

Why Health Care is Moving Away from the Hazardous Plastic Polyvinyl Chloride (PVC)

Health care leaders in Europe and the U.S. are increasingly preferring products that do not contain polyvinyl chloride (PVC) plastic. Kaiser Permanente, Vienna Hospital Association, Consorta, Stockholm County Council, Premier, Aarhus County (Denmark), and Catholic Healthcare West are among the leaders minimizing their PVC use in order to protect the health of patients, the public, and the environment.

PVC, or “vinyl” as it is often called, has some advantageous attributes, including flexibility, transparency, and strength. But PVC can also adversely impact human health and the environment. As a plastic, PVC differs from chemicals that health care professionals traditionally recognize as hazardous in their daily work, such as the sterilant ethylene oxide and the disinfectant glutaraldehyde. This is because the chemicals used to manufacture PVC products and the pollution they generate have until recently been largely invisible to health care professionals: they are outside of the walls of hospitals—either “upstream” in manufacturing or “downstream” in disposal.

Recent developments, however, have raised the awareness of health care professionals to the problems with PVC. Most notably that a chemical used to make PVC flexible is leaching out of PVC medical

devices and exposing patients. That chemical, di-2-ethylhexyl-phthalate (DEHP), is a reproductive toxicant. For this reason and others detailed below, many hospitals are seeking alternatives to PVC plastic medical devices, building products, and office supplies. Fortunately safer alternatives that meet or exceed the performance specifications of PVC products are widely available for most end uses. This fact sheet summarizes the hazards of PVC throughout the life of the product.

A12 San Francisco Chronicle ★★★★★

Toxic agent found in treated newborns is linked to plastic

Bay Area hospitals pressuring suppliers for safer products

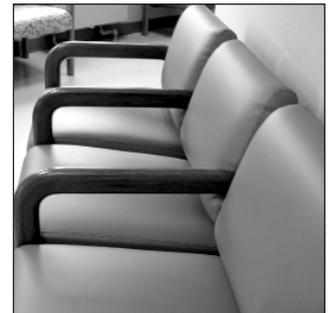
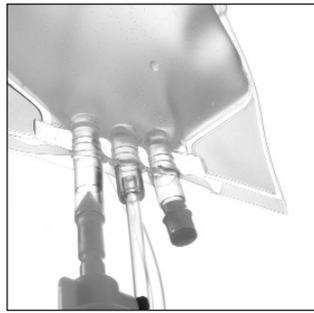
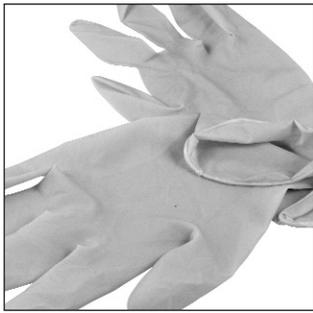
By Jane Kay
CHRONICLE ENVIRONMENT WRITER

Researchers have found a plastic-softening chemical used in some medical devices in the systems of newborn babies getting treatment in intensive-care units

sive care units.

Kaiser Permanente, Alta Bates Summit Medical Center, Catholic Healthcare West and the John Muir Medical Center in Walnut Creek, among others, already are buying mostly DEHP-free plastic devices, and pressuring manufacturers and suppliers to produce safe alternatives, according to representatives.

In addition, the American Academy of Pediatrics and the California Medical Association have recommended against using



Where is PVC used in hospitals?

IV bags and tubing, examination gloves, flooring, pipes, carpet backing, wall coverings, plastic food wrap, office furniture and supplies, etc.

PVC is used to make a wide variety of plastic products in hospitals, ranging from medical devices to building products to office supplies. PVC is used in both flexible and rigid applications. Most products are not labeled as PVC.

What is the chemistry behind PVC?

Chlorine, ethylene, and additives.

Figure 1 illustrates the key chemical stages in the manufacture of PVC. The chlorine content of PVC and the types of additives it requires distinguish PVC

from the vast majority of other plastics used in health care.¹ Unlike PVC, other plastics—including polyethylene (PET), polypropylene (PP), and ethylene vinyl acetate (EVA)—are not manufactured with chlorine, do not require metallic heat stabilizers to protect the plastic from degradation during production and use, and do not require “plasticizers”—softening agents—for flexibility. As detailed below, the chemicals used to manufacture PVC make it uniquely hazardous among plastics.

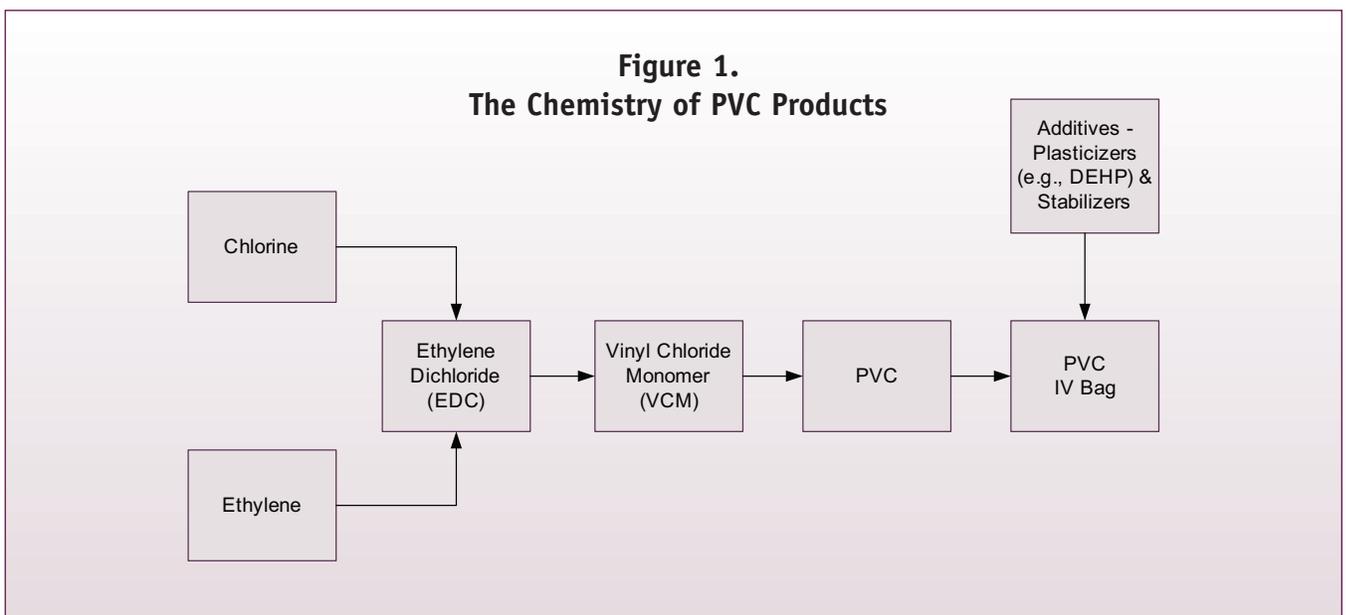
Why are there health concerns with PVC?

Highly hazardous chemicals:

- mercury
- DEHP
- dioxins, and other persistent, bioaccumulative, toxic organochlorines

- vinyl chloride monomer (VCM)
- lead, cadmium, and organotin (depending on the use/application)

Across its life cycle, from manufacture to use to disposal, PVC relies upon and creates chemicals that are highly hazardous to humans and the environment. Some, like mercury, dioxin, and vinyl chloride monomer, are released during manufacture. Some, like dioxin, are created when PVC is burned in a fire or an incinerator. Others, like lead, or other metal stabilizers, and DEHP, are added to PVC and may leach out during use and disposal. The use and generation of such hazardous chemicals, often hidden from health care practitioners, makes PVC a uniquely hazardous plastic.



What is the source of mercury in the PVC life cycle?

Chlorine production.

Chlorine can be manufactured from salt using three different processes.² One of these processes, the mercury cell process, is a significant source of mercury pollution. Environmental mercury enters into the food chain where it is ingested, primarily through fish consumption. Mercury damages the neurological development of children.³ Most states and localities have issued mercury fish consumption advisories warning children and women of reproductive age to limit their consumption of certain fish because of mercury contamination.

Despite the widely known hazards of mercury, chlorine producers continue to use the mercury cell process, with nine plants operating in the U.S. and 53 operating in Europe.⁴ These plants contain huge quantities of mercury, with an estimated 3,000 metric tons of mercury stored at existing facilities in the U.S.⁵ and some 12,000 tons of mercury in European chlor-alkali plants.⁶

The extent of mercury pollution from chlorine production is a matter of debate since the facilities' annual reports of mercury emissions are far less than the mercury they consume each year. For example, in 2002 the nine U.S. mercury cell facilities reported emissions of 7.0 metric tons of mercury, yet they purchased 25.5 metric tons of replacement mercury in 2002.⁷ For some reason, these chlorine facilities have 18.5 metric tons of "missing" mercury. With mercury releases in the U.S. ranging from 7.0 to 25.5 metric tons (including the missing mercury), chlorine facilities are a major, if not the largest, source of environmental mercury pollution.

Similar concerns have emerged in Europe, where 87 metric tons of mercury in chlorine plants were unaccounted for in 2000 and mercury

releases ranged from 8 to 95 (including the missing mercury) metric tons.⁸

PVC is the largest single end use of chlorine, accounting for 40% of all chlorine consumption.⁹ By virtue of its significant consumption of chlorine, PVC becomes a huge source of mercury pollution: ranging from a low of 2.8 metric tons (known releases) to a potential high (including missing mercury) of 10.2 metric tons per year in the U.S. and a low of 3.2 metric tons to a potential high of 38 metric tons per year in Europe.¹⁰

panel) have warned that certain patient populations such as sick infants may be harmed by DEHP leaching out of PVC medical devices. The agencies recommend that, when possible, health care providers use alternative medical devices that do not contain DEHP for treating vulnerable patient populations.¹²

Phthalates, including DEHP and others, are also used as plasticizers in flexible PVC building materials, such as vinyl flooring, carpet backing, wall coverings, electrical cable, shower curtains,

By virtue of its significant consumption of chlorine, PVC becomes a source of mercury pollution.

How are patients exposed to DEHP through PVC medical devices and building materials?

Flexible PVC medical products plasticized with DEHP can leach DEHP out of the medical devices during use and result in patient exposures.

DEHP is one of a family of chemicals known as "phthalates." Inherently a rigid material, PVC requires the addition of softening agents known as plasticizers to make it flexible. DEHP is the dominant plasticizer used in PVC medical devices.¹¹ Unfortunately, DEHP is a reproductive toxicant: animal studies have documented that the developing male reproductive system is most sensitive to DEHP exposure. DEHP leaches out of PVC under certain conditions, exposing patients who are being treated with DEHP-containing medical devices. DEHP exposures from PVC medical devices are well documented, with neonates in intensive care units receiving the highest exposures in hospitals. The US Food and Drug Administration, European Union, and Health Canada (expert

fabrics, and window treatments. The largest use of phthalates is in PVC building materials.¹³ Studies show that these phthalates migrate into the dust in buildings.¹⁴ An increasing body of scientific evidence points to a link between these phthalates in building interiors and asthmatic and allergic reactions in children.¹⁵

How does PVC contribute to dioxin pollution?

The chlorine content creates the potential for forming dioxins across PVC's entire life cycle.

The use of chlorine in PVC generates the possibility of dioxin formation throughout the PVC life cycle. Problems arise when chlorine mixes with what chemists call "organic" compounds to form "organochlorines."¹⁶ Dioxins, furans, and hexachlorobenzene are all examples of highly hazardous organochlorines (PVC itself is an organochlorine).

Dioxins are highly toxic chlorinated organic compounds, even at extremely low doses. The most potent dioxin

compound is a known human carcinogen, reproductive and developmental toxicant, and alters the immune and endocrine systems. Dioxins and related organochlorines are also persistent and bioaccumulative. These widely acknowledged hazards led to the inclusion of dioxins as well as furans (a similarly structured set of compounds) in an international treaty—the Stockholm Convention—to phase-out persistent organic pollutants (commonly referred to as POPs).

Unlike other industrial chemicals, dioxins and furans are not intentionally manufactured for use in products. Instead they are unintentional byproducts of industrial activity. The formation of dioxins, furans, and related organochlorines requires three conditions: the presence of chlorine, high temperature, and "organic" compounds. At any stage in the PVC life cycle where these three conditions are met, dioxins can result.

Thus dioxins and furans are formed:

- during the manufacture of chlorine, ethylene dichloride (EDC), and vinyl chlorine monomer (VCM);
- when accidental fires burn PVC products and building materials, for instance, in landfills or building fires; and
- when PVC is intentionally burned in medical waste and municipal waste incinerators, or other similar technologies.

Incineration remains a major source of dioxin emissions to the atmosphere in many countries, including Japan, the US and the European Union (EU). In the past, medical waste incinerators have been a major source of dioxins because of large quantities of PVC in medical waste and inadequate pollution controls. In recent years, incineration of medical waste has sharply declined.

What risks are associated with the chemicals ethylene dichloride (EDC) and vinyl chloride monomer (VCM)?

Cancer.

As illustrated in Figure 1, the production of PVC from chlorine and ethylene involves the creation of two intermediate chemicals: ethylene dichloride (EDC) and vinyl chloride monomer (VCM). Both EDC and VCM are highly toxic chemicals. EDC is classified as a possible human carcinogen and VCM as a known human carcinogen by the International Agency for Research on Cancer. The link between VCM and angiosarcoma of the liver in VCM workers led the U.S. Occupational and Safety Administration (OSHA) and the EU to set permanent standards to limit the exposure of plant workers to VCM.

People living adjacent to EDC/VCM/PVC manufacturing facilities are particularly vulnerable to EDC and VCM exposures. Significantly elevated levels of EDC and VCM have been recorded in the ambient air of communities neighboring these manufacturing facilities in Louisiana and Kentucky. For example, in the Calcasieu area of southwest Louisiana which has three VCM/PVC plants, ambient air concentrations have exceeded Louisiana air standards by as much as 102 times the VCM standard and 24 times the EDC standard.¹⁷

Any additional hazards associated with PVC?

Lead and other heat stabilizers.

Because PVC is susceptible to damage from heat and light during production and use, manufacturers add "heat stabilizers" to it to protect it from degradation. Many of these heat stabilizers are very hazardous chemicals, including cadmium, lead, and organotins. The once popular yet highly toxic cadmium stabilizers have largely been phased out. PVC manufacturers have been slower to move away from the lead stabilizers, which still dominate PVC coatings for electrical wires and were recently discovered in some PVC-lined children's lunch boxes.¹⁸ For other PVC products, especially in building products, the PVC industry is increasingly using organotins as stabilizers. The kinds of organotins used in PVC are toxic to the immune system in animal tests but data in humans are extremely limited.¹⁹ PVC medical devices do not use heavy metal stabilizers.

Is PVC recycled at the same rate as other plastics?

No.

PVC has the lowest post-consumer recycling rate among the commodity



plastics, with very few post-consumer PVC products recycled. The post-consumer PVC recycling rate is 3 percent in Europe and far below one percent in the U.S., where only 0.7% of PVC bottles are recycled.²⁰ A significant and unique challenge to recycling PVC is the wide variety of additives, including the heat stabilizers and plasticizers, incorporated into PVC products. The result is a PVC waste stream of products with highly variable inputs that are difficult to convert into products of value.²¹ In the recycling of other plastics, especially plastic bottles, PVC products are serious contaminants that reduce the value of the recycled material.²²

Recycling and landfilling PVC can also result in the dispersion of the toxic additives that are added to PVC products. For example, when PVC is landfilled, the additives—such as cadmium, lead, organotins, and phthalates—can leach from the plastic into landfill water (known as leachate), which can escape landfills and contaminate local ground water.²³

Are other plastics safer than PVC?

Yes.

Among the alternative plastics used for medical devices are polyethylene, polypropylene, polyurethane, silicone, ethylene vinyl acetate and multi-layer laminate plastics. Some of these plastics are also used for food packaging and office supplies. For building products, there are a wide range of substitutes, from materials such as wood and linoleum, to other plastics including polyethylene and polypropylene.

Since these plastics are inherently flexible, they do not require softening agents such as DEHP. And since the alternative plastics do not contain chlorine, they do not need heat stabilizers and avoid the life cycle formation of highly hazardous chlorinated organics.

Are these safer plastics readily available and cost effective for use in health care?

Yes.

The health care market has responded to concerns about PVC use and is increasingly bringing to market new alternatives. Many of the devices are cost competitive with PVC products. A list of PVC-free medical devices can be found at www.noharm.org. Moreover, health care facilities committed to eliminating their use of PVC are communicating their needs to manufacturers, who are responding with new PVC-free products, including carpeting, resilient flooring, wall protection and more. A list of PVC free building materials can be found at <http://www.healthybuilding.net/pvc/alternatives.html>.

What can health care do?

Health care institutions can take action to reduce their reliance on PVC products and materials. Hospitals can:

- Establish an organization-wide PVC reduction policy;
- Perform an audit to identify PVC medical devices and building materials;
- Identify PVC-free alternatives for medical devices and building materials; and
- Reduce PVC throughout the institution.

For more information and resources, please go to www.noharm.org/us/pvcDehp/issue.

Resources

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This publication is part of *Going Green: A Resource Kit for Pollution Prevention in Health Care*. For additional copies of this or other publications included in the kit, or to find out how to get a complete kit, visit Health Care Without Harm on the Web at www.noharm.org/goinggreen.



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