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Expert Opinion

MEDICAL SURVEILLANCE ON CHEMICALS HAZARDOUS TO HEALTH IN MALAYSIA

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1. INTRODUCTION

Medical surveillance as defined under the Occupational Safety and Health (Use and Standards of Exposure of Chemicals Hazardous to Health) Regulations 2000, or USECHH Regulations 2000 is “the monitoring of a person for the purpose of identifying changes in health status due to occupational exposure to chemicals hazardous to health” [1]. Chemicals hazardous to health are, as defined by USECHH Regulations 2000, any chemical or preparation which:

a) is listed in Schedule I or II.
b) possesses any of the properties categorized in Part B of Schedule I of the Occupational Safety and Health (Classification, Packaging and Labeling of Hazardous Chemicals) Regulations 1997. This Regulation has been superseded by the Occupational Safety and Health (Classification, Labeling and Safety Data Sheet of Hazardous Chemicals) Regulations 2013, or CLASS Regulations 2013.
c) comes within the definition of "pesticide" under the Pesticides Act 1974 [Act 149].
d) is listed in the First Schedule of the Environmental Quality (Scheduled Wastes) Regulations 1989.

Based on the definition above, “occupational exposure” to these hazardous chemicals is the prerequisite for conducting medical surveillance. In industries, occupational exposure takes place during various tasks carried out by the employees at the workplace. Tasks of mixing chemicals, performing maintenance works or carrying out laboratory tests potentially expose the employees to the hazardous chemicals that they handle. To eliminate or minimize the exposure, various preventive measures known as control measures are used. Gloves, goggles or fume cupboard are among the control measures intended to protect the employees from exposure to the hazardous chemicals. Breach in any of these control measures will potentially expose the employees to the hazardous chemicals, and put them at risk of contracting adverse health effects. Thus, to monitor their health as a result of exposure to the hazardous chemicals, medical surveillance needs to be conducted.

Department of Occupational Safety and Health Malaysia, or DOSH, has provided a guideline on how medical surveillance should be conducted [2]. This guideline outlines the tests to be carried out on 35 chemicals as part of medical surveillance program. However, this guideline lacks the details on why medical surveillance must be conducted. Thus, the author of this article will focus on the issue on *why* medical surveillance shall be conducted rather than *how* to conduct the medical surveillance.

2. CHEMICAL HEALTH RISK ASSESSMENT (CHRA)

Under the USECHH Regulations 2000, CHRA is a written risk assessment that must be carried out by employer prior to allowing any chemical to be used in the workplace [1]. It is a *qualitative* risk assessment based on observation at workplace. The assessment is essentially to evaluate the potential risks to employees as a result of exposure to the hazardous chemicals. For that reason, CHRA will look into the availability and adequacy of control measures at the workplace. Control measures act as barriers against hazardous chemicals from being in contact with the employees. There are four (4) routes where chemicals can get into contact with the employees and subsequently enter into the body. These are through inhalation, skin contact, ingestion and rarely inoculation. Control measures must be adequate to protect the routes of entry.

Apart from that, the CHRA report will recommend to the employers on the necessity to conduct airborne chemical monitoring and/or medical surveillance on their employees. These are essential to *quantitatively* asses the employees’ degree of exposure to the hazardous chemicals and the health effects from exposure to the hazardous chemicals. Results of chemical monitoring and medical surveillance are important to compliment the CHRA report, which, as mentioned above, is qualitative in nature. To get a better understanding on the association between CHRA and medical surveillance, the concept of risk, control measures and chemical monitoring is elaborated below.

2.1 RISK

There are many definitions of risk, but generally risk is a factor of consequences and probability. When handling hazardous chemicals, risk refers to:

i. Adverse health consequences when employees are exposed to the hazardous chemical, and
ii. Probability of employees being exposed to the hazardous chemicals.

Adverse health effect as a result of exposure to the hazardous chemical is due to the fact that each chemical possesses its own *intrinsic property*. These intrinsic properties may exist in many forms; such as carcinogenic, corrosive, irritant, mutagenic, etc. Following exposure, these chemicals are absorbed into the body, metabolized and excreted or excreted unchanged. However, there are some chemicals which are excreted unchanged. Interaction between these chemicals (or its metabolites) with the body can result in adverse health effects.

In industrial practice, each chemical will be assigned hazard rating that ranges from 1 to 5 based on its toxicity exerted by the intrinsic properties [3]. Chemicals with ratings 5 are most hazardous whereas those with ratings 1 are considered non-hazardous. It follows that based on the rating scale; exposure to chemicals with hazard rating 5 should result in more grave consequences than those with lower ratings. Despite that, these intrinsic properties could be altered through processes such as dilution, mixing, or chemical interaction. For example, acetic acid 100% which is corrosive, will be known as vinegar and edible when diluted to 0.4%.

Probability, on the other hand, refers to the chances of an employee being exposed to the hazardous chemicals at work-place. To objectively gauge the probability of exposure, an exposure rating scale ranges from 1 to 5, is used. Any chemical rated with exposure rating of 5 shows that the employee's probability exposure to the chemical is immense. On the other hand, a chemical rated with exposure rating 1 implies that there is practically no contact between the chemical and employee at all, and thus, the probability of employee being exposed to the chemical is negligible.

If hazard rating depends solely on the intrinsic factor of the chemicals, the probability of exposure is otherwise dependent on other factors [3]. These are:

i. Frequency of exposure.
ii. Duration of exposure.
iii. Intensity or magnitude of exposure.

Frequency of exposure refers to the *number of time* spent in handling chemicals. It can be once a week or twice a year. Duration of exposure otherwise refers to the *amount of time* spent for each session of work. For example, the duration can be six (6) out of eight (8) hours per shift or 75% of work hours, or fifteen (15) minutes performing chemical mixing out of an eight (8) hour shift, or 3% of work hours. Even though frequency and duration of exposure appear similar, they are in fact different. Frequency does not elaborate on the amount of time spent with chemicals as what duration of exposure does [3]. For that reason, frequency of exposure is more relevant to acute health effects, while duration of exposure implies effects of chronic exposure. Thus, duration of exposure gives a good indicator for medical surveillance.

From the above, it is clear that the amount of time spent by an employee in handling the chemicals is important in deciding the probability of one exposing him/herself to the hazardous chemicals. The more frequent and/or the longer time an employee spent in handling chemicals hazardous to health, the higher the exposure rating will be. Consequently, he/she will be more likely to be adversely affected by the hazardous chemicals.

The intensity or magnitude of exposure depends on the degree of chemical release and chemicals absorbed by the employee. A chemical with high vapor pressure (e.g. acetone) will be more readily airborne compared to those with low vapor pressure (e.g. diesel). Thus, acetone will be more easily released into the ambience where the employee is working, and will be more readily inhaled by the employees.

2.1.1 RISK MATRIX

To assess the risk posed by each chemical, a risk matrix is used [3]. The risk matrix has two (2) axes – the x-axis represents Exposure Ratings (ER) while the y-axis shows the Hazard Ratings (HR). Figure 1 shows a typical risk matrix used to assign the Risk Rating for any chemical used in the workplace [3].

The risk matrix above is divided into three (3) colored zones; green, yellow and red. Each zone denotes whether the risk posed by the chemical is significant or not. It could be seen that any chemical with both high hazard and/or exposure ratings will be categorized as chemicals with high Risk Rating. The reverse is true for chemicals with low hazard and/or exposure ratings.

The intrinsic property of a given chemical will determine its degree of toxicity and this is reflected by the assigned hazard rating. In practice, the hazard rating remains unchanged. However, exposure rating can be possibly reduced by implementing appropriate control measures. To illustrate this, imagine if a worker performing a cleaning task bare handedly using a solution with hazard rating 4. This will definitely exposes his skin to the solution and his exposure rating will be 5. However, by wearing appropriate gloves, his skin will not be in contact with the solution, and dramatically, his exposure rating is reduced from 5 to 1. Thus, based on the risk matrix above, his initial Risk Rating of 5 (HR 4, ER 5), has gone down to 2 (HR 4, ER 1). In addition, the Risk Rating has shifted from red to green zone (from "danger" to "safe"). This implies that despite using the same chemical, the risk could be possibly reduced by lowering the exposure rating. The aim is to place all the chemicals into the green zones where risk is not significant and thus, no medical surveillance is required for the employees handling the chemicals.

Another way of achieving the same low Risk Rating is by reducing the hazard rating. This means that the chemical used must be substituted with another less hazardous chemical. Chemical dilution is another possibility to achieve a lower hazard rating. However, in industrial

		EXPOSURE RATINGS (ER)				
		1	2	3	4	5
HAZARD RATING (HR)	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

RR = Risk Rating

RISK NOT SIGNIFICANT	RISK SIGNIFICANT CATEGORY 1	RISK SIGNIFICANT CATEGORY 2

Figure 1: Risk Matrix chart used in assigning Risk Rating for chemical. (Source: DOSH, 2000)

practice, substitution or dilution of chemicals is rarely an option.

2.2 CONTROL MEASURES

Control measures are all the steps taken to prevent or minimize risks [4] . Each of the control measures that will be discussed below is aimed in preventing contact between the chemicals hazardous to health and the employees handling them. In trying to control the identified risks, the measures taken should be in a certain hierarchy or order of priority and an assessment of the adequacy of the control measures need to be made.

2.2.1 Elimination of the hazardous chemicals

Elimination ranks the top in control measures. By eliminating the hazardous chemical in any process, exposure will obviously cease. Thus, no medical surveillance is required for the employees. However, one should bear in mind that certain chemicals which has been eliminated, for example Crocidolite, which is a type of asbestos, will only manifest its adverse health effect after many years, and in some cases, after thirty years. This exception example shows that despite elimination, the affected employee might have to undergo lifelong medical surveillance.

2.2.2 Substitution of the chemicals hazardous to health with a less hazardous chemical

The aim of this control method is to use another chemical of lower toxicity in place of the present chemical. As pointed out by the risk matrix above, this method will effectively shift the hazard rating of the chemical from high to a lower rating. If a suitable chemical is used, the shift will result in the chemical to be placed in the green zone – which means that the particular chemical will not pose a significant risk when handled.

2.2.3 Total enclosure

Total enclosure ensures that the chemicals used are contained and thus, preventing it from escape. Practically, there will be no contact between contained chemical and the employee handling it. Examples are formaldehyde which is supplied in containers or natural gas (which contains Mercury), that runs in a pipeline.

2.2.4 Isolation of the process releasing hazardous chemical

Isolation means removing the source of chemicals from the worker's working environment. It can either be a physical barrier separating the workplace from the employees, or the use of automated process where contact with chemicals will be unlikely.

2.2.5 Use of engineering control equipment

Local exhaust ventilation or LEV is engineering control equipment which will exhaust out chemical contaminants before they come into the employees' breathing zone. A breathing zone is essentially a hemisphere forward of the shoulders within a radius of approximately six to nine inches from the mouth and nose [5]. This control measure removes contaminants at source. A fume cupboard used to carry out laboratory tests is an example of LEV.

2.2.6 Administrative measures

Adoption of safe work practices and procedures are among administrative measures that can be used as control measure. Safe work system is a formal work procedure that results from systematic examination of a task in order to identify all hazards. It defines safe methods to ensure that hazards are eliminated or risks are minimized [4]. By abiding to the safe work practices and procedures, one can reduce the exposure to the chemicals hazardous to health.

2.2.7 Use of Personal Protective Equipment (PPE)

Use of PPE is usually seen as a last resort approach in achieving effective control methods due to problems associated with workers' compliance. In order to be effective, PPE must be properly and continuously worn when handling the chemicals. Respirators, gloves and goggles are among the PPE used to provide protection against chemical exposure.

2.3 CHEMICAL EXPOSURE MONITORING

Chemical Exposure Monitoring is a method used to quantify the concentration of a particular airborne chemical in the workplace. There are two (2) types of monitoring, namely personal and area chemical monitoring. Personal sampling results represent the exposure to the individual who was actually wearing a sampling device. Area samples are taken in a fixed location and results may represent the potential risk from airborne contaminants or physical agents to workers in that area [6]. The result obtained is compared to the Permissible Exposure Limit or PEL of the chemical. As a general rule, if the result is equal or exceeds the Action Level or AL of the chemical, medical surveillance is warranted. AL is typically one-half the value of PEL [7, 8]. It is important to stress that only results of personal chemical monitoring should be considered for medical surveillance. This is due to the reason that PEL values are only applicable to personal chemical monitoring and there is no PEL value for area chemical monitoring.

In interpreting the result, it must be made aware that the result is a sample of chemical concentration of "that particular day" only. Variation in workplace temperature, humidity, ventilation, alteration in process or change in control methods might give a totally different result from the result obtained on the sampling day.

3. INDICATIONS FOR MEDICAL SURVEILLANCE

Based on the discussion above, there are multiple factors that must be taken into consideration before subjecting employees for medical surveillance. In principle, there must be elements of chemical exposure which resulted in significant risk when handling the hazardous chemicals.

3.1 Adequacy of control measures

Control measures are the means to protect employees from being in contact with or exposed to hazardous chemicals. Inadequate control measure will result in escape of the hazardous chemicals into the ambience and risks the employees to be exposed to the chemicals. As a general rule, medical surveillance is warranted if assessment shows that the chemicals are not adequately controlled. Thus, control measures for each chemical as documented in the CHRA report must be reviewed before deciding if there is a need for medical surveillance to be conducted. Decision on conducting medical surveillance based on the control measures is illustrated by Figure 2.

Elimination and substitution of hazardous chemicals means that the chemicals used are no more in use or have been replaced with less toxic chemicals. At one glance, there is no requirement for medical surveillance to be conducted. However, medical surveillance must be considered if the employee has been exposed to the eliminated or substituted chemical before. This is because many adverse health effects will only manifest after years of exposure, despite the fact now the chemicals have since been discarded. Asbestosis which is caused by Crocidolite, cancer-causing asbestos, is a classic example where occupational disease is detected after the employee has probably retired, and no longer exposed to the chemical.

Local Exhaust Ventilation, or LEV, is a control measure used to remove hazardous chemicals at source. In order for LEV to function effectively, various LEV parameters such as face and duct velocities must always fall within range of the recommended values. These values are the standards set by the Professional Engineer during construction and commissioning of the LEV. Failure to obtain these values during LEV inspection and examination means that the LEV is suboptimal.

It is important to know that different chemical requires different face velocity in order for the LEV to exhaust it effectively. For example, face velocity to remove light hydrocarbon would differ from the velocity required to remove silica dust. Thus, each LEV is designed specifically for a particular process and for a particular chemical. If the same LEV is used for different chemicals and processes, the protection might be inadequate. Subsequently, the employees are at risk of being exposed to the hazardous chemicals when they use this LEV. Thus, in such cases, medical surveillance program should be considered.

There are situations where hazardous chemicals can only be controlled using lower hierarchies of control measures. These are the administrative and use of PPE methods. For these chemicals, the author is in the opinion that the employees would still have to undergo medical surveillance – despite the fact that the chemicals are "said to be adequately controlled". The reason is simple. Employees' compliance with these lower hierarchies of control measures is always questionable. A study in Africa on herbicide sprayers indicated that low PPE compliance persists despite workers' awareness of herbicide exposure risks [9].

Based on the control measures, the author of this article would like to propose on how to link between control measures and requirement to conduct medical surveillance.

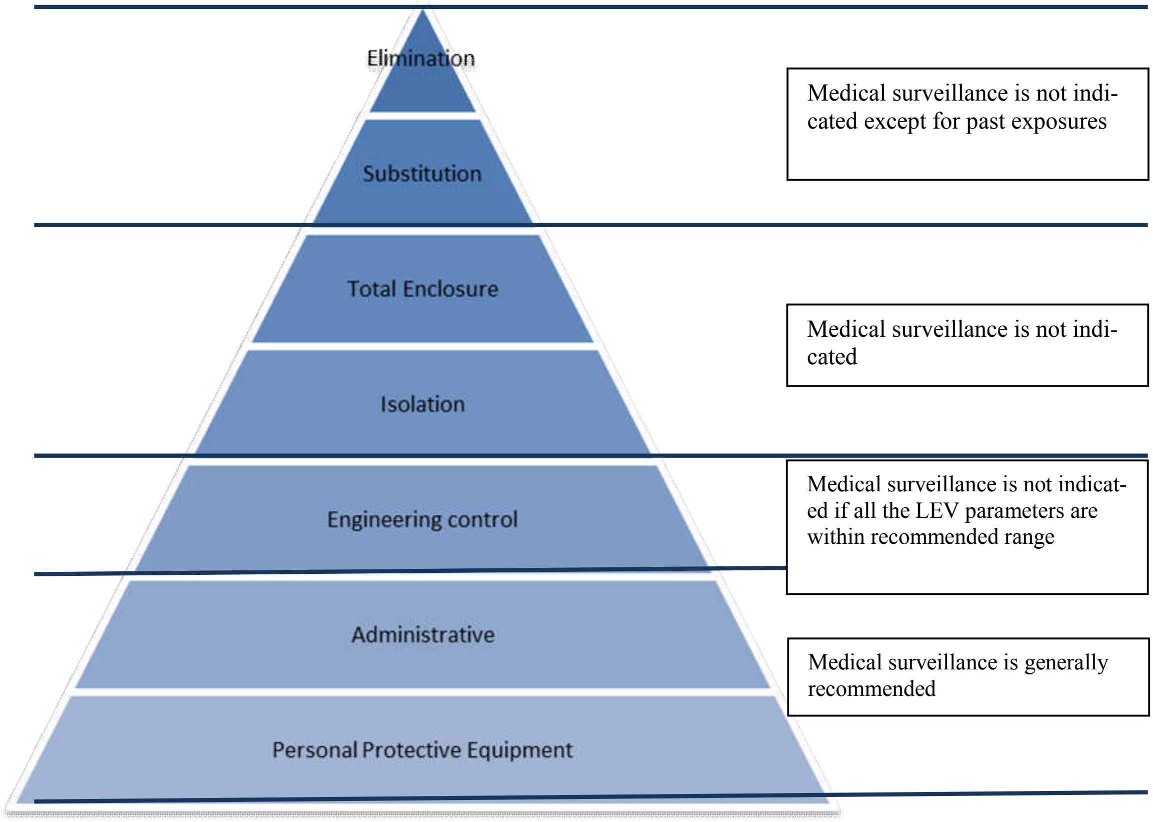

Figure 2: Proposed decision for conducting medical surveillance based on the control measures

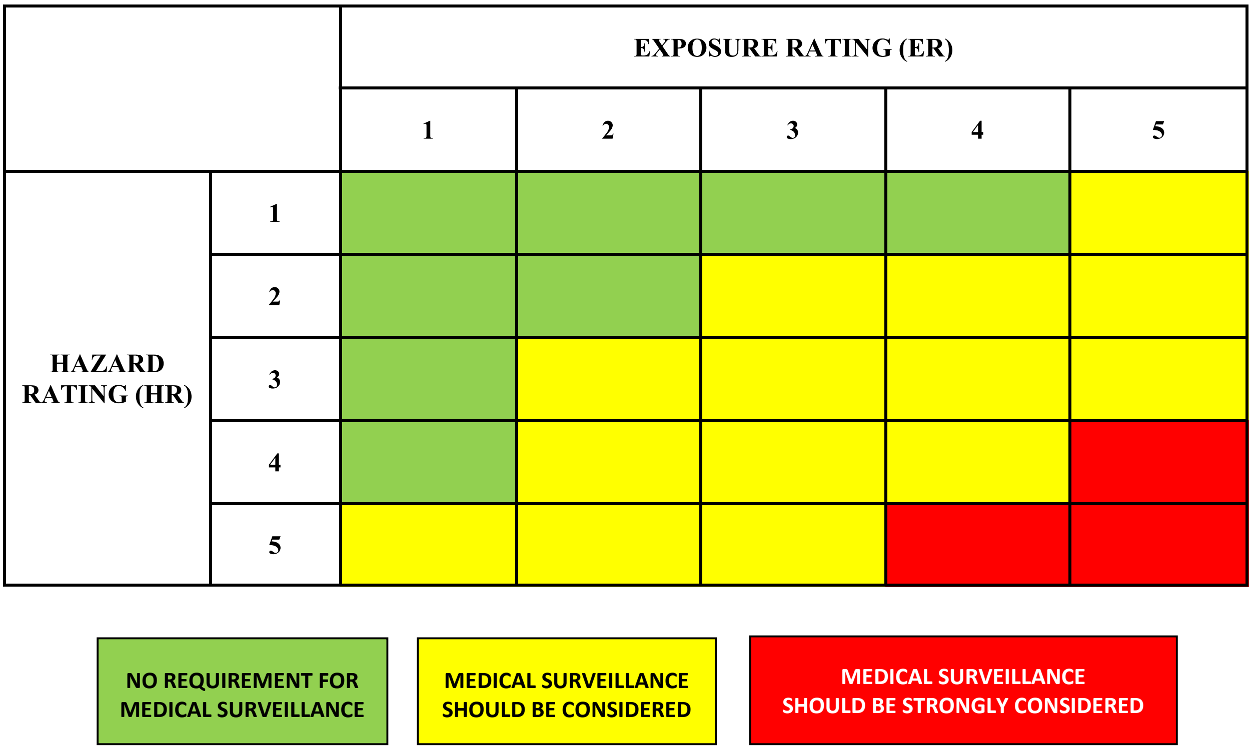

Figure 3: Proposed decision for conducting medical surveillance based on risk ratings.

3.2 Risk rating

Risk rating of any chemical is obtained using the matrix as described in Figure 1 above. The risk here refers to the health risk as a result of exposure to the hazardous chemicals. Obviously, the hazardous chemicals that fall into the green zones are of low risks (RR = 1 or RR = 2) can be regarded as of "low toxicity" and thus, generally, no medical surveillance is indicated for employees exposed to these chemicals. Despite that, it must be stressed that here is no such "safe chemical", but rather "safe handling of chemicals".

Generally, hazardous chemicals that fall into the yellow or red zones would require medical surveillance. This is because the toxicity of hazardous chemicals and/or the exposure to them will be considered as high. However, since medical surveillance involves recurrent longitudinal examinations and data analysis over time, only chemicals that produce *chronic rather than acute health effects* should be considered for medical surveillance. Chemicals that produce acute health effects (such as corrosive acids) pose safety rather than health issues.

To illustrate the association between risk ratings and requirement for medical surveillance, the same risk matrix chart as in Figure 1 is used below. It could be seen that chemicals with risk ratings of 1 and 2 will fall into the green zones and do not require medical surveillance. However, other chemicals with risk ratings of 3, 4 and 5 that will either be in the yellow or red zones shall be considered for medical surveillance. This is because the risk is considerably high. The author thus would like to propose that the medical surveillance consideration shall be based on the risk ratings as depicted in Figure 3.

3.3 Results of Personal Chemical Exposure Monitoring

Chemical sampling is only made possible if the airborne chemical is released into the employees' breathing zone. Thus, whatever chemical that has been sampled will represent the amount of chemical that is presumed to be inhaled by the employees. For that reason, the chemical concentration inhaled must be below a certain cut-off point to ensure that the employees are "safe" and this cut -off point is known as Permissible Exposure Limit or PEL. In addition to PEL, another important value of chemical concentration obtained from Personal Chemical Exposure Monitoring is the Action Level, or AL. AL is typically half (1/2) the value of PEL [10]. AL triggers many preventive and protective measures to be taken, and this includes conducting medical surveillance [10] .

As a general principle, employees whose results of personal chemical exposure monitoring equal, or exceed the AL, should be subjected to medical surveillance. Despite that, this does not mean that employees whose chemical exposures are below AL would not be subjected to medical surveillance. It is important to realize that chemical monitoring device will only sample airborne chemicals. Chemicals that are absorbed through skin such as hydrocarbons, or those which are ingested such as lead will not be sampled. As a result, the results of personal chemical exposure concentration might be falsely low because other routes of exposure were not considered. For that reason, it is important to conduct a walkthrough survey to observe the hygiene practice at workplace.

The chemical exposure monitoring result obtained must be compared with the Assigned Protection Factor or APF for a respirator before determining whether the employee has been adequately protected against chemical inhalation or not. A high personal chemical exposure monitoring result does not mean that the employee must undergo medical surveillance if the APF provided by the respirator is adequate. For example, the APF of a full face respirator is 50 [11]. Thus the respirator will be able to protect the employee wearing it even when the chemical concentration outside the mask is 50 times the PEL, provided that the user has undergone fit testing and use the respirator when at work. Respirators worn without the employee being fit tested risk the chemical might be inhaled through a loose-fitting respirator. The same goes with wrongly prescribed cartridge, or poorly maintained respirator.

It is important that one should not be "distracted" by the result of area chemical monitoring, but instead, focuses on the result of personal chemical monitoring. Unlike personal chemical monitoring, area chemical monitoring result does not have any PEL. Thus, it will be inappropriate to make any inference from it.

3.4 Availability of methods to perform medical surveillance

Medical surveillance is aimed to detect the earliest possible biological changes in an employee's health through continuous monitoring. The biological changes must be proven to be caused or associated with the hazardous chemicals absorbed by the body. Thus, there must be available methods to quantify the amount of hazardous chemical absorbed *and* the biological changes as a result of the absorption.

3.4.1 Biological Exposure Indices

Following exposure, hazardous chemicals will be absorbed into the body. These chemicals will undergo metabolism and excreted. Measuring the concentration of these chemicals will reflect the amount of chemicals absorbed in the body. The chemicals can either be the parent chemical or its metabolite – and both are known as determinants. An example involving the parent chemical is where blood lead concentration is measured to monitor the employees' exposure to lead. However, urine hippuric acid, instead of urine/blood toluene, will be measured to evaluate exposure to toluene. In this example, hippuric acid is the metabolite of toluene. The measured concentration of the determinants will be compared to a standard known as Biological Exposure Indices, or BEI.

BEI represents the level of determinant that is most likely to be observed in specimen collected from healthy workers. These healthy workers have been exposed to chemicals to the same extent as workers with inhalation exposure at the Threshold Limit Value, or TLV [12]. TLV "refers to airborne concentrations of chemical substances and represent conditions under which it is believed that *nearly all* workers may be repeatedly exposed, day after day, over a working lifetime, without adverse health effects" [12]. In Malaysia, TLV is known as PEL.

Each chemical has its own specific and unique BEI value. While laboratory results below BEI imply that the employees' exposure to the chemicals is low or negligible, results that exceed BEI do not necessarily mean that the employees' health has been adversely affected. Rather, this simply means that the control measures are inadequate or have been breached. In addition, BEI is not intended to be used as an index of occupational disease despite most BEIs have correlation with TLV [12]. For that reason, Biological Effect Monitoring or BEM must be performed to complement the results obtained for the BEIs [13].

3.4.2 Biological Effect Monitoring

While BEI is an indicator of adequacy of control measures, BEM is the measurement and assessment of early biological effects caused by absorption of chemicals [13]. It normally involves measuring *biochemical responses* such as measuring increases in urinary protein following exposure to Cadmium, a heavy metal known to be nephrotoxic [2]. By doing this, the adverse health effects of the chemicals on a particular organ can be assessed quantitatively. Other examples include conducting lung function test to look for features of restrictive lung disease on employees exposed to Silica dioxide at quarries. Or, performing peripheral blood count on offshore employees exposed to Benzene to look for abnormal blood cells as Benzene is a confirmed leukemia-causing agent [14].

Since medical surveillance is a component of secondary prevention, early detection of disease is crucial. Thus, it is important that the tests perform are specific to the organs that are affected by the chemicals. Review of the Safety Data Sheet (SDS) of the particular chemical is a must to determine the target organs affected by the chemical. Otherwise, there will be a great chance that the opportunity to detect the earliest occurrence of the disease will be missed.

4. DISCUSSION

Use of chemicals in industries is inevitable nowadays. Many of these chemicals are hazardous to health. Thus, employees are always at risk of exposure to these chemicals at workplace. Various control measures are designed to protect employees from such exposure, and these control measures must be strictly adhered. However, inadequate or breach in the control measures will result in loss of protection, and the employees will be at risk of contracting occupational disease or occupational poisoning.

It is important that the employees who are exposed or at risk of being exposed to hazardous chemicals to undergo medical surveillance to monitor their health. This is aimed to detect the earliest changes in the employees' health so that appropriate corrective measures can be taken and preventive measures instituted. This include removing the affected employees from the workplace through the action of Medical Removal for Protection, or MRP [1]. In addition, medical surveillance is a form of audit of the workplace. Result of the findings is a reflection of the workplace hygiene. Improvement of the workplace condition must be made if medical surveillance shows that the employees' health has been adversely affected.

Medical surveillance must be performed correctly in order for it to benefit both the employees and employers. While it monitors the employees' health, the cost that the employers have to bear can be enormous. To illustrate, while one sample of chemical monitoring might be adequate to represent the whole factory, medical surveillance otherwise requires each and every exposed employee to be sampled and examined. Thus, cost for conducting medical surveillance must be justified.

Risk assessment, adequacy of control measures, chemical monitoring results and availability of methods to conduct medical surveillance must be considered before decision to perform medical surveillance is made. These are essential not only to justify the cost factor, but more importantly, the results obtained can be used to gauge the effects of chemical exposure to the employees, as well to reflect the hygiene of the workplace. Table 1 below summarizes on what to look for before conducting medical surveillance.

Once medical surveillance has been conducted, the Occupational Health Doctor or OHD, must then decide whether the employees' health is affected or not by the chemical exposure. If there is evidence that the health has been affected, it is the duty of the OHD to associate the health condition with the hazardous chemicals that they are exposed to. In doing so, there are multiple factors that have to be considered such as gender, age and concomitant disease. Non-occupational exposure is another important factor that must be taken into account. Smoking for example, will increase the level of benzene in body and leads to increased incidence of leukemia in a study conducted recently in Japan [15].

Since medical surveillance is a process that involves monitoring of employees' health, it has to be repeated at scheduled intervals as long as the exposure element is there. In fact, cessation of exposure (elimination or substitution of chemical) might not necessarily mean that medical surveillance should not be conducted. As mentioned, there are diseases that manifest themselves rather slowly. Asbestosis and mesothelioma are only detected after years if not decades of exposure [16]. Thus, a continuous assessment of the employees' health must carry on despite the fact that the exposure has ceased or the employee has retired.

5. CONCLUSION

Medical surveillance is the “last defense” in detecting the earliest biological changes in body so that prompt action can be taken to remove the affected employee from the workplace. It can also be used as an audit tool to evaluate the hygiene aspect of an industry. Decision on whether to conduct medical surveillance is an art of science. Various considerations have to be made as the benefit to the employees must be balanced with the financial implication to the industries. When performed correctly, medical surveillance is a valuable tool in safeguarding the employees’ health and prevention of occupational disease or occupational poisoning.

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