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Occupational Safety and Health (OSH) with Emphasize on Biosafety in Parasitology Laboratory

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Review Article

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ABSTRACT

Aims: to refresh the memory regarding OHS implementation in the Parasiology clinical lab.
Discussion: around 380,000 workers or 13.7% of the 2.78 million workers die from work-related accidents and diseases. Furthermore, >374 million people are injured, wounded or become ill annually due to accidents that occur with workers. Unfortunately, work related accident data regarding specific population, namely lab worker is scarce, mostly due to underreported incident, near miss or even accident in the lab. Problems with OHS, including biosafety implementation, in a clinical laboratory commonly related to poorly written guidelines which can be overcome by making a laboratory guidelines. The purpose of OHS is to protect employees from accidents and injuries. The best way to prevent and avoid any unwanted laboratory incident or near miss or accidents is to be always prepared, always well trained and always informed about the exact lab procedure along with all the risk. Protecting and improving the health of lab workers and also the medical students is a mandatory and should conducted over and over until it become safety culture. Laboratory guideline suppose to be implemented actively and periodically must be upgraded. Along with proper

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usage of personel protective equipment, best practice of hygiene, lab waste management and control of access among all individuals whose conducted activities in the laboratory.
Conclusion: Occupational health and safety (OHS) as a multidisciplinary science and best practice is actually very dynamic. The scope is broad but all are aimed at safety and security. It is the duty and responsibility of every stakeholder to study, pay close attention and do their best to implement OHS.

Keywords: Incident; near miss; good clinical laboratory practice; safety culture.

1. INTRODUCTION

Occupational health and safety (OHS) is a multidisciplinary science and best practice that focuses on the health, safety, and welfare of everyone, especially employees, in the workplace, or in other word is to promoting health for the total wellbeing of the worker (de Maria et al., 2023). It is actually part of public health science which can be mention as limited to the laboratory milieu.

In the context of OHS, there are three terms that commonly mentioned, namely accident, incident and near miss (Nasrallah, et al., 2022). an accident is an unexpected event that results in harm, injury, or damage, while an incident is a broader term encompassing any unexpected or unwanted event, which may not result in harm or damage directly. However, if an incident is deliberately ignored, it tends to recur with the entity getting worse and worse, so it is only a matter of time before a serious accident occurs. A near miss or close call or near accident (three different terms with the same meaning) is a significant incident that almost caused definite harm. An incident, near miss or even accident at the workplace actually can be avoided, prevented or at least minimized. All of these three condition potentially exists in any type of workplace, including laboratory (Shu et al., 2023; Nasrallah, et al., 2022).

A laboratory is a predetermined facility which usually constitute of a number of room(s) for best practice of scientific research, experiments, and analysis (Siagian, 2021). It must be kept clean all the time, with controlled environment and milieu fitted with specialized apparatus and measuring devices, which to some extent must meet certain qualification (Wallace & McCulloch, 2021), in which scientific or technological approach, research, experiments, and measurement may be conducted in the name of scientific integrity and pure academic culture in order to find the answer to a research question (Liston & Fitzgerald, 2024). The setting of a certain lab, whether it is specifically tailored for research or teaching or clinical analysis, was rely solely on the initial purpose of the development of the lab (National Academies of Sciences, Engineering, and Medicine 2017).

A clinical Parasitology lab is a laboratory that examine clinical samples which suspected contain parasites and furthermore also their role in disease formation (Yücesan & Özkan, 2018). Advanced Parasitology labs use a variety of methods to isolate and identify parasites (Caliendo, et al., 2013) via (1) conduct certain specific tests for many kinds of clinical or environmental samples, (2) classic geometric morphological analysis (Suwandittakul, et al., 2022), (3) DNA sequencing and barcoding (Ondrejicka, et al., 2014), and (4) artificial intelligence (powered or augmented tools such as microscope or computer vision) (Kenneth, et al., 2024; Fathi, 2024); where all activities related to the procedure must always include and prioritize biosafety (Yücesan & Özkan, 2018).

With all the advancement of technology, the boundaries between classic labs are becoming blurred. It must be acknowledged that with the introduction of new techniques, sophisticated equipment and the advancement of methods combined with other advances make lab testing faster, more effective and more efficient (Caliendo, et al., 2013; Selvakumar, 2010). Unfortunately, all of these advances also have negative impacts, including potential risks for lab workers (Dunn, et al., 2023; Tziakou, et al., 2023). The aim of this review is to refresh the memory regarding OHS implementation to the clinical Parasitology lab.

2. SCOPE OF THE PROBLEM AND CONCERN REGARDING UNREPORTED LAB INCIDENT, ACCIDENT, OR NEAR MISS

Data regarding work related morbidity and mortality is enormous (Takala et al., 2024). The mortality rate due to occupational accidents and

occupational diseases is quite high. According to data from the International Labor Organization, every year around 380,000 workers or 13.7% of the 2.78 million workers die from work-related accidents and diseases. Furthermore, >374 million people are injured, wounded or become ill annually due to accidents that occur with workers (ILO, 2018). Pega et al., that cited the World Health Organization and the International Labor Organization estimate that only 363 283 (19%) of 1 879 890 work-related deaths globally in 2016 were due to injuries, whereas 1 516 607 (81%) deaths were due to diseases (Pega, et al., 2023).

Based on accident data cases from the report of the Social Security Implementation Agency (BPJS) of employment which cited by Bria et al, revealed that in Indonesia the number of work accidents reported increased in 2017 the number of work accidents reported was 123,041 cases, while throughout 2018 it reached 173,105 cases. Every year on average BPJS serves 130,000 cases of work-related accidents with the spectrum ranging from mild to fatal impacts (Bria, et al., 2024).

Unfortunately, work related accident data regarding specific population, namely lab worker is scarce (Al Qarni & Alnahdi, 2024), even though the fact that medical laboratories handle a wide range of materials, potentially dangerous pathogenic agents and exposes health workers to numerous potential hazards. This scarcity probably due to a number of factors, including fragmented health statistics, lack of diagnostic tests and especially due to under-reporting (Manheim, 2021).

Underreporting of lab accidents is common due to a number of factors, including a lack of safety culture (Nagy, 2023; Claxton et al., 2022; Selvakumar, 2010), fear of reprisal (Wirth, et al., 2020) and concerns about liability (Parks, 1996). However, a more transparent system of reporting could help reduce the number of accidents (Blacksell, et al., 2023). Problems with OHS, including biosafety implementation, in a clinical laboratory can include (1) poorly written guidelines which can be overcome by making a tailor made guidelines which adjusted to lab conditions (Sewunet, et al., 2014), (2) lack of resources (Olewski & Snakard, 2017), and (3) stress induced by unclear roles & responsibilities (Alrawahi, et al., 2024) and (4) unreported lab incident, accident, or near miss (Manheim, 2021).

An unreported incident, accident, or near miss in a lab can be a serious safety concern (Ayi & Hon, 2018). It Is important to report confidentially all incidents, even near misses, to ensure risks are properly assessed and mitigated as part of safety culture (Nagy, 2023) and appropriate risk management (Rodziewicz, et al., 2024). Incidents, accidents, and near Misses in laboratory is actually highlighting the need and the important role of Emergency Response Training including the importance of scheduled refresher training to reinforce policies and procedures (Ménard & Trant, 2020). Although not specifically required or considered mandatory by OSH administrative, annual refresher training is considered best practice to reinforce policies and procedures (Selvakumar, 2010).

Reporting any unexpected or unwanted condition of accident, incident or near miss can help identify negative trends and safeguard employees (Blacksell, et al., 2023). It can help reduce workplace accidents in overall and increase laboratory safety culture (Nagy, 2023; Claxton, et al., 2022) among all of those whose involved in the lab activity.

The take-home lesson from all of the report is regarding the critical awareness for lab staff to know how to respond properly in an emergency situation (National Research Council (US) Committee on Prudent Practices in the Laboratory, 2011). If the employees who initially should responded did not do so in accordance with the procedures reviewed in safety training, it is a must to determined and implemented periodic or scheduled reinforcement of laboratory policies and emergency response procedures (Selvakumar, 2010).

3. THE PURPOSE OF APPLICATION AND IMPLEMENTATION OF OHS

The purpose of Occupational Health and Safety (OHS) is to protect employees from accidents and injuries. The purpose of biosafety is to protect people, the public, and the environment from infectious agents. both can overlap and complement each other, especially if the activities in the lab include permanent workers who are routinely active in the lab and students, which his/her existence is temporary and he/she may come and go relatively frequently. This is the routine, everyday condition we experienced in the parasitology laboratory, faculty of medicine, Universitas Kristen Indonesia, Jakarta-Indonesia. The biosafety concerns of clinical

laboratories are distinct from research or public health facilities because each specimen presents an unknown hazard and the suspected diagnosis is often not shared with the laboratory. Thus, there are significant threats to public health when clinical laboratories cannot safely process specimens from patients with, or suspected to have, highly infectious diseases (Cornish et al., 2021).

At least there are three basic purpose for its application and implementation, which must be put into practice, rigidly with no excuse, namely: (1) to maximally prevent accidents and harm to people from work-related activities, (2) to improve working milieu and the surrounding supportive environment, and (3) to protect and improve the health of workers.

3.1 Accident Avoidance and Harm Prevention

The best way to prevent and avoid any unwanted laboratory incident or near miss or accidents is to be always prepared, always well trained and always informed about the exact procedure he/she working along with all the risk (Pearse & Scott,2023). This can surely be achieved through mandatory good laboratory practice (GLP) application for everyone in the lab (Jena & Chavan, 2017; Selvakumar, 2010). These aspects also became the main reason for the making of written and printed laboratory manual book and Checklist for the prevention of accidents in laboratories (European Agency for Safety and Health at Work, 2022) which must be actively read, studied and truly understood, regarding biosafety and OHS, before carrying out activities in the lab (Selvakumar, 2010; World Health Organization, 2003; European Agency for Safety and Health at Work, 2022). The clinical laboratory manual book actually contains detailed instruction regarding steps in receiving, preparing, examining until up to post-examination decontamination in relation to biosafety and OHS (Cornish, et al., 2021; Selvakumar, 2010).

Beside the manual book, anyone who wants to work in the lab, especially those who deal directly with parasitic organisms, must use adequate personal protective equipment (PPE) (Kening & Groen, 2023) especially if exposure almost impossible to be prevented by other means. The availability of appropriate protective equipment for his/her activity during work must be ensured to be available. Lab staffs and students also must aware regarding the proper use of PPE before start to do his/her work in the lab (Amoo & Ezoke, 2020). Everyone in the lab should have high awareness and good adherence to safety best practices (Kumar, et al., 2024).

3.2 Continuous improvement of Working Milieu and its Surrounding.

Continual advancement opportunities in routine daily laboratory operations which allude to the systematic processes aimed at enhancing the quality and efficiency of laboratory (Ifudu, et al., 2024) until it become a habit and culture (Nagy, 2023; Claxton, et al., 2022). This aspect is unique because it is actually a management process, rather than technical, that focus on analyzing and optimizing processes and also workflows which basically aim to improve efficiency and quality in delivering responsible and liable examination (Krasowski, et al., 2017).

The main goal is to improve the laboratory's ability to solve problems (Ifudu, et al., 2024; Krasowski, et al., 2017), save unnecessary and unwanted costs due to any unwanted situation which related to accident (Miller, 2013), and last but not least is to smoothly operate, by means of safer for everyone in a more efficient and effective manner (Selvakumar, 2010). Once again, Good Clinical Laboratory Practices (GCLP) should be applied rigidly by all laboratories where all examinations are conducted on biological materials for the purpose of diagnosis, patient care, disease control, bio bank, culture collection and especially in research setting (Selvakumar, 2010).

3.3 Protecting and Improving the Health of Lab Workers and also the Medical Students

In the context of lab worker, job growth and security are actually high in demand, especially for experienced medical laboratory technicians and scientists because these two are very important assets for the clinical laboratory (Bayot et al, 2024). Even though for most of the time, these two type professionals remain invisible and sometime undervalued (Jalloh, et al., 2024). Currently a shortage of medical lab technicians and scientists in many parts of the country (Robinson & Rohde, 2024). With the volume of laboratory tests continuing to increase due to both population growth and the development of new types of tests, job opportunities are expected to increase faster than average of other profession. With additional training and

experience, a medical lab scientist may have the potency to boost their career. Others may seek specializations to advance their careers. Typically, a medical lab technician will progress to a medical lab scientist with more training. Medical student, or more specifically those whose in his/her clinical rotation, is also important because during this phase he/she actively learn to develop their skills and build their clinical confidence. He/she will become doctor very soon, and their wellbeing is the biggest consideration, not just for their parents, but also for their institution and their future and the community he/she will serve in the future. With this in mind, the existence of lab workers, including medical students, becomes vital and their health needs to be maintained at its best; that is why this is also one of the three purposes of OHS in the laboratory.

Everybody must bear in mind, that OHS needs to be lived day to day as a safety culture (Nagy, 2023; Claxton, et al., 2022). This best practice of OHS is regulated down to the last detail by a wide variety of policies. In the next section, we will discuss about the application of OHS in daily routine activity inside the clinical Parasitology laboratory.

3.4 Implementation Best Practice of OHS: A Brief Description of Guideline

One of the basic principles for effective occupational health and safety is good working conditions (Krasowski, et al., 2017), which should always take account of human needs. Basically, everyone in the lab is mutually responsible for each other's safety during their presence in the laboratory, according to their qualification and competencies (Guererro, 2021; Ayi & Hon, 2018). Every member of the lab is obliged to do everything possible according to their role and expertise to carry out the duties assigned to them and to follow procedure (Ayi & Hon, 2018; Lunz, et al., 1992).

In the context of clinical Parasitology laboratory as a workplace entity, the application of OHS includes following rigid safety guidelines (Guererro, 2021; Ayi & Hon, 2018; Lunz, 1992), practicing good personal hygiene, and using personal protective equipment.

Safety guidelines Practical laboratory work in the context of medical student is essential to promote students' learning of science and scientific skills (Abu-Siniyeh & Al-Shehri, 2021) while at the same time, routine daily activity of this clinical laboratory is mandatory to carefully examine all the clinical sample and make the correct diagnosis for the doctor who sent the sample.

However, there are many hazardous substances and instruments used in our lab, which poses a significant risk of incident or near miss or even accidents and presents a potential danger to human health, and also to the surrounding natural environment. This demands specific care in order to protect human health, conserve the natural environment and to prevent laboratory accidents (Selvakumar, 2010).

This guideline should focus on

1. the requirement of Biosafety Level 2 precautions at a minimum, which include include wearing personal protective equipment (PPE) lab coat, gloves, and eye protection, face shield if needed, using biological safety cabinets, and decontaminating work surfaces. All PPE must be worn properly and adequately (Claxton et al., 2022; Selvakumar, 2010). Dress for work in the laboratory including wear sufficient but not excessive clothing and shoes that must be able to cover exposed skin and protect its user from potential splashes, tie back long hair, jewelry, or anything that may catch in equipment. It is forbidden eat food, drink beverages, chew gum, apply cosmetics (including lip balm), or handle contact lenses in the laboratory. Once again, for personnel (faculty, staff, students, visitors) in laboratories (research and teaching) that are in the presence of hazardous materials are required to wear appropriate clothing and personal protective equipment as determined by a risk assessment
2. Handle samples as if they are routine patient samples, for every sample must always be considered and treated as an infectious entity, until the results of the examination indicate otherwise (Redrup, et al., 2016),
3. Avoid contact with skin, eyes, or clothing, to prevent exposure, chemically or physically even Parasitologically, which can cause irritation, burns, infection and other health problems. The most common method of contact with skin and eyes usually through splashes; that is why wearing eye protection is mandatory when

working closely with liquid substance. Contamination in the skin should immediately wash with sufficient amount of running water (European Agency for Safety and Health at Work, 2022; Durkee, 2008)

4. Dispose of sharps in a safe disposal system, immediately after use (Patsopoulou, et al., 2022; European Agency for Safety and Health at Work, 2022). Sharps containers should be appropriately labeled with the biohazard symbol and kept out of reach of children. It is forbidden to squeeze anything with sharp objects in it,
5. Clean the area with absorbent paper and clean excess with suitable disinfectant, especially for spill (European Agency for Safety and Health at Work, 2022; World Health Organization, 2003), which recommendation should be managed as follows:

a. contain the spill: Start at the edges and use absorbent material to cover the spill,
b. Pour disinfectant: Slowly pour disinfectant over the absorbent material, working from the edges towards the center,
c. Allow contact time: make sure that the disinfectant sit for the recommended contact time, or at least 15–20 minutes,
d. Wipe up the spill: Use a squeegee and paper towels to wipe up the spill, working from the edges towards the center,
e. Dispose of contaminated materials: Place the absorbent material in a biohazard bag or chemical-resistant bin,
f. Clean the area again: Use fresh paper towels soaked in disinfectant to clean the area again.

6. Dispose of cleanup materials: Place all disposable materials in a biohazard container (European Agency for Safety and Health at Work, 2022; World Health Organization, 2003). Laboratory cleaning materials should be disposed of safely and in accordance with regulations (Beeckman & Rüdelsheim, 2020)
7. Always perform best practice of hand hygiene: Wash your hands prior and after working, also after cleaning up the spill. Practicing hand hygiene in a lab is important to prevent the spread of contamination and to protect yourself and others from infection (Toney-Butler, et al., 2023, Johnston, 2013)
8. Follow current local and national guidelines, where this surely helps prevent accidents, contamination, and damage to the environment (Mourtzikou, & Stamouli, 2017). Further efforts must be made to raise the awareness of all laboratory personnel involved in the total testing process and highlight the importance of periodical of guidelines upgrading as a quality indicator implementation for improvement in liability and safety.
9. Report any incident or near miss or even accident to your immediate superior which everyone must comply with this rule (Patsopoulou, et al., 2022; Jena & Chavan, 2017; Selvakumar, 2010), in order to make sure the prevention of future incidents and injuries, and to ensure proper investigation and follow-up to ensure that any required steps are taken (Nasrallah et al, 2022; Shu, et al., 2023). From the previous mistakes, lesson are learned and corrective steps are taken (Abu-Siniyeh & Al-Shehri, 2021).

3.5 Active Personal Hygiene

Hygiene is essential in all type of workplace milieu. It considers even deeper in significance in the case of laboratory environment, as both safety and quality of results are in direct relation to standards of personal hygiene (Purohit, 2018). Laboratory safety measures undoubtedly contribute to an accident free environment but good hygiene practices supplement it with higher productivity and health of laboratory workers. Personal hygiene in a lab is important to prevent exposure to chemicals and other hazards which should done actively.

Active Personal hygiene basically consists of

1. washing hands immediately after removing gloves, before leaving the laboratory, and after handling a potentially hazardous material (Toney-Butler, et al., 2023). The best practice for hand washing is to use soap and water to wash your hands for at least 20 seconds. If soap and water are not available, you can use a hand sanitizer with at least 60% alcohol.
2. Strictly prohibited to eat, drink, chew gum or tobacco, smoke or apply cosmetics in the laboratory, especially where hazardous materials are used. Furthermore, food, beverages, cups, and other drinking and eating utensils should not be stored in

areas where hazardous chemicals are handled or stored (European Agency for Safety and Health at Work, 2022; World Health Organization, 2003).

3. talk only as necessary- just as the sterile cockpit rule limits talking in the cockpit to activities necessary for safe flight, especially during critical phases and this rule applies to all flight operations- Such conditions should also be applied when working in the lab (European Agency for Safety and Health at Work, 2022; World Health Organization, 2003).

3.6 Personal Protective Equipment

Personal protective equipment minimally must be worn (Kening & Groen., 2023; Amoo, A., & Ezoke, 2020) and consists of (1) googles or eye protection, gloves, and laboratory coat, (2) Cover cuts or abrasions on your hands with an adhesive dressing. It is best to not wear any jewelry while in a laboratory. Chemicals can become trapped under the jewelry and cause injuries to the skin (Kening & Groen., 2023).

Laboratory environment hazards which consist of (1) Laboratory workers are exposed to numerous potential hazards including chemical, biological, physical and radioactive hazards, (2) Assume that all chemicals of unknown toxicity are highly toxic

3.7 Other Important Aspect of OHS

Laboratory waste management. Biological waste management is a part of biosafety, which is the practice of protecting against pathogen contamination. Biological waste management involves the collection, treatment, and safely disposal of biological waste (Beeckman & Rüdelsheim, 2020). Laboratory waste management is important for occupational health and safety because it helps to reduce the risk of exposure to hazardous chemicals and infectious waste. Effective laboratory waste management is needed to ensure a safe working area, adhere to regulations, and safeguard the ecosystem.

Control of Access. Access control is a key part of biosafety, which is the set of rules and barriers that prevent biological risk. Access control measures include restricting access to areas where infectious agents are handled and stored (Puro, et al., 2012). By creating a schedule of activities that is clearly communicated to all stakeholders is a fundamental part of access control.

4. CONCLUSION

Occupational health and safety (OHS) as a multidisciplinary science and best practice is actually very dynamic. The scope is broad but all are aimed at safety and security. It is the duty and responsibility of every stakeholder to study, pay close attention and do their best to implement OHS.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as large language models (chatGPT, COPILOT, etc.) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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