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Impact of Comprehensive Training for Enhancing Competency in HIV Testing Laboratory: Our Experience

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ABSTRACT

Background: This study evaluates the effectiveness of a 15-day hands-on training program to enhance the competency of health-care providers working in HIV testing laboratories in central India. The program targeted two participant groups: intern students and qualified staff, focusing on pre- and post-training assessments to gauge knowledge and skills in HIV testing processes.

Methods: Pre- and post-training assessments were conducted to measure the impact of the training on participants' knowledge and skills. The study compared the performance of intern students and qualified staff across different stages of HIV testing. Demographic data were analyzed to understand the participants' prior laboratory experience.

Results: The results indicated a significant improvement in the knowledge of intern students across all indicators, particularly in the post-analytical stage. Notably, most participants lacked prior pathology laboratory experience, highlighting the novelty of the intervention. Comparisons between Induction Training and Refresher Training revealed that the latter consistently led to more substantial improvements, especially for qualified staff. A follow-up session after ten months demonstrated sustained effectiveness in knowledge retention, underscoring the long-term impact of tailored training.

Conclusion: In conclusion, this study underscores the success of hands-on training in enhancing the capabilities of health-care providers in administering HIV testing laboratories. The findings suggest that tailored training programs can significantly improve the quality of laboratory practices and contribute to better public health outcomes.

Key-words: ART, BPMT, GLP, HIV, ISO, NACP, PGDMLT, Pre-test Post-test

INTRODUCTION

On June 5, 1981, the U.S. Centers for Disease Control and Prevention (CDC) [1] announced the discovery of a novel clinical condition named "acquired immunodeficiency syndrome" among men engaging in same-sex relations in New York and California. The identification of the causative agent of AIDS took place two years later. In 1986, the International Committee on Taxonomy of Viruses proposed a distinct name for the virus isolated from AIDS patients, naming it the Human Immunodeficiency Virus (HIV). India took its first steps to address the HIV/AIDS epidemic with sero-surveillance in 1985. Initially spanning from 1985 to 1991, the response primarily centered on identifying HIV in various population segments and locations. Activities included screening blood before transfusion and targeted awareness campaigns. The pivotal moment came in 1992 with the launch of the National AIDS and STD Control Programme (NACP), marking the initiation of a comprehensive approach to combat HIV/AIDS in India. Over the past 35 years, NACP has undergone five distinct phases, evolving into one of the world's largest programs dedicated to addressing the challenges posed by HIV/AIDS.

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NACP Phase-V, as a Central Sector Scheme, seeks to achieve an 80% reduction in annual new HIV infections and AIDS-related deaths by 2025-26, measured against the 2010 baseline [2]. This phase also targets the dual elimination of vertical transmission and the eradication of HIV/AIDS-related stigma. Additionally, it endeavors to facilitate universal access to high-quality STI/RTI services for at-risk and vulnerable populations. The specific goals of NACP Phase-V include ensuring that 95% of HIV-positive individuals are aware of their status, 95% of those familiar are undergoing treatment, and 95% of those in treatment achieve suppressed viral loads [2]. The emphasis on the third goal highlights the importance of accurate laboratory testing in achieving viral suppression.

The World Health Organization (WHO) and organizations like the National AIDS Control Organization and Clinical and Laboratory Standards Institute (CLSI) have published guidelines and handbooks on laboratory quality management systems [3,4]. These resources highlight the importance of establishing and maintaining quality management systems to enhance the reliability of laboratory results.

The International Organization for Standardization (ISO) 15189:2012 is defined as “processes that start, in chronological order, from the clinician’s request and include the examination request, preparation and identification of the patient, collection of the primary sample(s), and transportation to and within the laboratory, and end when the analytical examination begins”[5]. The pre-analytical phase is particularly vulnerable, with approximately 70% of all laboratory errors transpiring during this stage [6]. Such vulnerability can be ascribed to the heightened incidence of human errors impacting controllable variables within the pre-analytical phase [7]. Notably, as pre-analytical variables often come into play outside the confines of the laboratory setting, errors affecting these variables frequently fall beyond the purview of laboratory personnel [8].

These studies revealed that sample collection by laboratory personnel accounted for most errors during the phlebotomy process. Insufficient knowledge and training of laboratory personnel about the correct phlebotomy techniques and the harmful effect of errors on the numerous quality-sensitive pre-analytical variables are well known and commonly implicated. Quality assurance is the cornerstone of every laboratory since a laboratory's reputation and credibility depend on its ability to provide precise and accurate results. Providing high-quality, reliable results is emphasized because 60–70% of clinical decision-making is based on laboratory results [9,10].

The current body of research underscores the importance of adequately trained health-care professionals in guaranteeing the precision and dependability of diagnostic testing. However, there is a need to explore the specific impact of hands-on training on different cohorts, ranging from students to working professionals, in the context of laboratory processes. The role of well-trained health-care professionals in ensuring diagnostic testing accuracy, reliability, and overall quality in laboratory settings is crucial. The existing literature emphasizes the significance of competency and adherence to standardized procedures across laboratory processes' pre-analytical, analytical, and post-analytical phases.

The health-care field acknowledges the need for continuous competency assessment of laboratory personnel. Various studies have explored methods for evaluating the skills and knowledge of professionals involved in laboratory testing to ensure the delivery of accurate and reliable results. The ISO 15189-2012 Medical Laboratories–requirements for Quality and Competence, launched in 2003, includes technical and management requirements for laboratories [5].

Previous research has investigated the impact of different training programs on the performance of laboratory staff [11]. While theoretical knowledge is essential, hands-on training has been recognized as key to developing practical skills and improving overall competency. The literature discusses the broader context of capacity building in healthcare systems. This includes efforts to strengthen the skills and knowledge of healthcare professionals to meet the growing demand for diagnostic services and maintain high standards of quality. Some studies have identified challenges and areas for improvement in laboratory processes, including sample collection, storage, analytical techniques, and reporting issues. Addressing these challenges is crucial for maintaining the integrity of laboratory results. The curriculum of health-related academic courses includes testing procedures, sample collection, storage, packing, analytical testing, reporting, adherence to standard

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operating procedures (SOPs), biomedical waste management (BMW), universal safety measures, and good laboratory practices (GLP). Laboratory exposure to students may help understand the factors influencing the pre-analytical, analytical, and post-analytical processes of HIV testing [12-15].

MATERIALS AND METHODS

The present study employs a triangulation approach by synthesizing information from two distinct groups to evaluate the effectiveness of a training program designed to empower healthcare providers in administering HIV testing laboratories in central India. Initially, we examined data obtained from pre- and post-training questionnaires administered before and after two different groups' training sessions.

The research will involve a structured 15-day hands-on training program for each group, followed by pre and post-tests to measure the impact of the training. The second group underwent a follow-up training session after ten months to evaluate the sustainability of knowledge improvement.

Participants

Group 1 (Intern Students): Participants include intern students enrolled in Bachelor of Paramedical Technology (BPMT) and Post Graduate Diploma in Medical Laboratory Technology (PGDMLT) programs.

Group 2 (Qualified Staff): Participants consisted of 14 qualified and working staff at antiretroviral therapy (ART) centers and 44 staff of Integrated Counseling and Testing Centers (ICTC).

Pre-Test Assessment- Participants from both groups underwent a pre-test to evaluate their baseline knowledge regarding HIV serology and viral load testing procedures, including pre-analytical, analytical, and post-analytical processes.

Hands-On Training

Group 1: Students received a comprehensive 15-day hands-on training program covering the entire spectrum of HIV laboratory testing processes. This includes sample collection, storage, packing, analytical testing, reporting, and adherence to standard operating procedures (SOPs), biomedical waste management (BMW), universal safety measures, and good laboratory practices (GLP).

Group 2: qualified staff underwent a tailored training program to enhance their knowledge of HIV testing processes, safety measures, and adherence to guidelines. After ten months, a retraining session followed the initial training to assess knowledge retention and sustainability.

Post-Test Assessment- After the hands-on training, both groups undergo a post-test to measure the immediate impact on knowledge and understanding of HIV laboratory testing processes.

Follow-Up Training and Assessment (Group 2)

a) After ten months, the qualified staff in Group 2 received a follow-up training session to reinforce key concepts and address any evolving guidelines or best practices.

b) Post-tests were administered again to evaluate the long-term impact of hands-on training on knowledge retention and improvement.

Statistical Analysis- Quantitative analysis was conducted to compare pre and post-test scores within each group, assessing the degree of improvement in knowledge. Long-term impact was evaluated by comparing the post-test scores of Group 2 before and after the follow-up training session.

Percentage analysis was done to represent data as a percentage (a part of 100%) to understand the collected data better.

% = (No of response / Total questions asked) x 100

A Chi-square test was employed to test the hypothesis that hands-on training significantly improves participants' knowledge in both pre-test and post-test in both groups. MedCal software was used for data analysis.

Ethical Considerations- This study adhered to ethical guidelines and obtained approval from the Institutional Ethical Committee as per letter no-EC/Pharmac/GMC/NGP/4122, ensuring that the rights and confidentiality of the individuals involved were protected, whereas no personal information was collected. The data used were anonymized to maintain privacy and comply with ethical standards. This absent patient contact study approved a waiver of informed consent. The study followed ethical guidelines as per the

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Institutional Ethical Committee, Govt. Medical College Nagpur, MH, India.

RESULTS

One hundred thirty-three intern students from Government Medical College Nagpur participated in a laboratory training program lasting 15 days, organized in groups of 2-4 students each, between May 2023 and December 2023. Seven students who did not complete the full 15 training days were excluded, leaving 126 students who completed both the pre and post-training questionnaires. Table 1 provides an overview of the basic information and intended training exposure for the 126 students included in the study.

Table 1 offers a detailed breakdown of demographic information and background characteristics for the 126 intern students who completed the pre-post training questionnaire, with participant counts and percentages based on the total respondents. Among the participants, 9.5% (n=12) were male, and 90.5% (n=114) were female. Furthermore, 91.3% (n=115) had no prior experience working in any Pathology Laboratory, while a minimal percentage, 0.8% (n=1), possessed expertise in HIV testing. Additionally, most participants, 97.6% (n=123), had not undergone any hands-on training before the current program. This data provides a comprehensive insight into the participant demographics and their background characteristics within the context of the training program.

Table 1: working and training exposure related to laboratory testing (n=126)

Gender	
Male	12
Female	114
Working experience in any pathology laboratory	
Yes	11
No	115
Work in a Dedicated HIV Clinic	
Yes	1
No	125
Previous training	
Yes	3
No	123

Table 2 presents the percentage of participants in each indicator category (pre-analytical, analytical and post-analytical) who answered "No=wrong answer" or "Yes-right answer" in both the Pre-Test and Post-Test phases. In the pre-analytical category, there was a significant improvement from 67.69% to 86.51% for participants answering "Yes," indicating enhanced knowledge and skills. Conversely, the percentage of participants answering "No" decreased from 32.31% to 13.49%. Moving on to the analytical phase, there was a slight shift from 49.09% to 50.91% for participants answering "Yes," showcasing a marginal improvement. The more notable change occurred in the "No" responses, decreasing from 50.91% to 7.14%. The improvement was substantial for the post-analytical stage, with participants answering "Yes" increasing from 2.78% to an impressive 98.02%. The corresponding decrease in "No" responses went from 97.22% to 1.98%, highlighting a significant positive shift.

Table 2: Pre and post-test response of intern students (n=126).

Indicator	Pre Test		Post Test	
	Correct Response(%)	Incorrect response (%)	Correct Response (%)	Incorrect response (%)
Pre analytical	67.69	32.31	13.49	86.51
Analytical	49.09	50.91	7.14	92.86
Post analytical	97.22	2.78	1.98	98.02

Chi-square statistic is 66.078. The p-value is < 0.00001. The result is significant at p<0.05

The values in Table 3 represent the percentage of participants in Induction Training, who answered correctly in the pre- and post-test phases. A higher percentage in the Post Test indicates improved knowledge and skills. The significance of the comparison lies in the positive shift, demonstrating the effectiveness of Induction Training in enhancing participants' performance across the specified categories (pre-analytical, analytical and post-analytical). 37.19%, 50.25% and 75% of participants responded positively in the pre-test of pre-analytical, analytical and post-analytical questions, respectively.

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Table 3: Percent response of participants toward pre-test and post-test during induction training (n=58)

Indicator	Induction Training			
	Pre Test		Post Test	
	Incorrect response (%)	Correct Response (%)	Incorrect response (%)	Correct Response (%)
Pre analytical	62.81	37.19	10.59	89.41
Analytical	49.75	50.25	9.61	90.39
Post analytical	25.00	75.00	6.90	93.10

The chi-square statistic yielded a value of 30.4485, with a p-value of .000032, indicating a highly significant result at p<0.05. This suggests a strong association between the variables under investigation, supporting the rejection of the null hypothesis."

Table 4 illustrates the distribution of responses for the Refresher Training indicators, comparing the percentages of "Incorrect" and "Correct" responses in the pre-test and post-test phases. In the pre-test, 14.78% of responses were incorrect for the Pre-analytical indicator, contrasting with 85.22% being correct. This trend was similarly observed in the Analytical and Post-Analytical phases. However, in the post-test phase, a significant improvement was noted across all indicators, with a noticeable decrease in incorrect responses and a corresponding increase in correct responses, suggesting the effectiveness of the refresher training in enhancing participants' knowledge and understanding.

Table 4: Percent response of participant toward pre-test and post-test during refresher training (n=58)

Indicator	Refresher Training			
	Pre Test		Post Test	
	Incorrect response (%)	Correct Response (%)	Incorrect response (%)	Correct Response (%)
Pre analytical	14.78	85.22	2.96	97.04
Analytical	14.78	85.22	8.13	91.87
Post analytical	14.66	85.34	7.76	92.24

Chi-square analysis yielded a statistic of 2.8095 with a corresponding p-value of .832347, indicating that the result is not statistically significant at the conventional p<.05 level. This suggests insufficient evidence to reject the null hypothesis, and any observed associations between the variables may be due to random chance.

DISCUSSION

The findings of this study offer compelling insights into the efficacy of a specialized training program designed to empower health-care providers in HIV testing laboratories in central India. Utilizing a triangulation approach, which integrates data from two distinct participant groups, enriches evaluating the training program's impact on knowledge acquisition and skills development.

Demographic insights regarding intern students provide a nuanced understanding of the contextual factors influencing the training program's outcomes. Notably, a significant proportion of participants lacked prior experience in testing laboratories, underscoring the pivotal role of the training in establishing fundamental competencies. The prevalence of participants without hands-on experience underscores the intervention's novelty and potential transformative effect.

Pre-post training assessments unveil a substantial enhancement in participants' knowledge across all key indicator categories (pre-analytical, analytical, and post-analytical). The discernible increase in "Correct response" rates, alongside a corresponding reduction in "incorrect response" rates underscores the immediate impact of the hands-on training program. The marked improvement observed in the post-analytical stage is particularly notable, indicative of a robust assimilation of knowledge and skills garnered during the training sessions.

A comparative analysis between Induction Training and Refresher Training accentuates the effectiveness of both modalities. Notably, Refresher Training consistently

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yields more pronounced improvements across all indicator categories, affirming the efficacy of reinforcing and augmenting existing knowledge. The tailored approach to training for qualified staff demonstrates significant success in enhancing their comprehension of HIV testing procedures, safety protocols, and adherence to guidelines.

While experts emphasize the importance of supplementing training with additional strategies and health systems interventions, it remains evident that training will remain a fundamental component of most enhancement initiatives [16-18]. Consistent with earlier observations, refresher training participants consistently exhibited notable advancements across all three indicator categories (pre-analytical, analytical, and post-analytical). This corroborates previous trends, emphasizing the potency of targeted and customized training in fostering substantial enhancements in participants' competencies. Key elements contributing significantly to knowledge enhancement included training, whereas skill-building outcomes were notably influenced by follow-up training sessions [19].

The incorporation of a follow-up training session for Group 2 (qualified staff) after a 10-month interval aimed to evaluate the sustainability of knowledge retention. Encouragingly, the results indicate that the training program's long-term impact remained robust, with Refresher Training sustaining its efficacy over time. This underscores the program's capacity to instill enduring improvements in participants' proficiencies.

Earlier research has consistently demonstrated improvements across various outcomes, encompassing knowledge, skills, confidence levels, practice and policy enhancements, behavioral changes, and the application of acquired knowledge [20-22]. Building upon the existing literature on healthcare training [23,24], our study contributes valuable insights into tailored training methodologies and their enduring impact on health-care provider capabilities. These findings hold implications for designing and implementing training programs to enhance health-care service delivery in resource-constrained settings.

CONCLUSIONS

In conclusion, this study highlights the effectiveness of a 15-day hands-on training program in bolstering the proficiency of health-care providers in HIV testing laboratories. The significant enhancements observed, particularly in the post-analytical phase, underscore the immediate impact of tailored training interventions. Moreover, the comparison between Induction and Refresher Training emphasizes the importance of continuous education in sustaining and reinforcing knowledge over time. The enduring retention of expertise demonstrated in the follow-up session underscores the long-term benefits of such training initiatives.

The findings suggest the necessity for ongoing training programs to ensure health-care providers remain adept in their roles, thereby improving laboratory practices and fostering better public health outcomes. Future research could delve into these training interventions' scalability and long-term sustainability and their potential impact on patient outcomes. Additionally, exploring innovative approaches, such as incorporating technology-enhanced learning methods, could further enhance training effectiveness and accessibility, ultimately advancing health-care delivery in HIV testing and beyond.

SUMMARY

In summary, the current knowledge highlights the importance of quality management, competency assessment, and continuous training in laboratory settings. The proposed research aims to contribute to this body of knowledge by specifically examining the impact of hands-on training on different groups of participants, ranging from students to working professionals, in the context of pre-analytical, analytical, and post-analytical processes on HIV viral load testing.

CONTRIBUTION OF AUTHORS

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