

Risk Mapping to Consolidate the Control of Occupational Health in Institutions of Higher Education

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ABSTRACT— *In compliance with the Brazilian legislation risk maps and alternative signs are required for mapping environments where any type of risk is present. Current information on this subject is scarce; there is little knowledge about its use in the biological sciences and other health care higher education institutions units. The purpose of this paper was to assess occupational risks at the Health Sciences Institute of the Federal University of Bahia (ICS - UFBA); to identify risks, analyze potential consequences, set priorities of action and suggest strategic models of mapping to establish and strengthen occupational health and biosafety in this institution and other public institutions of higher education that offer biological sciences and biomedical programs. An observational study of the building infrastructure and signaling was conducted; questionnaires were distributed and answered by professionals responsible for the laboratories; current Brazilian legislation on risk maps and alternative signs was reviewed; all collected data was analyzed. The absence of adequate infrastructures signage or equipment was noted on this study. Models of risk map were suggested using a simple and objective signage to enable a better interpretation of professionals and students who move in and out laboratories or other environments that pose occupational or environmental hazards, as well as to the visitors and users of the teaching services of that unit.*

Keywords— biosafety, risk control, risk map, occupational safety, institutional biosafety

1. INTRODUCTION

Risk maps are described as a descriptive tool and qualitative safety mechanism to occupational risks implemented in Brazil in the early 1980s. The basis for building a quality safe environment is based on control parameters of biosafety, the types of occupational risks which are classified into five major groups: physical, biological, chemical, ergonomic or accident [1].

According to Oddonne et al (1986) [2] risk maps were developed for the study of working conditions incorporating in its origin the political dimension of worker action in defense of their rights based upon the Italian Worker Model. Mattos e Freitas (1994) [3] define a risk map, as being a graphic representation of a set of factors present in the workplace, able to cause injury to workers, such as, materials, equipment, facilities condition, the physical arrangement, pace of work, and work schedule. Brazilian regulatory standard N^o. 3.214/78 NR-01 [4] aims to gather the information required to establish safety and health at the workplace, and to enable the exchange and dissemination of information among employees, as well as stipulating their participation in activities of prevention [5].

According to National legislation [6] it is considered unhealthy activities any activity that by its nature, policies or methods of work, expose employees to hazard materials beyond safety limits set on its guidelines. According the Brazilian Ministry of Labor and Employment (MTE) [6] it is considered hazardous activities of operation those that by their nature or working methods, have permanent contact with inflammable or explosive hazardous materials.

In 1983 the Brazilian Ministry of Health set the Norm 196 to provide criteria for hospital infection control. The Regulatory Norm (NR) 5 controls the internal commission for the prevention of accidents (CIPA) and their obligation to elaborate the risk map (MR) and the NR-9 to environmental risk prevention program (PPRA). Information to the risk map was later described in the NR-25 (1994, MTE) [7].

Health care teaching facilities must comply with the NR-32 [8] of the MTE that addresses the health and protection of the worker in the health area. An update to NR-32 in August 30, 2011 states that every professional is responsible for knowing updated legislation and regulation of workenvironment.

Biosafety in Brazil became a specific field of study between 1970 and 1980. In medical schools and experimental science in the nineteenth century, teachers and other principal investigators elaborated some rules about the benefits of care for the risks inherent to scientific work, especially in laboratory environments. In the past fifteen years Oswaldo Cruz Foundation (Fiocruz) and the National Central Laboratories (Lacen) developed biosafety and quality systems in order to establish and control risks in health care and research workplace. Some undergraduate and graduate federal university courses in biomedical areas began to offer disciplines and lectures on biosafety starting in 2009, indicating an increased importance in this area.

The risk map can be done as a graphical representation and has specific requirements of visibility in an institution or an establishment [1,5]. The technical literature for specific risk maps in the biomedical area in Portuguese language scarcely addresses the specific recommendations and its importance in the scientific and academic environment.

The pioneer Italian model of risk maps focused in action planning and risk control in the health care workplace. Following demand and technological growth, countries in the Europe and America, and later Asia and Oceania implemented these ideas as well. In Brazil the MTE took some of those recommendations in the early nineties [9].

With biosafety measures observed the workplace becomes safer and less subjected to any risks. It is necessary for scientific findings and recommendations in this field to be widely spread to become more effective for the workers. People involved in health care should be proactive, becoming protagonists of the safer environment, minimizing risks and avoiding accidents. Only when specific goals are traced and employees and employers are aware of those needs, technical or regulatory changes can be made to minimize environmental risks [10,11].

Higher education institutions that provide health care courses and lectures should better prepare their students and future professionals in the biosafety field, educating them to follow proper legislation and safety procedures to a better work and quality of life.

2. OBJECTIVES

The main objectives of this study were to assess occupational risks at the Health Sciences Institute of the Federal University of Bahia (ICS - UFBA); to identify risks, analyze potential consequences, set priorities for preventive and corrective actions; to develop and implement an action plan to help institutions analyze their risks and how to address them; assess inadequacies and non observance of safety legislation; and, at last, to suggest an alternative strategic models of mapping to establish and strengthen occupational health and biosafety in this institution and other public higher education institutions that offer biological sciences and biomedical programs.

3. MATERIAL AND METHODS

Observational and qualitative analyzes were performed during inspections to assess the conditions and the infrastructure of the building based on national standards of legal requirements for occupational risks. Two examiners inspected the unit on separate days, using the same checklist format for note comparison. For this observational analysis, the basic tools used were based on legal and scientific government guidelines and recommendations in the area of biosafety.

The operating conditions of a higher education institution deal with risks and promote knowledge, awareness, management and risk minimization in promoting health maintenance. Qualitative analysis focused on presence or absence of proper log record, adequacy or inadequacy, compliance or noncompliance situations and structures observed in the institutional unit.

Professionals responsible for the laboratories received a standardized questionnaire to establish their level of knowledge regarding not only their own laboratory, but also about biosafety and the building itself. Some additional

data was also obtained from activities of vaccine analysis programs with students and professionals at the Federal University of Bahia, dissertations from the years 2006 and 2007, and a group project from 2011 were reviewed.

Based on the results obtained after data collection, and cross check between examiners, strategies were designed to follow current legislation, so that the institution could benefit from using an organizational structure to construct better models of communication. Proper legal requirements on occupational safety, occupational medicine and biosecurity was obtained from Brazilian guidelines from Ministry of Health, Ministry of Labor and Employment, Ministry of Education and Culture and Ministry of Science and Technology.

Steps followed to construct the risk map were: to obtain enough data to establish the diagnosis the status of safety and health at the workplace; to enable, during its development, the exchange and dissemination of information among employees, as well as stimulate their participation in prevention activities; to identify existing preventive measures and their effectiveness; to search for health indicators; to identify the most frequently causes of absence at work; to meet the environmental surveys already conducted on the site and to design a risk map on the layout of the place, using the classic map with color circles. Taking into consideration all these basic steps new designs were proposed and developed by the authors.

4. RESULTS

A Public Institution of Higher Education that offers health care and biological education, different clinical and social services to the community, conducting biomedical research, is subjected to follow certain rules and regulations regarding the safety of students, faculty and other employees. Occupational risks are present at anytime and include five groups: physical, chemical, biological, ergonomics and accidents, most varying from small to medium intensities. It is mandatory to follow proper protocol in order to minimize those risks.

Evaluation of the building infrastructure revealed a total of seven access doors; four stairways, two connecting all five floors of the building, one as isolated access to the roof, and one escape route; and three elevators with access to all floors.

Based on observational analysis laboratories in which workers handle different chemical products and biological agents were identified and categorized as BL1 and BL2. Log information and a questionnaire filled by the biosafety responsible for the building provided information regarding its last incidents. On the past year two fires occurred due to the lack of structure in chemical storage and old electrical wiring. Inside the institute there was no biological accident recorded in the past five years. Minor accidents that resulted in slips, falls and minor injuries such as bruises, occurred due to the lack of signage or inadequate structure.

Analysis of questionnaires answered by professionals responsible for the laboratories in the building revealed the following findings: under current renovation, some shortcomings on risk analysis will be modified and corrected; there is no formal courses or lectures on biosafety during the academic training; professional demonstrated diminished knowledge on legislation, actual risk present on health units of public institutions, their specific rights and duties regarding risk protection in occupational activities.

Other findings of this study showed lack of knowledge of specific risk situations and protocol by unit managers, teachers, researchers, technicians and graduates at the institution. Even though there are no dedicated disciplines to the study of biosafety and biosecurity, some disciplines contain some information regarding the subject, but most of the times the study material was found to be focused on microbiology.

5. DISCUSSION

Some attempts of strategic models for the establishment and strengthening of occupational health and occupational Biosafety in this institution were previously proposed and some were implemented over the past years. Biosafety courses were advertised by circular letters to the directors of the units; based on a pilot study from 2010 interviews about risks and plan of action offering training courses for mapping activities in each sector was conducted with institutional support; meetings between professionals and students were strongly suggested to discuss topics of interest in biosafety; agents from the Brazilian Intelligence Agency (ABIN) lectured on biosecurity proposals on past years (2008-2010); experienced professional lectured on waste disposal in health services; firefighters made live demonstrations in 2010 and 2013; a vaccination campaign conducted in every health care and health science unit including the University Hospital complex.

The proposed plan of action based on observation analysis and risk map elaboration is to integrate all sectors and have everyone involved at some level. Sharing responsibilities and propagating information. Each sector, after authorized and sensitized, would organize and engage groups to fulfill the schedule of activities carried out by standard operating procedures, followed by lectures and laboratory classes.

Once the groups are formed and engaged, training of the team, volunteers and other individuals indicated by the directors starts, and the group should be able to identify risks and elaborate concise reports providing important feedback. The group acts as a great support piece on the development and implementation of the actual action plan. Figures 1 and 2 indicate strategic moves for the successful bonding between professionals and managers of the units in order to consolidate safety at the environmental workplace.

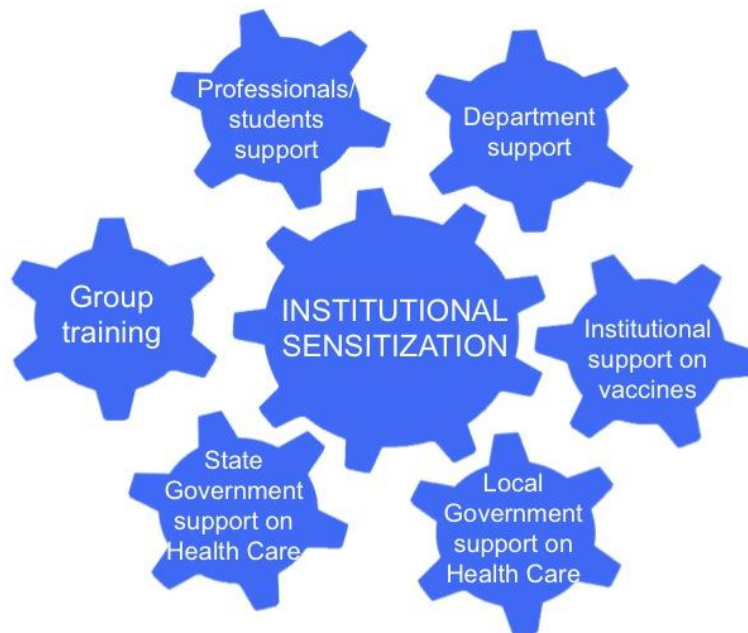


Figure 1. Strategic schematic model to engage sectors



Figure 2. Proposal of the Institutional strategic movement

The idea behind engaging groups is to get everyone involved and raise awareness of risks involved in the institution, those groups should be supervised by the institutions' head of biosafety in conjunction with the health committee for accident prevention, or the health committee for government employees (CISSP), they will coordinate and direct the

actions by facilitating activities, improve occupational risk prevention and minimize risks in all sectors. With the activities report and feedback provided, the supervising group would be able to provide determinations to be presented at a meeting with the board of directors. With the risk maps and other types of signage, the main office should have campus officer implement the final project and usage of the standardized models, having them evaluated periodically for control and improvement.

Models of risk maps

The Classic model (Figure 3) indicated in the original legislation of the Brazilian ministry documents, with circles and international standard colors, is widely used in the country, but can cause dispersion and little attention to community members because of the large amount of information on the floor plan containing many circles and colors, particularly those with many employees within the same circle or circle showing more than one color. The circles mean the intensity of risk that can be classified as low, medium and high while the colors indicate the agents of risk (Table 1).

Table 1. Color-coded indicating group risk, and its agent list, based on Norm 25 of Brazilian legislation.

GROUP 1 Physical risk	GROUP 2 Chemical risk	GROUP 3 Biologic risk	GROUP 4 Ergonomic risk	GROUP 5 Accident risk
noise	fogs	fungi	intense physical effort	inadequate illumination
cold	dust	virus	excessive pace	inadequate physical arrangement
heat	gases	parasite	day and night working	probability of fire
vibrations	mists	bacilli	lifting and carrying weight	machinery and equipment without protection
moisture	smoke	bacteria	monotony and repeatability	inadequate storage
ionizing radiation	compound or chemical substances	protozoa	stress	poisonous animals
non-ionizing radiation	-	-	poor or inadequate posture	inadequate or defective tools

The CobWeb model (Figure 4) shows the five different colors and is applied to a small group of individuals who work in the laboratory, office, research laboratory and know each detail of their workplace. It is known to be useful in facilities containing no more than five laboratories.

The Empty Map (Figure 5) with numbers in an empty physical space, was designed based on where the frequency of new equipment acquired or equipment or furniture need to be moved from one place to another. The main indication is to be used by a professor to teach and sensitize students about the meaning of biosafety and biosecurity by using the board as a floor plan where he writes the numbers indicating the intensity of risk, and each one with international standard color representing the different risk groups described on Table 1. It is strongly suggested that this lecture take place within the first weeks of the freshman year academic calendar, asking them to classify every each instrument or equipment in the laboratory according to its risk.

An ideal hybrid map to alert students and visitors can be the Floor Plan model with the risk severity numbers (Figure 6), corresponding to the color of its respective risk groups, instead of circles previously described. It can also be used in laboratories or other health areas containing no more than five laboratories, with the respective table with risk severity and color explanation.

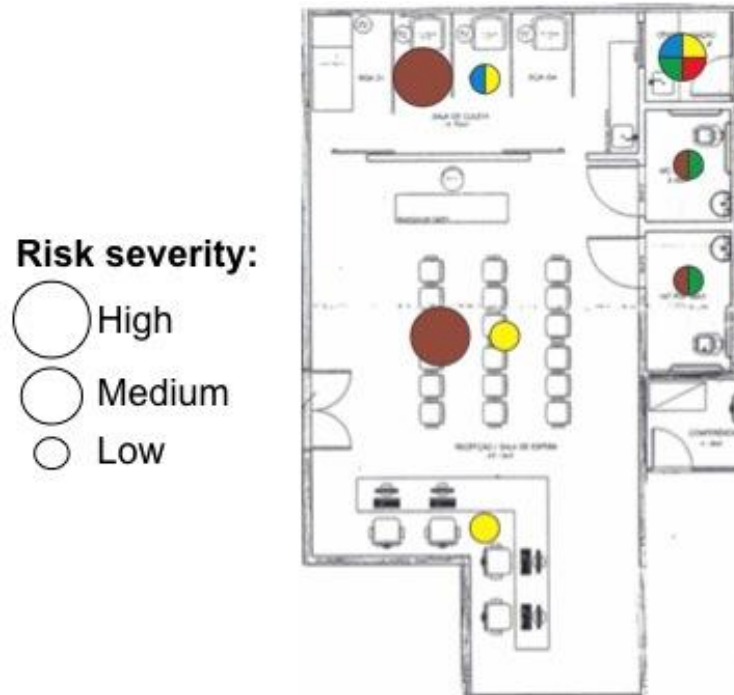


Figure 3. Risk map - Classic model

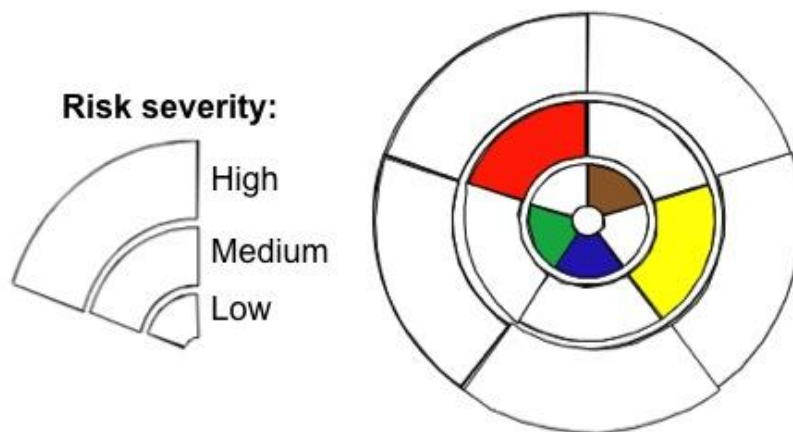


Figure 4. Risk map - CobWeb

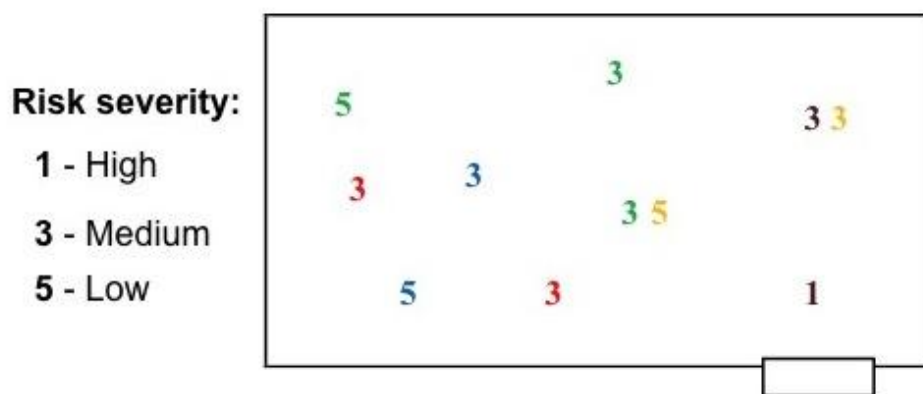


Figure 5. Risk map - Empty Map: classroom with numeric risk severity



Figure 6. Risk map -Floor plan: numeric indication of severity and the collors of the number indicate risk group

On a global scenario biosafety and its scope has been largely discussed, with international agreements and several national laws in several countries for regulation and protection human beings on regards of manipulation of biomaterials [12], equally relevant is the participation of all smaller constituents of a country, states and counties in order to establish that security on a global level. Undergraduate education students should work with agents of low risk, unlike the sectors that use special advanced technologies where would be possibilities of occupational exposure to harmful agents above the established tolerance limits. Brazilian law states that any building requires signalization, structure and training of appropriate personnel to the work environment. The labor legislation in Brazil requires all companies to develop and implement the Program for Prevention of Environmental Risks (PPRA) and keep record of these actions, which should include: strategy and methodology of action, registration, maintenance and dissemination of information; annual planning with goal setting and priorities; risks survey; and development assessment [4,8].

Inadequacies in following occupational health and safety legislation in health care teaching institutions can be attributed to the financial hardship to acquiring appropriate specific material or the appropriate required amount. The absence of appropriate infrastructure or equipment for the execution of the activities is another striking problem that can increase the exposure to risk. That can also happen due to the lack of resources for maintenance or to upgrade when renovation is needed to fit the demand of a growing sectors. At last risks can also occur due to the human factor, neglect and voluntary disobedience, insubordination and lack of attention to the standards involved in the process.

Visibility of biosafety concepts and applications is extremely important [13], identifiable risks in a public institution of higher education that offer biological sciences and biomedical programs, were exemplified in this study and correspond to the most common risks found on lecture halls, laboratories and common areas of these institutions.

Strategies for the establishment of security, biosafety and minimizing of occupational risks in the areas of biological and health sciences should be a priority. The establishment of an institutional policy to serve as an exemplary model to prevent occupational risk and minimize risks with the handling of hazardous agents.

Not only visitors but also students and sometimes employees rely on signs with text and symbols to navigate to specific destinations [14] such a laboratory, a lecture hall, or even the closest exit. Preventive and prophylactic measures of occupational activities with the development of the risk map, identification of risk areas and situations, needs to be fully understood by those involved in the process and should be visible in strategic locations within the building [15,16].

To elaborate the risk map it is necessary to have knowledge of the physical space, identify existing and potential risks, understand preventive measures and their effectiveness, prioritize individual and group protection. Communication and awareness of those directly involved is essential to minimize preventable losses.

The disadvantage of all models of risk is that the map does not show the problem in real time, being also limited because of the lack of other information on other aspects such as unsanitary and hazardous working conditions, the development of a risk map has to be as dynamic as possible. The universal model leaves individuals confused and dispersive due to the excess of information through circles and colors. The Cobweb Map with five regions is considered to be more specific to a small group of individuals and a private environment because it is easier to be understood for those who don't have intimacy with the environment.

There is some flexibility to choose between different types and models of the risk maps. Modifications suggested by the authors to a risk map comes to combine the risks present through the colors, indicating the intensity of this risk through numbers. The suggestion of an empty room risk map was based on the high frequency of changes of furniture, turnover and new appliances purchased, including frequent renovations in this location. We believe the combination of the floor-plan with risk intensity numeric codes, with colors relating to indicative groups, is an excellent option, due to the fact that it better accepted and more easily understood by users.

In order to develop and implement an ideal plan of action to improve biosafety and minimize occupational risks with proper use of custom made risk maps following current Brazilian guidelines, we need to rely on the motivation of the board of directors of the institution, professionals responsible for laboratories, professors, undergraduate and graduate students, it is ultimately a team effort where every person becomes responsible for doing their share.

6. FINAL CONSIDERATIONS

Biosafety comprises areas that guide, regulate and minimizes risks in occupational settings. A set of practical techniques and actions must be directed to social and environmental concerns, designed to control risks in academic and scientific settings. Based on this premise an offer of new guidelines, and different alternatives can an additional instrument to promote risk awareness and prevention.

With the implementation of the suggested risk map this health care educational unit can provide a safer environment. There are several and different tools to identify, assess and prioritize risks, that must be used and updated constantly to avoid situations that can affect the health of students, faculty, other employees and visitors.

All educational institutions should provide models and signage protocols in their facilities, they should also advise their members about the importance of current concepts and legal responsibilities.

Risk maps are very important because they allow easy identification of hazards to which students, faculty, workers and visitors may be exposed. Awareness and compliance with standardized safety procedures such as use personnel protective equipment based on a risk map could potentially reduce expenses in accidents, could also provide greater productivity, and sustainability on a safer learning and working environment.

Every unit of public institutions of higher education that offer biological sciences and biomedical programs should provide safe facilities with adequate signaling, going along with new technological advancement, to care for and protect their members and the members of their community and the society, following the law, and the concepts of biosafety and contemporary bioethics.

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