

## Biosafety perspective of clinical laboratory workers: a profile of Pakistan

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### Abstract

**Introduction:** Biosafety during lab work is an important concern in developing countries. Some critical issues concerning biosafety are lack of training, exceeding workload, working too fast, deciding not to follow safe practices, and skepticism about biohazards. This study aimed to determine biosafety perception and practices of laboratory technicians during routine work in clinical laboratories of Pakistan.

**Methodology:** A total of 1,782 laboratory technicians were interviewed from major public sector hospitals and a few private hospital laboratories throughout Pakistan.

**Results:** A total of 1,647 (92.4%) males and 135 (7.6%) females participated in the study, with over half (59.7%) having more than five years of work experience. Results showed that 28.4% of the laboratory technicians from Punjab, 35.7% from Sindh, 32% from Balochistan and 38.4% from Khyber Pakhtoon Khawa (KPK) did not use any personal protective equipment. Almost 46% of the respondents (34.2% from Punjab, 61.9% from Sindh, 25.2% from Balochistan and 85% from KPK) said they reused syringes either occasionally or regularly. Furthermore, 30.7% of the respondents said they discard used syringes directly into municipal dustbins. The majority (66.7%) claimed there are no separate bins for sharps, so they throw these in municipal dustbins. Mouth pipetting was reported by 28.3% technicians. Standard operating procedures were not available in 67.2% labs, and accident records were not maintained in 83.4%. No formal biosafety training had been provided to 84.2% of the respondents.

**Conclusion:** Laboratory technicians in Pakistan lack awareness of good laboratory practices and biosafety measures, and also face a lack of resources.

**Key words:** Biosafety; Laboratory Technicians; Perception

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### Introduction

Biosafety is an important issue in laboratory settings worldwide and especially in developing countries where standard operating procedures (SOPs) are lacking. Laboratory workers are exposed to a variety of potential occupational health risks that include infectious materials and cultures, radiation, toxic and flammable chemicals, as well as

mechanical and electrical hazards. Although all occupational hazards are important the risk of laboratory-associated infection in employees of clinical laboratories is greater than it is in many other occupations, which suggests that unique risks are associated with the laboratory work site [1]. Biosafety during laboratory work and the transferring of lab material from one place to another is a critical

tool in the global fight against infectious diseases. Laboratory personnel, particularly those working in microbiological laboratories, are exposed to biohazards which may result in laboratory-acquired infections [2]. Any laboratory worker who handles blood or any biological sample may be at risk for accidental injury or exposure. As all public and private-sector hospital-based laboratory personnel continuously deal with known and/or unknown pathogens they are continuously at risk of occupational infection [3,4]. The lack of awareness regarding biosafety issues results in improper handling and/or dangerous laboratory practices during sample collection, processing, and discarding of specimens, potentially making laboratory technicians more exposed to pathogens. In Pakistan ignorance among laboratory technicians is mainly due to lack of awareness and the scarcity of biosafety training programs regarding the proper handling of clinical samples and instruments [5]. In addition to the potential spreading of infections to others, these workers are constantly exposed to opportunistic pathogens or potentially pathogenic organisms such as HIV, HBV, HCV, *etc.*, since thousands of health-care workers in developing nations, including Pakistan, suffer accidental needle sticks every day [6,7]. The main causes of laboratory accidents are lack of training leaving technicians with little knowledge and experience in critical areas, excessive self-confidence, negligence, fatigue, taking shortcuts, workload, working too fast, deciding not to follow safe practices, and skepticism about biohazard [8,9,10]. In view of the importance of identifying the epidemiological distribution of hazardous exposures during collection, processing, storage, and disposal of specimens [10], the present study was conducted to assess biosafety knowledge among laboratory technicians in all major cities of Pakistan.

## Methodology

This survey was conducted in all four provinces of Pakistan by the Pakistan Medical Research Council (PMRC). PMRC research centres, which are located in the major cities of Karachi, Jamshoro, Quetta, Lahore, Faisalabad, Multan, Peshawar and in the Federal Capital, Islamabad, are public sector institutes. Our aim was to assess the awareness of biosafety measures and the practices performed by laboratory technicians during their routine laboratory work. This is a continuation of an earlier study conducted in Karachi by the PMRC specialized research centre on child health, the National Institute

of Child Health, Karachi. The above-mentioned research centres which participated in this study collected data from their respective areas. Comprehensive training was also arranged for research team members in all centers of Pakistan to maintain homogeneity of the questionnaire.

After acquiring consent from the head of the selected hospitals and the participating research centres, one research team member interviewed each clinical laboratory worker from the clinical laboratory who was present on the day of interview. A total of 250 workers were interviewed from each city except Hyderabad and Faisalabad, where only 140 workers were interviewed and their respective forms filled. The questionnaire was developed on the basis of available standard texts [10,11,12]. The questionnaire contained basic questions regarding routine laboratory practices, such as unsafe work practices (*e.g.*, eating or drinking in laboratories); mouth pipetting of biological samples; use of personal protective equipment (PPE); methods of disinfection; and specimen handling, collection, and processing. Questions regarding disposal of used syringes and sharps were also included.

Completed questionnaires from all research centers were received on weekly basis and data was qualitatively checked, managed, entered and analyzed using software SPSS 13.0.

## Study design

A quantitative and qualitative mixed, cross-sectional survey was performed. Simple random sampling was employed. The sample size calculated for this study was 230 participants from each city with 10% added to cover non-respondents; therefore, a total of 250 respondents were surveyed, calculated based on a previous study [10] at a 95% confidence level with 0.035% precision. Almost 250 samples were taken from each city, namely Quetta, Lahore, Multan, Peshawar, and Islamabad, while 140 technicians were selected from the smaller cities of Hyderabad and Faisalabad, concluding with a total of 1,782 samples.

## Results

This study was conducted in clinical laboratories of all four provinces of Pakistan. The sample size, based on the provincial strength, was 51% from Punjab, 21% from Sindh and 14% each from KPK and Balochistan. The duration of the survey was 11 months (October 2009 to September 2010). The total number of participants was 1,782, comprised of

**Table 1.** Knowledge about personal protective equipment

	Overall (N = 1782)		Province							
			Punjab (N = 907)		Sindh (N = 375)		Balochistan (N = 250)		KPK* (N = 250)	
	N	%	N	%	N	%	N	%	N	%
<b>Which safety precautions do you take during your work in the laboratory?</b>										
None	568	31.9	258	28.4	134	35.7	80	32.0	96	38.4
Lab Coat	542	30.4	309	34.1	53	14.1	113	45.2	67	26.8
Hand Gloves and Lab Coat	476	26.7	242	26.7	117	31.2	44	17.6	73	29.2
Hand Gloves	145	8.1	60	6.6	68	18.1	5	2.0	12	4.8
Not recorded	36	2.0	26	2.9	1	0.3	7	2.8	2	0.8
Mask	12	0.7	11	1.2	0	0.0	1	0.4	0	0.0
Eye Cover	3	0.2	1	0.1	2	0.5	0	0.0	0	0.0

\*Khyber Pakhtun Khawa

1,647 (92.4%) males and 135 (7.6%) females with a male-to-female ratio of 12:1. Almost 60% of the technicians from all provinces had working experience of more than five years, except those from Balochistan where only 43% of the technicians had similar length of experience and the remaining 57% had less than five years of experience. The biosafety practices in these laboratory personnel were noted and evaluated.

Regarding the use of personal protective equipment, (28.4% laboratory technicians from Punjab, 35.7% from Sindh, 32% from Balochistan and 38.4% from Khyber Pakhtoon Khawa (KPK) did not use any kind of PPE. Both gloves and lab coats were used only by 26.7% of the personnel, while a lab coat and gloves alone were used by 30.4% and 8.1%, respectively. Only 0.2% of all the respondents across Pakistan declared that they used eye covers (Table 1).

This study revealed that, overall, 23.7% of the technicians never disinfected their worktables, and this was maximally seen in Balochistan (40.4%), while in Sindh 71.2% disinfected their worktables daily while the remaining technicians disinfected their tables weekly or monthly or call sweepers to clean daily. The frequency of disinfecting worktables is given in Table 2. Almost 46% of the respondents (34.2% from Punjab, 61.9% from Sindh, 25.2% from Balochistan and 85% from KPK) said that they recap used syringes occasionally or regularly after use. Furthermore, 30.7% of the participants discarded used syringes directly into municipal dustbins without cutting them, and 66.7% said that there is no separate bin for the sharps so they also dispose of these in municipal dustbins (Table 3). Over all, mouth pipetting was practiced by 28.3% of

the technicians for different purposes as follows: approximately 18.0% for blood samples, 9.0% for chemicals, and 1.3% for preparing dilutions of various chemicals. Mouth pipetting practices for different specimens among laboratory workers is very common in the provinces of Sindh (34.7%) and Punjab (31.7%) (Table 4). Knowledge of technicians about using centrifuge machines and handling spills was evaluated in this study and it was found that 24.9% of the laboratory workers from Punjab, 25.4% from Sindh, 26.8% from Balochistan, and 35.2 from KPK never or occasionally closed centrifuge machines during centrifugation. Almost half (46.6%) of the technicians experienced breakage accidents during centrifugation; however, only 33.7% knew the right procedure to clean up a spill after breakage. The remaining respondents wipe up spills with tissue or wash them with water. Very few reported these accidents to their infection control committees (Table 5). Fire extinguishers were not available in 76.3% of cases and 83% of labs were without biosafety cabinets. About 70.3% of the technicians from all provinces had no separate place for eating and drinking while at KPK it was 86%. The availability of biosafety cabinets, fire extinguishers, and a separate place for eating and drinking in laboratories is shown in Table 6. On average, 67.5% of the labs throughout Pakistan are operating without a written standard operating procedure, while in Balochistan it was 95.6%. A large majority (89.3%) of the laboratories did not maintain any accident records. Strikingly 84.2% of respondents did not have any training in biosafety. As shown in Table 7, the percentage of technicians without biosafety training was relatively high in Balochistan (91.6%), while the lowest (81.1 %) was in Punjab. Results indicate that

**Table 2.** Frequency of disinfecting worktables

	Overall (N = 1782)		Province							
			Punjab (N = 907)		Sindh (N = 375)		Balochistan (N = 250)		KPK* (N = 250)	
	N	%	N	%	N	%	N	%	N	%
<b>Do you disinfect your worktable?</b>										
None	423	23.7	208	22.9	74	19.7	101	40.4	40	16.0
Daily	1067	59.9	557	61.4	267	71.2	118	47.2	125	50.0
Weekly	201	11.3	119	13.1	2	0.5	23	9.2	57	22.8
Monthly	43	2.4	17	1.9	2	0.5	8	3.2	16	6.4
Other	48	2.7	6	0.7	30	8.0	0	0.0	12	4.8

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**Table 3.** Disposal of used syringes and sharps

	Overall (N = 1782)		Province							
			Punjab (N = 907)		Sindh (N = 375)		Balochistan (N = 250)		KPK* (N = 250)	
	N	%	N	%	N	%	N	%	N	%
<b>Do you recap the used syringes?</b>										
No	921	51.7	561	61.9	136	36.3	187	74.8	37	14.8
Yes	769	43.2	297	32.7	201	53.6	58	23.2	213	85.2
Occasional	50	2.8	14	1.5	31	8.3	5	2.0	0	0.0
Not Applicable	42	2.4	35	3.9	7	1.9	0	0.0	0	0.0
<b>How do you discard used syringes?</b>										
Throw in a dustbin	547	30.7	216	23.8	143	38.1	20	8.0	168	67.2
Use needle cutter	1185	66.5	653	72.0	220	58.7	230	92.0	82	32.8
Needle discarder	42	2.4	37	4.1	5	1.3	0	0.0	0	0.0
Not applicable	8	0.4	0	0.0	7	1.9	0	0.0	0	0.0
<b>Do you have separate discarder for sharp-edged things?</b>										
No	1189	66.7	582	64.2	228	60.8	157	62.8	222	88.8
Yes	593	33.3	325	35.8	147	39.2	93	37.2	28	11.2

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**Table 4.** Mouth pipetting

	Overall (N = 1782)		Province							
			Punjab (N = 907)		Sindh (N = 375)		Balochistan (N = 250)		NWFP* (N = 250)	
	N	%	N	%	N	%	N	%	N	%
<b>For which samples do you do mouth pipetting?</b>										
Never	1244	69.8	611	67.4	220	58.7	192	76.8	221	88.4
Blood	320	18.0	181	20.0	81	21.6	40	16.0	18	7.2
Chemical	160	9.0	100	11.0	34	9.1	15	6.0	11	4.4
Dilutions	24	1.3	6	0.7	15	4.0	3	1.2	0	0.0
Jester	26	1.5	9	1.0	17	4.5	0	0.0	0	0.0
Not Applicable	8	0.4	0	0.0	8	2.1	0	0.0	0	0.0

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there was not much difference among the provinces of Pakistan regarding the percentages of laboratory technicians responding to the question about use of standard operating procedures, availability of accident records, and training on biosafety.

**Discussion**

In the present study, over all 31.9% of the laboratory workers from all provinces did not use any kind of personal protective equipment and this observation was more common in the province of KPK (38.4%). Both gloves and lab coats were used by 26.7% of the personnel, while a lab coat or gloves alone were used by 30.4% and 8.1%, respectively. All laboratories surveyed in this study were BSL-2; hence wearing personal protective equipment is an important requirement for all laboratory workers [3,13]. An earlier study from Karachi reported that out of 44 clinical laboratories evaluated, gloves were used in only two (4.5%) laboratories [5]. Though gloves play an important role in protecting personnel from contact with infectious materials, contaminated gloves can act as a means to spread infectious materials to environmental surfaces [14]. Hence disseminating knowledge and use of personal protective equipment is necessary.

The results regarding the use of lab coats and gloves in the present study are much lower than those reported from Turkey, where 91.3% and 87.4% of the participants used gloves and lab coats, respectively [2]. Safety glasses or other protective devices must also be worn when it is necessary to protect the eyes and face from splashes. The choice of equipment

depends on the activity performed. Current findings indicate that only 0.2% of the technicians surveyed in our study used safety glasses or similar protective equipment despite requirement.

According to the manuals for biosafety in microbiological and biomedical laboratories published by the Centers for Disease Control and Prevention (CDC) and the National Institutes of Health (NIH) in the United States, all worktables, biosafety cabinets, and other surfaces of the lab should be wiped daily with a disinfectant after the work is completed and also before starting any new work. The current study revealed that overall 23.7% technicians never disinfected their worktables and this practice was maximally seen in Balochistan (40.4%). However, these findings are better than those of a former study conducted in Lahore where more than 50% of the laboratories rarely used common surface disinfectants [15]. In Sindh, 71.2% of the laboratory technicians disinfected their work surfaces daily, which is also far better than the observations of a study conducted in Karachi where the use of disinfectant was noted in only 16% of the laboratories [5].

Reuse of disposable syringes and their improper disposal is a major route of transmission for hepatitis B virus [16], hepatitis C virus [17], HIV [18], abscesses [19], septicemia [20], malaria [21], and viral hemorrhagic fevers [22,23,24,25]. In the present study, on an average, 43.2% of the respondents regularly recapped needles after use and the situation was grim in KPK where 85% recapped them regularly. According to Biosafety in Microbiological and Biological Laboratories (BMBL) standards [26], recapping used needles is strictly prohibited,

**Table 5.** Use of centrifuge machines

	Overall (N = 1782)		Province							
			Punjab (N = 907)		Sindh (N = 375)		Balochistan (N = 250)		NWFP* (N = 250)	
	N	%	N	%	N	%	N	%	N	%
<b>Do you cover centrifuge machine and samples?</b>										
No	297	16.7	144	15.9	67	17.9	64	25.6	22	8.8
Yes	1306	73.3	681	75.1	280	74.7	183	73.2	162	64.8
Occasionally	179	10.0	82	9.0	28	7.5	3	1.2	66	26.4
<b>Do you come across any rupture accidents during specimen centrifugation?</b>										
No	<b>951</b>	53.4	409	45.1	178	47.5	158	63.2	206	82.4
Yes	<b>790</b>	44.3	476	52.5	180	48.0	92	36.8	42	16.8
Occasionally	41	2.3	22	2.4	17	4.5	0	0.0	2	0.8
<b>If spilling of specimen happens any time what do you do?</b>										
Wipe with tissue	789	44.3	364	40.1	175	46.7	122	48.8	128	51.2
Wash with water	373	20.9	220	24.3	48	12.8	66	26.4	39	15.6
Use disinfectant	601	33.7	314	34.6	142	37.9	62	24.8	83	33.2
Inform infection control committee	8	0.4	7	0.8	1	0.3	0	0.0	0	0.0
Other	3	0.2	2	0.2	1	0.3	0	0.0	0	0.0
Not Applicable	5	0.3	0	0.0	5	1.3	0	0.0	0	0.0
Call for Sweepers	3	0.2	0	0.0	3	0.8	0	0.0	0	0.0

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**Table 6.** Biosafety cabinets, fire extinguishers, and separate place for eating and drinking

	Overall (N = 1782)		Province							
			Punjab (N = 907)		Sindh (N = 375)		Balochistan (N = 250)		NWFP* (N = 250)	
	N	%	N	%	N	%	N	%	N	%
<b>Does your laboratory have fire extinguisher, fire blanket?</b>										
No	1359	76.3	658	72.5	286	76.3	203	81.2	212	84.8
Yes	423	23.7	249	27.5	89	23.7	47	18.8	38	15.2
<b>Do you use safety cabinet?</b>										
No	1479	83.0	726	80.0	302	80.5	239	95.6	212	84.8
Yes	303	17.0	181	20.0	73	19.5	11	4.4	38	15.2
<b>Is there any separate place for eating and drinking in the laboratory?</b>										
No	1253	70.3	648	71.4	213	56.8	177	70.8	215	86.0
Yes	529	29.7	259	28.6	162	43.2	73	29.2	35	14.0

\* Khyber Pakhtun Khawa

**Table 7.** Standard operating procedures, accident records, and biosafety training

	Overall (N = 1782)		Province							
			Punjab (N = 907)		Sindh (N = 375)		Balochistan (N = 250)		NWFP* (N = 250)	
	N	%	N	%	N	%	N	%	N	%
<b>Do you have SOPs/ BOPs(standard/basic operating procedures) in your laboratory?</b>										
No	1202	67.5	498	54.9	272	72.5	239	95.6	193	77.2
Yes	580	32.5	409	45.1	103	27.5	11	4.4	57	22.8
<b>Is your laboratory maintaining accident records?</b>										
No	1591	89.3	810	89.3	325	86.7	239	95.6	217	86.8
Yes	191	10.7	97	10.7	50	13.3	11	4.4	33	13.2
<b>Do you have any training on biosafety and bio security?</b>										
No	1500	84.2	736	81.1	320	85.3	215	86.0	229	91.6
Yes	282	15.8	171	18.9	55	14.7	35	14.0	21	8.4

\* Khyber Pakhtun Khawa

including in biosafety level - 2 (BSL-2) laboratories. In Pakistan cutting syringes and needles before disposal is generally recommended to avoid their reuse. An earlier study conducted in Rawalpindi showed that about 24% of the health-care providers reused a syringe to provide a therapeutic injection and most were unaware of the health consequences of reusing a disposable syringe [23]. To avoid reuse of syringes, they must be discarded properly; however, the present study showed that 30.7% of the respondents still throw syringes in a dustbin without using proper disposal measures. This rate was again very high in KPK (67.2%). A recent finding is in a former study from Karachi also showed that only 35% of the health-care facilities cut needles before disposal [6]. Sharps constitute a special category of medical waste that can expose waste handlers to infection via puncture injuries during collection, transportation, and disposal. To comply with standard operating procedures, sharps must be carefully placed in conveniently located puncture-resistant containers [26]. Contrary to this regulation, the majority (66.7%) of the laboratory workers from all provinces did not discard sharps properly, and this may be one of the major causes of percutaneous injury reported earlier in a cross-sectional survey where approximately 63% of health-care workers experienced at least one percutaneous injury each year [27].

Mouth pipetting is considered obsolete and is strictly prohibited in clinical laboratories [26]; however, this is still practiced in most laboratories of Pakistan as our study reveals that about 28% of the technicians perform mouth pipetting for various purposes, which is very high when compared with an Indian study where only 1.6% practiced mouth pipetting [10].

Centrifuge machines are one of the main vectors to disperse aerosol in the laboratory environment as they spin at a great velocity and exert the force needed to produce respirable aerosols. If these aerosols are inhaled, laboratory-acquired infections could result. Therefore, while centrifuging, the tubes should be closed with a suitable cap to avoid biohazards due to inhalation [26]. Similarly, the centrifuge machine should also be closed before its operation. In this study about 25% of the workers never or occasionally closed the centrifuge machines during centrifugation. These values are quite low when compared to an Indian study [12] where 63% of the lab workers did not close the centrifuge machine while operating it [10]. Breakage of tubes in a centrifuge can also disperse large amounts of aerosols so sealed buckets should be used for all samples. If breakage of the tube occurs the centrifuge buckets and rotor must be removed, autoclaved, and disinfected [10,26].

Although biosafety cabinets, fire extinguishers, and a separate place for eating and drinking are the desirable requirements for BSL-2 laboratories, in the

present study fire extinguishers were not available in 76.3% of the laboratories and 83% were without biosafety cabinets. These findings are similar to those of an earlier study performed in Sudan where only 20.5% of the laboratories had fire extinguishers and 5.8% had Biosafety cabinets [28]. Eating and drinking in laboratories were also very common in present study (70.3%), which was due to non availability of a dedicated place to eat. In contrast, a Turkish study reported that only 38.3% of the participants consumed food or drinks in the laboratory [2].

On an average, the majority (67.5%) of laboratories throughout Pakistan are operating without standard operating procedures while in Balochistan it was 95.6%. Earlier investigations have reported similar results [5,15] and an almost identical situation existed in Sudan where only 23.7% laboratories had SOPs [28]. Strikingly, in our study, 84.2% of the respondents did not have any training in biosafety, which was similar with the observations reported in Sudan's study where only 39.5% of the workers attended training courses on biosafety [28].

### Conclusion and recommendations

The results of this survey indicate that there is a lack of awareness regarding good laboratory practices among the laboratory technicians in Pakistan.

To address these issues institutional biosafety support to control, maintain, and record nosocomial infection and accidents should be initiated. Regular training on biosafety principles and self-hygiene for laboratory workers is needed along with the appointment of a biological safety officer to oversee the proposed work activities, procedures, equipment, personnel, storage, material transfer and transport, and proper destruction of biological material. This officer should indicate risk analyses and develop written standard operating procedures for the laboratories.

There should be a registration system for laboratories at the national level. Before issuing a license to any laboratory, proper evaluation should be performed to examine laboratory design, proper ventilation, entrance and exit, by experts to ensure laboratory biosafety.

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