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*Artículos Científicos*

## **Manejo de residuos peligrosos biológicos e infecciosos en una escuela de química de nivel superior**

*RPBI Management at High School of Chemical*

*Gestão de resíduos perigosos biológicos e infecciosos em uma escola de  
química de nível superior*

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## Resumen

**Introducción:** Los residuos peligrosos biológicos e infecciosos (RPBI) que se generan en las instituciones de educación superior provenientes de las actividades de docencia, investigación y de servicios del área de la salud deben ser gestionados para su adecuado manejo y control a través de los planes institucionales; estos deben contemplar en su planeación y ejecución el conocimiento de la población estudiantil y del público que se atiende para ser eficaces y apegados a la problemática real. **Objetivo:** Evaluar el conocimiento para el manejo de los RPBI por parte de docentes y estudiantes de una escuela de química de nivel superior, según lo establecido en la legislación vigente de esa casa de estudios. **Metodología:** Estudio cuantitativo de corte transversal y alcance descriptivo. Se aplicó un cuestionario validado a dos poblaciones: 1) los laboratoristas encargados de los laboratorios de docencia y servicios y 2) los estudiantes de la licenciatura en Química. En total participaron 92 personas. **Resultados:** 85.70 % de los laboratoristas y 40.44 % de los estudiantes encuestados tienen conocimiento de la clasificación y envasado de los RPBI. **Conclusiones:** El conocimiento del contenido de la norma NOM-087-SEMARNAT-SSA1-2002 en los participantes indica que es necesario instruir a los estudiantes sobre el contenido y aplicación de la norma para un adecuado manejo de los RPBI.

**Palabras clave:** control sanitario, desarrollo sustentable, participación comunitaria.

## Abstract

**Introduction:** Biological and infectious hazardous waste generated in higher education institutions from teaching, research and services activities in the health area must be managed for their proper management and control through institutional plans; these must contemplate in their planning and execution the growth of the student population and the public that is attended to be effective and attached to the real problems. **Objective:** To evaluate the knowledge for the management of RPBI by Teachers and students of a Chemistry School of a Higher Level according to what is established in the current legislation of the Institution. **Methodology:** quantitative cross-sectional study and descriptive scope. A validated questionnaire was applied to two populations: 1) the laboratories in charge of the teaching and services laboratories and 2) to the students of the Chemistry degree, with a total of 92 people. **Results:** 85.70% of the laboratories and 40.44% of the students surveyed are aware of the classification and packaging of the RPBI. **Conclusions:** The knowledge of the content



of the norm NOM-087-SEMARNAT-SSA1-2002 in the studied population indicates that it is necessary to instruct the students about the content and application of the Norm for an adequate handling of the RPBI.

**Keywords:** sanitary control, sustainable development, community participation.

## Resumo

**Introdução:** Os resíduos biológicos e infecciosos perigosos (RPBI) gerados em instituições de ensino superior a partir de atividades de ensino, pesquisa e serviços de saúde devem ser gerenciados para o gerenciamento e controle adequados através dos planos. institucional; Eles devem contemplar em seu planejamento e execução o conhecimento da população estudantil e do público que é servido para ser eficaz e apegado ao problema real. **Objetivo:** Avaliar o conhecimento para a gestão do RPBI por professores e alunos de uma escola de química de nível superior, conforme estabelecido na legislação atual dessa universidade. **Metodologia:** Estudo transversal quantitativo, com escopo descritivo. Um questionário validado foi aplicado a duas populações: 1) os especialistas de laboratório encarregados dos laboratórios de ensino e serviços e 2) os alunos da graduação em Química. No total, 92 pessoas participaram. **Resultados:** 85,70% dos trabalhadores de laboratório e 40,44% dos estudantes pesquisados estão cientes da classificação e embalagem do RPBI. **Conclusões:** O conhecimento do conteúdo da norma NOM-087-SEMARNAT-SSA1-2002 nos participantes indica que é necessário instruir os alunos sobre o conteúdo e a aplicação da norma para um manuseio adequado do RPBI.

**Palavras-chave:** controle sanitário, desenvolvimento sustentável, participação da comunidade.

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## Introduction

In accordance with NOM-087-SEMARNAT-SSA1-2002, infectious biological hazardous waste (RPBI) are those materials generated in all health sectors, clinical laboratories or research centers during health care services for humans or animals. Due to their infectious-contagious characteristics, these residues represent a risk to health and the environment, and their proper management and control represents one of the most controversial issues at present (Morelos, Ramírez, Sánchez, Chavarín and Meléndez, 2014 ; Neveu and Matus, 2007).

In addition to the urban solid waste generated in higher education institutions, in the health area there are wastes from teaching, research and service activities that must be adequately handled and controlled through institutional plans, which must instruct the student population on the type of materials available and their projection for annual growth (Rosales, Saldaña, Toledo and Maldonado, 2013; Vargas, Alvarado, López and Cisneros, 2015).

The Ministry of Environment and Natural Resources promulgated the General Law for the prevention and comprehensive management of waste in order to design a comprehensive waste management system. Planning a favorable strategy for waste management prevents ecological damage and health risks from infection transmission, all through a management culture that involves the entire university community (Castañeda, Jiménez, Urzua and Manzano, 2002 ; Saval, 2012; Rosales et al., 2013).

The RPBI institutional management program is responsible for its collection and temporary storage until they are delivered to the company responsible for its final disposal; Each laboratory that generates RPBI must collect, label and package them appropriately to avoid any biological risk. For this, the personnel in charge of the laboratory must be trained, as well as social service students through practices that support teaching activities.

The educational institution has implemented an environmental management system based on ISO 14001: 2004, whose purpose is university environmental training through the development of an environmental management system that complies with the legal provisions related to sustainability. In the FCQB the classification and packaging of RPBI is governed by NOM-087-SEMARNAT-SSA1-2002, the content of which must be taught to students and teachers to avoid damage to the environment and the general population. (Vargas *et al.*, 2015).

It is important that all the actors involved in the generation, storage and disposal of waste are aware of their participation in the institutional program to generate a positive interaction with the authorities and executing agents of the program. In this way, feedback and improvement of the measures adopted to solve unforeseen problems in the daily exercise of the activities assigned to teaching, research and services can be fostered (Morelos et al., 2014). By encouraging and training all waste generators, it is hoped to obtain environmental, social and economic benefits, fundamental pillars of health education and sustainable development.

The real problem of waste, in other words, must not only focus on correct management, but also emphasize on avoiding its generation and reducing waste as much as possible. By optimizing analysis techniques and methods, and by changing them to microanalytical techniques, the production of waste or the consumption of vital resources such as water is considerably reduced. Good planning of the services offered would avoid unnecessarily generating waste, by scheduling consultations and organizing work sessions to reduce the occupation of protective materials such as gloves, caps and mouthguards (Muñoz, 2010). The investigation of compliance with the waste management processes serves as feedback to the quality control system of the institutional plan because it provides updated and reliable information on the degree of execution of the policies in place, knowledge and monitoring of the provisions adopted, the needs or unforeseen problems, and the qualitative and quantitative composition of the waste generated. With the results of the evaluation of the degree of knowledge of the regulations and the degree of their compliance, the real state of the waste management program is analyzed to know the weaknesses, threats, strengths and opportunities.

The student community must be really and actively involved in the program because they are the majority responsible for the generation of waste, so there is an urgent need to raise awareness about its management and reduction. Without the social participation of university students, any provision adopted will not obtain the expected results (Olivos, Ávila and Arana, 2008). But in addition to a waste management plan, a minimization program must be jointly developed, as well as monitoring the efficiency of the reduction program and evaluating the costs of the processes used. (Lee, Guilarte, Lee, Samón y Fernández, 2017).

The generation of waste is inevitable because it represents the final phase of the productive, service and consumption activities of the academic and research personnel of the higher education centers; However, it is possible with a good organization and planning to reduce waste and to manage it correctly by involving the society responsible for its production to reduce environmental risk, avoid damage to the health of workers and reduce waste. the costs both by contracting the consumption of materials and reagents and by reducing the amount of waste that must be processed by private companies (Muñoz, 2010).

Improving resource and waste management systems is a dynamic and continuous process; For this reason, as each system rises one more level, there are new challenges to face, since other factors must be considered that due to the prioritization of emergencies are not initially considered and that arise when the preventive and corrective actions of the organization are organized and established. Program; to cite some of the challenges that are looming in the near future are the in situ control of micro-waste generated (solids, liquids and gases) and the sanitation of areas exposed to activities that generate infectious biological waste (Baquero, Sterling y Mara Benavides, 2010).

### **Involvement of RPBI in health and the environment**

Hippocrates, in ancient Greece, considered that health represents the unity of the human being with his environment and that, therefore, for that one to reach and preserve his health, he must respect and keep the environment clean. However, history shows that fulfilling this seemingly simple aspiration has not been easy, despite measures for health and environmental care, such as the elimination of RPBI produced by various institutions in the educational sector. and health, among others (Castañeda et al., 2002). Pollution caused by the generation of domestic, industrial and hospital waste constitutes a serious and complex problem of a civilization that has promoted economic growth and industrialization as a prototype of modernization and economic development. The global volume of hazardous waste is causing the poisoning of the planet and all its ecosystems, thereby degrading the quality of life of millions of human beings and causing serious public health problems. For this reason, the global elimination of pollutants at the world summits on the environment in Stockholm (Sweden), Rio de Janeiro (Brazil) and Johannesburg (South Africa) was determined as a priority, in which it is stated that health depends on last term of the ability to

control the interaction between the physical, economic and social environment (Olivos et al., 2008).

It is vitally important to analyze the situation that occurs in multiple countries due to the spread of viral diseases - such as hepatitis B and C or the acquired immunodeficiency syndrome (AIDS) due to causes of work activity - which have had a great impact on the health sector due to the inadequate management of RPBI (Lugo, Alzúa, Lagunas, Cuevas and Narváez, 2014). It is accepted that the biological risk —considered as accidental exposure— is more frequent for health workers, which can happen due to parenteral inoculations (punctures, cuts, scratches), contact with membranes, mucosa, tissue or other highly infectious fluids ( eg, laboratory samples) (Olivos et al., 2008). In 1995, the NOM-087-ECOL-1995 standard, the first dedicated to the management and treatment of RPBI, was published in the Official Gazette of the Federation. Using the criteria used to classify RPBI under rule 87, a large number of wastes that were not really hazardous were identified as such. This caused a great impact on the expense for its management. To improve the above, on February 17, 2003, the Mexican Official Standard (NOM) 087 of the Ministry of Environment and Natural Resources (Semarnat) and the Ministry of Health (SSA) of the 2002 (3.10).

In Mexico, RPBI are under the supervision of institutions such as Semarnat, Profepa, SSA and Cofepris, which monitor and regulate compliance with the different applicable standards, in terms of their classification, separation, regulation and final treatment. Likewise, they have the responsibility of granting licenses to companies in charge of storage, collection, transport and complying with national and international standards and processes. (Alvarado-Cabrero y Valencia-Cedillo, 2015; Lee *et al.*, 2017; Zúñiga, Lemus, Sánchez, González y González, 2015).

## Study methodology

A quantitative approach with a descriptive, cross-sectional and observational scope was carried out to find out the current status of the application of the program from a survey based on NOM-087-SEMARNAT-SSA1-2002. The universe was made up of all those in charge of the teaching laboratories and 85 students who were willing to fill out the questionnaire. The inclusion criteria were as follows: enrolled students who were studying

the fifth semester of the Bachelor of Pharmaceutical Chemist-Biologist and who had completed at least one subject with a laboratory in the clinical area. The exclusion criteria were these: students with an attendance rate of less than 65%, who did not want to freely answer the questionnaire or who were recursors.

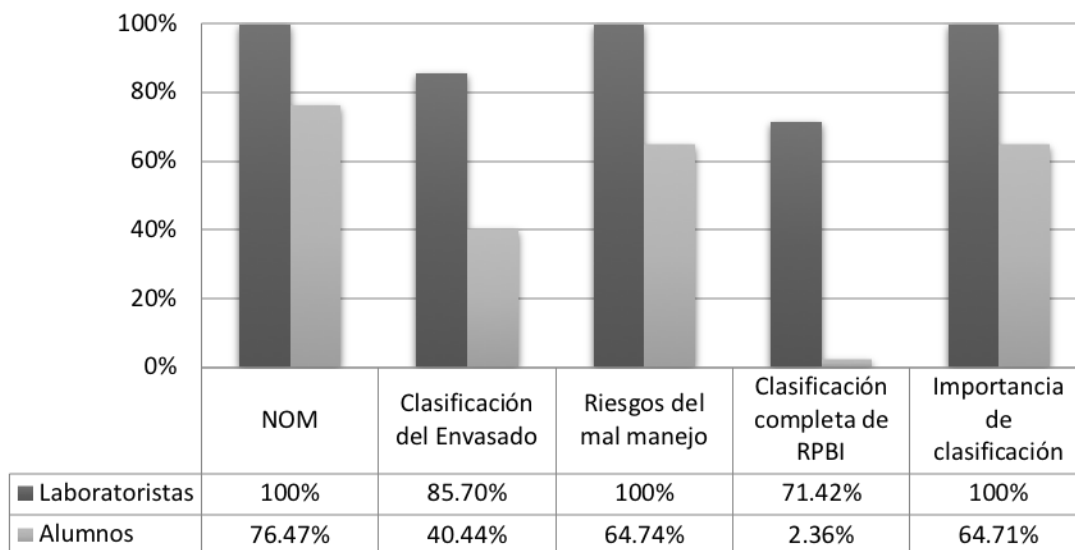
Initially, the questionnaire was developed by a group of five experts, who validated the construct and carried out the pilot test, applied to 20 students to test the reliability of the questionnaire. In this process, it was taken into account if the personnel to whom the questionnaire was assigned understood the different items raised, which served to measure the resolution time and adapt the questions originally asked. The survey consisted of a questionnaire of 10 questions: 5 multiple-choice and 5 open-ended. The focus was on 1) the correct handling of NOM-087-SEMARNAT-SSA1-2002, 2) the importance of RPBI classification, 3) packaging and 4) the procedure that RPBI follow after its generation. . The results obtained were classified according to the corresponding category. The data was processed in Excel to obtain the percentage and the corresponding graph on the knowledge of the standard.

## Results

In total, seven FCQB laboratory workers (that is, 100% of them) were surveyed. In addition, the survey was applied to 85 students of 5th and 7th semesters of the Biologist Pharmaceutical Chemist educational program. The results are reported in figure 1, where it is appreciated how many respondents know that NOM-087-SEMARNAT-2002 is the one that governs RPBIs and are aware of the importance of the classification and packaging of RPBIs in the care of the health and the environment, as well as the risk to which the student population, laboratory workers, collectors, administration staff, academics and administrative staff would be exposed when misclassifying and packaging this waste. In relation to the classification and packaging of RPBI, it should be known that RPBI are classified in blood, sharps, cultures and strains, non-anatomical and pathological as stipulated in NOM-087-SEMARNAT-SSA1-2002.



**Figura 1.** Comparación del conocimiento de los laboratoristas y los alumnos sobre los aspectos importantes en el manejo de RPBI



Fuente: Elaboración propia

The two laboratory workers (28.58%) who are unaware of packaging only handle hazardous waste that is generated in laboratory practices, but does not include infectious biologics. Although this minimizes the seriousness of the ignorance, it is important that all the actors involved know what the proper management of RPBIs should be; To do this, training and continuing education courses must be planned for laboratory workers as well as for teachers and students.

The results of the surveys show that the knowledge of the aspects involved with the classification and temporary disposition of the RPBI generated in the laboratory practices and during the services provided to the community (clinical laboratory and quality control laboratory for food and beverages) by students it is lower, since only 65 (76.47%) of the 85 students surveyed know that NOM-087-SEMARNAT-2002 governs the use of RPBIs. Regarding the knowledge about the classification and packaging of the RPBI, 54 students (63.52%) of the fifth semester are clear about this aspect.

The awareness of the student sector about the importance of its classification and packaging for the health care of staff and the environment is low: 58 students (68.23%) expressed that the proper classification of RPBI allows them to be handled properly and that their correct packaging prevents dangerous accidents that would cause environmental contamination, which at the same time could represent an epidemiological risk.

Although the majority of QFB students (55 of the respondents, 64.70%) are aware of the risk to which the student population could be exposed, some (30 students, 35.3%) did not show interest or awareness of the danger that manipulation implies incorrect RPBI. For this reason, the factors that promote this apathy must be studied, and then strategies must be designed to change this panorama. One recommendation would be to increase the participation of students in the temporary disposal of biological waste, because if they are limited to delivering RPBIs to laboratory workers, then they will not be aware of where they are discarded or the protocol that must be followed to safeguard the integrity of the community and the environment.

Finally, a greater ignorance of the students was detected with respect to the other two aspects surveyed; that is, only 34 students (40%) have knowledge about the classification and packaging of RPBI. In fact, only 14 students (16.47%) know how to pack them correctly and 2 (2.36%) know three of the five aspects contemplated in the RPBI classification. In short, it can be affirmed that it is alarming to have found that 83 students (97.64%) do not know the complete classification of the RPBI, which should be familiar to them because it is assumed that they have already handled biological samples in different learning units. In summary, they ignore that RPBI are classified into 1) blood, 2) sharps, 3) cultures and strains, 4) non-anatomical and 5) pathological.

## Discussion

RPBIs are constantly generated in clinical laboratories that handle patient samples and in research laboratories that work with both human and animal samples. Although all the degrees that are taught at the FCQB generate RPBI, it must be taken into account that the QFB career is the main generator of this type of material. Therefore, knowledge of NOM-087 is essential for the correct management of RPBIs, since in this way not only can work accidents (such as the transmission of infectious diseases) be avoided, but also the impact towards the environment (Lugo et al., 2014).

It is true that the FCQB has an institutional program of continuous education and training for its workers so that they can properly manage polluting waste. In addition, QFB students in their various subjects receive training on the regulations to manipulate RPBI, so it is assumed that everyone should know how to use the RPBI generated in laboratory practices or research projects. However, in a quality management system it is always

necessary to evaluate the current state of achievement of the objectives, since in this way intervention activities can be planned that allow improving the quality circle. NOM-087-SEMARNAT-SSA1-2002 contemplates compliance with the appropriate provisions of the RPBI, which includes 1) its identification, 2) packaging, 3) temporary storage, 4) collection and external transport, 5) treatment and 6) final disposition.

The correct disposition of the RPBI prevents the spread of fomites and the contamination of the surrounding fauna. Therefore, awareness must be promoted among FCQB students, teachers and laboratory workers to reduce the generation and mishandling of RPBIs. Keep in mind that investing in human resource training can achieve great benefits for the environment and society in general. (Alvarado-Cabrero y Valencia-Cedillo, 2015; López-Vigil *et al.*, 2015).

## Conclusion

The results obtained in this research indicate that most of the students who handle RPBI know the regulations and the basic aspects for their management; however, the measures regarding the application of NOM-087-SEMARNAT-SSA1-2002 must be reinforced, for which all actors involved in said process must be included: teaching, administrative and other chemistry students. To do this, you should think about including health education activities from the induction course. A comprehensive program of continuing education and promotion of the proper employment of RPBIs would promote a culture of prevention, as well as health and environmental care.

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