



INTERVENTION MODEL FOR EXPOSURE AND CONTROL OF BIOLOGICAL RISK

Study of universal precautions in nursing staff

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KEYWORDS

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ABSTRACT

In recent years, analyzes were carried out in hospitals in Colombia that showed that there were patients who contracted dangerous bacteria during their stay in some health institutions. In addition to patients, all health personnel are exposed to these pathogens, as they are present in the environment. They are threats of natural origin that extend beyond private spaces and activities of people, and that due to their magnitude, speed and contingency require a management process in which better and greater control is required to mitigate the risk. resulting effect.

PALABRAS CLAVE

Peligros microbiológicos
Ambiente
Riesgo químico
Enfermedades
Seguridad
Control
Buenas prácticas

RESUMEN

En los últimos años se realizaron análisis en los hospitales de Colombia que arrojaron que hubo pacientes que contrajeron bacterias peligrosas durante su estancia en algunas instituciones de salud. Además de los pacientes, se ven expuestos a estos patógenos todo el personal sanitario, al estar presentes en el ambiente. Son amenazas de origen natural que se extienden más allá de los espacios privados y de las actividades particulares de las personas, y que por su magnitud, rapidez y contingencia exigen un proceso de gestión en el que se requiere un mejor y mayor control para mitigar el efecto resultante.

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1. Introduction

In recent years, it became possible to carry out analyses in the hospitals in Colombia which yielded that there were patients who were affected by the occurrence of contracting dangerous bacteria during their stay in some health institutions. These impacts are caused by the pathogens found to be from microbiological and chemical hazards which can cause disease and are detrimental to health. They affect not only the patients but all staff who are constantly and directly exposed to these pathogens, by being present in the environment that causes the occurrence of threats of natural origin which extends beyond their private spaces and the activities of people that by their magnitude, speed and contingency require a management process in which better and more control is required to mitigate the resulting effect.

To provide better control, it is necessary to create good practices and safety management as actions that strengthen the processes adopted as improvement plans. The purpose of this paper is to study the effectiveness in the activities carried out within the above-mentioned procedures in the hospitals and health institutions which makes it possible to improve not only physical health but also mental and social health in all its workers generating efficiency in the execution of the processes.

Over the years, hospitals and health institutions applied asepsis and antisepsis for the control of chemical and microbiological risk to maintain in good condition the health of people who have access to surgery rooms. To achieve this, the institutions apply bio security protocols with the aim of reducing the levels of chemical, microbiological and endotoxin contamination of liquids, microbiological control of water, microbiological control of the air in the operating rooms and immunosuppressed units according to the type of an operating room.

On the other hand, health personnel have faced enormous work pressure on a daily basis, which includes being exposed to a high risk of suffering from virus infection, inadequate protection that causes contamination of the virus, feeling frustration, suffer discrimination, to be one more patient in isolation, to interact with patients with negative emotions, to the loss of contact with the family and to the physical and mental exhaustion caused by working directly with this type of patient (Lozano *et al.*, 2018).

So, the COVID-19 disease pandemic has had a strong impact on the health team, since numerous infections were registered among health personnel due to lack of supplies, little experience in managing the disease, inadequate equipment of resources in the hospitals, among others, mainly in those that provide functions in the first line of care for suspected or confirmed cases (Sabio, 2020).

Therefore, biosafety is of vital importance for health personnel who work in different areas, which makes it essential to apply the 5 moments of hand washing during the care of these patients, so that its purpose is to protect the health of the personnel. who works in the different hospital services, as well as cleaning people and users of different biological, chemical, and physical risks to which they are exposed in the performance of work functions. (Lara & Rojas, 2019).

According to the World Health Organization (WHO), the global burden of health care-associated infections (HCAI) (also called “nosocomial” or “hospital” infections) are infections contracted by a patient during the treatment in a hospital or other health facility which was not or was not incubating at the time of admission. HCAI can affect patients in any type of healthcare facility, and they may occur after the patient is discharged, including occupational infections contracted by health personnel (Filatov *et al.*, 2020).

Health care-associated infection (HCAI) is acquired by patients while receiving care and represents the most frequent adverse event. However, the global burden remains unknown because of the difficulty to gather reliable data. In many settings, from hospitals to ambulatory and long-term care, HCAI appears to be a hidden, cross-cutting problem that no institution or country can claim to have solved yet. (...) The impact of HCAI implies prolonged hospital stay, long-term disability, increased resistance of microorganisms to antimicrobials, a massive additional financial burden for health systems, high costs for patients and their families, and excess deaths. (...) A review of several studies showed that increased length of stay associated with HCAI varied between 5 and 29.5 days (World Health Organization, 2011, p. 3).

Chemical substances are used daily in health institutions, some consciously and others without prior knowledge of their handling, some of them causing irritation, damage to organs or other adverse health effects related to the time of exposure, amount, or concentration of the chemical to which you are exposed.

In accordance with principle 10 (Healthy, safe and well-adapted work environment and data protection) of the European Pillar of Social Rights, workers have the right to a high level of protection of their health and safety at work. Thus, workers have the right to a work environment adapted to their professional needs.

On the other hand, in the article 31 (Fair and just working conditions) of the Charter of Fundamental Rights of the European Union, it is established that:

Every worker has the right to working conditions which respect his or her health, safety and dignity.

Every worker has the right to limitation of maximum working hours, to daily and weekly rest periods and to an annual period of paid leave.

However, despite the care and precautions that are being implemented, it is common for some effects caused by the lack of prevention to affect people with some frequency. The General Directorate of Safety and Health at Work

of the European Commission has published a report on the implementation of the directive. The "Commission Staff Working Document" was approved in May 2021. This document complements the Communication from the European Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of Regions, "EU strategic framework on health and safety at work 2021-2027. Occupational safety and health in a changing world of work". The purpose of this document is to support:

the Communication on the EU strategic framework on health and safety at work 2021-2027 and complements it by additional information. It takes stock of the achievements in the implementation of the EU strategic framework on health and safety at work 2014-2020 (European Commission, 2021, p. 2).

The chapter 4 of this document presents "an assessment of the practical implementation of the Framework Directive 89/391/EEC on Safety and Health of Workers at Work (...) and 23 related EU directives for the period 2013-2017" (European Commission, 2021, p. 2).

On the other hand, and focusing on the case of Colombia, Álvarez & Riaño (2018) present how the development of the Colombian public policy on safety and health at work has been. In this paper, the international guidelines postulated by the ILO and the WHO were shown, their deployment in Ibero-American strategies and the application of public policy in the programs national standards of occupational safety and health.

We could see that health and safety at work are one of the focuses of attention of legislation, studies and documents by governments in various countries. But several studies show some edges between regulations and real practice in hospital institutions.

Consequently, the discussion arises about the measures used in health institutions and their real effectiveness, since they are not fortuitous circumstances or isolated unrelated events that lead to these situations. For this reason, the design of strategies for the prevention and control of chemical and microbiological risk in the operating rooms of Santander health institutions is more important than ever, since no measure will apparently be sufficient if it lacks constant review, adaptation, and planning. adequate.

In another study conducted by Call *et al.* (2009), sixty laryngoscope handles from the adult operating rooms were sampled with premoistened sterile swabs. They were tested for culture after the operating room and equipment had been cleaned and prepared for the next procedure (low-level disinfection). Authors hypothesized that laryngoscope handles may be sufficiently contaminated with bacteria and viruses to justify the implementation of new handle-cleaning protocols. The results showed that 75% of the samples were positive for bacteria, showing 62.5% positivity for *Staphylococcus coagulase negative*, 17.5% *Bacillus spp.* (Non anthracis), 7.5% *Streptococcus haemolyticus*, and 2.5% vancomycin-sensitive *Enterococcus spp.*, methicillin-sensitive *S. aureus*, and *Corynebacterium spp.* (Call *et al.*, 2009). They found a high incidence of bacterial contamination of laryngoscope handles despite low-level disinfection. The authors concluded that it was necessary the adoption of guidelines that included, at a minimum, mandatory low-level disinfection of laryngoscope handles after each patient use.

The influence of multiple hospital factors in the development of HCAI has been recognized, however, the role of the anesthetic procedure has not been clearly described. A study conducted by Castro *et al.* (2004) in operating rooms in hospitals in Mexico, aimed to evaluate the presence of microbiological contamination in anesthetic equipment, for this, nine surfaces of the anesthesia machine, monitoring equipment and laryngoscopes were analyzed during the morning and the afternoon. Each surface was subjected to four tests, detection of visible contamination, detection of blood contamination, adenosine triphosphate (ATP) count, and culture of *Staphylococcus spp.* The results of the tests showed high percentages of positive cultures for *Staphylococcus spp.*, both in the morning and in the afternoon, 52% versus 67%, respectively, allowing the conclusion that the anesthetic equipment was not being handled correctly, proposing as a control strategy the creation of cleaning and disinfection policies in order to reduce the exposure of patients to this type of microbiological agents, as well as the development of a tool for prevention, awareness on the subject, behavior modification and education. (Castro *et al.*, 2014).

El equipo anestésico no está siendo correctamente manipulado, es necesario crear políticas de limpieza del mismo ya que se expone a los pacientes a riesgos de salud innecesarios. Es pertinente más que el desarrollo de una herramienta de prevención, la sensibilización sobre el tema, la modificación de conductas y la educación¹. (Castro *et al.*, 2014)

Several researchers report that the waste derived from medical-surgical procedures represents a problem in terms of its elimination, due to the latent danger of high concentrations of microorganisms, with a high probability of acquiring multi-antibiotic resistance, as well as the presence of solvents and heavy metals. These residues make up a mixture of complex substances whose toxic, mutagenic and genotoxic activity will depend on synergistic and antagonistic interactions between their components and between them and the environment (Ortalan & Ayub, 2007; Boillot & Perrodin, 2008).

1 The anesthetic equipment is not being handled correctly, it is necessary to create cleaning policies for it, since patients are exposed to unnecessary health risks. It is pertinent more than the development of a prevention tool, awareness on the subject, behavior modification and education. (Own translation).

The aim of the study carried out by Boillot & Perrodin (2008) was to determine the combined effects of glutaraldehyde and three surfactants on *Daphnia magna*. Glutaraldehyde and surfactants are widely used in hospitals and these substances have been detected in urban sewer networks and in surface water (Boillot & Perrodin, 2008). With the aim of evaluate the combined effects of the mixtures on the selected organism, Boillot & Perrodin (2008) used two complementary methods: the Toxicity Index model (a quantitative method for analyzing the combined effects of binary and multiple mixtures) and the isobole representation (a qualitative method that has the advantage of being illustrative). This study concludes that an additive effect was observed between glutaraldehyde and surfactants for all the ratios studied and additive action could be an efficient method for evaluating the effect of hospital wastewater on *Daphnia magna*.

The level of danger of microorganisms derived from hospital type, being the case of surgical procedures, in the hospital environment and in the environment, is directly related to the occurrence of occupational diseases, as a result of direct contact with these pathogens and whose survival on surfaces and environment they depend on fluctuations in levels of physicochemical agents such as oxygen, pH and temperature (Alvarez & Riaño, 2018; Ministerio de Salud y Protección Social², 2004).

Finally, in the recent years, it became possible to carry out analyses in the hospitals in Colombia which yielded that there were patients who were affected by the occurrence of contracting dangerous bacteria during their stay in some health institutions. These impacts are caused by the pathogens which can cause disease and are detrimental to health. It is in this context that this study has been implemented. It is believed that pathogens affect not only the patients but all staff who are constantly and directly exposed to these pathogens, by being present in the environment that causes the occurrence of threats of natural origin which extends beyond their private spaces and the activities of people. The magnitude, speed and contingency of these processes require a management process in which better and more control is required to mitigate the resulting effect. For this reason, this study, focused in four health care institutions of Santander (Colombia), wants to identify pathogenic microorganisms and chemicals that are present in the operating rooms of healthcare institutions and sketch out some guidelines to design strategies for preventing diseases transmitted by pathogenic microorganisms and anesthetic gases present in the operating rooms of healthcare institutions in Santander.

2. Objective

This paper studies how the strategies can be designed to for preventing diseases transmitted by pathogenic microorganisms and anesthetic gases present in the operating rooms of healthcare institutions in Santander. So, the main objective is to analyze the conditions that favor the design of strategies for preventing diseases transmitted by pathogenic microorganisms and anesthetic gases present in the operating rooms of healthcare institutions in Santander

2.1. Specific objectives

Specific objectives of this research include: i) identifying pathogenic microorganisms and chemicals that are present in the operating rooms of healthcare institutions in Santander; ii) assessing the risk of workers from exposure to micro-organisms and chemicals in surgery rooms; and iii) proposing strategies for the control of chemical and microbiological risks in surgery rooms.

3. Methodology

The methodology applied in this research is descriptive of cross-section based on the quantitative technique. The research sample consists of the surgical rooms of health institutions in the Department of Santander. In total, 14 samples were collected from surgery rooms of 6 health institutions in Santander. The research aims to design strategies for the prevention and control of chemical and microbiological risks identified in surgery rooms of health care institutions in Santander.

The procedure and steps to follow to collect samples in a reliable and safe way, is shown in subsection 2.2, and the techniques that were used are shown in subsection 2.1.

On the other hand, the collection and analysis of the samples is complemented by the survey, by means of a questionnaire, of the nursing staff who work in the health institutions participating in the study. With the aim of delving into the procedures and protocols for waste management, as well as the knowledge and attitudes of workers on how to proceed and whether they have personal protection materials. The results are analyzed considering three dimensions: hazardous waste management, compliance with biosafety standards, and personal protection items.

3.1. Techniques

The following techniques were used:

1. Selective and non-selective culture media (Fungi and Bacteria).

2. Measurement of anesthetic gases.
3. Risk assessment (adaptation Matrix GTC 45).

3.2. Procedure

Likewise, in our project the following steps were followed, they were part of the agreed procedure. As a prerequisite, to be able to take part in the study, informed consent was requested from all participants, in accordance with the recommendations of the Belmont Report.

The main ethical principles established in the Belmont Report in research with human beings are also considered. These principles are:

Respect people. In this research, the personal autonomy of the participants is protected, that is, the freedom of decision.

Charity. This study seeks to increase the benefit for the research, and in turn, reduce the risks for the subjects of the same.

Justice. In this investigation, the procedures that are considered reasonable are used.

On the other hand, the dates and place for the collection of the samples were established according to the needs of each institution. Once the samples were collected, they were taken to the laboratory, where the most appropriate techniques were used for their treatment and analysis. Then a database was built with the Excel program, where the relevant information for the study was collected. This made it possible to assess the danger according to the pathogenicity of each microorganism.

Below, in a synthetic way, the steps of the procedure followed in the collection and analysis of the samples are shown.

Request for permission to participate in the study.

The schedule, date, and locations of sampling were agreed according to the needs of each institution and the schedule of surgery.

Samples were taken from the institutions which were taken to the laboratory, where the isolation and characterization of the micro-organisms present in the application of microbiological tests were carried out using selective and non-selective culture media and identification reagents, such as platform Crystal valuation of risk (adaptation Matrix GTC 45).

A database was built in the Excel program where all the information was included; institution, room number, sampled surface, identified micro-organisms, frequency and characterization thereof.

The hazard was finally assessed according to the pathogenicity of each micro-organism.

4. RESULTS

Our research yielded the following main results:

Common fungal microorganisms were identified in the operating rooms of four health institutions such as: *Aspergillus* spp, *Aspergillus Niger* spp, *Penicillium* spp, *Cladosporium* spp, *Cladophialopora* spp, *acremonium* spp, *Fusarium* spp, *Mucor* spp, and *Rhizopus* spp.

Common bacterial microorganisms were identified in the surgery rooms of four health institutions such as: *Pseudomona aeruginosa*, *Flavimonas oryzihabitans*, *Micrococcus luteus*, *Staphylococcus aureus*, *Staphylococcus epidermidis*, and *Aero coccus urinae*.

Microorganisms identified in the surgery rooms of four health institutions can transmit diseases through the enteral, respiratory, dermal, and blood pathways in through the workers in surgery rooms.

Microorganisms identified in surgery rooms can cause lung infections, wound contamination (abscesses), folliculitis, cellulitis, and otitis, among others.

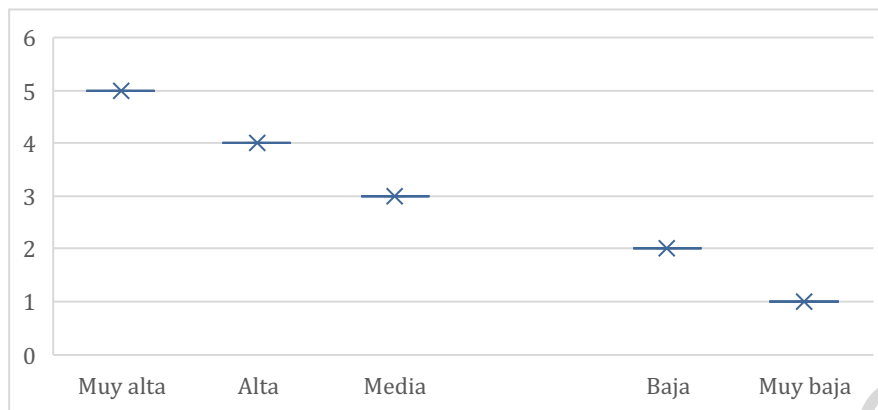
Disinfection, Handwashing, Asepsis, and Antisepsis Protocols must be strengthened and Universal Precautions enforced by the Atlanta CDC.

On the other hand, for the analysis of the results derived from the questionnaires, the following three dimensions were taken into consideration: hazardous waste management, compliance with biosafety standards, and personal protection items.

Below are the figures with the results considering each dimension. These results have been obtained from a questionnaire on the handling of high precaution bodily fluids – Biohazard. This questionnaire was answered by the nursing staff of each institution.

The following figure (figure 1) shows relations between high caution bodily fluids – Biohazard- and the dimension of hazardous waste management.

Figure 1. Dimension: hazardous waste management



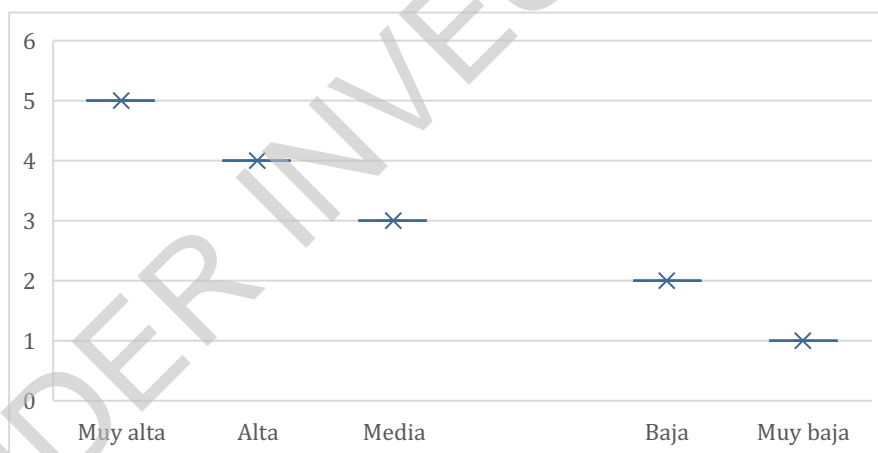
Source: Own elaboration (2021).

Regarding the dimension of hazardous waste management, half of the workers responded that they always make sure that the liquid waste of high precaution body fluids is gelled before being discarded (53.4%).

The 22.4% of the workers answered that they almost always make sure that the liquid waste of high precaution body fluids is gelled before being discarded. Then, other workers said that sometimes they make sure that the liquid waste of high precaution body fluids precaution is gelled before being discarded (12.1%), but, in another way, the same percentage of workers answered that they never make sure that the liquid waste of high caution body fluids is gelled before being discarded (12,1%).

In this way, it is explained if the statistical table is observed in the value column, the highest percentage represents the number 5, which corresponds to the always alternative.

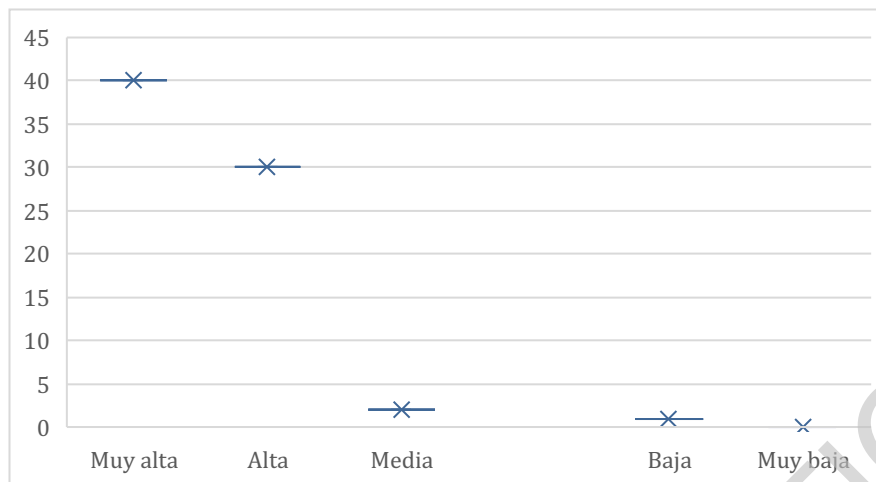
Figure 2. Dimension: compliance with biosafety standards



Source: Own elaboration (2021).

Regarding the dimension of compliance with biosafety standards, most of the workers answered that there is always a biosafety manual in the service (65.5%). Then, other workers responded that there is almost always a biosafety manual in the service (19%), and a smaller percentage of workers responded that sometimes there is a biosafety manual in the service.

According to the results found, Bejarano (2019) states that the most important document on biosafety is the Biosafety manual. The manual must be studied by all staff. Reading and discussion in each section of the laboratory seems to be the best option. Their evaluation can be of great help in the periodic updating of the manual, with the participation and experience of all staff.

Figure 3. Dimension: personal protection elements

Source: Own elaboration (2021).

Regarding the dimension of personal protection elements, most of the workers responded that they always use N95 masks for the management of patients with respiratory isolation (81%). However, the percentage of workers who said that they almost always use N95 masks to manage patients with respiratory isolation (19%). This percentage is low, we see that it does not reach 20%

In relation to the results found, Faizal (2010) states that N-95 masks should be used, whenever patients with respiratory tuberculosis are handled, the masks should have a fluid-repellent layer and be made of a material with high efficiency, filtration, to reduce the spread of germs through them during breathing, speaking, and coughing.

4. Conclusions

Microbiological contamination from hospital-type procedures is an important factor in terms of environmental health. This happens because a considerable number of microorganisms have the capacity of disperse into the environment as a result of the generation of bioaerosols or inadequate waste management, which requires measures aimed at monitoring, containment and proper disposal of them.

Previous studies conclude that the procedures to avoid these sources of contamination must be strictly adopted and monitored in hospital institutions. The conclusions of this study are in the same line and corroborate the results of previous research. As shown in the Results section, samples of body fluids have been collected and analyzed in four healthcare institutions in Santander, following the procedure established in subsection 2.1 and using the techniques explained in subsection 2.2.

Considering the specific objectives: i) identifying pathogenic microorganisms and chemicals that are present in the operating rooms of healthcare institutions in Santander, and ii) assessing the risk of workers from exposure to micro-organisms and chemicals in surgery rooms; specific pathogenic microorganisms have identified in the operating rooms and in the surgery rooms of four health institutions. On the other hand, the biological risks and the diseases, that the identified pathogens can transmit to the patients through the workers in surgery rooms, have been identified. It is concluded that microorganisms identified in the surgery rooms of the four health institutions that participated in the study, can transmit diseases through the enteral, respiratory, dermal, and blood pathways in through the workers in surgery rooms. It is also concluded that microorganisms identified in surgery rooms can cause lung infections, wound contamination (abscesses), folliculitis, cellulitis and otitis, among others.

On the other hand, complying with the third specific objective, iii) proposing strategies for the control of chemical and microbiological risks in surgery rooms, it is concluded that disinfection, hand washing, asepsis and antisepsis protocols should be strengthened, and universal precautions should be enforced by the Atlanta CDC.

On the other hand, in order to complement the research and take into account some aspects to consider in the design and implementation of prevention strategies, in addition to collecting and analyzing samples, a questionnaire was passed to the nursing staff of the health institutions that participated in the study with the prior consent of the participants. Based on the results obtained, three dimensions were analyzed: hazardous waste management, compliance with biosafety standards, and personal protection items. The results analyzed, considering each dimension, can be seen in figures 1, 2 and 3.

Regarding the first dimension, hazardous waste management, the main result is that half of the workers responded that they always make sure that the liquid waste of high precaution body fluids is gelled before being discarded (53.4%).

Regarding the second dimension, compliance with biosafety standards, the main result is that most of the

workers answered that there is always a biosafety manual in the service (65.5%).

Regarding the third dimension, personal protection items, the main result, by a large majority, is that most of the workers responded that they always use N95 masks for the management of patients with respiratory isolation (81%).

The International Labor Organization (ILO) and the World Health Organization (WHO) (2014) are taken as reference. The reports made by these institutions affirm that, within the hospital preventive framework, the management of hospital waste is of the most importance for the safe disposal of waste contaminated with bodily fluids and to guarantee the sustainability of the environment. Along the same lines and based on the results of the questionnaire answered by the nursing staff, the study allows us to conclude that although, as shown by the statistical data and taking into account the three dimensions analyzed, the nursing staff of the hospital institutions that have participated in this case study, mostly comply with the different biohazard prevention protocols. However, it is also concluded that an improvement process must be generated to improve the procedures and provide health personnel with the appropriate and necessary personal prevention material to prevent the slightest source of danger from causing a biological accident.

UNDER INVESTIGATION

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