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Healthcare Plastics Circularity: Real-World Application of Advanced Recycling for Hospital Waste

This white paper explores the findings of HPRC's advanced recycling project work, which involved the collection and processing of mixed plastics from hospitals' pre-surgical and laboratory areas using various advanced recycling technologies. The study aims to provide insights into the types and volumes of hospital-discarded plastics, demonstrate their potential as valuable feedstocks for advanced recycling, and identify the challenges faced in scaling up the recycling of healthcare plastics.

Contents

TARGET AUDIENCE

Audience	Goal
Recyclers	Generate interest in healthcare plastics as a feedstock for both mechanical and advanced recyclers.
Hospitals	Encourage hospitals to engage advanced recycling companies to recycle their healthcare plastics.
MDMs Manufacturers & **Packaging Converters**	Educate manufacturers and packaging converters on the opportunity to use virgin-equivalent recycled plastics from advanced recycling processes.
Resin Producers	Create circular systems to convert healthcare plastics to feedstocks back to plastics for healthcare applications.
Logistics Providers	Participate in the collection of healthcare plastics.
Sortation Facilities	Provide opportunities to test and tune AI sorting systems geared for healthcare plastics.
Legislators	Better understanding of the role of plastics in healthcare devices and packaging and opportunities for recycling and circular systems.

Introduction

Plastics serve a critical function in the global healthcare sector by ensuring the safe delivery of medical products and enhancing overall healthcare standards. The demand for plastics of superior quality, designed to endure sterilization processes and worldwide distribution, is driven by the rigorous safety criteria in healthcare. Plastic packaging serves to maintain the purity of medical items, preventing contamination and thus safeguarding patient well-being while also facilitating prompt access for healthcare providers.

The global demand for plastics, particularly those derived from recycled materials, is steadily increasing due to commitments made by major brands, retailers, and manufacturers toward achieving circularity in plastics usage. Forecasts indicate that the demand for chemicals, including those utilized in plastic production, is expected to increase by approximately 30% over the next decade[1]. Projections suggest that between 5 to 7.5 million metric tons of recycled plastic content will be required by 2030 to meet the needs of manufacturing new products[2]. This growth is spurred by legislation mandating responsible waste management by manufacturers or the incorporation of recycled materials into their processes.

The impetus for plastics recycling is further fueled by the escalating demand for plastic raw materials, coupled with public pressure to diminish reliance on fossil fuels and reduce landfill or incineration waste. Heightened climate concerns have amplified scrutiny on the fossil fuel industry, with shareholders of major energy corporations holding them accountable for their environmental impacts. These developments underscore a broader shift towards sustainable practices within the plastics industry, driven by increasing environmental consciousness and regulatory imperatives.

The Healthcare Plastics Recycling Council (HPRC) is actively addressing this issue by researching and implementing recycling solutions within healthcare environments. Through a flexible healthcare plastics recycling pilot program, HPRC has successfully demonstrated the mechanical recycling of mixed-material streams of flexible plastics. However, challenges such as contamination and degradation persist. In 2020, HPRC embarked on a multi-phase project to explore advanced recycling technologies as a means to address the healthcare plastics waste stream in a meaningful way

[1] https://www.americanchemistry.com/chemistry-in-america/news-trends/blog-post/2024/the-global-demand-for-chemistry-is-growing-can-us-policies-and-regulatory-action-meet-this-demand
[2] https://closedlooppartners.com/wp-content/uploads/2021/01/CLP_Circular_Supply_Chains_for_Plastics_Updated.pdf

ADVANCED RECYCLING RESEARCH

Advanced Recycling Technologies

Advanced recycling is a combination of several different technologies that complement traditional mechanical recycling to address plastic waste that is too degraded, complex, or contaminated to be recycled by mechanical means alone. These advanced recycling technologies allow plastics to be recycled multiple times without the degradation in quality that comes from mechanical recycling. The advanced recycling technologies are divided into three primary categories[3] .

- **Purification** is a solvent-based process that separates plastic polymers from additives, colorant, odor, and other resins. The purified polymers can then be made into new plastics. This technology generally requires segregated and single streams of particular plastic types.
- **Depolymerization** consists of chemical processes that break the molecular bonds of plastics into monomers and intermediates. Similar to purification, additives, colorants, odor, and other resins are removed, while the inputs are also generally single plastic types, and the end products can be used for the circular repolymerization of new plastics.
- **Thermal Conversion** brings plastics back to their most basic petrochemical building blocks by breaking molecular bonds. The resulting products from these processes are liquid and gaseous hydrocarbons that can be used for raw materials for the circular repolymerization of new plastics. Pyrolysis and gasification are two types of thermal conversion processes that are commonly used in advanced recycling technologies.

Phase 1 – Advanced Recycling Research + Industry Interviews

In phase 1 of the project, HPRC conducted interviews with sixteen advanced recycling companies from across the U.S. Through this work, we identified opportunities to expand current healthcare recycling capabilities, as well as challenges posed by the current level of maturity of the various advanced recycling technologies, including purification, decomposition, and conversion. Additionally, we carried out interviews with a number of logistics providers and healthcare facility professionals to gain further understanding of the feasibility of advanced recycling as a solution for healthcare plastics.

The phase 1 white paper includes:

- Discussion of common healthcare plastics and the challenges associated with recycling them.
- An overview of the advanced recycling industry, current technologies, and environmental impacts.
- Insights from advanced recyclers, healthcare organizations and logistics providers.

Phase 2 – Advanced Recycling Technical Feasibility Assessment

In phase 2 of the project, HPRC sought to better understand the suitability of a mixed stream of healthcare plastics as a feedstock for different advanced recycling technologies. Through this project, advanced recyclers that participated in HPRC's earlier research conducted a hands-on assessment of

[3] https://www.closedlooppartners.com/foundation-articles/assessing-molecular-recycling-technologies-in-the-united-states-and-canada/

clean healthcare plastic packaging provided by medical device manufacturers to determine compatibility with their technologies. The project incorporated a variety of advanced recycling technologies and demonstrates the complementary nature of the different technologies, as well as the opportunities for material circularity within the healthcare industry and across related sectors such as the biopharma industry.

The phase 2 white paper includes:

- An overview of the global healthcare plastics market and key drivers.
- Discussion of the growing opportunity for advanced recycling applications.
- Results from mock waste stream evaluations, including feedback on recycling success, compatibility with specific recycling technologies, negative effects of specific materials, and other observations.
- Summary of key takeaways by hospital, medical device manufacturer and advanced recycler stakeholders.

While these studies helped advance the knowledge around the potential applications of advanced recycling to medical plastics, additional questions remained including:

- What are the real-world plastic waste streams generated in healthcare facilities?
- How does a typical mix of healthcare packaging materials process in advanced recycling technologies?
- Which materials are more or less favorable for different recycling technologies?
- What real world barriers exist to scaling up the technology for healthcare materials?
- Are these materials valuable feedstocks for advanced recyclers?
- What challenges exist to scale hospital plastics as feedstocks for advanced recyclers?

To answer these questions, a third phase of this research was undertaken with a real-world hospital collection and analysis by advanced recyclers.

Scope

During 2022 and 2023, HPRC built upon the previous two phases of advanced recycling work to design and conduct a real-world collection of used mixed plastics from pre-surgical and laboratory areas of hospitals and process these mixed plastics with different advanced recycling technologies. The goals of this project include:

- Develop data on the real-world mix of plastic materials discarded by hospitals, including volume and types of materials and complexity of discarded products.
- Using these materials, demonstrate the value of healthcare plastics as viable feedstocks for advanced recycling by developing data on the quality of the output materials created via different advanced recycling technologies.

- Understand the complexities and current barriers to utilizing healthcare plastics at scale in advanced recycling.

Participants

Hospitals

Three distinct collection efforts were carried out involving a total of six hospitals. The initial collection took place in Ohio, involving Cleveland Clinic and Ohio State University Wexner Medical Center. The second collection occurred at a hospital in Northern California, while the third was conducted in Southern California, involving Sharp Healthcare San Diego, Palomar Health, and third hospital facility.

CLEVELAND CLINIC

Cleveland Clinic, situated in Cleveland, Ohio, stands as a distinguished academic medical center renowned for its pioneering medical research and patient care. It adopts a multidisciplinary approach to healthcare, integrating expertise from various medical specialties to offer comprehensive treatment options for patients. Committed to excellence, Cleveland Clinic has garnered global recognition for its delivery of high-quality healthcare services and advancement of medical science.

THE OHIO STATE UNIVERSITY MEDICAL CENTER (OSUMC)

Located in Columbus, Ohio, Ohio State University Medical Center stands as a prominent academic medical institution celebrated for its groundbreaking research, educational programs, and patient care. Offering a broad spectrum of medical specialties and services, OSUMC prioritizes innovation and collaboration to enhance patient outcomes. Within its esteemed university setting, OSUMC fosters an environment conducive to medical breakthroughs and the education of future healthcare professionals.

SHARP HEALTHCARE

San Diego Sharp HealthCare, headquartered in San Diego, California, is a leading healthcare provider renowned for its dedication to excellence in patient care and medical innovation. Operating numerous hospitals, specialty centers, and outpatient facilities throughout the San Diego region, Sharp HealthCare offers a wide array of medical services. Recognized for its patient-centered approach, advanced technology, and collaborative medical teams, Sharp HealthCare is committed to enhancing the health and well-being of the communities it serves.

PALOMAR HEALTH

Serving communities in North San Diego County, California, Palomar Health is a healthcare system comprising hospitals, outpatient facilities, and specialty centers. Offering a comprehensive range of medical services, Palomar Health is dedicated to providing compassionate care, innovative treatments, and advanced technology to improve patient outcomes and promote community health.

ADDITIONAL HOSPITAL PARTICIPATION

One additional hospital also provided material for analysis but wishes to remain anonymous.

Advanced Recyclers

Seven advanced recyclers participated in analyzing the materials collected at the six different hospitals. Multiple advanced recycling technologies were represented including dissolution (PureCycle), methanolysis (Eastman), gasification (Eastman), thermal pyrolysis (Alterra, Brightmark, Nexus Circular), and microwave pyrolysis (Ceclia Energy, Resynergi).

ALTERRA (HPRC MEMBER)

Alterra is the developer, operator, and licensor of a thermochemical liquefaction process technology that renews discarded plastic back into its original building blocks, thus minimizing the reliance on new fossil-derived materials for manufacturing plastic products. Their Akron, OH plastics circularity facility is the only full-scale, continuous plant of its kind. The discarded plastics are heated without oxygen until they break down into hydrocarbon vapor and non-condensable gas. The hydrocarbon vapor is then cooled into circular pyoil, a petrochemical product that can be further refined into feedstocks for new plastic and chemical production. Alterra transforms end-of-life plastics destined for landfills into petrochemical products that can be further refined into high-quality feedstock for new plastic production, enabling the circular economy. Alterra's purpose is to create a cleaner planet for future generations, and by keeping discarded plastic in the economy (infinite recycling), Alterra can increase national recycling rates and replace virgin fossil-derived resources in the production of new plastics.

BRIGHTMARK (HPRC MEMBER)

Brightmark® is a circular innovations company with a mission to Reimagine Waste®, developing solutions that make a positive environmental impact on the world and in the communities where it operates. Our projects focus on different types of waste streams, including plastic waste and organic waste. Through anaerobic digestion and our patented Plastics Renewal® technologies, we unlock the value in waste by converting it into new products.

Brightmark's Plastics Renewal® technology offers a crucial solution to plastic waste by converting difficult-to-recycle plastics into new, circular products, diverting plastics otherwise destined for landfills, incinerators, or the environment. Positioned within the waste hierarchy, advanced recycling technologies like Brightmark's complement traditional methods of reducing, reusing, and mechanically recycling plastics.

Our first-of-its-kind Brightmark Circularity Center in Ashley, Indiana, is one of the largest Plastics Renewal facilities in the world, capable of processing plastic types 1 through 7. Opened in 2020, the 120,000-square-foot facility has the capacity to recycle 100,000 tons of plastic waste annually and has achieved International Sustainability and Carbon Certification PLUS (ISCC PLUS) certification. Brightmark has also announced development plans in Thomaston, Georgia, and New South Wales, Australia, which will be able to divert 200,000 to 400,000 tons of plastic waste each year.

CECILIA ENERGY

Cecilia Energy, founded in 2021 in Newark, NJ, developed a proprietary microwave-assisted thermal decomposition of plastics that converts material directly from solid to gas, skipping the liquid phase, allowing for an energy-efficient, high conversion efficiency to gas. The primary products are solid carbon and hydrogen gas that can be used for advanced additive manufacturing for materials and clean energy. Cecilia Energy currently has long-term partnerships with NASA and the National Energy Technology Laboratory and has recently been exploring the use of sterilized hospital waste as a feedstock. Work with NASA is associated with their Moon to Mars directorate, focusing on In Situ Resource Utilization for long-duration and permanent space infrastructure using mission waste plastics. Cecilia will be commissioning their 5kg/day capacity Pilot Demonstration Unit in November 2024.

EASTMAN (HPRC MEMBER)

Global advanced materials and specialty additives company Eastman is focused on advancing the circular economy through its molecular recycling capabilities. It began commercial operation of its molecular recycling technologies in late 2019 and began operations of a 220-million-pound methanolysis facility at its Kingsport, TN headquarters in early 2024. The company has committed to recycling 250 million pounds of plastic waste annually by 2025 and more than 500 million pounds annually by 2030. Using its two molecular recycling technologies, carbon renewal technology (CRT) and methanolysis, Eastman can break down hard-to-recycle waste plastic to its basic building blocks and use them to create new materials an infinite number of times. Eastman's recycling processes produce molecules that are indistinguishable from those created using traditional processes. These materials are all ISCC PLUS certified, ensuring an unbroken chain of custody for recycled content from the point it is recycled all the way to the end consumer. Currently available products, made with up to 100% ISCC-recycled content, include a wide array of materials such as Eastman Eastar 6763 Renew used in rigid sterile barrier packaging, Eastman Tritan™ Renew that can be used in medical devices, as well as Eastar MN021 that can be used in applications such as blood tubes. Eastman has announced a second 250 million lb. methanolysis facility to be co-located with its Longview, TX operations with planned completion by the end of 2027 as well as plans for a third 250 million lb. methanolysis facility in Normandy, France.

NEXUS CIRCULAR, LLC (HPRC MEMBER)

Nexus Circular is a leading commercial pyrolysis-based advanced recycler, offering circular solutions for hard-to-recycle plastics, such as films and flexible packaging, that are not able to be addressed through the established mechanical recycling infrastructure. We commissioned our first commercial line in 2019 in Atlanta, GA and have been selling commercial volumes of our pyrolysis products for over five years.

Nexus pyrolysis products are purchased by global companies for use in their integrated manufacturing facilities as value-creating feedstocks for new, virgin quality plastics and other products, offsetting the demand for more extraction of resources. Every tanker or rail car of pyrolysis products produced by Nexus directly displaces the same volume of fossil-based feedstocks, reducing the need to extract and refine new fossil-based resources. At Nexus we are ensuring that the resources that we already have above ground stay in play, helping to reduce the dependence on non-renewable resources and to accelerate the circular economy.

Aligned with global partners who seek proven scalable solutions to meet ambitious plastic circularity goals and with the support of investors including Cox Enterprises, Chevron Phillips Chemical, Printpack and Braskem, Nexus is rapidly expanding its innovation footprint, moving decisively to address the complex challenges of plastics accumulation in the environment. We are on a trajectory to convert billions of pounds of hard-to-recycle plastics into circular products to support our global partners' 2025-2030 sustainability commitments.

PURECYCLE (HPRC MEMBER)

PureCycle Technologies™ uses a unique, patented technology, developed by The Procter & Gamble Company, to produce PureFive™ resin while using less energy than first-use plastic production.

The PureCycle purification technology is a form of dissolution. It is a physical process where polypropylene is dissolved in a solvent and purified to near-virgin conditions. PureCycle's unique technology separates color, odor, and contaminants from polypropylene waste feedstock, producing a recycled resin that can be used multiple times. The process is truly circular. In addition to the recycled resin that is produced, the primary byproducts of the process are also expected to have commercial uses.

PureCycle's process includes two steps, Feed Pre-Processing (Feed PreP) and Purification. The Feed PreP step collects, sorts, and prepares the feedstock for purification. The Purification step removes molecular contaminants from the feedstock and returns a recycled resin with technical characteristics like virgin resin. Because no chemical reactions are performed, the PureCycle process is less energy-intensive than virgin plastic production and can be reused many times on the same polypropylene.

PureCycle's flagship purification facility is located in Ironton, Ohio. The Ironton Facility is expected to have the capacity to convert approximately 130 million pounds of polypropylene waste to 107 million pounds of PureFive™ resin. The facility began commercial production in 2023.

PureCycle has announced future facilities in Europe and Asia and a second facility in the United States in Augusta, Georgia.

PureCycle Technologies offers an innovative, disruptive plastic-to-plastic recycling technology for waste polypropylene. The result is a repurposed, circular resin that can help companies reach their sustainability goals.

RESYNERGI

Resynergi is a pioneering entity specializing in the conversion of plastic waste into high-quality chemicals through an operational and modularly scalable approach. Resynergi's modular design allows for pre-assembled recycling facilities to go to the sources of waste plastic, instead of shipping plastic far distances which creates emissions and unneeded costs. With a network of global partners and esteemed brands such as Lummus and various leading waste management companies, Resynergi is at the forefront of sustainable solutions. Presently, the company is in the advanced stages of constructing its inaugural commercial system located in Rohnert Park, CA, designed to process up to 5 tons of waste plastic daily. With its pilot plant in operation in Santa Rosa, adjacent to a local waste management firm, Resynergi is ISCC Plus Certified, ensuring the highest levels of traceability in its operation from incoming waste-plastics to outbound circular chemicals. The company's comprehensive business model encompasses engineering, software development, and R&D for advanced front-end sorting, meticulously adhering to all regulatory frameworks and safety protocols at federal, state, and local levels, including those set forth by the EPA. Demonstrating operational viability and economic efficacy, Resynergi has consistently delivered batches of high-quality output to its global partners, seamlessly integrating these materials into existing production streams to yield virgin plastics. With Resynergi's innovative and modular processes, the prospect of eradicating waste plastics while simultaneously recovering valuable materials is within closer reach than ever before.

Overview of Project Phases

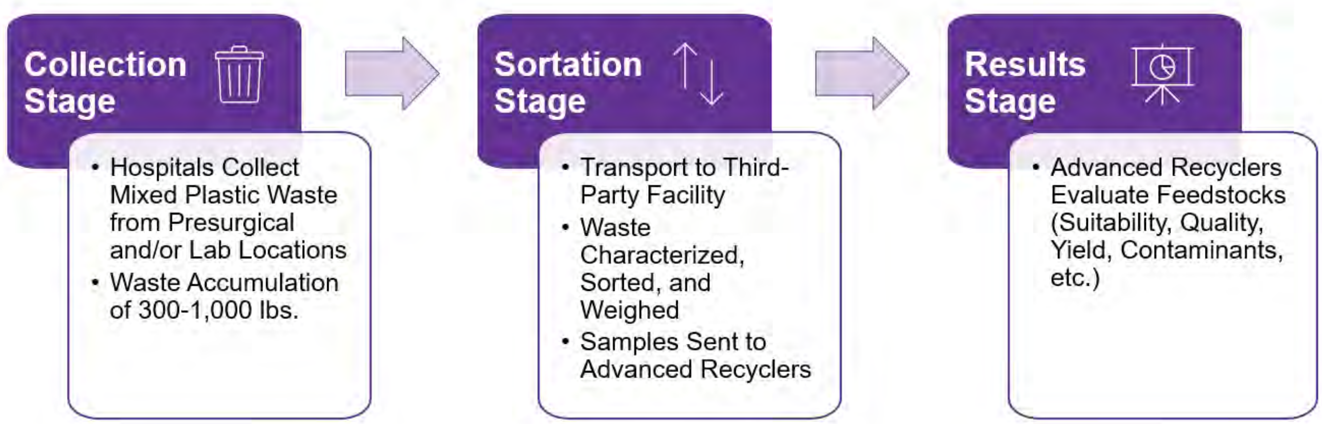
The real-world hospital pilot was separated into three stages: Collection, Sortation, and Findings.

Collection: Hospitals participating in the pilot initiative were tasked with gathering a mixed stream of plastic waste originating from their pre-surgical or laboratory facilities. The hospitals received instructions to collect the waste before it entered the final use environment to mitigate the risk of bio-hazardous contamination. Waste accumulation occurred on-site until a sufficient quantity (approximately 300-1,000 lbs.) was amassed for the pilot program.

Sortation: The mixed waste was transported to a third-party facility for characterization. Members of the HPRC project team conducted sorting activities to classify the waste into designated material types based on visual assessment. These categories included PET/PETG, polyethylene (PE)/Tyvek, polypropylene (PP)/Blue Wrap, polystyrene (PS), paper, and non-conforming materials. Non-conforming items comprised flexible tubing presumed to be PVC or silicone, along with medical devices that couldn't be disassembled into component pieces. Each waste type was weighed to gain insights into the composition of real-world waste streams. Initially, samples of each material type were dispatched to advanced recyclers capable of processing the respective materials for testing. Subsequently, representative mixed samples reflecting the composition of the collected materials were sent to all participating advanced recyclers.

Findings: Advanced recyclers evaluated the real-world feedstocks supplied by various hospital collections, assessing the suitability of sorted and mixed materials for their respective processes, as well as the quality and yield of the resulting output product. Additional information concerning contaminants was also provided to enhance understanding of feedstocks deemed suitable and valuable to advanced recyclers.

Process Overview Diagram



Collection

CALIFORNIA COLLECTION

Preparation for Collection

Preparation for the collection of plastics from hospital facilities involved several key steps. Except Cleveland Clinic, the hospitals participating in the pilot did not have extensive plastic waste collection programs in place. Initial meetings were held with representatives from various hospital departments, including ESG/sustainability, Operating Room (OR) management, Clinical Directors, and Environmental Services (EVS) personnel. These meetings aimed to assess the level of commitment from each team regarding the proposed recycling initiative. An HPRC member conducted site visits to walk through the waste streams, identifying potential barriers to successful implementation.

Despite some challenges, such as recyclable plastics being mixed with landfill waste due to the lack of a current recycling program, all departments demonstrated enthusiasm and dedication to recycling efforts. Educational sessions were conducted via video calls and onsite visits to familiarize staff with the importance of collecting specific plastics and the potential for advanced recycling. Additionally, observation of OR operations allowed for a better understanding of waste removal processes and staff collaboration. To facilitate the collection process, hospitals were provided with laminated signage, recycling bags, hampers, and gaylords for storage, with arrangements for secure gaylord storage made at each site in collaboration with the sortation center.

Process

On the day of collection, a brief overview of the process was given to staff during the morning huddle before starting surgical cases for the day. Emphasis was placed on the importance of ensuring that recyclable materials were both safe and clean, necessitating their placement in separate recycling bags. The high purity of products from sterile kits was emphasized, with bags removed from the OR suite or placed to the side of the room before patient entry to ensure they remained uncontaminated pre-patient plastic. Staff members were assigned specific roles before the start of daily cases, with at least one hospital employee responsible for transferring recyclable materials from the OR suite to a designated collection area Those involved in moving the bags of recycling included OR dedicated EVS techs, clinical nurse educators and operating room nurses.

To mitigate potential barriers, such as inadvertent disposal of bags containing recyclable materials, the bags were placed into a temporary staging area that was determined by the OR staff and specific to each site. This included using linen carts positioned outside of the OR for transportation of the recyclables to gaylords.. Secure storage of collected recyclables varied by location, including locked storage containers behind loading docks, gated and locked areas adjacent to loading docks, and secured patient floors designated for storage. Once ready for pickup, haulers from Resynergi and ACTenviro collected the gaylords for further sortation and processing.

Storage for recycling and waste is very limited at hospitals and considerations need to be made by individual site. For example, some facilities use garbage chutes and a process would need to be implemented to keep recyclables separate from municipal waste**.** For long-term success beyond a pilot, additional collection hampers, bins and/or bailers may need to be put into place

OHIO COLLECTION

The Cleveland Clinic actively participates in a recycling program, collecting a wide range of recyclable materials across its facilities. This initiative primarily focuses on materials generated in laboratory settings and other non-patient-contact areas to ensure optimal recycling quality. A significant portion of these recyclables includes rigid plastics and films, with blue wrap representing a major component. To streamline the recycling process, Cleveland Clinic has allocated designated storage areas within its facilities specifically for recyclables. Here, materials are manually sorted into specific categories based on the requirements outlined by their recycling provider.

The materials collected from Ohio State University Medical Center (OSUMC) include an array of rigid plastics and plastic films, gathered from multiple points of waste generation throughout the facility. This includes various types of pre-patient-contact waste from operating rooms, where materials have yet to be exposed to patients. One notable aspect of OSUMC's recycling efforts is its handling of blue wrap. OSUMC already has a recycling program in place specifically for uncontaminated blue wrap waste, so it was excluded from collection in this pilot.

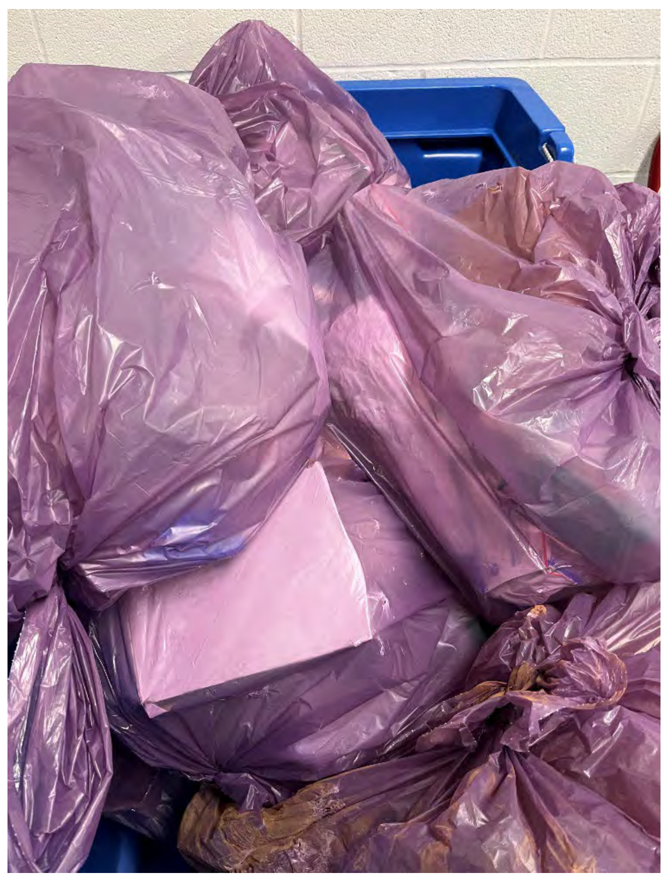
ANONYMOUS HOSPITAL PARTNER COLLECTION

Collection at the anonymous hospital partner was implemented as a structured program in the OR to separate and collect plastic waste, focusing on materials such as blue wrap, rigid, and flexible packaging. Gaylords were provided by Resynergi and placed in a secure area, with clear signage for the hampers to ensure proper disposal. This program evolved into a consistent bi-weekly process that ran for a year, until it was discontinued when the recycler moved to a commercial site.

Throughout the program, a characterization chart was available to monitor the types of waste collected, with the majority being blue wrap. Contaminants in the waste stream were minimal, and there were no reports of hazardous waste. Importantly, all waste collected was pre-patient, ensuring it was non-hazardous and suitable for recycling.

Collection Results Summary

The type and amount of waste collected from each hospital met expectations. The project team discovered that engagement from the key stakeholders in the hospitals, including EVS and OR staff, was essential to successful collection. With staff members and an HPRC team member helping in the pilot collection process, several gaylords of plastic waste were collected in one day. One important learning in the collection process was that bags with recyclable materials need to be included in the final surgical count to ensure all items are accounted for. This is an important step that needs to be considered when scaling recycling programs.



Sortation

OHIO REGION

The plastic waste collected from OSUMC was sent to Alterra in Akron, OH for sortation and characterization. The project team sorted the waste into pre-determined categories. These categories were selected based on research conducted in previous phases of the project which identified desirable material types per advanced recycling project. For example, PET and PETG are desirable for depolymerization and gasification technologies but are not desirable for pyrolysis technologies. They were therefore designated a unique category.

OSUMC waste characterization categories:

- Flexibles (Tyvek and PE films)
- HDPE, PP, and PS Rigids
- PET and PETG Rigids
- Non-Conforming

The samples collected from Cleveland Clinic were sorted and weighed on-site in a designated sortation area in the hospital campus. The sortation followed the hospital's existing sortation practices and protocols, with HPRC team members serving as sortation staff. The team elected to sort the waste into the same categories the hospital sorts to in practice. These categories differ slightly from those chosen in the preceding waste characterization study of the OSUMC waste. The team originally planned on separating PET and PETG rigids, but they found it difficult to do so due to mislabeled Resin ID codes, mostly PETG trays labeled as PET. PETG does not meet the requirements for a PET resin ID code #1 as specified in the ASTM D7611 standard for resin identification. #7 Other is the appropriate code for PETG. Previous versions of the ASTM standard did not explicitly exclude PETG from the definition of PET. Therefore, many PETG trays are made today using molds reflecting the #1 resin ID code. Given the uncertainty created by this factor, the PET and PETG trays were grouped together.

- Cleveland Clinic waste characterization categories:
- PET & PETG Rigids
- HDPE Rigids
- Flexibles (Tyvek and LDPE films)
- PP Rigids
- PS Rigids
- PP Blue Wrap

CALIFORNIA REGION

Sortation and waste characterization for the California region occurred at the ACTenviro facility in Escondido, CA, where plastic waste from Sharp Memorial and Palomar hospitals in Southern California was examined. The project team ensured that all materials were acquired prior to any operation or patient exposure, and so with minimal risk, latex gloves were used as a precautionary measure during handling.

Three gaylords containing materials were provided for sorting, predominantly comprising blue wrap, pre-surgical PP fiber sheets, and assorted rigid and film packaging materials. To accommodate the diversity of materials, smaller sortation boxes were arranged for PET and PETG, HDPE and LDPE combined (PE), PP, and PS, and paper. PVC was excluded due to limited interest from Advanced Recyclers at the time. Paper was included as a category due to a desire to understand the concentration of paper contamination in the stream, even when the staff was instructed to focus exclusively on plastic waste items. Sorting tables were set up with labeled sortation boxes.

California hospital waste characterization categories:

- PET & and PETG Rigids
- HDPE and LDPE Rigids and Films
- PP Blue Wrap and Rigids
- PS Rigids

- Paper

CHARACTERIZATION AND CLASSIFICATION

After the initial sortation, materials were weighed and then recategorized into film, rigid components, paper waste, and non-conforming components.

Film materials included film covers, film packaging with lids, and lids/covers. Rigid trays consisted of a mixture of PET, PETG, PP, and PE materials, with one tray identified as PS/HIPS. Blue wrap (PP) comprised approximately 55% of the overall collection.

Materials were then evenly distributed into eight different samples to provide to each advanced recycling partner. This approach aimed to mimic real-world collection scenarios from hospitals that do not segregate their packaging and materials. It also facilitated the assessment of these mixed samples to understand the value of a non-sorted sample to an advanced recycler.

Results and Findings

OHIO COLLECTION

Results from OSUMC were compiled and summarized in **Table 1** below. 304 lbs. of plastic waste material was sorted and characterized. Flexibles were the highest percentage of waste, accounting for 59% of the total. HDPE, PP, and PS rigids were the next highest category, accounting for 28% of the total waste. Note, blue wrap is known to be a prominent component of hospital waste streams. It was excluded from the OSUMC waste since the hospital has an existing recycling program in place for blue wrap.

Table 1. Summary of each material collected and sorted from OSUMC, quantified as a percentage of the total sample.

Category	OSUMC
Flexibles	59%
PET and PETG Rigids	6%
HDPE, PP, or PS Rigids	28%
Non-Conforming	7%

The OSUMC samples were tested exclusively by Alterra to gain a better understanding of how this representative stream would perform in their pyrolysis process. The PET and PETG trays were not included in their testing, given the known negative impact of those materials on their process.

Results from Cleveland Clinic were compiled and summarized in **Table 2** below. 277 lbs. of plastic waste material was sorted and characterized. HDPE rigids were the highest percentage of the waste, accounting for 39% of the total. PS Rigids were next, accounting for 33% of the total. Flexibles, the highest constitute of waste found at OSUMC, accounted for only 8% of the total at Cleveland Clinic. Upon this observation, the team discovered that most of the waste sampled at the Cleveland Clinic originated in their laboratory departments. The HDPE rigids were primarily saline solution bottles used in these areas. The PS rigids were primarily pipette racks. The balance of the waste originated from pre-operation settings.


Sani-Cloth

Table 2. Summary of each material collected and sorted from Cleveland Clinic, quantified as a percentage of the total sample.

Category	Cleveland Clinic
Flexibles	8%
PET and PETG Rigids	2%
HDPE Rigids	39%
PP Rigids	2%
PP Blue Wrap	8%
PS Rigids	33%
Non-Conforming	9%

PET and PETG rigids were sent to Eastman for processing in their depolymerization process. PP rigids and blue wrap were sent to PureCycle for processing in their purification process.

ANONYMOUS HOSPITAL PARTNER

Results were compiled and summarized in **Table 3** below. One full gaylord of unspecified weight was sorted and characterized. The most significant component of the mixed plastics collected was blue wrap, measured as 69% of the stream. Flexibles, PET and PETG rigids, and HDPE rigids were the next largest components, all around 8% of the stream. Non-conforming materials measured about 1%. This low level of non-conformance reflects the effectiveness of the collection efforts. All samples were sent to Resynergi for processing in their thermal conversion process.

Table 3. Summary of each material collected and sorted from Anonymous Hospital Partner, quantified as a percentage of the total sample.

Category	Cleveland Clinic
Flexibles	8%
PET and PETG Rigids	8%
HDPE Rigids	8%
PP Rigids	4%
PP Blue Wrap	69%
PS Rigids	2%
Non-Conforming	1%

CALIFORNIA REGION

Results were compiled from the collection and sorting of materials from two San Diego hospitals, Palomar Health and Sharp Memorial. Initial sorting categorized materials into plastic films/flexibles, plastic rigid materials, paper, and non-conforming materials. Plastic films/flexibles constituted the majority, accounting for 83% of Palomar Health's collection and 71% of Sharp Memorial's collection, with plastic rigids following at 9% and 18%, respectively.

The percentage of each material type was calculated relative to the total sample received from each hospital. The highest percentage of material comprised polypropylene plastic resin products, predominantly blue wrap, at 65% and 69% for the two hospitals. Polyethylene plastic resin, including Tyvek products, constituted the second highest proportion at 14% and 17%. Other potentially recyclable materials were present at lower levels, comprising 5% or less of the sample. Non-conforming materials, such as electronics and silicone tubing, accounted for 4% and 8% of the total sample for the two hospitals, respectively.

Table 4. Summary of each material collected and sorted from Palomar Health and Sharp Memorial hospitals, quantified as a percent of the total sample.

Category	Palomar Health	Sharp Memorial
Flexibles	17%	14%
PET & PETG Rigids	4%	5%
PP Rigids and Blue Wrap	65%	69%
PS Rigids	4%	2%
Paper	4%	1%
Non-Conforming	4%	8%

Lids are a common, lightweight flexible material format found in these samples and they may be loose or attached to the remainder of the packaging. Most of the lids can be both paper and plastic-based and it can be difficult to distinguish the two materials. The lids were tallied by hospital and type of material. The results are shown in **Table 5**.

Table 5. Summary of lids collected and sorted from Palomar Health and Sharp Memorial hospitals, quantified by direct count.

Category	Palomar Health	Sharp Memorial
Lids Only	18	48
Rigids with Lids (Partially Attached)	5	6
Total Lids	23	54

Following the sortation and data gathering for the various material types and formats, samples were prepared for sending to each participating advanced recycler to evaluate. The various materials were proportionally divided based on the distribution in **Table 3**, therefore each recycler would have a representative mix of materials to evaluate.

While all hospital collections contained similar materials, the distribution of the collected materials did differ. This was likely due to differences in collection area of a given hospital as well as the given caseload in the OR on the collection day. Different medical devices have different types of packaging, and even similar medical devices from different suppliers can have different types of packaging. All of these variables can impact the types of materials that are collected at hospitals.

ADVANCED RECYCLING PREFERRED FEEDSTOCK AND KNOWN IMPURITIES

Prior to sending samples of the collected materials, a survey was sent to all participating advanced recyclers to better understand the final products created by each process, the preferred feedstock, known impurities, and how each recycler assesses product quality. To obtain more detailed responses and better understand the suitability of hospital materials as feedstocks for advanced recycling, these results were provided anonymously from companies producing pyrolysis oil. Because of this, all of the results corresponding to a pyrolysis oil final product are reported together, and all results of this survey are provided in **Table 6**. It should be noted that exact specifications for feedstock, impurities, or quality testing could not be provided as these often provide insights into the process specifics of a given advanced recycling technology. This information would be available, typically under NDA, when working directly with an advanced recycler.

As seen in **Table 6**, ideal feedstocks are technology dependent and based on the chemistry and reactions that occur in each advanced recycling technology. Because of this, a wide range of materials can be recycled across all technologies, emphasizing the need for multiple solutions to address the many different types of plastic required for safe medical care. However, not all materials can be used and as can be seen, there are common impurities across all the advanced recycling technologies. These include PVC and any halogens, non-plastics including paper and aluminized films, high filler contents, and silicone.

These impurities can result in reduced yields, impact the quality of the final product, and cause damage to equipment. Given the commonality across all technologies, these impurities should be considered when choosing appropriate packaging materials to maximize recyclable plastics when the application allows.

Table 6: Advanced recycling technology ideal feedstocks, known feedstock contaminants, and final product quality testing.

Advanced Recycling Process	Final Product Sold	Ideal Feedstock	Known Feedstock Impurities	Final Product Quality Testing		
				Yields measured in addition to main product	Impurities	Product Characteristics
Purification	Polypropylene	PP	Fillers, Rubbers	–	–	Data Sheet Properties, MFI, color
Methanolysis	Polyesters, made from DMT and EG produced in methanolysis	PET, in a future state other copolyesters like PETG	Polymers that are not PET	---	Polyamides, metal, halides, silicone	Data sheet properties, viscosity, color
Gasification	Cellulosic polymers, made from carbon monoxide and hydrogen produced in gasification	Polymers rich in carbon, hydrogen, and oxygen	PVC, labels, halides, high nitrogen-based products like Nylons and some ABS, metal, high inorganic filler content	---	Metals, inorganics, halides, nitrogen	Data sheet properties, viscosity, color
Pyrolysis	Hydrogen and solid performance carbon	All thermoplastics except for PVC	PVC, metals, cotton, non-plastic components such as needles or cotton hospital gowns	Tars, oils, liquids, carbon dioxide	Organics, inks/dyes, labels, resins, non-plastic feedstock	Purity of hydrogen and carbon
Pyrolysis	pyrolysis oil	PP, PE, PS	PET, polycarbonate, PVC, high fiber/filler/pigment content plastics, non-plastics such as cardboard, metal, glass, wood, cotton, paper	Water, carbon/char, pyrolysis gas	Chlorine, bromine, fluorine, silicon, phosphorus, nitrogen, oxygen, sodium, calcium, iron, oxygenates	Bulk density, MFI, vapor pressure, boiling point, carbon content, hydrocarbon composition, pour point, viscosity, API gravity

ADVANCED RECYCLING RESULTS

All advanced recyclers who participated in this pilot study received samples from the various hospital collections such that analysis of these real world samples could be completed to understand viability of these materials as feedstocks across the different technologies. Please see **Table 7** for the feedstock provided to each advanced recycler as well as if it was a pre-sorted sample or a mixed-material sample.

Table 7: Summary of real-world hospital samples that were analyzed by each advanced recycler.

Advanced Recycler	Cleveland Clinic	Ohio State University Medical Center	Northern California Hospital	Southern California Hospital
PureCycle	Pre-Sorted			
Eastman		Pre-Sorted		Mixed
Alterra		Pre-Sorted		
Cecilia				Mixed
Nexxus Circular				Mixed
Brightmark				Mixed
Resynergi			Mixed	

Purification

Pre-sorted samples of rigid and non-woven (blue wrap) PP from the Cleveland Clinic collection were sent to Purecycle for analysis. Benchtop dissolution testing and a general material compositional analysis were used to verify the acceptability of the material into the PureCycle® process. This analysis showed that the rigid materials were greater than 96% PP while the non-woven materials were greater than 99% PP. This very high proportion of homopolymer PP content makes the samples look promising for future program development. However, having both rigid and non-woven materials make the overall Healthcare plastics more challenging in a pre-processing system for unmixing and separating as compared to some more traditional feedstocks that are available in the market today. As evidenced by this pilot sample, polypropylene is an abundant material used in healthcare applications and could be a future feedstock candidate for the PureCycle® process.

Non-Woven polypropylene (>99% PP)

Rigid Polypropylene mix (>96% PP)

Depolymerization: Methanolysis

Two samples were provided to Eastman to assess suitability as a feedstock in their methanolysis process. The first was a pre-sorted sample of rigid medical trays with some Tyvek lids attached from the Cleveland Clinic material collection, and the second was a highly mixed sample representative of a single stream collection at a hospital from the Southern California material collection. Eastman's methanolysis requires PET based materials to run at the highest yield, ensuring little waste and true material-to-material recycling.

Samples are first tested to verify the material make-up, testing the materials for the amount of PET present. During this step, the highly mixed sample was determined to be 94% non-polyester and therefore would not be acceptable for use in Eastman's methanolysis today or in the future. No additional testing was completed for this sample.

The pre-sorted sample was found to be a high percentage of polyester and so this material was then tested for the following contaminants as a second step in material qualification:

- Halogens
- Silicone
- Paper
- Wood
- Polyamides
- PVC

- Nitrogen content

This sample passed all contaminant testing, with all values below Eastman's required specification.

As noted, Eastman's current methanolysis technology is focused on PET-based-chemistries, however, the polyethylene Tyvek lids at the low level found in this sample are not considered a contaminant. This is because these would be separated in the current material preparation process for methanolysis and then used in Eastman's gasification process as a feedstock. This sample did contain a high level of PETG, as expected from rigid medical packaging, and a next generation methanolysis process is under development that would allow for the use of PETG as a feedstock where this pre-sorted sample would be ideal.

Further testing was not completed as Eastman does not have bench-top processes that could utilize the small amount of material received. Any additional testing would require 1,000 lbs. of material for a pilot sample. Despite this, Eastman's initial qualification testing indicates this pre-sorted sample would be a viable feedstock for a future generation of methanolysis at Eastman.

Conversion: Gasification

The same samples assessed for methanolysis were also analyzed by Eastman as a feedstock for their gasification process. These samples included a pre-sorted sample of rigid medical trays with some Tyvek lids attached from the Ohio material collection, and a highly mixed sample representative of a single stream collection at a hospital from the Southern California material collection. A similar material qualification process is used for gasification, in that samples are first verified for material make-up and then tested for the following contaminants:

- Halogens
- Silicone
- Paper
- Wood
- Polyamides
- PVC
- Nitrogen content

Eastman's material-to-material gasification technology can utilize a wide range of plastic materials as a feedstock including polyesters, HDPE, LDPE, PP, and PS. While the highly mixed sample was problematic for methanolysis, the wide-ranging material make-up is appropriate for gasification, as is the pre-sorted sample. Both samples passed all contaminant testing, with all values below Eastman's required specification.

While the material make-up is not problematic for gasification, the current technology requires a specific form factor which the flexible packaging, Tyvek lids and PETG trays in their as-received form would not currently meet. All of these products would require granulation and would be excellent candidates for use if it were possible to receive these materials in a granulated form. In addition, a next generation technology is under development that would not have these same form factor restrictions and both samples would be ideal feedstocks for this process.

Further testing was not completed as Eastman does not have bench-top processes that could utilize the small amount of material received. Any additional testing would require 1,000 lbs. of material for a pilot sample. Despite this, our initial qualification testing indicates the pre-sorted sample would be a viable feedstock for future generations of Eastman methanolysis and gasification.

Conversion: Pyrolysis

Alterra Energy received the full mixed-material collection from OSUMC that did not include blue wrap as OSUMC has a separate collection and recycler for this material. After sortation, Alterra removed the PET/PETG materials as these are known contaminants for the pyrolysis process. A 600g sample was then created from the flexibles and HDPE, PP, and PS rigids to test in their bench scale reactor, allowing Alterra to see potential yields and the quality of the resulting pyrolytic oil. The results of this analysis are seen in **Tables 8** and **9**.

Table 8: Measured output from Alterra's 600g benchtop pyrolysis reactor.

Benchtop Reactor Output	Mass (g)	Yield (%)
Pyrolytic Oil	399.5	66.6
Water	8	1.3
Char (Carbon)	48.5	8.1
Total Loss	144	24.0

Table 9: Potential contaminants measured in the output of Alterra's benchtop pyrolysis reactor.

Contaminant	Measured Quantity
Chlorine	130 ppm
Fluorine	4.7 ppm
Bromine	1.3 ppm
Nitrogen	630 mg/kg
Silicon	46 mg/kg
Phosphorus	17.6 mg/kg

Alterra Energy targets an 80% or higher yield of pyrolytic oil with their process, however the 66.6% yield measured with this sample would still be considered acceptable, although approaching the lower limit or what could be considered a viable feedstock. It is expected that if blue wrap were a part of this sample that the pyrolytic oil yield would be above 80%. The high char yield is believed to be due to paper labels found on flexible packaging. It is difficult to remove these labels prior to the pyrolysis process and further highlights the need for appropriate packaging design, as discussed in the HPRC Design Guidance.

The measured contaminants in **Table 9** are below the specification limits for Alterra's pyrolytic oil and would be considered acceptable. This is because Alterra's pyrolytic oil undergoes an additional refining step to remove these contaminants before the material is used for fuel production or as a feedstock for material-to-material recycling.

Overall, this mixed-material sample would be considered a viable feedstock for Alterra's current pyrolysis process.

Cecilia, Nexxus Circular, and Brightmark all received mixed-material samples from Southern California for analysis in their processes. Brightmark noted that these samples were approximately 90% by weight polyolefin materials - PE, PP, and PS - and about 10% by weight PET/PETG, PVC, paper, aluminum, and other unknown materials. All three companies noted that the materials were clean with minimum surface contamination and that PE, PP, and PS are the most preferred materials for their technologies. The ability to use the mixed material samples as-received varied based on the exact pyrolysis technology. More specifics are provided below.

- **Nexxus Circular:** Materials like PET, PVC, unknown polymers, paper, and trash are not accepted because they do not convert to usable materials and can clog equipment.
- **Brightmark:** The as-received mixed material sample can be used and all materials can be baled together, however if materials were sorted to remove PET and paper to a greater extent then they would be able to offer a higher rebate.
- **Cecilia:** Paper and PET can be processed, however these materials generate water, carbon monoxide, and carbon dioxide in their process which would require sequestration in back-end processing adding cost. In addition, the paper will result in a faster coking rate than polyolefins in Cecilia's process. While aluminum foil could be included, it is more ideal to remove it prior to entering the process because it turns to ash and accumulates in the reactor system. Finally, only trace amounts of PVC, below 1000 ppm, are acceptable with the current design but an additional back-end processing step could be designed in the future to sequester PVC specifically.

Resynergi received a mixed-material sample from the anonymous hospital partner that was over 95% polyolefin by weight. PET/PETG and other non-conforming materials were removed prior to testing as these are known contaminants for their process. The remaining olefin-based materials shown in **Figure X** were then ground, as shown in **Figure Y**, and tested in a small-scale reactor to assess suitability as a feedstock. The sample resulted in a pyrolytic oil yield of 78.5 wt%. The resulting pyrolytic oil, as seen in **Figure Z**, is clear and bright. The oil was then tested for quality, as shown in **Table 10**, with all results considered within specification for the final product. Resynergi found this material to be a high-quality feedstock and developed an ongoing relationship with the hospital facility to use these materials in their full-scale production. This shows that hospital waste is not only a feedstock in theory, but truly a commercially viable and scalable feedstock for pyrolysis processes.

Figure X: Remaining PE, PP, and PS parts after sortation that were used for feedstock testing by Resynergi.

Figure Y: Polyolefin materials shredded for use in small scale feedstock testing by Resynergi.

Figure Z: Resulting pyrolytic oil from feedstock testing at Resynergi using polyolefin hospital materials collected in Santa Rosa.

Table 10: Quality testing results for pyrolytic oil from feedstock testing at Resynergi using polyolefin hospital materials collected in Santa Rosa.

Test	Test Method	Units	Result
Sulfur Content	D 5453	ppmw	6.7
Ramsbottom Carbon Residue (10% bottoms)	D 524	% mass	0.078
Lubricity, HFRR	D 6079A	micron	167
Density	EN Category 1	kg/m3	810
Copper Corrosion at 50°C	D 130	n/a	1A
Oxidation stability	ISO 12205	g/m3	7
Appearance			Clear and bright
Hydrogen sulfide Content	IP 570	mg/kg	< 0.40
Phosphorus Content	ASTM D5185	ppmw	0.965
Silicon Content	ASTM D5185	ppmw	62
Chlorine Content	ASTM D7359	mg/kg	20.25
Fluorine Content	ASTM D7359	mg/kg	<0.10
Bromine Content	ASTM D7359	mg/kg	<0.50

All advanced recycling technologies showed that they could use real world end-of-use hospital materials to successfully produce new materials at high yield. These include polypropylene, the precursors for new virgin-equivalent polymers such as PET, PETG, polyethylene, and polypropylene, as well as hydrogen and performance carbon for applications such as carbon nanotubes. These materials could be used to make new products for medical care, allowing for full closed-loop recycling in applications where patient care and safety is paramount.

Challenges

Despite the success of this pilot, it should be noted that based on this work impurities in the collected material are a reality. Packaging today is not always designed for recycling and paper labels, aluminized film, and multi-material packages are all still commonplace. In addition, the resin identification code for PET is currently used on PETG and PET rigid medical trays and cannot be used as a reliable source for material identification. While education of hospital staff is key to helping reduce these impurities it should be recognized that employees are not experts, and that space is typically very limited in hospitals making additional sortation beyond a single stream difficult. Therefore, an additional sortation step between the hospital and the advanced recycler is likely necessary to remove impurities as well as separate polyolefins from polyesters and other material types that would be considered contaminants to meet preferences and requirements of advanced recyclers. This additional step will add cost to any recycling system and so a balance of sortation and packaging design is necessary to ensure recycling is economically viable for all parties involved.

Moving material from the hospital to a facility for sortation was also identified as a challenge. Reverse logistics are a challenge for many recycling and reuse programs today across many different markets, and the medical market is unfortunately no exception. To solve this will require engagement from current hospital waste handlers or leveraging different suppliers who could haul material after a supply or product drop-off. There is also additional complexity with hospital waste as this is often perceived to be contaminated with bodily fluids, and so additional education will be required to create understanding that these are non-contaminated, non-biohazardous materials.

Key Takeaways by Stakeholder

HOSPITALS

- Recycling hospital waste through advanced recycling is viable and should be examined as a potential end-of-use outcome for plastic materials throughout the hospital and not only relegated to the cafeteria.
- Sortation at the hospital can be difficult due to space limitations. Staff training is required to collect the highest value products and limit impurities.
- Recyclers typically prefer separated material types and where possible this could result in higher value material or potentially eliminate the need for additional sortation.

LOGISITICS PROVIDERS

- Removing materials from the hospitals to an appropriate aggregation and/or sortation site is often a difficult step that creates a barrier for developing recycling programs with hospitals because reverse logistics systems are not in place today and volumes can often be smaller than what a typical hauler may desire.

- Hospitals are willing to collect, and advanced recyclers will recycle these materials, but the logistics between collection and recycling need to be solved.
- It is important to engage with hospitals to develop an economically viable solution.

SORTERS (MRFS/PRFS)

- Most healthcare plastics are high quality, clean feedstock and are not contaminated with bodily fluids.
- Advanced recyclers can use this material and will pay for it but typically need some level of sortation to best utilize their equipment.
- Consider taking hospital plastics for sortation and developing an additional revenue stream.

RECYCLERS

- Most healthcare plastics are a high-quality material that can be processed with high yield across multiple recycling technologies. Consider seeking these materials out to further create demand.
- Partner with hospitals to develop this feedstock stream.
- Pay fair market prices for these clean feedstocks to create economic value and incentivize collection and sortation. Alternatively, pay for the transportation of these materials without an extra cost for the materials themselves.

MEDICAL DEVICE MANUFACTURERS

- Design packaging for recyclability both mechanical and advanced.
- Impurities are often the same for mechanical recycling and advanced recycling, and eliminating these in the design process can create a better end-of-use outcome for these materials.
- Leverage advanced recycled materials to help promote full closed-loop recycling, further creating economic incentive to collect these materials.

Future Research

This pilot was a success and established the viability of real-world hospital materials as feedstocks for advanced recycling technologies. It was noted that sortation is likely a needed step in the value chain and as such it is recommended that additional research be carried out on available sortation technologies and locations to overcome potential challenges with separating materials. Having completed a pilot, the next logical step would be to further scale recycling of healthcare plastics in a regional program to develop a financially viable system that could be replicated in other regions. To address this, a multi-year collaborative effort has been undertaken by the HPRC, AEPW, Vinyl Institute, and SPC in the Houston area with the Houston Methodist hospital system.