Review Article

A Brief Introduction to Activities in The Parasitology Laboratory for Medical Students

ABSTRACT

Aims: To revisited the basic of biosafety applied to our Parasitology laboratory and describe our simple student's centered practicum guide and preparation for use by medical or other health cluster students for their laboratory class activity in faculty of Medicine with the revelation of noble human values such as respect for others, honesty, trustworthy, and open hearted- open minded.

Discussion: Parasitology laboratory basically serves for education/teaching, diagnostic and research. Biosafety principles applies in our lab, even during parasitology laboratory lesson/practicum which consider as biosafety level 1. Lab coat, face mask, gloves, and eye protection/googles are some of the minimum required personal protective equipment (PPE). Students must comply with all the laboratory rules and regulation. Human values in medical education are important for the internalization of ethical, safety culture, and compassionate care. Some human values which considered important in the laboratory class session include respect for others, honesty, trustworthy, and open hearted- open minded.

Keywords: helminthology, protozoology, Entomology, Mycology, biosafety level 1, good laboratory practice, precaution, practicum

1. INTRODUCTION

All forms of education, formal or non-formal with no exception for Medicine, in its noblest mission aims to shape apprentice to become better and more righteous humans than before; and then after completing his/her education, these apprentice will be sent back to their milieu to become transformative agent of change [1] to his/her family, community, environment, and even his/her nation and country in order to form a better and more righteous family, community, environment, nation and country. In tiered education, from elementary, middle to advanced levels, these noble human values remain the spirit of every element of education taught [2].

Medical education is the process of training its pupils to become professional doctors. Becoming a doctor involves transforming a lay person into a medical professional, which is known as professional socialization [3]. It is a dynamic process that consists of basic medical education (pre-clinical) and hospital based clinical rotation. Medical education is actually a science field that plays a vital role in shaping the future of health care profession [4]. It can even be continued further to biomedical postgraduate or specialties medical education, and even proggramme such as continuing professional development or continuing medical education [5]. The goal of medical education is to prepare physicians to apply scientific knowledge to promote health and prevent disease, including parasitic diseases taught in medical parasitology, especially in the post Covid pandemic era [6].

Medical parasitology is the science that deals with parasitic organisms living in or inside the human body, namely the host, with focus on its medical significance of this host-parasite relationship [7], e.g., transmission, vector, vectorial capacity, spectrum of host (intermediate, definite or accidental), predilection, existence in the nature, clinical sign and symptom,

treatment and prevention etc. What is so special about medical parasitology is that the teaching includes the combination of expert lectures in the classroom and then practical sessions (active vs passive/demonstration) in the laboratory lessons [8]. Human Parasitology Lab session integrates the theory with practicum that covers the biology, morphology, pathogenesis, and treatment of major human parasitic diseases [9]. Students will learn basic techniques commonly used in parasitology and will also read and discuss current and latest state of the art achievement in Parasitology from scientific papers. Practical Guidance/handout for Clinical Parasitology, which has been prepared in advanced, provide sufficient practical information on the laboratory diagnosis of parasites from certain system in human body, especially in the recovery and identification of relevant human parasites [10]. This paper aim to describe a simple student's centered preparation and practical guide for use by medical or other health cluster students for their parasitology laboratory class activity in our faculty of Medicine.

2. BIOSAFETY PRINCIPLES IN PARASITOLOGY LABORATORY LESSON

Parasitology laboratory is a room or building equipped specifically for scientific experiments, research, or teaching, or for the manufacture of drugs or chemicals or other parasitic science related activity. It is predominantly designed for three main purpose, namely:

(1) Laboratory education which implement experimental exposure [11] of theory through demonstration and or direct hands-on practicum [12] or other state of the art medical teaching technology such as the application of case histories [13], or concept maps [14], virtual reality simulation [15], innovative tools such as Eye –tracking [16] and even live streaming [17], which provide students with learning experiences that can help them understand and remember concepts better [18] than just feed with theory alone. The primary aim of arranging laboratory learning for students is including to develop the practical competence [19] commonly within their scope of intended future specialization [20]. Laboratory learning provides opportunities for students to clearly relate and strengthening the theoretical concepts taught in class [21],

(2) making correct diagnosis for prompt treatment [22]. Diagnosis of parasitic infections requires laboratory support, since the signs and symptoms are often nonspecific. A variety of quick methods and specimens are used in order to make rapid diagnosis of parasitic diseases [23] which is directed by the results of the careful anamnesis and physical examination [24]. A proper parasitology laboratory examination involves a careful microscopic analysis of clinical sample sent to the lab for parasites detection [25]. Diagnosis of parasitic infection may be made by direct examination of a clinical specimen to identify the presence of a parasite [26]. Indirect methods of detection for certain parasite [27], such as serology [28], immunology [29], and many more are also available for many parasitic infections. the majority of samples received for analysis constitute of feces [30], blood [31] and serum [32], urine [33], sputum [34], liver [35] or duodenal [36] or breast [37] or lymph nodes [38] or any other bodily aspirates [39], bile fluid [40], corneal scrapings [41], contact lens fluid [42], ear scrapping [43] and as well as other tissues that have not been previously mentioned and may be infested with parasites,

(3) conducting research with long history of maintaining high quality standards in parasitological research [44,45] that supports scientific progression-advancement-development and the achievement of sustainable development goals, e.g., by ending the still existing neglected tropical diseases [46], solve parasitic problem or at least make prioritization, e.g., by modern and continuously updated modern strategies for diagnosis and treatment of parasitic diseases [47], and makes the lives of those involved better and more righteous in this continuously changing world [48].

Apart from all the explanations above, one of the benefits of the lab is as a place for learning. Basically, Lab teaching is a teaching method that uses a laboratory to help students develop their understanding of a subject and connect theory with practice. It can also help students develop skills for analyzing and solving real-world problems. The department of Parasitology, in this case lecturers, must develop strategies for effective teaching in the laboratory practicum session [49]. For the following text, all discussion regarding laboratory was meant to focus on laboratory teaching as a support for theory obtained in class based learning.

All parasitic agents must generally consider as infectious, we emphasize first the importance of understanding the concept of biosafety in laboratory [51] especially in the effort to prevent laboratory acquired infection and related risks [52]. Biosafety in the area of laboratory is a succinct list of practical guidelines for handling and disposing of biohazardous materials for continuous improvement of safety practices [53]. In the context our student's education, simply put, we want students to come to study in the lab in good health condition, also during the teaching and learning process and even until it is finished and students leave the lab without carrying the seeds of parasitic agents in their bodies or their clothes; and the basis for this is called biosafety.

The very basic idea of biosafety has launch to be arranged and prioritized due to the obligation to assure the culture of safety and well-being of everybody which involved with working or learning activity in laboratories for education, routine diagnosis and research purposes, and that also including people outside the laboratory and laboratory materials. Institutions necessitating uncompromising adherence to these biosafety guidelines without exception [54]. For parasitic agents, the risk was divided based on the microbiological risk classification [50, 54].

Since the end of the last millennium, the foundation of biosafety has commenced to be arranged for laboratories; and following the rise of the awareness, biosafety protocols or guidelines have initiated to be released by various universities and institutions [50,51,54,55]. Careful precautions which rely on evidence based [56] that are related to biosafety and standards are determined based on the risk assessment of microorganisms to be analyzed in the laboratory. According to these risk assessments [50,51,54,55], microorganisms have been classified into four risk groups and, four kinds of laboratory biosafety levels have been determined [57].

In these laboratory biosafety levels, as well as standard microbiological applications, specific applications and precautions are taken that are mentioned as primary and secondary property barriers. Primary barriers are both techniques and equipment that guard against the release of biological material; they may also be referred to as primary containment [58]. Secondary barriers in a laboratory are physical features that separate the laboratory from the outside or non-laboratory areas to prevent pathogens from escaping into the environment. These barriers include: (1) air handling systems through the application of High-Efficiency Particulate Air (HEPA) filters for air filtration system [59], (2) walls and doors functioned as separator from the outside world [60], (3) decontamination equipment [61] e.g., autoclaves, dunk tanks, and barrier autoclaves, (4) handwashing facilities [62], (5) directional airflow including airlock-controlled entry and exiting, or specialized ventilation systems [62], (6) controlled access zones [51], (7) Separate buildings or modules, in order to physically isolate the laboratory building [63], and (8) sealed laboratory walls and floors [51]. The existence of these features can keep the working milieu safer against infection.

Animal care units, specific arthropods multiplication and specialized care centers are also classified as laboratories. The term of biosafety also includes topics such as proper collection of waste generated in the laboratory, transportation and disposal of chemical and radioactive substances [50-52, 54-57, 60-63].

Once again, the topics mentioned in this review are dealt based on parasitology laboratories in accordance to pre-clinical medical curriculum, which suitable for laboratory biosafety level 1, that we will revealed in the next section.

3. PRE-PRACTICUM PREPARATION

Biosafety level 1 (BSL-1) is the most basic strata of containment for doing laboratory activity with microorganisms that present minimal risk to the environment and laboratory personnel [50,54]. Laboratory type of BSL-1 is appropriate for work with well-characterized agents that are not known to consistently cause disease in healthy adults of general population [64] or in our department of Parasitology, we have confirmed that these parasitic organisms are no longer contagious or has been secured in such a way that are no longer dangerous for those studying it [56].

Actually, the existence of potential risk and hazard to laboratory personnel and the environment cannot be 100% eliminated [65], However, work culture within the limit of good work/practice according to protocols and instructions during the practicum will greatly minimize the potency of those hazard [60]. The BSL-1 lab is used in a variety of settings [54], including the undergraduate and secondary educational training and teaching laboratories.

In the context of learning in the lab, the practicum is a critical time for medical students to apply learning from coursework into authentic practice in laboratory settings [10-12] with sufficient supervision, support, and feedback [9] which students likely will not get in large class based lectures. Meaningful and vigorous laboratory-based experience start from the pre-practicum preparation [66] set up students to successfully observe, learn and demonstrate their abilities in the practicum and make sure that they are fully ready to positively impact hands-on learning from the very beginning of laboratory class. Student preparedness is very important for clinical learning in the laboratory class/practicum, with professionalism and willingness as the most supportive characteristics followed by personal attributes and combined with further strengthening learning opportunities; all these four characteristics of preparedness will facilitate the student in the laboratory learning [67].
Once again, the basic application of biosafety when in the laboratory, even in a learning context, always prioritized due to the obligation to protect the whole individuals (students, lecturers, laboratory technician) working in laboratories as well as people outside the laboratory and laboratory materials [50-52, 54-57, 60-63].

3.1 Several good laboratory practices that meet biosafety level 1.

3.1.1. Student preparation. Medical students who are well prepared for laboratory class activities are more credible to flourishingly develop excellent laboratory skills and obtain the greatest feasible advancement and scientific reasoning [68] from the laboratory learning milieu [66,67].

For activities in our Parasitology laboratory which categorized as a Biosafety Level 1 (BSL-1) lab [58], during this post COVID-19 pandemic era, a medical student should correctly wear a lab coat, face mask, gloves, and eye protection as the minimum required personal protective equipment (PPE) [69]. As BSL-1 labs handle microorganisms not known to consistently cause disease in healthy adults and present minimal hazard to lab workers; therefore, only standard microbiological practices and basic PPE are needed and once again it must have worn correctly. A Lab coat should always be wear as a minimum standard PPE to protect clothing from potential spills. The use of disposable gloves aimed to prevent direct contact of

the hand with microorganisms while safety goggles or glasses aimed to protect the eyes from the potency of splashes. Other PPE such as face shield or biological safety cabinets only use as needed.

To facilitate effective student preparation and improve their learning outcomes, we have designed and developed resources including the laboratory manual prior to attendance in laboratories which are used by students in conjunction with relevant text book or lecture materials. Resources comprise a series of activities including presentations, pre-laboratory check list and even questions or quizzes related to the laboratory activities that the students must complete. To determine how effective these resources were in facilitating laboratory preparation, students were surveyed both before and after the introduction of the resources. Surveys were designed to establish student perceptions regarding their preparatory practices.

The implementation of this blended learning approach has improved the nature of student preparation prior to practicum [67,70]. Presenting information in a flexible, easy to adapt learning format, prior to practicum participation, enhanced student familiarization with theoretical and practicum procedures [67]. Furthermore, well-organized preparation reduced the potential risk of cognitive dissonance by improving student organizational abilities which in turn lead to better hands-on practicum learning outcomes and value-added student perception of the laboratory experience as a whole.

3.1.2. Laboratory preparation Routine decontamination of work surfaces and after any spill of potentially infectious material is a must [71]. In a clean and well prepared lab, lecturer and lab tech prepares the proper equipment. For demonstrating micro-size parasite (e.g., slides of malaria, intestinal protozoan, the yeast Cryptococcus etc.), usually light microscope was used, and for macro-size parasite a loup or magnifying glass is considered sufficient.

Certain aspects of medical parasitology education rely mostly upon good microscopic images. The mechanisms for providing microscopic images to medical students have evolved greatly since the initial introduction of microscopes and microscopic images into medical education [72]. Lecturer and lab techs put the slide on the correct position of image they want to show to the students, and a group of students alternately look through the eyepiece of the microscope to observe the object and they can compare the image with their handouts, and add notes if necessary. For macro-size parasite, usually the parasite is already put in a sealable container, and if necessary the staff can put magnifying glass or loupe near the macro-size parasite.

For active practicum, the preparation is tailor made, depends on what examination being held, but basically, the use of sterile equipment (e.g., blood syringe needle) is recommended and Likewise, disinfectant must always be prepared around the workplace.

3.1.3 Practicum During practicum, students must follow all the rules to ensure their own safety and the safety of others [73]. Student must enter the lab for practicum according to schedule. When first entering the labs room, students must not touch any equipment, chemicals, or other materials in the laboratory area until they are instructed to do so. For passive practicum where the slides have been placed under a microscope, students can see the object through the ocular lens, but they are not permitted to shift/change the position of the slide; Students are only allowed to adjust the micrometer slightly up and down to suit their visual acuity that best suits their eyes. To help student understand what parasite being showed under the microscope, we placed postcard-sized paper containing information about the parasite's morphological characteristics that had been prepared in advance next to the microscope.

In most of the cases, the practicum is passive; means that the slides already set by the lecturer or the lab technician, and students can directly see it under the microscope; the student does not require to make a parasitology slides first and then go through the hassle of searching. But due to the limitation of time allocation in practicum, students are not allowed to move the slides, in order to keep the parasitic objects being studied visible to every student throughout the entire practicum. Students are only allowed to slightly turn the micrometer up and down a little bit to adjust his/her visual acuity. The use of a pointer put in one of the oculars of individual student microscopes allowed the observer to pin point the parasite or its morphological characteristics. Usually, the discussion takes place during this observation phase of passive practicum, where there is a lecturer who is on standby to explain if a student asks a question.

In cases of active practicum, students gained experience by preparing their own slide preparations, especially in terms of blood smears [74] or skin scrapping [75] or stool specimen slide [76] or scotch tape anal swab techniques of examination [77]. Unfortunately, this active practicum was time consuming and need more effort for the lecturers or lab staff to assist and to oversee all students. The most important thing to do is to ensure that all students comply with the detailed examination protocols that have been given to study one or two days beforehand. Through the lab module, which has been prepared and distributed beforehand, student should explore the challenges, purposes, and ways of doing each steps of active practicum through clear instruction, which ensure first the safety of the methods [50], followed by the effectivity and efficiency of the procedure in order to obtain the greatest benefits for student learning.

Of course we understand that making good slides requires a lot of practice (something that is not possible in the context of regular practical learning) but at the very least we hope that students can feel the detailed stages of making parasitology slides, starting from informed consent, to determine the portion of anatomical location to be examined, for example in the context of fungal based skin disorders, followed by sample collection, samples handling and how to make slides for examination under a microscope. To my opinion, active practicum is more demanding compared to passive practicum.

After carrying out active lab activities, the remaining clinical materials and disposable equipment are thrown into the disinfectant container [50-52, 54-57, 60-63]. All laboratory waste from laboratory experiments can be toxic and dangerous to health and the environment. So, it is necessary to do proper handling in the waste treatment process.

3.1.4 Post Practicum After completing practicum session, all students must ensure that all equipment used is returned to its original place or position. If there is still another session, then the microscope is left on, and the lecturer re-check to ensures that the parasitic object shown is still there and the slide has not moved. Students who come into contact with practical equipment are reminded to wash their hands with soap in the sink provided, then dry their hands with lab tissue and throw the tissue in the trash bin provided.
All students still have to follow the universal precautions while they are still in the lab, until they complete the practicum properly and correctly and then leave the practicum room in the same healthy condition as when they first entered the lab.
After all the practicum session finished and all the students already left the room, lab staff collecting all the slide and put it back to the microscope slide box. All microscopes used then being cleaned. For the quick and easy cleaning of flat surfaces (removing oil from cover slips or front of lenses), it is advisable to use 100% ethanol use in lens paper. For cleaning all other optical surfaces, use freshly made cotton swabs as they absorb dirt through their microfiber surfaces. Freshly made cotton swabs can be made by winding the cotton around

the thin wooden sticks. The correct maintenance and sanitation of the microscope are essential to ensure its optimal performance and longevity.

3.1.5 Noble human values Human values in medical education are important for the internalization of of ethical, safety culture, and compassionate care. Some human values that are important in medical education, especially in the laboratory class session include: Respect for others, honesty, trustworthy, and open hearted- open minded.

- Respect for other and humility [78] are very important values in medical education, especially regarding clinical samples that came from patients. Humility is the basis for respect; self-respect and respect for others. Respecting the process of taking samples and also the subject from where the sample came from means to show empathy and the ability to feel the suffering of the patient. Respect also means that the examiner/doctor accept somebody for who they are, even when they are different from the examiner/doctor or the examiner/doctor do not agree with them. Respecting patients ensure that all things related with the patient (his/her identity, background, his/her clinical bodily sample and the result of examination) remain confidential and treated with dignity and respect, all the time.
  In the context of appreciating research while studying or practicing a topic in parasitology, respect is a fundamental principle in the ethics of conducting or learning science. By showing interest and enthusiasm in learning something and be on time are great example of to show the student's respect for lecturer's and lab staff's time and effort. Because lab staff certainly need to enforce good laboratory practices and sensible safety measures for all students during the preparation, implementation and even until it was finished. Furthermore, respect for rules can be demonstrated by obedience, which is defined as following instructions or complying with demands. There are many reasons why people should obey the rules, including for the sake of their own safety.
  The Lab is safer when lecturers, lab staffs and students are aware of the potential hazards and take necessary and appropriate safety precautions.

- honesty is a positive character strength that involves being truthful and sincere, and taking responsibility for one's integrity of actions and feelings. Some ways to demonstrate honesty in practicum session include being responsible, accountable, consistent and also respectful. Honesty can help students develop good habits and skills, such as discipline, integrity, and the ability to thrive in diverse environments. Honest behavior especially shown with truth-seeking, belief-speaking, and fostering understanding of the truth in Others [79]

- trustworthy is a value that involves being honest, reliable, and accountable. Trustworthy individuals exhibit consistency, accountability, and dependability in their actions. Building trust through communication enhances relationships and boosts collaboration. Developing trust as a soft skill is crucial for successful leadership and team dynamics. Developing teamwork is important in practicums, which are work placement programs that provide students with practical work experience. Trust can be built in a number of ways, including open communication, providing ideas and guidance, mutual deference and caring, promise fulfillment, abiding by an agreement and mutual aid and help [80]

- open hearted-open minded: with intense academic communication, relationship building is the keystone for success for medical student's academic programs, including laboratory class session, and it must involve reciprocal communication appreciation, perseverance and respect which all based on the value of open hearted-open minded. From an academic standpoint, relationship building applies every soft skill to connect with others fellow students to form positive professional relationships. The same thing is true for building and maintaining an interprofessional relationship between medical personnel, e.g.,

doctors, nurses, physiotherapists, lab technicians and so on which should ideally be started while still in the earliest phase of education [81].

These noble human values are actually being cultivated and practiced in the process of teaching and learning of Parasitology for pre-clinical students. By originating from the implementation noble human values on regular daily basis activity in our Parasitology education, good character can be formed according to educational goals.
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4. CONCLUSION

Parasitology laboratory in the context of education/teaching must comply with biosafety principles of biosafety level 1. Student must comply and wear minimum requirement of personal protective equipment (PPE). The laboratory also having rules and regulation which must be adhered to by anyone carrying out activities in the laboratory. Human values in practicum, as well as in class, are important for the internalization of ethical, safety culture, and compassionate care. Some human values which considered important in the laboratory class session include respect for others, honesty, trustworthy, and open hearted- open minded. The implementation of these noble human values in Parasitology teaching contributes to the making of good character of the students.

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.

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