SCIENCE FOR ENVIRONMENT POLICY

Plastic hospital waste can be recycled into new medical devices

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Each year, hospitals in the Netherlands generate about 1.3 million kilograms of plastic waste from polypropylene wrapping paper on surgical instruments. Researchers have suggested that this waste could be turned into new medical devices. They recovered surgical wrapping paper from the operating theatre at a hospital in Rotterdam, the Netherlands. The waste was melted into solid blocks, granulated and injection moulded into new medical products.

There is growing interest in reducing and recycling medical waste. Furthermore, there is an increased awareness of the need for sustainability in health care. Circular reprocessing also helps to relieve the supply chain as resources are under increasing pressure. Medical products are scarce (for example, when demand for face masks surged during the COVID-19 pandemic).

Recycling may also offer financial gains for hospitals – for example, by saving on the costs of medical waste disposal – while addressing public concern over these increasing costs.

The operating theatre is a major contributor to hospital waste[1], and previous work has raised the possibility of recycling the blue and green polypropylene wrapping used to pack surgical instrument trays after sterilisation. The researchers behind a new Netherlands-based study and field laboratory set out to test the practicality of this idea. In particular, they wanted to find out if this waste could be used, without additives, for injection-moulded products. They based their research on a limited study of one hospital in Rotterdam, the Netherlands.

Over a three-day period, the researchers collected 8.16 kg of discarded wrapping[2] from Maasstad Hospital, via a sterilisation facility. They melted the plastic, producing bars that could then be turned into granules, ready for injection moulding.

European Commission

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Plastic hospital waste can be recycled into new medical devices (continued)

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The researchers found little difference in mechanical properties between granules produced at melting temperatures of 200, 250 and 300 °C. Test items were, therefore, produced from initial melting at 250 °C, followed by injection moulding at 200 °C.

Items were produced with 100% recycled polypropylene, 100% virgin material and mixtures including different ratios of both (25%, 50% and 75% recycled), in order to test their relative properties. 'Dog bones' were produced for strength testing, as well as instrument openers – cross-shaped devices used to keep hinged operating instruments (such as bone cutters) open during washing and disinfection in a decontamination machine.

The ratio of recycled to virgin material had a strong influence on the material properties. Products of 100% recycled polypropylene were stiffer, harder and more brittle than those made from pure virgin material. Dog bones from 100% recycled granulate were approximately 6% weaker – in terms of the strain they could take before breaking – than 100% virgin, for example, while mixed bones had intermediate strength.

Hardness – which increased with the amount of recycled material – could be advantageous for devices used to support heavy and sharp instruments during sterilisation, particularly when a high flow of water is used. In addition, following ten disinfection cycles, at 90 °C, the strength of virgin and 50% recycled bones even increased slightly (by up to 2%), though there was little change for 100% recycled bones.

In addition, 25 instrument openers made from 50% recycled blue-wrap material were used in the hospital's sterilisation facility for four weeks – and proved to be both effective and resistant to degradation. After a month the openers had some surface scratches, but otherwise had not deteriorated. The instrument openers have been validated by the EU's Medical Device Regulation[3], including a validation using recycled materials. The openers have CE approval – meaning that they are ready for entry in the European market.

The study shows that it is feasible to recycle hospital polypropylene wrapping waste into high-quality raw material for injection moulding of new medical devices. Some 8.3 million instrument openers, as used in this experiment, could be manufactured from one years' waste wrapping collected from the Netherlands' hospitals, say the researchers. There is also scope for developing other medical products using recycled plastic, such as trays, accessories, labels, nozzles, tubes and containers. Further life cycle analysis could be conducted to calculate the environmental impacts and benefits of such recycling.

1. Approximately 30% of all hospital waste is plastic, 30% is cardboard and paper (see: Lee, B., Ellenbecker, M., Moure-Eraso, R. (2002) Analyses of the recycling potential of medical plastic wastes. *Waste Manag.* 22: 461–470), and about 20% comes from operating theatres.

2. This type of surgical waste is categorised as medical waste and is subject to legislation for hazardous and medical waste when transported and processed.

3. Under the EU's Medical Device Regulation every medical product needs to undergo CE (*Conformitè Europëenne*) approval. Testing is mandatory, and material specifications must be demonstrated in technical files. This includes toxicity testing of the material, which may exclude the toxicity of potential pollutants and unknown substances during recycling, demonstrating that products made out of waste can be safely used in hospitals.