CHEMICAL HEALTH RISK ASSESSMENT AT PRIVATE MEDICAL LABORATORY

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ABSTRACT

The use of chemicals in laboratories need proper safety management to protect staff from chemical health risk during performing their work. The purpose of this study is to identify and evaluate the level of exposure of chemicals towards staffs which working in the laboratory. A private medical laboratory was selected and chemical health risk assessment (CHRA) was conducted. The CHRA was carried out according to guidelines from DOSH under Use and Standard of Exposure of Chemicals Hazardous to Health (USECHH), 2000 Regulations. The assessment involving site visit, observation on handling chemicals by laboratory staff, reviewing lab manual and other relevant documents. Overall, 10 work units with total 108 chemicals managed to be assessed. Result found that risk of chemicals are significant either C2 or C3. There are four work units were marked C2 by having significant risk and adequately controlled. The other six work units fall under C3 which having significant risk but inadequately controlled. Based on the conclusion, CHRA were conducted to reduce the risks of chemical exposure among laboratory staff. This study can be useful to implement CHRA program in laboratories to assess the risk of chemical exposure and required control measures for the protection of laboratory staff.

ABSTRAK

Penggunaan bahan kimia dalam makmal memerlukan pengurusan keselamatan yang betul untuk melindungi pekerja dari risiko kesihatan kimia semasa melaksanakan kerja mereka. Tujuan kajian ini adalah untuk mengenal pasti dan menilai tahap pendedahan bahan kimia terhadap kakitangan yang bekerja di makmal. Sebuah makmal perubatan swasta telah dipilih dan penilaian risiko kesihatan kimia (CHRA) telah dijalankan. CHRA telah dijalankan mengikut garis panduan dari DOSH di bawah Penggunaan dan Standard Pendedahan Bahan Kimia Berbahaya kepada Kesihatan (USECHH), Peraturan 2000. Penilaian yang melibatkan lawatan tapak, pemerhatian mengendalikan bahan kimia oleh kakitangan makmal, mengkaji manual makmal dan dokumen lain yang berkaitan. Secara keseluruhan, 10 unit kerja dengan jumlah 108 bahan kimia berjaya ditaksir. Keputusan mendapati bahawa risiko bahan kimia adalah penting sama ada C2 atau C3. Terdapat empat unit kerja ditandakan C2 dengan mempunyai risiko yang signifikan dan dikawal secukupnya. Enam unit kerja yang lain jatuh di bawah C3 yang mempunyai risiko ketara tetapi tidak terkawal. Berdasarkan kesimpulannya, CHRA telah dijalankan untuk mengurangkan risiko pendedahan kimia di kalangan kakitangan makmal. Kajian ini berguna untuk melaksanakan program CHRA di makmal untuk menilai risiko pendedahan kimia dan langkah-langkah kawalan yang diperlukan untuk perlindungan kakitangan makmal.

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LIST OF SYMBOLS AND ABBREVIATIONS

ACH	:	Air change per hour
ACGIH	:	American Conference of Governmental Industrial Hygienist
ASHRAE	:	American Society of Heating, Refrigerating and Air-Conditioning Engineers
CHRA	:	Chemical Health Risk Assessment
DOSH	:	Department of Occupational Safety and Health
ER	:	Exposure Rating
GV	:	General Ventilation
GHS	:	Globally Harmonized System
HR	:	Hazard Rating
LC50	:	Lethal Concentration, 50%
LD50	:	Lethal Dose, 50%
LEV	:	Local Exhaust Ventilation
MR	:	Magnitude Rating
OSHA	:	Occupational Safety and Health Act
PEL	:	Permissible Exposure Limit
PPE	:	Personal Protective Equipment
RR	:	Risk Rating
SDS	:	Safety Data Sheet
SK	:	Skin Notation
TWA	:	Time-Weighted-Average
TD	:	Total Duration of Exposure
USECHH	:	Use and Standard of Exposure of Chemicals Hazardous to Health

CHAPTER 1

1.0 INTRODUCTION

Laboratory is an area that equipped with various instruments, equipment and chemicals or reagents for performing experimental works, research activities and investigative procedures. Medical laboratory is a part of laboratory that provides a facility to perform a test on clinical specimens in order to obtain information about the health of a patient as pertaining to the diagnosis, treatment, and prevention of disease. There are various of biomedical instruments, equipment, materials and chemicals for performing different laboratory investigative activities by using biological specimens such as whole blood, serum, plasma, urine and body tissues. Medical laboratory is a complex field embracing a number of different disciplines such as Microbiology, Hematology, Urinalysis, Serology, Immunology, Molecular, Cytopathology, Histopathology and others. People who involve or working in medical laboratory known as pathologist, medical laboratory technologist (MLT), phlebotomist, laboratory manager, dispatch, general worker and other support staff. These people are exposed to chemical directly or indirectly.

Laboratory staff have high tendency of susceptible to chemical hazards because they handle the chemical directly in order to perform laboratory tests. According to OSHA-US Department of Labor, hazardous chemical can be present as health threats or in physical form to workers whether in academic laboratories, industrial and clinical. The health effects are toxins, carnogenics, corrosives, irritants, sensitizers, hepatotoxins, neurotoxins, nephrotoxins as well as agents that act to damage the lungs or on the hematopoietic systems, eyes, skin or mucous membranes (OSHA, 2002). There are several ways of for hazardous chemicals enter through the body. Basically, there are 4 ways of hazardous chemicals may enter the body. The chemical

may enter through inhalation, skin absorption, ingestion and injection. In a laboratory, the primary entry is through inhalation and dermal contact (CEOSH, 2013). The effects of exposure to a chemical are dependent on many factors. The dose is the amount of a medicine or drugs that enter the body. The dosage depends on the concentration of the chemical and the frequency and duration of the exposure that person received. To determine the dosage, all possibility routes of exposure must be considered. Besides the quantity of the dose itself, the resultant of exposure is related to the factor of (1) the way the chemical enters the body, (2) the physical properties of the chemical, and (3) the susceptibility of the individual receiving the dose.

Since the employees and laboratory staff may expose to various hazardous chemicals, their safety and health of individuals involved must always be safeguarded especially laboratory staff. This is because they are continuously exposed to hazardous chemicals. It is the general responsibility of an employer under the Occupational Safety and Health Act 1994 (514 Act), whereby the employer is required to provide a safe working environment for his employees and other related individuals (Husin, Mohamad, Abdullah, & Anuar, 2012). To provide safe work environment, the hierarchy for control measures need to be assessed and applied (OSHA, 2003). Thus, to manage the chemical hazard in laboratory potential hazard must be identified and quantified the risk. An effective engineering controls can reduce exposure to acceptable levels and at minimum intensity or concentration which can eliminate the exposure. The hierarchy in controlling exposure: elimination, substitution, engineering, administrative, and personal protective equipment (PPE). The best controls of all are eliminating the hazard altogether or substituting a less hazardous chemical or process. Engineering controls, including enclosure, redesign, automation, ventilation, or robotics, are also effective and reliable methods to eliminate hazardous exposure (Burton, 1997).

In Malaysia, the main statute protecting safety and health of workers at the workplace is Occupational Safety and Health Act 1994 (Act 514). The Act provides legal frameworks to ensure safety, health and well-being among all employees and to protect others from any harm to safety or health in connection with the activities of others in the workplace. The provision of the Occupational Safety and Health Act 1994 is derived from a self-regulatory philosophy whose primary responsibility is to ensure the safety and health for those who make the risks and work at risk. With the aim of protecting workers from hazardous chemical exposure and their risk, Chemical Health Risk Assessment (CHRA) needs to be carried out.

Under Use and Standard of Exposure of Chemicals Hazardous to Health (USECHH) Regulations 2000, under section 26 Part VIII Monitoring of Exposure at the Workplace which required for employers to perform CHRA assessment whenever involving any duty that related to the handling, use, storage or transportation of chemicals hazardous to health in the workplace. The purpose of the assessment is to allow identification and evaluation of risks involved and the level of exposure to chemicals handled at the laboratory (Husin et al., 2012). An employer has the obligation to stop and not to perform any work or activity, if any of their employees was exposed or possible exposed to any hazardous chemical that are harmful to the employee's health. Otherwise, in order to perform the activities or work, an employer shall perform a written risk assessment, affected by the chemical to the employee's health.

It has been always the responsibility of the employer to ensure a healthy and safe working environment for employees and others. Thus, in this study the researcher want to conduct a Chemical Health Risk Assessment at his workplace in one of private medical laboratory which located in Kuala Lumpur. The results of the study may be beneficial to the company so as to

protect employees from the adverse health effects of chemicals and also to comply with the Occupational Safety and Health (Use and Standard Exposure of Chemical Hazardous to Health) Regulations 2000.

The purpose of this study are

1) To identify hazard posed by chemical substance used, stored, handled or transported within the place of work.
2) To evaluate degree of exposure of employees to hazardous chemicals, either through inhalation, skin absorption or ingestion.
3) To evaluate the adequacy of existing control measures.
4) To conclude the significant of the health risk posed by the hazardous chemicals.
5) To recommend further the appropriate control measures to prevent or reduce risks.

CHAPTER 2

2.0 LITERATURE REVIEW

2.1 Chemical Hazard Exposure

Chemical is one of the hazards which seriously highlight the effect of its exposure either through a short term or a long term. Each individual may have different effects when being exposed to the same chemical type and quantity. These different effects are due to various factors such as gender, age, genetic and other health condition. Under a low dose chemical exposure, there might be no significant effects shown at all in a short duration of time. While under high doses of exposure to the same chemical, if there is no observable effects shown it can be considered as a no observable adverse effect level (NOAEL). This is a stage where certain chemicals are considered to have no significant increase in statistics significantly by comparing both exposed populations and controlled populations. However NOAEL for each particular chemical might not be perfectly risk free. This is due to the unknown long term effect that might appear later. Hence, there is ongoing research to gain new findings to be discovered in the future (Huntzinger & Eatmon, 2009).

In medical laboratory, Formaldehyde is primarily used as a tissue preservative. It is usually found in a solution called formalin, which is 37% to 50% formaldehyde in water with 6-15% alcohol stabilizer. Laboratory staffs are at risk of formaldehyde. Skin inhalation and absorption is the primary route of exposure. Formaldehyde is a confirmed human carcinogen (Charney, 2010). Skin exposure can cause sensitization, which can lead to dermatitis upon contact with small amounts of formaldehyde or formalin. Exposure to Formaldehyde can cause other health effects also such as irritation and burning of nose and throat, irritation of mucous membranes, burning of the skin, coughing, and vomiting. Formaldehyde is also classified as highly

flammable chemical. The OSHA PEL is 0.75 ppm with a 15-minute ceiling of 2 ppm, and the ACGIH TLV-Ceiling limit is 0.3 ppm. NIOSH recommends a TWA of 0.016 ppm and a ceiling of 0.1 ppm.

Ben Owen has reviewed on requirements before the hazardous chemicals can be used in laboratories by the University requires approval for highly dangerous chemical. Historically, usage of chemicals in the field of research are not restricted from high-level expertise to low-level skills researchers as they are qualified and have the right to use chemicals. Therefore, the wisdom of chemical safety is generally not an important concern. Inconsistency in regulations that result in strict regulatory and research requirements rather than the severity and potential hazards posed by the chemicals (Owens, 2014)

2.2 Permissible Exposure limit (PEL)

An exposure limits are the concentration of chemicals in the workplace that most workers may be repeatedly exposed without adverse health effects. Permissible exposure limits are guidelines for determining the toxicity of the substance. There are many organizations which published PEL values based on past experience and laboratory testing data. Threshold limit values (TLVs) are exposure guidelines developed by the American Conference of Governmental Industrial Hygienists (ACGIH) (M. A. Jayjock, 2001). Permissible exposure limits (PELs) are legal exposure limit in the United States, from the Occupational Safety and Health Administration (OSHA) and Workplace Environmental Exposure Level (WEEL) from the American Industrial Hygienist Association (AIHA) are some well-recognized exposure guidelines in industrial hygiene applications. However, there are three different types of exposure limits in common use:

1) Time-weighted average (TWA) exposure limit is the time-weighted average concentration of a chemical in air for a normal 8-hour work day to which nearly all workers may be exposed day after day without harmful effects.

2) Short-term exposure limit (STEL) is the average concentration to which workers can be exposed for a short period (15 minutes) without experiencing irritation, long-term or irreversible tissue damage.

3) Ceiling exposure limit (C) is the concentration which should not be exceeded at any time.

For example, Formaldehyde is classified as highly flammable chemical. The OSHA PEL is 0.75 ppm with a 15-minute ceiling of 2 ppm, and the ACGIH TLV-Ceiling limit is 0.3 ppm. NIOSH recommends a TWA of 0.016 ppm and a ceiling of 0.1 ppm (Charney, 2010).

2.3 Chemical Health Risk Assessment

There are many guidelines available to evaluate hazards and assessing risks in the workplace. The purposes of these guidelines is to reduce all chemical exposures and risks to health. Each chemical in available in the laboratory not all are hazardous to health. Therefore, not all labs are potentially harmful to health. However, general precautions for handling all chemicals in laboratory should be adopted. Other than these general guidelines for chemicals that are used frequently or are principally hazardous specific guidelines should be adopted (OSHA, 2013).

A study of chemical health risk assessment was carried out on chemical usage at the Chemical and Biochemical Engineering Laboratory. The purpose of the assessment is to identify and evaluate the risks involved and the level of exposure to chemicals handled at the labs. Besides that, it is also for evaluation on the sufficiency of the current control measures practiced by the staff and students of the department. This detailed and qualitative assessment is based on

observations made of the staff while handling chemicals and reviews of the work procedures and manual as well as other related documents and records. Prevention and mitigation measures by a proactive approach were taken to minimize health risks during the learning and research process (Husin et al., 2012).

2.4 Chemical Management in Laboratory

Proper chemical management and training are essential to make laboratory staffs and employees aware of potential hazards related to chemical use. Improper chemical management in laboratories can lead to threats to laboratory staffs (Mogopodi, Paphane, & Petros, 2015). Eguna et. al. (2011) in its review of the management of chemical laboratories in developing countries has noted the chemical risks that have jeopardized academic institutions because of budget constraints. Since an explosion incident occurred at Texas Tech University's Chemical Lab in 2010 the appropriate review was required and required institutional approval for the use of chemicals in research laboratories (Eguna, Suico, & Lim, 2011). This has been disclosed by Robert Emery (2013) in his paper on the criteria for avoiding high risk chemicals that have been used have posed a real challenge to make work safer because the dispute articulated the value of prevention by all laboratory staffs such as awareness and compliance with security requirements and practices (Emery, 2013). Chemical management should be implemented in laboratories in order to minimize the exposure to chemicals and control the hazards, these include chemical register, chemical storage and chemical inventory.

2.4.1 Chemical Register

The chemical list is required by all employers to identify and register all hazardous chemicals to the health of the workplace. This requirement is stated under USECHH Rules, 2000. The purpose of registering chemicals is to ensure that laboratory personnel are aware of the

presence of hazardous chemicals in their laboratory and information on health risks and preventive measures against them. This chemical list is a tool for assessors to obtain information for risk assessment (HSW, 2015).

2.4.2 Chemical Inventory

In order to ensure laboratory a safe place for working, chemical inventory have to be maintained and updated (Richards-Babb, Bishoff, Carver, Fisher, & Robertson-Honecker, 2010). Bynam et al. suggested that chemical inventories in the lab can reduce the risk of laboratory personnel from hazardous chemicals. This list allows the decision to be made in determining the required chemicals and also to dispose of unnecessary chemicals (Bynam et al., 2009). Foster (2003) stated that chemical inventory is part of nine elements of an effective laboratory safety. Foster has also identified the management of hazardous materials as the most important aspect and emphasizes it as the principle of laboratory safety management at higher institutions (Foster, 2003).

2.4.3 Chemical Storage

Chemicals should be segregated and stored in the category of hazards and compatibility to prevent laboratory staffs in facing these chemical risks. Moreover, when buying chemicals, it is best to buy according to the quantity requested to avoid the harmful effects of storing excess chemicals, saving space in storage rooms and also minimizing waste to the lowest level. Additionally, storing chemicals requires a good understanding about the chemical hazards. Chemical spills or sparks can create fires, toxic fumes and explosions (Foster, 2004).

Becker and Elston (2004) conducted an evaluation for storing hazardous chemicals in secondary schools. They concluded that the chemical storages in these schools were improper

and the high percentages of chemical reagents increase the severity of the risk through accidental reactions (Becker & Elston, 2004).

It is the responsibility of the teachers and the supervisors to teach the student about proper chemical storage, as well as to enhance their safety knowledge (Sarquis, 2003). Cournoyer et al. (2005) suggested to use the chemical inventory software programs as an easy way to develop chemical storage. This software able to organize the chemicals according to their compatibility and minimize the hazard (Cournoyer, Maestas, Porterfield, & Spink, 2005). However, the efficiency of this software depends on the accuracy of the input data. Furthermore, Gibbs (2005) reported that such systems can organize hazard reports and offer MSDSs, besides it can also show the chemical expiration date (Gibbs, 2005).

2.5 Material Safety Data Sheet (MSDS)

A Material Safety Data Sheet (MSDS) is a document that contains information on the potential health effects of exposure as well as information concerning safe use, handling, and storage. This is an important starting point for complete healthcare development and a safe program. It contains hazard assessments regarding the use, storage, handling and emergency procedures associated with the substance. The MSDS also contains more information about the material than the material label (Greenberg, Cone, & Roberts, 1996).

The MSDS must consists of physical and chemical characteristics of the product, precautions for a safe product handling, and health hazards from exposure to the product. However, as stated by Foster, the American National Standard Institute (ANSI) established 16 standard sections of MSDS format (Foster, 2007):

1. Material identification

2. Composition

3. Hazards identification

4. First aid measures

5. Firefighting measure

6. Accidental release measures

7. Handling and storage

8. Exposure controls and personal protection

9. Physical and chemical properties

10. Stability and reactivity

11. Toxicological information

12. Ecological information

13. Disposal consideration

14. Transport information

15. Regulatory information

16. Additional information

Phillips conducts studies on employees understanding and acceptance of MSDS. The results have shown that most employees report that MSDS is acceptable and accessible, while others do not agree that MSDS is easy to read and understand. Furthermore, they were not asked to see it while working with chemicals (Phillips et al., 1999). Bernstein have stated four major limitations of MSDSs (Bernstein, 2002):

1. Elimination of basic information regarding the general chemical names and formulas of hazardous agents.
2. Omission of the listing of potential respiratory and skin sensitizing agents that are known to induce reactions through a specific immune response.

3. Failure to update current permissible exposure levels (PELs) for many agents that are higher than the PELs set by OSHA in 1989.
4. Failure to require documented clinical information regarding specific occupational lung diseases (occupational asthma) associated with a specific agent is also a major limitation.

CHAPTER 3

3.0 METHODOLOGY

Chemical health risk assessment is carried out according to Manual Assessment of the Health Arising from the Use of Hazardous Chemicals in the Workplace, 2nd edition. This guideline was outlined by Department of Occupational Safety and Health (DOSH). The procedures in carrying out a CHRA is given in Appendix 3, which consists of ten steps (DOSH, 2000).

Step 1: Deciding the assessor

Step 2: Gather information about chemicals, work & work practices

Step 3: Divide into work units

Step 4: Determine degree of hazards

Step 5: Evaluate exposure

Step 6: Assess adequacy of control measures

Step 7: Conclude the assessment

Step 8: Identify actions to be taken

Step 9: Reporting the assessment

Step 10: Review assessment

In this study, the assessment is conducted until Step 8 because Step 9 and Step 10 will involve follow up action to employer.

3.1 Deciding the Assessor

In order to comply with the USECHH Regulations 2000, the appointed assessor must be registered with the Director General of Occupational Safety and Health, Malaysia. However, this study will not be assessed by any registered CHRA assessor. The researcher will conduct the assessment with his knowledge and guideline of CHRA manual from DOSH.

3.2 Gather Information

For this step, all chemicals hazardous to health found in the workplace need to be identified and information about the work and work practices involving chemicals hazardous to health will be collected. The assessment begins with the collection of the following information:

1. Chemical hazardous to health used or released in the workplace
2. Employees at risk
3. Control equipment design parameter and maintenance
4. Monitoring record

3.3 Divide into work unit

Categorisation of a work unit is based on the two basic requirements:

a) Work similarity

   Workers in the work unit must perform similar tasks. *'Similar tasks'* means that the workers are having similar potential for exposure; and

b) Similarity with respect to the hazardous agent

   Workers using or are exposed to the same chemical hazardous to health.

3.4 Determine degree of hazards

Hazard rating is used to prioritize hazards based on the potential health effects of chemical. The hazard is assessed on a scale of 1 to 5 with a rating of 1 that implies not hazardous and a rating of 5 implies the most hazardous to health.

3.4.1 Hazard Information

All the hazardous chemicals were identified through the site visit, review of the chemical list and chemical register.

The degree of Hazards is based on the Chemical Safety Data Sheet (CSDS), Material Safety Data Sheet (MSDS), Hazard Classification Manual by DOSH and other reliable internet source.

The main information from the CSDS/MSDS derived is the chemical constituents of the mixtures. The hazard classifications area derived base on the Hazards Classification Manual by DOSH. If the classification by the CSDS and MSDS is less hazardous than the manual; cross referenced through the internet will be conducted to ascertain the validity of the conclusions. The manufacturer will also be contacted to gain access on the evidence of such conclusion.

3.4.2 Hazard Rating Determination

Based on these data, the hazard of each chemical can be evaluated and assigned a hazard rating. The procedure to assign the hazard rating to the chemical is as follows:

1. Obtained information on the hazard categories, hazard classification and risk phrases for the chemical substance or preparation.
2. Used Table 3.1 to get hazard rating based on the hazard classification or hazard categories, or risk phrases;
3. List the hazard ratings obtained in descending order;
4. Assign a single hazard rating based on the greatest degree of hazard from Group 1 hazard categories: -

Very toxic	R26-28, 39, 45(1), 46(1), 47(1), 49(1)
Toxic	R23-25,39, 48, 45(2), 46(2), 47(2), 49(2)
Harmful	R20-22, 40, 40(3), 40(M2), 48,
Respiratory sensitizer	R42
Respiratory irritant	R37

5. Assign an "sk" notation for those chemicals in Group 2 hazard categories: -

Corrosive to skin/eye	R34, 35
Skin and eye irritants	R41, 38, 36

6. For a chemical substance or preparation that fall only under Group 2 and do not fall into Group 1, the hazard rating assigned is to be based on Group 2

The risk phrases used in Table 3.1 are:

Acute effects:

Acute lethal effects	(R20 to 28)
Non-lethal irreversible effects after single exposure	(R39, 40)
Corrosive	(R34, R35)
Irritant	(R36 to 38, R41)
Sensitizer	(R42, R43)

Chronic effects:

Severe effects after repeated or prolonged exposure (R48)

Carcinogen (R40, R45, R49)

Mutagen (R46, R40)

Reproductive hazards (R60 to 64)

Teratogen (R47)

Table 3.1 Hazard Rating Based on Risk Phrase

EFFECT	ACUTE /CHRONIC	ROUTES OF EXPOSURE					HAZARD RATING (HR)
		INH.	DERMAL		ING.	NOT SPECIFIED	
			SKIN	EYE			
Very Toxic	Acute	R26	R27		R28	R39	5
	Chronic	-	-		-	-	
Toxic	Acute	R23	R24		R25	R39	4
	Chronic	-	-		-	R48, R39	
Harmful	Acute	R20	R21		R22	R40	3
	Chronic	-	-		-	R48, R40	
Corrosive	Acute		R35				4
			R34				3
Irritant	Acute	R37	-	R41			3
		-	R38	R36			2
Sensitizing	Acute	R42	-	R41			3
		-	R43				2
Carcinogenic	Chronic	R49(1)				R45(1)	5
		R49(2)				R45(2)	4
		-				R40(3)	3
Mutagenic						R46(1)	5
						R46(2)	4
						R40(M2)	3
Teratogenic						R47(1)	5
						R47(2)	4

3.5 Evaluate Exposure

For this step, we will assess the potential of chemicals enter the body through various routes of entry or possibility for contact with eye, skin or respiratory. The exposure rating can be determined according to these 3 parameters:

a) Frequency of exposure, F

b) Duration of exposure, D

c) Intensity or magnitude of exposure, M

3.5.1 Frequency of Exposure, F

The frequency of exposure is defined as the number of times exposed to chemical that have a significant effect on the degree of exposure. Frequency rating is used and determined from Table 3.2.

Table 3.2 Frequency rating

Rating	**Description**	**Definition**
5	Frequent	Potential exposure one or more time per shift or per day
4	Probable	Exposure greater than one time per week
3	Occasional	Exposure greater than one time per month
2	Remote	Exposure greater than one time per year
1	Improbable	Exposure left than one time per year

3.5.2 Duration of Exposure

The exposure duration is the product of the number of exposure and the average duration of each exposure. The duration of exposure can be calculated using formula below:

Total exposure per week, TD

= (Number of exposure per week) x (Average duration of each exposure)

Table 3.3 Duration rating

Rating	**Total Duration of Exposure**	
	% work hour	**Duration per 8 hours shift or per 40 hours week**
5	>87.5	> 7 hrs/ shift or > 35 hours/ week
4	50 – 87.5	4 to 7 hrs/ shift or 20 to 35 hours/ week
3	25 – 50	2 to 4 hrs/ shift or 10 to 20 hours/ week
2	12.5 – 25	1 to 2 hrs/ shift or 5 to 10 hours/ week
1	<12.5	< 1 hr/ 8 hr shift or < 5 hours/ week

3.5.3 Magnitude of Exposure

Magnitude of exposure rating will determines degree of chemical release or presence and also degree of chemical absorb or contact.

1) Degree of Chemical Release

Table 3.4 Degree of chemical release

Degree	**Observation**
Low	Low or little release into the air. No contamination of air, clothing and work surfaces with chemicals capable of skin absorption or causing irritation or corrosion.
Moderate	Moderate release of chemicals. Evidence of contamination of air, clothing and work surfaces with chemicals capable of skin absorption or causing irritation or corrosion
High	Substantial release of chemicals. Gross contamination of air, clothing and work surfaces with chemicals capable of skin absorption or causing irritation or corrosion.

2) Degree of Chemical Absorbed

Table 3.5 Degree of chemical absorbed

Degree	**Observation**
Low	Low breathing rate (light work). No contamination or indication on skin or eyes
Moderate	Moderate breathing rate (moderate work) Source in close to respiratory zone Capable to skin penetration
High	High breathing rate (heavy work). Source within respiratory zone. Damage to skin.

3) Magnitude Rating

Table 3.6 Magnitude rating

Degree of Release	Degree of Absorption	MR
Low	Low	1
	Moderate	2
	High	3
Moderate	Low	2
	Moderate	3
	High	4
High	Low	3
	Moderate	4
	High	5

4) Exposure Rating

Table 3.7 Exposure Rating

		Magnitude Rating (MR)				
		1	2	3	4	5
Frequency Rating / Duration Rating	1	1	2	2	2	3
	2	2	2	3	3	4
	3	2	3	3	4	4
	4	2	3	4	4	5
	5	3	4	4	5	5

3.6 Adequacy of Control Measures

This step was conducted at the same time during the exposure evaluation by inspection, checking records on control equipment and procedures including the use of personal protective equipment (PPE). Also checked were equipment maintenance records and records of incident or accidents. The current control measures applied in the laboratory have to be assessed to ensure they are adequate or not. By observing the following factors, we can assess the adequacy of control measures:

a) Suitability
b) Use
c) Effectiveness
d) Maintenance

3.7 Conclusion of the Assessment

Risk is evaluated as either “significant” or “not significant”. Significant means if the exposure give health adverse effect. Risk rating can be calculated from the following equation:

$$RR = \sqrt{(HR \times ER)}$$

Risk also can be evaluated using the summarized risk matrix as shown in Table 3.8 below.

Table 3.8 Risk Matrix

		Exposure Rating (ER)				
		1	2	3	4	5
Hazard Rating	1	RR=1	RR=2	RR=2	RR=2	RR=3
	2	RR=2	RR=2	RR=3	RR=3	RR=4
	3	RR=2	RR=3	RR=3	RR=4	RR=4
	4	RR=2	RR=3	RR=4	RR=4	RR=5
	5	RR=3	RR=4	RR=4	RR=5	RR=5

Risk Not Significant

Risk Significant – Category 1

Risk Significant – Category 2

According to the risk decision and the assessment of existing control measures, the conclusion can be made from the assessment. The conclusion, C is range from C1 to C5

Table 3.9 Risk Conclusion

Conclusion	**Risk Decision**
C1	Risk Not Significant Now
C2	Risk Significant but Adequately Controlled
C3	Risk Significant and Not Adequately Controlled
C4	Insufficient Information
C5	Uncertain About Exposure

3.8 Actions to be taken

The actions to be taken can be recommended according to the risk decision obtained after the assessment findings. the actions to be taken by the management in order to obtain control on the hazards and risk due to exposure to chemical hazardous to health. The action recommended will be the practicable options and decided after discussion with the management on the practicability.

CHAPTER 4

4.0 RESULT

This study was conducted at private medical laboratory which located in Kuala Lumpur. This medical laboratory have 7 laboratory departments and 5 departments was selected to perform chemical health risk assessment. The 5 departments are Biochemistry, Hematology, Histopathology, Cytopathology and Microbiology. Based on the findings, there are about 108 total number of chemicals were assessed in this medical laboratory. The work unit is determined by the type of works. Table 4.1 below shows numbers of work unit and total of chemical in each department.

Table 4.1 Number of Work Unit and Total of Chemicals

No.	Laboratory Department	No. of Work Unit	No. of Chemicals
1	Biochemistry	1	29
2	Hematology	1	13
3	Histopathology	4	45
4	Cytopathology	3	15
5	Microbiology	1	6

4.1 Work Unit Description

The work units involved in the assessment are:

a) Biochemistry

b) Haematology

c) Specimen Grossing

d) Specimen Processing and Routine Staining

e) Special Stain

f) Immunohistochemistry Staining

g) Surepath Test

h) Non-Gynae Sample

i) Cell Block Sample

j) Bacteriology

Table 4.2 Biochemistry

Work unit name	Biochemistry
Work area	Biochemistry Laboratory (Level 3)
Work unit staffing	Male: - Female: 5
Work unit shift and time	Normal: 8.30 AM to 5.30 PM
Work unit function	Performs a wide variety of different biochemical tests for blood and other body fluids.
Task involving chemical	Routine : • Sample management – receiving • Sample processing • Equipment preparation • Staining of slides • Clinical waste disposal Non-Routine : • Equipment cleaning, maintenance or troubleshooting • Goods receiving • Chemical waste disposal

Table 4.3 Haematology

Work unit name	Haematology
Work area	Heamatology Laboratory (Level 3)
Work unit staffing	Males: - Females: 3
Work unit shift and time	Normal: 8.30 AM to 5.30 PM
Work unit function	Performs routine tests of blood and full differential counts from venous and capillary blood samples from patients.
Task involving chemical	Routine : • Sample management – receiving • Sample processing • Equipment preparation • Staining of slides • Clinical waste disposal Non-Routine : • Equipment cleaning, maintenance or troubleshooting • Goods receiving • Chemical waste disposal

Table 4.4 Specimen Grossing

Work unit name	Specimen Grossing
Work area	Histopathology Laboratory (Level 4)
Work unit staffing	Male: 7 Females: 6
Work unit shift and time	Normal: 8.30 AM to 5.30 PM
Work unit function	Perform grossing of tissue samples.
Task involving chemical	Routine:

	• Sample management – receiving & registration
	• Sample processing
	  • Grossing
	  • Tissue processing
	  • Tissue embedding
	  • Tissue sectioning and fishing
	  • Slide staining
	  • Slide mounting
	  • Slide sorting and distribution
	• Special stain and Immunohistochemistry staining
	Non-Routine:
	• Frozen section session
	• Chemical preparing
	  • Formalin
	  • Alcohol
	  • Acid alcohol
	  • Staining solution or chemical
	  • Tissue processor solution or chemical
	  • Special stain/IHC solution or chemical
	• Equipment cleaning, maintenance or troubleshooting.
	• Chemical Waste Disposal
	• Slide, block and sample filing

Table 4.5 Specimen Processing and Routine Staining

Work unit name	Specimen Processing and Routine Staining
Work area	Histopathology Laboratory (Level 4)
Work unit staffing	Male: 7 Females: 6
Work unit shift and time	Normal: 8.30 AM to 5.30 PM
Work unit function	Specimen fixation and staining.

Task involving chemical	Routine:
	• Sample management – receiving & registration
	• Sample processing
	  • Grossing
	  • Tissue processing
	  • Tissue embedding
	  • Tissue sectioning and fishing
	  • Slide staining
	  • Slide mounting
	  • Slide sorting and distribution
	• Special stain and Immunohistochemistry staining
	Non-Routine:
	• Frozen section session
	• Chemical preparing
	  • Formalin
	  • Alcohol
	  • Acid alcohol
	  • Staining solution or chemical
	  • Tissue processor solution or chemical

	• Special stain/IHC solution or chemical • Equipment cleaning, maintenance or troubleshooting. • Chemical Waste Disposal • Slide, block and sample filing

Table 4.6 Specimen Processing and Special Stain

Work unit name	Specimen Processing and Special Stain
Work area	Histopathology Laboratory (Level 4)
Work unit staffing	Male: - Females: 2
Work unit shift and time	Normal: 8.30 AM to 5.30 PM
Work unit function	Specimen Processing and Special Staining.

Task involving chemical	Routine:
	• Sample management – receiving & registration
	• Sample processing
	  • Grossing
	  • Tissue processing
	  • Tissue embedding
	  • Tissue sectioning and fishing
	  • Slide staining
	  • Slide mounting
	  • Slide sorting and distribution
	• Special stain and Immunohistochemistry staining
	Non-Routine:
	• Frozen section session

	• Chemical preparing
	  • Formalin
	  • Alcohol
	  • Acid alcohol
	  • Staining solution or chemical
	  • Tissue processor solution or chemical
	  • Special stain/IHC solution or chemical
	• Equipment cleaning, maintenance or troubleshooting.
	• Chemical Waste Disposal
	• Slide, block and sample filing

Table 4.7 Immunohistochemistry Staining

Work unit name	Immunohistochemistry Staining
Work area	Immunohistochemistry Staining CLS/MLT (Level 4)
Work unit staffing	Male: 1 Females: 1
Work unit shift and time	Normal: 8.30 AM to 5.30 PM
Work unit function	To analyze tissue sample from hospital and other sources.

Task involving chemical	Routine:
	• Sample management – receiving & registration
	• Sample processing
	  • Grossing
	  • Tissue processing
	  • Tissue embedding

	• Tissue sectioning and fishing • Slide staining • Slide mounting • Slide sorting and distribution • Special stain and Immunohistochemistry staining Non-Routine: • Frozen section session • Chemical preparing • Formalin • Alcohol • Acid alcohol • Staining solution or chemical • Tissue processor solution or chemical • Special stain/IHC solution or chemical • Equipment cleaning, maintenance or troubleshooting. • Chemical Waste Disposal • Slide, block and sample filing

Table 4.8 Surepath Test

Work unit name	Surepath Test
Work area	Surepath Test CLS/MLT (Level4)
Work unit staffing	Male: 1 Females: 4
Work unit shift and time	Normal: 8.30 AM to 5.30 PM
Work unit function	To analyze the cervical samples.

Task involving chemical	Routine:
	• Sample management – receiving & registration
	• Sample processing
	  • Slide labelling
	  • Fluid processing
	  • Slide clearing
	  • Slide staining
	  • Slide mounting
	  • Slide sorting and distribution
	
	Non-Routine:
	• Cell block preparation
	• Chemical preparing
	  • Alcohol rinse
	  • Tris buffer
	  • 90% alcohol
	  • 70% alcohol
	• Equipment cleaning, maintenance or troubleshooting.
	• Chemical Waste Disposal

Table 4.9 Non Gynae Sample

Work unit name	Non Gynae Sample
Work area	Histopathology Laboratory (Level 4)
Work unit staffing	Male: 1 Females: 3
Work unit shift and time	Normal: 8.30 AM to 5.30 PM
Work unit function	To analyze the cervical samples and non-gynae samples and produce result.
Task involving chemical	Routine:

	• Sample management – receiving & registration
	• Sample processing
	  • Slide labelling
	  • Fluid processing
	  • Slide clearing
	  • Slide staining
	  • Slide mounting
	  • Slide sorting and distribution
	
	Non-Routine:
	• Cell block preparation
	• Chemical preparing
	  • Alcohol rinse
	  • Tris buffer
	  • 90% alcohol
	  • 70% alcohol
	• Equipment cleaning, maintenance or troubleshooting.
	• Chemical Waste Disposal

Table 4.10 Cell Block Sample

Work unit name	Cell Block Sample
Work area	Histopathology Laboratory (Level 4)
Work unit staffing	Male: 1 Females: 3
Work unit shift and time	Normal: 8.30 AM to 5.30 PM
Work unit function	To prepare cell block and pass to immunohistochemistry for further testing.
Task involving chemical	• Received request from branch

	• Spin the cytology fluid
	• Add plasma and thromboplastin
	• Vortex or tap gently on the countertop
	• Place the mass in formalin
	• Cell block pass to immunohistochemistry for further testing.
	Routine:
	• Sample management – receiving & registration
	• Sample processing
	  • Slide labelling
	  • Fluid processing
	  • Slide clearing
	  • Slide staining
	  • Slide mounting
	  • Slide sorting and distribution
	Non-Routine:
	• Cell block preparation
	• Chemical preparing
	  • Alcohol rinse
	  • Tris buffer
	  • 90% alcohol
	  • 70% alcohol
	• Equipment cleaning, maintenance or troubleshooting.
	Chemical Waste Disposal

Table 4.11 Bacteriology

Work unit name	Bacteriology
Work area	Bacteriology Laboratory Level 6
Work unit staffing	Male: 1 Females: 5
Work unit shift and time	Normal: 8.30 AM to 5.30 PM
Work unit function	To receive samples, process, analyse the microbiological samples and produce result.
Task involving chemical	Cleaning and disinfecting work bench, Sample collection, Pre analytical - receiving &registration,agar preparation & macroscopic, sorting of plated specimens. Analytical - Sample processing: Sample streaking, staining & microscopic examination. Analytical – plate reading , staining & reporting Analytical – bacteria identification & susceptibility testing Post Analytical – finalizing identification and sensitivity & reporting NON ROUTINE: Equipment cleaning, maintenance or troubleshooting.

4.2 Hazard Rating

Hazard rating is concluded according to information about the physical properties of the chemicals and its health hazards.

4.2.1 Work Unit: Biochemistry

No	Name of Chemical	Hazard Classification	Risk Phrases	Skin Notation ?	Hazard Rating
1	Cell Wash Solution II / Acid Wash	Irritant	R36	SK	2
2	C.f.a.s. HbA1c	Corrosive	R34, R41	SK	3
3	C.f.a.s. Lipids	Harmful	R22	-	3
4	Eco Tergent, Cobas c501/502, 12x59ml	Corrosive	R22, R35 R36, R48	SK	4
5	NaOH (sodium hydroxide 2-5%)	Irritant	R36, R38	SK	2
6	ALB2	Irritant	R36	SK	2
7	ALP2	Irritant	R36, R37	SK	3
8	ASLOT	Harmful	R21,R36 R60/61	SK	3
9	BIL-D Gen. 2	Corrosive	R34	SK	3
10	BIL-T Gen. 3	Corrosive	R35	SK	4
11	CHOL2	Toxic	R22, R23/24/25, R34 R41, R48/20/21/22	SK	4
12	Creatine Kinase	Harmful	R22, R34, R61	SK	3
13	CREJ2	Corrosive	R34	SK	3

14	FRA	Harmful	R22 R36/37/38, R41	SK	3
15	IGA-2	Irritant	R36	SK	2
16	IGG-2	Irritant	R36	SK	2
17	IGM-2	Irritant	R36	SK	2
18	IRON2	Corrosive	R35	SK	4
19	MG2	Irritant	R36, R38	SK	2
20	PHOS2	Corrosive	R35	SK	4
21	TP2	Corrosive	R35	SK	4
22	TPUC3	Corrosive	R20, R22 R34, R35	SK	4
23	UA2	Irritant	R36	SK	2
24	UIBC	Irritant	R37, R40	SK	3
25	Sample Cleaner 2	Corrosive	R35	SK	4
26	AMPS2	Harmful	R22	-	3
27	C.f.a.s. PAC	Harmful	R22	-	3
28	Steriline	Harmful	R21/22/34	SK	3
29	CHOL2	Irritant	R36	SK	2

4.2.2 Haematology

No	Name of Chemical	Hazard Classification	Risk Phrases	Skin Notation ?	Hazard Rating
1	G6PDH Deficiency Screening Test	Harmful	R22, R32	-	3
2	SD Bioline Malaria Ag P.f/Pan, Assay diluent	Irritant	R36	SK	2
3	Immersion oil	Harmful	R22	-	3

4	Entellan	Harmful	R20, R21, R38	SK	3
5	Reticulocyte stain	Harmful	R21, R22, R36 R37, R38	SK	3
6	Leishman's eosin methylene blue	Toxic	R23/24/25	SK	4
7	CELLCLEAN AUTO	Corrosive	R34	SK	3
8	Fluorocell WDF	Harmful	R22	-	3
9	Fluorocell WNR	Harmful	R22	-	3
10	NOVACLONE Medical Diagnostic Reagent	Harmful	R22	-	3
11	Histolene	Irritant	R36, R37, R38	SK	3
12	DEPEX Mounting Medium	Toxic	R24, R60, R38	SK	4
13	NaOH	Irritant	R36, R38	SK	2

4.2.3 Specimen Grossing

No	Name of Chemical	Hazard Classification	Risk Phrases	Skin Notation ?	Hazard Rating
1	Formalin 10%	Harmful	R20/21/22, R40/43	SK	3

4.2.4 Specimen Processing and Routine Staining

No	Name of Chemical	Hazard Classification	Risk Phrases	Skin Notation ?	Hazard Rating
1	Ultraclear	Irritant	R65, R37	-	3
2	Formalin solution 10%	Harmful	R20/21/22, R40, R43	SK	3
3	Reagent Alcohol 100%	Harmful	R20/21/22	SK	3
4	Decalcifier I®, Decalcifier I® Modified	Harmful	R20/21/22, R40, R43	SK	3
5	Decalcifier 2	Corrosive	R34, R37	SK	3
6	Isopropanol 100%	Irritant	R36	SK	2
7	Paralast™	Harmful	R40	SK	3
8	Eosis 515Lt	Harmful	R36, R38, R20/21/22	SK	3
9	Hematoxylin 560MX	Harmful	R22, R36	SK	3
10	Sub-X® Xylene Substitute	Harmful	R40	-	3
11	Entellan®	Harmful	R20/21, R38	SK	3
12	Eosin Y	Irritant	R36	SK	2
13	Ethanol 96	Irritant	R36/37/38	SK	3
14	2-Propanol	Irritant	R36, R38	SK	2
15	Xylene (98.5%)	Harmful	R20/21, R38	SK	3
16	Hematoxylin 560	Harmful	R22	-	3

4.2.5 Specimen Processing and Special Stain

No	Name of Chemical	Hazard Classification	Risk Phrases	Skin Notation ?	Hazard Rating
1	Acetic acid (>=10% - <20%)	Irritant	R36, R38	SK	2
2	Acetone (<=100%)	Irritant	R36, R66, R67	SK	2
3	Alcian Blue (>=1% - <5%)	Corrosive	R35	SK	4
4	Ammonia solution 25%	Corrosive	R34, R37	SK	3
5	Methenamine (<100%)	Sensitizing	R43	SK	2
6	Sodium disulphite	Harmful	R31, R22, R41	SK	3
7	Sulphuric acid (>=25% - <50%)	Corrosive	R35	SK	4
8	Toluene (<100%)	Harmful	R63, R48, R20, R65, R38	SK	3
9	Tungstophosporic acid hydrate (<=100%)	Corrosive	R34	SK	3
10	Hydrochloric acid (<36.5%)	Corrosive	R34	SK	3
11	Chromium (VI) oxide (<=100%)	Very Toxic	R45, R46, R62, R26, R24/25-48/23, R35, R42/43	SK	5

4.2.6 Immunohistochemistry Staining

No	Name of Chemical	Hazard Classification	Risk Phrases	Skin Notation ?	Hazard Rating
1	DAB Quanto Chromogen	Irritant	R36, R37, R38	SK	3
2	Quanto HRP	Irritant	R36, R37, R38	SK	3
3	Tri Buffered Saline	Irritant	R36	SK	2
4	10X EZ Prep Solution, 2L	Irritant	R36, R37, R38	SK	3
5	10X SSC Solution, 2L	Irritant	R36, R37, R38	SK	3
6	Bluing Reagent	Irritant	R36, R38	SK	2
7	Cell Ceonditioning Solution (CC2), 1L	Irritant	R36	SK	2
8	Hematoxylin II	Harmful	R22, R34, R36, R37	SK	3
9	LCS	Irritant	R36, R37, R38	SK	3
10	Ultra-view silver wash II	Irritant	R36, R37, R38	SK	3
11	Ultra-view SISH DNP Detection Kit	Harmful	R43, R40	SK	3
12	Ultra-view Universal DAB Detection Kit	Irritant	R38, R36, R45	SK	2
13	Hydrogen peroxide 30%	Harmful	R22, R41	SK	3
14	INFORM HER2 DUAL ISH DNA PROBE CKTL US	Harmful	R61, R40	-	3

15	Reaction Buffer Concentrate	Harmful	R38, R36, R20	SK	3
16	Confirm ™ Primary Antibodies	Irritant	R36, R37, R38, R43	SK	3
17	ULTRAVIEW RED ISH DIG DETECTION KIT	Irritant	R36	SK	2

4.2.7 Surepath Test

No	Name of Chemical	Hazard Classification	Risk Phrases	Skin Notation ?	Hazard Rating
1	Alcohol 100%	Harmful	R68, R20, R21, R22	SK	3
2	BD Prepstain™ Alcohol Blend Rinse	Harmful	R36, R40	SK	3
3	BD Prepstain™ Hematoxylin Stain	Harmful	R22, R36, R37, R38	SK	3
4	Density Reagent	Harmful	R22	SK	3
5	DPX non-aqueous mounting medium for microscopy	Harmful	R20, R21, R38	SK	3
6	Entellan® new rapid mounting medium for microscopy	Harmful	R20, R21, R38	SK	3
7	Histolene	Irritant	R38, R43	SK	2
8	Isopropanol 100%	Irritant	R36	SK	2
9	Sub-X® Xylene Substitute	Irritant	R36, R37, R38	SK	3
10	Hematoxylin 560	Harmful	R22	-	3

11	Orange G-6	Harmful	R20, R21, R22, R68	SK	3
12	Eosin 515 Lt	Harmful	R20, R21, R22, R68	SK	3
13	Tris Buffered Saline	Irritant	R36, R37, R38	SK	3

4.2.8 Non-Gynae Sample

No	Name of Chemical	Hazard Classification	Risk Phrases	Skin Notation ?	Hazard Rating
1	May-Grunwald Stain (Methanol 100%)	Toxic	R23/24/25	SK	4

4.2.9 Cell Block Sample

No	Name of Chemical	Hazard Classification	Risk Phrases	Skin Notation ?	Hazard Rating
1	STA® - NEOPLASTINE® CI PLUS	Harmful	R20, R22, R38, R43	SK	3

4.2.10 Bacteriology

No	Name of Chemical	Hazard Classification	Risk Phrases	Skin Notation ?	Hazard Rating
1	TDA Reagent	Irritant	R36	SK	2
2	Peptidase Reagent	Harmful	R34, R22, R21, R20, R37, R38, R36	SK	3
3	Indol Reagent	Corrosive	R37, R35	SK	4
4	Vitek-MS CHCA	Harmful	R20/21/22, R36/37/38	SK	3
5	Vitek-MS FA	Corrosive	R34	SK	3
6	Xpert MTB/RIF	Corrosive	R34, R36, R62	SK	3

4.3 Exposure Rating

4.3.1 Biochemistry

No.	Name of Chemical	Frequency Duration (FR)	Degree Chemical Release	Degree Contact	MR	ER
1	Cell Wash Solution II / Acid Wash	2	L	L	1	2
2	C.f.a.s. HbA1c	2	L	L	1	2
3	C.f.a.s. Lipids	3	L	L	1	2
4	Eco Tergent, Cobas c501/502, 12x59ml	3	L	L	1	2
5	NaOH (sodium hydroxide 2-5%)	5	L	L	1	3
6	ALB2	5	L	L	1	3
7	ALP2	5	L	L	1	3
8	ASLOT	5	L	L	1	3
9	BIL-D Gen. 2	5	L	L	1	3
10	BIL-T Gen. 3	5	L	L	1	3
11	CHOL2	5	L	L	1	3
12	Creatine Kinase	5	L	L	1	3
13	CREJ2	5	L	L	1	3
14	FRA	4	L	L	1	2
15	IGA-2	4	L	L	1	2
16	IGG-2	4	L	L	1	2
17	IGM-2	4	L	L	1	3
18	IRON2	5	L	L	1	3
19	MG2	5	L	L	1	3
20	PHOS2	5	L	L	1	3
21	TP2	5	L	L	1	3
22	TPUC3	5	L	L	1	3
23	UA2	5	L	L	1	3

24	UIBC	5	L	L	1	3
25	Sample Cleaner 2	5	L	L	1	3
26	AMPS2	4	L	L	1	2
27	C.f.a.s. PAC	2	L	L	1	2
28	Steriline	2	L	L	1	3
29	CHOL2	5	L	L	1	3

4.3.2 Hematology

No.	Name of Chemical	Frequency Duration (FR)	Degree Chemical Release	Degree Contact	MR	ER
1	G6PDH Deficiency Screening Test	2	L	L	1	2
2	SD Bioline Malaria Ag P.f/Pan, Assay diluent	3	L	L	1	2
3	Immersion oil	5	L	L	1	3
4	Entellan	5	L	L	1	3
5	Reticulocyte stain	4	L	L	1	2
6	Leishman's eosin methylene blue	5	L	L	1	3
7	CELLCLEAN AUTO	5	L	L	1	3
8	Fluorocell WDF	5	L	L	1	3
9	Fluorocell WNR	5	L	L	1	3
10	NOVACLONE Medical Diagnostic Reagent	5	L	L	1	3
11	Histolene	5	L	L	1	3
12	DEPEX Mounting Medium	5	L	L	1	3
13	NaOH	4	L	L	1	2

4.3.3 Specimen grossing

No.	Name of Chemical	Frequency Duration (FR)	Degree Chemical Release	Degree Contact	MR	ER
1	Formalin 10%	5	L	L	1	3

4.3.4 Specimen Processing and Routine Staining

No.	Name of Chemical	Frequency Duration (FR)	Degree Chemical Release	Degree Contact	MR	ER
1	Ultraclear	5	L	L	1	3
2	Formalin solution 10%	5	M	L	2	4
3	Reagent Alcohol 100%	5	M	L	2	4
4	Decalcifier I®, Decalcifier I® Modified	4	M	L	2	4
5	Decalcifier 2	4	M	L	2	3
6	Isopropanol 100%	5	M	L	2	3
7	Paralast™	5	M	L	2	4
8	Eosis 515Lt	5	M	L	2	4
9	Hematoxylin 560MX	5	M	L	2	4
10	Sub-X® Xylene Substitute	5	M	L	2	4
11	Entellan®	5	M	L	2	4
12	Eosin Y	5	M	L	2	4
13	Ethanol 96	5	M	L	2	4
14	2-Propanol	5	M	L	2	4
15	Xylene (98.5%)	3	M	L	2	3
16	Hematoxylin 560	5	M	L	2	3

4.3.5 Specimen Processing and Special Stain

No.	Name of Chemical	Frequency Duration (FR)	Degree Chemical Release	Degree Contact	MR	ER
1	Acetic acid (>=10% - <20%)	2	L	L	1	2
2	Acetone (<=100%)	2	L	L	1	2
3	Alcian Blue (>=1% - <5%)	3	L	L	1	2
4	Ammonia solution 25%	3	L	L	1	2
5	Methenamine (<100%)	4	L	L	1	2
6	Sodium disulphite	4	L	L	1	3
7	Sulphuric acid (>=25% - <50%)	3	L	L	1	3
8	Toluene (<100%)	4	L	L	1	2
9	Tungstophosporic acid hydrate (<=100%)	3	L	L	1	2
10	Hydrochloric acid (<36.5%)	3	L	L	1	2
11	Chromium (VI) oxide (<=100%)	4	L	L	1	2

4.3.6 Immunohistochemistry

No.	Name of Chemical	Frequency Duration (FR)	Degree Chemical Release	Degree Contact	MR	ER
1	DAB Quanto Chromogen	5	L	L	1	3
2	Quanto HRP	2	L	L	1	2
3	Tri Buffered Saline	1	L	L	1	1
4	10X EZ Prep Solution, 2L	5	L	L	1	3
5	10X SSC Solution, 2L	5	L	L	1	3
6	Bluing Reagent	5	L	L	1	3
7	Cell Ceonditioning Solution (CC2), 1L	5	L	L	1	3
8	Hematoxylin II	5	L	L	1	3

9	LCS	5	L	L	1	3
10	Ultra-view silver wash II	5	L	L	1	3
11	Ultra-view SISH DNP Detection Kit	5	L	L	1	3
12	Ultra-view Universal DAB Detection Kit	5	L	L	1	3
13	Hydrogen peroxide 30%	1	L	L	1	1
14	INFORM HER2 DUAL ISH DNA PROBE CKTL US	4	L	L	1	2
15	Reaction Buffer Concentrate	5	L	L	1	3
16	Confirm ™ Primary Antibodies	5	L	L	1	3
17	ULTRAVIEW RED ISH DIG DETECTION KIT	5	L	L	1	3

4.3.7 Surepath Test

No.	Name of Chemical	Frequency Duration (FR)	Degree Chemical Release	Degree Contact	MR	ER
1	Alcohol 100%	5	L	L	1	2
2	BD Prepstain™ Alcohol Blend Rinse	5	L	L	1	2
3	BD Prepstain™ Hematoxylin Stain	5	L	L	1	2
4	Density Reagent	5	L	L	1	2
5	DPX non-aqueous mounting medium for microscopy	5	L	L	1	2
6	Entellan® new rapid mounting medium for microscopy	5	L	L	1	2
7	Histolene	5	L	L	1	2
8	Isopropanol 100%	5	L	L	1	2
9	Sub-X® Xylene Substitute	5	L	L	1	2

10	Hematoxylin 560	5	L	L	1	2
11	Orange G-6	5	L	L	1	2
12	Eosin 515 Lt	5	L	L	1	2
13	Tris Buffered Saline	5	L	L	1	2

4.3.8 Non-Gynae Sample

No.	Name of Chemical	Frequency Duration (FR)	Degree Chemical Release	Degree Contact	MR	ER
1	May-Grunwald Stain	5	L	L	1	3

4.3.9 Cell Block Sample

No.	Name of Chemical	Frequency Duration (FR)	Degree Chemical Release	Degree Contact	MR	ER
1	STA® - NEOPLASTINE® CI PLUS	5	L	L	1	3

4.3.10 Bacteriology

No.	Name of Chemical	Frequency Duration (FR)	Degree Chemical Release	Degree Contact	MR	ER
1	TDA Reagent	5	L	L	1	3
2	Peptidase Reagent	5	L	L	1	3
3	Indol Reagent	5	L	L	1	3
4	Vitek-MS CHCA	5	L	L	1	3
5	Vitek-MS FA	5	L	L	1	3

6	Xpert MTB/RIF	5	L	L	1	3

4.4 Adequacy of Existing Control

From the observation, the existing control measure mostly available and adequate. Personal protective equipment were provided to staff such as nitrile glove, face mask, goggle and lab coat. General ventilation and local exhaust ventilation were applied in laboratory area. Staff used fume cupboard when handling the chemicals to perform their works and this equipment also have regular maintenance.

4.5 Conclusion of the Assessment

For the conclusion, risk rating is computed first based on hazard rating (HR) and exposure rating (ER). Then, the conclusion can be made according to the risk rating (RR) and the assessment of existing control measures. The conclusion for every chemicals are shown in table below.

4.5.1 Biochemistry

No	Name of Chemical	Risk Rating (RR)	Control Adequacy (Yes/No)	Conclusion
1	Cell Wash Solution II / Acid Wash	2	YES	C1
2	C.f.a.s. HbA1c	2	YES	C1
3	C.f.a.s. Lipids	3	YES	C2
4	Eco Tergent, Cobas c501/502, 12x59ml	3	YES	C2
5	NaOH (sodium hydroxide 2-5%)	3	YES	C2
6	ALB2	3	YES	C2

7	ALP2	3	YES	C2
8	ASLOT	3	YES	C2
9	BIL-D Gen. 2	3	YES	C2
10	BIL-T Gen. 3	4	YES	C2
11	CHOL2	4	YES	C2
12	Creatine Kinase	3	YES	C2
13	CREJ2	3	YES	C2
14	FRA	3	YES	C2
15	IGA-2	2	YES	C1
16	IGG-2	2	YES	C1
17	IGM-2	2	YES	C1
18	IRON2	4	YES	C2
19	MG2	3	YES	C2
20	PHOS2	4	YES	C2
21	TP2	4	YES	C2
22	TPUC3	4	YES	C2
23	UA2	3	YES	C2
24	UIBC	3	YES	C2
25	Sample Cleaner 2	4	YES	C2
26	AMPS2	3	YES	C2
27	C.f.a.s. PAC	3	YES	C2
28	Steriline	3	YES	C2
29	CHOL2	3	YES	C2

4.5.2 Haematology

No	Name of Chemical	Risk Rating (RR)	Control Adequacy (Yes/No)	Conclusion
1	G6PDH Deficiency Screening Test	3	YES	C2

2	SD Bioline Malaria Ag P.f/Pan, Assay diluent	2	YES	C1
3	Immersion oil	3	YES	C2
4	Entellan	3	YES	C2
5	Reticulocyte stain	3	YES	C2
6	Leishman's eosin methylene blue	4	YES	C2
7	CELLCLEAN AUTO	3	YES	C2
8	Fluorocell WDF	3	YES	C2
9	Fluorocell WNR	3	YES	C2
10	NOVACLONE Medical Diagnostic Reagent	3	YES	C2
11	Histolene	3	YES	C2
12	DEPEX Mounting Medium	4	YES	C2
13	NaOH	2	YES	C1

4.5.3 Specimen Grossing

No	Name of Chemical	Risk Rating (RR)	Control Adequacy (Yes/No)	Conclusion
1	Formalin 10%	3	No	C3

4.5.4 Specimen Processing and Routine Staining

No	Name of Chemical	Risk Rating (RR)	Control Adequacy (Yes/No)	Conclusion
1	Ultraclear	3	YES	C2
2	Formalin solution 10%	4	NO	C3
3	Reagent Alcohol 100%	4	NO	C3
4	Decalcifier I®, Decalcifier I® Modified	4	YES	C2

5	Decalcifier 2	3	YES	C2
6	Isopropanol 100%	3	YES	C2
7	Paralast™	4	YES	C2
8	Eosis 515Lt	4	YES	C2
9	Hematoxylin 560MX	4	YES	C2
10	Sub-X® Xylene Substitute	4	NO	C3
11	Entellan®	4	NO	C3
12	Eosin Y	3	YES	C2
13	Ethanol 96	4	YES	C2
14	2-Propanol	3	YES	C2
15	Xylene (98.5%)	3	NO	C3
16	Hematoxylin 560	3	YES	C2

4.5.5 Specimen Processing and Special Stain

No	Name of Chemical	Risk Rating (RR)	Control Adequacy (Yes/No)	Conclusion
1	Acetic acid (>=10% - <20%)	2	YES	C1
2	Acetone (<=100%)	2	YES	C1
3	Alcian Blue (>=1% - <5%)	3	YES	C2
4	Ammonia solution 25%	3	YES	C2
5	Methenamine (<100%)	2	YES	C1
6	Sodium disulphite	3	YES	C2
7	Sulphuric acid (>=25% - <50%)	4	NO	C3
8	Toluene (<100%)	3	NO	C3
9	Tungstophosporic acid hydrate (<=100%)	3	YES	C2
10	Hydrochloric acid (<36.5%)	3	YES	C2
11	Chromium (VI) oxide (<=100%)	3	YES	C2

4.5.6 Immunohistochemistry Staining

No	Name of Chemical	Risk Rating (RR)	Control Adequacy (Yes/No)	Conclusion
1	DAB Quanto Chromogen	3	NO	C3
2	Quanto HRP	3	NO	C3
3	Tri Buffered Saline	2	NO	C1
4	10X EZ Prep Solution, 2L	3	NO	C3
5	10X SSC Solution, 2L	3	NO	C3
6	Bluing Reagent	3	NO	C3
7	Cell Ceonditioning Solution (CC2), 1L	3	NO	C3
8	Hematoxylin II	3	NO	C3
9	LCS	3	NO	C3
10	Ultra-view silver wash II	3	NO	C3
11	Ultra-view SISH DNP Detection Kit	3	NO	C3
12	Ultra-view Universal DAB Detection Kit	3	NO	C3
13	Hydrogen peroxide 30%	2	NO	C1
14	INFORM HER2 DUAL ISH DNA PROBE CKTL US	3	NO	C3
15	Reaction Buffer Concentrate	3	NO	C3
16	Confirm ™ Primary Antibodies	3	NO	C3
17	ULTRAVIEW RED ISH DIG DETECTION KIT	3	NO	C3

4.5.7 Surepath Test

No	Name of Chemical	Risk Rating (RR)	Control Adequacy (Yes/No)	Conclusion
1	Alcohol 100%	3	NO	C3
2	BD Prepstain™ Alcohol Blend Rinse	3	NO	C3
3	BD Prepstain™ Hematoxylin Stain	3	YES	C2
4	Density Reagent	3	YES	C2
5	DPX non-aqueous mounting medium for microscopy	3	YES	C2
6	Entellan® new rapid mounting medium for microscopy	3	NO	C3
7	Histolene	2	YES	C1
8	Isopropanol 100%	2	YES	C1
9	Sub-X® Xylene Substitute	3	YES	C2
10	Hematoxylin 560	3	YES	C2
11	Orange G-6	3	YES	C2
12	Eosin 515 Lt	3	YES	C2
13	Tris Buffered Saline	3	YES	C2

4.5.8 Non-Gynae Sample

No	Name of Chemical	Risk Rating (RR)	Control Adequacy (Yes/No)	Conclusion
1	May-Grunwald Stain	4	NO	C3

4.5.9 Cell Block Sample

No	Name of Chemical	Risk Rating (RR)	Control Adequacy (Yes/No)	Conclusion
1	STA® - NEOPLASTINE® CI PLUS	3	YES	C2

4.5.10 Bacteriology

No	Name of Chemical	Risk Rating (RR)	Control Adequacy (Yes/No)	Conclusion
1	TDA Reagent	3	YES	C2
2	Peptidase Reagent	3	YES	C2
3	Indol Reagent	4	YES	C2
4	Vitek-MS CHCA	3	YES	C2
5	Vitek-MS FA	3	YES	C2
6	Xpert MTB/RIF	3	YES	C2

4.5.11 Summary of the Assessment Conclusion

Work Unit	**Laboratory Department**	**Number of Chemicals Assessed**	**Conclusion**
Biochemistry	Biochemistry	29	C2
Haematology	Heamatology	13	C2
Specimen Grossing	Histopathology	1	C3
Specimen Processing and Routine Staining	Histopathology	16	C3
Specimen Processing and Special Stain	Histopathology	11	C3

Immunohistochemistry Staining	Histopathology	17	C3
Surepath Test	Cytopathology	13	C3
Non-Gynae Sample	Cytopathology	1	C3
Cell Block Sample	Cytopathology	1	C2
Bacteriology	Microbiology	6	C2

CHAPTER 5

5.0 DISCUSSION

5.1 Conclusion of Assessment

From the result, all work units from Biochemistry, Haematology and Microbiology can be concludes with C2. Therefore, these departments can continue with their current practice. However, the work units from Histopathology and Cytopathology departments fall into C3 conclusion which is the risk of chemicals is significant but not adequately control. These departments need to identify precautions, measures, requirement for monitoring or health surveillance that need to be taken to maintain controls and minimize exposures.

5.2 Technical Measures

5.2.1 Elimination / Substitution

From the observation, the chemicals used are essential in order to perform laboratory testing. Most of the laboratory analyser or equipment are provided together with their chemicals or reagents. Therefore, there is no planning to eliminate or substitute those chemicals with high hazard rating. The staff can continue to use the chemicals with their existing control measure.

5.2.2 Isolation / Enclosure

All work unit is being carried out according to their specific area and isolated from other activities. All laboratory department located at their respective floor such as Level 3, 4, 5 and 6 and separated from office area which located at Level 1 and 2. The flammable and corrosive chemicals are stored separately within their designated cabinet storage. The chemicals are stored separately because to prevent incompatible when stored together. Other than that, chemical wastes disposal is located at separated area. The chemical waste is temporarily keep in laboratory while waiting waste collection. Waste collection is held once a week and usually

on Friday. Prior to waste disposal, lab personnel will fill up waste collection form to indicate the amount of waste generated at their laboratory.

5.2.3 Ventilation

The general ventilation and local exhaust ventilation are applied in all laboratory. General ventilation refers to the ventilation system covering the entire work area. The general ventilation system distributes fresh air through the work space through external air intake. Air from outside the workplace is mixed with the indoor air. The recommended ventilation rate from various standards and guidelines varies from 4 to 12 air changes per hour (ACH) (Jin, Memarzadeh, Lee, & Chen, 2012). There are about 10 to 12 ACH applied in the all laboratory to control level of volatile chemicals and airborne contaminant concentration maintaining a comfortable environment (Stuart, Sweet, & Batchelder, 2015). The general ventilation of the workplace is suitable for the area does not produce other concentration of smoke, dust, or air pollutant. This is because the general ventilation system does not remove pollutants from the air, but only dilutes them by mixing the air of working space with fresh supply from the outside. An efficient and capable method to this problem is the installation of local exhaust ventilation (LEV). LEV captures airborne contaminants close to the source of emission. It is generally achieved by using hood, duct, air cleaner, fan and discharge which remove contaminants before they have a chance to escape in workstations. LEV is used in order to help reducing workers exposure to contaminants at workstations. The use of LEV resulted in an overall exposure reduction of 92% (Croteau, Flanagan, Camp, & Seixas, 2004). From the observation, there are fume hood, biosafety cabinet, and article arm available in the laboratory. These equipment is part of element for LEV system. Laboratory staff will using fume hood when handling the chemicals to perform their task. The LEV system also were tested annually by Hygiene Technician 2 registered with DOSH to ensure the system is effective. The effectiveness of the

LEV system is determined with sufficient air flow to capture the contaminants. Result of LEV testing are found meet the minimum requirement of ACGIH Standard of Recommendation and Australian Standard – Safety in Laboratories AS2243.8 Fume Cupboards.

5.2.4 Work Practice / System of Work

Laboratory staffs have shown their good work practice during performing their works. They were briefed by lab manager and supervisor every time in the early morning before started their works. Lab manual and Standard Operating Procedure (SOP) are available and easily accessible. Every work units have their own SOP for handling of chemicals hazardous to health. Every incident or accident due to chemicals will be reported and investigated through Incident Form.

Chemical register and safety data sheet are available in the laboratory. All chemicals must be registered in a form known as Chemical Hazardous List to Health based Guidelines for Preparation of Chemical List. The chemical list and safety data sheet will provide information on trade and the general name, chemical composition, quantity used and location where chemicals are used or stored. Based on Method 5 (1), Occupational Safety and Health (Use and Exposure Standards of Chemicals Hazardous to Health, 2000) specifies that employers should identify and record on the list of all hazardous chemicals to health used in the workplace. This chemical list is used as a reference to staff regarding the dangers of chemicals found in their workplace and the precautionary measures to take in case of accident (Husin et al., 2012).

5.2.5 Personal Protection

Personal protective equipment (PPE) are compulsory to wear when entering the laboratory and performing any work task. From the observation made, the staffs were equipped with necessary PPE such as nitrile gloves, face mask, lab coat and safety glasses. Personal protective equipment provided also located at an open and easy to access location. There are also PPE issuance and PPE inspection form. This form need to be filled every months for records and also to ensure the PPE available are in good condition. However, for work units under Histopathology and Cytopathology department, the adequacy and suitability of PPE need to be assessed. These department involves with harmful chemical such as formalin, toluene and xylene. The routes of entries are through inhalation, skin and eye contact. Thus, the chemical exposure monitoring for these chemicals shall be carried out for the purposes of evaluating current PPE provided.

5.3 Action to Control

In order to control current condition, the chemical exposure monitoring for some chemicals need to be carried out. Chemical exposure monitoring is needed to ensure that airborne chemicals exposed to staffs are within permissible limits. These permissible exposure limits (PELs) have been established by the Occupational Safety and Health Administration (OSHA). The purpose of this monitoring also to evaluate the suitability of personal protective equipment such as nitrile gloves and face mask with the specific hazardous chemical such as formaldehyde. If the results of the monitoring indicates the presence of health effects on the staff, the current PPE needs to be substituted with other suitable PPE. According to the result of this study, chemical exposure monitoring need to be carried out for formaldehyde, isopropyl alcohol, xylene, ethanol and ethylene glycol.

In the Histopathology Laboratory, there is an unpleasant odor or smells of formaldehyde in the atmosphere. Breathing of formaldehyde can cause irritation in the eyes and nose, which may cause burning, stinging or itching sensations, a sore throat, watery eyes, blocked sinuses, runny nose, and sneezing (Ahmed, 2011). Although, there are local exhaust ventilation are according to ACGIH standard, it is recommended to improve general ventilation in order to reduce the smells. There should be a minimum of 6 to 12 air changes per hour, and should be increased until 12 ACH if the current ACH is insufficient. There should be also 100% exhaust to outside for all work area. This is to ensure air from the laboratory not be recirculated within a facility (Karen, Anne, Rodney, Patrick, & Jonathan, 2007). Other than that, staffs need to use local exhaust ventilation such as fume hood, article arm, grossing station and downdraft workstation that available in the laboratory when handling the specimen.

It is recommended also for labelling of chemical's container should follow the Occupational Safety and Health (Classification, Labelling and Safety Data Sheet for Hazardous chemical) Regulations 2013. Ensure that all chemical's container are clearly labeled with the chemical's name, supplier information, signal word, hazards statements, hazard pictogram and precautionary statement (OSHA, 1994).

CHAPTER 6

6.0 CONCLUSION

This Chemical Health Risk Assessment was conducted at a private medical laboratory located in Kuala Lumpur. The involved departments are Biochemistry, Hematology, Histopathology and Cytopathology. This study was done according to the standards and guidelines set by the Department of Occupational Safety and Health (DOSH). Through this assessment, chemicals hazardous to health were identified, and conclusion for each of the work unit had been assigned respectively. Appropriate recommendation based on the safety data sheet, observation and regulations were being made.

Overall, 10 work units with total 108 chemicals managed to be assessed. The assessments conducted can be conclude that the risk of hazardous chemicals at the laboratories is significant either C2 or C3. Four work units were marked C2 and the other six work units fall under C3. The work units that fall under C2 conclusion can continue the current practice and maintaining their control measure while for C3 conclusion, the current control measures can be further improved in the effort to provide safe working environment for laboratory staff. Although C2 can defined as the risk is significant and adequately controlled, the possibilities of risk might increase in the future if there is failure of control measures and change in the work process.

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