Adherence to universal precautions among laboratory personnel in Lebanon

J.G. Kahhaleh[1] *and A.R. Jurjus*[2]

مدى التزام العاملين في المختبرات في لبنان بالاحتياطات الشاملة

جوزيف جبران كحالة، عبده رومانوس جرجس

الخلاصة: لتقييم الوضع الحالي ورسم التوجُّهات المستقبلية، في ما يتعلق بتطبيق الاحتياطات الشاملة في مختبرات فحص عينات الدم، أجرى الباحثان في عام 2003، دراسة وطنية مستعرضة شملت جميع القطاعات، على عينة ممثَّلة من المختبرات، تم اختيارها بطريقة الاعتيان (أخذ العينات) العنقودي على مرحلتين. ثم قاما بمقارنة نتائج الدراسة مع نتائج دراسة مماثلة أجريت في عام 1993، فلاحَظَا تحسناً في المستوى التعليمي للعاملين، إذْ أصبحوا أكثر تخصصاً في العلوم المختبرية. كما لاحَظَا تحسناً لا بأس به في معظم المتغيِّرات ذات الصلة بالتضارب بين ما يعرفه العاملون في المختبرات، وما يعتقدونه ويمارسونه، وبين ما يُلاحَظ بالفعل في الواقع العملي. كما تحسَّنت طرق التخلص من الإبر والمَحَاقن بشكل كبير، في حين لم يتَحسَّن التخلص من المواد الملوثة بالدم. ونظراً لمخاطر الممارسات غير السليمة، يدعو الباحثان إلى وضع سياسات لتنفيذ الاحتياطات الشاملة، مع تقديم التدريب الدوري للعاملين، بما يمكِّنهم من معرفة هذه الاحتياطات وممارستها، وتصحيح الإجراءات المنفَّذة في المختبرات.

ABSTRACT To evaluate the present situation and plan future directions with regard to implementation of universal precautions in laboratories testing blood samples, we carried out a national cross sectional study in 2003 on a representative sample of laboratories in Lebanon. We compared the results with those of a 1993 study. We found that the education profile of staff had improved, being now more specialized in laboratory science. The discrepancies between what technicians knew, believed in and practised and what was observed in the field improved to some extent in most variables. Disposal of needles and syringes had improved greatly but disposal of blood-contaminated material had not. Given the risks of improper practice, a policy of universal precautions is essential and regular training should be carried out so that staff know and practise the universal precautions and correct laboratory procedures.

Respect des précautions universelles par le personnel de laboratoire au Liban

RÉSUMÉ Afin d'évaluer la situation présente et d'établir les orientations futures concernant l'application des précautions universelles dans les laboratoires qui testent les échantillons de sang, nous avons réalisé une étude transversale nationale en 2003 sur un échantillon représentatif de laboratoires au Liban. Nous avons comparé les résultats avec ceux d'une étude similaire réalisée en 1993. Nous avons constaté que le profil de formation du personnel s'était amélioré, celui-ci étant maintenant davantage spécialisé en sciences des laboratoires. Les écarts entre les connaissances, les croyances et les pratiques des techniciens et les observations sur le terrain se sont résorbés dans une certaine mesure pour toutes les variables. L'élimination des aiguilles et des seringues s'est beaucoup améliorée, ce qui n'a pas été le cas pour l'élimination des matériaux contaminés par du sang. Étant donné les risques que comportent des pratiques inadéquates, une politique de précautions universelles est essentielle et une formation régulière devrait être mise en œuvre de sorte que le personnel connaisse et applique les précautions universelles et les procédures de laboratoire correctes.

[1]*Faculty of Public Health, Lebanese University, Beirut, Lebanon.*
[2]*Faculty of Medicine, American University of Beirut, Beirut, Lebanon (Correspondence to A.R. Jurjus: aj00@aub.edu.lb)*
Received: 11/03/04; accepted: 06/07/04

Introduction

The transmission of blood-borne pathogens from patients to health care workers via occupational exposure has been well known for many years [*1*]. The term health care worker refers to any person working in health care settings and who has the potential for exposure to infectious materials including body substances, contaminated medical supplies and equipment, contaminated environmental surfaces or contaminated air [*2*]. They include, but are not limited to, physicians, nurses, technicians, therapists, pharmacists, nursing assistants, laboratory personnel, autopsy personnel, emergency medical service personnel, dental personnel, students and trainees, contractual staff not employed by the health care facility and persons not directly involved in patient care but potentially exposed to infectious agents (e.g. volunteer, dietary, housekeeping, maintenance and clerical personnel) [*3*]. All these people are potentially exposed, directly or indirectly, to blood-borne pathogens. As a result, health care workers are at increased risk of acquiring human immunodeficiency virus (HIV), hepatitis B virus (HBV) and hepatitis C virus (HCV), which can all be transmitted through percutaneous injury.

In this study, our concern was limited to laboratory personnel who perform blood sampling (risk of needle-sticks) and deal with blood or body fluid samples or reagents on an almost daily basis.

The true rate of sharps injuries in health care workers is not known and impossible to calculate because of differences from institution to institution in case ascertainment, compliance with reporting and type of service [*1*]. Data from EPINet, the Exposure Prevention Information Network of Hospitals in the United States of America, reported an overall rate of sharps injuries at 27 per 100 occupied beds [*1*]. Causes of occupational sharps injuries include recapping needles, disassembling equipment, accessing intravenous (IV) tubing devices, disposing of contaminated sharps, disengaging pre-filled cartridge and needle units from reusable holders and pipetting [*1,4*].

Data from EPINet revealed that 68.5% of injuries were linked to hollow-bore needles (syringes, butterfly needles, phlebotomy needles, needles on IV lines and blood gas syringes) [*1*]. In a retrospective survey done in 1989–90 to investigate the incidence of needle-sticks and other exposures to patients' blood or body fluids among medical students and residents, 71% of respondents had 1 or more needle-sticks or other exposures during the training year, while the surgical residents had a > 6-fold greater risk of occupational exposure [*5*]. Other studies reported that > 60% of residents and students had sustained contact with blood, mucous membranes and broken skin or other potentially infectious sources [*5–10*]. In addition, health care workers in general, and laboratory personnel in particular, are at risk of acquiring a wide variety of pathogens, including HBV, HCV and HIV type I, through occupational exposure to blood and certain body fluids [*11*]. It was recently reported that annually worldwide injections cause an estimated 8–16 million cases of HBV infection, 2.4–4.5 million cases of HCV infection and 80 000–160 000 cases of HIV infection [*12*]. Laboratory-associated infections could also be caused by aerolization of specimens, mouth pipetting or percutaneous injury [*2*].

Although data in the literature indicate that the risk of acquiring a blood-borne pathogen after accidental exposure is in some cases low, approximately 0.4%, it is important to note that researchers and health care workers with frequent occupational exposure to high concentrations of viruses would be at increased risk, especially after working for many years [*13*]. The occupational risk of contracting HIV by health care personnel is also a well-documented reality. Several studies have consistently indicated that the risk of acquiring HIV infection after percutaneous exposure to infected blood is approximately 0.4% [*11,14*]. In addition, 6 aggregated studies in the United States of America estimated the risk after a mucous membrane exposure at 0.1%. Despite reports of low incidence after occupational exposure, seroconversion can occur. This is a source of concern because of the high mortality rate and the current lack of curative treatment, and because the overall risk is dependent on the rate of transmission per episode and cumulative exposure over time [*11*].

In Lebanon, the number of reported cases of HIV/AIDS has been increasing steadily since 1985, when the first locally treated case was reported [*15*]. By December 1997, the cumulative number of reported cases had reached 580; by December 2001 this was 650 and by July 2003 it was 706 [*14*]. Therefore, the increasing prevalence of HIV in Lebanon would probably lead to an increase in the risk of exposure of health care workers to blood from patients infected with the virus, especially when blood and body fluid precautions are not followed for all patients. Thus, there is a need to consider all patients as potentially infected with HIV and other bloodborne pathogens and to adhere rigorously to infection-control precautions to minimize the risk of exposure to blood and fluids [*12*].

Hepatitis C has a worldwide distribution and an estimated overall prevalence of 3%; the prevalence in the United States of America is around 1.8% compared to more than 20% in Egypt [*16*]. Although the incidence of acute hepatitis C has declined from 175 000 cases per year in 1989 to about 30 000 in 1997, HCV is still the most common cause of chronic viral hepatitis in the United States of America; 85% of people infected with HCV remain persistently infected [*17*]. Because of the high rate of chronic infection and because many infected people are asymptomatic and unaware of their infection health care workers are at risk of infection. From a random needle-stick in the hospital the risk is about 0.1%, and from patients known to be infected the risk is 5%–10% [*18*]. Bizri reported that the epidemiological society of Lebanon has calculated the prevalence of HCV in the general population to be 0.7% (range 0.4%–1.0%) by screening 3000 serum specimens from major laboratories in Lebanon for antibodies to HCV [*16*]. He also compared that to a similar study done in 2001 on 3000 samples from blood donors and found a similar (0.7%) prevalence [*16*].

Hepatitis B virus was one of the first blood-borne pathogens to be recognized as an occupational risk among health care workers [*19*]. The risk of contracting occupationally-acquired HBV in non-immune health care workers is 2%–40%, depending on the hepatitis Be-antigen (HBeAg) status in the source patient [*1*]. When a needle is used on a patient who is HBeAg positive, the exposure-associated attack rate is 20%–40%, while in HBV-negative cases it drops to 2%.

In hepatitis C, the rate ranges between 1% and 10% and for HIV it is much lower, 0.1%–0.4 % [*20,21*]. These infections lead to chronic disease, disability and death. Clinical laboratory technicians, like others, if not more, are subject to occupationally-acquired infection.

Universal precautions exist to prevent transmission of infection among health care workers [*22*]. In Lebanon, an assessment study in 1993 showed that the willingness of health care personnel, particularly laboratory technicians, to follow universal precautions was not adequate [*19*]. Wide discrepancies existed between what the technicians knew, what they believed in and what they practised. Extensive training workshops and curriculum modifications followed in an attempt to improve the situation [*4*]. Consequently, it was felt that an update on the situation was in order to evaluate the present situation and plan future directions in light of internationally recognized data [*20,21*].

The objectives of this national reassessment study are: 1) to depict the degree of adherence of clinical laboratories in Lebanon to the implementation of universal precautions and prevention of occupational risk of transmission of pathogens which are blood-borne or associated with other body fluids, 2) to reassess knowledge, attitudes and practices of laboratory technicians regarding the implementation of universal precautions, 3) to identify unsafe practices that may lead to infection, 4) to determine whether a facility that deals with blood and body fluids meets the necessary requirements for equipment, supplies and waste disposal, 5) to compare new data with previous data and evaluate achievements and identify lacunae, and 6) to outline educational and training needs and focus on possible activities and interventions oriented to remedial action.

Methods

This cross-sectional study included laboratory personnel throughout Lebanon. Variables included the knowledge, attitudes and practices of laboratory technicians concerning blood-borne pathogens (e.g. HIV, HBV and HCV) and adherence to universal safety precautions in relation to experience, formal training and workplace setting among technicians dealing with blood and body-fluids, as well as laboratory directors in hospital-based and non-hospital-based laboratories (private, governmental and those belonging to nongovernmental organizations).

To obtain a representative sample of the laboratories in Lebanon, we used a 2-stage cluster-sampling technique where self-weighting was ensured through selecting all 6 provinces of the country. Clusters were selected in proportion to the number of laboratories per province, and in respective numbers of sampling units within each cluster using a list of all licensed, registered laboratories provided by the Syndicate of Laboratories in Lebanon.

In the first stage, we used the provinces as administrative sections: these were non-overlapping and exhaustive (all the geographic areas were included). We determined the number of licensed laboratories for each province using the latest list submitted from the Syndicate of Laboratories in Lebanon, then selected 1 cluster of 12 laboratories from each province using random numbers and an additional cluster from the provinces that had more than 50 laboratories, a total of 8 clusters (Table 1).

The sample size selected was 12 × 8 = 96 licensed laboratories out of a total of 183 and up to 3 technicians per laboratory = 288 technicians. Of the 93 laboratories, 73 actually participated. The 68 directors interviewed reported that they had 475 technicians working in their laboratories. We distributed the questionnaire to almost all of them but only 222 completed the survey form.

In order to obtain accurate information and to avoid reporting bias and observer-induced changes in practice, we used the combination of interview and structured observation.

A survey form was developed for technicians and an interview form for the

Table 1 **Distribution of the samples by province**

Province	No. of licensed laboratories	No. of clusters	No. of laboratories included
Beirut	53	2	20
Mount Lebanon	58	2	20
North Lebanon	25	1	11
South Lebanon and Nabatieh	31	2	12
Bekaa	16	1	10
Total	183	8	73

laboratory directors. These were pretested in at least 5 laboratories, then adjusted and modified before running the actual survey.

Field workers visited the laboratories included in the study. They explained the purpose of the study to the respondents, interviewed the laboratory director, distributed the questionnaire to the technicians, and checked off on a separate observation list the availability of certain safety materials and equipment in the laboratory and the practices of technicians.

The information was collected by 3 instruments: structured observation of practices, equipment, and supplies (observation list); structured interview on available supplies, knowledge and enforcement of implementation of universal precautions (with the laboratory owners/directors); and survey of knowledge, attitudes and practices of the laboratory technicians concerning universal precautions (self-completed by technicians). All participants signed a consent form before proceeding. Results were combined to address specific questions and to allow for cross verification.

The interview with the laboratory directors covered professional background, attitudes and behaviour concerning implementation of universal precautions as well as relations with patients and physicians. The questionnaire for the laboratory technicians consisted of 3 major sections. The first covered parameters of knowledge, attitudes, practices and safety precautions; the second section dealt with material resources available in the laboratory and the disposal of medical waste; the last section included questions about education, training and relations with patients and physicians. The observation list included items dealing with basic practices, safety precautions and waste disposal.

The proposed instruments were pilot-tested and adapted to ensure that they were suitable to the particular circumstances and that the right nomenclature was used. The data collection procedure was standardized in laboratories located in the capital city, one of the 6 provinces, because it has the largest population. Then the team was distributed into groups. Data coding, computer processing and statistical analysis were done according to standard statistical methods. The recorded answers were cleaned, coded, processed and analysed using *SPSS*, version 11.0, and then compared with the data from 1993.

The questionnaire for the technicians was tested for reliability. We randomly chose 30 technicians from Beirut and Mount Lebanon provinces. We introduced the questionnaire using different researchers and then matched the results for agreement.

The population proportion found in the 2003 sample was compared to that of 1999. We calculated z at 95% confidence interval; the difference was considered to be significant if computed z was ≥ 1.645.

Results

Profile of laboratory manpower

Among the professional directors of the laboratories, 59 out of the 68 interviewed (86.8%) were full-time, i.e. always present in the laboratory, while the other 9 (13.2%) were present for only part of the day. Their educational background varied: 63 (92.6%) of the directors reported their education (we were unable to interview 5 directors) (Table 2). A far greater proportion of directors had a medical background compared with those in 1993 ($P < 0.0001$).

The directors we interviewed (68/73) reported that out of 475 technicians in their laboratories:

- 400 performed tests on blood in general
- 375 performed blood sampling
- 369 performed tests on body fluids
- 329 performed hepatitis testing
- 244 performed HIV testing.

It was also reported that some technicians could be carrying out all these procedures.

The education profile of laboratory technicians also varied; 195 (90.3%) had a technical professional degree or higher (Table 3). Compared with 1993, the general level of education among the technicians had increased significantly (Table 3). It was also reported that 69 (31.1%) of the technicians had attended education sessions on AIDS and hepatitis prevention and transmission and 45 (20.3%) had training on how to perform HIV testing. In addition, of the 222 technicians, 177 (79.7%) said they would be willing to participate in future training sessions; 45 did not respond. Of the 177, 145 indicted what they would want from training—to get new information (118, 66.7%), more awareness and protection at work (17, 9.6%), or more information about

Table 2 **Comparison of the education profile of laboratory directors in 1993 and 2003**

	1993		2003	
	No.	%	No.	%
Pharmacy background	25	43.1	3	4.8
Medical background	26	44.8	55	87.3
Bachelor of science	5	8.6	3	4.8
High school diploma	2	3.4	2	3.2
Total	58[a]	100	63[b]	100

[a]*Information was missing for 1 director.*
[b]*Information was missing for 5 directors.*
$\chi^2_3 = 28.01, P < 0.0001.$

Table 3 **Comparison of the education profile of technicians in 1993 and 2003**

Education level	1993		2003[a]	
	No.	%	No.	%
High school diploma and/or training on the job	16	13.9	21	9.7
Technical degree	27	23.4	81	37.5
Bachelor of medical laboratory science	41	35.6	96	44.4
Bachelor of Science	12	10.4		
Master degree (MSc or MPH)	4	3.4	17	7.9
Doctorate degree	15	13.0	1	0.5
Total	115	100	216	100

$\chi^2_5 = 56.49, P < 0.0001.$
[a]*Information was missing for 6 technicians.*

the testing procedures and the protection measures (10, 5.6%)—32 did not respond.

The technicians reported that they acquired their knowledge about the various aspects of AIDS, hepatitis and the prevention techniques and measures mostly in discussions with physicians, from medical literature or from lectures (Table 4).

Knowledge of the technicians about universal precautions and safety measures

Almost all the technicians knew that while working they should take protective measures by wearing laboratory gowns or gloves and that they should dispose of used needles and syringes in special containers (Table 5). Their level of knowledge about the modes of transmission of each of HIV (90.1%), HBV (92.3%) and HCV (88.3%) through blood and its components was also very good overall.

Only 23 (31.5%) of the laboratories had the list of universal precautions posted, and some laboratory technicians did not even know about the existence of such a list. As for deactivation of HIV, 118 (53.2%) technicians considered heat the most effective method, 54 (24.3%) did not agree and 50 (23.0%) said they did not know. Similarly, 113 (50.1%) did not agree that methods that deactivate hepatitis B virus or other viruses could also deactivate HIV. In addition, 216 (97.3%) knew that blood or other contaminated material must be disposed of in special containers. However, the field workers noted that only in 55 (75.3%) of the laboratories that they visited was this actually done.

Table 4 **Sources of information on HIV/AIDS-related safety measures reported by the technicians**

Source	No. (*n* = 222)	%
Conferences and meetings with physicians	153	68.9
Medical journals and books	140	63.1
Lectures	116	52.3
Media	97	43.7
Other sources	19	8.6

Categories are not mutually exclusive.

Beliefs, attitudes and practices in testing

The behaviour of laboratory technicians seemed to be very much affected by the spread of AIDS and hepatitis. Most of the technicians (88.3%) reported changing their practices after hearing about AIDS or hepatitis, either by becoming more aware when performing tests on body fluids (187, 84.2%), when sampling, (168, 75.7%) or when dealing with patients (108, 48.6%). One technician reported that he stopped performing HIV or hepatitis testing. In some laboratories only 8 of the 73 (11.0%) technicians showed some behavioural laxity inside the laboratory: eating, drinking, smoking or pipetting by mouth. However, 218 (98.2%) did not work with reusable syringes. With respect to disposing of contaminated syringes and needles in a special box, a significant difference was found between what was observed in laboratories and what technicians reported they practised (Table 5).

With regard to beliefs, 37 (16.7%) believed that pregnant technicians should not perform blood testing. Only 98 (44.1%) believed that virus testing should be done in specialized laboratories, 101 (45.5%) did not agree and 12 (5.4%) said they did not know; the other 11 did not respond. The great majority (90.1%) also believed that proper disinfection of all materials was an important measure for prevention and protection from disease transmission in the

Table 5 **Comparison of knowledge, use and availability of protective devices between 1993 and 2003**

Protective device	Knowledge				Beliefs				Practice				Use of devices as recorded in the technicians' questionnaire				Observed use of devices[a]		Observed availability of devices in laboratories[a]			
	1993		2003		1993		2003		1993		2003		1993		2003		2003		1993		2003	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Wearing lab coats	115	100	219	98.6	113	98.3	214	96.4	113	98.3	214	96.4	107	93.0	192[b]	86.5	63	86.3	59	100	73	100
Wearing gloves	109	94.8	218[c]	98.2	103	89.6	209	94.1	60	52.2	207[d]	93.2	34	29.6	82	36.9	27	37.0	57	96.6	63[e]	86.3
Disposal of syringes & needles in special boxes	110	95.7	216	97.3	–	–	206	92.8	104	90.4	208	93.7	70	60.9	167[f]	75.2	55	75.3	34	57.6	44	60.3
Total	115	100	222	100	115	100	222	100	115	100	222	100	115	100	222	100	73	100	59	100	73	100

[a]*We observed each laboratory (73) to check what protective devices were available and if all the technicians were using them in all the visits and scored the laboratory accordingly.*
[b]*Significant $P = 0.0322$.*
[c]*Significant $P = 0.0401$.*
[d]*Significant $P > 0.0001$.*
[e]*Significant $P > 0.0202$.*
[f]*Significant $P = 0.003$.*

health care setting. Almost all believed in wearing laboratory coats or gloves while working. Gloves were reported to be available by 95.0% of technicians and by 92.6% of laboratory directors; these were latex in 83.3% of laboratories rather than nylon or dishwashing gloves which are sometimes used as a substitute. It was, however, observed that the technicians actually wore gloves in only 27 laboratories and laboratory coats in only 63 (Table 5).

Sterilization, disinfection of laboratory materials and waste disposal

The field workers observed that 64 (87.7%) laboratories had an adequate liquid disinfectant present on the bench and in 66 (90.4%) there was an autoclave available. However, only 61 (89.7%) laboratory directors reported that they used the autoclave (once per week 13.2%, once per day 17.6%, 3 times per week 25.0%). The rest either did not specify, or gave different frequencies. Furthermore, 61 (83.6%) of the laboratories reported sterilizing material for repeated usage: 57 (93.4%) by autoclaving, 9 (14.8%) by boiling, 21 (34.4%) by washing and 19 (31.1%) by immersion in disinfectants.

On the other hand, 28 (46.6%) of the laboratories disposed of their blood-contaminated waste separately in their laboratory after autoclaving it, but they did not know how it was disposed of once it left the laboratory (Table 6). Twenty-one (35.0%) reported disposing of contaminated waste the same way as non-contaminated waste, 16 (26.7%) would incinerate it, and 10 (16.7%) said they would dump it and cover it with soil.

Table 6 **Comparison of disposal of blood-contaminated waste in the laboratories between 1993 and 2003**

Disposal and supervision measures	1993 (n = 59) %	2003 (n = 60[a]) %
Disposal of blood-contaminated waste		
In special containers	71.1	46.6
With non-contaminated garbage	28.9	35.0
Incineration	–	26.7
Dumping in soil		16.7
Supervision of garbage disposal	30.0	91.7
Until the end (incineration or scientific dumping)	–	45.0
Until the door of the laboratory	–	46.7

[a]Information was missing for 13 laboratories.
n = total number of respondents

Dealing with blood spillage

Observations showed that spillage of blood on the floor or bench was handled by pouring disinfectants in 48 (65.8%) of the 73 laboratories, or by cleaning with dry napkins in 22 (30.1%).

Management of residual blood in Vacutainer® tubes was mostly by sterilizing before disposal with normal waste or separating inside the laboratory then disposal with normal waste (Table 7). On the other hand, the handling of spillage from broken blood samples was more conservative; 52 (71.2%) of the 73 laboratories would wash and disinfect the blood, while 19 (26.0%) would clean with dry napkins without disinfecting.

Technician–patient relations

In 28 (38.4%) laboratories, the technicians deal directly with clients, and in the other laboratories 33 (45.2%) of the technicians do not have to deal with patients; they receive blood already collected in tubes. On the other hand, only 21 (9.9%) would give results directly to the patient. In the other 12 it was not specified.

Table 7 **Comparison of management by laboratories of residual blood in Vacutainers®**

Disposal	1993 (n = 59) %	2003 (n = 65[a]) %	P
Sterilization before disposal with normal waste	16.7	41.5	0.0006
Separation then disposal with general waste	0	33.8	
Pouring blood into the sink	60.0	20.0	< 0.0001
Throwing with regular garbage without treatment	23.3	4.6	< 0.0001

Categories are mutually exclusive.
[a]Information for 8 laboratories was missing.
n = total number of respondents

Discussion

The data collected in the survey indicated that the education profile of professional laboratory directors improved between 1993 and 2003. The number with a medical background exceeded the number with a pharmacy background. In addition, the profile of the technicians also improved. There were more university graduates in the laboratories (43.2% in 2003 compared to 35.6% in 1993), and more had a technical degree in laboratory sciences (36.5% in 2003 compared to 23.4% in 1993) [*4*].

Laboratory facilities for HIV and hepatitis testing were adequate in the country, and almost all the laboratories do the testing. However, the distribution of laboratories was not equitable between the various provinces. In the peripheral provinces, the facilities could be increased and strengthened. In addition, many laboratories, all over Lebanon, are working illegally without being registered with the Syndicate of Laboratory Owners in Lebanon. Such laboratories are not supervised and their adherence to universal precautions is not known. Thus our results may be an underestimate of any problems that may exist.

The major findings of this study provide some interesting insights into the question of preventing the transmission of pathogens (HIV, hepatitis virus etc.) through preventive measures used by laboratory technicians in Lebanon. Despite their relatively high level of education, and the advanced level of knowledge about the modes of transmission of the pathogens, there were great disparities among technicians in knowledge, attitudes and practices [*4*].

On the one hand, protection techniques such as regular hand washing or use of barrier protection, including gloves of the proper quality and protective body clothing, were available and used to various extents to prevent skin and mucous membrane contamination with blood or body fluids. This is good laboratory practice reducing exposure from prolonged or extensive contamination of skin with infectious fluids [*13,21*].

On the other hand, despite the wide availability of gloves reported both by laboratory directors and technicians, the excellent knowledge of the protective efficiency of wearing gloves, the high rate of belief in this practice, and the reports by 92.8% of technicians that they practise this protection measure, it was observed that in only 37% of the laboratories the technicians actually strictly follow this measure. Compared with the previous study, we noticed a slight increase (7.3%) in this practice, which is not sufficient. We noted that within a laboratory either all or none of the technicians wore gloves.

Gloves need not be changed during laboratory activities that routinely result in contaminated gloves. Rather, gloves should be changed when these tasks are completed [*13,21*]. Among the recommendations published by the Centers for Disease Control in 1987, updated in 1988 and reviewed in 1991, was "blood and body-fluid precautions" that should be used consistently for all patients [*23*]. This approach of "universal precautions" was added to our lexicon and has eliminated the need for the category-specific blood and body fluid isolation [*13*]. In our study, it was evident that such a comprehensive approach was not clear in the minds of most laboratory staff. Therefore, the concept, use and effectiveness of universal precautions need to be clearly presented to all technicians and laboratory directors.

The practice of mouth pipetting decreased from 43.4% to about 11% of the technicians. Although this is a low percentage, careful consideration should also be given to this issue, particularly since HIV shares routes of infection with HBV and HCV, and in relation to the prevalence of HIV and HBV in the population. Actually, HIV, HBV and presumably HCV may be transmitted in the laboratory directly through mucous membranes [*23*]. Contamination of mucosal surfaces with infectious blood, plasma, serum or other body fluids may occur with mouth pipetting or spattering of oral or nasal mucosa. For this reason mechanical pipetting devices should be used for all liquids in the laboratory and mouth pipetting must not be practised at all [*13,21*].

Another problem that emerged from the survey related to the utilization and disposal of used syringes and needles. Although technicians knew that direct percutaneous transmission of HIV is possible, that it could occur by parenteral inoculation of infected blood by needle-sticks accidents, and that they should dispose of needles and syringes in special needle containers, which 93.7% of them claimed to do, observation showed that only 44 (60.3%) laboratories had containers available for this purpose as observed by us. This was higher than 10 years previously when the availability of containers was observed only in 57.6% of the laboratories. Needle containers should be available in all laboratories and accessible to all technicians, since the major source of occupationally-acquired HIV infection reported is from needle-sticks [*21*].

There was some negligence in handling blood-contaminated material. It was reported that 46.6% of the laboratories disposed of their contaminated garbage in special containers, 35.0% of them discarded their contaminated waste the same way as non-contaminated and 16.7% of them dump it in soil.

Complete supervision of garbage disposal (incineration or dumping) was reported to be practised in 40.2% of laboratories and supervision to the door of the laboratory in 41.2%. Laboratories reported that they supervise only the disposal of proven infected material done in their laboratory. Comparing these results to those of 1993, there is more supervision especially inside the laboratory but the end point of waste outside the laboratory is unknown. Laboratory provision of special containers has decreased, probably due to the high cost of these items.

Awareness should be raised about this problem, stressing the importance of developing and following guidelines for correct handling of laboratory wastes, particularly contaminated waste. Medical waste could be classified into general refuse, special medical waste and potentially infectious categories and processed accordingly.

Autoclaves were available in 90.4% of the laboratories. The practice of on-site autoclaving is becoming standard. Medical waste may be decontaminated on-site as long as guidelines are followed. When "potentially infectious" waste is decontaminated, it becomes "general domestic" waste and may be disposed of with general waste. This requires a national policy that should be adopted and implemented by the health authorities.

The decontamination of spills by the technicians seemed to be inadequate. However, the management of residual blood in Vacutainers® or other containers has improved since 1993. Sterilization and separation had improved and pouring residues down the sink or throwing them out with general waste had decreased. This, along with other issues of medical waste disposal, still needs to be improved by developing appropriate policies, mechanisms and monitoring.

The attitudes of the technicians towards HIV testing were not consistent. They were fully aware of the risks when dealing with body fluids or when sampling. Although 98 (44.1%) technicians said they would prefer that HIV testing be done in a specialized laboratory, less than 1% reported refusing to work with blood. Meanwhile, the same people would test for HBV, HCV or other viruses. Such attitudes and practices were not consistent with the high rate of knowledge about the very important measures for prevention and self-protection from pathogen transmission. Technicians also showed some laxity in their behaviour, e.g. eating, drinking or smoking in the laboratory, as well as receiving visitors sometimes. Such practices should be limited to assigned areas in the facility.

Since in about 38% of the laboratories technicians dealt directly with patients, some pre-counselling should be provided.

The education profile of the human resources in the great majority of laboratories was adequate, except for the 3.2% of laboratories lacking a professional director or the 9.5% of technicians who had only a high school diploma or on-the-job experience. Furthermore, the majority of the technicians did not have training on how to perform HIV testing with educational sessions on AIDS and hepatitis transmission and prevention. This deficiency was found mostly in peripheral/remote laboratories.

Conclusion

Discrepancies between what the technicians knew, believed and practised have decreased since 1993 but these should still be addressed by stressing the benefits of correct practice to the laboratory directors and administrators to enforce such measures and then to technicians to make them more aware of the risks of neglecting correct safety measures.

In addition, since it is known that illegal laboratories exist, the health authorities should enforce registration and licensing of laboratories as well as optimal laboratory practices. In cooperation with the professional directors and administrators, they should write comprehensive guidelines promoting the implementation and monitoring of universal precautions. They should develop policies and procedures which will effectively protect laboratory personnel from infectious diseases in general. This is consistent with the fact that the employer must provide for the employee a safe working environment and appropriate barriers and ensure their appropriate use.

Implementation of a universal precautions policy is not without difficulties. Health care workers unaccustomed to routine use of gloves or masks may find them inconvenient and choose not to comply. Others may overreact and use barrier precautions unnecessarily when contact with blood or body fluids is not likely. Both problems can be addressed by providing in-service training programmes and incentives to encourage compliance. The universal precautions system will add to costs, especially for disposable gloves, masks and aprons, but may also save money in laundry costs and employee workdays lost due to illness.

In short, given the current status of HIV, hepatitis and other pathogen infection and testing, a policy of universal precautions is much more likely to serve both patients' and providers' interests.

Lastly, regular training should include the universal precautions, initial biohazard handling, safety policies, safety activities, safety equipment and materials, ongoing monitoring and potential exposure of staff.

Acknowledgement

This study was technically and financially supported by a grant from the World Health Organization Regional Office for the Eastern Mediterranean Small Grants Programme (SGS 02/182).

References

1. APIC position paper: prevention of device-mediated blood borne infections to health care workers. *American journal of infection control*, 1998, 26(6):570–80.
2. Public health service guidelines for the management of health care worker exposures to HIV and recommendations for postexposure prophylaxis. *MMWR. Morbidity and mortality weekly report*, 1998, 47, No. RR–7:1–28.
3. Case–control study of HIV sero-conversion in health care workers after percutaneous exposure to HIV-infected blood. France, United Kingdom and United States, January 1988–August 1994. *New England journal of medicine*, 1995, 44(50):929–33.
4. Jurjus A. Assessment of AIDS knowledge, attitude, behaviors and occupational risk of laboratory. *Lebanese medical journal*, 1998, 46(5):285–90.
5. Radecki S, Abbott A, Eloi L. Occupational human immunodeficiency virus exposure among residents and medical students: an analysis of 5-year follow-up data. *Archives of internal medicine*, 2000, 160(20):3107–11.
6. Gerberding JL. Management of occupational exposures to blood-borne viruses. *New England journal of medicine*, 1995, 312(7):444–51.
7. Rattner SL, Norman SA, Berlin JA. Percutaneous injuries on the "front line": a survey of housestaff and nurses. *American journal of preventive medicine*, 1994, 10(6):372–7.
8. Shalom A, Ribak J, Froom P. Needle sticks in medical students in university hospitals. *Journal of occupational and environmental medicine*, 1995, 37(7): 845–9.

9. De Vries B, Cossart YE. Needlestick injury in medical students. *Medical journal of Australia*, 1994, 160(7):398–400.

10. Henry K, Campbell S. Needle stick/sharps injuries and HIV exposure among health care workers. National estimates based on a survey of US hospitals. *Minnesota medicine*, 1995, 78(11):41–4.

11. Wong ES et al. Are universal precautions effective in reducing the number of occupational exposures among health care workers? A prospective study of physicians on a medical service. *Journal of the American Medical Association*, 1991, 265(9):1123–8.

12. Centers for Disease Control and Prevention. *HIV/AIDS surveillance report*. Atlanta, Georgia, US Department of Health and Human Services 1994, 6:21.

13. *Protection of laboratory workers from infectious disease transmitted by blood, body fluids, and tissue*, 2nd ed. Wayne, Pennsylvania, National Committee for Clinical Laboratory Standards, 1991 (Document M29-T2).

14. *National AIDS program, Lebanon: annual report 1995.* Beirut, National AIDS program, 1995.

15. Mokhbat JE et al. The acquired immunodeficiency syndrome. *Lebanese medical journal*, 1985, 35(4):293–319.

16. Bizri A. Epidemiology and prevention of hepatitis C. *Lebanese medical journal*, 2001, 49:45–6.

17. Management of hepatitis C [concensus conference]. *Hepatology*, 1997, 26(suppl. 1):1–155S.

18. Gross JB. Clinician's guide to hepatitis C. *Mayo Clinic proceedings*, 1998, 73(4): 355–61.

19. Nassar N. Epidemiology and prevention of hepatitis B. *Lebanese medical journal*, 2001, 49:40–2.

20. Alter MJ. Epidemiology of hepatitis C in the west. *Seminars in liver disease*, 1995, 15(1):5–14.

21. De Vita VT Jr, Hellman S, Rosenberg SA, eds. *AIDS: biology, diagnosis, treatment and prevention*, 4th ed. Philadelphia, Lippincott-Raven Publishers, 1997.

22. Recommendations for prevention of HIV transmission in health-care settings. *MMWR. Morbidity and mortality weekly report*, 1987, 36(suppl. 2):1–18S.

23. National Committee for Clinical Laboratory Standards. *Protection of laboratory workers from infectious diseases transmitted by blood, body fluids and tissue*. Pennsylvania, National Committee for Clinical Laboratory Standards, 1991 (Document no. M29-T2).