Recycling Pilot for Nonhazardous Medical Plastic Waste

COLLABORATION PARTNERS

Lehigh Valley Health Network
B. Braun Medical Inc.
PureCycle Technologies, LLC
Enabled by a grant from the Pennsylvania Department of Human Services

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Executive Summary

The medical plastic waste recycling pilot brought together B. Braun Medical Inc. (a medical device manufacturer of smart-infusion therapy and related products), Lehigh Valley Health Network (a nationally ranked premier health system based in Allentown, Pa.) and PureCycle Technologies LLC (an advanced recycler of plastic) to evaluate and evolve the concept of health care medical plastic recycling. PureCycle Technologies focuses on the recovery and recycling of polypropylene (PP), the targeted material for this pilot. Also engaged in this pilot were Cougle's Recycling, Inc. of Hamburg, Pa., a material recovery facility (MRF) in the Lehigh Valley region of eastern Pennsylvania, and Kurt Duska Consulting of Girard, Pa., a plastics recycling industry expert and primary author of this report. The goal of the pilot was to identify barriers to increasing nonhazardous medical plastic recycling rates at health care providers by instituting a collection and processing program aligned with the quality requirements of an advanced plastics recycler in the region. This effort was enabled by a grant from Pennsylvania's Department of Human Services.

Over an eight-month period from April to December 2023, an estimated 18,000 pounds of materials – ranging from blue sterile wrap to PP-based IV bags – were collected at the designated hospital. The materials were then collated at the MRF and shipped to the recycler for processing. The recycler's target material requirements were met. The pilot was successful in achieving the objective to further understand what needs to be true for nonhazardous medical plastic waste to be recycled. The pilot identified challenges which centered on costs to collect and transport, physical space availability in the hospital, and hospital employee training.

The challenges to recycle nonhazardous medical plastics will not be resolved by any one part of the chain but require all stakeholders to be involved, including government. Best practices from product and packaging design, logistics and recycling infrastructure must be identified and consolidated to allow for improved recycling rates and decreased environmental impact. Financial transformations to address the increased costs associated with a recycling program must also be achieved to enable a circular economy for medical plastics.

Objective

The objective of the medical plastic waste recycling pilot is to identify barriers to increasing nonhazardous medical plastic recycling rates at health care providers. This must take into consideration the impact on health care services, safety to employees, cost and total environmental impact. According to the Healthcare Plastics Recycling Council (HPRC), U.S. hospitals generate about 28 million pounds of waste a day, with 20-25 percent of that plastic products and packaging. Only a small percentage of these plastics are recycled today. Plastic recycling at hospitals is less than 10 percent, which fills landfills, wastes natural resources and increases carbon emissions.

For the purposes of this document, the terms medical and health care will be used interchangeably when referring to plastics.

Methodology/Process

1 **Planning/Team Definition:** Determine which organizations and individuals need to be engaged to identify and resolve the problem. The scope of a recycling program must be defined by capabilities of shareholders, including hospitals, logistics and recyclers. Limitations and methods must be considered before starting a program. All parties must agree to the plan and understand the full process from collection to recycling.

2 **Targeting Materials:** The first step in developing a recycling trial is to analyze the material stream to understand opportunities and obstacles with specific families of products and/or packaging. Once the analysis is completed, the collection program can be defined for the highest potential success. This will include resin type, product type, product density, safety concerns and waste regulations. It is preferred to start with a limited collection-scope and add to the stream after review.

3 **Collection:** The most challenging part of hospital recycling is the development of the collection program. Hospitals are typically space restricted and not designed for easy transport of recycled products to storage and consolidation areas. Review of best collection points, container design and handling methods was the first consideration. Storage locations within the hospital needed to be identified and marked to hold sufficient material collected between collections from the transportation partner.

4 **Logistics:** Cost and the true environmental impact are influenced by transportation efficiency to a recycling facility. It is critical to increase the bulk density of the recycled product and to find creative methods for collection. Existing waste/recycling infrastructure should be analyzed for specific opportunities such as paperboard and corrugate collection (baling/compactors), standard plastic recycling collection (e.g., from food service operations), existing sharps and biohazard collection, laundry services and other backhaul opportunities.

5 **Recycling:** It is critical to look at multiple recycling methods and the associated restrictions to best define the recycling process for the targeted materials. Broad-reach programs will have significantly different recycling needs than narrow-focused collection. Once the targeted materials are defined, it is necessary to understand the impact on the recycling process. Sorting cost, contamination, product density and other factors will impact efficiency, quality and costs.

6 **Recycled Material Best Use/Value:** It is possible to recycle any material, but it doesn't mean it should be. Environmental impact and cost must be considered as part of the analysis. It is also necessary to create demand for recycled material by seeking products and/or packaging that utilize recycled plastics. This requires significant volume of consistent quality material at a competitive price.

7 **Training:** Once the items are targeted and collection is defined, it is necessary to create a circular training program that interacts with all aspects of the system. Recycling programs must include continual feedback to identify issues and allow for modification of the methods/items. Programs should start with a limited scope of products that are easy to identify for training education and literature. Reviews of collected items must be shared with the group to verify success or to correct issues.

Advanced Recycling Pilot

Repurposing plastics and avoiding the landfill

Materials must be collected with the blue wrap

Acceptable materials: lightweight plastics, plastic packaging, plastic bottles, not visibly contaminated PPE

IV bags (including plastic packaging) and tubing

Blue wrap

Lightweight plastic bags/packaging

Plastic and Tyvek peel packs

Plastic bottles (saline, sanitizing wipes, etc.)

Slider tubes

Not visibly contaminated PPE (masks, hair/shoe coverings)

Collection Logistics

- Preoperative areas identified for collection of noncontaminated medical plastics
- A total of 23 bins placed in these areas, one per suite, with bags collected after each medical case
- Average of 50 cases per day in total across the 23 operating suites
- Bags collected from operating suites collated in a central room adjacent to the suites using a cube truck
- Cube truck transported to loading dock area where bags transferred to gaylord boxes
- Gaylord boxes collected 2-3 times per week for transport to Cougle's Recycling, where bags were condensed and baled

Collection bins at LVHN. Rubbermaid model FG395800BEIG. Labels designed and printed by B. Braun.

Filled bags to be transported to dock. Grainger cube truck model 36FL03. 45 gallon, 1.2 mil translucent blue bags, model 31DL08.

Storage container (gaylord box) for bags used at LVHN loading dock and for analyses sortation.

Bailed bags ~ 1,100 pounds each.

Material Analysis Process

- Representative bales shipped to PureCycle's Ironton, Ohio, facility
- Selected random, visually typical bale for sortation
- Used gaylord pallet-sized containers to sort materials
- Selected 100 bags for in-depth sorting and evaluation
- PPE including safety glasses, long-sleeve protection and puncture-proof gloves was utilized

Bales were de-wired and bags were pulled apart. Once bales were separated, 100 representative bags were analyzed for acceptable and nontargeted items.

This was a manual sortation which required opening the bags and pulling apart packaging and products.

Rigid and flexible polypropylene materials were observed in the bags. Irrigation bottles and IV bags shown here were made from PP.

Material Analysis

Target material: Polypropylene (PP)

	Gaylord 1	Gaylord 2	Gaylord 3	Gaylord 4	Total
Contents	Blue wrap	Blue wrap	Contaminated bags	100 representative bags	
Weight*	280 lbs.	175 lbs.	180 lbs.	390 lbs.	1,025 lbs.
PP Weight Estimate	266 lbs.	166 lbs.	108 lbs.	234 lbs.	774 lbs.

**Bulk ctr and pallet tare weight = 25 lbs. Figures above reflect net weights. Measurements via fork-truck load cell.*

Total bale weight – 1,025 lbs.

Average bag weight – 4 lbs.

Estimated PP in total bale ~ 75 percent on average (met PureCycle Technologies' minimum standard)

Estimated PP per bag can range from 60 percent to 95 percent (including the bag resulting largely from nonplastics being present)

Estimated bags per bale – 250

Material Observations

- A total of approximately 18,000 pounds of materials were collected.
- Bags that were collected with a high concentration of blue wrap were much cleaner, with a higher percentage of target materials and a lower percentage of nontarget waste items. Bag quality was likely impacted by collection area and medical procedures.
- A high percentage of nontarget materials in mixed bags required increased transportation, sorting costs and potential disposal fees.
- Paper fiber materials such as corrugated and paperboard were often included in bags, which drastically influenced costs and efficiency.
- The program met PureCycle Technologies' minimum acceptable quality standard of 75 percent target plastic.

Key Findings

1 **Targeted Material:** Plastic recyclables at hospitals are difficult to identify and often contain multiple materials. The long-term solution is for manufacturers to design for recyclability and consolidation design and provide material identification on the packaging. While the medical industry converts to a more recyclable product by following available guidance from organizations such as the Association of Plastic Recyclers and the HPRC, it is necessary to work within the existing model. This requires a limited scope of products or looking at methods such as waste to energy. Hospital policies regarding handling of items such as IV bags with some fluid, irrigation bottles, used clean gowns and other critical items must be taken into consideration. Plastic recycling facilities, including both mechanical and advanced molecular recycling, are dependent on the makeup of the material stream. Eliminating plastics such as PVC (polyvinyl chloride) from the material stream, which contaminate more valuable materials such as PET, should be pursued.

2 **Collection:** Hospitals have minimal space, limited staff and potentially dangerous recyclables. Concerns for controlled substances, liquids, sharps and blood-borne pathogens will always be an issue. Densification, handling equipment and processes need to be developed for medical streams. The process must be designed to optimize the flow of material from the hospital to the recycler, which will require densification and efficient, safe handling.

3 **Logistics:** Not every region in the country has recyclers with the space, technology and desire to process medical plastics. Consolidation of recycled material is necessary to lower costs and allow shipping to recycling facilities. Third-party companies will need to be investigated to develop options including the exploration of reverse logistics. The logistics cost and impact often limit the success of a program.

4 **Recycling:** There have been incredible advances in technology to allow for automated sorting that lowers cost and improves the quality of the recycling process. Medical plastics are made up of multiple resin types, and most recycling operations (whether chemical or mechanical) handle limited streams. While chemical and other advanced molecular recycling processes can tolerate higher contamination levels, they still require a minimum quality level of inbound scrap for efficient production and output quality.

5 **Recycled Materials:** The price for virgin plastic is driven by global supply and demand and the cost for feedstocks. Recycled materials' cost is driven by fixed costs and often is not competitive with virgin resin pricing. Increasing volumes and the efficiency of recycling will improve the cost structure, but for recycling to continue, there must be a demand for the recycled resin to drive value. Given the smaller volume of medical plastics relative to the volume of consumer plastics typically collected from curbside and industry today, targeting the most valuable plastic types will enable cost competitiveness. These plastic types include HDPE, PET and PP.

6 **Training:** The keys to any program are training and program feedback. Hospitals, like other organizations, are seeing increased turnover with new employees. It is critical that new employees are trained on recycling programs to ensure consistent collection. Feedback from recyclers and logistics companies is required to allow continual improvement and efficiency.

Summary

The development of a state or national recycling solution for hospitals requires a partnership between hospitals, transportation, recycling operations and manufacturers. With the low disposal cost of waste in the U.S., it is difficult to financially justify a recycling program that is likely more expensive than standard landfill disposal. Recycling programs are driven by high volume and consistent quality recyclables that promote efficient recycling and valuable end products. Until the process is developed to meet these criteria, recycling medical plastics will be a cost that needs to be shared to allow future success.

Virgin plastic today is typically lower in cost than recycled materials because of the collection, contamination and recycling costs. The focus on sustainability is driving companies to design products and packaging to minimize material use and for recycling and the use of recycled materials. If recycled plastics are more expensive than virgin plastic, it may require financial incentive to promote the process.

While new technology in both product-sorting and recycling allows for more options, contamination and logistics costs are a large part of a program. Development of baling/densifying equipment designed for hospital use and limitations is key, and mass production of this equipment will lower costs. Understanding internal and external handling is critical for efficient operations. Creative partnerships to allow for collection and consolidation are required to develop a viable program.

Understanding of both regional and national recycling options is necessary to develop a comprehensive solution. Consolidation of truckloads of materials allows for greater shipping distance to recycling operations. It is necessary to develop a program around generic recycling capabilities and not target one recycling process to allow for regional variation.

Neither hospitals nor recyclers are experts in evaluating medical plastic waste. It is necessary to offer a proven solution covering all aspects of the program for success. Developing a database of approved recyclers that are interested in medical plastic with capabilities and locations is key to program development. Material types should be clearly identified and designed for recycling. Densifying equipment designed for optimum handling of collected material, both in and out of the hospital, will need to be promoted. Collection and consolidation services need to be identified to allow for lower transportation costs and increased volume.

A national guide for recycling needs to be developed to ensure quality and safety in the recycling process. It is necessary to define which products are safe to recycle and reach a clear understanding of contamination limitations. Since products may ship from hospitals in one state to another state for processing, there must be national guidance. Hospitals and recyclers will not take on the responsibility and potential liability for these decisions.

A recycling program needs to be part of a sustainability culture in an organization to be successful. Recycling programs require support from the CEO to the staff, with continual feedback and education. Recycling is not a marketing tool but a necessary change to allow for minimizing the consumption of natural resources, waste and pollutants generated throughout the entire production and consumption process.

Are We Ready to Start a Recycling Program?

Strategic alignment

- Is there a culture of sustainability?
- What are the goals for a recycling program?
- Is there top-down support for the program?
  - Do you have an executive sponsor of this program?
  - Does C-suite understand that recycling will cost more than landfill?
  - Does C-suite understand time commitment from workforce?
- Will you commit to long-term development and success?
- Are you properly funded to execute this program as it is likely an added cost?
  - Landfill is typically cost-advantaged vs. recycling today but not a long-term viable option.
- Are there emerging regulations that you will need to comply with?
  - New regulations (both state and federal) are changing waste management.
- Will you resource a "champion" who will support the program?

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