

Designing a ward inventory for a sustainable healthcare. Framework for healthcare providers of configurations among disposable medical devices, clinical procedures, and medical equipment in the Neonatology department.

Abstract

During the pandemic emergency, the need for a critical review of the healthcare sector has been accentuated, particularly regarding the environmental impact caused by the use of single-use, non-recyclable, and non-biodegradable products. The aim of this doctoral research is to investigate and reconsider the flow of single-use products, mainly plastic, generated by local hospital units, with a focus on the Neonatology department. Currently, there are still few sustainable research and actions implemented in one of the departments that most produces single-use waste in the healthcare sector, where the use of single-use products has a significant impact on costs and the environment. The research path aims to conduct a thorough contextual analysis in the field, to review, understand, and analyze the dynamics within the "Salute Lazio" Regional Health System, specifically within the Neonatology departments of Umberto I Polyclinic in Rome. The industrial doctoral research goal is to generate, implement, and communicate new sustainable approaches for the management, reformulation, collection, and disposal of medical single-use items, with the aim of creating a zero-impact circular economy model. New sustainable approaches will be applied both in a corporate context, regarding the production, communication, and configuration of packaging and consumables, and in a healthcare context, such as Neonatology departments. This can be achieved through data collection, field surveys, and multidisciplinary tables on the use and end-of-life management of products, to share ideas and achievable challenges with department personnel. The methodology employed in the research encompasses systemic and circular design approaches, which aim to consider the interconnection between the various elements of a system and their relationships, to create sustainable and resilient solutions. The intermediate results of the research demonstrate how the development of user guidelines leads to better identification of single-use medical devices related to the use of electromedical equipment and clinical procedures and improved management and utilization of resources in the department. The research outputs serve as the starting point for subsequent department visits aimed at defining the criticalities within the entire care delivery system. This process will contribute to the development of design methodologies and greater attention to a practical sustainability model within the Neonatology department system.

Author keywords

Circular economy; sustainable healthcare; Systemic design; Neonatal care; single-use medical devices.

Introduction

The key term of the doctoral path is sustainable healthcare, an expression that refers to a care system aiming to ensure quality care access for all while optimizing the use of available resources, reducing waste, and valuing human resources. Although a universally accepted definition of sustainable healthcare has yet to be established, studies on the topic are united in pursuing solutions to make our healthcare systems more economically, socially, and environmentally sustainable (Jamieson et al., 2015). The present research, as part of the doctoral thesis entitled "Design for Sustainable Healthcare," aims to investigate which design methodologies to apply and which activities to perform for a life cycle analysis of disposable medical devices in the Neonatology department at the Umberto I Polyclinic in Rome. The study operates in new research scenarios for sustainable healthcare. The specific needs of the project

are represented by the requirement to review and remodel the environmental impact generated by the healthcare system throughout the life cycle of consumable medical products. In particular, the research questions driving the study are the following:

1. What disposable medical devices are used in the Neonatology department of the Umberto I Polyclinic in Rome and what procedures require the use of specific disposable devices?
2. What procedures, equipment and medical single-use devices are daily used within the various levels of healthcare in the mentioned structure?

Background

The expression "Sustainable Healthcare" is defined by the World Health Organization as a vision in which health systems can improve, maintain, or restore health, while minimizing negative impacts on the environment and leveraging opportunities to restore and enhance the environment for the benefit of current and future generations' health and well-being (WHO, 2017, p.9). In recent years, there has been an increasing interest in circular actions that can be implemented in health contexts, following the shift from a linear to a circular approach to resource consumption. Freire and Sangiorgi (2010), in their text "Service Design & healthcare innovation: from consumption to co-production and co-creation", state that the role of designers within the English healthcare system has changed, moving from the mere design of products to a role of facilitator of connections between stakeholders and provider of tools, methodologies, and strategies to evaluate and resolve the complex system's problems (Freire and Sangiorgi, 2010). Settimo & Viviano (2013) share a similar vision and state that sustainability concepts allow designers to undertake actions ranging from designing the product from the waste perspective already in the choice of materials, through information and personnel training, optimization of the management system, adoption of computer technologies, and actions that can lead to a reduction of medical waste flows and disposal costs (Settimo & Viviano, 2013). Several studies argue that a "green healthcare team" (comprising doctors, nurses, clinical staff, and environmental specialists) would be useful in promoting environmental sustainability in healthcare (Chenven & Copeland, 2013; Weiss et al., 2016). Therefore, the designer can represent a new key figure for project collaborations with the system's stakeholders to make healthcare sustainable, and multidisciplinary actions considering the entire system can generate environmental, social, and economic results in the short, medium, and long term.

To date, the literature reviewed shows a growing attention to the urgent need for sustainable healthcare, which is becoming a focal point in many departments with diverse procedures, products, and knowledge. However, there are still few sustainable research studies and actions that can be implemented in one of the departments that produces the most single-use waste: neonatology departments. The use of single-use products in neonatal care has a significant impact on costs and the environment (Newman, 2011; Nichols, 2013, 2014). Proper waste separation is crucial for neonatal care as failure to do so can compromise Neonatology departments, reducing staff's ability to effectively separate waste at the point of generation (Nichols, 2014). Proper waste separation prevents non-infectious waste from being disposed of through the more costly clinical waste stream, which can increase costs up to three times higher than necessary (Nichols et al., 2016). The field requires further investigation and interventions that can reduce waste costs and emissions and even lead to revenue generation through increased use of recycling (McGain, 2009; AOMRC, 2014). The lack of published material could indicate that this is a relatively unexplored area, and further research such as the doctoral pathway is needed to address this issue.

Methodology and Research phases

The research presented utilizes the Systemic Design methodology as its investigatory approach, adopting design tools to highlight needs that have emerged through a holistic diagnosis,

problem definition, levers for change, system design, theoretical studies of implementation outcomes, and finally, result and feedback analysis (Barbero S., 2016). The phases outlined for the research have allowed for the detailed examination of parameters and values related to consumables within a healthcare facility, generating results that are repeatable not only in other neonatal departments but also in other clinical areas that regularly use single-use medical devices. Greater attention was given to highlighting critical issues and concerns related to polymeric products and hazardous infectious waste during the various analysis phases.

The first phase of the doctoral research involved desk-based studies to allow for a preliminary analysis of the systems to be considered. This phase aimed to acquire knowledge and information regarding the existing regulations within the healthcare system, the registries that track the flow of waste produced, the policies adopted in separation, treatment, and final disposal of waste, as well as the roles of the various stakeholders who get in touch with such devices during their lifecycle within the healthcare facility. Subsequently, after the creation of a Guide for Analysis in the first phase of the research, the following phases focus mainly on the field research conducted for on-site observation, utilizing the analysis tools elaborated in the previous phase.

FIELD RESEARCH. The field research involves on-site analysis to acquire data regarding the lifecycle of single-use medical devices within the healthcare system of the neonatal departments of Polyclinic Umberto I. The research is broken down into sub-phases to allow for the achievement of intermediate research results.

- **Phase 1. Department visits**
By accessing the various department areas, the contexts of use for single-use medical devices were defined, related to the respective electromedical equipment and care assistance procedures present in the various levels of the neonatal department.
- **Phase 2. Medical Single-Use Device Inventory**
By considering parameters useful for classifying consumable items within the department, it was possible to compile an inventory of all single-use items based on the type of medical assistance provided and the electromedical equipment used for each type of item available in the department.
- **Phase 3. Summary Document Generation**
The table summarizing the items, activities, and tools necessary for medical care available, it was possible to generate a research output that had a dual utility, the first being a general overview that would be useful for those involved in planning subsequent phases of the research, and the second being the needs of healthcare providers working in the department by preparing medical procedures and medical equipment, finding precise instructions and guidelines in the document to follow in order to provide care with consumables suitable for the medical procedure or equipment [Fig.1].

INDUSTRIAL DOCTORAL RESEARCH PROJECT "DESIGN FOR SUSTAINABLE HEALTH CARE"

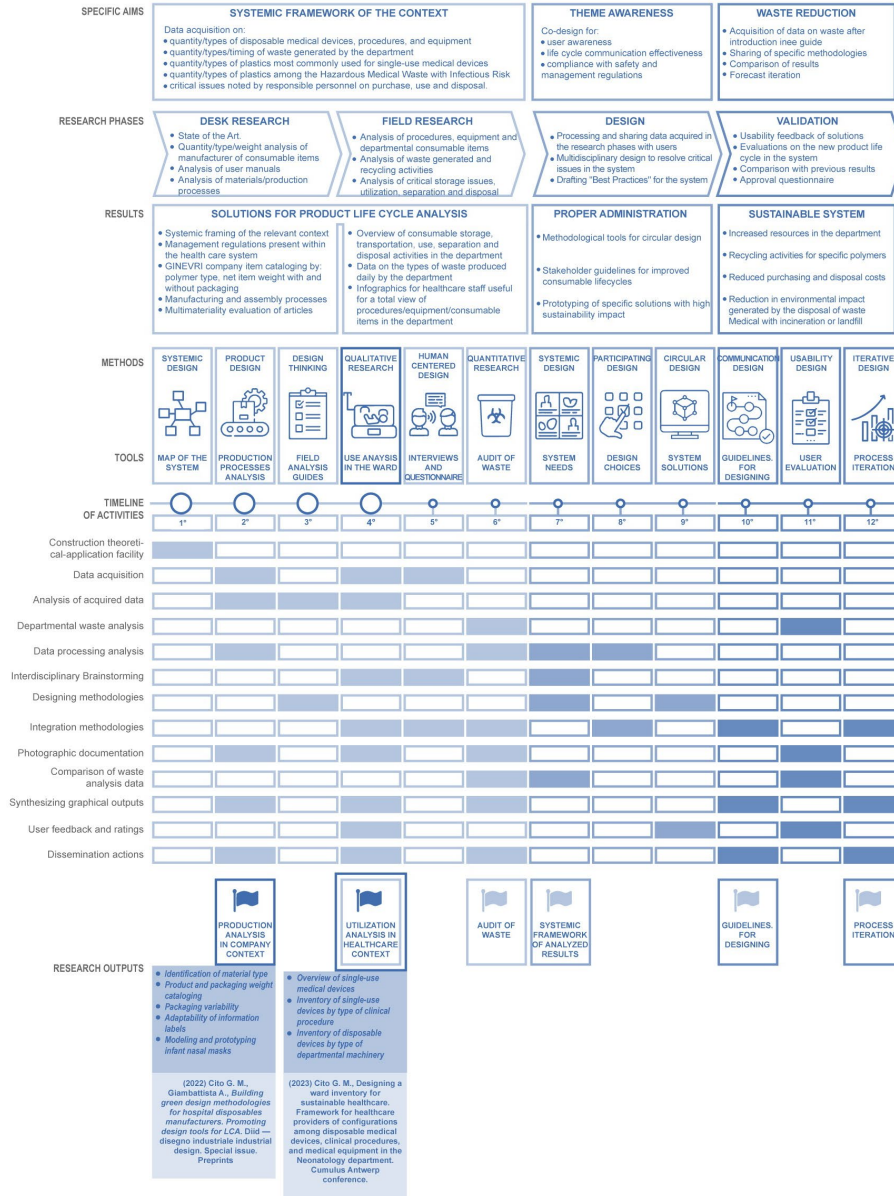


Figure 1. A summary of doctoral research pathway

Intermediate Results and Future Developments

The proposed research has defined conceivable scenarios within the system by using modeling techniques and analysis methods for each case of investigation. The research outputs aim to

answer the research questions, allowing for a more complete understanding of the structure of the life cycle of single use supplies throughout the entire system under consideration. After completing the field experimental research, an explanatory document was generated to provide end-users, in close contact with medical procedures and medical devices and equipment, with guidelines for a better understanding of which items are used for certain procedures, which items are used on specific electromedical equipment and medical devices, and what the needs of the users are in preparing and using this type of product. Following the highlighted phases, further steps will be taken to evaluate the system generated within the Neonatology department in its entirety. These activities will mainly involve:

- Department Analysis. Insight visits to different healthcare areas within the facility where single-use medical devices are stored, transported, separated after use, and stored before disposal. [Fig.2].
- Interviews and questionnaires. Multi-disciplinary interviews with healthcare personnel, with whom open discussions in round tables are conducted to identify waste management issues and debates and reflections on the results obtained in the previous phase.
- Audit. Review of the waste generated in the department over a 24-hour period, performing a quantitative acquisition on the weight of the bags, items, the type of material, and the quantity of identified items, along with a video documentation for each type of waste, unused open products, those not open but available on the workbench, as well as recycled and reused items.
- Data collection. Data processing and synthesis of research outputs, which will allow to highlight trends and issues in the life cycle of specific consumable items, future estimates of cost and supply reduction.



Figure 2. Observational study in Neonatology department of Umberto I Polyclinic in Rome where identify instant need of single-use devices and their relationship among electronical medical devices and procedures.

The next developments of research activities will include:

- **SYSTEMIC DESIGN:** This involves preparing a program that offers innovative and sustainable solutions for the facility. These solutions should be implementable in the short term and address the issues faced in the various areas where products are produced, used, and disposed of.
- **EVALUATION TESTS:** Once the identified solutions have been shared with stakeholders, it is important to obtain feedback from them and the involved users. This feedback will help in improving the proposed tools and evaluating possible process iterations. The sharing of methodologies and guidelines, including autonomous forms, should be done by the involved personnel.

Conclusion

The doctoral thesis journey, in line with the literature, systematically addresses various needs in the healthcare sector. Interdisciplinary collaboration among different professionals was necessary to generate a sustainable footprint in the healthcare context. This collaboration led to the identification of issues encountered in the life cycle of single-use medical devices for Neonatology, which were addressed through systemic design project methodologies to develop new strategies and practices. The journey will allow the Umberto I Polyclinic Hospital to re-evaluate advantageous possibilities of purchasing, storing, using, separating, and disposing of consumable items. These strategies will have a reduced impact on healthcare spending and the pollution generated by the processes involving the life cycle of consumable devices in the various contexts mentioned.

References

- Academy of Medical Royal Colleges (2014) Protecting resources, promoting value: a doctor's guide to cutting waste in clinical care. *Academy of Medical Royal Colleges*, London.
- Barbero, S. (2016) Opportunities and challenges in teaching Systemic Design. *6th International Forum of Design as a Process Systems & Design: Beyond Processes and Thinking*. Valencia.
- Barbero, S., & Pallaro, A. (2017) Systemic Design for Sustainable Healthcare, *The Design Journal*, 20:sup1, S2473-s2485, DOI: 1080/14606925.2017.1352762
- Chenven, L., & Copeland, D. (2013) Front-line worker engagement: greening health care, improving worker and patient health, and building better jobs. *New solutions: a journal of environmental and occupational health policy*, 23 (2), 327-345
- Freire, K. & Sangiorgi, D. (2010) Service Design & healthcare innovation: from consumption to co-production and co-creation. *Nordic Service Design Conference*.
- Jamieson, M. et al. (2015) Becoming environmentally sustainable in healthcare: An overview. *Australian Health Review*, 39(4), 417-424.
- McGain, F., Story, D., Hendel, S., (2009) An audit of intensive care unit recyclable waste. *Anaesthesia* 64, (12) 1299-302.
- Newman C, (2011) How to reduce medicines waste. *Clinical Pharmacist*. CP, 2011;():DOI:10.1211/PJ.2021.1.66385
- Nichols, A., (2013) Sustainable family centred care in the neonatal unit. *Journal of Neonatal Nursing*. 19, (5) 266-270.
- Nichols, A., (2014) The impact of the clinical environment on family centred care in the neonatal unit: A qualitative investigation. *Journal of Neonatal Nursing*. 20, (5) 230-235.

- Nichols, A., Grose, J., & Mukonoweshuro, R. (2016) Achieving cost and carbon savings in neonatal practice: A review of the literature on sustainable waste management. *Journal of Neonatal Nursing*, 22(2), 81–87. <https://doi.org/10.1016/j.jnn.2016.01.002>
- Settimo, G., & Viviano, G. (2013) I rifiuti sanitari: problematiche nella gestione e smaltimento – Rifiuti speciali. [Medical waste: issues in management and disposal - Special waste]. *Rivista Ambiente rischio comunicazione*. (6), 53-61.
- Weiss A, Hollandsworth HM, Alseidi A, Scovel L, French C, Derrick EL, Klaristenfeld D., (2016) Environmentalism in surgical practice. *Current Problem Surgery*. 2016 Apr;53(4):165-205. DOI: 10.1067/j.cpsurg.2016.02.001.
- World Health Organization. Regional Office for Europe. (2017) Environmentally sustainable health systems: a strategic document. *World Health Organization. Regional Office for Europe*. <https://apps.who.int/iris/handle/10665/340375>