Understanding the Safety of the DEHP Substitutes

vinyl plus healthcare

COMMITTED TO SUSTAINABILITY IN MEDICAL APPLICATIONS

Background

Polyvinyl chloride, known as PVC or vinyl is the single most used plastic for disposable medical devices such as masks, tubing and bags. Most of the PVC-based medical devices are soft, which requires that a so-called plasticiser is added to the compound. For many years the plasticiser of choice was the phthalate DEHP. Based on its toxicological profile the substance has been under increasing scrutiny by regulatory and medical authorities.

Under the EU Medical Device Regulation (MDR), DEHP may continue to be used in legacy medical devices during the transition period, provided its presence is justified according to the latest SCHEER guidelines. The MDR transition deadlines are 31 December 2027 for high-risk devices and 31 December 2028 for low- and medium-risk devices.[1] Under the EU's chemical regulation REACH, the sunset date for DEHP is 1 July 2030.[2]

The plasticiser industry has invested more than €6 billion in developing safe alternatives to DEHP. For medical applications, the European Pharmacopoeia has since 2016 listed the following plasticisers as suitable replacements: DINCH, BTHC, TOTM, and DEHT (also known as DOTP/DEHTP).[3]

These plasticisers are technically suitable for replacing DEHP across virtually all medical applications, including blood bags, as demonstrated by recent studies from European blood services.[4] In Europe, the switch has already taken place, and most PVC-based medical devices are now produced using DEHP-free plasticisers.

Yet some stakeholders are questioning the safety of the new plasticisers, which this document seeks to address.

1. Aren't all plasticisers alike?

A main concern related to plasticisers is that they can migrate, leach, or evaporate from the products as they are not chemically bound to the PVC matrix. In certain medical treatments, this can lead to relatively high exposure to DEHP.

However, not all plasticisers are alike. The adverse effects associated with DEHP and other low molecular weight (LMW) phthalates are linked to their specific molecular structures. The authorised DEHP substitutes have very different structures, migrate far less, and do not exhibit the adverse effects observed with LMW phthalates.

2. What has industry done to prove the safety of the DEHP substitutes before introducing them on the market?

The authorised DEHP substitutes were thoroughly tested before they were introduced in medical devices. Development of these substances began years before the introduction of the REACH regulation, and they were designed specifically to avoid the toxicological concerns associated with DEHP and other low molecular weight (LMW) phthalates.

Under the EU chemicals regulation REACH, manufacturers must prove that a substance is safe before it can be placed on the market. This requires registration with the European Chemicals Agency (ECHA) and the submission of extensive toxicological and environmental data. Because these plasticisers are used in multiple regulated applications, they are subject to the full REACH information requirements, meaning their complete toxicological and environmental profile has been generated and assessed.[5]

For medical devices, which fall under the EU Medical Device Regulation, manufacturers must provide an additional benefit–risk analysis and demonstrate that the material is safe for the intended clinical use.[6]

The safety data generated for these assessments cover all relevant endpoints, including acute toxicity, skin and eye irritation, sensitisation, repeat-dose toxicity, genotoxicity, carcinogenicity, reproductive and developmental toxicity, and potential endocrine activity. Environmental effects are also evaluated.

The plasticiser producers continue to meet their obligations as REACH registrants by updating their dossiers whenever new information becomes available that could influence the substance's classification, labelling or risk-management measures. This includes incorporating new data on long-term effects, high-dose toxicological studies and any other relevant safety findings.

In summary: the substitutes were extensively tested, assessed under the EU's strictest regulatory frameworks, and demonstrated to be safe for use in medical devices.

3. We don't know the long-term consequences of the DEHP substitutes. Shouldn't we use the precautionary principle and avoid using the substances, in particular in medical devices that are used on newborns or other vulnerable patients?

The four plasticisers listed in the European Pharmacopoeia for medical use (DINCH, BTHC, TOTM, and DEHT) have been in use for more than 20 years, with no adverse effects observed during clinical use. In addition to the extensive studies submitted under the REACH regulation, DINCH, BTHC, and DEHT have undergone repeat-dose toxicity testing via the intravenous route, covering exposure durations sufficient for medical safety assessment.

Importantly, long-term human biomonitoring data confirm their safe use in the general population, including vulnerable groups. A recent study from the German Environmental Specimen Bank, covering the period 1988 to 2022, shows that population exposure to DEHP substitutes such as DINCH and DEHT remains consistently low and well below conservative health-based guidance values.[7]

These large-scale, government-run datasets provide robust evidence that real-world exposure to the substitutes is minimal, even as their use has increased.

Taken together, two decades of clinical use, extensive toxicological assessment and long-term biomonitoring data provide strong evidence that these substitutes are safe, including for newborns and other vulnerable patients.

4. Isn't it better to replace PVC altogether to avoid plasticisers?

Plasticisers are among the most extensively studied chemical groups in the world. While some low molecular weight (LMW) phthalates such as DEHP have raised concerns, the authorised substitutes used today – DINCH, DEHT, BTHC, and TOTM – have very different molecular structures and well-established safety profiles. In Europe, these substitutes have already replaced LMW phthalates in almost all medical applications.

However, replacing PVC with another plastic does not eliminate the need for additives. Other polymers also require a wide range of chemicals to achieve flexibility, transparency, durability, softness or fire performance – and many of these additives can migrate.

Recent analyses show that more than 16,000 chemicals are used in plastics, with at least 4,200 substances identified as of potential concern based on EU persistence, bioaccumulation or toxicity criteria.[8] Likewise, a 2025 study of food-contact materials identifies over 1,200 hazardous chemicals, including in many so-called PVC-free polymers. [9] These findings clearly demonstrate that simply replacing PVC does not guarantee improved safety.

Concrete examples illustrate the risk of regretful substitution. The classified phthalate DIBP has been found migrating from polypropylene (PP) and polyethylene (PE) products, likely originating from catalyst mixtures used in their production.[10]

European authorities recognise these issues. As stated by the European Commission's Directorate-General for Environment, the "[u]se of alternative plastics in direct physical contact with patients poses similar issues to PVC with regard to transfer of toxic additives to the body."[11]

Taken together, the evidence shows that replacing PVC without a thorough evaluation of the alternatives risks introducing new, and potentially greater, chemical exposure concerns. Thus, a material change does not guarantee higher safety – and may lead to regretful substitution.

5. Are there any third-party bodies such as government agencies that have assessed the safety of the DEHP substitutes?

- Not classified as hazardous according to the CLP Regulation.[12]
- DINCH and DEHT were subject to PACT and REACH compliance checks by ECHA. For some other substances minor formal requirements need to be completed to comply with increase production volumes under REACH.
- Listed for medical applications by the European Pharmacopoeia.[13]
- Meet requirements of the EU Medical Device Regulation.[14]
- Evaluated by the European Food Safety Authority (EFSA).
- Evaluated by the French Agency for Food, Environmental and Occupational Health & Safety (ANSES).[15]
- Evaluated by the Danish Environmental Protection Agency.[16]
- Evaluated by the Swedish Chemicals Agency.[17]

- Evaluated by the European Commission's Scientific Committee on Emerging and Newly-Identified Health Risks (SCENIHR).[18]
- Toxicity reviews by the US Consumer Product Safety Commission.
- Assessment by the Australian Inventory of Chemical Substances (AICS).
- Peer-reviewed publications by the US NSF (health advisory board chaired by the US EPA).

Endnotes

[1] European Parliament and Council of the European Union. (2023). Regulation (EU) 2023/607 of the European Parliament and of the Council of 15 March 2023 amending Regulations (EU) 2017/745 and (EU) 2017/746 as regards the transitional provisions for certain medical devices and in vitro diagnostic medical devices. Official Journal of the European Union. http://data.europa.eu/eli/reg/2023/607/oj

[2] European Commission. (2023). Commission Regulation (EU) 2023/2482 of 13 November 2023 amending Regulation (EC) No 1907/2006 of the European Parliament and of the Council as regards the substance bis(2-ethylhexyl) phthalate (DEHP) in medical devices. Official Journal of the European Union, L 2023/2482, 14 November 2023. http://data.europa.eu/eli/reg/2023/2482/oj

[3] European Directorate for the Quality of Medicines & HealthCare. (2024). 3.1.13 Plastic additives (Monograph 01/2020:30113). In European Pharmacopoeia (12th ed.). EDQM. https://www.edqm.eu/en/european-pharmacopoeia-new-online-only-12th-edition

[4] Chartois, A., Aoustin, L., Rivery, E., Colombat, M., Acquart, S., & Bigey, F. (2023). In vitro evaluation of red cell concentrates and plasma prepared and stored in non-DEHP bags from whole blood collected in full non-DEHP in-line system. Vox Sanguinis, Volume 118(Issue S1), 6-118. https://doi.org/10.1111/vox.13433

L Lasocka, J., Goczynska, P., Potocka, E., Rosiek, A., & Lachert, E. (June 2023). Evaluation of containers with innovative PVC plasticizer used for 42-day storage of BCR-AS. Vox Sanguinis, Volume 118 (Issue S1), 6-118. https://doi.org/10.1111/vox.13433

Lagerberg, J., Go, M., Vlaar, R., Klei, T. (June 2023). Comparison of the in vitro quality of red cell concentrates, prepared from whole blood collected in DINCH-PVC and stored in BTHC-, DEHT- and DINCH-PVC storage bags. Vox Sanguinis, Volume 118(Issue S1), 6-118. https://doi.org/10.1111/vox.13433

[5] European Chemicals Agency. (n.d.). Understanding REACH. https://echa.europa.eu/da/regulations/reach/understanding-reach; European Chemicals Agency. (n.d.). ECHA CHEM. https://chem.echa.europa.eu; European Chemicals Agency. (n.d.). Registered substances. https://echa.europa.eu/information-on-chemicals/registered-substances

[6] European Parliament & Council of the European Union. (2017). Regulation (EU) 2017/745 of 5 April 2017 on medical devices, amending Directive 2001/83/EC, Regulation (EC) No 178/2002 and Regulation (EC) No 1223/2009 and repealing Council Directives 90/385/EEC and 93/42/EEC (consolidated version as of 10 January 2025) .http://data.europa.eu/eli/reg/2017/745/2025-01-10

[7] Kasper-Sonnenberg, M., Pälmke, C., Wrobel, S., Brüning, T., Murawski, A., Apel, P., Weber, T., Kolossa-Gehring, M., & Koch, H. M. (2024). Plasticizer exposure in Germany from 1988 to 2022: Human biomonitoring data of 20 plasticizers from the German Environmental Specimen Bank. Environment International, 109, 109190. https://doi.org/10.1016/j.envint.2024.109190

[8] PlastChem. (2024). State of the science on plastic chemicals. https://plastchem-project.org. p. 34

[9] Wiesinger, H., et al. (2025). Food Contact Chemicals Priority (FCCprio) List. Zenodo. https://doi.org/10.5281/zenodo.14881617

[10] Tegengif. (2024). Report on plastic drinking bottles. https://www.tegengif.nl/wp-content/uploads/2024/09/report_plastic_drinking_bottles_2024.pdf

[11] European Commission, Directorate-General for Environment, (2022). The use of PVC (poly vinyl chloride) in the context of a non-toxic environment : final report, Publications Office of the European Union. https://data.europa.eu/doi/10.2779/375357. p. 298.

[12] European Union. (2025). Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures (consolidated version: 01 September 2025). http://data.europa.eu/eli/reg/2008/1272/2025-09-01

[13] European Directorate for the Quality of Medicines & HealthCare. (2024). 3.1.13 Plastic additives (Monograph 01/2020:30113). In European Pharmacopoeia (12th ed.). EDQM. https://www.edqm.eu/en/european-pharmacopoeia-new-online-only-12th-edition

[14] European Parliament and Council of the European Union. (2023). Regulation (EU) 2023/607 of the European Parliament and of the Council of 15 March 2023 amending Regulations (EU) 2017/745 and (EU) 2017/746 as regards the transitional provisions for certain medical devices and in vitro diagnostic medical devices. Official Journal of the European Union. http://data.europa.eu/eli/reg/2023/607/oj

[15] European Plasticisers. (2016, March 18). No further regulatory risk management action needed for DEHTP and DINCH, ANSES confirms. https://www.plasticisers.org/news/no-further-regulatory-risk-management-action-needed-for-dehtp-and-dinch-anses-confirms

[16] Danish Environmental Protection Agency. (2014). Alternatives to classified phthalates in medical devices. https://www2.mst.dk/Udgiv/publications/2014/03/978-87-93178-27-4.pdf

[17] Swedish Chemicals Agency. (2015). Phthalates which are toxic for reproduction and endocrine-disrupting – proposals for a phase-out in Sweden. https://www.kemi.se/download/18.6df1d3df171c243fb23a98ed/1591454109598/report-4-15-phatalates.pdf

[18] Scientific Committee on Emerging and Newly Identified Health Risks. (2016, February). The safety of medical devices containing DEHP-plasticized PVC or other plasticizers on neonates and other groups possibly at risk (2015 update). European Commission. https://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_047.pdf