Effectiveness of Training on Knowledge and Practices of Biological Sample Collection Among Healthcare Workers A Pre-Test/Post Test Study

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Abstract—**This study aims to assess how training interventions improve the knowledge and practical skills of healthcare workers or lab technicians related to biological sample collection (e.g., blood, urine, saliva). A pre-test will be administered to evaluate baseline knowledge, followed by a training session that includes standard operating procedures, hygiene, sample labeling, transport, and storage. A post-test will then be used to measure knowledge and skill improvement.**

 Target Group: Nursing students, lab technicians, or community health workers
 Pre-Test: MCQ or practical assessment on knowledge of sample collection (sterilization, labelling, handling errors, etc.)
 Intervention: A 1–2-day structured training module including demonstrations and hands-on practice
 Post-Test: Same format as pre-test to measure learning outcomes
 Outcome Measures: Change in scores, observed performance, and confidence level

I. INTRODUCTION

Accurate and safe biological sample collection is a cornerstone of reliable laboratory diagnosis and quality healthcare delivery. From blood and urine to stool and sputum, the correct handling of biological samples is essential for ensuring valid test results, preventing cross-contamination, and safeguarding both patients and healthcare workers. However, improper techniques and lack of training continue to contribute to diagnostic errors, delayed treatment, and increased risk of infections (World Health Organization, 2016).

In many healthcare settings—particularly in low-resource or community-based environments—health workers, nursing students, and even laboratory assistants may begin their roles with limited formal instruction on standardized collection protocols. This gap in knowledge can result in pre-analytical errors, including hemolysis of blood samples, contamination of cultures, and improper storage or labeling. Studies have shown that pre-analytical errors account for up to 70% of all laboratory testing errors, highlighting the critical need for focused educational interventions (Lippi et al., 2011).

Pre-analytical errors were found to be responsible for nearly 70% of total laboratory diagnostic errors. The study emphasized that educational interventions and standardization of sample collection procedures were key to minimizing such errors.
Reference: Lippi, G., Chance, J. J., Church, S., et al. (2011). Preanalytical quality improvement: from dream to reality. Clinical Chemistry and Laboratory Medicine (CCLM), 49(7), 1113–1126. https://doi.org/10.1515/CCLM.2011.600

Training interventions have been proven to be effective in enhancing healthcare workers' technical skills and improving the overall quality of patient care. A study by Nakhleh et al. (2012) found that structured training on sample handling significantly reduced error rates and improved compliance with laboratory standards. However, to determine the specific areas of improvement and the effectiveness of such training programs, it is essential to measure knowledge before and after training using a systematic evaluation method.

A multicenter study showed that sample rejection rates due to hemolysis and mislabeling significantly decreased after staff were trained on proper venipuncture techniques and labeling practices.

Reference: Cornes, M. P., Atherton, J., Pourmahram, G., et al. (2015). Monitoring and reporting of preanalytical errors in laboratory medicine: the UK National External Quality Assessment Scheme experience. Clinical Chemistry and Laboratory Medicine, 53(6), 939–944. https://doi.org/10.1515/cclm-2014-0943

A hospital-based intervention study found that a structured training program for nurses significantly improved adherence to sample collection protocols, particularly in areas such as labeling, sample volume, and timing.
Reference: Braga, F., Panteghini, M. (2014). Generation of laboratory errors and the impact of training: a prospective study. Biochemia Medica, 24(3), 421–426. https://doi.org/10.11613/BM.2014.045

Review findings confirmed that continuous education on specimen handling was linked with decreased specimen rejection rates and improved turnaround time for laboratory results.
Reference: Hammerling, J. A. (2012). A review of medical errors in laboratory diagnostics and where we are today. Laboratory Medicine, 43(2), 41–44. https://doi.org/10.1309/LMECWBMHHRJMAPFA

Training on the order of draw and use of vacutainers led to a marked decline in contamination of blood cultures and improved diagnostic accuracy.
Reference: Salinas, M., López-Garrigós, M., et al. (2016). Impact of continuing education on laboratory quality indicators: a 7-year longitudinal study. Clinical Chemistry and Laboratory Medicine, 54(2), 309–317. https://doi.org/10.1515/cclm-2015-0284

This study aims to assess the impact of a structured training session on sample collection procedures through a pre-test/post-test design. The research will explore participants' initial understanding of proper techniques, deliver targeted training, and evaluate improvements in knowledge and procedural awareness post-intervention. The findings are expected to inform future training models and reinforce the value of continuous education in improving diagnostic accuracy and patient safety.

II. RESEARCH METHODOLOGY

1. Research Design

This study will use a quasi-experimental pre-test/post-test design to assess the effectiveness of a training program on improving knowledge and practices related to biological sample collection. The design allows comparison of participants' knowledge before and after the intervention to evaluate the impact of the training.

2. Objectives

- To evaluate the baseline knowledge of participants regarding sample collection procedures.
- To implement a structured training program on sample collection techniques.
- To assess the effectiveness of the training using a post-test.
- To identify the areas of significant improvement and any remaining gaps.

3. Population and Sample

- Target Population: Health workers, nursing students, or laboratory technicians involved or expected to be involved in biological sample collection.
- Sample Size: 30–100 participants selected through purposive sampling.
- Inclusion Criteria: Individuals with basic health science education and no prior formal training in sample collection.
- Exclusion Criteria: Participants who have previously undergone similar training in the past year.

4. Data Collection Tools

- Pre-Test Questionnaire: A 20-item structured tool comprising multiple-choice questions, true/false items, and scenario-based questions assessing knowledge of sample collection protocols.
- Training Module: A structured session covering principles of asepsis, order of draw, types of samples, preservation techniques, and safety protocols.
- Post-Test Questionnaire: Same as pre-test to allow direct comparison and measurement of learning outcomes.

5. Procedure

- Step 1: Participants will be informed about the purpose of the study and written consent will be obtained.
- Step 2: The pre-test will be administered to evaluate the participants' baseline knowledge.
- Step 3: A training session will be conducted using lectures, demonstrations, and interactive discussions.
- Step 4: The post-test will be administered one day after training to assess the immediate impact.
- Step 5: Data will be collected, coded, and analyzed to compare pre- and post-test results.

6. Data Analysis

- Descriptive statistics (mean, standard deviation) will summarize participant demographics and overall scores.
- Paired t-test will be used to compare pre-test and post-test scores to determine the significance of the training's impact.
- A p-value < 0.05 will be considered statistically significant.

7. Ethical Considerations

- Confidentiality and anonymity of participants will be ensured.
- Participation will be voluntary with the option to withdraw at any point.

III. SAMPLE COLLECTION KNOWLEDGE ASSESSMENT

Section A: Multiple Choice (1–10)

1. Which of the following is the most critical step in preventing contamination during sample collection?

- a) Using gloves
- b) Washing hands
- c) Labeling the sample
- d) Sealing the sample bag

Answer: b

2. What is the correct order of draw when collecting multiple blood samples?

- a) Green, blue, red, lavender
- b) Yellow, light blue, red, green, lavender, gray
- c) Red, lavender, blue, green
- d) It doesn't matter

Answer: b

3. What is the ideal time to collect a fasting blood sample?
- a) After lunch
- b) Before bedtime
- c) In the morning before eating
- d) Anytime during the day

Answer: c

4. Which type of container should be used for a urine culture sample?
- a) Any clean plastic cup
- b) Non-sterile bottle
- c) Sterile, screw-capped container
- d) Glass jar

Answer: c

5. Which of the following is *not* a common error in blood sample collection?
- a) Hemolysis
- b) Improper labeling
- c) Using a sterile needle
- d) Inadequate sample volume

Answer: c

6. Which site is commonly used for venipuncture in adults?
- a) Radial artery
- b) Brachial vein
- c) Median cubital vein
- d) Femoral vein

Answer: c

7. Samples for hormone testing like cortisol should be collected at what time?
- a) Midnight
- b) Randomly
- c) Early morning
- d) Late afternoon

Answer: c

8. Which preservative is commonly used for blood glucose estimation?
- a) EDTA
- b) Fluoride
- c) Heparin
- d) Citrate

Answer: b

9. Which of the following is important for sample transportation?
- a) Keep samples exposed to sunlight
- b) Use ice packs if required
- c) Store all samples at room temperature
- d) Avoid using transport bags

Answer: b

10. Why is proper labeling essential in sample collection?
- a) To identify the collector
- b) To avoid mix-ups and ensure correct diagnosis
- c) To record the expiration date
- d) For billing purposes

Answer: b

Section B: True/False (11–15)

11. It is acceptable to touch the inside of a sterile collection container.
Answer: False
12. Reusing tourniquets between patients is a safe practice.
Answer: False
13. Samples for blood culture should be collected before starting antibiotics.
Answer: True
14. All samples should be centrifuged immediately after collection.
Answer: False
15. Sharp containers are used to dispose of used needles.
Answer: True

Section C: Scenario-Based (16–20)

16. You are asked to collect a stool sample from a 4-year-old child. What instructions will you give to the parent?
- a) Collect any sample in a diaper
- b) Collect stool using a clean stick and place it in a sterile container
- c) Mix stool with urine and send
- d) Place the whole diaper in a plastic bag

Answer: b

17. During a blood draw, you notice the vein is collapsing. What should you do?
- a) Continue with more suction
- b) Change to a smaller needle
- c) Ignore and proceed

- d) Withdraw and label the attempt as failed

Answer: b

18. A urine sample was left unrefrigerated for 6 hours before testing. What should be done?

- a) Proceed with testing
- b) Reject the sample and request a new one
- c) Add water to dilute
- d) Filter the urine

Answer: b

19. You are collecting blood for a potassium test. What precaution must you take?

- a) Shake the tube vigorously
- b) Avoid hemolysis during collection
- c) Delay sample transport
- d) Use a wooden stick for mixing

Answer: b

20. If a child starts crying and moving during blood collection, what should you do?

- a) Proceed anyway
- b) Ask the parent to restrain the child
- c) Pause, calm the child, and attempt again
- d) Skip the procedure

Answer: c

IV. RESULTS

🔍 Overall Summary (Pre-Test)

- Total Respondents: 95
- Average Accuracy Across All 20 Questions: 46.74% △

📋 Individual Question-wise Summary

Q.No	Question (Short Description)	Accuracy (%)	Correct	Incorrect
1	Most critical step in sample collection	41.05%	39	56
2	Correct order of draw (color coded tubes)	73.68%	70	25
3	Ideal time to collect fasting blood sample	92.63%	88	7
4	Container used for urine sample collection	90.53%	86	9
5	Errors in sample collection	61.05%	58	37
6	Site for venipuncture	84.21%	80	15
7	Timing for cortisol sample collection	73.68%	70	25

Q.No	Question (Short Description)	Accuracy (%)	Correct	Incorrect
8	Preservative in blood glucose sample	77.89%	74	21
9	Sample transportation	65.26%	62	33
10	Importance of proper labeling	0.00%	0	95
11	Touching inside of sterile container	0.00%	0	95
12	Reusing tourniquets	0.00%	0	95
13	Blood culture sample collection	0.00%	0	95
14	Immediate centrifugation of all samples	0.00%	0	95
15	Puncture-proof containers for disposal	0.00%	0	95
16	Stool collection method	0.00%	0	95
17	Action when vein collapses during blood draw	32.63%	31	64
18	Urine sample left unrefrigerated	89.47%	85	10
19	Potassium test - key precaution	71.58%	68	27
20	Managing a crying child during blood collection	81.05%	77	18

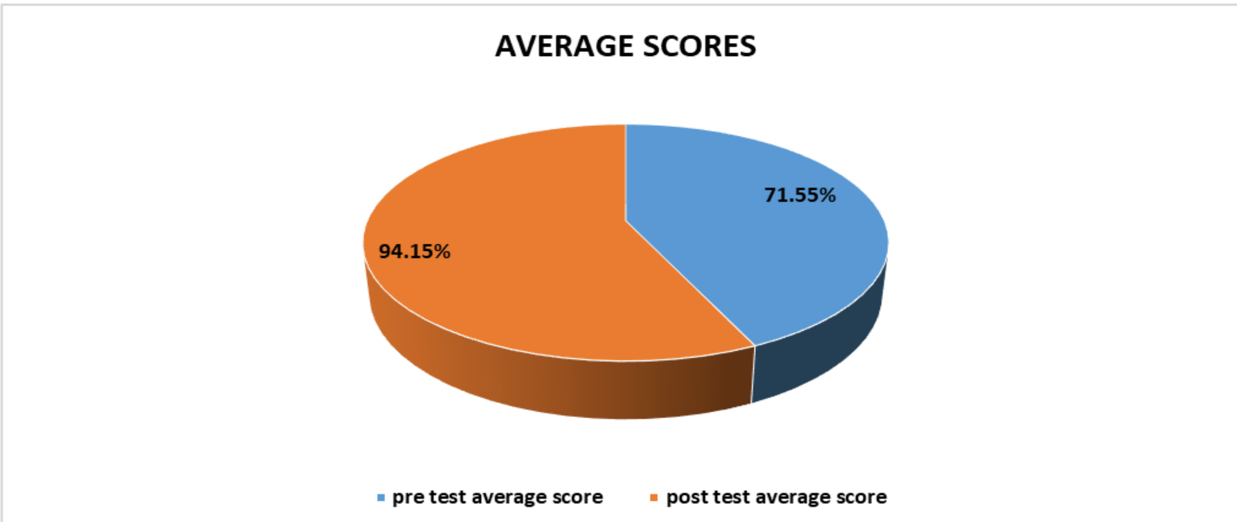
Overall Summary (Post-Test)

- Total Respondents: 95
- Average Accuracy Across All 20 Questions: 99.11%. △

Q.No	Question (Short Description)	Accuracy (%)	Correct	Incorrect
1	Critical step to prevent contamination	98.95	94	1
2	Correct order of draw	100	95	0
3	Ideal time for fasting blood sample	100	95	0
4	Container for urine culture	100	95	0
5	Not a common error in blood collection	98.95	94	1
6	Common site for venipuncture	100	95	0
7	Time to collect cortisol samples	98.95	94	1
8	Preservative for blood glucose	96.84	92	3
9	Important for sample transportation	98.95	94	1
10	Importance of proper labeling	98.95	94	1
11	Touching the inside of a sterile container	100	95	0
12	Reusing tourniquets	97.89	93	2
13	Blood culture before antibiotics	98.95	94	1
14	Immediate centrifugation of all samples	98.95	94	1

15	Puncture proof containers	97.89	93	2
16	Stool sample from a 4-year-old	100	95	0
17	Vein collapsing during blood draw	100	95	0
18	Unrefrigerated urine sample	98.95	94	1
19	Precaution for potassium test	98.95	94	1
20	Child crying during blood collection	98.95	94	1

Total score	Pre test	Post test	t statistic value	P value
Mean ± SD	71.55±13.79	94.15± 0.813	7.4268	<0.00001*



V. CONCLUSION

The results of the pre-test/post-test study demonstrate a significant improvement in participant scores after the training.

- Significant Increase in Mean Score: The average score of the participants increased substantially from 71.55 on the pre-test to 94.15 on the post-test. This indicates a marked improvement in knowledge following the training.
- Reduced Variability in Scores: The standard deviation (SD) decreased from 13.79 on the pre-test to 0.813 on the post-test. This suggests that the training standardized the knowledge levels across the group, as the scores became much more consistent and clustered closely around the new, higher mean.
- Statistical Significance: The t-statistic value of 7.4268 and an extremely low p-value of <0.00001 confirm that the observed increase in scores is statistically significant. This means that the improvement is not due to random chance and can be confidently attributed to the effectiveness of the training program.