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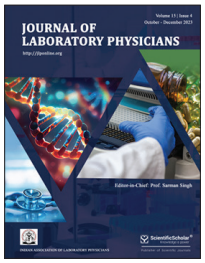

Brief Report

Quality control in antibiotic susceptibility testing: Insights into laboratory technologists' knowledge, attitudes, and practices in a low- and middle-income country setting

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ABSTRACT

Objectives: This study aimed to assess the knowledge, attitudes, and practices regarding quality control (QC) of antibiotic susceptibility testing (ABST) among medical laboratory technologists (MLTs) in state-sector hospitals in Sri Lanka.

Materials and Methods: A descriptive cross-sectional survey was conducted using a self-administered questionnaire covering demographics, knowledge, attitudes, practices, challenges, and suggestions regarding QC of ABST. The questionnaire was distributed in print at selected hospitals and online through Google Forms.

Statistical analysis: Descriptive statistics, Chi-square, and Fisher's exact tests were performed using Jamovi version 2.3.28, with significance considered at $P < 0.05$.

Results: The response rate was 54%. Most respondents (103, 53.4%) were aged 31–40 years, and 118 (61.1%) held a Bachelor's degree. Clinical and Laboratory Standard Institute M100 was used by <50% as a reference for QC strain acceptable diameters (90, 46.6%) and clinical isolate (95, 49.2%) interpretation. The majority (183, 94.8%) strongly agreed on the importance of QC. Among 109 with recent experience in Microbiology, 67 (61.4%) practiced proper QC strain storage. While most had favorable attitudes, good knowledge was observed in less than half, and good QC practices remained low, particularly among those with less experience.

Conclusions: QC awareness was high, but knowledge and adherence to proper practices were limited, especially among less experienced MLTs.

Keywords: Antimicrobial susceptibility testing, Attitudes, Knowledge, Laboratory personnel, Microbial sensitivity tests, Practice, Quality control, Sri Lanka

INTRODUCTION

Quality control (QC) is a statistical process that monitors test procedures to ensure reliable, accurate, and timely test results in clinical laboratories, maintaining diagnostic integrity and supporting patient care.[1,2]

State-sector hospitals in Sri Lanka employ Medical Laboratory Technologists (MLTs) with a degree or diploma. They work across laboratory sections, but specialization is lacking, and postgraduate studies are optional.

This study evaluated MLTs' awareness, knowledge, attitudes, and practices on QC in antibiotic susceptibility testing (ABST) in Sri Lanka while identifying challenges faced and recommendations to improve the QC of ABST.

No studies on this topic have been conducted in Sri Lanka. A search using the keywords Awareness, Knowledge, Attitudes, Practices, QC, Antibiotic Susceptibility Tests, MLTs on Google Scholar, PubMed, ResearchGate, and ScienceDirect revealed no similar global studies. Although this study is country-specific, the findings could be relevant to other Low- and Middle-Income Countries with similar infrastructure.

MATERIALS AND METHODS

This was a descriptive cross-sectional survey-based study conducted among the MLTs of the state sector hospitals in Sri Lanka. A self-administered questionnaire was developed from the Clinical and Laboratory Standard Institute (CLSI) guidelines and validated by two QC experts to include sections on demographics, awareness, knowledge, attitudes, practices, challenges, and suggestions.[3,4] The sample size was calculated using Cochran's (1977) formula for a finite population, with a 10% non-response rate yielding a final size of 358.[5,6] MLTs in state-sector hospitals were recruited through convenient sampling, while retirees and full-time private-sector MLTs were excluded.

Data were collected from October 23rd to November 29th, 2024. Participants received an information sheet and consent form along with the questionnaire in Google Forms (through WhatsApp, email, and Facebook), and printed copies were distributed in select hospitals. A declaration section ensured that each participant completed one questionnaire. Ethical clearance was obtained from the Ethics Review Committee, Faculty of Allied Health Sciences, University of Peradeniya (Reference: AHS/ERC/2024/056).

Collected data were entered into Excel 2013 after checking for inconsistencies and eligibility, then analyzed using Jamovi 2.3.28. Descriptive statistics were used for demographic data and knowledge, attitude, and practices (KAP) responses. Knowledge and attitude scores were calculated for all responders, while the practice score was calculated for those who were either working in microbiology sections or had worked in the microbiology section within 5 years. Total KAP scores were categorized using Bloom's cutoff point.[7] Chi-square test or Fisher's exact test assessed the association between demographics and KAP levels ($P < 0.05$ for significance). The challenges were presented descriptively and the suggestions were analyzed through thematic analysis.

RESULTS

The total number of responses received was 193 (response rate 54%); of them, 84 (43.5%) were paper questionnaires, while 109 (56.5%) were filled out online.

Demographic details of the study participants are shown in Table 1.

The majority (150, 77.7%) of participants had work experience in a state sector microbiology laboratory, and 133 (68.9%) performed QC of ABST during their employment.

Table 1: Demographic details of the study participants (n=193).

Characteristic	Frequency	%
Age categories in years		
20–30	31	16.1
31–40	103	53.4
41–50	37	19.2
>50	22	11.4
Gender		
Male	71	34.7
Female	122	63.2
Education		
Diploma in Medical Laboratory Technology	65	33.7
Diploma followed by any BSc. Or only BSc in Medical Laboratory Science/BSc in Biomedical Science/BSc	118	61.1
Postgraduate degree (M.Sc./M.Phil)	10	5.2
Years of service		
<10	102	52.8
10–20	53	27.5
>20	38	19.7
Hospital category		
National/Teaching/Provincial general/ District general hospital	156	80.8
Base hospital/Other	37	19.2
Current working station		
Microbiology	60	31.1
Biochemistry	32	16.6
Hematology	32	16.6
Histopathology	14	7.3
Virology	8	4.1
OPD	14	7.3
Laboratory administration	10	5.2
Other	23	11.8

OPD: Outpatient department

Table 2: Frequency of knowledge, attitudes, and practices regarding QC of ABST.

Section A: Knowledge	**Frequency**	**%**
Reference to interpret the zone diameters for QC organisms		
CLSI M100	90	46.6
CLSI M02	12	6.2
Laboratory Manual in Microbiology by the Sri Lanka College of Microbiologists	72	37.3
Not aware	19	9.8
Reference to interpret the zone diameters for clinical isolates		
CLSI M100	95	49.2
CLSI M02	8	4.1
Laboratory Manual in Microbiology by the Sri Lanka College of Microbiologists	66	34.2
Not aware	24	12.4
Corrective action if the QC of ABST fails		
Refer to CLSI M100	78	40.4
Refer to CLSI M02	36	18.7
Discussion with other/senior MLTs	119	61.7
Discussion with the consultant microbiologist	147	76.2
Elements to be quality controlled		
Antibiotic disks		
Yes	173	89.6
No	4	2.1
Don't know	16	8.3
Agar media (Ex: MHA)		
Yes	155	80.3
No	14	7.3
Don't know	24	12.4
Organism inoculum		
Yes	149	77.2
No	19	9.8
Don't know	25	13.0
Section B : Attitudes		
Do you think that QC for ABST is essential?		
Strongly agree	183	94.8
Agree	10	5.2
Neutral	0	0
Disagree	0	0
Strongly disagree	0	0
Do you think that QC results affect the patient's ABST test results?		
Strongly agree	158	81.9
Agree	35	18.1
Neutral	0	0
Disagree	0	0
Strongly disagree	0	0
Are you confident in performing QC of ABST?		
Strongly agree	88	45.6
Agree	73	37.8

(Contd...)

Table 2: *(Continued).*

Section B : Attitudes		
Neutral	31	16.1
Disagree	1	0.5
Strongly disagree	0	0
Are you confident that your ABST results are accurate and precise to be reported to the patients?		
Strongly agree	80	41.5
Agree	89	46.1
Neutral	23	11.9
Disagree	1	0.5
Strongly disagree	0	0
Do you think that you need further training on QC of ABST?		
Strongly agree	67	34.7
Agree	111	57.5
Neutral	14	7.3
Disagree	1	0.5
Strongly disagree	0	0
Section C : Practices		
QC organisms obtained from		
MRI	99	90.8
Neighboring hospital	3	2.8
ATCC or NCTC	2	1.8
Not aware	4	3.7
Other	1	0.9
Storage of stock culture of QC organisms		
−80° C freezer	25	22.9
−20°C freezer	42	38.5
Refrigerator	39	35.8
Room temperature	2	1.8
Unsure	1	0.9
Storage of stock of antibiotics for combination antibiotics (e.g. co-amoxiclav)		
−80°C freezer	4	3.7
−20°C freezer	67	61.5
Refrigerator	36	33.0
Room temperature	2	1.8
Unsure	0	0
Storage of stock of antibiotics other than combination antibiotics		
−80°C freezer	4	3.7
−20°C freezer	61	56.0
Refrigerator	42	38.5
Room temperature	0	0
Unsure	2	1.8
QC for each new lot of media and/or antibiotics		
Yes	81	74.3
No	22	20.2
Not aware	6	5.5

(Contd...)

Table 2: *(Continued).*

Section C : Practices		
How long F1(first passage) is used		
1 week	11	10.1
1 month	47	43.1
3 months	13	11.9
Not aware	21	19.3
Do not practice this step	17	15.6
How long is F2(second passage) used		
1 day	7	6.4
1 week	37	33.9
1 month	24	22.0
Not aware	23	21.1
Do not practice this step	18	16.5
QC plans when introducing a new antibiotic		
CLSI: 20- or 30- day plan	44	40.4
CLSI: 15 replicate (3- ×5- day) plan	14	12.8
CLSI: Daily QC testing	12	11.0
Stokes: Daily QC testing	5	4.6
Not aware	32	29.4
Other[#]	2	0.9
QC plans for regular in-use antibiotics		
Daily	9	8.3
Weekly	49	45.0
No regular QC is done	46	42.2
Not aware	5	4.6
Record keeping of ABST QC result		
Laboratory logbooks	91	83.5
LIMS	10	9.2
Cloud storage	1	0.9
Do not keep records	6	5.5
Other*	1	0.9

[#]Can't remember, Do QC monthly, *Separate book. LIMS: Laboratory information management system, QC: Quality control, CLSI: Clinical and Laboratory Standard Institute, MRI: Medical research institute, ABST: Antibiotic susceptibility testing, MLT: Medical laboratory technologists, MHA: Mueller Hinton agar, LIMS: Laboratory information management systems, American type culture collection, ATCC: American type culture collection, NCTC: National collection of type culture

The frequency of answering knowledge-based questions is shown in Table 2. Eighty-one (42.0%) had good knowledge, while 66 (34.2%) had moderate, and 46 (23.8%) had poor knowledge of QC in ABST.

The frequency of favorability toward each attitude is illustrated in Table 2. Most respondents, 187 (96.9%), had favorable attitudes, while 6 (3.1%) had moderate attitudes, and none were unfavorable toward QC in ABST.

Only 109 (56.5%) participants were either currently working or had worked in a microbiology laboratory within the past 5 years to be included in this section of the analysis [Table 2].

A similar proportion had poor 38 (34.9%), moderate 37 (33.9%), and good 34 (31.2%) practices. Knowledge was significantly associated with hospital category (P = 0.006) and working station (P = 0.017), but not with age, gender, education, or years of service. Participants in National/Teaching/Provincial/District general hospitals had better knowledge than those in base or other hospitals. Those currently working in the Microbiology section had better knowledge than those in other sections. Attitude levels showed no significant associations with the variables considered. However, practice levels were significantly

influenced by age (p=0.034), educational qualifications ($P = 0.001$), years of service ($P = 0.005$), and current working station ($P = 0.013$). Participants aged ≥40 years (12, 38.7%) demonstrated better practices compared to those aged <40 years (22, 28.2%). Both MLTs with a diploma (10, 31.2%) and those with qualifications beyond the diploma level (24, 31.2%) had the same percentage of good practices. However, individuals with qualifications beyond the diploma level (34, 44.2%) showed more poor practice compared to those with only a diploma qualification (4, 12.5%). Individuals with ≥10 years of service (16, 35.6%) exhibited a significantly higher percentage of good practices compared to those with <10 years of service (18, 28.1%). Participants currently working in the Microbiology section (24, 40%) had the highest percentage of good practices compared to those in other sections, but worked in Microbiology within 5 years (10, 20.4%).

The commonest challenges identified were, workload/lack of staff, time constraints, financial constraints, limited access to QC strains, and lack of training and awareness. The majority (143, 74.1%) of participants identified workload/lack of staff as the most common challenge for doing QC of ABSTs.

The participant provided suggestions, based on thematic analysis, were categorized as follows: improving workforce, maintaining and calibrating equipment, conducting regular training and development programs, appointing dedicated QC officers, providing access to the latest CLSI guidelines, and ensuring a continuous and adequate supply of QC strains, antibiotics, culture media, and other essential resources.

DISCUSSION

To the best of the author's knowledge, this is the first study assessing awareness, knowledge, attitudes, and practices on QC of ABST among MLTs in state sector hospitals, Sri Lanka.

Most MLTs (186, 96.4%) learned about ABST in their degree/diploma programs, and 133 (68.9%) performed QC during employment, indicating adequate awareness and theoretical knowledge. For interpreting zone diameters for QC strains, 72 (37.3%) relied on the Laboratory Manual in Microbiology by the Sri Lanka College of Microbiologists. Since CLSI guidelines are regularly updated while the National Laboratory Manual is not, this gap may lead to misinterpretations. For systematic troubleshooting, most of the respondents selected the discussion with other MLTs/senior MLTs (119, 61.7%) or consultant Microbiologists (147, 76.2%) rather than referring to CLSI guidelines. It indicates gaps in knowledge about CLSI troubleshooting protocols as well as a lack of access to the said documents.

Most participants (187, 96.9%) had positive attitudes toward the significance of QC in ABST for patient care. While most expressed confidence in performing QC and reporting accurate results, 60 (31.1%) had never conducted QC during their employment, suggesting potential bias or overconfidence. The high willingness to undergo further training indicates the likely effectiveness of training programs.

The study found that 39 (35.8%) store QC strains in refrigerators, which is not recommended. This is likely due to infrastructure limitations in Sri Lankan laboratories, as highlighted by questions on the availability of ultra-low temperature freezers. Improper storage can alter QC strain characteristics, leading to incorrect interpretation of QC results and ultimately producing inaccurate ABST results for patients. Regarding QC strain management, 47 (43.1%) and 37 (33.9%) correctly adhered to the first and second passage guidelines, respectively. The lower percentages highlight a lack of familiarity with the CLSI M02 guidelines. Possible reasons for this include limited personnel involvement in performing QC, the complexity of CLSI guidelines for first-time readers, and insufficient training sessions. On a positive note, 81 (74.3%) perform QC for each new lot of media or antibiotics, ensuring their quality before use.

Good knowledge was significantly linked to hospital category and working station. Nearly half lacked good knowledge of QC of ABSTs, underscoring the need for ongoing training. This is likely due to many not working in microbiology labs, limiting knowledge reinforcement.

Attitudes were not significantly associated with demographics, indicating uniformly positive attitudes.

Good practices (32.1%) were significantly associated with age, years of service, education, and work in Microbiology labs, indicating that experience and maturity contribute to better practices. As poor practices were more common among those with qualifications beyond the diploma level, a qualitative study to explore the reasons for this is essential.

A major limitation is the low response rate, a common issue in healthcare research, as seen in many studies.[8,9] We analyzed practices based on 109 of 193 participants who answered practice-related questions. Bias may arise from convenient sampling, as hospital representation was uneven. Lack of similar studies made comparisons challenging. In 2025, CLSI revised its QC recommendations, emphasizing the need for an Internal Quality Assurance Plan (IQAPs). However, a strong understanding of ABST QC remains essential for developing IQAPs.[10]

Future studies are recommended for representative sampling of MLTs in microbiology labs to assess QC practices. As no prior studies were found, qualitative research is needed to explore factors behind poor practices despite adequate knowledge. Key recommendations include regular training, adequate resources, updated guidelines, workload management, and audits.

CONCLUSIONS

Most participants had moderate to good knowledge and favorable attitudes toward QC in ABST, but practices varied. Knowledge correlated with hospital category and working station, while practices linked to age, education, experience, and working station. Attitudes showed no significant associations. Targeted training, resource allocation, and practicable protocols are crucial for the improvement of QC of ABSTs.

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Authors' contributions: JLW: Study design, data collection, analysis, and writing up a paper; VL: Study concept, design, overseeing the analysis, and editing and approving the paper.

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