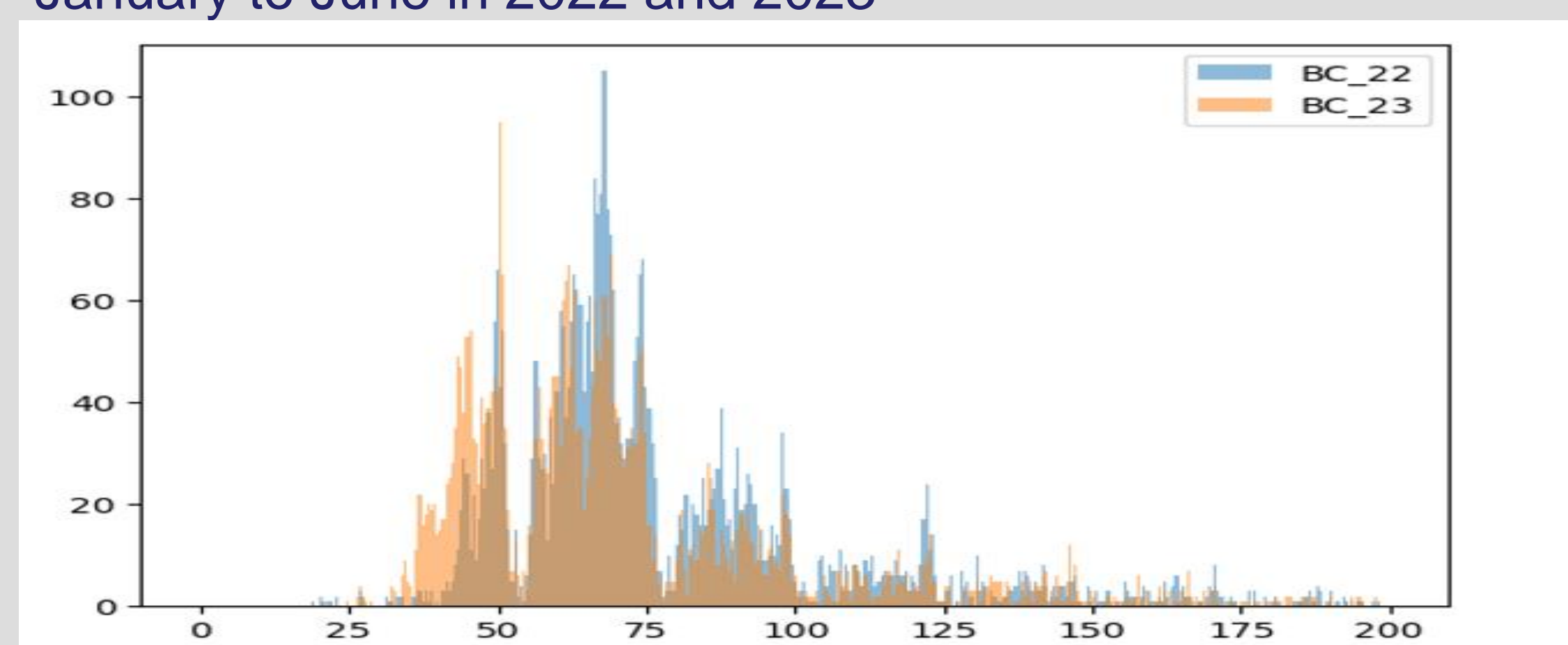


Table 2 : Comparing the TAT and SD in urine culture reports from January to June in 2022 and 2023

Month	2022	2023	P-value
	Mean ± SD (N)	Mean ± SD (N)	
JAN	54.1 ± 21.1 (5302)	53.7 ± 17.3 (5643)	0.28
FEB	54.5 ± 19.8 (4707)	54.5 ± 19.5 (5480)	0.99
MAR	54.9 ± 20.4 (6119)	51.0 ± 15.4 (6424)	1.34
APR	55.8 ± 19.9 (5245)	54.1 ± 16.8 (6112)	<0.001
MAY	55.2 ± 21.3 (4932)	53.6 ± 17.5 (6870)	<0.001
JUN	55.4 ± 20.2 (5467)	55.3 ± 18.5 (6591)	0.67
Total	55.0 ± 20.5 (31772)	53.7 ± 17.6 (37120)	<0.001

Figure 2 : Distribution of positive blood culture TATs from January to June in 2022 and 2023



Conclusions:

The introduction of TLA and a 6-hour image interpretation protocol significantly reduced positive blood cultures TAT. Similarly, automated systems for urine cultures improved colony identification and decreased the reporting time.