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How circular economy technology contributes to sustainable instrument management

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Background:

In 2018, the Netherlands exported 6.847 thousand tonnes of recyclable metal waste only.[1]
Most of the discarded instrumentation and device waste contains valuable materials that can be reused on a components or materials level. Within our research initiatives we try to reduce instrumentation waste by creating new local recycling methods and by developing a new modular design approach for sustainable instruments.

Methods:

In the past 24 months we investigated the feasibility of recycling stainless steel waste material from multiple Dutch hospitals by analyzing the waste composition and by calculation of the percentage of Stainless steel that could be recovered and turned in to new medical devices. New modular instruments were developed for advanced endoscopic surgery and investigated for sustainability in terms of cost reduction versus (dis)assembly effort.

Results:

More than one ton of rejected instruments were collected from four different hospitals during a period of six months. One container of 100 Kg with disposable and contaminated instruments was collected and, after disinfection in a thermo washing machine, melted and recycled to new raw sheet material. This raw material was used on a water jet cutting machine to make new components for surgical instrument mesh baskets. Some instruments needed to be separated on material specification. 95% of the waste consisted stainless steel that was completely recyclable.[2] Meaning that the stainless steel waste was offered for recycling which resulted in 100% reprocessing of this material into metal sheet by means of melting. The metal sheet was used to make new medical components i.e. for instrument fixation and stainless steel mesh baskets. The remaining 5% consisted of plastic wrappings and protective caps, valves and aluminum labels/ tags. From the 1380 Kg, 50 Kg consisted of disposable stainless steel instruments. The cleaning and handling costs of disposable stainless steel instruments was calculated at 50 cents per Kg waste. 1230 Kg was found to be surplus stainless steel instruments and surplus mesh baskets.
The data from our experiments conducted with a new 5 mm fully modular multi steerable laparoscopic instrument indicates that ten students were able to fully assemble the instrument shaft in 65 (SD43) seconds and disassemble it in 12 (SD 7) seconds during 60 trials.

Discussion:
The results of the circular program demonstrate that circular reprocessing of surgical instruments and stainless steel waste into new raw material can be used for the manufacturing of new medical products. The new modular multi steerable laparoscopic instrument assemble experiments show that this type of instruments can be reprocessed for 60 times. Compared with a similar Davinci Si robotic grasper, this instrument can be used 6 times longer before some components need replacement potentially reducing the costs related to instrument up to 83% in case of a comparable cost prize.

Conclusion:
The outcome indicates that circular models for reprocessing of surgical waste, tracking of instruments during surgery and development of modular advanced endoscopic instruments are feasible in terms of waste and cost reduction. Collecting and recycling of stainless steel waste is economically feasible. The multi-DOF (degree-of-freedom) cableless grasper can be (dis)disassembled for cleaning and sterilization within an acceptable time frame.

References:
1. Central Bureau of Statistics (CBS), Ministry of Infrastructure and Water Management, waste figures at national level, 2019 - https://www.cbs.nl/nl-nl/maatwerk/2019/11/export-van-afval -

2. Circularity as a new approach for sustainable instruments. “How a circular approach will provide cost benefits and sustainable benefits” Submitted for WFHSS 2019 - dual oral presentation; Tim Horeman & Bart van Straten