Disposal issues in healthcare packaging

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Reducing waste at the source through changes in package design can help disposal efforts.

According to the EPA, a typical hospital generates approximately 13 lb of waste per bed per day, of which 20% may be plastic. As a result of waste stream analyses conducted at several hospitals, WMI Medical Services has documented that at least 25% of regular solid waste may be corrugated. Depending on regulations and existing practices within the facilities, anywhere from 10% to 30% of the 13-lb total is considered infectious or regulated medical waste.

In 1989, the Council on Scientific Affairs, American Medical Association, Chicago, reported that approximately 750-800 million lb of regular waste was generated by U.S. hospitals (*1*). Arthur D. Little reported hospitals spent an estimated $3.6 billion to dispose of this amount of regular waste. It cost $973 million to dispose of the infectious or regulated medical waste portion.

The growth of healthcare product packaging not only adds to the cost of disposing regular waste in landfills and municipal incinerators but can have a significant impact on the infectious or regulated medical waste stream. Infectious or "red bag" waste often must be handled separately, resulting in treatment costs five to ten times higher than solid-waste disposal costs.

Regulations that provide clear definitions of infectious or regulated medical waste allow for clearer waste segregation practices. While this encourages that outer-wraps, which often consist of plastic, be kept out of the red bags and possibly out of incinerators, the problem of excessive packaging waste has only been diverted, not eliminated.

Healthcare facilities are faced with implementing comprehensive waste management programs while they also are seeking additional solutions. With no financial relief for a nonreimbursable cost, the healthcare community is beginning to look to manufacturers to help temper the issue.

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The growth of healthcare packaging

Medical products suppliers are quick to respond to their customers' concerns. Consequently, they have begun to design products to assure safety as well as streamline packaging. However, according to one major supplier, manufacturing "environmentally safe" products could increase costs by 30%, an expense not readily welcomed by the already financially burdened healthcare consumer.

In order to be responsive to the healthcare community today, manufacturers need to understand the concerns over increasing waste disposal costs, help the customer understand waste disposal, and work with the customer to identify opportunities for cost-effective, efficient waste disposal. Medical product costs have gone from a simple equation of "cost of the product plus inventory plus disposal." Packaging design as well as product design must be equally weighed. And finally, manufacturers need to understand and control their own waste before they can begin to contribute to resolving the problem for their customers.

The volume of medical waste and the cost of disposing it have grown steadily over the past decade or more, fueled in part by the growth of single-use disposable items. It has been estimated that the volume of disposables will increase 5-8% annually. While there has been some pressure by environmentalists for healthcare facilities to switch from disposable to reusable items, the use of disposables—particularly plastics—will continue to grow because of AIDS and other infectious diseases such as hepatitis.

Plastics are extremely important to the medical industry because they provide efficient barriers to the transmission of AIDS. With as many as 1.5 million people predicted to carry the AIDS virus by 1992 (*2*), a 20% annual growth rate for plastic in AIDS-related medical devices is expected.

Several companies have addressed their customers' concerns by redesigning and minimizing packaging. Downsizing the package that a product comes in can reduce the amount of shelf space required, enable the use of smaller shipping containers or the ability to pack more units in the same size container and, of course, cut down on waste.

We can expect to see more standardized packaging. I.V. tubing, for example, can be coiled to be more efficiently

packaged. Packaging or overwraps could utilize recycled materials or can be recyclable.

The custom procedural kits and trays market has grown dramatically. Before their introduction, between 10 and 20 items were individually picked for just one procedure such as a bone marrow biopsy, lumbar puncture, or cardiac catheterization. Besides the obvious savings in labor and storage and more easily recoverable charges, there is only one pack to open, which reduces the number of outerwraps that must be disposed.

The operating room contributes as much as 50% of medical waste generated in a facility. By diverting packaging and sterile wraps into the solid-waste stream, medical waste generated by the operating room may be reduced up to 30%. The use of custom kits and trays could have further impact on that percentage.

While there are several basic packs available that fulfill a large percentage of the normally performed procedures, healthcare customers may specify specialized kits and trays unique to their facility.

The arguments against custom packs include the cost to customize and the need for backup items in case a piece is dropped or otherwise rendered useless. Therefore, the disposal cost savings from utilization of custom packs may be offset by the actual cost of the pack itself. And unless the saved storage space is utilized for items which further favorably affect the bottom line, the full dollar benefit of this product category may never be realized.

Nevertheless, the custom procedural kits and trays market saw sales of $212 million in 1985, $382 million in 1988, and an estimated $450 million in 1989. It is predicted to reach $823 million in sales by 1993 (*3*).

Corrugated, which we have already indicated accounts for approximately 25% of a hospital's waste stream, can be minimized through one of the recently introduced stockless or just-in-time inventory programs. While the main concentration has been on inventory cost savings, the second benefit can be a significant reduction in the large amounts of corrugated.

The corrugated, while eliminated from the hospital waste stream, remains at the distribution warehouse. However, the warehouse may be in a better position to negotiate savings from recycling the larger amounts or reusing the corrugated which has been handled less and therefore may be still usable.

Healthcare facilities which cannot or choose not to participate in stockless inventory or just-in-time programs should question their suppliers on the availability of a buy-back program for recyclable materials. Once again, the supplier is in a stronger position to capture a significant savings from large amounts of recyclable materials. Savings would be realized from eliminating recyclable materials from the regular waste stream, although some of these savings may be offset by special handling, storage requirements, or a combination of both.

Growth of packaging for handling and disposal of medical waste

In addition to the obvious materials used to overwrap products, there is the packaging system used to contain the waste prior to treatment or disposal. Plastic bags have long been recognized as a convenient primary container. They not only serve as a barrier against occupational and environmental exposure but also facilitate and can withstand multiple handling.

According to WMI Medical Services guidelines, as well as many current state and local regulations, all infectious or regulated medical waste, including sharps containers, should be contained in double disposable plastic bags and then boxed in sealable, rigid corrugated containers prior to transport. Regulations allow for other types of outer containerizations such as reusable plastic carts.

The Environmental Protection Agency addressed this issue in the Medical Waste Tracking Act of 1988. While they recognized that plastic bags and other commonly used waste containers normally are able to withstand multiple handling and transport within a facility, additional rigid containerization is required to ensure integrity of the packaging for off-site transport (*4*).

Most regulations, including the Medical Waste Tracking Act, allow some options in the packaging of medical waste to reduce the cost of handling and disposal. Reusable containers, as mentioned, are an option, but not the plastic red bag liners.

The use of corrugated in disposing of medical waste

Rigid, corrugated containers are available in white (bleached) or kraft (natural) boxes. When WMI Medical Services initiated its business, white corrugated boxes were offered, as they presented a more positive image to hospitals, as well as patients and visitors who might see them. Clients are now encouraged to utilize the natural product, not only because of cost, but also because the actual bleaching process used to make the white boxes can release dioxins into the environment.

Some customers, however, still prefer the white boxes which are used in patient care areas as the waste container itself. Customers will pay a higher price for what they feel is the more aesthetically pleasing container when it is in continual view. White corrugated accounts for a very small percentage of total volume of containers used by WMI Medical Services.

Currently all of the boxes provided by WMI Medical Services contain at least 8–25% recycled material. While one of the criteria for selecting container manufacturers is a maximum amount of recycled material, there are major difficulties in utilizing 100% recycled materials.

There are very few U.S. plants that produce 100% recycled corrugated containers. The high cost of shipping corrugated from these plants significantly affects price. In 1990, Stone Container Corp. and Burlington Northern announced a joint agreement which has helped address this issue. The "Recycle Express" uses empty boxcars which have been used to deliver paper from Stone Container's Missoula, Mont., mill to backhaul corrugated waste at a reduced rate.

Stone Container is currently building two new plants to produce 100% recycled containers. Other manufacturers, like Western Craft, purchase recycled material on the open market, the primary source being a Canadian firm. Inland has two plants. One is dedicated to the "medium material," which is the middle section of the corrugated, and the other is dedicated to linerboard.

A typical hospital generates 13 lb of waste per bed daily. Of this, up to 30% can be infectious "red bag" waste requiring disposal treatment that costs five to 10 times more than regular solid waste.

While 100% recycled medium material is weaker than a mixed product, this does not significantly affect strength. Linerboard strength, however, is severely compromised when made from a high percentage (>70%) of recycled material.

The cost of 100% recycled containers is higher than partially recycled, primarily because of low efficiency of the process, which results in a high volume of wasted material. Also, the process is more energy intensive. Corrugated suppliers are actively addressing this issue.

WMI Medical Services continues to evaluate corrugated suppliers and will move to higher percentage recycled material as it becomes available, can meet regulatory strength standards, and is cost efficient for the manufacturers. Because of Waste Management's commitment to recycling, cost is not the only criterion considered.

The impact of plastics on the medical waste stream

Plastics in products and packaging continue to stir up controversy. Plastic, however, continues to be utilized for sensible reasons. It replaces heavier, thicker materials such as glass which saves on transportation, handling, and storage costs. Disposable products do not have to be cleaned and processed after use, and they minimize the spread of infection. Because plastics are thinner and lighter today than in the past, they have a lower strength threshold which allows them to be crushed more easily. Their benefits are often ignored when their opponents argue that plastics last practically forever, that they are derived from oil, and that burning some plastics can produce dioxins.

It is estimated that 20-30% of infectious or red bag waste is made up of plastic disposable items. In 1988, more than 124 million lb of polypropylene was molded into disposable syringes; 155 million lb of polyvinyl chloride was used to make blood bags, molded blood-transfer devices, and disposable gloves; and nearly 85 million lb of polyethylene was used for disposable containers (*5*).

Most medical products manufacturers use a variety of plastic products for the outer packaging or innerwraps. Not only does this pose a disposal problem for healthcare facilities as end users of the products and packaging, but the manufacturers are left with plastic waste resulting from trimmings, startups and ends, off-spec, defective, or damaged materials. The amount of plastic waste is dependent upon a variety of factors, such as the number of manufacturing steps and the number of grades being produced.

Members of a Waste Management waste reduction team recently visited a manufacturing facility producing plastic packaging products used primarily for outerwraps. The facility uses 20-25 million lb of resin per year. A bubble molding process is used to form plastic bags and sheets. The primary waste from this process is in unit startup and off-spec product, which is compacted and landfilled. The trimming waste is recycled through a grinder back into the bubble molding operation.

After the plastic products are formed, they are usually imprinted using alcohol-based inks. Any material that is off-spec after imprinting, however, is not considered for recycling because the inks would cause color variations in the subsequent products.

Some packaging is completed at this facility, creating mixed plastic/paper or mixed plastic waste. This waste is of low value due to the mixture of materials. Production personnel also mix the various plastic scraps, which further deters recycling. A small amount of clean, high-grade plastic scrap is recycled through a plastics recycler. Approximately 1.3 million lb of plastic waste produced at this facility during the year is compacted and landfilled.

Among the recommendations the Waste Management team made were:

1. Install a chipper/grinder to recycle high-grade plastic scrap internally, which would reduce raw material costs.
2. Use low-grade or imprinted plastic scraps to produce items such as garbage bags.

Even though this would take up manufacturing time and labor, disposal costs, which were running over $100,000 a year, would be significantly reduced. Revenue could be derived from selling this new product, or the company could save money by utilizing the bags internally.

Impact of healthcare packaging on landfills

About 80% of U.S. municipal solid waste goes to a landfill. According to the EPA, half of our nation's 6000 landfills currently in operation will be closed by 1995 due to filled capacity or inability to meet new environmental controls. Siting difficulties have dramatically slowed down development of new landfills, which will replace less than 10% of lost capacity (*6*).

Approximately 30% of all solid waste by weight and 34% by volume is made up of packaging materials (*7*). Of these packaging materials, 48% are paper and paperboard and 13% are plastics (*8*). Just as with regular consumer products, healthcare packaging can end up in landfills and take up volume. Consequently, a reduction in the amount of material used in healthcare packaging will reduce the total waste volume generated by hospitals.

Regulated medical waste sent to an incinerator for treatment is reduced to 10% of its total volume. On the other hand, regulated medical waste that is steam sterilized, even though compacted afterwards, will still take up valuable landfill space. Needles or other items of

the sharps category released during compaction may still pose an occupational hazard if waste handlers and/or landfill workers are not wearing appropriate safety attire.

And there are some states which allow for untreated medical waste to be buried in landfills either in the plastic bags alone or bagged and boxed. Some regulations call for compaction only after being covered with a layer of dirt. Whether or not pathogens can survive in a landfill environment and perhaps contaminate groundwater has yet to be adequately studied. There is also the possibility of vector spread by rodents and birds.

There are problems in utilizing biodegradable red bags or autoclavable bags. There is also more and more evidence denouncing the theory of making plastic degradable to save our landfills.

It is known that appropriately operated landfills are virtual tombs, allowing no sunlight, oxygen, or rain to contribute to the type of degradation required to break down biodegradables. Once oxygen is depleted within a covered landfill, anaerobic decomposition takes over, but at an extremely slow rate. To minimize leachate which may contaminate groundwater, landfills are kept dry. The less water in the landfill, the slower the waste degrades.

Moreover, plastics are inert and unlikely to break down in a landfill and, therefore, are unlikely to introduce toxic chemicals into that particular environment. Additives used to make plastics degradable, however, may include heavy metal salts, which would increase the probability of pollution (*9*).

In 1989, however, 32 states enacted laws that ban or somehow restrict certain plastics or plastic products from landfills. While most laws apply to products such as disposable diapers or allow only degradable grocery and trash bags, can regulations affecting other plastic products such as red bags or steam sterilization bags be far behind? Plastics experts feel that legislation in this direction will decrease somewhat as more evidence supports that plastic is not the lone culprit of overburdened landfills.

Source reduction and recycling are recognized as being the preferred methods of addressing this issue. Both environmental groups and private industry support this approach. For example, the Du Pont Co. and Waste Management, Inc. have formed a joint venture that will sort and recycle plastics from the solid waste generated by the nation's municipalities.

Hospital plastic waste has not yet been adequately addressed by current recycling efforts. However, Nicholas Pappas, Du Pont executive vice president, indicates that this joint venture demonstrates the belief that plastics, regardless of construction and origin, are some of the most recyclable of all materials. Discovering the recyclability of medical plastic waste and subsequent marketability should receive high priority from any type of recycling effort.

Impact of healthcare packaging on incineration

As already discussed, much of healthcare packaging is comprised of plastic. It is known that some plastics contain lead and cadmium, which are used in pigments and stabilizers. In fact, our research has shown that some companies offer red bags that contain enough lead to render fly ash hazardous for a typical incinerator. Some sharps containers contain even more lead, but they do not make up as much of the waste stream as the bags. Typically, the lead is in the form of a heavy metal-based pigment that one may replace with organic pigments.

Approximately 30% of all solid waste by weight is made up of packaging materials. To address their customers' concerns about the increasing volume of medical waste and the cost to dispose of it, many companies are redesigning and minimizing packaging.

Incinerator ash is disposed in landfills. When metals contaminate the ash, levels can be high enough to put the ash within the regulatory definition of "hazardous." The ash must then be disposed as hazardous waste, which typically costs up to 10 times that of disposal at a regular sanitary landfill.

Fly ash, a relatively small component of the total ash, collects in fabric filter air pollution control devices. Material tests hazardous about 90% of the time, due in part to the presence of metals in plastics. The disposal cost for hazardous ash adds about $0.02 to the disposal cost of a pound of medical waste.

Another impact of packaging is the effect of dioxins. Although the exact mechanism of dioxin formation is not known, plastics used in packaging provide the necessary dioxin precursors. However, proper incinerator design and operation—meaning complete destruction of organic compounds—can largely prevent their formation.

According to a 1988 study by the Office of Technology Assessment, outmoded hospital incinerators may pour out higher concentrations per pound burned of some toxic pollutants than their larger municipal counterparts. The reason is often attributed to the high percentage (20–30%) of plastic found in hospital waste, combined with the operating standards of some hospital incinerators which were not designed to handle the types of wastes being burned (*10*).

Appropriate air pollution control devices, proper incineration operation, and reduction of heavy metal content of healthcare packaging materials, are key issues.

Many questions remain to be answered about the actual impact of emissions such as dioxins. Potential pollution related to medical waste incineration can best be addressed by combining good incineration operating techniques, realistic emissions monitoring, and, most certainly, by looking at packaging types and excesses, as well as disposable product use.

Conclusion

Reducing waste at the source is widely endorsed by both the public and private sectors. Although frequently discussed as a means of responding to the waste management crises in communities, the opportunities for reducing waste at the source by encouraging changes in design of products and packaging have not been systematically explored.

Recently, the National Solid Wastes Management Association released a report supporting an integrated approach to waste management that should be embraced by generators of all waste streams (*11*). It recommended:

- Source reduction to eliminate unnecessary waste or one-time use products before entering the waste stream
- Recycling to extend life-cycles and produce revenue resources
- Volume reduction of waste through incineration utilizing best available technology to control possible harmful emissions
- Disposal in appropriately designed and controlled landfills.□

Literature cited

1. Council on Scientific Affairs, American Medical Association, JAMA 262(12): 1669(1989).
2. Kimball, M. C., Healthweek News 4(10): 45(1990).
3. Thill, M. D., Hospital Purchasing News 13(12): 1, 36(1989).
4. Environmental Protection Agency, Federal Register, Standards for the tracking and management of medical waste; interim final rule and request for comments, 54(56): 12345(1989).
5. Infectious Waste News, "Plastics in medical waste stream will continue to increase," 4(10): 5(1989).
6. National Solid Wastes Management Association, Landfill capacity in the year 2000, Washington, D.C., (1989).
7. Holusha, J., New York Times, "New technology that spares the environment," March 29, 1990.
8. New Jersey Commission on Sciences and Technology, Council for Solid Waste Solutions, Plastics Recycling Foundation, Plastics recycling: from vision to reality (1989).
9. Lee, W. Y., from a speech given at the Degradable Plastics and the Environment Symposium (1988).
10. Office of Technology Assessment, Handling medical wastes and potential occupational risks, Background paper: Issues in medical waste management, Washington, D.C., (1989).
11. National Solid Wastes Management Association, Public attitudes toward garbage disposal, Washington, D.C., (1990).

Received for review June 27, 1990.

Accepted Jan. 14, 1991.

Presented at the TAPPI 1990 Polymers, Laminations & Coatings Conference.