

RESEARCH

MANAGEMENT OF BIOLOGICAL AND CUTTING WASTE HAZARDS: KNOWLEDGE OF UNDERGRADUATE STUDENTS IN BIOLOGICAL AND HEALTH SCIENCES COURSES AT UNIVERSIDADE FEDERAL DE MINAS GERAIS

*GESTÃO DE RESÍDUOS COM RISCO BIOLÓGICO E PERFUROCORANTES:
CONHECIMENTO DE ESTUDANTES DE GRADUAÇÃO DAS ÁREAS BIOLÓGICAS
E DA SAÚDE DA UNIVERSIDADE FEDERAL DE MINAS GERAIS*

*MANEJO DE RESIDUOS PELIGROSOS BIOLÓGICO- INFECCIOSOS Y DE OBJETOS PUNZOCORTANTES:
CONOCIMIENTO DE LOS ESTUDIANTES DE GRADO DE LAS ÁREAS BIOLÓGICAS Y DE LA SALUD
DE LA UNIVERSIDAD FEDERAL DE MINAS GERAIS*

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ABSTRACT

This study aimed to assess the knowledge of undergraduate students in biological and health sciences courses, regarding waste management according to Brazilian law. This was a descriptive study that treated the knowledge of management actions regarding biological and cutting waste hazards. Structured questionnaires were applied to students outside of the classroom in the Institute of Biological Sciences at Universidade Federal de Minas Gerais in 2008 and 2009. The results were discussed based on current Brazilian law concerning waste as well as on findings from other similar studies. This study's results show that students have insufficient and informally acquired knowledge on the issue. It seems that the students are interested in the issue, but they acknowledge that they are not prepared to handle biohazardous and cutting wastes, which shows the need to improve the teaching-learning process on the theme. Answers concerning the problem showed that students are in agreement that such materials can cause health hazards, although they do not have sufficient information on the current laws that deal with the issue. The information on the theme, acquired by the students, clearly appears in fragments, given that their search for information appears to have come only from observations.

Keywords: Medical Waste; Risk Reduction Behavior; Cross Infection; Students, Health Occupations.

RESUMO

O estudo objetivou avaliar o conhecimento dos estudantes dos ciclos básicos de graduação das áreas biológicas e da saúde, relativos ao gerenciamento de resíduos conforme a legislação brasileira. Trata-se de um estudo descritivo sobre o conhecimento das ações de gestão dos resíduos biológicos, infectantes, perfurocortantes. Foram aplicados questionários estruturados a estudantes presentes fora das salas de aula no Instituto de Ciências Biológicas da Universidade Federal de Minas Gerais em 2008 e 2009. Os resultados foram discutidos com base na legislação de resíduos vigente no Brasil e em outros estudos similares. O estudo demonstra que os alunos apresentam pouco conhecimento sobre o tema, adquirido informalmente, têm interesse sobre o assunto, reconhecendo não estarem preparados para lidar com resíduos com risco biológico e perfurocortante na graduação, o que demonstra a necessidade de aprimoramento do processo ensino-aprendizagem sobre o tema. Há concordância, nos pesquisados de que os resíduos biológicos e perfurocortantes representam um risco à saúde, embora estes não tenham informações suficientes sobre as legislações pertinentes ao assunto. As informações sobre o tema, adquiridas pelos alunos apresentam-se visivelmente de forma fragmentada, sendo que as buscas sobre o assunto partiram de observações.

Palavras-chave: Resíduos de Serviços de Saúde; Comportamento de Redução do Risco; Infecção Hospitalar; Estudantes de Ciências da Saúde.

RESUMEN

El presente estudio buscó evaluar el conocimiento en gestión de residuos de los estudiantes de grado de los cursos básicos de biología y ciencias de la salud, en conformidad con la Legislación Brasileña. Se realizaron encuestas fuera del aula con los alumnos de la Facultad de Ciencias Biológicas de la Universidad Federal de Minas Gerais en 2008 y 2009. Los resultados se discutieron en base a la legislación de residuos vigente en Brasil y en otros trabajos similares. El estudio indicó poco conocimiento, adquirido de manera informal, de los alumnos, interés en el asunto y reconocimiento de no estar preparados para manejar dichos residuos. Tales resultados señalaron la necesidad de mejorar el proceso enseñanza-aprendizaje del tema. Los investigadores reconocieron que los residuos biológicos y punzocortantes representaban un riesgo a la salud y que no conocían suficientemente la legislación pertinente al tema. Los alumnos tenían información fragmentada y el interés en obtener más conocimiento partió de observaciones.

Palabras clave: Residuos de Hospitales; Conducta de Reducción del Riesgo; Infección Hospitalaria; Estudiantes del Área de la Salud.

INTRODUCTION

Health hazards related to medical waste can present a great risk to the worker, as well as for the community and the environment. Hazard studies are essential, given that the perception of hazards influences the behavior and the degree of precaution taken by individual actions when faced with situations that can cause harm, accidents, or both.¹ In 1949, Sulkin *et al.*² published the first of a series of works on infections associated with laboratories, where in one third of the cases the source of infections was associated with the handling of animals and infected tissues. At the end of the 1980's, the concern with medical-hospital waste resulted in the publication of the "Medical Waste Tracking Act" implemented in the USA in 1988.² The principles set forth for the handling of potentially infectious waste as an occupational hazard were reinforced by the National Research Council, entitled "Biosafety in the Laboratory."²

The Resolution from the Board of Directors (RDC Nº 306/2004)³ of the Brazilian Health Surveillance Agency (ANVISA) and the Resolution from the Brazilian National Environmental Council (CONAMA) (Nº 358/2005),⁴ as well as other pertinent legislation, establish the technical regulations for medical waste management. These resolutions aim to preserve both public health and environmental quality, with a similar standardization of actions and a similar language. For this, the resolutions consider biosafety, in addition to technical, administrative, and regulatory measures to prevent accidents. According to these legislations, medical waste is classified in 5 groups (A, B, C, D, and E). Group A consists of biological waste and waste containing the possible presence of biological agents that can present the risk of infection. In Group E, medical waste is classified as cutting waste, such as needles, glass vials, scalpel blades, glass utensils broken in the laboratory, and other similar waste.

Medical waste management includes a series of planned and executed procedures from scientific, technical, regulatory, and legal bases to promote the safe transport of the generated waste, in turn minimizing its production. Such management aims to protect the workers and preserve public health, natural resources, and the environment. The generators of medical waste are defined as the services related to human or animal

healthcare. At Universidade Federal de Minas Gerais (UFMG), the Institute of Biological Sciences is a department in which biological and health sciences students carry out part of their basic level undergraduate studies. Thus, for the reasons mentioned above, this institute is considered a generator of medical waste.

Considering the concerns surrounding the hazards generated by the medical waste from Groups A and E, the level of knowledge regarding these materials in higher-education institutions is of utmost importance for the population as a whole. This importance is based on the fact that the students are exposed to hazards and, in these establishments, these social actors must acquire the necessary basic knowledge for their future professional practices. Therefore, the present study aimed to identify the knowledge of students who study in the biological and health sciences courses at UFMG concerning the management of medical waste from Groups A and E.

MATERIAL AND METHODS

The Institute of Biological Sciences at UFMG (ICB-UFMG) offers basic level undergraduate courses in the areas of Biological Sciences, Physical Education, Nursing, Pharmacy, Physical Therapy, Phonology, Medicine, Veterinary Sciences, Dentistry, and Occupational Therapy. This community develops activities that handle biological materials with microorganisms or objects contaminated by these; perforating, cutting, or scarring materials; as well as waste from these materials and these substances.

This study is an observational, sectional, and descriptive study conducted at ICB-UFMG from November 2008 to May 2009, when there were 2,432 undergraduate students studying at this institution.

A structured questionnaire was used for data collection, focusing on the students' knowledge of the management of biological and cutting waste and the aspects of its stages, from the generation of the waste to its final destination, with additional questions about current Brazilian laws on the issue. The questionnaires were drafted based on ANVISA Resolution 306/04³ and CONAMA Resolution 358/05⁴ and consisted of 18 total questions.

The project was submitted to and approved by the UFMG Research Ethics Committee in December 2008, under protocol

number ETIC 527/08. 24. The undergraduate students were recruited in random samples with approximately 10% of the total number of students in each course, outside of the classroom, with no distinction in gender and age. After having received the invitation to participate as a volunteer in the research project, each student was instructed as to the aims and characteristics of the study and, those who agreed to participate, signed a Free Informed Consent Form before answering the questionnaire.

The questionnaire consisted of dichotomous questions, with three or four alternatives to choose from as answers. Six were affirmation questions that followed the properties of the Likert scale, using attributes such as: strongly disagree, disagree, agree, strongly agree. Such a scale quantifies the answers of these questions, contemplating them with values from a linear scale, which are later used to create a specific graph.⁵ The proportions of the results found in each answer had their confidence intervals (CI) calculated with a 95% significance level, as they made generalizations possible.⁶

The arrangement of the data bank was performed using the EPI-DATA 3.1 software,²⁶ the exported data, the CI, and the graphs were calculated using the Microsoft Excel software, 2003 version.

RESULTS

Of the sample of 270 undergraduate students, the average age was of 20.5 years, with a minimum age of 18 and a maximum age of 32, with a standard deviation of 2. Of these students, 201 were female.

Table 1 shows the answers from the beginning level students of the biological and health sciences courses when asked "if the waste from group A should be considered chemical waste," as well as demonstrates these same students' proportion of agreement regarding the affirmation that "the waste from cultures and stocks of microorganisms, culture mediums, and waste from genetic manipulation present a health hazard."

For the affirmation "If the waste from Group A should be considered chemical waste," 91.8% did not know the classification, 1.6% disagreed with the affirmation, and 6.6% agreed with the affirmation. In the understanding of the students, 68.8% agreed and 24.8% strongly agreed that "the waste from cultures and stocks of microorganisms, culture mediums, and waste from genetic manipulation," are waste that present a health hazard (Figure1). In the category concerning the disposal of the material, 62.2% of the students in the beginning levels of the biological and health sciences courses at UFMG did not know that the bags for the disposal of biological and infected waste are white; 27.4% agreed with the affirmative; and 10.3% thought that they were a different color (Table 1).

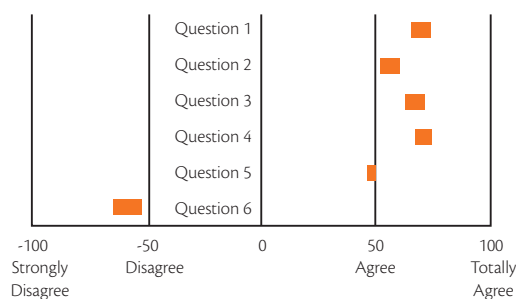


Figure 1 - Proportion of agreement from undergraduate students in the beginning levels of the biological and health sciences courses regarding the existence of hazards related to waste from Groups A and E (ICB-UFMG, Belo Horizonte – Brazil, 2008).

Question 01: waste management is a theme that must be taught during the basic level courses, preceding laboratory, clinical, and research activities.

Question 02: waste from cultures and stocks of microorganisms, culture mediums, and genetic manipulation laboratories are wastes that represent a health hazard.

Question 03: carcasses and waste consisting of blood and body fluids represent a health hazard.

Question 04: if you answered "yes" to Question 3, should these wastes undergo a special treatment before their final disposal.

Question 05: wastes from cultures and culture mediums, stocks of microorganisms, must be inactive before being discarded.

Question 06: The disposal of cutting waste must be placed in plastic bags.

Table 1 - Proportions (\pm Sample Standard Error with 95% CI) of the answers from undergraduate students from the biological and health sciences courses regarding Medical Waste Management (ICB-UFMG, 2008).

Affirmation	Disagree (%)	Agree (%)	Do not know (%)
ICB-UFMG generates Medical Waste	1,1 (\pm 1,3)	62,6 (\pm 5,8)	36,3 (\pm 5,7)
Accordinging the classification of waste, Group A is considered chemical waste	1,5 (\pm 1,4)	6,7 (\pm 3,0)	91,9 (\pm 3,3)
The perforating, cutting, or scarring waste are considered a health hazard	1,1 (\pm 1,3)	98,5 (\pm 1,4)	0,4 (\pm 0,7)
White bags are used for the disposal of biological and infectious waste	10,4 (\pm 3,6)	27,4 (\pm 5,3)	62,2 (\pm 5,8)
The waste bins for biological and infectious waste must have a cover activated by a foot pedal	6,3 (\pm 2,9)	85,2 (\pm 4,2)	8,5 (\pm 3,3)
The hazard symbol for biological and infectious waste is a skull with an X	27,8 (\pm 5,3)	31,1 (\pm 5,5)	41,1 (\pm 5,9)
The acronym ANVISA is familiar to you	9,3 (\pm 3,5)	85,9 (\pm 4,1)	4,8 (\pm 2,6)
ANVISA and CONAMA are the agencies responsible for Technical Regulations for Medical Waste Management	3,0 (\pm 2,0)	33,0 (\pm 5,6)	64,1 (\pm 5,7)

The majority (98.5%) of the beginning level undergraduate students in biological and health sciences courses agreed that the perforating, cutting, and scarring wastes are considered a health hazard (Table 1). A large proportion of the students (43.3%), when question whether or not the cutting wastes should be placed in plastic bags, strongly disagreed with this affirmation, while 45.5% only disagreed (question 6, Figure 1). Of the total number of students, 75.5% (69.2% to 79.6%) declared that they did not have enough information to handle materials and cutting wastes generated in laboratory activities.

The origin of the information from the interviewed students as regards the knowledge on the theme of "Waste Management" and the questions concerning all of the information provided in the study are shown in Figure 2. Nearly half of the students (51.4% ± 6.0%) had not received information on how to discard waste generated in practical classes or in research laboratories. Moreover, 82.9% (78.4% to 87.4%) believe that they do not have sufficient information to handle substances and biological waste generated in laboratory activities.

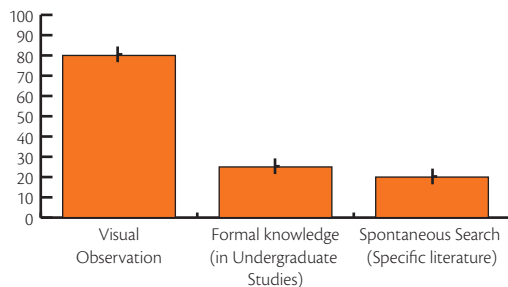


Figure 2 - Graph shows the proportion of basic level undergraduate students in the biological and health sciences courses (columns) and their respective 95% CI (black lines) as regards the origin of knowledge on the Waste Management of Groups A and E (ICB-UFGM, Belo Horizonte – Brazil, 2008).

The confusion students make regarding the identification symbols of biological and chemical wastes is shown in Table 1. In this same table, the majority of the students can recognize the acronym ANVISA and consider it familiar. However, nearly one third of the interviewed students did not know that ANVISA and CONAMA were the agencies responsible for the Technical Regulation of Medical Waste management. As regards the term Medical Waste Management, which is currently used in the field of health services to characterize the correct handling of waste, 51.8% (45.8 – 57.8%) of these same students did know the correct term used for this service.

DISCUSSION

Analyzing the results obtained through the questionnaires applied to undergraduate students, it could be observed that,

although half of the students did not know the term "Medical Waste Management," almost the same proportion knew that ICB/UFGM generates this type of waste. The percentage difference proved to be significant when treating the classification of biological waste, since the great majority (91.9%) did not know of the classification and were unable to affirm if these types of waste belonged to Group A, as defined by ANVISA in RDC 306/04³ and by CONAMA in Resolution 358/05.⁴ In a study with dentists, these professionals demonstrated difficulty in knowing how to properly separate infectious wastes, confusing the groups with sub-groups.⁷ These professionals also emphasized the relevance of the knowledge of the stages of separation and disposal of wastes for the continuation of an appropriate handling process.⁸ These findings suggest that further studies are warranted to determine the conditioning factors of such a fragmentation of knowledge.

Another important point to note was the students' inability to recognize hazard symbols for biological and infectious wastes and chemical hazards, factor which generates confusion among the symbols. This confusion may well stem from the construction of common sense linked to the hazard symbol, that is, a greater contact of these students with the symbol of a chemical hazard, thus leading to a generalization. It is important to note that this affirmation is essential to evaluating the separation and correct disposal of the wastes. These symbols were established in the 1970's by the US Center for Disease Control and have been adopted in other countries, including Brazil, through the Brazilian Association of Technical Norms.⁹ Of the 270 interviewed students, 139 reported not having received information on how to discard waste generated in practical classes or in research laboratories. The majority of the students reported not having sufficient information to deal with substances and biological wastes generated in laboratory activities and believe that they have not been properly prepared for this activity.

The majority of students agree that the waste bins for the biological and infectious wastes should have a cover activated by a foot pedal (Table 1), confirming this recommendation, even without having knowledge of the relevant Brazilian laws.

As regards the treatment of wastes consisting of microorganism cultures, a considerable percentage (61.4%) of the students agreed that they must be inactive before disposal. In addition, 95.5% agreed that "cultures and stocks of microorganisms, culture mediums, and waste from genetic manipulation are wastes that represent a health hazard."

Even though the students were able to recognize that biological wastes, such as cutting wastes, represent a health hazard, and are fairly certain that the cutting wastes should not be discarded in plastic bags, the same students were unable to identify the color of the bag used for the disposal of biological waste. Therefore, it is quite evident that the knowledge acquired from the practical activities is fragmented and disconnected.

In general, the results from the present study agree with those obtained with students from half of the Medicine and Nursing courses in a private institution from the state of Minas Gerais.¹⁰

The knowledge acquired in a fragmented manner regarding the disposal of cutting wastes should be interpreted with concern, given that other studies have shown that the handling and disposal of this class of materials represents the main factor in the occurrence of accidents with Medical School and Nursing students involving blood and body fluids.¹⁰⁻¹²

Regarding the bags specially made for the medical waste from Group E, findings from the present work are in agreement with other studies as regards the knowledge of Medical School and Nursing students on this type of waste.^{10,13} The proper disposal is characterized as that in which the cutting object is disposed of in a recipient that has hard walls and an inner protective lining. Although the proportion of students that agreed with the Brazilian law was high, the results of the present work reinforce the need to consolidate the knowledge of these students as regards the proper disposal in all situations generated by the medical waste from Group E.

The results from the works of Oliveira and Gonçalves,¹⁰ and Toledo Júnior *et al.*,¹¹ verified a lesser incidence of accidents among students in the Nursing course who studied a discipline of biosafety as compared to students from the Medical School who did not have a course on this same theme. Contrasting such results with those from the present study, it also becomes evident that there is a need for new research to verify the effects of this lack of knowledge concerning medical waste management in each target course.

Although 266 students could recognize the ANVISA acronym, only one third demonstrated that they had any knowledge of the role of ANVISA and CONAMA in the context of waste management. It was also clear that the undergraduate students observe and are interested in subjects that can contribute to their education, since the visual observation of the management of waste from laboratories and practical classrooms was the main factor for the students' search for knowledge on the issue. A large portion of the interviewed students admitted not being properly prepared to deal with biological substances and wastes, as well as the cutting materials and wastes that exist and that are generated in practical classes and laboratory activities at ICB/UFMG.

It is possible that flaws do exist in the education offered in undergraduate courses, in such a way that they do not favor the study on this theme and do not adequately invest in research with this focus. The solutions depend on a series of decisions made at different levels of the Brazilian educational system, such as professionals educated in a manner that is different from the norm in the majority of universities.⁸ Teaching techniques, such as the "learning based on and geared toward

problems" has been assessed in universities, given that the contribution toward a sustainable development is well-known. The educational models evolved to include real world problems and to give incentive to alternative solutions to these problems.¹⁴

One study carried out in Poland points to the need to better educate the people about solid waste management, as well as to promote the teaching of pro-environmental attitudes. This study also recommended that the environmental education should begin during the the professor' professional training, with emphasis on continuous enhancement. Moreover, the research also promotes the need for understanding on the part of those who formulate the educational policy, placing environmental education as an integral part of the school curricula.¹⁵ Analyzing the course work and content of the disciplines from the basic levels offered in the undergraduate courses (Biological Science, Physical Education, Nursing, Pharmacy, Physical Therapy, Medicine, Veterinary Medicine, Dentistry, Psychology, and Occupational Therapy)¹⁶⁻²⁴ at ICB-UFMG, in 2008, it could be observed that the courses of Nursing, Pharmacy, Physical Therapy, Phonology, Medicine, and Dentistry offer a discipline of microbiology that treats themes related to disinfection, sterilization, control of microbial infections, washing and anti-sepsis of one's hands, as well as relevant parameters in the control of infections. Nonetheless, only in the Pharmacy course, according to that observed in the course work, is there a more specific approach to environmental contaminants. No course offered the content or discipline under the name of "Waste Management".

Analyzing the o Biosafety in Laboratories course, offered by the Extension Center at ICB/UFMG and administered by the professors and technicians of the Institute itself, what could be observed was a course load of approximately two hours specifically focused on the content of "Waste Management". These courses may also offer approaches on the theme in various contents, such as: chemical safety, safety with radioisotopes, microbiological safety, the laboratory, and biosafety.

The education on biological safety in the laboratory, that is, knowledge of confinement, technologies, and practices employed to avoid the unintentional exposure of students to pathogenic agents and toxins, is essential for all students in the fields of biological and health sciences. This education must aid the student to comprehend the need to protect themselves from the materials and the fundamental logic of specific measures for biological protection. In addition, these must include a study of the norms and specific procedures pertinent to the institution. The education must also offer the knowledge of the role and responsibility of each individual with him/herself and with others. Ethics needs to be included within the essence of the role of education as a part of the practice of the educator and the act

of education.²⁵ Data show that the stages of external waste management identify incorrect concepts and confusion, mainly between the treatment and final destination, highlighting the need for training and courses in this area.²⁷

The appropriate management of biological hazards should guarantee a safe environment for work and study, with appropriate conditions for the students, making it possible for an advanced and reliable learning process, employing actions that minimize or eliminate the risks inherent within these activities, which can cause accidents, in turn compromising one's health.

CONCLUSION

The fragmented level of knowledge, acquired predominantly in an empirical manner, evidenced by the results from the present study, lead to the conclusion that the teaching-learning process regarding Medical Waste Management is carried out in an incomplete manner for basic level undergraduate students in the biological and health sciences courses at ICB/UFMG while studying at the institute. Such a flaw in the teaching-learning process needs to be corrected to reduce the exposure of these students to medical waste hazards. The solution for such problems depends on a series of decisions made at different levels of the educational system responsible for the education policy projects from different courses. Such findings agree with and aid in explaining results from prior studies in the scientific literature⁸. The results also point toward the need for new studies to identify similar flaws in other higher-education institutions. There is an evident need for a greater comprehension of the effects of these facts in research laboratories and other places that are home to undergraduate and incoming students in the biological and health sciences courses.

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