

Reducing Polyvinyl Chloride (PVC) Use in Hospitals

There are many ways in which hospitals can take immediate action to reduce PVC use. The process will involve:

- gathering data through audits and letters to vendors;
- identifying alternatives;
- developing and implementing a PVC reduction plan; and
- establishing a PVC reduction policy.

Begin by identifying products that contain PVC and determining appropriate alternatives

Reducing PVC requires knowing which products contain PVC and the availability of alternatives. PVC products range from critical health care devices, such as disposable intravenous (IV) bags and tubing, to bedpans and notebook binders, as well as basic construction materials and furnishings, such as water pipes and wall coverings. If you take the time to identify products your hospital purchases and the materials that they are made of, it will facilitate the process of reducing PVC use over time. For example, Catholic Healthcare West, a large nonprofit hospital system, requires its group purchasing organization (GPO) to identify products that contain PVC.

To start a list of PVC products in your hospital see Table 1 and the Sustainable Hospitals Project website, www.sustainablehospitals.org.

What should be included in a PVC reduction plan?

Reduction priorities should be based on the potential for patient exposure to di(2-ethylhexyl) phthalate (DEHP), potential for the PVC product to be incinerated upon disposal, volume of PVC use, and availability of substitute products.

Taking into consideration these concerns, it is wise to establish an organization-wide PVC reduction plan that includes the following priorities:

- a. First, target disposable PVC health care products, especially within neonatal intensive care units (NICUs), maternity departments, and pediatrics.
- b. Second, phase out the purchase of PVC office supplies.
- c. Third, purchase PVC-free furnishings, furniture products, and construction products when purchasing new furniture, renovating existing departments, or constructing new wings or buildings;
- d. Fourth, when buying durable medical products, specify those that are PVC-free.

Disposable PVC health care products should be the first priority because of the potential for significant patient exposure to DEHP and because they may be incinerated at the end of their useful life. DEHP exposure is critical to consider, especially for fetuses, newborns, and toddlers who may be exposed to levels of DEHP near or at those that cause harm in relevant animal models. Since DEHP is a reproductive and developmental toxicant, DEHP use in NICUs, maternity departments and pediatrics is of particular concern. For maternity departments, NICUs, and pediatrics, health care providers may decide that eliminating DEHP exposures in their particularly vulnerable patients justifies the occasional higher cost of alternatives.

Office supplies are another priority for elimination because they may be incinerated upon disposal, cost-competitive alternatives are widely available, and hospitals usually can replace them easily under existing contracts.

PVC-containing furnishings, furniture products, and construction products should be eliminated from new purchases, building renovations, and new building construction. For most of these products, cost-competitive, PVC-free alternatives are widely available.⁴

Durable medical products pose the greatest challenge to reduction due to the lack of knowledge of their PVC content and availability of PVC-free devices. The primary use for PVC in durable medical products is as the housing — the rigid, outer plastic covering — for testing and diagnostic equipment. Since durable medical products have a longer use life than disposable medical products (such as IV bags) and result in little DEHP exposure, they are a secondary target for reduction. A first step in reducing PVC use in these applications would be to require vendors to disclose the PVC content in their equipment.

How do PVC-free and DEHP-free alternatives differ?

DEHP-containing PVC: Because PVC is a rigid plastic by nature, manufacturers add DEHP to make PVC flexible. DEHP does not chemically bind to PVC. DEHP may therefore leach from plasticized PVC when a medical device comes into contact with fluids, lipids, and/or heat. DEHP is a reproductive and developmental toxicant in laboratory animal testing. Other toxicity concerns are unresolved. [See Health Care Without Harm's *Going Green* fact sheet 3-06, "DEHP Exposure During the Medical Care of Infants: A Cause for Concern."]

PVC-free: Non-PVC plastics used in medical devices include silicone, polyethylene, and polypropylene. Most flexible, PVC-free medical devices do not contribute chlorine to waste incinerators and are, therefore, less likely to contribute to dioxin formation when waste is burned. In addition, PVC-free products do not contain plasticizers, avoiding the potential risks from plasticizer leaching.¹ Finally, PVC is the only plastic that contributes to dioxin formation during manufacturing. No other plastic production process is listed in the U.S. Environmental Protection Agency's dioxin inventory as a source of dioxin emissions.

DEHP-free: DEHP-free PVC medical devices contain alternative softening agents (plasticizers), such as citrates, adipates, and trimellitates, which have been substituted for DEHP. These plasticizers may leach from PVC, although at different rates, depending on the nature of the solution in the bag. Citrates are less hazardous than DEHP, as indicated by their use as a food additive. Much less is known about the safety/hazards of the trimellitates, though some research indicates that trimellitates leach less than DEHP.^{2,3} While purchasing DEHP-free PVC products is an option for reducing DEHP exposure, it should only be considered an interim solution because it does not address the lifecycle impacts of PVC.

Which disposable PVC health products contain PVC and what are the alternatives?

Disposable PVC health care products fall into five broad categories: bags, tubes, gloves, trays,⁵ and catheters. Bags (42.5%), tubes (43.0%), and gloves (12.5%) account for 98% of disposable PVC health care products.⁶

PVC bags package IV products, enteral feeding formulas, and blood products (including packed red blood cells, fresh frozen plasma, and platelet rich plas-

ma). PVC bags are also used to collect bodily fluids. DEHP-containing PVC medical bags first became a matter of concern in the 1970s because of DEHP exposures from the use of blood and total parenteral nutrition (TPN) bags.

Alternatives to PVC bags: PVC-free bags are on the U.S. market for packaging IV products, platelet rich plasma, fresh frozen plasma, enteral formula, and TPN. The PVC-free bags are both cost- and technically-competitive with the PVC bags.

For packed red blood cell bags, however, there is only a DEHP-free alternative. An unintended consequence of DEHP leaching from PVC bags is that it acts as a preservative of red blood cells by extending the shelf-life of stored red blood cells. The Food and Drug Administration does not regulate DEHP as an additive to red blood cells. The alternative plasticizer used in red blood cell bags is a citrate. Citrates, in fact, have a long history of use as a blood preservative. The shelf life of blood in citrate-plasticized bags is similar to that of DEHP-plasticized bags. A DEHP-free bag is on the market at a slightly higher cost than the DEHP-containing PVC bag.

PVC tubing conveys liquids — such as IV solutions and nutritional formulas — and respiratory gases to patients. PVC tubing and catheters are actually poor technical performers in medical treatments that involve contact with human tissue longer than approximately three to seven days. The leaching of DEHP not only exposes patients to the plasticizer, but also causes the product to become brittle and subject to cracking. For these reasons, manufacturers began introducing PVC-free products, such as silicone umbilical vessel catheters, in the late 1970s and early 1980s to address the performance problems of PVC. Recent research suggests that significant levels of DEHP may leach out of nasogastric tubes within 24 hours. A Swedish study of PVC nasogastric tubes used for 24 hours "showed that the section of the tube which had been

inside the infant's stomach contained only half as much plasticiser as the rest of the tube. ...Since this discovery, the [Swedish County] council's medical board decided to substitute polyurethane tubes for the PVC ones.⁷⁷

Alternatives to PVC tubing: PVC-free or DEHP-free tubing is on the US market for most medical applications. Silicone, polyethylene, and polyurethane are three alternative polymers frequently used in tubing applications. In most applications, at least one of these polymers can compete with PVC in terms of technical performance. In terms of economic performance, PVC-free tubing generally costs more than PVC tubing. In the next few years, however, plastics industry analysts expect metallocene polyolefins (polyethylene and polypropylene are polyolefins) to become cost-competitive with flexible PVC medical products.⁸

PVC gloves: PVC is used primarily in the manufacture of examination gloves and has little market share in the surgical glove market.

Alternatives to PVC gloves: Latex is the dominant material used in the manufacture of examination gloves. However, concerns with latex allergies have led hospitals and manufacturers to consider gloves made of different materials. For example, when Kaiser Permanente decided to phase-out the use of latex gloves it searched for PVC-free gloves, ultimately settling on gloves made of nitrile. While these are more expensive than latex and PVC gloves, Kaiser received a cost-competitive bid due to the size of its contract. Reflecting growing demand, a diversity of latex-free and PVC-free gloves is on the market today, although costs are slightly higher.⁹

Table 1. Polyvinyl Chloride (PVC) Products in Hospitals

Disposable Health Care Products

Blood Products and Transfusions

- apheresis circuits
- blood bags and tubing
- extracorporeal membrane oxygenation circuits

Collection of Bodily Fluids

- dialysis, peritoneal: drainage bags
- urinary collection bags, urological catheters, and irrigation sets
- wound drainage systems: bags and tubes

Enteral Feeding Products

- enteral feeding sets (bags and tubing)
- nasogastric tubes
- tubing for breast pumps

Gloves, Examination

Intravenous (IV) Therapy Products

- catheters
- solution bags
- tubing

Kidney (Renal Disease) Therapy Products

- hemodialysis: blood lines (tubing) and catheters
- peritoneal dialysis: dialysate containers (bags) and fill and drain lines (tubing)

Packaging, Medical Products

- film wrap
- thermoformed trays for admission and diagnostic kits, and medical devices

Patient Products

- bedpans
- cold and heat packs and heating pads
- foot orthoses
- inflatable splints and injury support packs
- patient ID cards and bracelets
- sequential compression devices

Disposable Health Care Products (continued)

Respiratory Therapy Products

- aerosol and oxygen masks, tents, and tubing
- endotracheal and tracheostomy tubes
- humidifiers, sterile water bags and tubing
- nasal cannulas and catheters
- resuscitator bags
- suction catheters

Office Supplies

- notebook binders
- plastic dividers in patient charts

Durable Medical Products

- testing and diagnostic equipment, including instrument housings

Furniture Products and Furnishings

- bed casters, rails, and wheels
- floor coverings
- furniture upholstery
- inflatable mattresses and pads
- mattress covers
- pillowcase covers
- shower curtains
- thermal blankets
- wallpaper
- window blinds and shades

Construction Products

- doors
- electrical wire sheathing
- pipes: water and vent
- roofing membranes
- windows

Are PVC-free construction and furnishing products available?

PVC-free construction and furnishing products are widely available and are often cost-competitive. For example, PVC-free mattress covers and shower curtains can be purchased and are cost-competitive with the PVC products. During renovations and new building construction, hospitals should specify PVC-free products. Including home and commercial buildings, construction products, furnishings, and furniture products account for approximately 75% of all PVC end uses.

Why establish an organization-wide PVC reduction policy?

An organization-wide PVC reduction policy is an important step toward eliminating PVC products from hospitals because it reflects senior management's support for action, signals staff to take the issue seriously, and illustrates to vendors the need to market PVC-free products. Educational programs - workshops, grand rounds, and conferences - can raise staff and management's awareness of the lifecycle hazards of PVC and the toxicity of DEHP. The time investment in planning and education internally can result in broader PVC reduction policies. For example, Tenet Healthcare and Universal Health Services entered into memoranda of understanding between management and shareholders on reducing PVC use throughout their hospital systems after learning about the hazards of PVC.

Tenet Healthcare agreed to: "investigate the availability and utility of PVC-free and phthalate-free disposable medical products available in the marketplace;" "seek information on a regular basis from its suppliers of disposable medical products concerning whether

their products are PVC-free and phthalate-free;" and "request its suppliers of disposable medical products to aid in the development of and further advancements in PVC-free and phthalate-free disposable medical products."

Notes

1. A few PVC-free products do contain chlorine, including neoprene gloves, which are manufactured from polychloroprene.
2. Christensson A, Ljunggren L, Nilsson-Thorell C, Arge B, Diehl U, Hagstam KE, Lundberg M. In vivo comparative evaluation of hemodialysis tubing plasticized with DEHP and TEHTM. *Int J Artif Organs* 14(7):407-10, 1991.
3. Quinn MA, Clyne JH, Wolf MM, Cruickshank D, Cooper IA, McGrath KM, Morris J. Storage of platelet concentrates—an in vitro study of four types of plastic packs. *Pathology* 18(3):331-5, 1986.
4. Currently wire and cable coated with PVC is the most difficult of these products to replace.
5. Trays are used to package surgical instruments, kits for surgical procedures, medical diagnostic kits, and admission kits.
6. Schlechter, M. *Plastics for Medical Devices: What's Ahead?* Norwalk, CT: Business Communications Company, Inc., 1996.
7. The Federation of Swedish County Councils, *PVC in the Swedish Healthcare System*, Stockholm, 2000.
8. "The PVC markets that are specifically targeted for replacement [by metallocene polyolefins] include flexible medical uses, packaging film, wire and cable insulation, transportation, flooring and geomembranes" (Aida M. Jebens, 1997, *Chemical Economics Handbook: Polyvinyl Chloride (PVC) Resins*, Palo Alto: SRI International, p. 580.1882B).
9. For a list of products see: www.sustainablehospitals.org.



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