

Healthcare Waste Management And Biosafety: a Reflective Literature Review

Gerenciamento de Resíduos de Serviços de Saúde e Biossegurança: Uma Revisão Reflexiva da Literatura
Gestión de Residuos de Servicios de Salud y Bioseguridad: Una Revisión Reflexiva de la Literatura

RESUMO

Objetivo: Refletir sobre a relação entre gerenciamento de resíduos de serviços de saúde, biossegurança e educação permanente. **Método:** Revisão teórica reflexiva, qualitativa, fundamentada em literatura científica, legislações e documentos institucionais publicados entre 2020 e 2025. **Resultados:** Evidenciou-se que falhas no gerenciamento dos resíduos relacionam-se à insuficiência de capacitação, fragilidade institucional e distanciamento entre teoria e prática. A educação permanente favorece práticas seguras, consciência ambiental e fortalecimento da biossegurança nos serviços de saúde. **Conclusão:** A integração entre educação permanente, biossegurança e gerenciamento de resíduos constitui estratégia essencial para redução de riscos ocupacionais, promoção da sustentabilidade ambiental e qualificação da assistência em saúde.

DESCRIPTORES: Resíduos de serviços de saúde; Educação permanente; Enfermagem; Biossegurança; Saúde ambiental.

ABSTRACT

Objective: To reflect on the relationship between healthcare waste management, biosafety, and continuing education. **Method:** A reflective, qualitative literature review based on scientific literature, legislation, and institutional documents published between 2020 and 2025. **Results:** It was evident that failures in waste management are related to insufficient training, institutional weaknesses, and a disconnect between theory and practice. Continuing education promotes safe practices, environmental awareness, and the strengthening of biosafety in healthcare services. **Conclusion:** The integration of continuing education, biosafety, and waste management constitutes an essential strategy for reducing occupational risks, promoting environmental sustainability, and improving the quality of health care.

DESCRIPTORS: Healthcare waste; Continuing education; Nursing; Biosafety; Environmental health.

RESUMEN

Objetivo: Reflexionar sobre la relación entre la gestión de residuos de servicios de salud, la bioseguridad y la educación permanente. **Método:** Revisión teórica reflexiva, de enfoque cualitativo, fundamentada en literatura científica, legislación y documentos institucionales publicados entre 2020 y 2025. **Resultados:** Se evidenció que las deficiencias en la gestión de los residuos se relacionan con la insuficiencia de capacitación, la fragilidad institucional y el distanciamiento entre la teoría y la práctica. La educación permanente favorece prácticas seguras, la conciencia ambiental y el fortalecimiento de la bioseguridad en los servicios de salud. **Conclusión:** La integración entre la educación permanente, la bioseguridad y la gestión de residuos constituye una estrategia esencial para la reducción de los riesgos ocupacionales, la promoción de la sostenibilidad ambiental y el fortalecimiento de la calidad de la atención en salud.

DESCRIPTORES: Residuos de servicios de salud; Educación permanente; Enfermería; Bioseguridad; Salud ambiental.

RECEIVED: 06/27/2026 APPROVED: 07/31/2026

How to cite this article: Almeida VL, Sbampato CG, Fonseca JPS. Healthcare Waste Management And Biosafety: a Reflective Literature Review. Saúde Coletiva (Brazilian Edition) [Internet]. 2026 [cited year month day];18 (112):20758-20769. Available from: DOI: 10.36489/saudecoletiva.2026v18i112p20758-20769

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INTRODUCTION

Healthcare waste (HW) poses a significant challenge for healthcare systems and contemporary environmental management, particularly due to the biological, chemical, and sharps hazards associated with the improper handling of these materials^[2,4]. The complexity involved in the segregation, packaging, transportation, and final disposal of waste requires technical expertise, ethical responsibility, and environmental commitment on the part of professionals and students working in health care services^[2]. The generation of hospital waste represents a growing global challenge, with a direct impact on health care systems, environmental sustainability, and operational costs, varying across continents depending on the structural, economic, and organizational conditions of health care services^[5].

In the Brazilian context, regulations governing the management of hospital waste are primarily established by Collegiate Board Resolution (RDC) No. 222/2018 of the National Health Surveillance Agency (ANVISA), which sets forth guidelines for all stages of managing this waste^[2]. In addition, the National Solid Waste Policy reinforces principles related to sustainability, prevention, and shared responsibility, broadening the debate on the environmental impacts resulting from improper disposal practices^[1].

Despite regulatory advances, the literature shows that failures in waste management remain a frequent reality in Brazilian health care services. Among the main related factors are insufficient training, weak institutional oversight, structural deficiencies, and the disconnect between theoretical knowledge and practices carried out in clinical settings. According to Mekaro et al.^[6], structural limitations, insufficient training, and operational failures compromise the effectiveness of waste management in healthcare services.

In this context, continuing education in health emerges as a fundamental strategy for consolidating safe and sustainable practices. Unlike one-time training sessions, continuing education involves continuous learning processes integrated into the reality of the workplace, fostering critical reflection, the examination of practices, and the transformation of daily institutional routines.

Therefore, it is essential to discuss the relationship between biosafety, waste management, and continuing education as strategies to strengthen safe practices, reduce occupational risks, and promote environmental sustainability in healthcare services. Furthermore, the World Health Organization () emphasizes that improperly managed healthcare waste poses a significant risk to occupational, public, and environmental health^[4].

OBJECTIVE

To critically reflect on the importance of continuing education and the integration of theory and practice in the management of healthcare waste during technical nursing training.

METHOD

This is a reflective theoretical review, qualitative in nature and employing a theoretical-discursive approach, grounded in scientific literature, national legislation, and institutional documents related to healthcare waste management, biosafety, continuing health education, and technical nursing education. The reflective theoretical review is characterized by a critical and interpretive analysis of the available scientific literature, allowing for the discussion of concepts, practices, and challenges related to the subject under investigation, without the need for the rigid systematization protocols common to systematic reviews^[1,2].

The reflective analysis was based on a critical review of publications available in national and international scientific databases, as well as official documents from the Brazilian Health Surveillance Agency (ANVISA), the World Health Organization (WHO), and Brazilian legislation pertaining to waste management and public environmental health policies.

The search for articles and texts covered the Portuguese, English, and Spanish languages for the period from 2020 to 2025, corresponding

to the last five years. The Health Sciences Descriptors (DeCS) and Medical Subject Headings (MeSH) terms used were: “Healthcare waste management”; “Biosafety”; “Continuing health education”; “Nursing”; “Hospital waste”; and “Environmental sustainability.” These terms guided the search in the following databases: Medical Literature Analysis and Retrieval System Online (Medline), via PubMed; ScienceDirect; Scientific Electronic Library Online (SciELO); CINAHL; the Nursing Database (BDENF); and Google Scholar.

Materials such as abstracts published in conference proceedings, letters to the editor, and book chapters were excluded from the analysis; instead, full-text articles that met the proposed objectives were selected. After defining the eligible materials, the studies were thoroughly reviewed through careful reading to identify excerpts and content consistent with the theoretical assumptions relevant to the topic. The theoretical references consisted of national and international literature, given that the phenomenon under analysis has a global dimension. Thus, in order to organize and present the data analysis, four categories emerged to underpin the theoretical and reflective content of this study.

The discussion was organized into thematic areas related to the fundamentals of waste management, occupational risks, public policies, biosafety, and continuing health education.

RESULTS AND DISCUSSION

In this theoretical reflection, the findings derived from the evaluation of the selected articles encompassed the following themes: healthcare waste management, biosafety, occupational risks related to improper waste handling, continuing health education, technical training in nursing, theoretical-practical integration

in healthcare settings, environmental sustainability in healthcare services, and institutional strategies for promoting safe waste disposal practices.

Reflection on healthcare waste management reveals that the difficulties encountered in healthcare services are not limited to a lack of material resources or inadequate infrastructure. A large part of the challenges relates to the weakness of training processes and the insufficiency of continuing education initiatives.

Although Brazilian laws establish clear guidelines on healthcare waste management, it is observed that the effectiveness of these regulations depends directly on institutional commitment to the continuing education of professionals and students^[2,9]. Continuing education thus plays a strategic role in transforming everyday practices.

Healthcare professionals often replicate institutional practices that have already become normalized in healthcare settings. When inappropriate behaviors related to waste disposal become part of the routine, there is a greater likelihood of perpetuating unsafe behaviors and increasing occupational and environmental risks, including infectious, toxic, and occupational exposures^[13]. Recent studies demonstrate that exposure to healthcare waste can trigger infectious, toxic, mutagenic, and occupational risks, reinforcing the need for rigorous institutional management and biosafety strategies^[13].

Thus, the integration of theory and practice must go beyond a purely normative approach. The development of safe practices requires critical, participatory, and context-specific pedagogical methodologies capable of fostering ethical reflection, environmental awareness, and collective responsibility. The management of hospital waste involves interdependent organizational, educational, ethical, and environmental dimensions^[9].

Furthermore, proper waste management must be understood as a component of the quality of health care. Biosafety is not limited to the individual protection of workers, but also involves environmental protection, patient safety, and institutional sustainability.

The use of educational materials and teaching technologies focused on healthcare waste management can serve as an important tool to support learning. Educational initiatives related to waste management promote greater adherence to personal protective measures and occupational safety^[11].

In this context, continuing health education has the potential to promote significant institutional changes, fostering the reorganization of work processes, strengthening a culture of safety, and increasing environmental awareness in health care services.

Healthcare Waste Management and Associated Risks

Healthcare waste is classified as potentially hazardous material due to the presence of biological, chemical, and sharps agents capable of causing occupational, environmental, and public health hazards^[2]. The World Health Organization notes that a significant portion of the waste generated in healthcare settings requires specialized management due to its contaminating potential^[4]. Furthermore, improper management of this waste contributes to environmental contamination, the spread of infectious agents, and increased occupational risks^[4].

Inadequate segregation of this waste compromises all subsequent stages of management, increasing the risks of occupational accidents, contamination, and environmental impacts^[2,4]. Furthermore, improper disposal increases the risk of exposure for cleaning staff, healthcare pro-

professionals, students, and the general public.

The literature shows that many healthcare facilities still face challenges related to infrastructure, oversight, and professional training, which directly affect the effectiveness of management practices^[6,9]. Recent studies demonstrate that exposure to healthcare waste can pose infectious, toxic, mutagenic, and occupational risks, reinforcing the need for rigorous institutional management and biosafety strategies^[13].

This scenario demonstrates that compliance with technical standards depends not only on the existence of regulations but also on the adequate training of those involved in the care process.

Legal Framework and Institutional Responsibility

The Brazilian legal framework related to healthcare waste establishes institutional and individual responsibilities regarding the implementation of safe practices. RDC No. 222/2018 mandates the Healthcare Waste Management Plan (PGRSS), as well as the ongoing training of professionals involved in the generation and management of such waste^[2]. The aforementioned RDC No. 222 reinforces that proper waste management must involve institutional planning, ongoing training, and continuous monitoring of practices related to the PGRSS^[3].

The National Solid Waste Policy broadens this discussion by incorporating principles related to environmental sustainability and shared responsibility^[1]. However, it is observed that the existence of regulatory instruments, on their own, does not guarantee effective changes in institutional practices.

Structural inequalities persist among municipalities and healthcare institutions, especially in regions with lower investment in sanitation and infrastructure^[5]. This reality highlights

that waste management goes beyond the technical dimension, involving social, economic, political, and educational issues.

Biosafety and Professional Training

Biosafety is a central element in the management of healthcare waste, as it is directly related to accident prevention and the reduction of occupational risks^[2,4]. Among the most frequent incidents are accidents involving sharps and exposure to biological agents.

Healthcare professionals are frequently exposed to occupational risks related to the improper handling of waste, especially in settings characterized by insufficient training and institutional weaknesses^[6,9]. In the absence of ongoing educational initiatives and adequate supervision, unsafe practices tend to become normalized in daily clinical care.

Educational initiatives related to biosafety and the proper use of personal protective equipment are fundamental strategies for preventing accidents and strengthening safe practices in healthcare settings^[11].

In this context, risk perception becomes an essential aspect for the adoption of safe behaviors. The development of this perception depends not only on the transmission of technical standards but also on critical and y reflection on the ethical, environmental, and occupational consequences resulting from improper waste management^[9].

Biosafety must be understood as going beyond mere compliance with technical standards; it constitutes a strategic component of the quality of care and worker safety. In this sense, the critical training of professionals promotes the incorporation of safe practices and the creation of safer and more sustainable work environments^[17].

Continuing education and the

strengthening of safe practices

Continuing education in health care has transformative potential by proposing educational processes integrated into the daily work routine^[7,12,15]. Unlike one-off, top-down training sessions, this approach emphasizes the critical examination of reality, the collective construction of knowledge, and the active participation of individuals. Learning based on the concrete needs of health services promotes changes in work processes and improves the quality of care provided to the population^[16,18,19].

In health services, topics related to waste management are often addressed in a fragmented and decontextualized manner, hindering the effective incorporation of biosafety standards into institutional routines^[6,9].

Participatory pedagogical strategies, such as the use of educational materials, case studies, workshops, and reflective supervision during clinical rotations, foster a closer alignment between scientific knowledge and professional practice^[7]. Active methodologies, such as rotation through learning stations, have demonstrated significant pedagogical potential in teaching about healthcare waste, fostering greater critical engagement by students and bridging the gap between theory and practice^[8].

Furthermore, such strategies contribute to strengthening environmental awareness, biosafety, and ethical responsibility. Dantas et al.^[14] demonstrate that sustainable nursing practices contribute to reducing waste generation, promoting the rational use of materials, and strengthening socio-environmental responsibility in health care services.

Recent research shows that waste management is directly related to sustainable nursing care, the rational use of materials, and the quality of care provided^[10].

Review studies show that continu-

ing education in health contributes to the improvement of professional practices, the strengthening of teamwork, the enhancement of care quality, and the incorporation of sustainable institutional changes^[19]

The use of educational booklets and institutional guidance resources can promote a better understanding of waste management and strengthen adherence to safety standards^[3]. Such strategies enable a better understanding of waste management flows and increase adherence to safety standards.

The use of participatory pedagogical strategies fosters the construction of meaningful knowledge and the development of autonomy among students and workers. From this perspective, health education goes beyond the simple transmission of information, contributing to the formation of critical, reflective individuals committed to transforming social and environmental realities^[17,20]

CONCLUSION

This theoretical reflection highlights that the management of healthcare waste transcends the operational and regulatory dimensions, emerging as a strategic component of biosafety, quality of care, and environmental sustainability in healthcare services. Although Brazil has robust regulatory frameworks, such as RDC No. 222/2018 and the National Solid Waste Policy, the effectiveness of these regulations still faces significant obstacles related to structural weaknesses, insufficient institutional oversight, and, above all, inadequate or inconsistent training of professionals involved in waste management.

It was observed that the risks arising from the improper management of medical waste have a direct impact on occupational health, patient safety, public health, and environmental balance. Exposure to biolog-

ical, chemical, and sharps materials, combined with incorrect segregation and improper disposal, increases the incidence of workplace accidents, cross-contamination, and potentially persistent environmental damage. In this context, biosafety must be understood in a broader sense, not merely as a measure of individual protection, but as an institutional commitment to safe, ethical, and environmentally responsible practices.

Within the context of technical nursing education, there is a clear need to move beyond fragmented and overly prescriptive pedagogical approaches, which are often disconnected from the practical realities of clinical settings. The integration of theory and practice emerges as an essential element for strengthening risk awareness, professional responsibility, and the incorporation of safe practices into the daily routine of care. The critical and contextualized training of future professionals constitutes an indispensable strategy for breaking the cycle of inappropriate practices that have historically become normalized in health care services.

Continuing education in health has proven to be one of the main transformative mechanisms for improving practices related to waste management. Unlike one-off training sessions, continuous, participatory, and problem-based educational initiatives foster more consistent institutional changes, strengthen the culture of safety, and broaden collective environmental awareness. Pedagogical strategies such as workshops, reflective supervision, case studies, and educational technologies can contribute significantly to greater adherence to safe and sustainable practices.

Finally, it is concluded that strengthening the management of healthcare waste requires a shared commitment among educational institutions, managers, professionals,

and public policymakers. Investing in continuing education, adequate infrastructure, effective supervision, and an organizational culture focused on biosafety represents an essential path toward reducing occupational risks, promoting environmental sustainability, and improving the quality of healthcare. It is hoped that this reflection will contribute to broadening the debate and encouraging institutional practices that are more critical, responsible, and committed to safety and environmental preservation.

ACKNOWLEDGMENTS

We thank the educational institution for its constant encouragement of research and support for academic development.

FUNDING SOURCES

Self-funded by the research authors.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS' CONTRIBUTIONS

Research conception and design, manuscript drafting, critical review of the manuscript regarding important intellectual content: Almeida VL, Sbampato CG, Fonseca JPS.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

During the preparation of this manuscript, a generative artificial intelligence tool was used to assist with linguistic review, grammatical correction, and the refinement of the scientific writing in this manuscript.

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