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Sustainable Medical Devices:
A Video Laryngoscope Case Study

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ABSTRACT

The requirement for innovative solutions to meet sustainability needs is clear and urgent. Medical devices are an appropriate target as healthcare has been estimated to contribute up to 4.4% of global emissions. The author presents a case study seeking a credible sustainability benefit for a novel medical device. Materials of construction, renewable sources, and end fate are discussed. To move towards circularity, closed loop recycling of single use medical devices is demonstrated, and factors around further scale up discussed.

KEYWORDS

Medical Devices, Sustainable Materials, Bio-Based Materials, Polypropylene, Video Laryngoscope

INTRODUCTION

The protect video laryngoscope (VL) was recently launched as a novel and innovative medical device, developed with sustainability as a defining principle. As detailed below, the Protect VL was engineered for extensive reusability, with single-use components intentionally designed to be lightweight and composed of a single material offering high recycling potential, where recycling infrastructure exists.

The need for innovative, sustainability-oriented medical solutions is both critical and time-sensitive. Medical devices represent a significant target area, as healthcare contributes up to 4.4% of global greenhouse gas emissions (Karliner et al., 2020). The UK National Health Service (NHS) has already initiated its transition toward achieving "net zero" emissions by 2045. In 2022, the NHS reported that approximately 10% of its total emissions stemmed from medical equipment, including various types of devices (National Health Service England, 2022).

To address these challenges, recent reviews have examined the potential for sustainable medical devices (Montesinos et al., 2024) and emphasized the opportunity for device design and polymer innovation to make a positive contribution (Vienken & Boccato, 2024). The World Health Organization (2020) has also issued guidance on sustainable healthcare delivery, recognizing that substantial emissions originate from the healthcare supply chain through the production, transport, and disposal of goods and services, including medical devices. These findings underscore the need to assess the complete "cradle-to-grave" lifecycle and acknowledge that current initiatives primarily concentrate on the early stages—design, development, manufacture, and use—while insufficiently addressing disposal and end-of-life management.

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METHOD

This paper serves as a case study demonstrating how sustainability can be integrated into the development of novel medical devices. This seemingly simple objective was the clear focus at the project's inception; however, the work also reveals the complexity of achieving that goal and the practical limitations of what is currently possible. The initial stage involved defining the overall product concept, guided by user requirements and emphasizing substantial reusability to minimize waste streams. For device components that remained single-use, a comparative analysis of construction materials was undertaken, prioritizing low bulk density to reduce material weight for a fixed shape and volume, adequate mechanical strength, and suitability for cost-effective injection moulding. The analysis also considered the relative global warming potential (GWP) of the candidate materials. Finally, to establish proof of concept for circularity in medical device utilization, efforts were made to recover devices after clinical use and demonstrate successful reprocessing and remanufacturing.

RESULTS

We have outlined our goal to develop a more sustainable medical device and presented a situational analysis supporting the selected construction materials (see Discussion section). Our findings indicate that transitioning to polypropylene (PP) as the primary material could reduce GWP by up to 73% compared to polycarbonate (PC) or acrylonitrile butadiene styrene (ABS) polymers commonly used in VL. Ultimately, PP partially derived from renewable, plant-based sources was selected, with its sustainable content quantified using a "mass balance" approach. The novel device is currently in clinical use, and sustainability benefits are consistently highlighted in written feedback from clinicians. We successfully demonstrated the recovery, reprocessing, and recycling of single-use devices from clinical settings into new products, providing strong proof of concept for circularity within healthcare.

DISCUSSION

Laryngoscopes enable visualization of the vocal cords and glottis (larynx), typically during intubation—the insertion of an endotracheal tube—to support respiration during general anesthesia or resuscitation. These handheld, L-shaped medical devices consist of a vertical handle and a horizontal blade that is inserted into the oral cavity. Various techniques exist to visualize the larynx, but a "lifting" force is often required. Consequently, laryngoscopes must be robust and manufactured from suitable materials. A minimum applied breaking force of more than 150 N is specified by the relevant consensus standards (ISO 7376, 2020).

Historically, direct laryngoscopes (DLs), typically constructed of metal and incorporating a battery-powered light source, were commonly used. Anatomical visualization is limited to the operator's direct line of sight. Due to cost pressures and infection control concerns, such traditional laryngoscopes have increasingly been replaced by low-cost, single-use versions. However, their mixed materials—including embedded battery components—make disposal problematic. Their complex, integrated structure renders recovery and recycling uneconomical, while decontamination after use poses additional challenges. Consequently, incineration is the likely end-of-life outcome in the UK, incurring both weight-based and metal disposal costs and failing to meet sustainability objectives.

In contrast to DLs, VLs incorporate a camera and video display to provide an enhanced view of the larynx. National guidance identifies VL use as clinical best practice in the UK (Lewis et al., 2022; NICE, 2018). Compared with DLs, VLs offer several advantages, including a reduced incidence of failed intubation, lower risk of soft tissue trauma (Lewis et al., 2022), and decreased likelihood of esophageal intubation—a rare but potentially fatal misplacement of the endotracheal tube (Chrimes et al., 2022).