

11. Design towards a more sustainable healthcare system

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SPECIAL SESSION

KEYWORDS: *design for a circular economy, design for sustainability, design for transition, patient safety*

SESSION AIM

The Dutch healthcare sector is responsible for 5-7% of the national ecological footprint. The daily average waste per patient generated at an intensive care unit in a Dutch hospital is seven full waste bags. To a large extent most supplies are disposables, even some high value products. There is an urgent need to develop (design) interventions to reduce the environmental impact of the healthcare system while keeping healthcare standards and patient safety in mind.

Recent design initiatives like the 'Green Operating Room' and the 'Circular Intensive Care Unit' started to map the environmental impact of the current healthcare system and to identify opportunities to

transition healthcare towards a more sustainable future. For this, multiple perspectives insights of the current healthcare systems are needed to understand the reason why for example so much disposables are being used: From a human perspective (staff and patient), patient safety (protocols), infrastructure (within hospitals), procurement (suppliers) and more. These insights in combination with emerging technologies (for examples new ways of reprocessing) and design thinking will lead to new sustainable product-service systems. An interdisciplinary approach is essential in this transition to overcome barriers in the healthcare system and between disciplines.

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11.1 Going green: Waste collection and analyses in pediatric intensive care

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KEYWORDS: *pediatric intensive care, waste collection, sustainability*

BACKGROUND AND AIM

The Dutch health care system is responsible for 7% of the national CO₂ footprint, and has agreed to achieve climate goals as defined by the United Nations and by the “Green Deal” for the healthcare sector. Insight in waste production (amount) and composition (type) is essential to move towards a more circular PICU. The aim of this project was to analyze the waste produced during four days in our PICU.

METHODS

The tertiary PICU is a 28 bed ICU in four units, divided in (1) short stay, (2) cardiothoracic care, (3) general PICU and (4) long stay. Waste was collected for four days and the trash bags were counted. Per day, waste from one of the units was separated by hand and categorized and weighted.

RESULTS

The total amount of waste was 26,9kg/day, with a significant difference between the four units (0.6 - 7.2 bags/patient/day). The amount of waste per category was similar between units, with a high percentage of food products, protective clothing and medical product packaging. Fluid containing bottles such as formula were responsible for a large part of the food products. Six percent of the waste consisted of unused items.

CONCLUSIONS

The amount of waste in our tertiary multidisciplinary PICU was large, differed between type of patients

and was lower in short-stay patients. This small study can be used as a hotspot analysis to help gain awareness in our unit, reduce waste, and increase recycling in short term practical changes.

11.2 Towards greener ICUs: Redesigning the use of disposable gloves

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KEYWORDS: *design for sustainability, gloves, user-centred, medesign, infection prevention, intensive care unit*

Full paper will be available in the [HEPS2022 Conference Proceedings](#)

ABSTRACT

A large volume of medical supplies is used in the Intensive Care Unit (ICU) to provide high-quality care for critically ill patients. The production, use and disposal of these supplies contribute to the environmental impact created by the ICU. One of these medical supplies are the disposable gloves. In the ICU around 108 gloves are used per patient per day; to protect the user (and healthcare staff) from infections. The high frequency of use and the resource-intensive production define disposable nitrile gloves as one of the 'hotspots' contributing to the environmental impact created by the ICU. At the start of this research it was unknown how these gloves were used or if they were actually used at all before ending up in the waste.

This research and design project addressed the problem from three different perspectives: usercentred, product-centred, and supply-centred. The users of the gloves were observed during their work to identify the problems that occur. The product was analyzed by trying to take out the gloves one by one out of the cardboard box. Due to poor design and packaging, the gloves are difficult to dispense one by one. By analyzing the waste of the children's ICU, it became clear that around 6% of the gloves end up in the waste unused.

The extensive research resulted in three design directions on how to reduce the environmental impact of gloves. Subsequently, all insights from the research were brought together into 5 design

building blocks. These design building blocks provided guidance for the design phase of the project.

The project resulted in a redesign of the current glove dispensers. The final design is named 'GloVe', a vertical dispense system. By incorporating the five building blocks, the design can provide benefits for multiple stakeholders within the healthcare system. It reduces the environmental impact of gloves in the ICU by dispensing one glove at a time. Furthermore, the gloves are dispensed at the cuff, which comes in little contact with the patient. The vertical movement is pleasant to the user. The use of colour for different sizes makes it clear to the care assistant which box should go in which holder. Also, nurses will see at a glance which size gloves they are dispensing. The small V-shaped opening makes the undesirable behaviour, of placing gloves back, almost impossible.

The design thinking approach has yielded a design, insights, and recommendations for subsequent projects. Furthermore, the project has drawn a lot of attention in the media to making healthcare more sustainable. The project has been a necessary start towards more sustainable ICUs.

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11.3 Reducing the environmental impact of syringes at the Intensive Care Unit

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KEYWORDS: *circular healthcare, syringe,
environmental impact, design*

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ABSTRACT

This research project, part of the Green Intensive Care Unit (ICU) initiative at the Erasmus University Medical Center (EMC), is focused on reducing the environmental impact of syringes at the ICU by designing solutions based on circular economy principles. Based on a Material Flow Analysis of the EMC ICU, syringes and their packaging have been identified as one of the main environmental impact hotspots. Therefore, this project aimed to redesign the syringes, their packaging, and their use, according to circular design strategies suitable for medical products to decrease their environmental impact, while remaining convenient and safe in use for the healthcare staff and patients. Research was executed to understand the context from multiple perspectives. The outcomes demonstrated that decreasing the impact of syringes is not only related to the design of the syringe itself. Manufacturing, preparation, use and disposal, all contribute to the environmental impact of the syringe. Various possible interventions were derived to reduce its impact:

1. Adapting the infection prevention protocol and behaviour of the staff;
2. Separating infectious waste from general hospital waste;
3. Redesigning the syringe itself;
4. Optimising the filling process of syringes.

The final design is an optimised filling process

for prefilled sterilised syringes (PFSs), based on circular strategies such as reduce, reuse, rethink and repurpose. Interventions include: eliminating a redundant sterilisation phase, reducing residual medication and changing from steam to gamma sterilisation. This resulted in decreasing the amount of waste, material, energy and water consumption, while offering similar convenience and safety for the staff and patients of the ICU.

11.4 Towards circular ICUs: Circular intubations as a catalyser for systemic change

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KEYWORDS: *circular healthcare, systemic design, intensive care unit, intubation*

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ABSTRACT

This project aims to reduce the environmental impact of the Intensive Care Unit (ICU) of the Erasmus Medical Center (EMC).

Systemic design research was executed to map the current waste flow created by the ICU. Literature review, interviews and observations were performed to gather information about the healthcare protocols, hospital procurement process, intubation practices and used devices and consumables. This resulted in a set of challenges which were used to ideate from different perspectives to improve the sustainability of the ICU.

A set of opportunities to introduce circularity within the ICU were defined. These opportunities ranged from waste separation to the reduction of the disposal of unused products. The selected circular opportunity was intubation, needed when patients cannot breathe by themselves. For this, a video laryngoscope, which is composed of various plastics, a video camera, and a led light, is used for only a few minutes and disposed of (and incinerated) directly afterwards. The aim of the second part of this research project was: Can we design a circular intubation procedure as a catalyzer for systemic change towards circular ICUs?

One of the proposed circular strategies for the video laryngoscope is the reprocessing of intubation devices used at the ICU itself. A

transition model toward reprocessing using UV-C radiation technique was further developed. Compared to current reprocessing procedures, UV-C disinfection consumes no water and less electricity and offers the possibility of decentralized reprocessing within the ICU department itself. This project aims to provoke conversations between the hospital, manufacturers and other stakeholders about how the healthcare sector could start reprocessing valuable medical devices towards a circular ICU.

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