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Hazardous Waste Management in Public Health Centers in La Maná, Ecuador

By

Juan Pablo Urdánigo Zambrano
Magister en Desarrollo y Medio Ambiente; Universidad Técnica Estatal de Quevedo, Quevedo; Ecuador; Av. Quito km. 1 1/2 vía a Santo Domingo de los Tsáchilas
Email: jurdanigo@uteq.edu.ec; https://orcid.org/0000-0002-8972-0279

Cristina Juliana Castro Zambrano
Ingeniera Ambiental; Universidad Técnica Estatal de Quevedo; Quevedo; Ecuador; Av. Quito km. 1 1/2 vía a Santo Domingo de los Tsáchilas;
Email: cristina.castro2016@uteq.edu.ec; https://orcid.org/0000-0003-2457-7384

Mariela Díaz Ponce
Magister en Administración Ambiental; Universidad Técnica Estatal de Quevedo, Quevedo; Ecuador; Av. Quito km. 1 1/2 vía a Santo Domingo de los Tsáchilas
Email: mdiaz@uteq.edu.ec ; https://orcid.org/0000-0001-8944-5994

Yarelys Ferrer Sanchez
PhD Recursos Naturales; Universidad Técnica Estatal de Quevedo; Quevedo; Ecuador; Av. Quito km. 1 1/2 vía a Santo Domingo de los Tsáchilas
Email: yferrer@uteq.edu.ec; https://orcid.org/0000-0003-0623-1240
Universidad Técnica Estatal de Quevedo – Facultad de Ciencias de la Ingeniería – Quevedo– Ecuador

Abstract

Hospital facilities are responsible for reducing and preventing health problems in the population, although they inevitably generate waste that can be hazardous to human well-being or negatively influence the environment. This research aimed to evaluate the sustainable integrated management of hazardous waste in public health facilities in the urban area of "La Maná". Surveys were applied to the health workers of the three public health centers; in addition, a hazardous waste characterization was carried out, then the environmental impacts were evaluated by means of a cause-effect matrix. The information collected was analyzed using descriptive statistics, and the qualitative variables were analyzed with the Chi test^2; an ANOVA was also applied to identify statistical differences in the generation of hazardous waste between medical centers and areas of care. 66.67% of the workers have not received training on hazardous waste management and 93.06% do not know the applicable environmental regulations. The average rates of hazardous waste generation depend on the area and type of health center. Type C health sub-center is the facility with the highest daily generation of sharps and infectious biological waste; it also has the highest environmental impact (62%). The investigation revealed the deficient management of hazardous waste, non-compliance with sanitary regulations and health risks for medical personnel and patients, and the negative environmental impact on water, soil and air.

Keywords: healthcare waste management; healthcare institutions; biohazards

Resumen

Las instalaciones hospitalarias son las encargadas de reducir y prevenir los problemas

de salud de la población, aunque inevitablemente generan desechos que pueden ser peligrosos para el bienestar humano o influir negativamente en el ambiente. El objetivo de esta investigación fue evaluar la gestión integral sostenible de los residuos peligrosos en los centros de salud pública del área urbana de la ciudad de "La Maná". Se aplicaron encuestas a los trabajadores sanitarios de los tres centros de salud pública; además, se realizó una caracterización de los residuos peligrosos, posteriormente se evaluaron los impactos ambientales mediante una matriz causa-efecto. La información recolectada fue analizada mediante el uso de estadística descriptiva, las variables cualitativas fueron analizadas con la prueba de Chi^2, además, se aplicó un ANOVA para identificar diferencias estadísticas en la generación de residuos peligrosos entre centros médicos y áreas de atención. El 66.67% de los trabajadores no han recibido capacitaciones sobre manejo de residuos peligrosos y el 93.06% no tienen conocimiento sobre la normativa ambiental aplicable. Las tasas medias de generación de residuos peligrosos dependen del área y del tipo de centro de salud. El Subcentro de Salud Tipo C es el establecimiento de mayor generación diaria de residuos cortopunzantes y biológico infecciosos; además, presenta el mayor impacto ambiental (62%). En la investigación, se evidenció el deficiente manejo de los residuos peligrosos, el incumplimiento de la normativa sanitaria y los riesgos en la salud del personal médico y pacientes, además, del impacto ambiental negativo en agua, suelo y aire.

Palabras claves: gestión de residuos sanitarios; instituciones de salud; riesgos biológicos.

Introduction

Recently, concern about the negative impacts of solid waste produced in hospitals has grown worldwide, especially in developing countries (1) (2). Medical Centers (MCs), including hospitals, clinics, and diagnostic and treatment sites, generate waste that is highly hazardous to public health and the environment (3). Health care waste, also referred to as medical waste, comprises general non-hazardous health care waste (or household waste) and hazardous health care waste, such as sharps, infectious, chemical, radioactive and pharmaceutical waste (4).

Inadequate treatment of these wastes presents serious risks of disease transmission to waste pickers, garbage workers, health care workers, patients, and the community at large through exposure to infectious agents. (5). The World Health Organization (WHO) states that in 2010, syringe use in inappropriate circumstances resulted in 33,800 new HIV infections, 1.7 million hepatitis B virus infections and 315,000 hepatitis C virus infections (6). Many of these infections could have been avoided through efficient waste management.

In Ecuador, following the Regulation "Management of Waste Generated in Health Establishments in Ecuador" R.O. N°450 of 2019 (7) has been responsible for implementing hospital waste management systems that demonstrate their responsibility to the environment, to their staff and promote their main objective of providing adequate patient care. Despite the efforts made, many CMs cannot still develop activities related to hospital MRP due to the lack of technical advice and financial resources (8).

Problems related to Hazardous Waste Management (HWM) are also evident at the local level. In this regard, the study conducted in the Type C health center in the city of La Maná in 2014 showed serious shortcomings related to hospital MRP, among which the most important are that the CM does not label the bags for transfer to the hazardous waste storage space. As a result, common and hazardous waste are mixed at the storage site, which is

unsuitable because it does not have the necessary characteristics for storing the different types of waste; it has no signage, its location is inadequate, and it is outdoors. Furthermore, the CM has vans, which are not properly equipped to transport the waste, nor does it have trained personnel to handle such waste. The final destination of the facility's hospital waste ends up in the open dump in the canton of La Maná, where all the waste is mixed and not properly treated (9).

Today, the Public Health Centers (PHCs) of the canton of La Maná continue to face several of these problems. Therefore, the objective of this research was to evaluate the Integrated Management of Hazardous Waste (GIRP) generated in the PHCs in the urban area of the canton of La Maná. The research is expected to promote a culture of environmental commitment through the correct disposal of waste. In addition, compliance with the norms established by the national and municipal environmental authorities would help to solve the public health (PH) and environmental problems generated by these wastes, as well as the reduction of operating costs related to the MRP activities for the CSPs (9).

Materials and methods

Type of study and study population

This descriptive cross-sectional study developed between June and December 2021 in the CSPs located in the urban area of La Maná canton, belonging to the province of Cotopaxi, Ecuador. In the urban area of the canton of La Maná there is three CM of different sizes, function and designation, which provide SP services to the community. The ConsulMed Medical Specialties Center is an external provider of the Ecuadorian Institute of Social Security (IESS), located at UTM coordinates WGS84 zone 17S (X:0697044; Y:9895880). It offers general medicine, obstetrics, clinical psychology, dentistry, and laboratory services 8 hours a day; it has 19 health workers, including physicians, nurses, assistants, and a cleaning person.

On the other hand, the Outpatient Health Unit of the Patronato de Amparo Social is a municipal institution belonging to the Decentralized Autonomous Government (GAD) of the canton of La Maná, located at coordinates (X:0696298; Y:9895546). It provides general medicine, physiotherapy, obstetrics, nutrition, dentistry, traumatology, and laboratory services 8 hours a day. This CM has nine workers, including physicians, nurses, assistants and one person in charge of cleaning. Finally, the Type C Health Sub-Center is a primary hospital, i.e., it provides 24-hour care and is located at coordinates (X:0695742; Y:9895253). It provides general medicine, dentistry, obstetrics, psychology, nutrition, laboratories, imaging, rehabilitation therapy, and emergency services; 83 health workers, including physicians, nurses, and auxiliaries, and four cleaning staff.

Procedures and instruments

In order to diagnose the current management of the PR generated at the CSP, a tour of the facilities was conducted (10). In addition, semi-structured interviews were conducted with the heads of health services in charge of PRM at each center (11). The questions were adapted from the WHO rapid assessment tool on medical waste management and water sanitation (12).

In addition, surveys of 20 closed questions on the generation, separation, storage, transport, treatment and final disposal of hazardous waste were applied to the personnel working in the institutions, including physicians, nurses, assistants and cleaning staff of the CMs, according to the methodology proposed by Ortega C. (13). The study population

consisted of 72 workers. Since this was a small population, the questionnaire was applied to all workers without calculating a sample.

To identify the PR generated in each hospital area according to the category or type of waste, the classification established in Agreement No. 00036-2019 was used as a basis (14). On the other hand, to obtain the daily rate of PR generation, the methodology established in Mexican standard NMX-AA-061-1985 was used (15). The methodology proposed in standard Mexican NMX-AA-019-1985 was used to calculate the volumetric weight "in situ" (16).

The environmental aspects and impacts were identified to evaluate environmental impacts. Subsequently, the evaluation criteria were selected according to the methodology proposed by Quintero G. (Table 1). (17). Consequently, each environmental aspect impact was assigned a value between 1 and 5 according to the established scales, obtaining an individual value for each criterion. The individual values for each criterion were added together to obtain the final value for each environmental impact. Finally, those with a value greater than or equal to 2 were considered significant environmental impacts. (10).

Table 1. Environmental impact assessment criteria applied in public health centers in the canton of La Maná.

Criteria	Description	Rating	Importance (%)
Magnitude	Severity of the damage that can be caused to the environment	5 Discharge 3 Media 1 Leaves	30
Control	Possibility of intervening in the aspect and/or environmental impact		10
Legal Requirement	Applicable environmental legislation	5 Exists and is not complied with 2 Exists and is complied with 1 No requirement	30
Frequency	Periodicity	5 High 3 Media 1 Low	10
Community	Impact on stakeholders or neighboring villages	Scale from 1 to 5. Whereas 1 is low and 5 is high	20

Source: Adapted from Quintero, G. (2015). (17).

Statistical analysis

The results of waste generation and surveys were recorded and tabulated in SPSS V. 22 software. Descriptive statistics were calculated (mean, mode, standard deviation); the Chi-square (H) statistical test was used by means of cross tables to determine the statistical associations between survey questions. In addition, an ANOVA test was applied to identify statistical inferences in the generation of hazardous waste with an axb factorial design, where the first factor was public health center and the second factor was an area of care; a significance level of $p<0.05$ was considered.

Results

Diagnosis of current Hazardous Waste Management

According to the interviews, two of the three CMs have hired an authorized PR manager and have a collection frequency of 15 days. However, the Type C Sub-Health Center does not have an authorized manager (Table 2), so the management is done with the help of the GAD of Pangua County, depending on the space available in the collection vehicle; for this, the PR is transported in dump trucks to the turnoff at the Manguila precinct (Pangua County) where the waste is transferred. As a result, there is no established collection schedule, so this waste is stored for several months, generating waste piles that cause bad odors and the presence of pests (flies, cockroaches, bacteria and viruses), becoming a source of infections that can affect the health not only of the facility's workers but also of the patients who come to the CM.

MRP within the three CSPs located in the urban area of La Maná canton**.**

Name of the CM	Specific final storage site for RP	It has the services of an authorized RP manager	Frequency of PR collection	Reports on PR generation
ConsulMed Medical Specialties Center	No, hazardous and common wastes are stored in the same warehouse.	Yes	Every 15 days	Yes, by the authorized manager
Ambulatory Health Unit of the Patronato de Amparo Social del GAD	No, hazardous and common wastes are stored in the same warehouse.	Yes	Every 15 days	Yes, by the authorized manager
Type C Health Sub-Center	Yes	No	Time not established	Yes, by the cleaning staff

* Reference category CM: Medical office; GAD: Decentralized autonomous government; RP: Hazardous waste.

Officials at the three medical centers indicate that they use special red containers and bags (high-density polyethylene) for primary storage of PRs and disinfection protocols at the final storage site. Nevertheless, 94.44% of the respondents consider being exposed to infectious diseases in the hospital environment. However, 76.39% of health workers stated that they had not suffered accidents due to handling RP in the last six months (p=0.52); while 13.89% suffered accidents in the last two years and 9.72% in the last year, respectively, which indicates that accidents are less frequent now than they were two years ago. Regarding this problem, the workers indicated that needle sticks mainly caused accidents due to the defective state of personal protective equipment.

Regarding the training on hazardous waste management in the HCs, 66.67% of the health workers have not received any orientation, thus increasing the probability of accidents due to handling hazardous waste (p=0.03). Regarding the environmental regulations applicable to RP, 93.06% of the healthcare workers stated that they did not know this subject. The lack of knowledge of the environmental regulations applicable to the MRP is due to the lack of training on GIRP since they are dependent variables (p=0.02). In the case of the CMs where training has been given, the lack of knowledge of environmental laws is because the talks were related to occupational safety and not to environmental issues.

Hazardous Wastes generated at La Maná's CSPs

Most sharps waste consisted of vacutainer tubes (1.13 kg/day) and slides (0.45 kg/day). Although the generation of sharps waste presented significant statistical differences between public health centers and areas of care (p=0.001), the CSP that presented the highest generation was Subcenter Type C in the laboratory area with 3.18 kg/day, followed by the dentistry area at 0.70 kg/day respectively.

The most generated infectious biological waste was urine containers (0.98 kg/day) and feces (0.80 kg/day), with an average volume of 0.046 m^3 /day. These wastes presented statistical differences between public health centers and care areas (p=0.001); Subcenter Type C presented the highest generation in the laboratory area with 2.20 kg/day; while the general medicine area of Subcenter Type C generated 0.63 kg/day of infectious biological waste.

Environmental impacts caused by Hazardous Waste Management in medical centers.

Of the total environmental impacts identified at ConsulMed Medical Specialties Center, 53% are significant, presenting alterations in air and water quality and consumption of natural resources. This is evident in dentistry due to patient care activities, dental prophylaxis, filling of dental cavities, extraction of dental pieces, whitening, washing and sterilization of dental instruments. Similarly, in the laboratory area, due to sample handling and processing activities, washing and sterilization of materials, since most of the waste generated is in direct contact with biological fluids or chemical substances, which are disposed of directly in the sink, thus affecting the environment.

Thirty percent of the environmental impacts identified in the Ambulatory Health Unit of the Patronato de Amparo Social del GAD are significant, with the dental area having the greatest impact due to water and electricity consumption in the washing and sterilization of dental instruments. The clinical laboratory area is also affected by air and water quality alterations during sample handling and processing activities since the waste generated are in direct contact with biological fluids and generates foul odors. At the same time, it remains in the containers or is often disposed of directly in the sink after analysis.

Of the total environmental impacts identified in the Type C Health Sub-Center, 62% are significant, presenting alterations in the quality of air, water and consumption of natural resources in the areas of dentistry due to patient care, prophylaxis, cavity filling, extraction of parts, washing and sterilization of instruments. Similarly, in the laboratory area, in activities such as handling and processing biological fluids and washing and sterilizing materials. Significant environmental impacts are also present in the emergency area, with alterations in air quality due to the care provided during labor since the AD is sent to the storage warehouse and spend several months in storage, causing foul odors that affect the environment and disturb the health workers and cleaning staff.

Discussion

The integrated management of hazardous waste is essential for achieving sustainability in health care; however, few studies on PRM have been carried out in the city of La Maná and in Ecuador. Although there have been many revisions in the regulatory guidelines for proper management of such waste by the authorities in this region, no significant improvement in management efficiency has been observed during the study period. The results showed that poor environmental culture and awareness, the strong need for training for health personnel, and the non-existence of an environmental technician are some of the concerns that need to be addressed to improve efficient implementation and reduce negative environmental impacts and human health. This deficiency can be attributed to the financial crisis and lack of government support.

The fact that more than 90% of health workers are exposed to infectious diseases in the hospital environment, such as AIDS or hepatitis B and C, is sometimes because personal protective equipment is not in good condition, a similar figure, although slightly higher than the 93% reported by Vallejo Ilijama *et al*. (18) in 46 Ecuadorian employees of the Cordero

Crespo health center in the city of Guaranda. In this sense, a greater number of workers are exposed to infectious diseases in relation to the study of Vallejo Ilijama et al. (18) study because the sample size is smaller. Nevertheless, these results suggest that exposure to infectious diseases is a frequent problem among health care workers.

It was found that more than 50% of the sanitation workers have not received any orientation on GIRP and have no knowledge of environmental laws. Similarly, Fonseca (19) at the General Hospital of Latacunga indicated that the causes that impede adequate MRP begin with the lack of knowledge of current regulations and the lack of compliance with training programs since only 10.9% of the workers had received training. This is evidence of the lack of knowledge about the proper management of hospital waste. Something similar occurs in the department of Meta, Colombia, where only 21% of the health care institutions carry out training programs, with the Local Hospital of Guamal being the establishment with the lowest percentage of compliance with the regulations, which affects the potential risk to which the general population and the environment are exposed (20).

The total production of PR depends on several factors, the most important of which are the number of patients attended, the type of health facility - size and complexity - and the areas into which it is divided (10). This aspect is identified when comparing the results obtained by Heredia *et al*. (10) regarding the production of infectious waste generated at the Padre Alberto Buffoni Hospital in the province of Esmeraldas, Ecuador, which generated 473.47 kg during 15 days, as opposed to one of the CMs under study (Type C Health Sub-center) which generated 123.10 kg of RP including sharps, infectious biological, anatomopathological and hazardous pharmaceutical waste during 12 days.

Dentistry and clinical laboratory are the areas that cause significant impacts at the ConsulMed Medical Specialties Center and the Ambulatory Health Unit of the Patronato de Amparo Social del GAD. In the case of the Type C Health Sub-Center, the emergency area has been added, and the impacts generated are changes in air and water quality and consumption of natural resources. The environmental impacts caused by CM are due to the generation of solid waste, mainly bio-contaminated waste, and the consumption of natural resources such as water and energy (21). As in the present study, Brito *et al*. (22) identified high environmental impacts caused by hospital waste generated at the SOLCA Oncology Unit in Riobamba using the Leopold matrix. Similarly, Rivera (23) determined that 75% of the impacts caused at the Dr. Paolo Marangoni Soravia Hospital in Guayaquil are negative impacts caused by operational activities in the hospitalization and delivery room areas, which generate alterations in air quality due to gas emissions and PR contamination (23).

It is evident from the above results and analysis that there are gaps in infrastructure, capacity, monitoring, disposal and awareness levels necessary for effective PR management at La Maná's CSPs. Based on this, the main strategies proposed in an ISWM plan that includes training programs, impact prevention and mitigation, occupational health and safety, hazardous waste management, and a contingency plan are established. Similarly, the management proposals made by Ramírez and González in health centers in Uruguay and by Domínguez *et al*. (24) and by Domínguez *et al*. (25) in the Daule Hospital area 16 “Dr. Vicente Pino Morán” focus on these important criteria to mitigate the impact of PRs on the environment and on workers' health. Consequently, implementing the TP would reduce operating costs, increase ecological efficiency, and promote the environmental sustainability of the CSP in the canton.

This study is the starting point of a broader investigation to determine whether

implementing ISWM plans in public sector hospital activities improves environmental impact through analyzing the results obtained before and after the implementation of PT. The findings of this research also have significant implications for policymakers and hospital management by helping them identify and work on problem areas, benefiting these hospitals to minimize pollution, encourage ISWM techniques, conserve natural resources, and achieve sustainability.

Conclusions

In the CMs of La Maná canton, few training programs are related to hazardous waste. However, workers who handle this type of waste have a basic knowledge of the correct classification. The laboratory area of the type C health sub-center generates a greater amount of CD and DBI than the other CMs, since it is the CM with the largest capacity. As for AD, these originate only in the emergency area because they provide care during labor and delivery, where the resulting by-product is placentas.

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