

Hazard Identification, Risk Assessment, and Determining Control (HIRADC) Method in a University Laboratory in Surabaya, Indonesia

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Abstract

Risk management is a system owned by every organization, including university laboratory, to prevent losses. Amongst the methods of risk management that are usually applied is HIRADC method, which is a systematic stage to identify hazards, to assess and analyze risks, and to plan controls measures according to the existed risks. This research is observational research which aims to describe the phenomena. There are several stages in this method, namely hazard identification, risk analysis, and determining control. The data is collected by conducting observation before doing data matching with laboratory worker. The research results indicate that from five activities performed in the Laboratory of Histology Anatomy at Faculty of Medicine Universitas Airlangga, such as experiments by the medical students, dry cadaver shaping, new cadaver shaping, cadaver maintenance and the goods burning by the laboratory worker, there are 16 hazards discovered, with two extreme-risk hazards and three high-risk hazards. The controls and recommendation provided are giving socialization about the importance of wearing PPE (rubber gloves, safety goggles, and laboratory coat), providing explanation about the work to the worker as well as explanation about the laboratory SOP and providing the fire extinguishers.

Keywords: Risk Management, HIRADC, Laboratory

Introduction

Every workplace, including university laboratory, carries its own hazards and risks of occupational accidents. Based on the book authored by Ramli (2010) entitled “*Pedoman Praktis Manajemen Risiko dalam Perspektif K3 OHS Risk Management*”, hazard is all that includes problems or actions that lead accidents or damages to humans or other disturbances⁽¹⁾. According to ILO (International Labour Organization), every year the number of occupational accidents reach more than 250 million accidents at work and 160 million workers suffer from occupational illnesses⁽²⁾.

Risk management must be owned by every organization, including university to protect it from

all things that can cause accident, injury or losses. As mentioned in ISO 45001, risk can be explained as the terms of a combination of the severity caused by the events and its likelihood of adverse events. Risk management can be defined as the total procedure related with identifying an existing hazard, assessing the risk, arranging control measures, and reviewing the outcomes⁽³⁾.

HIRADC (Hazard Identification, Risk Assessment, Determining Control) in ISO 45001 is listed in the planning section, as a procedure resolve the risks which consists of several stages of activity, specifically hazard identification, risk assessment, and determining control⁽⁴⁾. Hazard identification is a process of identifying the hazards that may occur in a workplace. The types of hazards are physical, chemical, biological, psychosocial, or ergonomic hazards and also be caused by the workers, which also known as at-risk behavior.

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Risk assessment as referred from ISO 45001 is an activity to assess the level of the risk from identified hazards as well as to review the effectiveness of the existing control program. Risks that are assessed by the results of the likelihood and severity will be matched to the risk matrix to determine the level of each risk and to priorities identified hazards.

Table 1. Likelihood Level by AS/NZS 4360: 1999

Level	Description	Explanation
5	Almost certain	Expected to occur in most circumstances
4	Likely	Will probably occur in most circumstances
3	Possible	Might occur at some time
2	Unlikely	Could occur at some time
1	Rare	May occur only in exceptional circumstances

Table 2. Severity Level by AS/NZS 4360: 1999

Level	Description	Example detail
1	Insignificant	No injuries, low financial loss
2	Minor	First aid treatment, on-site release immediate contained, medium financial loss
3	Moderate	Medical treatment required, on-site release contained with outside assistance, high financial loss
4	Major	Extensive injuries, loss of production capability, off-site release with no detrimental effects, major financial loss
5	Catastrophic	Death, toxic release off-site with detrimental effect, huge financial loss

Table 3. Risk Matrix Scale (Level of Risk) in AS/NZS 4360

Likelihood	Severity				
	1	2	3	4	5
5 (Almost Certain)	H	H	E	E	E
4 (Likely)	M	H	H	E	E
3 (Possible)	L	M	H	E	E
2 (Unlikely)	L	M	M	H	E
1 (Rare)	L	L	M	H	H

Determining risk control usually uses the hierarchy of control to established priority order for the types of action to be used to minimize or control risks. There are five stages in Hierarchy of Control ANSI Z10: 2005 in Djatmiko (2016)⁽⁵⁾:

1. Elimination is the most effective way to control the risk, to eliminate potential hazards.
2. Substitution to replaces hazardous materials, process or equipment to become more harmless.
3. Engineering Control by modifying machine/equipment or workplace to become safer.
4. Administrative Control to secure workers from exposure by implementing SOP, training, working hours, etc.
5. Personal Protective Equipment (PPE) such as helmet, safety glasses, mask, gloves, earplug, work shirt and safety shoe is the most ineffective way to control and reduce the impact of hazards.

Material and Method

This research is an observational research and then the data are analysed descriptively, which is aimed to delineate a phenomenon. The method of risk analysis applied in this research is HIRADC method in accordance with AS/ NZS 4360: 1999 and ISO 45001: 2018. There are several steps mentioned in this research before, namely hazard identification, risk assessment, and determining control. The data collected is qualitative data in form of description, words or behaviour that were observed. Researchers completed the data collection from hazard identification by making an observation in the Laboratory of Histology Anatomy in Faculty of Medicine, Universitas Airlangga. Then, the researchers give the score in the risk assessment based on the likelihood and severity level. After that, the researchers match and check it with the laboratory worker. After completing a risk assessment, the researchers start to plan the control activity to reduce the risks that are likely to occur in the laboratory.

Findings

Hazard Identifications

Hazard identification is determined by the activities conducted in the Laboratory of Histology Anatomy. The Laboratory of Histology Anatomy contains five main

activities, such as experiments conducted by the students, dry cadavers shaping by the laboratory worker, the used goods burning, new cadavers shaping and cadaver maintenance by the laboratory worker. The chemical substances used in cadaver handling that are likely to be hazard sources are 70% alcohol, formaldehyde, and glycerin.

In the Laboratory of Histology Anatomy, risks identified is mostly related to chemicals and psychology because of the cadaver. The two extreme-risk level risks found caused by the exposure of formaldehyde in a new shaping of cadaver and cadaver maintenance by the laboratory worker. There are three high-risk level risks identified, namely fire that used for goods burning, inconvenience and scare that affect laboratory psychology in new cadavers shaping and cadaver maintenance. Eight moderate-risk level risks are fingers injuries from sharp laboratory equipment, Musculoskeletal Disorders (MSDs) because of the sitting position, blisters from boiled water, skin and eyes irritation caused by 70% alcohol, glycerine in new cadaver shaping and cadaver maintenance, and skin diseases from *Candida* sp. and *Epidemophyton* sp., fungi while making new cadavers and maintaining cadavers. And three low-risk hazards are injuries by glass-made laboratory equipment, diseases transmission and eyes fatigue.

In fact, formaldehyde as the primary chemical substance is often used in cadaver handling (new cadaver shaping and cadaver maintenance). The students and the laboratory worker can expose by the chemical substances to the respiratory, eyes or skin and they can experience the inconvenience because of the cadaver during the laboratory activities.

Experiments Conducted by the Medical Students

Based on the findings in Laboratory of Histology Anatomy, the experiment usually uses the cadaver. Formaldehyde is a main chemical substance that can potentially cause any issue on Occupational Safety and Health in laboratory. The students can easily smell the formaldehyde in the air when entering the laboratory because of the cadaver. They may be exposed continuously to the formaldehyde for 2-3 hours in the laboratory and they feel the pain in the throat and shortness of breath and formaldehyde has an odor that makes many students feel unpleasant during the anatomy experiments. Moreover, the effect of formaldehyde exposure to the students are likely possible to irritate the

respiratory tract.

According to the previous finding by Raja & Bahar (2011), it was affirmed that during the gross anatomy dissection, the main exposure to formaldehyde vapor and contact with formaldehyde can cause several effects. The common effects of exposure to formaldehyde are skin disorders, congenital malformations, ocular irritation, cancer risk, ingestion-related gastrointestinal effects, inhalation-related upper airway irritation and bronchial asthma⁽⁶⁾.

Cadaver Handling (Dry Cadaver Shaping, New Cadaver Shaping and Cadaver Maintenance) and The Goods Burning by the Laboratory Worker

From the research in Laboratory of Histology Anatomy, the laboratory worker is continually exposed to the chemical substances during the cadaver handling and the goods burning activity. The hazards from this activity can be classified to chemical, psychology and biological hazards. The chemical hazards in Cadaver Handling are alcohol 70 %, formaldehyde, and glycerin. The use of formaldehyde which is the fundamental substance to shape new cadavers and to maintain the existed cadavers surprisingly becomes the main hazard source in the Laboratory of Histology Anatomy.

Additionally, the potential hazard that may occur during the existed cadaver maintenance is extreme due to the fact that the maintenance is a routine activity every two weeks and also the shaping of a new cadaver is done once every two or three months. The manual handling process of formaldehyde may increase the risk of formaldehyde spill and spark to the skin or eyes. And when handling the cadaver, the laboratory worker doesn't wear PPE properly. The laboratory worker experienced discomfort in breathing, eye and nose nerves irritation, and sore throat which known as the symptoms from formaldehyde exposure.

Formaldehyde is a colorless, flammable gas with a pungent odor used as a preservative and a corrosion inhibitor that are highly irritating to the nose and toxic if swallowed. If the skin contacts with formaldehyde, it can cause severe injury accompanied by drying, cracking, and scaling⁽⁷⁾. The International Agency for Research on Cancer (IARC) has classified formaldehyde in Group 1 as a carcinogenic agent for human and someone is exposed formaldehyde will suffer from nasopharynx cancer⁽⁸⁾.

This is in accordance with the research initiated by Jalles Dantas de Lucena, et al. which also took place in a Laboratory of Anatomy. In result, they discovered that 70.3% of the respondents were in discomfort due to unpleasant and disturbing smell from the use of formaldehyde. Furthermore, the formaldehyde exposure is followed by the symptoms, such as excessive lacrimation, red eyes, nasal congestion, and respiratory disorder which continuously happen in the laboratory⁽⁹⁾.

Other potential hazards in the Laboratory of Histology Anatomy are having a nightmares and stress due to the works with the dead body that can affect laboratory worker's psychology because of the inconvenience and scare. Afterwards, other activity is burning the goods with fire that carried out inside the laboratory and without providing fire extinguishers. This can be a high- risk level since the severity and impact can cause enormous losses both for laboratory and university.

Risk Assessment

The risk assessment is arranged to present the risk analysis and suggestions for the evaluation stage, which later will be considered by the organization to decide what control measures that effectively control the risk. In this stage, the assessment by giving scores to hazard ratings is needed by the Likelihood (the possibility of the risk occurrence) and the Severity (the consequences of the risks) in accordance with AS/NZS 4360 standard⁽¹⁰⁾.

There are two extreme-level risks on Laboratory of Histology Anatomy that caused by cadaver handling. The exposure of formaldehyde in new cadavers shaping has the level of likelihood of 4 and in cadaver maintenance has the level of likelihood of 5 which means that the possibility of hazard occurrence will probably and expected to occur in most circumstances. This happens because formaldehyde is a main chemical used in cadaver handling activities. In this two cadaver handling activities the Severity level of 5. This can be said so due to the fact that formaldehyde may cause toxic release with detrimental effect to the respiratory tract, eye and skin.

In risk assessment process, it is noticed that the total risk of the exposure of formaldehyde in new cadavers shaping is 20 and 25. Based on the result of the risk assessment, the exposure of formaldehyde is categorized as extreme risk. It means that the control and consideration of resources are immediately needed to

reduce risks based on the priority in controlling the risks.

And three high-level risks on Laboratory of Histology Anatomy which also need to be noticed are fire on goods burning, inconvenience and scare that affect laboratory psychology in new cadavers shaping and cadaver maintenance. The fire risk of goods burning has the level of likelihood of 2 which means could occur at some time and the severity of 4 means can cause extensive injuries, loss of production capability, major financial loss with the total risks is 8. Both in new cadavers shaping and cadaver maintenance, psychology hazard has the level of likelihood of 3 which means might occur at some time and severity level of 3 means medical treatment required with the total of the risk is 9. Based on the result of the risk assessment, the exposure of fire and psychology hazards are categorized as high risk that need to be controlled so the risk not become more dangerous or change to extreme-risk level risks.

Risk Control

Determinant control is performed to reduce risk level to minimize the risks that can affect Occupational Safety and Health when conducting activities in the Laboratory of Histology Anatomy Universitas Airlangga. In accordance with hierarchy of control, risk controls need to be carried out to decrease the occurrence of occupational accidents in laboratory based on the hazards and risks that have been identified are analyzed to arrange the control measures by the priority of each risk level.

Moreover, the authors provide several recommendations to reduce the extreme-risk the engineering control which can be applied is by increasing the number of the ventilation. Laboratory worker needs to check the smell and temperature in the laboratory and open the ventilations immediately when strong formaldehyde odor was found. The next control is by giving socialization about the importance of wearing Personal Protective Equipment (PPE) while handling the cadaver or chemical substances, such as rubber gloves and laboratory coat, safety goggles and mask to avoid direct contamination with hazardous substances that can cause irritation and burns. And providing fire extinguishers when burning the goods in the laboratory. Therefore, the risk of psychological hazard while handling the cadavers can be done with adapting to the work, providing further explanation regarding the job and undertake the work together while handling the cadaver shaping at least

with 3 people in a team. Providing the explanation about the laboratory SOP to the students and academicians who are involved in the laboratory activities and also providing the fire extinguishers when burning the goods in the laboratory

Conclusions

Based on the research that has been done, it can be concluded that at Laboratory of Histology Anatomy has a low to extreme-risk potential. There are 16 risks found with two extreme-hazard from formaldehyde exposure and three high-risk hazards that need to be controlled. The controls and recommendations that can be provided are giving socialization about the importance of wearing PPE (rubber gloves, safety goggles, and laboratory coat), providing the explanation about the work to the worker as well as explanation about the laboratory SOP to the academicians who are involved in the laboratory activities and providing the fire extinguishers.

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