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ORIGINAL

Proposal for an epidemiological surveillance program for the prevention of occupational accidents and diseases in workers exposed to carbon dioxide (CO2) at a Venezuelan brewing company

Propuesta de programa de vigilancia epidemiológica para la prevención de accidentes y enfermedades laborales en trabajadores expuestos a dióxido de carbono (CO2) en empresa Cervecera venezolana

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ABSTRACT

Introduction: in manufacturing companies, specifically in the brewery, there are processes that involve the handling and use of chemical agents, such as carbon dioxide (CO2), this is the reason why workers are exposed to this agent. In the studied company, an accident was caused by exposure to this substance.
Objective: to propose an epidemiological surveillance program for the prevention of occupational accidents and diseases in workers exposed to carbon dioxide (CO2) in a Venezuelan brewery.
Methods: a qualitative-quantitative, field, descriptive, feasible project-type research was carried out, with the epidemiological surveillance program as the unit of analysis. Documentary review, direct observation and the interview were used as data collection techniques, and the observation guide, the sociodemographic form and the field diary were used as instruments.
Results: the machine room has 18 workers, which shows that the workforce is composed of men over 40 years of age. Among the main causes of consultation of workers to the medical service are headache with 24,1 %, followed by fatigue with 20,6 % and then dizziness with 13,7 %.
Conclusion: we propose an Epidemiological Surveillance Program aimed at machine room workers exposed to Carbon Dioxide (CO2), since there is no system that collects complete information on the working conditions and health of its workers, thus failing to comply with the legal framework governing the subject.

Keywords: Carbon Dioxide; Environmental Monitoring; Biological Monitoring; Occupational Accidents.

RESUMEN

Introducción: en las empresas manufactureras, específicamente la cervecera, existen procesos donde se ven involucrados el uso y manipulación de agentes químicos, como el Dióxido de Carbono (CO2), es por ello que los trabajadores, se encuentran expuestos a dicho agente. En la empresa estudiada se generó accidente por exposición a dicha sustancia.
Objetivo: proponer un programa de vigilancia epidemiológica para la prevención de accidentes y enfermedades laborales en trabajadores expuestos a dióxido de carbono (CO2) en empresa cervecera venezolana.
Métodos: se realizó una Investigación bajo un enfoque cuali-cuantitativo, de campo, descriptiva, tipo proyecto factible, siendo la unidad de análisis el programa de vigilancia epidemiológica. Como técnica de recolección de los datos se utilizó la revisión documental, la observación directa y la entrevista, y como instrumentos la guía

de observación, la ficha sociodemográfica y el diario de campo.
Resultados: la sala de máquinas, cuenta con 18 trabajadores, evidenciándose que la población laboral está conformada por hombres de más de 40 años. Dentro de las principales causas de consulta de los trabajadores al servicio médico, se encuentra la cefalea con 24,1 %, seguido de Fatiga con 20,6 % y luego mareos con 13,7 %.
Conclusión: se propone un Programa de Vigilancia Epidemiológica dirigido a los trabajadores de sala de máquinas expuestos a Dióxido de Carbono (CO2), toda vez que no existe un sistema que recoja la información completa de las condiciones de trabajo y de salud de sus trabajadores, incumpliendo, de esta manera, con el marco legal que rige la materia.

Palabras Clave: Dióxido de Carbono; Monitoreo del Ambiente; Monitoreo Biológico; Accidentes de Trabajo; Enfermedades Profesionales.

INTRODUCTION

Industrialization and advances in the use of chemical products, while determining progress in new production processes, have also generated new risks in the workplace.[1] One of these risks derived from industrialization are those related to exposure to chemical risk factors, of which there is the possibility that workers may suffer harm from contact with hazardous substances.

In this regard, according to reports from the Occupational Safety and Health Administration OSHA, European Union section[2], a large number of workers worldwide are exposed to chemical agents that can cause health damage. In fact, in 2015, 17 % of workers in the European Union (EU), reported being exposed to chemicals for at least a quarter of their working time, a proportion virtually unchanged since 2000, in addition 15 % reported inhaling smoke, fumes, and dust at work.[3]

It is important to note that people working in indoor environments with risk of contact with the pollutant chemical agent such as carbon dioxide (CO2) often experience different signs and symptoms such as headaches, irregular breathing, weakness, visual disturbances, and even loss of consciousness, etc.,[4] which is why there is often a tendency to confuse these signs with other pathologies of common origin.[2]

In relation to this, there are industries that have difficulties in obtaining information and appropriate records on occupational diseases and accidents, so an epidemiological surveillance system should be developed to monitor the health of the workers and help with prevention of occupational diseases and accidents.[5,6,7]

Epidemiological surveillance applied to the work environment can be defined as the systematic control of health-related episodes in the working population, in order to prevent and control occupational risk factors, as well as the diseases and injuries associated with them. It is a pillar for prevention that requires the continuous collection, analysis and interpretation of health data and its determinants, which will allow preventive actions to be taken.[8]

Consequently, this tool used for the collection of information, is of utmost importance in decision making with respect to the risk factors present in the workplace and, therefore, useful to minimize or control the impact on the health of workers due to exposure to chemical agents.[9]

Now, the Venezuelan brewery under study, despite having state-of-the-art technology, is not exempt from dangerous situations that can generate accidents and occupational diseases caused by exposure to Carbon Dioxide (CO2), because it does not have an epidemiological surveillance program that allows the Occupational Safety and Health Service (SSST by its Spanish acronym) to monitor workers that work in areas where this chemical is used, generating a negative impact, not only for the organization but for the most important part of it: the health of its workers. Therefore, once a diagnosis of the situation was made, specifying the absence of such epidemiological surveillance program, population exposed to risk and health effects, as well as the technical, operational, legal and financial feasibility for prevention management, this research was conducted with the objective of proposing an epidemiological surveillance program for the prevention of occupational accidents and diseases in machine room workers exposed to Carbon Dioxide (CO2) in a Venezuelan brewery company.

METHODS

A descriptive, observational, field research was carried out, of the feasibility study type, using the qualitative-quantitative paradigm, the unit of analysis being the epidemiological surveillance program for the prevention of accidents and occupational diseases in workers exposed to Carbon Dioxide (CO2) in a Venezuelan brewery company, in which a total of 18 workers exposed to this substance work. The data collection technique used was the documentary review of the medical records at the company's SSST Medical Service for the socio-demographic and labor characterization of the working population with occupational exposure to CO2, and as an instrument, a socio-demographic-labor data sheet. A documentary review of the Morbidity Records of

this area over the last year (2021) was also carried out, with the purpose of specifying the main reasons for consultation of this group of workers.

Likewise, the production and work process were described through non-participant observation of the activity, supported by an observation guide and filming, allowing the identification of hazardous conditions.

Afterwards, the feasibility study was carried out and finally, the proposal was prepared based on the review of technical documentation (toxicological and hygiene data sheets) and legal documentation on the prevention of occupational accidents and diseases.

The sociodemographic and labor characteristics were analyzed quantitatively and descriptively with absolute and percentage values. In addition, the results obtained from the observation of the production and work process, the results of the interviews with key company and SSST personnel, as well as the documentary review of the legal framework and other related literature that contributed to the preparation of the proposal, were described and interpreted in text form, from a qualitative point of view.

Ethical aspects

The present research work was based on the ethical principles established in the Code of Ethics in Life[10] respecting the principles of bioethics: responsibility, non-maleficence, justice, beneficence, autonomy and precaution.

Informed consent was requested from the workers involved in the research, i.e., operators in the area, production management, maintenance and SSST, providing them with the necessary information, so that they could clearly and precisely understand the methodology to be used in this study, as well as the guarantee of respect for the confidentiality of the information obtained from the observations in the area, and other techniques and instruments that were applied during the study.

RESULTS

Socio-demographic and labor characteristics

Table 1. Socio-demographic and labor characteristics of the machine room area personnel of the Venezuelan brewery company

VARIABLES	N=18	%	X ± SD
Age (Years)			
20-30	6	33,33	
31-40	5	27,78	40 ± 13,05
≥40	7	38,89	
Seniority (Years)			
1-10	12	66,67	
11-20	2	11,11	10 ± 9,30
≥20	4	22,22	
Roles			
Manager	1	5,55	
Supervisor	5	27,78	
Operator	12	66,67	

Source: review of medical histories of engine room workers

Table 1 shows that of the total number of machine room workers (18 in total), those over 40 years of age are the predominant population with 38,89 %. In addition, it was shown that the preponderant working population in the studied area has seniority between 1 and 10 years (66,7 %). Likewise, operators predominate the group under study with 66,67 %. It should be noted that machine room workers are all men.

Morbidity

Table 2, shown below, illustrates that the main reasons for medical consultation of machine room workers in 2021 were: headache with 7 cases (24,1 %), fatigue with 6 cases (20,6 %) and dizziness with 4 cases (13,7 %). It is worth noting that the three main causes of consultation by these workers could be related to CO2 exposure.

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Table 2. Morbidity of the machine room personnel of the Venezuelan brewery company

Period	Diagnosis	Roles		Total
		Operator	Supervisor	
1st quarter 2021	Dizziness	2	0	2
	Cutaneous Mycoses	0	1	1
	Fatigue	1	1	2
	Pterygium	1	0	1
	Headache	1	0	1
	TOTAL	5	2	7
2nd quarter 2021	Headache	3	1	4
	Fatigue	0	2	2
	high blood pressure	1	0	1
	Nausea	2	0	2
	Bronchitis	1	0	1
	TOTAL	7	3	10
3rd quarter 2021	Dizziness	2	0	2
	Pharyngitis	1	0	1
	Fatigue	1	0	1
	Hepatitis	0	1	1
	Headache	2	0	2
	TOTAL	6	1	7
4th quarter - Until October 2021	Fatigue	0	1	1
	High blood pressure	0	1	1
	Cutaneous Mycoses	0	1	1
	Rhinitis	1	0	1
	Headache	1	0	1
	TOTAL	2	3	5

Source: Morbidity Company Medical Service

Production process and work process

During the observation of the processes described in the machine room, where CO2 is used to extract and fractionate the hops used for brewing beer, it was identified that the worker may be exposed to mechanical and chemical risk factors such as: fires, explosion, extreme temperatures exposure, falls, blows and harmful substances exposure (Ammonia/CO2/Water vapor).

Feasibility study

To determine the technical feasibility, the SSST Coordinator was interviewed and confirmed that environmental monitoring is carried out annually by a contracted company, which has a permit from the Ministry of Eco socialism. It uses a portable flue gas analyzer, model PCAR3 Bacharach, which measures CO, CO2, O2, SO2, NO, NO2, NOx, gas temperature, ambient temperature and differential pressure; it also calculates and samples excess air (EA) and combustion efficiency (CE). The last environmental monitoring performed was in March 2021. Other office equipment and supplies necessary for the implementation of the program proposal were also found to be available. Biological monitoring of exposed workers is performed annually by means of complete Blood Count, chest X-ray, determination of carboxyhemoglobin and blood gas analysis at a private health center.

The national labor legal framework made it possible to determine the importance of its application and to determine its legal feasibility. Through the interview with the SSST Coordinator, the operational feasibility was determined by corroborating the existence of trained personnel (doctors and nurses, Occupational Health and Hygiene Specialists and Hygiene and Safety Technicians) for the correct use of the equipment and for the implementation of the program proposal. For the financial feasibility, the Budget Manager was interviewed and verified the existence of economic resources to guarantee its execution, and the proposal is shown below.

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Epidemiological surveillance program proposal

Title

Epidemiological Surveillance Program for the prevention of occupational accidents and occupational diseases due to exposure to Carbon Dioxide (CO2) in the workers of the Machine Room of a Venezuelan brewery company.

Objective

To prevent occupational accidents and occupational diseases caused by exposure to Carbon Dioxide (CO2) in the workers of the Machine Room of the Venezuelan brewery company.

Scope

The epidemiological surveillance program is aimed at workers exposed to CO2 in the machine room of the brewery where this chemical risk is present. In addition, it is oriented to the early detection of cases, the diagnosis and assessment of their origin, the treatment and rehabilitation of affected workers and, finally, the follow-up of indicators that measure the impact and management of this program.

Rationale

The Union Institute of Work, Environment and Health (ISTAS, 2020) mentions that in Spain there are more than 3,2 million workers exposed to chemicals in their workplaces.

In Venezuela, this information is not available at this time, however, regarding health effects, according to statistics processed in the period 2009 to February 2013 by the Epidemiology and Strategic Analysis Directorate of the National Institute for Occupational Prevention, Health and Safety (INPSASEL) reveal that in that period a total of 10 625 Occupational Diseases, within which, 12 cases (0,11 %), corresponded to Pathologies due to Chemical Risks, occupying the seventh place; and as for Occupational Accidents, out of a total 279 421 registered in that same period, 12 274 cases (4,39 %) were derived from exposure to harmful substances, occupying the fifth place.[11]

Therefore, occupational epidemiological surveillance is fundamental since the analysis of its data allows determining the causes of health effects in the working population and implementing measures to prevent work-related diseases and accidents, in this case, aimed at preventing occupational accidents and diseases caused by exposure to Carbon Dioxide (CO2).

Furthermore, this epidemiological surveillance program is justified from the legal perspective, since there is a regulatory framework on this matter in Venezuela, which requires its implementation to guarantee adequate working conditions for the prevention of occupational accidents and diseases, as expressed in articles 83 and 87 of the Constitution of the Bolivarian Republic of Venezuela[12], Article 40, paragraphs 1, 3, 5 and 8, of the Organic Law on Prevention, Conditions and Working Environment[13], Article 34 of the Partial Regulations of the Organic Law on Prevention, Conditions and Working Environment[14] and COVENIN 2253:2001[15] which establishes the Permissible Environmental Concentrations (PAC) of chemical substances in workplaces to avoid or reduce adverse effects on the health of occupationally exposed workers.

Responsibilities

The responsibility for the development and implementation of this epidemiological surveillance program lies with:

- Occupational Safety and Health Service (SSST) according to its functions contemplated in the Article 40, paragraphs 1, 3, 5 and 8 of the LOPCYMAT (2005).
- Prevention Delegates (DDP) according to their attributions and faculties expressed in Articles 42 and 43 of the LOPCYMAT (2005).
- Occupational Health and Safety Committee (CSSL) according to its attributions and faculties expressed in Articles 47 and 48 of the LOPCYMAT (2005).
- The company's management which is responsible for providing the human resources, supplies and equipment necessary for the implementation and maintenance of the program (Articles 1 and 56 of LOPCYMAT, 2005).
- Workers in the Machine Room area, who must comply with everything related to this program in order to guarantee their health and safety at work (Article 54 of the LOPCYMAT, 2005).

Program content

This program includes four (04) components:

1. Data entry: the sources of information are made up of the data obtained through daily medical consultation in the company, which allows identifying all the data of each worker (socio-labor, reason for consultation, diagnosis, medical rest leave, reason for these, referrals to specialists, risk factors, people with disabilities, results of health examinations, control measures).

2. Reporting frequency: the frequency of the report will be quarterly, according to Article 34 of the Partial Regulation of the Organic Law of Prevention, Conditions and Work Environment.

3. Data processing: for this activity it is necessary to have complete information which is collected by the company's medical service through medical consultations. This information will be loaded into an Excel spreadsheet designed for this purpose, which will allow the analysis of the information. This workbook is elaborated with formulas that allow calculating the totals of each line, it also has links with other Excel workbooks where the graphs will be fed, which allow visualizing the information quickly.

4. Information output: this will be done through different written reports with proposed actions addressed to the occupational health and safety management, in order to take the corresponding actions for early intervention. The statistics should be published in the company's different media.

Epidemiological surveillance of the health of workers exposed to carbon dioxide (CO2)

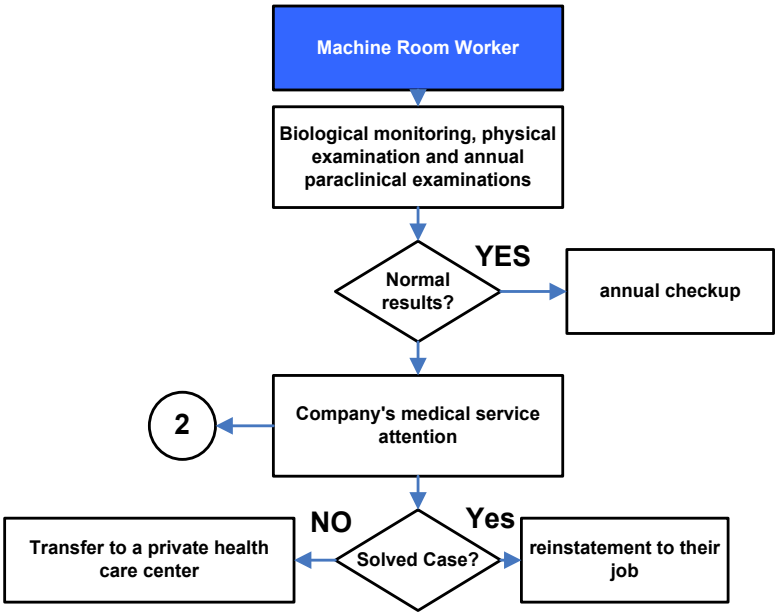

Figure 1. Flowchart of the Epidemiological Health Surveillance of workers exposed to Carbon Dioxide (CO2)

Epidemiological Surveillance of Working Conditions and Environment in areas of Carbon Dioxide (CO2) exposure

The design of this program (figure 2) also included a section on “definition of terms” and “indicators”, allowing the latter to determine its effectiveness, with indicators for attention, prevention and absenteeism due to accidents and occupational diseases.

DISCUSSION

The machine room department of the brewing company has 18 workers, evidencing that the labor population is predominantly made up of men over 40 years old, which coincides with Bonilla[16], who in his research had a sample of 22 workers and two contractors, all of them men.

Among the main causes of consultation of the machine room workers to the company’s medical service is headache with 24,1 %, followed by fatigue with 20,6 % and then dizziness with 13,7 %. These findings are consistent with the acute effects produced by CO2, as reported by the New Jersey Department of Health[17], which states that these effects include dizziness, fatigue, headache, weakness, nausea, vomiting, chest pain, confusion and a feeling of fainting, since it displaces oxygen in the body, causing asphyxia.

However, the health damages produced or derived from work such as those described above, are preventable, through controls in the working conditions and environment and with a good epidemiological surveillance system which agrees with Murcia et al.[18] who states in their research that the design of an epidemiological surveillance system arises from the need to prevent and control diseases in previously defined human groups.

The proposed epidemiological surveillance program or system (EVS) aims to continuously collect information on working conditions and environment, which will allow early detection of environmental concentrations of CO2 in order to prevent the repercussions on the health of workers exposed to this chemical substance. This postulate is in line with Gómez Miranda et al.[19], who state that EVS, represents the ability to correctly detect cases that have a given disease or given risk factor.

Therefore, as a result of the diagnosis of the above situation, an Epidemiological Surveillance Program is

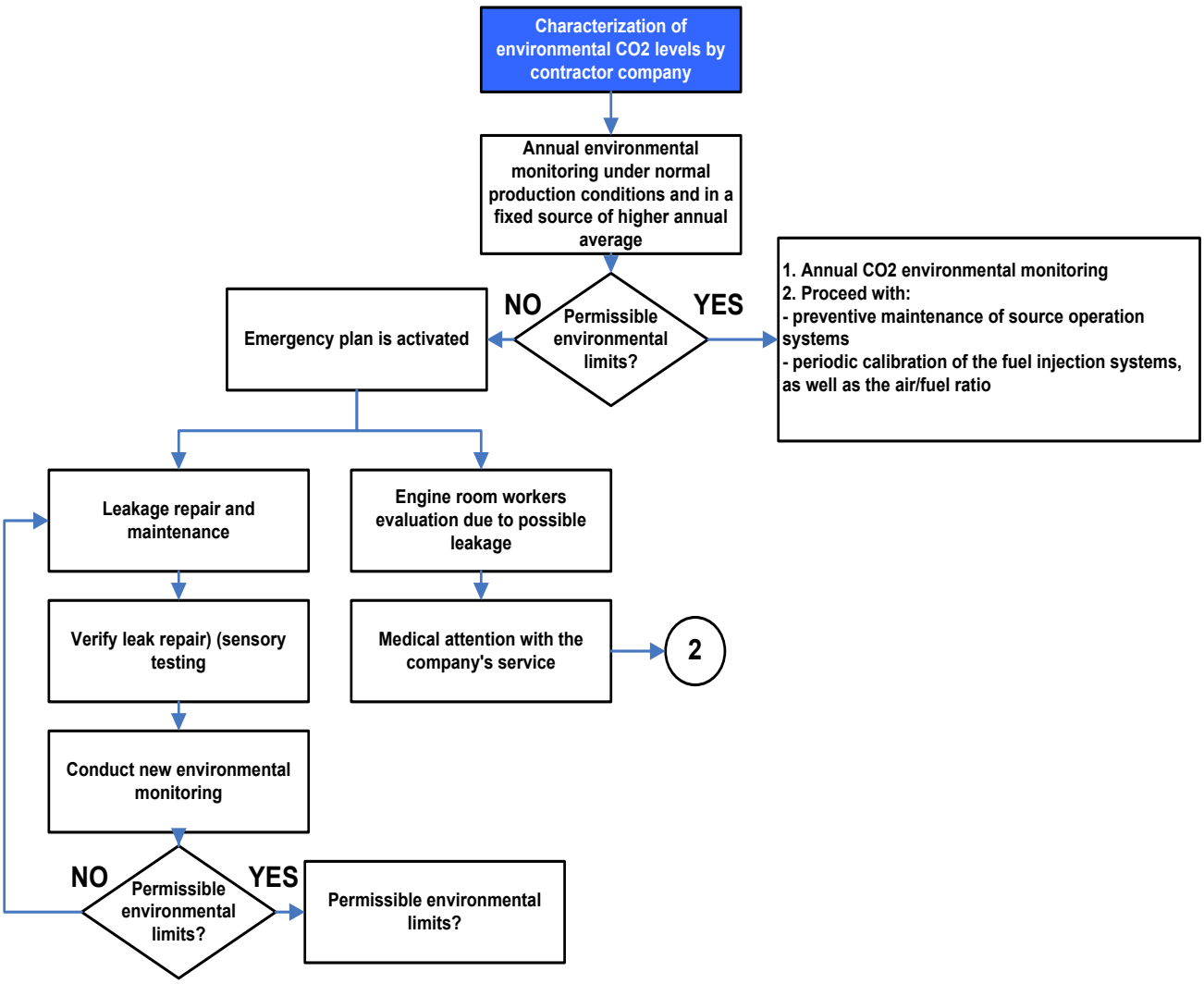

Figure 2. Flowchart of Epidemiological Surveillance of Working Conditions and Environment in areas of exposure to Carbon Dioxide (CO2)

proposed in the Venezuelan Brewery, specifically aimed at machine room workers exposed to Carbon Dioxide (CO2), since at present there is no program or system that collects all the information on the working conditions and health of its workers, thus failing to comply with the legal framework regulating the issue.

For this reason, it is recommended to implement the proposed program for the collection and analysis of data for decision making regarding the protection of the health of workers in the engine room, exposed to Carbon Dioxide (CO2). To this end, prior training of all personnel responsible for its application is of the utmost importance, so that they are familiar with its content and operation in detail. Finally, evaluate the program on a quarterly basis by means of effectiveness indicators and ensure the dissemination of information at all levels of the organization.

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CONFLICT OF INTEREST

None.

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