VETERANS AFFAIRS HOSPITAL
HOSPITAL WASTE MINIMIZATION CASE STUDIES

by

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ABSTRACT

The U.S. Environmental Protection Agency has instituted a broad pollution prevention research program through the Office of Research and Development to support continued environmental improvements throughout the nation. The Agency is also responding to the national concern in regards to the generation and disposal of medical wastes. Recently, EPA's Risk Reduction Engineering Laboratory (RREL) produced the "Guide to Waste Minimization in Selected Hospital Waste Streams" (1) with the cooperation of the California Department of Health Services (hereafter referred to as the “California Study”). The California Study serves as a manual for conducting waste minimization assessments at surgical and general medical hospitals to reduce the generation of hazardous wastes from chemotherapy and antineoplastic chemicals, formaldehyde, photographic chemicals, radionuclides, solvents, mercury, anesthetic gases and other waste chemicals.

In order to effectively implement its pollution prevention programs, the EPA is also investigating how the departments and agencies within the Federal community can help each other reduce their generation of wastes. As a part of these efforts, RREL provides staff and support to conduct waste minimization assessments under the Waste Reduction Evaluations and Assessments at Federal Sites (WREAFS) Program. Under the WREAFS program, the U.S. Department of Veterans Affairs Cincinnati - Fort Thomas Medical Center (DVA-Cin) offered to host an assessment of pollution prevention opportunities at their facility (2). With the California study having researched the generation of hazardous wastes in hospital settings, the DVA-Cin study investigated the use of disposables in patient care in order to identify research opportunities for future solid waste minimization.

During the assessment it became clear that DVA-Cin, driven by its sensitivity to health care costs, has in place some very effective waste minimization practices. Unlike most hospitals, DVA-Cin does not have access to private insurance and therefore cannot assign costs on a per bed basis. As a result, the generation of medical waste is well below the average level for a hospital of this size.

This paper has been reviewed in accordance with the U.S. Environmental Protection Agency’s peer and administrative review policies and approved for presentation and publication.
VETERANS AFFAIRS HOSPITAL AND HOSPITAL WASTE MINIMIZATION CASE STUDIES

INTRODUCTION

The California Study and the DVA-Cin Study represent RREL's initial efforts in the research of hospital wastes. Together, the studies profile those wastes that are unique to medical care facilities: hazardous and bio-hazardous wastes, wastes generated from patient care, and medical laboratory wastes. RREL did not attempt to study wastes generated in other areas of the hospitals (e.g., office settings, cafeteria, plant maintenance), as these wastes are common to many non-medical facilities which have been examined in prior studies.

This paper will outline the waste profile of medical care facilities and suggest waste minimization options based upon the results of both the California and DVA-Cin studies. This will include a discussion of research needs/opportunities derived from the DVA-Cin study.

THE CALIFORNIA STUDY

HAZARDOUS WASTE PROFILE

While the volumes of hazardous wastes generated are small in comparison to an industrial facility, hospitals do employ a wide variety of toxic chemicals and hazardous materials for numerous diagnostic and treatment purposes. Based on the assessments of three hospitals under the California study, the highest volume of hazardous waste generation comes from the use of chemotherapy and antineoplastic chemicals, followed by spent photographic chemicals and formaldehyde solutions used for disinfecting equipment. Briefly, the wastes studied include:

Chemotherapy and Antineoplastic Chemicals - Antineoplastic, or cytotoxic, agents are typically kept on hand in quantities sufficient to last two weeks. To produce chemotherapy solutions, chemicals are mixed under a hood which recirculates air through a filter. Only a small percentage of these wastes contain concentrated amounts of chemotherapy compounds. Much of the waste is associated with lightly contaminated items such as personal protective clothing and gauze pads. An average of 2 to 8 cubic feet of chemotherapy wastes were generated weekly by the hospitals surveyed. These wastes were either transported off-site to a Class I landfill or incinerated as hazardous waste. It should be noted that individual States have differing regulations
on how such waste is to be disposed. What is allowed in one State may be a violation in another. Therefore, the waste minimization recommendations that are made in this paper have to be taken in light of the medical waste regulations of the State in which the hospital is located.

**Formaldehyde** - Formaldehyde is used in pathology, autopsy, dialysis, embalming, and nursing units. For use in dialysis, formaldehyde is generally purchased as a 37 percent solution (formalin) that will be diluted with filtered, de-ionized water to a final formaldehyde concentration of 2-4 percent. Formaldehyde is used to disinfect membranes in dialysis machinery and, in other departments, to preserve specimens. Effluent is commonly discharged to a sewer, although in some States this may be considered an illegal practice.

**Photographic Chemicals** - Photographic developing solutions consist of three parts: developer, stop bath, and fixer. The developer normally contains approximately 45 percent glutaraldehyde. Acetic acid is a component of stop baths and fixer solutions. The fixer will contain 5-10 percent hydroquinone, 1-5 percent potassium hydroxide, and less than 1 percent silver. Silver-containing effluent is typically passed through a steel wool filter or electrowinning unit to recover the metal. The remaining aqueous waste, containing approximately 1.4 percent glutaraldehyde, 0.3 percent hydroquinone, and 0.2 percent potassium hydroxide, is typically discharged to the sewer.

**Radionuclides** - Radioactive wastes are generated in nuclear medicine and clinical testing departments. At the hospitals surveyed, radioactive materials in nuclear medicine were held on-site until they decayed to non-hazardous levels. In clinical testing laboratories, solvents were used for radioactive tagging. Wastes at the hospitals were generated at the rate of 800 cubic centimeters per week. Radioactive wastes were transported off-site to a landfill.

**Solvents** - Solvent wastes are generated in small amounts in various departments: pathology, histology, engineering, embalming, and laboratories. A variety of halogenated and non-halogenated compounds are used, but, in the hospitals surveyed, the most frequently used solvents were non-halogenated: xylene, methanol, and acetone. While acetone and methanol wastes are usually evaporated and/or discharged to a sewer, xylene is handled as a hazardous waste. Solvent wastes are typically recycled or transported off-site for incineration. However, some solvent wastes become absorbed into the specimen and then must be treated as infectious wastes. In the past, small quantities of solvent waste would be routinely disposed via lab packs to landfills. However, high disposal costs, long term liability and regulatory limitations make this an undesirable disposal alternative.

**Mercury** - Mercury wastes are primarily generated by broken or obsolete equipment. Spilled mercury can be recovered and reused if uncontaminated, however, spillage is not frequently recovered and no mercury spill kits were present in any of the surveyed hospitals.

**Anesthetic Gases** - Nitrous oxide and the halogenated agents halothane (Fluothane), enflurane (Ethrane), isoflurane (Forane), and other substances are used as inhalation anesthetics. Nitrous oxide is supplied as a gas in cylinders and used containers are returned to the supplier for refill. The
Halogenated agents are supplied in liquid form, in glass bottles. Once empty, the bottles are treated as hazardous waste. Waste anesthetic gases are vented from the operating room directly to the outside, or through a charcoal filter. Spent charcoal filters are transported off-site and disposed of as hazardous waste.

**HAZARDOUS WASTE MINIMIZATION OPTIONS**

As a result of the hospital assessments, a series of waste minimization options were developed for the wastes categorized above, as well as some other wastes not addressed by this paper. These options are briefly portrayed in Table 1.

While the waste minimization options listed on Table 1 respond to specific waste streams, better operating practices are essential to hospital-wide waste reduction. Better operating practices are procedures and institutional policies that result in a reduction of waste, and are exhibited through such pollution prevention measures as:

**Waste Stream Segregation** - It is important to keep hazardous waste segregated from non-hazardous waste, since all materials that come into contact with hazardous waste becomes hazardous. Hazardous chemical wastes should be kept separate from infectious wastes. Further, dilution of hazardous waste should be avoided, as it only increases the volume of waste that will have to be treated as hazardous. Finally, recyclable materials should be segregated from non-recyclable waste.

**Monitoring Procurement and Product Flow** - By centralizing the purchasing and dispensing of drugs and other hazardous chemicals, a facility can more readily recognize the occurrence of unnecessary waste and spillage, while assessing opportunities to minimize usage. Monitoring drug and chemical flows from receipt to disposal can be achieved through the use of automated data systems and bar-coding similar to that used in supermarkets. In addition to improving tracking and control, such a system may also provide cost savings by allowing the hospital to carry lower stocks in inventory efficiently.

**Integrating Individual Departments with Waste Management Responsibilities** - Apportion waste management costs to the departments generating the wastes, and require users of chemicals with limited shelf life to use up old stock before ordering new and to report on expired stock.

**Training Employees and Providing Necessary Equipment** - Employees should be trained in hazardous materials management and waste minimization. Employees need to be aware of chemical hazards, how to prevent spills, how to provide adequate maintenance of equipment, and how to remediate spills quickly and safely.
<table>
<thead>
<tr>
<th>WASTE CATEGORY</th>
<th>WASTE MINIMIZATION METHOD</th>
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| Chemotherapy and Antineoplastics | › Optimize drug container sizes in purchasing.  
› Return outdated drugs to manufacturer.  
› Centralize chemotherapy compounding location.  
› Minimize waste from compounding hood cleaning.  
› Provide spill cleanup kits.  
› Segregate wastes. |
| Formaldehyde                   | › Minimize strength of formaldehyde solutions.  
› Minimize wastes from cleaning dialysis machinery.  
› Use reverse osmosis water treatment to reduce dialysis cleaning demands.  
› Capture waste formaldehyde.  
› Investigate reuse in pathology, autopsy labs. |
| Photographic Chemicals         | › Return off-spec developer to manufacturer.  
› Cover chemical tanks to reduce evaporation.  
› Recover silver efficiently.  
› Use squeegees to reduce bath losses.  
› Use counter-current washing. |
| Radionuclides                  | › Use less hazardous isotopes whenever possible.  
› Segregate and label radioactive wastes, and store short-lived radioactive wastes on-site until decay permits disposal as general trash. |
| Solvents                      | › Substitute less hazardous cleaning agents.  
› Reduce analyte volume requirements.  
› Use pre-mixed kits for tests involving solvent fixation.  
› Use calibrated solvent dispensers for routine tests. |
| Mercury                        | › Substitute electronic devices for mercury-containing devices.  
› Provide spill cleanup kits and personnel training.  
› Recycle uncontaminated mercury wastes. |
| Waste Anesthetic               | › Employ low-leakage work practices.  
› Purchase low-leakage equipment.  
› Maintain equipment to prevent leaks. |
The fact that hospital and medical care costs have risen dramatically throughout this decade is commonly attributed to the cost-plus-fee reimbursement structure of medical insurance. Under this system, the health care facility is able to pass on direct costs, a portion of overhead costs, and service fees to each patient for eventual reimbursement by an insurance carrier following an established rate scale. Since the insured patient does not feel the full impact of the cost of services received, the health care facility has had little direct incentive to reduce those costs, and probably even less incentive to investigate the cost benefits from incorporating pollution prevention opportunities. However, DVA facilities are not reimbursed for health care services; each facility operates under a budget fixed by the Department of Veterans Affairs for the fiscal year. Therefore, individual facilities such as DVA-Cin are very sensitive to cost, since achieving cost savings translates into an ability to extend their services.

Since the California study had previously emphasized the opportunities for hazardous waste minimization, RREL and DVA-Cin chose to look for pollution prevention alternatives for minimizing the discarded medical supply wastestream. That the VA-Cin is uniquely suited to such a study is directly attributable to its cost sensitivity. The need to deliver services under a fixed budget has led DVA-Cin to both adopt environmentally clean practices on its own, and to continue clean practices that cost-reimbursement hospitals had abandoned. For example, the DVA-Cin Medical Center carefully segregates its waste in order to minimize the volume that will have to be transported by the infectious waste hauler (unit costs for infectious waste disposal far exceed those of general refuse). Also, taking advantage of its access to a DVA operated laundry in Dayton, Ohio, DVA-Cin still uses durable cloth gowns and drapes instead of the disposable paper variety. Hospital staff who indicated having prior work experience with other Cincinnati area hospitals maintained that DVA-Cin’s consumption of disposable gowns and drapes was the lowest in the metropolitan area.

DISPOSABLE MEDICAL SUPPLIES

The use of disposables in hospitals and the medical profession has increased steadily over the past thirty years as devices and items constructed of metal, glass, and fabric have been replaced with plastic and paper materials intended to be used once, and then discarded. There are four major factors that explain this preference for disposables:

**Health and Safety** - Products that arrive prepackaged and pre-sterilized reassure medical professionals of their integrity, and eliminate the burden of monitoring inhouse re-sterilization procedures.

**Cost** - Disposables lower inhouse labor costs and manpower associated with cleaning, re-sterilizing and wrapping durable devices and products.
Convenience - Such things as disposable operating room (OR) packs provide all the sterile materials needed for a specific operation, reducing OR prep time.

Space Constraints - Only needed materials are kept in stock, and there is no need to review inventory for aging and obsolete items.

DISPOSABLE WASTE PROFILE

The majority of waste generated by a hospital consists of disposable products. According to DVA-Cin personnel, approximately 80 percent of the hospital’s supplies are disposed after a single use. The DVA-Cin saw a change from reusables to disposables 10-15 years ago and an additional increase in the use of disposables in the last 2-3 years due to concern by hospitals over both patient safety and staff occupational exposure to the AIDS virus. Therefore, the increase results from greater usage of existing disposable supplies (i.e., single-use sponges for patient surgery, and disposable gloves and masks worn to protect hospital staff) rather than from the use of newly developed disposable items.

This section will profile the major disposable items ordered by these DVA-Cin departments: Laboratory Services; Surgery: Surgical Intensive Care Unit (SICU); 5 South (a patient floor); Medical Intensive Care Unit (MICU); Hemodialysis; and the Outpatient Clinic.

Laboratory Services - This department performs analyses on specimens taken from patients. In a 9 month period ending June 30, 1989, the laboratory had conducted 41,097 venipunctures, 9,935 bacterial cultures, 4,730 blood cultures, 854 fungal cultures, and 815 tuberculosis cultures. The Laboratory consists of 4 areas: (1) Hematology, (2) Clinical chemistry, (3) Microbiology, and (4) Histopathology.

1) Hematology Laboratory - Hematology draws and analyzes blood samples from 50-60 patients daily. The technicians visit the patients to draw samples and then return to the laboratory to conduct the analyses. Cloth gowns are worn while blood is drawn and then replaced with a second cloth gown for lab work. All gowns are laundered for reuse.

Hematology generates two 30-gallon bags of infectious waste each day. It is rendered non-infectious via autoclaving and disposed of as general trash. Sharps (needles, broken glass) are placed in sharps containers and those containers are collected by housekeeping staff for weekly incineration.

2) Clinical Chemistry Laboratory - Clinical Chemistry conducts blood serum and urine analyses on samples drawn by the hematology technicians. Approximate waste generation rates for the principle disposables are:

> Glass test tubes - 2,100 per week
> Glass sample cups - 2,000 per week
> Dry reagent slides - 21,000 per week
Like Hematology, Clinical Chemistry generates just under two 30-gallon bags of autoclaved waste each day. The laboratories are adjacent and share the same autoclave. The only disposable medical supply items that are reused are cuvette rings, used to test blood coagulation. Cuvette rings are washed and reused 5-10 times before disposal. This is done because of the high unit cost ($2.30) of a cuvette ring.

3) Microbiology Laboratory - This section of the laboratory produces the greatest amount of discarded supplies by weight because most of its wastes are glass products. At least three 30-gallon bags of autoclaved waste are produced each day. The waste profile primarily consists of:

- Petri dishes with Agar culture media - 1500 per week
- Blood culture bottles and Contaminated Slides
- Vitek Cards - 225 per week
- Paper towels, gowns and disposable gloves (for tuberculosis isolation)

No disposables are reused. Petri dishes are not reused because they are difficult to clean properly and safely, and preparing media on-site is not cost effective.

4) Histopathology Laboratory - This laboratory is responsible for analyzing tissue specimens and body parts from surgery and the morgue. Histopathology produces no more than one 5-gallon bag of autoclaved waste per day. Pathological wastes are incinerated on-site. Disposable specimen containers containing formaldehyde are autoclaved and then incinerated on-site.

Surgery Department - The Surgery handles approximately 15 cases daily. According to DVA officials, DVA-Cin is one of the last hospitals in Cincinnati that continues to use woven gowns. The greatest volume of medical supplies disposed of after a single use are exam gloves and surgical sponges. Surgical sponges had been reused in the past, but are now disposed after a single use due to concerns over the AIDS virus. Surgery also utilizes operating room packs that are prepared with all the disposable products necessary for a specific type of operation. The packs are generally used in full, although sometimes specific items may not be used.

The Surgery Department generates between one and two 30-gallon bags of blood and body fluid waste per case, or 15-30 bags per day. Approximately 70 percent of this work is estimated to be contaminated paper waste. According to DVA-Cin officials, other Cincinnati hospitals generate three 30-gallon bags of waste per case; DVA-Cin maintains its lower waste generation rate through their continued use of wovens. Surgery carefully segregates wastes as they are generated. Wastes to be disposed of as blood and body fluid waste must be “grossly contaminated” (i.e., soaked, or dripping with blood). However, DVA-Cin feels that surgeons and nurses ought not be burdened by waste segregation duties during surgery, and are likely to curtail this activity.

Sharps are placed in sharps containers, which are then clear-bagged against leakage, and sent to the on-site incinerator. Blood and body fluid is taken by an infectious waste hauler for off-site treatment and disposal. All other waste is general trash.
Surgical Intensive Care Unit (SICU) - Almost all of SICU’s eight beds are occupied on a regular basis. Cloth gowns are worn by patients and staff and are laundered for reuse. Procedure trays are re-sterilized on-site and reused, but SICU staff would like to go to the disposable packs like those used in surgery.

Blood and body fluid waste generated by SICU consists mainly of suction liners and tubes. Foley bags and chest tubes are flushed of their fluids and placed in general trash. I-V bags go directly into general trash. Sharps are boxed and incinerated on-site.

Waste is segregated into three categories: (1) sharps; (2) blood and body fluids, and; (3) general trash. Blood and body fluid wastes are strictly segregated into one-to-two 30-gallon bags per day. However, for those patients requiring isolation, SICU may generate as much as ten 5-gallon bags of medical waste per day for each patient. The number of patients in isolation varies.

5 South: Patient Floors - 5 South has 36 beds, of which 29-32 are occupied at any given time. 5 South provides pre- and post-operative care, including administration of medications and changing dressings. In total, the medical and surgical patient floors have 106 beds, of which 78 are occupied at any given time. Cloth gowns are generally worn on patient care floors, although disposable gowns are used whenever cloth is unavailable.

Waste is segregated into three categories: (1) sharps; (2) blood and body fluids, and; (3) general trash. 5 South generates one-to-two 30-gallon bags of blood and body fluid waste per day. In practice, nurses often dispose of non-blood and body fluid waste in the blood and body fluid waste container as a matter of convenience.

Medical Intensive Care Unit/Cardiac Care Unit (MICU/CCU) - the MICU/CCU has eight beds, all of which are constantly occupied. MICU/CCU reuses woven gowns and pressure bags. Pressure bags are used to introduce blood to a patient, and will be cleansed out for reuse.

Waste is segregated into three categories: (1) sharps; (2) blood and body fluids, and; (3) general trash. The assessment team again observed waste being dropped in blood add body fluid containers that did not need to be there; empty disposable urinals were observed in the blood and body fluid waste container.

Hemodialysis - This unit has 9 treatment stations. Treatment occurs in shifts with a capacity to treat 55 patients each week. Treatment takes about 5 hours. Nearly all products are disposable, including aprons and masks. As is common practice in many hospitals, disposable dialyzers are re-sterilized and reused approximately 20 times before disposal. The practice of reusing disposables in health care is controversial and will be discussed further in this paper.

At least four 30-gallon bags of blood and body fluid waste are generated each day. Most of the disposable items are discarded in the blood and body fluid containers. Sharps are handled as previously indicated.
Outpatient Clinic - The clinic services approximately 500 patients each day. The services include: surgical procedures, medical exams, chemotherapy, dermatology, urology, plastic surgery, orthopedics, and ear, nose and throat. Plastic-coated paper gowns are worn for chemotherapy procedures (disposed of as cytotoxic waste) and often for other outpatient treatment and procedures. Reusable wovens would include sheets, pillow cases, towels and blankets. Badly soiled linens are often discarded rather than laundered. Gomco suction apparatus, suture removal sets and scalpels are all reused.

The Outpatient Clinic fills one 30-gallon bag of blood and body fluid waste each day. Chemotherapy wastes are packaged in white plastic containers, and eventually transported to final disposal off-site by a licensed cytotoxic waste hauler. Sharps are handled as previously indicated.

DVA-CIN WASTE GENERATION COMPARED TO OTHER HOSPITALS

As indicated earlier, DVA-Cin does not generate waste in the quantities common to hospitals having access to cost-plus-fee reimbursement mechanisms. On average, hospitals generate between 0.5 and 4 pounds of infectious waste per patient each day (3). The DVA-Cin facility produces approximately 0.6 pounds of infectious waste per patient each day, placing it at the low end of the spectrum.

There are inconsistencies in how hospitals from different States define what is infectious waste. For example, DVA-Cin classifies its laboratory waste as general trash after autoclaving, whereas a hospital in New Jersey would continue to list such waste as infectious, despite the autoclave treatment. Inflating the DVA-Cin’s quantity of infectious waste to reflect lab wastes would raise the generation rate to 0.87 pounds per patient each day - still quite low in comparison to other hospitals. DVA-Cin’s continued use of wovens is likely the primary reason for this lower rate.

POLLUTION PREVENTION OPPORTUNITIES AT HOSPITALS

The purpose of this section is to identify and evaluate the opportunities to minimize waste in a hospital setting. In addition to responding specifically to the waste profiles already presented, it is important to discuss issues affecting pollution prevention decision-making: the benefits/costs of disposable versus reusable products; the reprocessing of disposable items intended for single-use; the factors that continue to promote reliance on disposables; and the ability to implement better operating practices. The weight of State regulation also bears heavily upon this decision-making process, but is best addressed through the efforts of individual facilities formulating pollution prevention programs that comply with both legal and health requirements.
CHOOSING BETWEEN DISPOSABLE AND REUSABLE PRODUCTS

As stated earlier in this paper, there are four major factors supporting the medical professions preference for disposables: health and safety: cost: convenience: and space constraints. With the advance of technology, intricate devices are mass-produced and sold as single-use items, prepackaged and sterilized to relieve the hospitals of such quality assurance concerns. Labor and reprocessing costs are relieved, being replaced by the apparently lower costs of treatment, destruction, or disposal. Packs of disposable goods are custom-fitted, used and discarded, alleviating OR prep time and simplifying inventory control.

An excellent example of this decision-making process is found in the demise of hospital laundries. Reimbursement of medical services on a cost-plus basis provided the incentive to introduce new products and services to ease hospital workloads. This created a situation wherein funds were not allocated to upgrade traditional services, because there was little incentive to modernize operations and streamline procedures. In the case of hospital laundries, they were experiencing a rising demand for all linen products as inpatient services increased during this period. Antiquated laundry operations were incapable of meeting the new demand, becoming unable to efficiently process and sterilize the soiled linens. Acquiring disposable linens ensured an adequate supply of products, relieved an overburdened laundry, and provided cost savings by allowing hospitals to abandon or further downgrade this service, rather than invest in capital improvements. The cost-plus reimbursement method for medical services had led the hospitals into allowing formerly efficient laundries to lapse into a condition in which the most cost effective solution resulted in the greatest generation of solid waste (4). The assessment team for the VA-Cin study suggested that the medical center’s extraordinary use of linens and access to the Dayton laundry was a significant factor in explaining DVA-Cin’s very low waste generation rate.

REUSING SINGLE-USE DEVICES

Hospitals and other-health care facilities have attempted to reduce costs by reprocessing disposable, single-use devices/products (see Table 2 for a listing of the most commonly reused disposable products). Although the issue of reusing disposable devices is highly debated, health care professionals agree that if a product is to be reused it must be as functional, sterile, and safe as when new. In making this decision, health care professionals must consider the possibility of disease transmission or infection, assumption of product liability, decreased reliability, and cost.

These concerns impact the decision on what may be reused. The less critical an item, the more likely it can be reused (5). For example, because a bedpan is considered to be a non-critical item by the Center for Disease Control (CDC) and the risk of infection or disease transmission is minimal, reuse would be considered. However, an arterial embolectomy catheter would be considered critical and the potential risks from reuse great. The hospital will always opt for health and safety over any issue of economics or ecology.
<table>
<thead>
<tr>
<th>Medical Device</th>
<th>Reuse Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemodialyzers</td>
<td>(46%)</td>
</tr>
<tr>
<td>Cardiovascular catheters and guidewires</td>
<td>(31%)</td>
</tr>
<tr>
<td>Respiratory therapy breathing circuits</td>
<td>(18%)</td>
</tr>
<tr>
<td>Biopsy needles</td>
<td>(17%)</td>
</tr>
<tr>
<td>Cautery devices</td>
<td>(16%)</td>
</tr>
<tr>
<td>Anesthesia breathing circuits</td>
<td>(14%)</td>
</tr>
<tr>
<td>Endotracheal tubes</td>
<td>(10%)</td>
</tr>
<tr>
<td>Suture staple removers</td>
<td>(9%)</td>
</tr>
<tr>
<td>Syringes</td>
<td>(9%)</td>
</tr>
<tr>
<td>Orthopedic appliances</td>
<td>(7%)</td>
</tr>
<tr>
<td>Suction canisters</td>
<td>(7%)</td>
</tr>
<tr>
<td>Tracheal tubes</td>
<td>(6%)</td>
</tr>
<tr>
<td>Bovie cords</td>
<td>(5%)</td>
</tr>
<tr>
<td>Esophageal thermometers</td>
<td>(4%)</td>
</tr>
<tr>
<td>External pacemaker electrodes</td>
<td>(4%)</td>
</tr>
<tr>
<td>Arterial catheter needles</td>
<td>(2%)</td>
</tr>
<tr>
<td>Aseptic irrigating syringes</td>
<td>(2%)</td>
</tr>
<tr>
<td>Shunt connectors</td>
<td>(2%)</td>
</tr>
<tr>
<td>Sterile skin scribes</td>
<td>(2%)</td>
</tr>
<tr>
<td>Cholangiographic catheters</td>
<td>(1%)</td>
</tr>
</tbody>
</table>

### TABLE 2. DISPOSABLE MEDICAL DEVICES REPORTED TO BE REUSED (in Descending Order of Frequency)

- Pacemakers (1%)
- Pulmonary nebulizers (1%)
- Skin staplers (1%)
- Urinary catheter plugs (1%)
- Allen needles (1%)
- Arterial embolectomy catheters (<1%)
- Condensing bottles (<1%)
- Operating room clamps (<1%)
- Ear syringes (<1%)
- Face tents (<1%)
- Gastric pH monitors (<1%)
- Hypodermic needles (<1%)
- Javid tubes (<1%)
- Oxygen masks (<1%)
- Microscaipels (<1%)
- Stone baskets (<1%)
- Surgical gloves (<1%)
- Triadaptors (<1%)
- Tracheostomy tubes (<1%)
- Urethral stents (<1%)
- Urinary bags (<1%)

'Reuse of Disposable Medical Devices in the 1980's.' Proceeding of the International Conference. Institute for Health Policy Analysis. Georgetown University Medical Center, 1984, Appendix B.
FACTORS AFFECTING CONTINUED RELIANCE ON DISPOSABLES

When considering reusable, or durable, products and reuse of disposable products as a means for reducing the rate of waste generation and its associate costs, infection control is the primary limiting factor. This paper has noted the increased attention that medical professionals are paying to this issue in the wake of public concern over the AIDS virus and other blood-borne pathogens. The CDC's Universal Precautions state that all blood and body substances must be treated as potentially infectious. As the first line of defense against pathogen transmissions, the medical community employs physical barriers to prevent contact with body substances: gloves, protective clothing, masks and eye protection. Single-use items intended for personnel protection provide hospitals with added assurance against accidental transmissions because they are used once, rendered non-infectious through autoclaving and either hauled off-site as general trash, or incinerated on-site. This eases the quality control burden for the hospital.

In any case, the barriers are employed but once, and that is what counts to the peace of mind of both doctor and patient. And, from a more pragmatic viewpoint, it is clear that, when considering the increasing frequency of AIDS in urban areas and the seriousness of all infectious diseases, health facilities must first ensure the sterility of a product or device first, and then consider the opportunity for pollution prevention.

Another obstacle to converting from a single-use back to a durable product or device is that it may simply no longer exist in that form, or be too expensive to employ. The DVA-Cin procurement office indicated that disposable products had, in many instances, completely eliminated the market for the durable good. As a result, the durable version is either no longer available, or can be acquired through special-order supply companies that may be unable to guarantee long term availability and unable to provide sufficiently large quantities. This situation in turn drives up the cost of the durable version, potentially making it cost prohibitive.

POLLUTION PREVENTION OPPORTUNITIES AT DVA HOSPITAL

A variety of disposable devices ranging from syringes to hemodialyzers, from Petri dishes to bedpans, contribute to the growing waste streams generated by health care facilities. In order to successfully reduce waste, it is important for hospitals to reconsider the situations in which single-use devices/products are used and evaluate whether the disposable is still the best option. If a reusable good provides comparable reliability, sterility and safety, it would be reasonable to consider going back to the reusable. In those instances wherein the hospital is reprocessing single-use devices, it would appear that the durable version is an even more attractive substitute because the disposable has not relieved the hospital of the burden of re-sterilization, quality assurance, or labor costs.

Because of the diversity of the areas toured at DVA-Cin, it would be best to discuss pollution prevention opportunities by ward. The major disposable items in each ward will be reviewed.
Laboratory Services - Nearly all items used in Laboratory Services are disposable. All glass products (e.g., test tubes, sample cups, Petri dishes, slides, pipettes, pipette tips) are autoclaved and disposed after a single use as a matter of safety. Although glass could be re-processed for reuse, immediate treatment and disposal lessens handling time, decreasing the chance of exposure to accidents and spills. Plastic products (e.g., pipettes, pipette tips, test tubes, testing items, specimen bags, cuvette rings, etc.) are autoclaved and disposed after a single use. Of these, only cuvette rings are reused, due to their high cost. Since the only good durable substitutes would be made of glass, and glass would not be re-processed for the reasons given, substitution in this case would only increase the weight of the wastestream.

However, it was noted that the Microbiology Lab disposed of 1500 Petri dishes each week. Because they are glass, there is an opportunity to reprocess the dishes and prepare them with new media. While they are difficult to clean, and Agar preparation is very labor intensive, it is important to consider developing an opportunity to have the dishes re-processed off-site. Such an alternative would allow the lab to continue functioning without the disruption from implementing inhouse reprocessing activities and significantly decrease the weight and volume of the waste generated by the lab. Within a two-mile radius of DVA-Cin there are eight other large hospitals (Holmes, Christ, Good Samaritan, Bethesda, Deaconess, and the University of Cincinnati hospitals, Children’s Hospital Medical Center, and Shriner’s Burns Institute). It would seem to be a reasonable entrepreneurial opportunity for some business to provide reprocessing services since it would have easy access to these main facilities. There are several more hospitals in the Greater Cincinnati area, but the ones listed are located in a way that facilitates the potential for a sharing of services.

Surgery - Because DVA-Cin already uses woven gowns, drapes, and instrument wraps, the greatest volume and weight of disposables in medical waste from surgery are made up of surgical sponges and exam gloves. While waste sponges should continue to be considered potentially infectious, it would be worthwhile to investigate whether sponges are being also used for purposes better suited for absorbent, reusable towels (i.e., cleanup activities). The CDC advises that all sharps, including syringes, be disposed rather than re-processed, and therefore this paper follows that recommendation.

The current use of wovens over disposables by DVA-Cin greatly reduces the potential volume of waste. Additional opportunity for substitution in this area is limited due to professional caution over health and safety, as well as cost considerations. It should be noted that the DVA laundry in Dayton does serve several facilities. As in the case of the Petri dish reprocessing recommendation, this may be an area in which several community hospitals may share a service and thus minimize their investment/capital costs.

SICU/MICU/CCU - The major disposable products used are catheters, tubing, suctioning equipment, I-V bags, needles and syringes. Catheters, tubing and suctioning equipment come into contact with body fluids during use and must be treated as potentially infectious. In accordance with Universal Precautions, needles and syringes are destroyed in a medical incinerator. However, I-V
bags never come into contact with body fluids and remain uncontaminated during use. Therefore, plastic I-V bottles could be safely reused for a single patient, and should be considered as a substitute for the I-V bags.

5 South - Patient Floors - Outpatient Clinic - The disposable products regularly used on the patient floors include suctioning equipment, tubing, catheters, blood transfusion equipment, chucks, and dressing supplies. Because of the inherent contact with blood and body fluids, these products are assumed to have a high risk of disease transmission. The only pollution prevention option recognized is in the use of chucks. Chucks act as linen and surface protectors, absorbing blood and body fluids in order that the reusable linens will not become grossly soiled and that surfaces will be easier and safer to clean. (Chucks are used in the laboratories as well to contain small spills at work stations.) Chucks are present throughout the hospital, and DVA-Cin may want to review the use of chucks to determine whether their availability has led to use in situations where they are not needed.

Hemodialysis - The major disposable products in this ward are I-V bags, tubing, gloves and dialyzers. Most of these items have been discussed, and it has been noted that the dialyzers are reused approximately 20 times before their disposal. The reuse of dialyzers has been found to be a common practice in health care institutions. An informal survey on the reuse of disposables, conducted at the 1984 Georgetown University International Conference, showed 46 percent of the respondents reporting the reuse of this item in their institutions (6).

With respect to high-tech items, it is believed that hemodialyzers are the only devices which have been studied in sufficient depth to show that function is not impaired through reuse (7). With this technical knowledge as evidence of safety and reliability, hospitals are able to write policies allowing dialyzer reuse as a waste reduction option.

ADDITIONAL OBSERVATIONS ON DVA-CIN'S POLLUTION PREVENTION EFFORTS

The DVA Hospital has already realized many of the waste reduction opportunities arising from product substitution and waste segregation practices. The hospital's standard use of wovens is a significant part of the reason DVA-Cin's waste generation rates are so low in comparison to industry average. The use of wovens in surgery accounts for the fact that DVA-Cin produces 50% to 65% of the waste normally produced during operations in Cincinnati area hospitals.

There has been some discussion on the reprocessing of glassware. The recycling of glassware-from sodalime (e.g., Pasteur pipettes) may greatly reduce the volume and weight of a hospital's current wastes. However, a large percentage of the glassware used in laboratories is made of borosilicate which cannot be recycled with general consumer waste glass. Also, despite the reliability of disinfection from autoclaving there is a stigma ascribed to medical waste that may restrict or eliminate recycling as a pollution prevention option. Community recycling centers should be contacted regarding their policies for accepting waste glass from health care facilities.
The Outpatient Clinic uses both woven and plastic-coated paper gowns. For most treatments the woven gown is a safe, reliable barrier against infection and should be the primary gown worn by the Outpatient staff. The use of the paper gowns are best limited to those treatments, such as chemotherapy, which require more stringent infection control and increased personnel protection.

RESEARCH AND DEVELOPMENT OPPORTUNITIES

In addition to assisting in the identification of pollution prevention opportunities for health care facilities, a major concern for RREL in conducting these studies has been to look for those areas in which research and development may support advancing new alternatives. In learning of the concerns, difficulties and successes of the health care profession, RREL hopes to expand EPA’s experience in the medical waste area and provide a solid basis for planning future research. Suggestions for further research in the health care industry are presented below:

Evaluate Reuse Potential in Single-Use Devices - As stated earlier in this paper, hemodialyzers are reused because they have been studied and evaluated closely to determine that such reuse does not impair their function, nor compromise patient safety. There are indications that other disposable products may not as yet have been studied in sufficient depth to make reliable determinations of their suitability for reuse. A cooperative effort could be established between EPA and representatives of the health care community to undertake this research and provide substantive data to either support or reject reuse considerations for the items listed in Table 2. Research data of this kind would give health care professionals a firm basis on which to make such decisions, as well as opening up a potential to uncover cleaner alternatives to some of the disposable products being reused.

Quality Assurance - There are also legal and ethical considerations associated with the reuse of disposables. Among which are the manufacturers disclaimers of warranty for reuse. There is agreement that manufacturers can offer a higher assurance of sterility than an individual health care facility. Research conducted by the EPA in cooperation with health care professionals, other Federal agencies (such as the Food and Drug Administration), and trade associations can form the basis for developing a protocol for reuse, giving hospitals a standard under which to set down operating procedures and institutional policies.

Hidden Cost Factors - There appears to be some confusion in comparing the relative costs of disposables versus reusables. The unit cost of a disposable does not represent the full cost of actually using that product. Disposal costs are becoming an ever more important factor as landfill and incineration regulations become increasingly more stringent. For its part, the reusable also carries storage and handling costs. The EPA may wish to conduct analytical studies in conjunction with health care facilities in order to quantify these costs as an aid in decision making.
Development of Reprocessing Capacity - Two pollution prevention alternatives cited by this paper involved reprocessing services that have been diminished by the disposable revolution. Space and labor constraints, coupled with the general availability and convenience of disposables, appear to be the major obstacles to on-site reprocessing of durable materials. However, as health care cost containment gains increasing importance, reprocessing may become cost effective for some items. The potential for promoting some reprocessing capability should be explored, particularly in those areas exhibiting a high density of medical facilities.

Developing a Reusable Market - Certain bills in Congress to amend the Resource Conservation and Recovery Act (RCRA) will require that Federal agencies meet certain objectives for use of recyclable products. The EPA and DVA should consider working together in developing procurement guidelines for the DVA which will stimulate the production and distribution of reusable and recyclable products.

CONCLUSION

In the case of the DVA study, the Assessment Team was impressed by the difficult challenges undertaken by the hospital professionals to perform their duties of human care while attempting to minimize the impact of those activities on the environment. Follow-on discussions indicate that this is a dynamic process for DVA-Cin, as they develop initiatives in training, information sharing and cooperation with other Federal agencies.

For its part, the EPA hopes to learn from future cooperation with DVA, seeking the health care professionals advice and guidance in planning and implementing research programs to respond to the needs of the medical community in the areas of hazardous waste, infectious waste, and other waste-streams. Opportunities to reduce these wastes do exist, and additional opportunities will be uncovered through research. Research will also provide the data on which to make operational decisions of benefit to health care facilities, while favoring environmental considerations.


5) According to the Center for Disease Control, a critical item is one that will enter the vascular system or any sterile area of the body. An item is semi-critical if it comes into contact with only intact mucous membranes. A non-critical item comes into contact only with intact skin.

6) “Reuse of Disposable Medical Devices in the 1980s”, Proceedings of the International Conference. Institute for Health Policy Analysis, Georgetown University Medical Center, 1984, Appendix B.

7) "Single Use or Reuse: What's the Answer?", Or Manager, October, 1985, p. 6.