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Scientific Paper Entitled: The Effect of Educational Intervention on The Knowledge, Attitudes, And Practices of Laboratory Technicians Regarding Comprehensive Work Precautions in The Government Health Sector in The Kingdom Of Saudi Arabia

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Abstract

Introduction: Laboratory technicians face occupational health hazards that pose a serious risk to their well-being. To protect themselves from infections acquired in the laboratory, it is important for technicians to be familiar with universal work precautions. A targeted educational program was developed to increase awareness of universal precautions and promote behavioral changes in attitudes and practices, ultimately reducing the occurrence of laboratory-acquired infections. This study aimed to assess the existing levels of knowledge, attitudes, and practices among laboratory technicians regarding universal work precautions a in the government health sector in the kingdom of Saudi Arabia, as well as to evaluate the effectiveness of educational interventions.

Methods: The study involved 40 laboratory technicians who received educational interventions in the form of training on universal precautions. Pretest and posttest evaluations were conducted using questionnaires to measure the extent of knowledge gained. The responses to each question in the pretest and posttest were compared using the

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Pearson chi-square test. The mean scores from the pretest and posttest were compared using paired t-tests, with a significance level set at .05.

Results: Following the educational intervention and training sessions, there was a significant improvement in the knowledge, attitudes, and practices of laboratory technicians regarding universal work precautions.

Conclusion: Based on the findings, it is recommended that regular training sessions be conducted for laboratory technicians to enhance knowledge retention and foster a positive attitude towards universal precautions.

Key words: *knowledge, attitude, practices, educational intervention, laboratory technicians, universal precautions, laboratory-acquired infections.*

Introduction

Laboratory technicians face occupational health hazards that can pose a significant threat to their well-being and lives if proper biosafety precautions are not followed. These technicians must be aware of universal work precautions to protect themselves against laboratory-acquired infections.

Laboratory technicians working with a large volume of clinical specimens are regularly exposed to numerous potential pathogens. However, they may lack awareness of the associated risks and therefore may not be sufficiently motivated to adhere to basic universal work precautions. This can lead to unsafe laboratory practices during specimen collection, transportation, storage, processing, and disposal, making laboratory technicians more vulnerable to infections.

According to the guidelines from the Center for Disease Control and Prevention (Atlanta, GA), universal work precautions are applicable to blood, body fluids containing visible blood, semen, vaginal secretions, body tissues, and certain fluids such as cerebrospinal, synovial, pleural, peritoneal, pericardial, and amniotic fluids. However, they do not apply to feces, nasal secretions, sputum, saliva, sweat, tears, urine, and vomitus, unless these fluids contain visible blood. Implementing personal protective equipment (PPE) such as masks, gloves, gowns, aprons, goggles, or protective eyewear is an essential part of universal work precautions. These measures help reduce the risk of exposing the skin or mucous membranes to potentially infectious materials. Healthcare workers need to exercise judgment in determining the appropriate barriers for various clinical situations. Additionally, precautions should be taken to prevent injuries when using needles, scalpels, and other sharp instruments or devices, as well as during the handling and disposal of these items.

All clinical samples, including blood and certain body fluids, should be considered potentially infectious. Laboratory workers should have a comprehensive understanding of biosafety, which promotes safe laboratory practices, proper use of containment equipment, and appropriate disposal procedures. The adherence to standard guidelines can be influenced by factors such as awareness, threat perception, attitudes, beliefs, availability of resources, workload, and work culture. Therefore, laboratory technicians must possess the necessary knowledge, attitudes, and skills to ensure safe laboratory practices. This study proposes that an educational intervention can enhance knowledge, raise awareness, and bring about behavioral changes in attitudes and practices, thereby reducing the risk of laboratory-acquired infections.

A review conducted by Safdar and Abad analyzed 26 studies involving different populations of healthcare workers and demonstrated a statistically significant decrease in laboratory-associated infection rates, ranging from 0% to 0.79%, following educational interventions.

The educational process should include an assessment of the factors influencing compliance with biosafety precautions among laboratory technicians, addressing any knowledge and practice gaps, and formulating strategies and interventions to minimize the risk of laboratory-acquired infections. Before being implemented as an institutional policy, the effectiveness of educational strategies should be evaluated to ensure desired outcomes.

Considering the aforementioned factors, this study was designed and conducted as a questionnaire-based intervention to assess the impact of an educational intervention on the knowledge, attitudes, and practices of laboratory technicians regarding universal work precautions in a tertiary care teaching hospital in the government health sector in the Kingdom of Saudi Arabia.

Materials and Methods:

This interventional study aimed to assess the knowledge, attitudes/perceptions, and practices of laboratory technicians working in the government health sector in the Kingdom of Saudi Arabia. The study specifically focused on technicians employed in the central clinical laboratory of a tertiary care teaching hospital. The effectiveness of educational interventions in bridging any existing gaps in education and work practices was also evaluated. Before commencing the study, clearance was obtained from the institutional ethics committee at the hospital.

The study participants were provided with a detailed explanation of the content, purpose, scope, and nature of the study. They were informed that participation was voluntary and that their responses would remain anonymous. Only those who voluntarily agreed to participate were included in the study. Verbal consent was obtained from each participant. Instructors were available to provide clarifications and ensure that the participants understood the questions.

All study participants completed a pretest questionnaire, following which they underwent an educational intervention. The intervention consisted of two interactive lectures, each lasting 1.5 hours, on universal precautions and laboratory biosafety measures. These lectures were conducted in two separate sessions by the principal investigator. After the intervention, the participants were given a posttest questionnaire that was identical to the pretest questionnaire.

The structured questionnaire was designed based on relevant literature and standard guidelines, such as the World Health Organization's Laboratory Biosafety Manual and the Centers for Disease Control and Prevention's Perspectives in Disease Prevention and Health Promotion Update. The questions were carefully reviewed for relevance, clarity, and understandability, and necessary changes were made to ensure ease of comprehension. Senior subject experts reviewed both the teaching module and the questionnaire to assess the relevance of their contents, and modifications were made accordingly.

The study took place in the Demonstration Hall of the hospital, where seats were numbered. The pretest and posttest questionnaires were assigned numbers corresponding to the seat numbers. The study participants selected their seats randomly, and they were provided with questionnaires labeled with the code number corresponding to their seat number. The questionnaires were anonymous and linked only to the seat number, not the participant's identity. Confidentiality regarding the identity and personal details of the study participants was strictly maintained.

The questionnaire consisted of 60 questions divided into four parts. The first part collected demographic information through five questions. The second part assessed knowledge through 18 questions, including multiple-choice questions, yes/no items, and enumerative questions. The third part evaluated attitudes/perceptions through 12 questions, with respondents indicating their opinions on a 1 to 5-point Likert scale ranging from strongly agree to strongly disagree. The fourth part examined practices through 19 questions, with respondents rating their practices on a 1 to 5-point Likert scale ranging from never to always.

Scoring was employed to assess the knowledge, attitudes/perceptions, and practices components. One point was awarded for each correct response in knowledge, positive attitudes/perceptions, and correct practices, while incorrect knowledge, negative attitudes/perceptions, and suboptimal/risky practices received zero points. A score of 75% or higher was considered good, 50% to 74% was deemed moderate, and less than 50% was classified as poor.

Statistical Analysis:

The responses obtained from the participants who voluntarily completed the questionnaire were carefully tabulated and compiled using Microsoft Excel 2010 software. Appropriate statistical tools were employed as per the specific requirements of the study. P values were calculated using the Pearson chi-squared test to determine the significance of differences between pretest and posttest responses for each question. Paired t-tests were conducted to compare the participants' pretest and posttest scores, and a significance level of P<.05 was set.

$$\frac{\text{(post-test score)} - \text{(pre-test score)}}{\text{Max. score} - \text{(pre-test score)}}$$

To assess the effectiveness of the educational intervention, the authors calculated the absolute learning gain and class average normalized gain. The absolute learning gain was determined by subtracting the pretest score from the posttest score. The class average normalized gain, as defined by Hake's criteria, was calculated using the formula:

The brackets in the formula indicate class averages or mean test scores. The class average normalized gain was categorized as follows: 0.1 to 0.29 indicated low gain, 0.3 to 0.69 indicated medium gain, and 0.7 to 1.0 indicated high gain.

Results:

Knowledge of Universal Work Precautions:

The evaluation of knowledge regarding universal work precautions among laboratory technicians was conducted through pretest and posttest questionnaires that included the same set of questions administered before and after the educational intervention. The results demonstrate a highly significant improvement in knowledge levels following the training session (P<.00001).

Before the training, the majority of the study participants (60%) exhibited poor levels of knowledge, while 25% displayed moderate levels, and only 15% possessed good levels of knowledge (Figure 1). However, after the training, 45% of the trainees demonstrated good levels of knowledge, 32.5% showed moderate levels, and only 22.5% remained with poor knowledge levels (Figure 1).

Out of the 18 questions asked, a significant difference in responses between the pretest and posttest was observed for 14 questions, indicating a remarkable improvement in the participants' knowledge levels after the training (Table 1).

Attitudes Regarding Universal Work Precautions:

The assessment of attitudes in this study indicated an improvement in attitude levels among the study participants following the training. This improvement was statistically significant (P<.0001).

Before the training, the majority of the study subjects (82.5%) demonstrated moderate levels of attitude, while 17.5% displayed good attitudes, and none exhibited poor attitudes. However, after the training, all of the trainees (100%) were found to have developed good attitude levels regarding universal work precautions (Figure 1).

Out of the 12 questions assessing attitudes, a significant improvement in attitude levels between the pretest and posttest responses was observed for 4 questions (Table 2).

Practices Regarding Universal Work Precautions:

The assessment of practices in this study indicates a statistically significant improvement in practice levels among the study participants following the training (P<.0001).

Before undergoing the training program, the majority of the participants in our study displayed poor levels of practice (60%), while 30% exhibited moderate levels, and only 10% demonstrated good levels of practice. However, after completing the training, there was a noticeable improvement in practice levels. Specifically, 40% of the participants achieved good levels of practice, 35% displayed moderate levels, and only 25% remained at poor levels of practice (Figure 1). Out of the 20 questions assessing practices, a significant difference in practice levels between the pretest and posttest responses was observed for 14 questions (Table 3).

As depicted in Table 4, all three sections of the study showed significantly high absolute learning gain. Hake's class average normalized gain metrics indicated a medium learning gain for all sections. It is worth noting that the knowledge and practice sections exhibited similar and comparatively higher learning gains than the attitude section.

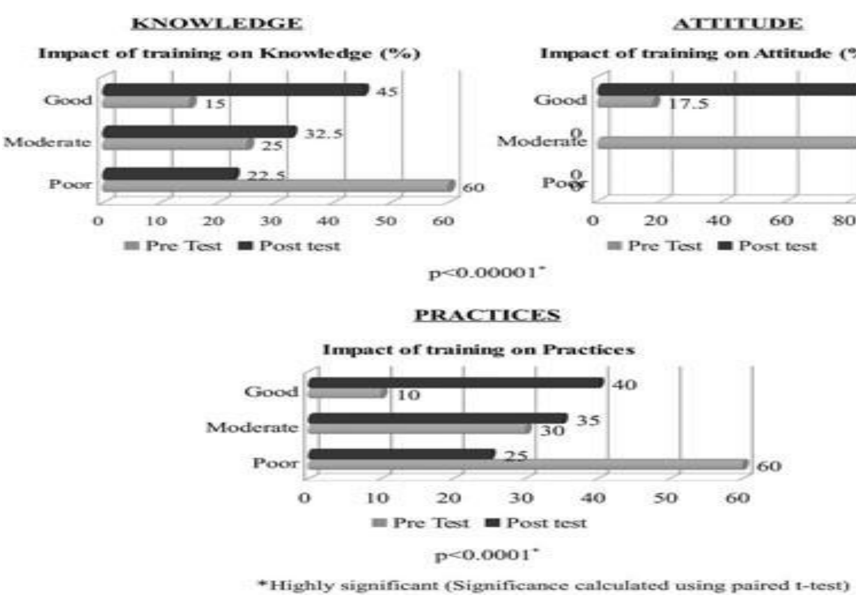

Figure 1. Assessment of impact of training on knowledge, attitudes, and practices regarding universal work precautions among laboratory technicians.

Table 1. Knowledge of universal work precautions among laboratory technicians

		Correct responses				
		Before training		After training		
Question/item		n	%	n	%	P-value
K1	Are you aware of universal work precautions?	16	40	28	70	.007**
K2	Body fluids to which universal work precautions apply.	18	45	30	75	.01206*
K3	Body fluids to which universal work precautions do not apply.	7	17.5	24	60	.0001**
K4	Are you aware of the potential risks of being infected at your workplace?	28	70	36	90	.025347*
K5	Are you aware of prophylactic measures to be taken in the event of injury/exposure?	16	40	25	62.5	.044105*
K6	According to the World Health Organization, how many steps of hand washing do you know?	9	22.5	27	67.5	.00005**
K7	What is the minimum time needed for alcohol-based hand rub to kill most germs on your hands?	8	20	24	60	.00026**
K8	If hands are not visibly soiled/contaminated, which method is most effective for reducing the number of pathogenic bacteria on the hands?	6	15	18	45	.0034*
Components of universal precautions						
K9	Avoid injury with sharp	28	70	36	90	.02535*
K10	Barrier precautions	30	75	34	85	NS
K11	Hand hygiene	34	85	39	97.5	.048*
K12	Mention names of various PPE for lab workers	12	30	18	45	NS
K13	How is liquid waste disinfected in labs?	26	65	28	70	NS
K14	How are blood samples discarded after serum preparation?	30	75	34	85	NS
K15	Actions to be taken in case of accidental blood spillage	6	15	17	42.5	.0066*
K16	Actions to be taken in case of needle-stick injury (after exposure prophylaxis)	8	20	19	47.5	.0093*
K17	Actions that are prohibited on laboratory premises	20	50	30	75	.021*
K18	Risk of acquiring HIV infection following needle-stick injury	6	15	20	50	.00083**

[a] Significance was calculated using the Pearson chi-square test.

NS indicates P>.05 (not significant).

*P<.05 (significant); **P<.001 (highly significant).

Table 2. Attitudes regarding universal work precautions among laboratory technicians

Positive attitude

Question/item		Before training n	Before training %	After training n	After training %	P value[a]
A1	Universal precautions should be strictly followed by all healthcare workers.	30	75	40	100	NS
A2	Do you believe that keeping proper personal hygiene decreases the risk of infection?	25	62.5	36	90	.004*
A3	I have sufficient knowledge to properly follow biosafety precautions.	15	37.5	24	60	NS
A4	Correct hand hygiene practices should be adhered to at all times.	27	67.5	32	80	NS
A5	I feel guilty when I omit hand hygiene.	24	60	38	95	.000178
A6	Wearing gloves eliminates the need to wash hands.	17	42.5	28	70	.0132*
A7	Do you believe that overcrowding of the working area increases transmission of infection?	26	65	32	80	NS
A8	Do you think that an increased workload increases the risk of laboratory-acquired infections?	34	85	36	90	NS
A9	Proper biomedical waste management practices are essential.	32	80	38	95	NS
A10	In my opinion, it is important to always use gloves while manipulating human samples.	36	90	40	100	NS
A11	I can curb poor practices in my workplace.	23	57.5	30	75	NS
A12	Training programs regarding universal precautions should be conducted regularly for laboratory workers.	20	50	37	92.5	.000027**

Significance was calculated using the Pearson chi-square test. NS indicates P>.05 (not significant).

*P<.05 (significant); ** P<.001 (highly significant).

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Table 3. Practices regarding universal work precautions among laboratory technicians

Question/item		Correct practices Before training n	%	After training n	%	P value[a]
P1	Do you wash your hands with soap and water after taking a sample?	20	50	30	75	.02*
P2	Do you wash your hands immediately when you come into contact with blood, body fluids, or contaminated items?	26	65	35	87.5	.02*
P3	Do you routinely use alcohol-based hand rub for hand hygiene?	18	45	27	67.5	.04*
P4	Do you wear gloves and apron during work?	27	67.5	36	90	.014*

P5	Do you wear gloves and apron outside the workplace?	30	75	37	92.5	.034*
P6	Do you wear a mask during sputum sample collection and processing?	32	80	40	100	.013*
P7	Do you recap needles before disposal?	26	65	12	30	.002*
P8	Do you discard disposable needles and other sharps into puncture-resistant containers?	20	50	30	75	.02*
P9	Do you cover wounds and cuts on your skin before you start your work?	36	90	40	100	NS
P10	Do you eat or drink in your work area?	32	80	37	92.5	NS
P11	Do you cover spills of blood or body fluids with 1% freshly prepared sodium hypochlorite for 10 minutes and then mop dry?	15	37.5	33	82.5	.0071*
P12	Do you always wash hands or use hand rub after removing gloves?	27	67.5	34	85	NS
P13	Do you dispose of biomedical waste in appropriate color-coded containers?	30	75	38	95	.01*
P14	Do you take off gloves when working on the computer?	32	80	39	97.5	.01*
P15	Do you take off your gloves while using a phone?	27	67.5	36	90	.014*
P16	Do you take a shower immediately after laboratory work?	12	30	23	57.5	.0132*
P17	Do you cover the sample before centrifugation?	27	67.5	33	82.5	NS
P18	Are high-risk samples received in leak-proof containers?	30	75	34	85	NS
P19	Are workstations decontaminated regularly?	32	80	37	92.5	NS

Table 4. Comparison of mean pretest and posttest knowledge, attitude, and practice scores

	Mean test score + SD		Absolute learning gain	Class average normalized gain (g)	df	t value	P value[a]
	Pretest	Posttest					
Knowledge	7.68–4.72 12.49	12.13–3.86 <.001*	4.45	0.6	39		
Attitude	7.7–1.07 13.44	10.2–0.72 <.0001**	2.50	0.43	39		
Practice	12.08–3.21 10.06	16.2–2.00 <.0001**	4.13	0.6	39		

Significance was calculated using a paired t-test.

*P<.001 (significant); **P<.0001 (highly significant).

Discussion:

Upon analyzing the results of our study, it was observed that over 70% of the study subjects, who are laboratory technicians, initially had poor levels of knowledge before participating in the training program. This finding aligns with several previous studies conducted in the field. For instance, Zaveri and Karia reported a low level of awareness about universal work precautions, with only 20.8% of the subjects having heard the term. Similarly, studies conducted by Omokhodion, Alam, Odusanya, Ejilemele, and Ojule, Suchitra et al., and El Gilany et al. indicated low levels of attitude and practice among healthcare professionals. However, contrasting findings were reported by Goswami et al. and Gurubacharya et al., who observed good levels of knowledge, attitude, and practice regarding universal work precautions among paramedical staff.

In our study, out of the 18 questions used to assess the knowledge levels of the participants, a significant increase in the number of correct responses was observed for 14 questions after the educational intervention. However, there was no significant improvement in the responses to questions related to barrier precautions, personal protective equipment (PPE), liquid waste disinfection, and methods of discarding blood samples. This lack of statistical improvement can be attributed to the already high level of knowledge in these areas during the pretest, leaving less room for improvement. However, it is important to note that the level of awareness regarding PPE remained low even after the intervention.

The results of our study demonstrate a remarkably significant improvement in the knowledge, attitudes, and practices of laboratory technicians regarding universal work precautions after the educational intervention and training sessions. These findings are consistent with previous studies conducted by Suchitra et al., Goswami et al., Malgaonkar and Kartikeyan, El-Gilany et al., and Gaikwad et al. The study by El-Gilany et al. emphasized the importance of regular and repeated training sessions to reinforce safe laboratory practices.

In our study, it was found that 65% of the lab technicians reported engaging in the risky practice of routinely recapping needles. This practice poses a significant risk of needle-stick injuries and is not recommended according to the standard guidelines in Biosafety in Microbiological and Biological Laboratories. This finding is in line with a study conducted by Nasim et al., which reported that approximately 50% of lab technicians also practiced this risky behavior. However, after completing the training program, most of the technicians in our laboratory discontinued this unsafe practice.

Another study conducted by Kamal and Khan highlighted the high prevalence (24%) of reusing disposable syringes among healthcare providers, with many being unaware of the associated health hazards. Proper disposal of used syringes is crucial to address this issue. However, Nasim et al. found that 43% of study subjects from the public sector disposed of used syringes in regular dustbins without following proper disposal methods. Additionally, Habibullah and Afsar reported that only 35% of healthcare facilities cut needles before disposal.

Paraphrased and enhanced sections:

Centrifuge machines in laboratories are a significant source of aerosol dispersal, which can lead to laboratory-acquired infections if inhaled. To prevent biohazards from inhalation, it is recommended by the US Department of Health and Human Services, the Centers for Disease Control and Prevention, and the National Institutes of Health to cap the tubes and close the centrifuges before centrifugation.

In a study conducted by Nasim et al., it was found that 34% of lab technicians either never or only occasionally closed centrifuge machines during centrifugation. Similarly, Misra et al. reported an even higher percentage of 63%. However, in our study conducted in the government health sector of the Kingdom of Saudi Arabia, more than 65% of the respondents followed the correct practice of closing the centrifuge before operation. This percentage further improved to 87.5% after the training program.

Previous studies by Suchitra et al. and Wagner et al. demonstrated that while educational interventions initially led to improvements in knowledge and practices, there was a decline in retention of knowledge over time. To address this issue, it is recommended that regular training sessions be conducted at intervals to reinforce knowledge and instill a positive attitude towards universal work precautions. This repetitive reinforcement can result in behavioral changes, reducing the incidence of laboratory- and hospital-acquired infections. Additionally, written standard institutional guidelines and well-structured training modules should be implemented for healthcare workers, including lab technicians.

In our study, we found statistically significant absolute learning gains and a medium level of class average normalized learning gains in all three aspects: knowledge, attitude, and practices. While these findings support the effectiveness of the induction program, there is still room for improvement in the training program to achieve higher levels of learning gains. Therefore, we plan to redesign the training modules in consultation with subject experts, adopting a more targeted and personalized approach. These redesigned interventions will be conducted at regular intervals, particularly focusing on participants with lower performance levels.

It is important to note that a limitation of our study was the use of self-administered questionnaires to assess the levels of practice among the respondents. Self-reporting may introduce bias, as respondents may tend to report better practices than what they do. To analyze the impact of educational interventions on actual practices, further studies involving checklist-based onsite assessments through direct observation are recommended.

While educational interventions can contribute to the reduction of laboratory-acquired infections, it is important to consider multiple factors that influence compliance with safe laboratory practices. These factors include knowledge, experience, training, institutional guidelines, workload, staffing, motivation, resources, administrative support, work culture, incentives, risk perceptions, time pressures, and available facilities. Future studies should encompass these factors to assess sustained improvement in adherence to safe laboratory practices.

Ethical approval: Obtained from the Institutional Ethics Committee, Govt. Medical College, Datia. Informed consent was obtained from all participants.

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