PHTHALATES IN PVC MEDICAL PRODUCTS FROM 12 COUNTRIES

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A Greenpeace investigation revealed the widespread presence of DEHP[i], a toxic phthalate softener, in a sample of 46 common PVC medical products from twelve countries. Like toys, soft PVC medical products easily release DEHP to surrounding fluids. This occurs in devices such as intravenous (IV) bag solutions. Many countries have already taken precautionary action to restrict the use of DEHP and other phthalates in PVC toys due to concerns about exposure in young children (see Appendix 1). The U.S. toy industry voluntarily stopped using DEHP in toys designed for the mouth in 1986.[ii] No similar restriction exists for PVC medical devices that release DEHP directly into the body.

The U.S. Environmental Protection Agency currently considers DEHP to be a probable human carcinogen.[iii] Evaluation of DEHP in the European Union (EU) has changed in the last 10 years. In 1990, the EU stated that DEHP "should not be classified as carcinogenic or an irritant substance".[iv] In 1998, the EU Scientific Committee concluded that the relevant critical effect of DEHP for humans was testicular damage.[v] Currently, EU lab researchers receive the following safety information about DEHP: R45, may cause cancer; R62, possible risk of impaired fertility; R63, possible risk of harm to the unborn child; and R36/37/38, irritating to eyes, respiratory system, and skin.[vi]. Peer-reviewed animal studies of DEHP exposure have revealed toxic effects on the developing foetus, reproductive system, liver, kidneys, heart, and lungs.[vii, viii, ix, x, xi, xii, xiii, xiv]

Since DEHP and other phthalates are not chemically attached to the plastic, they are easily released to surrounding fluids (IV solutions, blood) and air (infant respiratory therapy).[xv] Some clinically important drugs actually increase the release of DEHP. Pharmaceutical manufacturer Bristol Myers Squib Co. warns that Taxol (paclitaxel), a drug used to treat AIDS-related Kaposi's sarcoma and breast cancer, should not be used in PVC containers or tubing because DEHP levels "increase with time and concentration".[xvi] Other drugs incompatible with PVC include: the anti-anxiety drug Librium (chlordiazepoxide HCl), the anti-fungal drug Monistat IV (micronazole), the immunosuppresant Sandimmune (cyclosporine) and various fat emulsions.[xvii]

Humans are exposed to DEHP from PVC medical products in a variety of common treatments. Dialysis patients receive large doses of DEHP if PVC tubing is used for treatment.[xviii, xix] Patients needing blood transfusions are also infused with DEHP since PVC blood bags release significant amounts

of DEHP into stored blood.[xx] IV bag manufacturers admit that DEHP also leaches into sodium chloride and dextrose solutions commonly used in patient IV solutions.[xxi] In fact, the DEHP levels measured in IV solutions are more than 800 times higher than permitted levels in the U.S. drinking water.[xxii]

Manufacturers of medical products also warn about DEHP release and exposure in another sensitive population: nursing mothers and children.[xxiii] DEHP has been measured in the blood of infants receiving exchange transfusions and extracorporeal membrane oxygenation as well as the lungs of infants undergoing respiratory therapy.[xxiv, xxv, xxvi] The World Health Organization summed up the situation as follows: "Case reports of adverse effects linked to haemodialysis and artificial ventilation underscore the need to reduce exposure arising from the use of plastic tubes containing DEHP in such clinical procedures as transfusion, haemodialysis, and artificial respiration."[xxvii]

A sampling of common PVC medical products from EU countries, Brazil, India, Philippines, and U.S., showed that DEHP was widely present. Table 1 shows that this sample of PVC medical products contained between 12% and 80% DEHP by weight. These levels were also observed in a previous sample of PVC medical products from the U.S. that contained between 29% and 81% DEHP by weight (Table 2). Both medical product samples contained amounts of DEHP similar to, and in some cases, greater than the levels of phthalates previously found in PVC toys (6%-41%).[xxviii, xxix, xxx, xxxi]

PVC medical products containing large amounts of DEHP included IV bags, an enteral nutrition bag, various types of tubing, and syringes. Without DEHP, these PVC medical products would be hard and brittle. In contrast, Tables 1 and 2 shows that high levels of DEHP could not be detected in the non-PVC versions of these products since they do not require a chemical additive to make them pliable.

Surprisingly, some "non-PVC" products actually included PVC parts that would still result in patient exposure to DEHP. For example, a Baxter non-PVC parenteral nutrition bag used in the UK (Baxter, Miramed) consisted of a non-PVC bag connected to PVC tubing containing 80% DEHP. In addition, low levels of DEHP (<0.05%) were detected in some non-PVC samples, probably reflecting contamination; possibly during manufacturing or packaging with PVC parts of the same product. Good quality control should yield non-PVC products with undetectable amounts of DEHP (Tables 1 and 2).

Fortunately, the exposure of patients to DEHP through use of PVC medical products is unnecessary due to the availability of safer alternative materials for most uses except red blood cell storage.[xxxii, xxxiii, xxxiv] The small sample of medical products in Table 1 contains non-PVC products from Austria, Brazil, Denmark, Netherlands, U.K., and U.S. These products include tubing, IV bags, parenteral and enteral nutrition bags, and syringes. All of them are approved by the relevant government regulatory agencies.

The medical products market in Europe is dominated by four manufacturers: Fresenius, B. Braun, Baxter/Clintec, and Pharmacia.[xxxv] All four companies sell non-PVC products and examples are shown in Table 1. Other companies offering non-PVC products include Codan, Ohmeda, Clinico, Plasti Medical, Baird, Corpak, and Aster Productos Medicos (Tables 1 and 2; see [xxxvi] for review). B. Braun is a major provider of non-PVC medical products in Europe and the only supplier of non-PVC IV bags in the U.S. where it commands about 20% of the market (as B. Braun McGaw). The largest U.S. medical products manufacturer is Baxter Healthcare. In March 1999, Baxter committed to "exploring and developing alternatives to PVC products" worldwide after U.S. shareholders filed a resolution asking for implementation of a materials substitution policy.[xxxvii] In contrast, U.S.-based Abbott Laboratories rejected a PVC substitution policy and apparently is not a contender in the non-PVC market.

EU Directive 93/42/EEC states requirements for medical products that point towards adoption of non-PVC materials.[xxxviii] For example, the directive requires that medical devices should "eliminate or reduce risks as far as possible" through "inherently safe design and construction". This requirement contradicts an inherent part of PVC product design that requires chemical softeners such as DEHP because PVC is hard and brittle. The directive also explicitly states that medical devices "must be designed and manufactured in such a way as to reduce to a minimum the risks posed by substances leaking from the device" and that "particular attention must be paid to the choice of materials used, particularly as regards toxicity….". The risk that accompanies the leaching of toxic softeners such as DEHP has already been eliminated with alternative materials that do not require it for pliability.

A precautionary approach to health policy would eliminate PVC in medical product design due to its requirement for toxic additives such as DEHP, as well as its link to dioxin production in manufacture and disposal by incineration.[xxxix] Health professionals have a special responsibility in this regard since their guiding ethic is 'first, do no harm.'

Materials and Methods

Products were provided by medical personnel from the country of use. Phthalate determinations were performed by Stat Analysis, Chicago, Illinois AIHA-, ELLAP-, NIST/NVLAP-accredited. Samples were prepared according to EPA Method 3550M and phthalate content was determined essentially according to EPA Method 8270M.[xl] All testing was conducted in duplicate.

Table 1. DEHP in PVC and non-PVC medical products from 12 countries

Country	Item	PVC	DEHP (%)
Austria	IV bag; 1000 ml; non-PVC Mfr: Modenplast; Italy	no	0.05
	Parenteral nutrition bag; Dimix, 1 L; Mfr: Diffuplast; Italy	no	0.02
	Tubing; parenteral nutrition bag, Dimix, 1 L mfr: Diffuplast; Italy	yes	46
	Tubing; non-PVC IV bag Mfr: Modenplast, Italy	yes	41
	Tubing; 150 cm Intrafix Air Neutrapur PVC-free set; mfr: B. Braun; Germany	no	ND
	Tubing, 150 cm Intrafix Air IV set for gravity infus. mfr: B. Braun; Germany	yes	46
	Tubing; 180 cm Tutoplus PVC-free, EVA mfr: Plasti Medical S.p.A.; Italy	no	ND
Brazil	Bottle; 0.9% NaCl 125 ml Mfr: Aster Productos Medicos; Brazil	no	ND
	IV bag; 0.9% NaCl 1000 ml Mfr: Aster Productos Medicos; Brazil	no	NT
	IV bag; 0.9% NaCl 1000 ml Mfr: Baxter Healthcare; Brazil	yes	36
Denmark	Syringe; Sangofix blood admin. Set Mfr: B. Braun; Germany	no	ND
	Tubing; Sangofix blood admin. Set Mfr: B. Braun; Germany	yes	41
	Tubing; suction catheter, 53cm, Mfr: Maersk Medical; Germany	yes	38

Abbreviations: mfr, manufacturer; ND, below detection limit of 0.01%; NT, not tested; DEHP, di(2-ethylhexyl) phthalate. Results shown are the averages of duplicates. The average coefficient of variation was 7.8%.

Table 1 continued

France	IV bag; Tuliflex 250 ml 0.9% NaCl mfr: Laboratoire Aguettant; France	yes	35
	IV bag; Tuliflex 1000 ml 0.9% NaCl mfr: Laboratoire Aguettant; France	yes	37
Germany	IV bag; 2500 ml; Ecobag mfr: B. Braun; Germany	no	ND
Greece	tubing; IV set solutran-set mfr: Lovero Valtellino; Italy	yes	43
	tubing; duodenal tube Pharmaplast mfr: Maersk Medical; Denmark	yes	36
	tubing; duodenal tube Levin mfr: Uroplast A/S; Denmark	yes	41
India	syringe; Hema-Flo infusion set mfr: Hemant Surgical Ind.; India	yes	16
	tubing; Hema-Flo infusion set mfr: Hemant Surgical Ind.; India	yes	41
	tubing; Ryle's tube 105 cm mfr: Romsons Sci & Surg Ind.; India	yes	41
	tubing; JMS infusion set type 220 mfr: Japan Medical Supply; Singapore	yes	44
Netherlands	IV bag; Urias A Series 1500 ml mfr: Urias; Denmark	yes	36
	tubing; Foly catheter Bardia PTFE mfr: Bard Limited; UK	no	ND
	tubing; Codan Med. transfusion set mfr: GmbH & Co; Germany	yes	46
Philippines	tubing; Medichoice duodenal tubing; mfr: Indoplas; Philippines	yes	31
	tubing; McDrip IV set mfr: Cosmo Medical Inc.; Philippines	yes	28

Table 1 continued

	Tubing; Intrafix IV gravity infusion mfr: B. Braun; Germany	yes	35
	Tubing; McVein blood transfusion set mfr: Globe Medical Products; U.S.	yes	36
Spain	IV bag; 750 ml mfr: Hollister Iberica, SA; Spain	yes	27
	syringe; IntrasetI10 Luer Sistema de Infusion; mfr: Intraven, SA; Spain	yes	26
	Tubing; IntrasetI10 Luer Sistema de Infusion; mfr: Intraven, SA; Spain	yes	23
	Tubing; suction catheter mfr: Dahlihausen MedTech.; Germany	yes	29
	Tubing; Izasa Sonda Duodenal mfr: Maersk Medical; Denmark	yes	31
U.K.	IV bag; Macoflex 50 ml 0.9% NaCl mfr: Maco Pharma; UK	yes	36
	IV bag; 500 ml EVA bag mfr: Pharmacia & Upjohn; Ireland	no	ND
	parenteral nutrition bag; 1 L EVA Mfr: Clintec Nutrition; UK	no	0.03
	parenteral nutrition bag; Miramed 1 L Mfr: Baxter; Italy	no	ND
	Tubing; EVA parenteral nutrition bag Mfr: Clintec Nutrition; UK	yes	40
	Tubing; Miramed parenteral nutrition bag mfr: Baxter; Italy	yes	80
	Tubing; 2 lead transfer set mfr: Pharmacia; Ireland	yes	40
U.S.	enteral feeding bag; 500 ml Polar mfr: Corpak; U.S.	no	ND
	enteral feeding bag; 500 ml	yes	12

mfr: Sherwood Medical; U.S.		
Tubing; for enteral feeding bag; 500 ml Polar; mfr: Corpak; U.S.	yes	32
Tubing; for enteral feeding bag; 500 ml mfr: Sherwood Medical; U.S.	yes	35

Table 2. DEHP in PVC and non-PVC medical products from the U.S.

Country	Item	PVC	DEHP (%)
U.S.	Blood bag; CPDA-1 Whole Blood PL146; mfr: Baxter	yes	65
	Catheter; Tri-flo suction catheter 14Fr Mfr: Baxter	yes	41
	IV Bag; 0.9% sodium chloride injection USP 250 ml mfr: Baxter	yes	42
	IV Bag; 0.9% sodium chloride injection USP 250 ml mfr: Baxter	yes	39
	IV Bag; 0.9% sodium chloride injection. mfr: B. Braun McGaw	no	ND
	Syringe in IV tubing; primary IV set NO. 11961 mfr: Abbott	yes	29
	Syringe in IV tubing; vented solution set 105'' long; mfr: Baxter	yes	30
	tubing; 36" arterial pressure tubing No. 42363-01; mfr: Abbott	yes	29
	tubing in blood bag; CPDA-1 whole blood PL146 mfr: Baxter	yes	67
	tubing in IV Bag; primary IV set NO. 11961 mfr: Abbott	yes	81
	tubing in IV Bag; vented solution set 105'' long; mfr: Baxter	yes	35

Abbreviations: mfr, manufacturer; ND, below detection limit of 0.02%; DEHP, di(2-ethyl hexyl) phthalate. Results shown are the averages of duplicates. The average coefficient of variation was 9.8%.

Source: Di Gangi, J. “Phthalates in vinyl medical products” Greenpeace USA. February 1999.

Appendix 1. Government actions and initiatives on PVC toys

Country	Action
Austria	Phthalates in toys for children under three years old banned in August 1998, in full effect in January 1999.
Belgium	Toy retailers urged to take immediate voluntary measures to cease the marketing of soft PVC toys designed to be chewed by young children by Marcel Colla, Minister of Public Health in October 1997.
Canada	Parents advised to throw away soft PVC (vinyl) toys designed to be sucked or chewed by the federal government health authority, Health Canada, "because there are scientific indications of a potential health risk for very young children (weighing less than 8kg) who have high oral contact with soft vinyl products".
Denmark	Phthalates in toys and childcare articles for children under three and in products to be used as toys by children under three banned in April 1999 and will take effect in April 2000.
Finland	The Finnish government has banned the use of five phthalate additives in soft PVC toys and childcare products for children under three that are intended for oral use beginning November 1, 1999. These soft PVC products may not contain more than 0.05% of the relevant phthalates.
France	In July 1999, France placed a one-year immediate ban on toys and childcare items made from soft PVC containing six phthalate softeners. The ban covers the sale, import, export and manufacture of items intended to be placed in the mouth of children under 3 years of age. France also notified a permanent national ban of the same scope to the European Commission.
Germany	In August 1999, the Federal Health Minister of Germany, Andrea Fischer, gave a 3 month notification to the European Commission that Germany will ban the use of all phthalates in teething rings and toys for children under three years of age.
Greece	The import and sale of all soft PVC toys for children under three was banned on January 15, 1999. The ban on sales became effective September 1999.
Italy	During 1998, 37 provinces passed resolutions opposing the use of soft PVC toys in Italy. Further, in early March 1999, the Ministry of Industry notified the European Commission that it was intending to ban all toys for children under three that contain phthalate additives. The ban would begin 15 days after publication in the national official journal.

Appendix 1 continued

Country	Action
Mexico	The Health Ministry announced on November 30, 1998 that it would stop the import of soft PVC toys for small children and withdraw these products from sale.
Netherlands	After testing teethers, rattles and toy figurines sold for babies, the Ministry of Health found that the Dutch acceptable daily intake of one softening chemical would be exceeded by 5 - 50% for all babies sucking or chewing on PVC teethers. On July 16, 1997, the ministry urged major retailers to take voluntary measures to "avoid this unnecessary and unwanted exposure of babies to phthalates in baby toys" and "no longer to market toys for babies which contain PVC which has been softened".
Philippines	On October 24, 1997, the Philippines Department of Health issued a press statement, citing Greenpeace's findings, and called on all toy retailers and manufacturers to remove from sale "soft PVC toys and infant care products for infants/children under 3 years of age." The government also recommended the use of alternatives to soft PVC that do not require additives or softeners.
Norway	On December 18, 1998 the Norwegian EPA proposed a ban on the use of phthalates in toys sold for children under three years old that came into force on July 1, 1999.
Sweden	In September 1998, Sweden notified the European Commission of a ban on phthalates in toys for children under three years old. The ban came into force on August 1, 1999 and will take effect on April 1, 2000. The proposal also includes a provision to prohibit other chemical additives from replacing phthalates.
U.S.	On December 2, 1998, the Consumer Product Safety Commission (CPSC) announced a voluntary withdrawal on the manufacturing of teething toys containing phthalates and requested retailers withdraw these products from their shelves. DEHP use in toys designed for the mouth was voluntarily restricted in 1986 at the request of the CPSC.

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