Sudan University of Science and Technology

College of Graduate Studies

Assessment of Facilities and Safety in National Public Health Laboratory - Sudan - 2015

تقويم المعينات والسلامة في المعمل القومى للصحة العامة - السودان -٢٠١٥م

A dissertation submitted in fulfillment of the degree of M.Sc in total quality management and Excellence

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Declaration2

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إقرار

أنا الموقع أدناه أقر بأننى المؤلف الوحيد لرسالة الماجستير المعنونة Assessment of Facilites and safety in National Public Health Laboratory - Sudan - 2015

تقويم المعيات والسلامه في المعمل القومي للصحه العامه - السودان 2015

وهى منتج فكري أصيل . وباختياري أعطى حقوق طبع ونشر هذا العمل لكلية الدراسات العليا - جامعه السودان للعلوم والتكنولوجيا، عليه يحق للجامعه نشر هذا العمل للأغراض العلمية .

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كلية الدراسات العليا

جامعة السودان للعلوم والتكنولوجيا

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بسم الله الرحمن الرحيم

(وَقُلِ اعْمَلُوا فَسَيَرَى اللَّهُ عَمَلَكُمْ وَرَسُولُهُ وَالْمُؤْمِنُونَ)

صدق الله العظيم (سوره التوبة الاية 105)

Dedication

TO:

MY PARENTS

MY SISTERS

MY BROTHERS

MY HUSBAND

MY DOUGHTERS

MY BIG FAMILY

MY LOVELY FRIENDS

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Praise to Allah, the grateful, who gave me the strength to conduct this work.

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Abstract

This descriptive case study was conducted in National Public Health Laboratory during period from July to December 2015; the study was aimed to assess the quality management system in facilities and safety in the laboratory. Questioner was checked by senior technologists of 12 departments, data was analyzed using SPSS computer program, frequencies and percentages were calculated.

The present study reveals this result: the design easy to clean was found in 10/12(83.3%), the bench top water proof and resist to acid, alkali and organic solvents 10/12(83.3%). The adequate illumination provided, 4/12(33.3%), the adequate storage space 7/12(58.3%), the sink available for hand washing 10/12(83.3%), the corridor is free and unobstructed 8/12(66.7%), the flammable store in flammable storage cabinet 1/12 (8.3), the use of mouth pipette was prohibited in 5/12(41.7%), the centrifuge with cup 10/12(83.3%), the glass container stored on the floor 2/12 (16.7%), the valid fighting fire equipments 9/12(91.7%), the availability of first aid kits in laboratories 7/12(58.3%), 2/12(16.7%) from the staff was trained for firefighting , the biological safety cabinet certified last year 2/12 (16.7%), the biosafety cabinet surface disinfected by appropriate disinfectant at the begin and end of each procedures 4/12(33.3%), the open flame used inside cabinet 1/12 (8.3%), the access limited and restricted to authorized personnel 9/12(75.0%), the availability personnel protective equipments (PPE) 10/12(83.3), the non wearing of (PPE) outside laboratory 5/12(41.7), the eating ,drinking ,smoking and using cosmetics inside laboratory 1/12 (8.3%), the registration of incident 3/12(25.0%), the laboratory personnel immunized against occupational infectious diseases

4/12(33.3%), the safety manual 2/12 (16.7%), the bio hazard signs posted on laboratory door 5/12(41.7%), the safety signs in the laboratory 5/12(41.7%). All cylinder secure 10/12(83.3), the chemical property segregated in laboratory 7/12(58.3) , the hazardous chemical above eye level 3/12(25.0%), the chemical store on the floor 4/12(33.3%), the chemical container left open 1/12(8.3%), the proper label of solutions in 10/12(83.3%), availability of chemical waste container in 3/12(25.0%), the availability of chemical waste container 3/12(25.0%), the liquid chemicals equipment generated waste couplet with waste collected container 2/12 (16.7%), the chemical waste labeled appropriately 3/12(25.0%), the chemical waste hazard identified on hazards waste labeled 1/12 (8.3%) the chemical waste tightly capped 4/12(33.3%), method for minimization of chemical waste 1/12 (8.3%) , procedure for collection of solvents 1/12 (8.3%), chemical waste container less than 55gallons in working area 2/12 (16.7%), types of waste in the laboratory 6/12(50.0%), the waste bag coded by color 5/12(41.7%), the availability of sharps box container 4/12(33.3%).The study observed some safety variables were completely not available such as the availability of eye wash in laboratory, waste management guidelines, waste collection program , radioactive waste container, the availability of hazards chemical waste management guidebook and special procedure for disposable for acids and bases.

The study concluded that some variables were well establish such as the design easy to cleaning and the bench top water proof resist to acid ,alkali and organic solvents. Some variables were not well establish such as adequate illumination, the flammable store in flammable storage cabinet and the availability of first aid kits. Some variables are not available such as

eye wash machine, waste management guidelines, waste collection program, radioactive waste container and hazards chemical waste management.

المستخلص

أجريت هذه الدراسة الوصفية في المعمل القومي للصحة العامة في الفترة من يوليو حتى ديسمبر 2016 ,هدفت الدراسة لمعرفة وضع السلامة المعملية في تطبيق معايير الجودة في أقسام المعمل المختلفة ,تم توزيع استبانه مكونة من 52 سؤلا علي كبير التقنيين في 12 قسم من أقسام المعمل لمعرفة مدي تطبيق معايير الجودة في المعمل . تم تحليل البيانات بواسطة الحزم الاحصائيه للعلوم الاجتماعية وتم حساب التردد والنسب المئوية للمتغيرات.

أظهرت الدراسة النتائج الآتية: كانت المعامل مصممة بحيث تكون سهلة التنظيف 12/10(83.3%), وجدت أسطح طاولات المعمل مقاومة للحوامض والقلويات والمذيبات العضوية في 12/10 (83.3%) , الإضاءة كافية في 12/4 (33.3%) , توفر مساحات للتخزين الكافي وجدت في 12/7(58.3%) , وجدت أحواض الغسيل الخاصة بغسيل اليدين في12/10(83.3%) , كانت الممرات الداخلية للمعامل خالية من اي عوائق 12/5 (66.7 %) المعامل التي تمنع استخدام الماصات الفموية 12/1(8.3%)المعامل التي تستخدم أجهزة الطرد المركزي بأغطية 12/10(83.3%). المعامل التي تخزن المواد الكيميائية علي الأرضيات 12/2 (16.7%). وجدت طفايات الحريق الصالحة في 12/9(75.7 %) .معمل واحد فقط (8.3%) توفرت به صناديق الإسعافات الأولية.وجدت الدراسة أن المعامل التي يوجد بها العاملين المدربين علي استخدام طفايات الحريق 12/2 (16.7%), وجدت شهادة صلاحية سارية لكابينة السلامة في 12/2 (16.7%), المعامل التي كانت تطهر أسطح كابينة السلامة بالمطهرات المناسبة في بداية ونهاية العمليات كانت 12/9 (75.7%). وجدت المعامل التي تستخدم اللهب داخل كابينة السلامة 1/ 12 (8.3%), وجدت المعامل التي تمنع الدخول لغير المسموح لهم بالدخول 12/9 (75%), وسائل الحماية الشخصية موفرة في 12/10 (83.3%), عدم الالتزام بعدم ارتداء البالطو الواقي خارج المعمل 12/5(41.7%), تناول المأكولات والمشروبات والتدخين واستخدام الماكياج داخل المعمل كان يتم في 12/1 (8.3%). تسجيل الحوادث والإصابات كان يتم في 12/3 (25%). تحصين العاملين ضد الأمراض المكتسبة مهنيا متوفر في 12/4 (33.3 %). دليل السلامة كان متوفرا في 12/2(16.7 %), علامات السلامة المثبتة في أبواب المعمل كانت موجودة في 12/5(41.7 %), وجود علامات السلامة داخل المعامل وجد في 12/5 (41.7%), وجد ان الاسطوانات مؤمنة بأغطية 12/10 (83.3%), تصنيف المواد الكيميائية حسب خصائصها 10/ 12 (58.3 %), وضع المواد الكيميائية

الخطرة في مستوى اعلي من مستوي العين كان في 12/3(25%), ترك حاويات المواد الكيميائية مفتوحة كان في 12/1(8.3%), توسم كل المحاليل بدقة كان في 10/ 12 (83.3 %) حاويات للنفايات الكيميائية كانت موجودة في 12/3 (25%)الأجهزة الكيميائية التي تنتج محاليل سائلة متصلة مع حاويات جمع النفايات وجدت في 12/2 (16.7%), الكتابة بدقة علي حاويات النفايات الكيميائية كان في 12/3(25%) تمييز النفايات الكيميائية الخطرة كان في 12/1 (8.3%), إغلاق حاويات النفايات الكيميائية بإحكام كان في 4/ 12 (33.3%), وجود طريق لتقليل النفايات الكيميائية كان فى 12/1 (8.3%), طرق جمع المذيبات العضوية ومذيبات الكلور ومذيبات غير الكلور كانت في 12/1(8.3%), وجود حاويات النفايات الكيميائية اقل من 55 جالون في مكان العمل كان في 12/2 (16.7 %),تمييز انواع النفايات المعملية كان في 6/ 12 (50%).وجود أكياس النفايات المميزة بالألوان كان في 12/5 (41.7%). توفر حاويات النفايات الحادة كان في 4/ 12 (33.3%).

وجدت الدراسة أن هناك بعض العناصر غير متوفرة أصلا بالمعمل مثل عدم وجود جهاز غسل العينين وعدم وجود موجهات أدارة النفايات وعدم وجود برنامج جمع النفايات وعدم توفر حاويات للنفايات المشعة وعدم وجود كتيب توجيهي للنفايات الكيميائية الخطرة وعدم وجود طريقة خاصة للتخلص من الأحماض والقلويات.

خلصت الدراسة إلى أن هنالك بعض العناصر مطبقة بنسبة عالية مثل تصميم المعامل بحيث تكون سهلة التنظيف و أسطح طاولات المعامل مقاومة للحوامض والقلويات والمذيبات العضوية وبعض العناصر مطبقة جزئيا مثل توفر الإضاءة الكافية وتوفر صناديق الإسعافات الأولية .بعض العناصر غير مطبقة لعدم توفرها مثل جهاز غسل العين ,نظام التخلص من النفايات.

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Chapter One

Introduction

Chapter One

Introduction

1-1 Introduction:

The National Public Health Laboratory (NPHL) was established in 1903 to perform chemical analysis. NPHL responsibilities and duties include advanced clinical and epidemiological investigation of a wide range of pathogens which pose a high risk to laboratory workers and the environment. These demands reliable protection of laboratory personnel as well as the community from these pathogens, and the implementation of safe and secure detection and diagnostic capacities for highly pathogenic agents(Abdelrahman *et al* ;2015).

Currently, the Sudanese Federal Ministry of Health endeavors to mitigate these risks by using and implementing adequate practices and procedures, suitable personal protective equipment, as well as administrative and engineering controls. In order to strengthen the systematic implementation of the biorisk management at the NPHL, a biorisk department has been established to approach that could function as a role model for the state public health laboratories in the future. These efforts are supported by several international partnerships with world organizations and countries, such as WHO, German partnership program for excellence in biological and health security and Robert Koch institute (Abdelrahman *et al* ;2015).

The implementation of laboratory practices and procedures specific construction features of laboratory facilities, safety equipments, and appropriate occupational health programs when working with potentially infectious microorganisms and other biological hazard (Bakanidze *et al*; 2010).

A quality management system defined by the International Organization for Standardization (ISO) and by the Clinical and Laboratory Standards Institute

(CLSI) as coordinated activities to direct and control an organization with regard to quality. In a quality management system, all aspects of the laboratory operation, including the organizational structure, processes and procedures, need to be addressed to assure quality. The quality model used here organizes all of the laboratory activities into 12 quality system essentials; one of them is facilities and safety (Albetkova *et al*; 2011)

Many factors must be a part of the quality management of facilities and safety, include the process of preventing unwanted risks and hazards from entering the laboratory space. Containment which seeks to minimize risks and prevent hazards from leaving the laboratory space and causing harm to the community. Safety which includes policies and procedures to safe workers, visitors and the community. Ergonomics which addresses facility and equipment adaptation to allow safe and healthy working conditions at the laboratory site (Albetkova *et al*; 2011) .

1-2 Objectives

1-2-1 General objective

To study the facilities and safety variables application in NPHL.

1-2-2 Specific objectives

To assess laboratory design variables.

To assess safety equipments.

To assess safety documents .

To assess safety personnel variables.

To assess chemical safety .

To assess the waste management system.

Chapter Two

Review of literature

Chapter Two

2. Review of literature

2-1 Quality management system in the medical laboratory:

Medical laboratory services are essential to patient care and therefore should meet the needs of all patients and clinical personnel responsible for human health care. ISO15189, the first quality management ISO system for medical laboratories, has attracted the attention of all medical laboratories. ISO 15189:2003, medical laboratories particular requirements for quality and competence, provides a framework for the design and improvement of process-based quality management systems by medical laboratories. It is based on ISO17025:1999, general requirements for the competence of testing and calibration laboratories, but provides specific requirements for implementation in medical laboratories. This will help medical laboratories to comply with regulatory requirements, to meet the expectations of their clients and, most importantly, to improve and maintain their service to patients. ISO15189 an important template for assessing and recognizing the competence of medical laboratories in their technical capacity and the effective quality management of a professional service and its staff with or without the aim of accreditation (Byori ,2004).

2-2 Biosafety Level two

Biosafety level two builds upon BSL-1. BSL-2 is suitable for work involving agents that pose moderate hazards to personnel and the environment. It differs from BSL-1 in these points., laboratory personnel have specific training in handling pathogenic agents and are supervised by scientists competent in handling infectious agents and associated procedures; access to the laboratory is restricted when work is being conducted; and all

procedures in which infectious aerosols or splashes may be created are conducted in BSCs or other physical containment equipment (Casey and Wilson ,2005)

2-2-1 Facility design and construction (Secondary barriers)

The design and construction of the facility contributes to the laboratory workers protection, provides a barrier to protect persons outside the laboratory, and protects persons or animals in the community from infectious agents that may be accidentally released from the laboratory (Casey and Wilson ,2005)

Laboratories are designated to maintain the health and well safety must remain the primary goal of laboratories. The laboratory designed to be easily cleaned. Walls should be painted with washable, hard non porous paints. Spaces between benches, cabinets, and equipment must be accessible for cleaning. Laboratory furniture must have smooth, nonporous surfaces so as to resist the absorption of liquids and the harsh effects of disinfectants. Furniture must not be positioned in such a manner that makes it difficult to clean spilled liquids or conduct routine maintenance (Sadrieh,*etal* ;2013).

It is very important that all areas of the laboratory are cleaned and maintained on a regular basis. Examples of areas that need daily attention are bench tops clean and disinfect bench tops after completing examination, and after any spills of samples or reagents.

Floors are usually cleaned by cleaning staff, unless restricted access

allows only technical staff to disinfect the floors at the end of the day (Albetkova *et al*; 2011).

Laboratory doors should be self closing and have locks in accordance with the institutional policies. Laboratories must have a sink for hand washing.

The sink may be manually, hands-free, or automatically operated. It should be located near the exit door (Casey and Wilson ;2005).

2.2.2 Design features:

Ample space must be provided for the safe conduct of laboratory work and for cleaning and maintenance. Walls, ceilings and floors should be smooth, easy to clean, impermeable to liquid sand resistant to the chemicals and disinfectants normally used in the laboratory. Floors should be slip-resistant.

Bench tops should be impervious to water and resistant to disinfectants, acids, alkalis, organic solvents and moderate heat (Barkley *etal*; 2004).

Illumination should be adequate for all activities. Undesirable reflections and glare should be avoided. Laboratory furniture should be sturdy. Open spaces between and under benches. Cabinets and equipment should be accessible for cleaning. Storage space must be adequate to hold supplies for immediate use and thus prevent clutter on bench tops and in aisles. Space and facilities should be provided for the safe handling and storage of solvents, radioactive materials, and compressed and liquefied gases Additional long-term storage space, conveniently located outside the laboratory working areas, should also be provided. Hand-washing basins, with running water if possible, should be provided in each laboratory room, preferably near the exit door (Barkley *et al*; 2004).

2-2-3 Personal protective equipments:

Protective laboratory coats, gowns, or uniforms are recommended to prevent contamination of personal clothing. Gloves must be worn to protect hands from exposure to hazardous materials.

Glove selection should be based on an appropriate risk assessment. Protective laboratory coats, gowns, smocks, or uniforms designated for laboratory use must be worn while working with hazardous materials.

Remove protective clothing before leaving for non-laboratory areas, e.g., cafeteria, library, and administrative offices. Dispose of protective clothing appropriately, or deposit it for laundering by the institution. It recommended that laboratory clothing not be taken home. Eating, drinking, smoking, handling contact lenses, applying cosmetics, and storing food for human consumption must not be permitted in laboratory areas. Food must be stored outside the laboratory area in cabinets or refrigerators designated and used for this purpose (Casey and Wilson ,2005).

Access should be limited to authorized and designated employees based on the need to enter sensitive areas. Methods for limiting access could be as simple as locking doors or having a card key system in place

-Incidents that may result in exposure to infectious materials must be immediately evaluated and treated according to procedures. All such incidents must be reported to the laboratory supervisor. Medical evaluation, surveillance, and treatment should be provided and appropriate records maintained (Casey and Wilson ,2005).

The use of vaccines may provide an increased level of personal protection.

Commercial vaccines should be made available to workers to provide protection against infectious agents to which they may be occupationally exposed. The advisory committee on immunization practices (ACIP) provides expert advice to the Secretary of the DHHS, the assistant secretary for health, and the CDC on the most effective means to prevent vaccine. (Casey and Wilson ,2005).

2-2-4 General safety

Each laboratory should develop or adopt a biosafety or operations manual that identifies the hazards that will or may be encountered, and that specifies

practices and procedures designed to minimize or eliminate exposures to these hazards(Environmental health and safety;2015).

This laboratory safety manual is your reference for chemical health and safety and the policies affecting laboratories. A sign incorporating the universal biohazard symbol must be posted at the entrance to the laboratory when infectious agents are present (Casey and Wilson ;2005).

The international biohazard warning symbol and sign must be displayed on the doors of the rooms where microorganisms of risk group two or higher risk groups are handled (Environmental health and safety;2015).

2-2-5 Chemical safety

Chemicals are frequently used in our daily life and at work. Quite a number of the chemicals are dangerous substances by nature, without adequate knowledge of the hazards or in the absence of appropriate precautionary measures, accidents may occur .Only amounts of chemicals necessary for daily use should be stored in the laboratory. Bulk stocks should be kept in specially designated rooms or buildings. Chemicals should not be stored in alphabetical order (Barkley *et al*; 2004).

Always keep containers of chemicals closed when not in use, store chemicals and/or apparatus on the lab bench. The hazards presented by any chemical depend upon the properties of that chemical. Each chemical is different from all others because it has properties that are different.

Precautionary labels for chemicals typically present information in four parts. Know in advance the hazards presented by that chemical and the precautions you must follow to minimize the probability of harm. Identify which chemicals in your storeroom and laboratory may be properly disposed of down the sink drain and which may not be (Young; 2001)

2-2-6 Safety equipments

The principles for the selection of laboratory equipment, including biological safety cabinets are the same as for the basic laboratory biosafety Level 2.

However, at biosafety level three, manipulation of all potentially infectious material must be conducted within a biological safety cabinet or other primary containment device(Barkley *et al*; 2004).

Consideration should be given to equipment such as centrifuges, which will need additional containment accessories, for example, safety buckets or containment rotors. Some centrifuges and other equipment, such as cell-sorting instruments for use with infected cells, may need additional local exhaust ventilation with HEPA filtration for efficient containment.

Place fire extinguishers near an escape route, not in a dead end.

Regularly maintain fire extinguishers and keep records of that maintenance.

Arrange with your local fire department for the training of teachers and administrators in the proper use of extinguishers (Barkley *et al*; 2004).

2-2-7 Waste management system

Healthcare waste management includes all activities involved in waste generation, segregation, transportation, storage, treatment and final disposal of all types of waste generated in the healthcare facilities. Waste segregation investigation was made on whether the facility practices waste segregation or not. Also the following were investigated: if the color coding system were used in managing waste in the facilities, the type of containers used in collection of waste in the health facilities and if those containers were readily available all the time for use(Mayela and lyasenga,2010).

The waste is stored, for how long the facility stores that waste before further actions. The standard time for storing medical wastes recommended by the WHO should not exceed 24 hours (Mayela and lyasenga,2010)

Chemical waste disposal and treated according to its physical and chemical properties therefore segregation of waste products is crucial. The mixing of incompatible materials in waste streams can result in unwanted reactions, such as the production of toxic gases or explosions. All chemical waste containers must be labeled to accurately reflect their contents. The following details must be included the name of waste generator and contact details, department and contact phone number description of contents (including estimates of concentration where possible), date of generation

(Loughran, *etal* 2011).

Packaging should be done to minimize the possibility of breakage or leakage during handling (all bottles should be tightly capped to prevent leakage)

Bottles of liquid chemicals should be packed with absorbent materials to contain the material in the event of breakage. Five gallon solvent cans in good condition do not need to be over-packed (Daniel,2007)

Chapter Three

Materials and Methods

Chapter Three

3-Materials and Methods

3-1 Study design:

This descriptive case laboratory based study was carried out during the period from July to December 2015, to assess the facilities and safety in national public health laboratory**.**

3-2 Study area:

This study was conducted in national public health laboratory located in Khartoum state**.**

3-3 Study period:

This study was conducted in period from July to December 2015

3-4 Data collection :

The check list contain 52 questions distributed to 12 laboratories in NPHL filled by senior technologists of laboratories and observation analysis.

3-5 Data analysis:

Collected data was analyzed using the statistical package of social science computer program. Frequency and percentage were calculated.

3-6 Ethical consideration:-

Written permission was obtained from general directorate of the national public health laboratory (NPHL) to carry out this study.

Chapter Four

Results

Chapter Four

4-Results

Table.4. 1 Frequency of laboratory design variables

Result		Frequency	%
Frequency of laboratories design easy to clean	Yes	10	83.3%
	No	2	16.7%
Frequency of bench top water proof & resist to acid ,alkali and organic solvents in laboratories.	Yes	10	83.3%
	No	2	16.7%
Frequency of adequate illumination provided in laboratories.	Yes	4	33.3%
	No	8	66.7%
Frequency of adequate storage space in laboratories.	Yes	7	58.3%
	No	5	41.7%
Frequency of sink available for hand washing in laboratories.	Yes	10	83.3%
	No	2	16.7%
Frequency of corridor is free and unobstructed in laboratories.	Yes	5	41.7%
	No	7	58.3%

As show in above table: The design easy to clean were found as follow 10(83.3%) have walls and benches are easy to clean, while two (16.7%) view have not. The bench top water proof and resist to acid ,alkali and organic solvents were found as follow 10(83.3%) have design of benches resistance to water ,acid and alkali ,while two (16.7%)view have not.

The adequate illumination provided, were found as follow four (33.3%) have good illumination and adequate lamps, while eight (66.7 %) view have not.

The adequate storage space were found as follow seven (58.3%) have suitable and enough place for storage , while five (41.7%) view have not.

The sink available for hand washing were found as follow 10(83.3%) have design contain hand washing place while two (16.7%) view have not.

The corridor is free and unobstructed were found as follow eight (66.7%) have corridor free from obstacles, while four (33.3%) view have not.

Table.4-2 Distribution of safety equipments

Frequency of flammable store in flammable storage cabinet in laboratories.	Yes	1	8.3%
	No	11	91.7%
Frequency of mouth pipe ting prohibited in laboratories.	Yes	1	8.3%
	No	11	91.7%
Frequency of centrifuge with cup in laboratories.	Yes	1	8.3%
	No	11	91.7%
Frequency of glass container stored on the floor in laboratories.	Yes	2	16.7%
	No	10	83.3%
Frequency of fighting fire equipments found & valid in laboratories.	Yes	11	91.7
	No	1	8.3
Frequency of first aid kits available in laboratories	Yes	7	58.3%
	No	5	41.7%
Frequency of staff trained for fire fighting in laboratories	Yes	10	83.3%
	No	2	16.7%
Frequency of biological safety cabinet certified last year in laboratories	Yes	2	16.7%
	No	10	83.3%
Frequency of BSC surface disinfected by appropriate disinfectant at begin and end of each procedures in laboratories.	Yes	9	75.0%
	No	3	25.0%
Frequency of open flame used inside cabinet in laboratories.	Yes	1	8.3%
	No	11	91.7%

As show in above table:-

The flammable store in flammable storage cabinet were found as follow one (8.3) have store the flame in cabinet, while 11 (91.7) view have not. The mouth pipetting prohibited the were found as follow five (41.7%) did not pipe ting while seven(58.3%)view have not.

The centrifuge with cup were found as follow 10(83.3%) have closed Centrifuge, while two (16.7%)view have not .

The Glass container stored on the floor were found as follow two (16.7%) were stored on floor, while 10(83.3%) view have not.

The fighting fire equipments found and valid were found as follow nine (91.7%) have validated fighting fire equipments, while three (8.3%) view have not.

The availability of First aid kits in laboratories were found as follow seven(58.3%) have First aid kits while five(41.7%)view have not.

The staff trained for firefighting were found as follow two (16.7%) have trained personnel for firefighting while 10(83.3%) view have not.

The Biological safety cabinet certified last year were found as follow two (16.7%) have Biological safety cabinet certified last year while 10 (83.3%) view have not.

the BSC surface disinfected by appropriate disinfectant at the begin and end of each procedures were found as follow four(33.3%) have BSC surface disinfected by appropriate disinfectant at the begin and end of each procedures eight (66.7%)view have not .

The Open flame used inside cabinet were found as follow one (8.3%) have Open flame used inside cabinet while 11 (91.7%) view have not.

Table.4- 3 Frequency of safety personnel variables

Frequency of personnel protective equipments available (gloves, gowns, lab coats,….etc) in laboratories.	Yes	10	83.3%
	No	2	16.7%
Frequency of personnel protective equipment not worn outside laboratories	Yes	5	41.7%
	No	7	58.3%
Frequency of food for human consumption present in laboratories.	Yes	1	8.3%
	No	11	91.7%
Frequency of eating ,drinking ,smoking and cosmetics inside laboratories	Yes	1	91.7%
	No	11	8.3%
Frequency of laboratory personnel immunized against occupational risk in laboratories.	Yes	4	33.3%
	No	8	66.7%
Frequency of registration of incident in laboratories.	Yes	9	75%
	No	3	25%
Frequency of access limited and restricted to authorized personnel in laboratories	Yes	9	75.0%
	No	3	25.0%

As show in above table:-

The access limited and restricted to authorized personnel were found as follow nine (75.0%) have limited access to the patients ,co patients and visitors …etc while three(25.0%)view have not .

The availability Personnel protective equipments (PPE) were found as follow 10(83.3) have (PPE), while two (16.7) view have not.

There no worn of Personnel protective equipments (PPE) outside laboratory were found as follow five(41.7) followed the instructions for not worn the (PPE) outside the lab ,while seven(58.3)view were not.

The food for human consumption present were found as follow one (8.3%) have present of food in lab, while 11 (91.7%) view have not.

The eating ,drinking ,smoking and cosmetics inside lab were found as follow one (8.3%) have Eating ,drinking ,smoking and cosmetics inside lab while 11 (91.7%) view have not.

The Registration of incident were found as follow three (25.0%) have Registration of incident while nine (75.0%) view have not.

The Laboratory personnel immunized against occupational risk were found as follow four(33.3%) have Laboratory personnel immunized against occupational risk, eight (66.7%)view have not

Table.4- 4 Distribution of safety manual and hazard sings

Frequency of safety manuals in laboratories	yes	2	16.7
	No	10	83.3
Frequency of bio hazard signs posted on laboratory door	yes	5	41.7%
	No	7	58.3%
Frequency of safety signs in laboratories	yes	5	41.7%
	No	7	58.3%

As showed in above table:-

The safety manual were found as follow two (16.7%) have this document (safety manual), while 10(83.3%) have not.

The bio hazard signs posted on laboratory door were found as follow five (41.7%) have doors with bio hazard sings, while seven (58.3%) view have not .

The safety signs in the labs were found as follow five (41.7%) have safety sings distributed on the lab in right position, while seven (58.3%) view have not.

Table.4- 5 Frequency of chemicals safety

Frequency of All cylinder secure in laboratories.	yes	10	83.3%
	No	2	16.7%
Frequency of Chemical property segregated in laboratories.	yes	7	58.3%
	No	5	41.7%
Frequency of Hazardous chemical above eye level in laboratories.	yes	3	25.0%
	No	9	75.0%
Frequency of Chemical store on the floor in laboratories.	yes	4	33.3%
	No	8	66.7%
Frequency of chemical container left open in laboratories.	yes	1	8.3%
	No	11	91.7%
Frequency of All solution properly labeled in laboratories.	yes	10	83.3%
	No	2	16.7%

As show in above table: All cylinder secure were found as follow 10(83.3) have well secure cylinders, while two (16.7) view have not cylinder.

The chemical property segregated in laboratories were found as follow seven (58.3) were segregated the chemicals while five (41.7) view have not.

The hazardous chemical above eye level were found as follow three (25.0%) were found the hazardous chemical above eye level, while nine (75.0%) view have not.

The Chemical store on the floor were found as follow four(33.3%) have bottles of chemical solutions under the benches on floor ,while eight (66.7%)view have not. the chemical container left open were found as follow one(8.3%) have chemical container without cover, while 11 (91.7%)viewed close.

The proper label of solutions were found as follow 10(83.3%) have clear labeled solutions, while two (16.7%) view have not.

Table.4- 6 Frequency of waste management system

Frequency of chemical waste container found in laboratories.	Yes	3	25%
	No	9	75%
Frequency of chemical waste separation found in laboratories.	Yes	2	16.7%
	No	10	83.3%
Frequency of liquid chemicals equipment generated waste couplet with waste collected container in laboratories	Yes	2	16.7%
	No	10	83.3%
Frequency of chemical waste labeled appropriately in laboratories	Yes	3	25%
	No	9	75%
Frequency of chemical waste hazard identified on hazards waste labeled in laboratories	Yes	1	8.3%
	No	11	91.7%
Frequency of chemical waste tightly capped in laboratories.	Yes	4	33.3%
	No	8	66.7%
Frequency of method of minimization of chemical waste in laboratories	Yes	1	8.3%
	No	11	91.7%
Frequency of procedure for collection organic solvents, chlorinated solvent ,non chlorinated solvent in laboratories.	Yes	1	8.3%
	No	11	91.1%
Frequency of Chemical waste container less than 55 gallons in working area found in laboratories.	Yes	2	16.7%
	No	10	83.3%
*Frequency of SOPs for waste management in laboratories.	Yes	3	25%
	No	9	75%
Frequency of waste management segregation system found in laboratories	Yes	3	25.0%
	No	9	75.0%
Frequency type of waste in laboratories	Yes	6	50.0%
	No	6	50.0%
Frequency of waste bag are coded by color in laboratories.	Yes	5	41.7%
	No	7	58.3%
Frequency of sharps box container found in laboratories.	Yes	4	33.3%
	No	8	66.7%

As show in above table:-

Availability of chemical waste container were found as follow three (25.0%) have container for chemical waste while nine (75.0%) view have not.

The availability of chemical waste container were found as follow three (25.0%) have container for chemical waste while nine (75.0%) view have not.

The liquid chemicals equipment generated waste couplet with waste collected container were found as follow two (16.7%) have equipment produced liquid waste while 10(83.3%)view have not .

The chemical waste labeled appropriately were found as follow three (25.0%) have a proper labeled while nine(75.0%)view have not .

The chemical waste hazard identified on hazards waste labeled were found as follow one (8.3%) have labeled of chemical hazardous waste while 11 (91.7%) view have not

The chemical waste tightly capped were found as follow four(33.3%) have tightly capped while eight (66.7%)view have not .

Method for minimization of chemical waste were found as follow one (8.3%) have procedures for decrease of chemical waste while 11 (91.7%).

Procedure for collection of solvents were found as follow one (8.3%) have ways of collection while 11 (91.7%) view have not any procedures for collection of (chemical not exist).

Chemical waste container less than 55gallons in working area were found as follow two (16.7%) have tank (55g) , while 10(83.3%)view have not.

Types of waste in the laboratory were found as follow six(50.0%) have different types of waste in the laboratory while six(50.0%)view have not .

The waste bag coded by color were found as follow five(41.7%) have coded bags with different colors to classification of waste, while seven(58.3%)view have not.

The availability of sharps box container were found as follow four(33.3%) have sharps box container, eight (66.7%)view have not .

The results of some in national public health laboratory like (the availability of eye wash in laboratory, waste management guidelines waste collection program , radioactive waste container ,the availability of hazards chemical waste management guidebook, special procedure for disposable for acids and bases) is not available.

Chapter Five

Discussion

Chapter Five

5- Discussion

The present study found the majority of laboratories were not using safety manual, this result is not fulfillment with WHO guidelin (WHO;2004),which reported that all laboratories must used safety manual. In addition safety manual is difficult to write because there are no knowledge or expertise in laboratory safety ,and it need large budget to print this document .

The study found that the majority of laboratories were designate according to international standards (WHO.2004).

The study found few laboratories have bio hazard signs posted on laboratory doors. This result not fulfillment with WHO guideline(WHO.2004) reported that the labs should posted the safety sings specially the laboratories that dealing with infectious biological agent that mean there is high risk and hazard.

The study found the majority of laboratories have access limited and restricted to authorized personnel. That is compatible to international standard (WHO.2004).The system of the NPHL is for patients and

co patients are enter by special door to collection rooms then the samples are transport to laboratories by lab assistances for testing process then the results arrive to patient in the same room.

The study found the majority of laboratories not posted safety sings this result is not fulfillment with WHO guideline (WHO.2004) the signs posted in laboratories that assigned safety officer responsible for safety, and know the important of safety sings.

The present study found that the majority of the laboratories' benches is made by resistance material to water, acids, or any solvents and that is compatible to international standers.

The illumination in the NPHL as general is not good in offices in colluders in laboratories, that not fulfillment with WHO guideline (WHO.2004) and that due to low quality of the lamps and no maintenance system.

The storage space is suitable in most laboratories that agreed to WHO guidelines (WHO.2004) because there are large storage room for laboratory equipments and reagents.

The majority of the laboratories designs contain place for hand washing and that is fulfillment with international standers and WHO guidelines (WHO.2004) .

The majority of the laboratories have PPE, and that fulfillment to international standards ,WHO guidelines(WHO.2004) ,and that because people know the important of it , but some laboratories need specials types of PPE due to nature of work.

The study found that people worn Personnel protective equipment outside the lab , and that is fulfillment to international standards(WHO.2004) , the employees in NPHL have different level of knowledge , the lower level not know the danger of worn the PPE outside the labs.

The current study were found the majority of laboratory have well secured cylinders in laboratories that dealing with chemical solutions , and that is applicable to international standards. (WHO.2004) .

The majority of laboratories did not have flammable storage cabinet available in NPHL, which is not fulfillment to international standards (WHO.2004). The flammable storage cabinet very expensive expect in one

lab, this lab funded by (WHO) and the validation and certification it done by external body .

The majority of laboratories that dealing with chemicals are segregates the solution well , and that fulfillment with WHO guideline(WHO.2004) but there are few laboratories is not have segregation system and that is not agreed to international standards.

The majority of laboratories did not put the hazardous chemical above eye level, that is not fulfillment with international standards (WHO.2004) , due to lack of awareness of hazard chemicals and risk .

The majority of laboratories did not store chemical substance on floor, and that is fulfillment with international standards (WHO.2004).

The majority of laboratories did not left the chemical containers open that is fulfillment with international standards(WHO.2004),because there is knowledge about the chemical nature of solutions and the danger of that .

The majority of laboratories have proper and clear labeled solutions as part of laboratory instructions, and that is compatible with international standards (WHO.2004).

The study was found the majority of laboratories did not contain any food that is agreed with international standards (WHO.2004), because there is special place for that.

The majority of laboratories did not have SOPs of waste management that is not fulfillment with international standards (WHO.2004) , due to lack of awareness of disposal of waste .

The majority of laboratories did not have system for segregation of laboratories' waste, and that is not fulfillment with international standards (WHO.2004) .

The current study were found that most laboratories did not have waste bag are coded by color that is not fulfillment with international standards (WHO.2004) , because there are no waste management system concern with segregation of waste.

Few laboratories have sharps box container that is not fulfillment with international standers (WHO.2004) , this laboratories funded by external body like WHO.

The majority of laboratories did not have Chemical waste container due to lake of waste management system and that is not fulfillment with international (WHO.2004) .

The majority of laboratories did not make separation of chemical waste and that is fulfillment with international (WHO.2004).

The majority of laboratories did not have liquid chemicals equipment generated waste couplet with waste collected container .and that is not fulfillment with WHO international standards (WHO.2004).

The majority of laboratories did not have chemical waste labeled appropriately, and that is not fulfillment with international standards (WHO.2004).

The majority of laboratories did not have chemical waste hazard identified on hazardous waste labeled and that is not fulfillment with international standards (WHO.2004).

The majority of laboratories did not have chemical waste tightly capped that is not fulfillment with international standards (WHO.2004).

The majority of did not have method for minimization of chemical laboratories waste, and that is not fulfillment with international standards (WHO.2004).

The majority of laboratories did not have procedure for collection:-Organic solvents, chlorinated solvent, non chlorinated solvent, and that is not fulfillment with international standards (WHO.2004).

The majority of laboratories did not have chemical waste container less than 55gallons in working area found, that is not fulfillment with international standards (WHO.2004).

The majority of people working in laboratories not eating, drinking, smoking and using cosmetics inside lab that fulfillment with international standards, (WHO.2004) as good behavior.

The majority of laboratories did not pip ting by mouth, and that is not with fulfillment international standards (WHO.2004) .

The majority of laboratories contained Centrifuge with cup, and that is fulfillment with international standards (WHO.2004) .

The majority of laboratories did not have Glass container stored on the floor, and that is fulfillment with international standard (WHO.2004) .

The majority of laboratories contained valid Fighting fire equipments , and that is fulfillment with international standard (WHO.2004) .

The majority of laboratories did not contain First aid kits that not fulfillment with international standards. (WHO.2004) .

The majority of laboratories have Corridor is free and unobstructed, and that is fulfillment with international standard (WHO.2004) .

The majority of laboratories did not training personnel for fire fitting, and that is not fulfillment with international standards (WHO.2004) .

In this study we found the majority of laboratories did not make certification of biological safety cabinet , that is not fulfillment with international standards. (WHO.2004) , that due to not availability of company in Sudan .

Some laboratories make disinfection of BSC surface by appropriate disinfectant at the begin & end of each procedures ,that is not fulfillment with international standards (WHO.2004) .

The majority of laboratories did not used Open flame inside cabinet , and that is not fulfillment with international standards.

The majority of laboratories did not make registration of incident and accident , due to the weakness in documentation system at general ,and that is not fulfillment with international standards.

The majority of Laboratory personnel did not immunized against occupational risk, and that is not fulfillment with international standards.

The present study found that this variables not available in NPHL

The availability of (eye wash , Waste management guidelines , Waste collection program , Radioactive waste container , Hazards chemical waste management guidebook , Special procedure for disposable for Acids and bases, in laboratory).that is not fulfillment with WHO guideline (WHO.2004) because it is very expensive in cost ,the top management did know the important of it, there is no care about it ,some safety equipments not available in Sudan in local market, it is not take the prioritization in safety management system and it need deep knowledge and experience .

Chapter Six

Conclusion and Recommendations

Chapter Six

Conclusion and Recommendations

6-1 Conclusions

On the bases of this study we conclude that:

Some variables are well establish such as the design easy to cleaning , centrifuge with cup, availability personnel protective equipments.

Other variables are not well establish such as adequate illumination, the registration of incident, laboratory, personnel immunized against occupational risk, the safety signs in the laboratories.

Some variables are not available such as: eye wash machine, radioactive waste container.

6-2 Recommendations

On the bases of this study we recommend that:

Documentation system should be developed.

Laboratories infrastructures should be completed.

Biorisk management system should be established.

Waste management system should be established.

PPE must be match with the kind of risks.

Personnel should be vaccinated against infection diseases.

Raising awareness and conduct training in safety .

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Appendix

Appendix Sudan University of Science and Technology

MSc Program in management of Quality &Excellence

Assessment checklist

Department :- **Responsible :-**
Date :- / / 2015

No	Checked Item	Yes	No	Not applicable	Comments
1	Safety manual found				
2	Design easy cleaned				
3	Bio hazard signs posted on laboratory door				
4	Access limited &restricted to authorized personnel				
5	Is there safety signs in the labs				
6	Bench top water proof &resist to acid ,alkali &organic solvents				
7	Adequate illumination provided				
8	Adequate storage space				
9	Sink available for hand washing				
10	Personnel protective equipments available (gloves, gowns ,lab coats,….etc)				
NO	**Checked Item**	**Yes**	**No**	**Not applicable**	**Comments**
11	Personnel protective equipment not worn outside laboratory				
12	Eye wash available in laboratory				
13	All cylinder secure				

14	Flammable store in flammable storage cabinet				
15	Chemical property segregated				
16	Hazardous chemical above eye level				
17	Chemical store on the floor				
18	chemical container left open				
19	All solution properly labeled				
20	Food for human consumption present				
21	Waste management guidelines found				
22	SOPs for waste management				
23	Waste collection program found				
NO	**Checked Item**	**Yes**	**NO**	**Not applicable**	**Comments**
24	Waste management segregation system found				
25	Type of waste in the laboratory:- check all applicable				
	- Infectious				
	- Sharps				
	- Chemical				
	- Pharmaceutical				
	- Toxins				
	- GMOs				
	- Heavy metals				
	- Radio active material				

26	Waste bag are coded by color				
27	Sharps box container found				
28	Radio active waste container found				
NO	**Checked Item**	**Yes**	**No**	**Not applicable**	**Comments**
29	Hazards chemical waste management guidebook				
30	Chemical waste container found				
31	Chemical waste separation found				
32	Liquid chemicals equipment generated waste couplet with waste collected container				
33	Chemical waste labeled appropriately				
34	Chemical waste hazard identified on hazards waste labeled				
35	Chemical waste tightly capped				
36	Method of minimization of chemical waste				
37	Procedure for collection:-				
	1- Organic solvents				
	2- Chlorinated solvent				
	3- Non Chlorinated solvent				
38	Chemical waste container less than 55gallons in working area found				
NO	**Checked Item**	**Yes**	**No**	**Not applicable**	**Comments**
39	Special procedure for disposable				
	1- Acids				

	2- bases				
40	Eating ,drinking ,smoking &cosmetics inside lab				
41	Mouth pipe ting prohibited				
42	Centrifuge with cup				
43	Glass container stored on the floor				
44	Fighting fire equipments found & valid				
45	First aid kits available				
46	Corridor is free &unobstructed				
47	Staff trained for fire fighting				
48	Biological safety cabinet certified last year				
49	BSC surface disinfected by appropriate disinfectant at the begin & end of each procedures				
NO	**Checked Item**	**Yes**	**NO**	**Not applicable**	**Comments**
50	Open flame used inside cabinet				
51	Registration of incident				
52	Laboratory personnel immunized against occupational risk				