CHEMICALS
of concern for the
HEALTH SECTOR

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Health Care Without Harm

Acknowledgment

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Abbreviations

A-	Asthmagen
C-	Carcinogenic
CAS:	Chemical Abstract Service
CMR-	Carcinogenic, mutagenic (developmental toxin), and reproductive hazard
EDCs:	Endocrine disrupting chemicals
GHS:	Globally Harmonized System of Classification and Labelling of Chemicals
HCWH:	Health Care Without Harm
IARC:	International Agency for Research on Cancer
M-	Mutagenic hazard
ODS:	Ozone-depleting substances
PBT-	Persistent, Bioaccumulative and Toxic
POPs:	Persistent Organic Pollutants
REACH:	Registration Evaluation and Authorisation of Chemical Substances Regulation
R-	Reproductive hazard
S-	Sensitive to skin and other organs
SDGs:	Sustainable Development Goals
SPHS:	Sustainable Procurement in the Health Sector
T-	Toxicity
UNDP:	United Nations Development Programme
vPvB-	very Persistent and very Bioaccumulative
WHO:	World Health Organisation

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1. About the document

This document is based on the report "Chemicals of Concern to Health and Environment"[1] published by Health Care Without Harm and UNDP in 2018. The chemicals listed in the document were carcinogen, mutagen, endocrine disruptor or reproductive hazards and/or bioaccumulative and persistent to the environment based on the authoritative lists[2]. Extracted from the 2018 report, the current document includes the list of chemicals used by the health care sector and/or included in health products. In addition, the document includes case examples that demonstrate how hospitals have successfully substituted chemicals and chemicals in products with more sustainable alternatives. The case studies showcase how health systems are moving away from hazardous products by substituting with safer alternatives.

The intended audience for this document are health sector procurement officers, sustainability coordinators, and others concerned with procuring and using safer and more sustainable materials. The document is designed to help health care facilities identify the type of hazards, the application and use of the chemicals, their safer alternatives. The list can also be used by suppliers, in order to identify products containing the chemicals for elimination or substitution with less hazardous, clinically appropriate alternatives.

2. Context

Chemicals are widely used in daily life. They have a unique importance in the health sector, where they are used as disinfectants, cleaning agents, laboratory reagents, sterilants, pesticides, pharmaceuticals, medical devices and equipment, furnishings and building materials and are unintended chemical by-products, like dioxins, produced during medical waste incineration. The hazards of the chemicals are not well understood by health professionals nor adequately incorporated into procurement decisions.

To minimize the hazards, the health sector has been taking steps to promote and implement sustainable health care within their institutions and to collaborate externally with suppliers and manufacturers to advance sustainable procurement within the health sector.

The Sustainable Development Goals (SDGs) and the 2030 agenda are important drivers to promote sustainable health systems. Specifically SDG3 on good health and wellbeing and SDG12 on sustainable consumption and production.

WHO's chemical roadmap and workbook[3] responds to chemical risk reduction by providing guidance for health care settings to promote and facilitate the use of safer alternatives and sound management of health care waste. WHO calls on health leaders to develop and implement awareness campaigns for health workers about chemicals of concern and to establish best practices for safe chemicals management within the health sector, including occupational, patient/community and environmental impacts in health care settings. Increasingly hospitals are substituting some of the most hazardous chemicals with safer alternatives without compromising the quality of patient care and are modifying their procurement criteria to reduce hazardous chemicals in the products that they use. The UN informal interagency task team on Sustainable Procurement in the Health Sector (SPHS), of which WHO is a member alongside UNDP and five other UN agencies, agreed to a joint statement: "Engaging with suppliers and manufacturers to promote environmentally and socially responsible procurement of health commodities."[4] These initiatives by WHO and other UN agencies contribute to the health of people and the planet and move the health sector toward more sustainable practices.

1 https://noharm-global.org/sites/default/files/documents-files/6471/Chemicals of Concern to Health and Environment.pdf

2 Authoritative lists: WHO's International Agency for Research in Cancer (IARC) list of probable and known human carcinogens; The European Union list of Substances of Very High Concern and Restricted Substance List as determined under the Registration Evaluation and Authorisation of Chemical Substances (REACH) Regulation; The California Proposition 65: Safe Drinking Water and Toxic Enforcement Act

3 https://www.who.int/ipcs/roadmap/en/

4 http://savinglivesustainably.org/news/87777K.html

3. Methodology and criteria for hazard identification

This document provides a list of chemicals of concern used in the health sector. The list is a subset of the broader list of 200 chemicals of concern published in the Chemicals of Concern for Health and Environment in 2018.

This list includes highly hazardous chemicals/ mixtures/ polymers derived from authoritative lists[5] and multilateral environmental agreements (MEAs). The chemicals are identified by their Chemical Abstract Service (CAS) registry number and given a health and/ or environmental hazard label based on the UN Globally Harmonized System of Classification and Labelling of Chemicals.

Authoritative lists and environmental conventions

The list has been developed and adapted from the review of evidence underlying the following authoritative lists for chemical and material hazards of concern that are carcinogenic, mutagenic, or reproductive hazards and/or listed in international environmental instruments (conventions):

- The International Agency for Research in Cancer (IARC) list of probable and known human carcinogens[6]
- The California list of chemicals known to cause cancer or reproductive toxicity under the California Proposition 65: Safe Drinking Water and Toxic Enforcement Act of 1986[7]
- The European Union list of Substances of Very High Concern and Restricted Substance List as determined under the REACH Regulation. These include carcinogenic, mutagenic or toxic to reproduction (CMR), persistent, bioaccumulative and toxic (PBT) substances and some endocrine disruptors, asthmagens and allergens[8]
- The Minamata Convention on Mercury[9]
- The Stockholm Convention on Persistent Organic Pollutants[10]
- Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade[11]
- The list also includes WHO's "Ten chemicals of major public health concern": arsenic, asbestos, benzene, cadmium, dioxin and dioxin-like substances, lead, mercury and highly hazardous pesticides[12];
- Association of Occupational and Environmental Clinics (AOEC) list of asthmagens[13];
- The Montreal Protocol on Substances that Deplete the Ozone Layer was excluded from this systematic review for the list of chemicals of concern. Chemicals used in metered-dose inhalers for the treatment of asthma were identified by the Montreal Protocol (MP) as ozone depleting substances (ODS) and received an initial exemption from listing because of their 'essential use' in health care but were subsequently phased out when alternatives became available. Refrigerants in coolers used to keep vaccines cold in the immunisation cold chain formerly contained ODS which were eliminated as required in the WHO Prequalification Standard for this equipment. These good practice examples demonstrate the impact of a global environmental convention on improving the safety and sustainability of essential medications and cold chain equipment.[14]
- Region Stockholm, Sweden's phase out list for chemicals hazardous to the environment and human health. This list is based on the Swedish Chemical Agency (KEMI) database. The aim of the phase-out list is to define the chemicals hazardous to the environment and human health which are important for the region to phase out. This phase-out list covers chemicals which are used by healthcare facilities and operations responsible for public transport and property.

Criteria for hazard identification

Health and environmental impacts of hazardous chemicals

In this document the criteria for hazard identification of the chemicals listed are based on the impacts of the chemicals on human health and the environment. The parameters considered are listed below

- Toxicity (e.g., carcinogen, mutagens, reproductive hazards)
- Endocrine disrupting chemicals (EDCs)
- Neurotoxicity, developmental toxicity and immuno-toxicity
- Allergenicity/asthmagenicity
- Sensitiser

5 Agencies such as IARC, REACH, California Proposition 65, that contribute extensively on classifying chemicals based on their hazards.

6 https://monographs.iarc.fr

7 http://oehha.ca.gov/proposition-65/how-chemicals-are-added-proposition-65-list

8 https://echa.europa.eu/regulations/reach/understanding-reach

9 http://www.mercuryconvention.org/Convention

10 http://chm.pops.int/TheConvention/ThePOPs/AllPOPs/tabid/2509/Default.aspx

11 http://www.pic.int/TheConvention/Chemicals/AnnexIIIChemicals/tabid/1132/language/en-US/Default.aspx

12 http://www.who.int/ipcs/assessment/public_health/chemicals_phc/en/

13 http://www.aoecdata.org/Default.aspx

14 Inhalers and coolants relevant to the health sector have not been included in the list from the Montreal Protocol

- Skin and eye irritants
- Environmental determinants linked to:
  - Persistent and bioaccumulative toxicants (PBTs) in the products
  - Acute and chronic aquatic toxicity

Labelling and classification of the chemicals

The chemicals listed in the document have been classified by the unified classification and labelling identified globally. Each chemical has been provided with a Chemical Abstract Service (CAS) registry number and a hazard label from the UN Global Harmonisation System of Classification and Labelling. This classification and hazard labelling will help health care facilities understand the hazards linked with the chemicals and further classify the hazards in their workplaces as well as to look for safer alternatives and eliminate these chemicals when possible.

Globally harmonized system of classification and labelling[15]

- To unify the variety of classification and labelling of chemicals by international and national regulatory systems, the United Nations developed the Globally Harmonized System of Classification and Labelling of Chemicals (GHS). The GHS is an international harmonized standard for classification and labelling of chemicals and mixtures and hazard communication via safety data sheets. This is an ongoing process as more chemicals and mixtures are being classified by the GHS. Although implementation of the GHS is not a legally binding regulation, it is increasingly being adopted by countries: including in European Union Law as the CLP regulation, 2008; Australia, 2015; Argentina, 2015; and the US Occupational Safety and Health Administration (OSHA) effective June 2015.

The GHS classification system is based on 28 hazard classes comprising:

- 16 physical hazards (explosives, flammable gases, aerosols, oxidizing gases, liquids and solids, gases under pressure, flammable liquids and solids, self-reactive substances, pyrophoric liquids and solid, self-heating substances, substances which in contact with water emit flammable gases, organic peroxide and corrosive to metals)
- 10 human health hazards: Acute toxicity (oral/dermal/inhalation), skin corrosion/irritation, serious eye damage/eye irritation, respiratory or skin sensitisation, germ cell mutagenicity, carcinogenicity, reproductive toxicology, target organ systemic toxicity - single exposure, target organ systemic toxicity (repeated exposure, aspiration toxicity)
- Environmental hazards (aquatic hazards and more recently hazards to the ozone layer).

Health hazards

Explosives

H200:	Unstable explosive
H201:	Explosive; mass explosion hazard
H202:	Explosive; severe projection hazard
H203:	Explosive; fire, blast or projection hazard
H204:	Fire or projection hazard
H205:	May mass explode in fire

Flammables

H206:	Fire, blast or projection hazard; increased risk of explosion if desensitizing agent is reduced
H207:	Fire or projection hazard; increased risk of explosion if desensitizing agent is reduced
H208:	Fire hazard; increased risk of explosion if desensitizing agent is reduced
H220:	Extremely flammable gas
H221:	Flammable gas
H222:	Extremely flammable aerosol
H223:	Flammable aerosol
H224:	Extremely flammable liquid and vapour
H225:	Highly flammable liquid and vapour
H226:	Flammable liquid and vapour
H227:	Combustible liquid
H228:	Flammable solid
H229:	Pressurized container: may burst if heated
H230:	May react explosively even in the absence of air
H231:	May react explosively even in the absence of air at elevated pressure and/or temperature
H232:	May ignite spontaneously if exposed to air

Explosives

H240:	Heating may cause an explosion
H241:	Heating may cause a fire or explosion

15 http://www.unece.org/fileadmin/DAM/trans/danger/publi/ghs/ghs_rev08/ST-SG-AC10-30-Rev8e.pdf

Flammables

H241:	Heating may cause a fire or explosion
H242:	Heating may cause a fire
H250:	Catches fire spontaneously if exposed to air
H251:	Self-heating; may catch fire
H252:	Self-heating in large quantities; may catch fire
H260:	In contact with water releases flam mable gases which may ignite spontaneously
H261:	In contact with water releases flammable gas

Oxidizers

H270:	May cause or intensify fire; oxidizer
H271:	May cause fire or explosion; strong oxidizer
H272:	May intensify fire; oxidizer

Gases under pressure

H280:	Contains gas under pressure; may explode if heated
H281:	Contains refrigerated gas; may cause cryogenic burns or injury

Corrosive

H290:	May be corrosive to metals

Health hazards

Toxicity

H300:	Fatal if swallowed
H301:	Toxic if swallowed
H310:	Fatal in contact with skin
H311:	Toxic in contact with skin
H330:	Fatal if inhaled
H331:	Toxic if inhaled

Harmful

H302:	Harmful if swallowed
H303:	May be harmful if swallowed
H305:	May be harmful if swallowed and enters airways
H312:	Harmful in contact with skin
H313:	May be harmful in contact with skin
H315:	Causes skin irritation
H317:	May cause an allergic skin reaction
H319:	Causes serious eye irritation
H332:	Harmful if inhaled
H335:	May cause respiratory irritation
H336:	May cause drowsiness or dizziness
H316:	Causes mild skin irritation
H317:	May cause an allergic skin reaction
H320:	Causes eye irritation
H333:	May be harmful if inhaled

Corrosive

H314:	Causes severe skin burns and eye damage
H318:	Causes serious eye damage

Health hazard

H304:	May be fatal if swallowed and enters airways
H334:	May cause allergy or asthma symptoms or breathing difficulties if inhaled
H340:	May cause genetic defects
H341:	Suspected of causing genetic defects
H350:	May cause cancer
H351:	Suspected of causing cancer
H360:	May damage fertility or the unborn child
H361:	Suspected of damaging fertility or the unborn child
H362:	May cause harm to breast-fed children
H370:	Causes damage to organs
H371:	May cause damage to organs
H372:	Causes damage to organs through prolonged or repeated exposure
H373:	May cause damage to organs through prolonged or repeated exposure

Environmental hazards

Dangerous for the environment

H400:	Very toxic to aquatic life
H401:	Toxic to aquatic life
H402:	Harmful to aquatic life
H410:	Very toxic to aquatic life with long-lasting effects
H411:	Toxic to aquatic life with long-lasting effects
H412:	Harmful to aquatic life with long-lasting effects
H413:	May cause long-lasting harmful effects to aquatic life

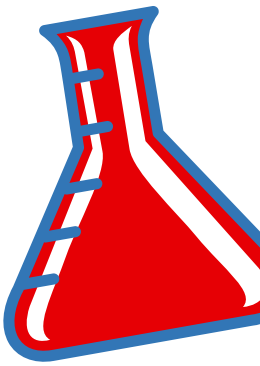
Harmful

H420:	Harms public health and the environment by destroying ozone in the upper atmosphere

Description of the hazard categories[16]

Each hazard class contains at least one category. The hazard categories are assigned a number (e.g., 1, 2) Categories may also be called "types". Types are assigned an alphabetical letter (e.g., A, B). In a few cases, sub-categories are also specified. Subcategories are identified with a number and a letter (e.g., 1A and 1B).

- Some hazard classes have only one category (e.g., corrosive to metals), others may have two categories (e.g., carcinogenicity) or three categories (e.g., oxidizing liquids). There are a few hazard classes with five or more categories (e.g., organic peroxides). The category tells you about how hazardous the product is (that is, the severity of the hazard).
- Category 1 is always the greatest level of hazard (that is, it is the most hazardous within that class). If Category 1 is further divided, Category 1A within the same hazard class is a greater hazard than category 1B.
- Category 2 within the same hazard class is more hazardous than category 3 and so on.



16 Adopted from: https://www.ccohs.ca/oshanswers/chemicals/whmis_ghs/hazard_classes.html

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Chemicals in medical products

Shortlisted chemicals and mixtures	CAS number	Authoritative lists containing the chemicals	Hazard potential	GHS symbol	GHS hazard statements	Occurrence/ use	Occurrence/ use in health sector
1,1-Dichloroethane	75-34-3	California Proposition 65 list	C		H225: Highly flammable liquid and vapour [2] H315: Causes skin irritation [2] H319: Causes serious eye irritation [2A] H332: Harmful if inhaled [4] H341: Suspected of causing genetic defects [2] H370: Causes damage to organs [1] H402: Harmful to aquatic life [3] H411: Toxic to aquatic life with long lasting effects [2]	Intermediate in chemical synthesis of products such as PVC; Formerly used as a surgical anaesthetic gas	Formerly used as surgical anaesthetic gas
1,1,2-Trifluoro-1,2,2-trichloro- ethane (CFC-113)	76-13-1 (group), 26523-64-8	Montreal Protocol, Stockholm Phase out list			H319: Causes serious eye irritation H411:Toxic to aquatic life with long lasting effects H420: Harms public health and the environment by destroying ozone in the upper atmosphere	Hazardous to the environment with prolonged effects, harmful to the ozone layer	Cooling agent
2,3,7,8-Tetrachlorodibenzo-para-dioxin (PCDD)	1746-01-6	IARC, California Proposition 65 list, Stockholm Convention	C (1)		H300: Fatal if swallowed [1,2] H310: Fatal in contact with skin [1,2] H315: Causes skin irritation [2] H319: Causes serious eye irritation [2a] H341: Suspected of causing genetic defects [2] H350: May cause cancer [1a, 1b] H360: May damage fertility or the unborn child [1a,1b] H370: Causes damage to organs [1] H372: Causes damage to organs through prolonged exposure [1]	Byproduct of manufacture of chlorophenols, hexachlorophene and herbicides; contaminant of the Agent Orange, PCBs and pentachlorophenol; component of combustion, including waste incineration and tobacco smoke.	This is the byproduct of medical waste incineration of chlorinated compounds including PVC plastic. Dioxin is also an unintentional byproduct of the production of PVC and other chlorinated compounds like pesticides and solvents.
2,4-Hexadienal	142-83-6	IARC, California Proposition 65 list	C (2b)		H227: Combustible liquid [4] H301: Toxic if swallowed [3] H311: Toxic in contact with skin [3] H314: Causes severe skin burns and eye [1a,b,c] H318: Causes serious eye damage [1] H351: Suspected of causing cancer [2]	As a chemical intermediate in various organic synthetic reactions and as a raw material in the manufacture of sorbic acid (a widely used food preservative)	As a pharmaceutical intermediate in the manufacture of mitomycins and antihypercholest-eraemics
Antimony oxide (Antimony trioxide)	1309-64-4	IARC, California Proposition 65 list	C (2b)		351: Suspected of causing cancer [2]	Component of flame retardant treatment for polymers; opacifying agent for glasses, ceramics, and enamels; specialty pigments; naturally occurring as valentinite and senarmontite	The main application is as a flame retardant synergist in combination with halogenated materials in furnishings and other products.

PBT- persistant, bioaccumulative and toxic
vPvB- very persistant and very bioaccumulative
CMR- carcinogenic mutragenic (developmental toxin) and reproductive hazard
S- Sensitive to skin and other organs

C- Carcinogenic
R- Reproductive hazard
T- Toxicity to humans
A- Asthmagen

Chemical:

2,3,7,8-Tetrachlorodibenzo-para-dioxin (a Polychlorinated dibenzodioxins PCDD)

Source:

Byproduct of medical waste incineration

Health and environmental hazards:

Carcinogen and endocrine disruptor
H300: Fatal if swallowed H310: Fatal in contact with skin H315: Causes skin irritation H319: Causes serious eye irritation H341: Suspected of causing genetic defects H350: May cause cancer H360: May damage fertility or the unborn child H370: Causes damage to organs H372: Causes damage to organs through prolonged exposure

Waste autoclave: photo credit HECAF360

Case study:

Waste management system in National Kidney Center, Nepal[17]

2,3,7,8-Tetrachlorodibenzo-para-dioxin has been identified as a persistent organic pollutant by the Stockholm Convention. Medical waste incinerators have been identified as a major source of dioxins and in low-income countries, where they are rarely equipped with air pollution control devices, they can emit particularly high concentrations[18].

HCWH has been working with WHO, UNDP, ministries of health and environment and health systems across the world to phase out the use of incineration and promote non-burn technologies for the treatment of health care waste. Numerous examples from health care waste management projects in Africa, the Americas and Asia have demonstrated the elimination and/or controlling releases of dioxin by implementing alternative treatment technologies whose goal is to protect human health and the environment from the harmful impacts of dioxin.

The case study from National Kidney Center, Nepal shows the initiatives taken by the health center to reduce infectious waste and adopt alternative waste treatment technologies utilizing autoclaves for the treatment of infectious waste.

The center initiated safe health care waste management in all of the units—with a governance structure and system in place for the safe segregation of the wastes, transportation, and treatment using autoclave technology, and recycling. The implementation process included an initial assessment of the quantity and types of waste generated, existing facilities, methods of waste collection, storage and treatment options, and occupational health and safety issues. A waste treatment and storage centre for the autoclaves was constructed. After disinfection in the autoclave, recyclable materials are sold and costs of the waste management system recovered.

The hospital has demonstrated that even in a setting with limited resources, health care facilities can successfully manage their waste without using burn technologies, and at the same time, reduce the amount of waste and increase options for recycling from the waste. Additionally, the center has also successfully replaced mercury-based medical devices with non-mercury devices.

17 https://www.hospitalesporlasaludambiental.net/wp-content/uploads/2016/08/Leadership-Energy-Waste-and-Chemicals-Pioneer-in-Safe-Health-Care-Waste-Management-in-Nepal-National-Kidney-Center-Nepal.pdf

18 https://www.who.int/water_sanitation_health/medicalwaste/en/smincinerators.pdf

Shortlisted chemicals and mixtures	CAS number	Authoritative lists containing the chemicals	Hazard potential	GHS symbol	GHS hazard statements	Occurrence/ use	Occurrence/ use in health sector
Arsenic	7440-38-2	IARC, California Proposition 65, REACH restricted list	C (1)		H220: Extremely flammable gas [1] H280: Contains gas under pressure; may explode if heated H330: Fatal if inhaled [1,2] H350: May cause cancer [1a,1b] H370: Causes damage to organs [1] H372: Causes damage to organs through prolonged exposure [1]	Wood preservative, herbicide, nonferrous alloys, medicine (leukemia treatment); component of tobacco smoke. Formerly used in optical glass.	Arsenic and its compounds, especially trioxide, are used in the production of pesticides, treated wood products, herbicides and insecticides.
Asbestos (all forms, including actinolite, amosite, anthophyllite, chrysotile, crocidolite and tremolite)	1332-21-4 77536-67-5 12172-73-5 77536-66-4 12001-29-5 12001-28-4 77536-68-6	IARC, California Proposition 65, REACH restricted list and Rotterdam Convention	C (1)		H350: May cause cancer [1a], H372: Causes damage to organs through prolonged exposure [1]	Roofing, thermal and electrical insulation, cement pipe and sheets, flooring, gaskets, friction materials	Asbestos has been used in the past in contruction of buildings including health care facilities.
Acrylamide	79-06-1	IARC, California Proposition 65, REACH candidate and restricted list, Stockholm phase out list	C (2a), M R S		H301: Toxic if swallowed [3] H312: Harmful in contact with skin [4] H315: Causes skin irritation [2] H317: May cause an allergic skin reaction [1] H319: Causes serious eye irritation [2a] H332: Harmful if inhaled [4] H340: May cause genetic defects [1a,1b] H350: May cause cancer [1a,1b] H361: Suspected of damaging fertility or the unborn child [2] H372: Causes damage to organs through prolonged exposure [1]	A reactive monomer and intermediate in the production of organic chemicals and in the synthesis of polyacrylamides. Acrylamide is also used as a flocculent for sewage and waste treatment, soil conditioning agents, ore processing, paper and textile industries, and in the manufacture of dyes, adhesives and permanent press fabrics.	Used in the health sector as a binding agent in dyes paints and glue
Azacitidine	320-67-2	IARC, California Proposition 65 list	C (2a)		H302: Harmful if swallowed [4] H341: Suspected of causing genetic defects [2] H350: May cause cancer [1A, 1B] H360: May damage fertility or the unborn child [1A, 1B] H372: Causes damage to organs through prolonged or repeated exposure [1]	Medicine (treatment of myelodysplastic syndrome)	Used in the health sector as a pharmaceutical drug
Benzidine	92-87-5	IARC, California Proposition 65, REACH restricted list	C (1)		H302: Harmful if swallowed [4] H341: Suspected of causing genetic defects [2] H350: May cause cancer [1a,1b] H372: Causes damage to organs through prolonged exposure [1]	Reagent base for the production of a large number of dyes, particularly azo dyes for wool, cotton and leather. Earlier use in clinical laboratories for detection of blood.	Some dyes used as stains for microscopy and similar laboratory applications may contain benzidine as an impurity
Bis (2-ethylhexyl)phthalate (DEHP)	117-81-7	IARC, California Proposition 65, REACH candidate and restricted list	C (2b) MR		H320: Causes eye irritation [2B] H335: May cause respiratory irritation [3] H351: Suspected of causing cancer [2] H360: May damage fertility or the unborn child [1A, 1B] H373: Causes damage to organs through prolonged or repeated exposure [2] H400: Very toxic to aquatic life [1] H411: Toxic to aquatic life with long lasting effects [2]	The major use of DEHP is in the production of PVC and vinyl chloride resins, where it is added to plastics to make them flexible	DEHP has been used extensively as a plasticizer in PVC medical devices. Most DEHP, greater than 90%, is used as a plasticizer in the manufacture of PVC products including floorings, wall coverings, furniture and medical applications including PVC intravenous (iv) bags and tubing and masks

Chemical:

Di ethylhexyl phthalates (DEHP)

Use:

Extensively used as a plasticizer in PVC, products like IV tubing, umbilical vessel catheters, peripherally inserted central catheter lines (PICC lines) and enteral feeding products

Health and environmental hazards:

H360: May damage fertility or the unborn child (classified as endocrine disruption agent and reproductive hazard)

Case study:

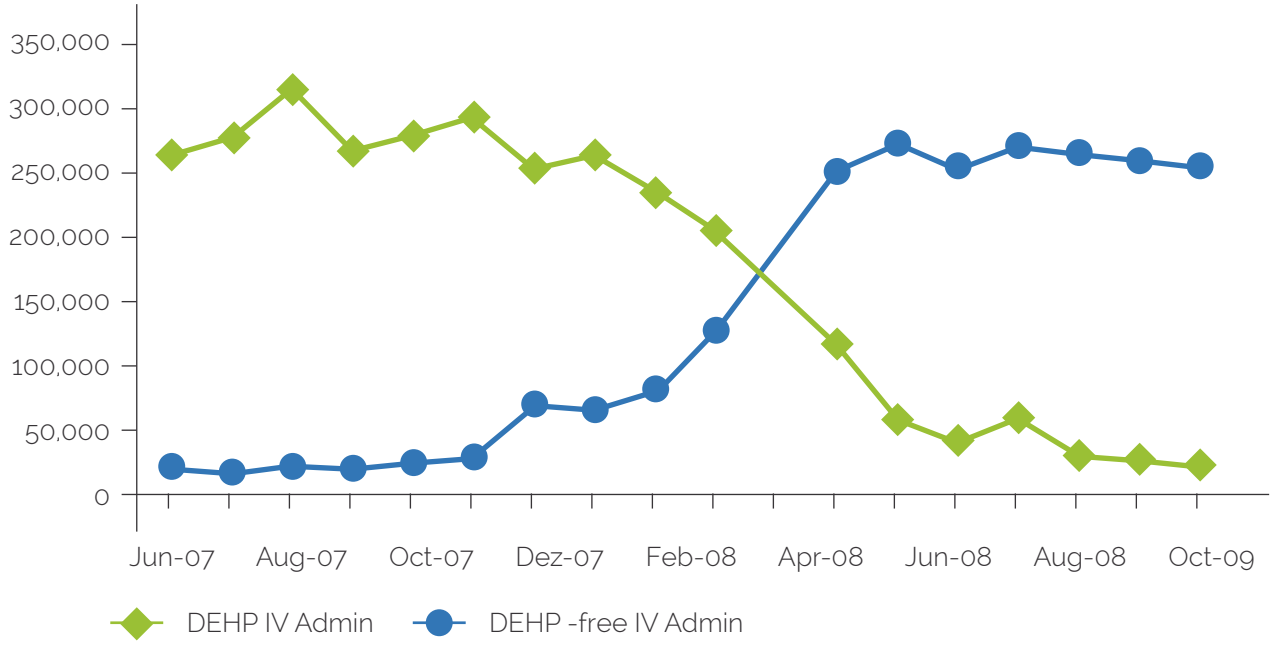
DEHP minimisation in intravenous (IV) administration sets by Kaiser Permanente Hospital, United States

Beginning in July, 2001, after learning of the potential hazards from DEHP exposure, Kaiser Permanente staff underwent a process to identify DEHP-containing medical devices used in the neonatal intensive care units and to evaluate alternatives. After successful substitution with non- DEHP products in neonatal department, Kaiser Permanente decided to minimize the use of DEHP from various products including IV administrative tubes, which is a key point of DEHP exposure to the patients.

In 2007, a technical team consisting of Kaiser's National Product Council and the IV Sourcing and Standards Team decided to transition from the DEHP containing IV administrative sets to non-DEHP sets. The team worked with the suppliers and manufacturers on identifying safer alternatives. After successful clinical trials at the end of 2008, Kaiser Permanente's California and Hawaii regions had converted approximately 85% of their IV adminstrative sets to DEHP-free. The DEHP free sets were provided by a specific supplier that are made from polycarbonate and silicone and do not contain latex or DEHP.

Conversion to DEHP-free IV administration sets

(KP California and Hawaii regions use approximately **3 million** sets per year)



Link: US: Kaiser Permanente - DEHP Minimisation in Intravenous (IV) Administration Sets

Shortlisted chemicals and mixtures	CAS number	Authoritative lists containing the chemicals	Hazard potential	GHS symbol	GHS hazard statements	Occurrence/ use	Occurrence/ use in health sector
Bisphenol A (BPA)	80-05-7	California Proposition 65, and REACH candidate list	R		H303: May be harmful if swallowed [5] H313: May be harmful in contact with skin [5] H317: May cause an allergic skin reaction [1] H318: Causes serious eye damage [1] H361: Suspected of damaging fertility or the unborn child [2] H370: Causes damage to organs [1] H373: Causes damage to organs through prolonged or repeated exposure [2] H401: Toxic to aquatic life [2]	Used to make certain plastics and epoxy resins. BPA-based plastic is made into a variety of common consumer goods, like water bottles, sports equipment, CDs and DVDs. Epoxy resins containing BPA are used as coatings on the inside of many food and beverage cans and in making thermal paper like that used in sales receipts.	Bisphenol A is used in medical devices as the lining of tubing and blood bags. Medical devices made from poly carbonate, like intravenous administration sets, stopcocks, syringes, intravascular catheters, urinary catheters, gastrointestinal tubes, cardiopulmonary bypass circuits, eye lenses, tubing, blood oxygenators and dialysers. Other products made from polysulfone, like surgical trays, nebulizers, humidifiers, and haemodialysis membranes are made from polyacrylates, for example, dental composite resins, dental sealants and coating for medical devices. Polyetherimide: sterilisation trays, dentist devices, and pipettes are sources of exposure to BPA. BPA is an additive to PVC and used in autotransfusion apparatus, intravenous fluid bags, nasogastric and enteral feeding tubes, respiratory masks, endot racheal tubes and umbilical catheters
Bromoform	75-25-2	IARC and California Proposition 65 list	C (3)		H302: Harmful if swallowed [4] H315: Causes skin irritation [2] H319: Causes serious eye irritation [2a] H341: Suspected of causing genetic defects [2] H351: Suspecting of causing cancer [2] H361: Suspected of damaging fertility or the unborn child [2] H372: Causes damage to organs through prolonged exposure [1] H401: Toxic to aquatic life [2] H411: Toxic to aquatic life with long lasting effects [2]	Analytical reagent. Formerly used as a solvent, sedative medicine and flame retardant	A sedative medicine
Cadmium and cadmium compounds	7440-43-9	IARC, California Proposition 65 list, Stockholm phase out list, REACH restricted list and authorisation list	C (1), M R		H250: Catches fire spontaneously if exposed to air [2] H330: Fatal if inhaled [1,2] H341: Suspected of causing genetic defects [2] H350: May cause cancer [1a,1b] H372: Causes damage to organs through prolonged exposure [1] H400: Very toxic to aquatic life [1] H410: Very toxic to aquatic life with long-lasting effects [1]	Used in fabricated metal products, electronic rechargeable batteries, corrosion resistant electroplating, barrier to control neutrons in nuclear fission, alloys, dental amalgam, plastic (PVC) stabilizer; production of pigments, television phosphors, photoelectric cells, electronics, fungicides, photography and lithography; component of tobacco smoke	Cadmium is used as a colouring agent for the red waste collection bags within the health sector. It is also used in dental amalgam and as a plastic (PVC) stabilizer

Chemical:

Poly Vinyl Chloride (PVC)

Use:

Extensively used in the health sector, like in IV bags, gloves, breast pumps, enteral tubes, respiratory therapy products and blood bags

Health and environmental hazards:

Carcinogenic hazard
H220: Extremely flammable gas, H280: Contains gas under pressure; may explode if heated H315: Causes skin irritation, H341: Suspected of causing genetic defects H350: May cause cancer, H361: Suspected of damaging fertility or the unborn child H370: Causes damage to organs, H372: Causes damage to organs through prolonged or repeated exposure H402: Harmful to aquatic life

Replacement of PVC anaesthesia mask with silicone at Fundación Valle del Lili, Cali, Colombia. Photo credit: Fundación Valle del Lili, Cali, Colombia

Case study:

Replacement of PVC anaesthesia mask with silicone at Fundación Valle del Lili, Cali, Colombia

Implementation of a reuse policy for the gradual and progressive replacement in surgery and respiratory therapy of disposable PVC masks with reusable silicone face masks. The substitution resulted in cost savings and use of a product made with less toxic material.

The process of replacing the disposable facial masks began in 2015 when the Maintenance and Environment Department observed that large amounts of single-use face masks were discarded as biohazardous waste. The department also highlighted that these masks were made from polyvinyl chloride (PVC), a material that needs to be prioritized for replacement due to its composition and environmental impact when treated as waste.

Based on these recommendations, the Green Procurement Department Co Eco program started to look into reusable, PVC-free alternatives and opted for silicone masks that were approved by the patient safety, procurement and hospital supplies committees. The silicone mask is made from less toxic materials with reusable potential and end of life recyclability. These silicone masks are used to anesthetize both adults and children for surgery.

To ensure that these masks are used for their expected lifespan, the Sterilisation Centre of the Fundación Valle del Lili cleans and disinfects them before and after each use. Reuses are controlled using 100 unit batches corresponding to the same reference. The reuse of the silicone mask saves the Fundación $0.72 USD per mask when compared to PVC masks.

After their lifespan or at the end of use, masks are disinfected and delivered to an external agency specialized in pellets that uses them as raw material for industrial processes after recycling.

Shortlisted chemicals and mixtures	CAS number	Authoritative lists containing the chemicals	Hazard potential	GHS symbol	GHS hazard statements	Occurrence/ use	Occurrence/ use in health sector
Chloroethane	75-00-3	IARC and California Proposition 65 list	C (3)		H220: Extremely flammable gas [1] H280: Contains gas under pressure; may explode if heated H315: Causes skin irritation [2] H319: Causes serious eye irritation [2a] H351: Suspected of causing cancer [2] H370: Causes damage to organs [1] H372: Causes damage to organs through prolonged or repeated exposure[1] H402: Harmful to aquatic life [3] H412: Harmful to aquatic life with long lasting effects [3]	This substance is used for the manufacture of: chemicals and rubber products, refrigerant, aerosol propellant, blowing agent for foam packaging; medicine (anaesthetic; 'dead tooth' diagnosis); chemical intermediate in production of thickening agents.	Used as an anaesthetic, for dead tooth diagnosis and other the general occurrences like refrigerants and blowing agents
Cyclohexane (Lindane)	58-89-9, 110-82-7	IARC, REACH restricted list, Stockholm phase out list, Stockholm, Rotterdam and Minamata Convention	C (1) and PBT		H225: Highly flammable liquid and vapour [2] H315: Causes skin irritation [2] H319: Causes serious eye irritation [2a] H371: May cause damage to organs [2] H400: Very toxic to aquatic life [1] H412: Harmful to aquatic life with long lasting effects [3]	Lindane has been used as a broad-spectrum insecticide for seed and soil treatment, foliar applications, tree and wood treatment and against ectoparasites in both veterinary and human applications.	Used for lice and scabies treatment
Dantron (Chrysazin; 1,8-Dihydroxyanthraquinone)	117-10-2	IARC and California Proposition 65 list	C (2b)		H351: Suspected of causing cancer [2] H400: Very toxic to aquatic life [1] H410: Very toxic to aquatic life with long-lasting effects [1]	Medicine (palliative-laxative), chemical intermediate (dyes), used as an antioxidant in synthetic lubricants, in the synthesis of experimental antitumor agents, as a fungicide and as an intermediate for making dyes.	Medicine (palliative- laxative), chemical intermediate (dyes)
DDT (4,4'-Dichlorodiphenyltrichloroethane)	50-29-3	IARC and California Proposition 65, list	C (2a), M R, PBT		H301: Toxic if swallowed [3] H351: Suspected of causing cancer [2] H372: Causes damage to organs through prolonged or repeated exposure [1] H400: Very toxic to aquatic life [1] H410: Very toxic to aquatic life with long-lasting effects [1]	Insecticide, a POP in Stockholm Convention, restricted use to public health vector control.	Used for vector control, indoor residual spraying (IRS)
Dinbutyl phthalate (DBP)	84-74-2	California Proposition 65, REACH candidate and restricted list	M R		H317: May cause an allergic skin reaction [1] H335: May cause respiratory irritation [3] H360: May damage fertility or the unborn child [Category 1A, 1B] H372: Causes damage to organs through prolonged or repeated exposure [1] H400: Very toxic to aquatic life [1] H411: Toxic to aquatic life with long lasting effects [2]	Plasticizer in carpet backings, paints, adhesives, hair spray and nail polish; ectoparasiticide.	Plasticizer used in plastic products
Dinhexyl phthalate (DnHP)	84-75-3	California Proposition 65 list and REACH candidate and restricted list	R		H360: May damage fertility or the unborn child [1A, 1B]	DnHP is used in automobile parts (e.g., air filters, battery covers), tool handles and dishwasher baskets	Plasticizer used in plastic products, vinyl flooring

Chemicals:

Pesticides

These include different chemicals used for pest control like Difenacoum an anticoagulant, a Class Ia (extremely hazardous) pesticide that belong to a chemical family of coumarins, Deltamethrin, Alphacypermethrin and Hydramethylnon which are Class II (moderately hazardous) pesticides. Imidacloprid, a Class II pesticide that belongs to a chemical family of neonicotinoids and Indoxacarb, a Class II pesticide that belongs to the oxadiazine chemical family. Brodifacoum, a Class Ia pesticide, Bromadiolone pesticide that both belong to a chemical family amino hydrazone.[19]

Use:

Pest and insect control and the preservation of food, wood and laboratory specimens

Health and environmental hazards:

Carcinogen, mutagen, reproductive hazard and endocrine disruptor
H300: Fatal if swallowed H310: Fatal in contact with skin H330: Fatal if inhaled H360D: May damage the unborn child H372: Causes damage to organs through prolonged or repeated exposure H400: Very toxic to aquatic life H410: Very toxic to aquatic life with long-lasting effects

Flying insect trap. Photo credit: v74@adobestock.

Case study:

Integrated pest management in Bongani Regional Hospital, South Africa[20]

Bongani hospital is a pioneer in introducing Integrated Pest Management (IPM) within a hospital system in the country. The hospital implemented IPM by substituting the use of hazardous pesticides with more sustainable methods. Based on the successful experience of IPM, the hospital later drafted and documented the IPM policy for the province of Free State to ensure that the IPM becomes a legally binding policy.

Prior to the implementation of IPM, the hospital's pest control program was centered on the use of pesticides which were harmful to the employees and patients and also the environment. The use of pesticides was not only expensive but also ineffective as it only lasts for a few weeks.

IPM is implemented in three phases: a) introducing pest repellents, b) sterilisation of natural predators using insect light traps and c) bird control.

Implementation process: IPM implementation was introduced to the procurement unit using the green procurement principle, which favours environmentally sound services for pest control. IPM policy was drafted at the provincial level to ensure that this green initiative is legislated throughout the provincial health system.

Benefits of Integrated Pest Management in the hospital:

- 50% cost reduction
- 80% reduced use of pesticides in all the health establishments in the Free State and promotion of sustainable and environmentally-friendly approaches has been deployed to all health facilities
- Human health benefits resulting from reduced exposure to harmful pesticides to employees, patients and community members.

19 https://www.beyondpesticides.org/assets/media/documents/hospitals/Healthy_Hospitals_Report.pdf

20 https://www.greenhospitals.net/wp-content/uploads/2018/05/Implementation-of-Integrated-Pest-Management-South-Africa.pdf

Shortlisted chemicals and mixtures	CAS number	Authoritative lists containing the chemicals	Hazard potential	GHS symbol	GHS hazard statements	Occurrence/ use	Occurrence/ use in health sector
Di(2-ethylhexyl) phthalate (DEHP)	117-81-7	IARC, California Proposition 65 list, REACH restricted and candidate list	C (2b), R and developmental Toxin		H320: Causes eye irritation [2B] H335: May cause respiratory irritation [3] H351: Suspected of causing cancer [2] H360: May damage fertility or the unborn child [1A, 1B] H373: Causes damage to organs through prolonged or repeated exposure [2] H400: Very toxic to aquatic life [1] H411: Toxic to aquatic life with long-lasting effects [2]	Plasticizer for many resins and elastomers; component of tobacco smoke. It is also used as a hydraulic fluid and as a dielectric fluid in capacitors. DEHP also finds use as a solvent in glow sticks.	DEHP is widely used as a plasticizer for PVC in medical devices.
Dichloroacetic acid	79-43-6	IARC and California Proposition 65 list	C (2b) R		H290: May be corrosive to metals [1] H311: Toxic in contact with skin [3] H314: Causes severe skin burns and eye damage [1A, B, C] H318: Causes serious eye damage [1] H341: Suspected of causing genetic defects [2] H351: Suspected of causing cancer [2] H360: May damage fertility or the unborn child [1A, 1B] H370: Causes damage to organs [1] H372: Causes damage to organs through prolonged or repeated exposure [1] H402: Harmful to aquatic life [3]	Dichloroacetic acid, particularly in the form of its esters, is an intermediate in organic synthesis, used in the production of glyoxylic acid, dialkoxy and diaroxy acids and sulfonamides and in the preparation of iron chelates in the agricultural sector. It is also used as a medicinal disinfectant (substitute for formalin).	Dichloroacetic acid is used in medical practice as a cauterizing agent. It rapidly penetrates and cauterizes the skin and keratins. Its cauterizing ability compares with that of electrocautery or freezing. It is used on calluses, hard and soft corns, xanthoma palpebrarum, seborrhoeic keratoses, in-grown nails, cysts and benign erosion of the cervix.
Ethylene oxide	75-21-8	IARC, California Proposition 65 list and Rotterdam Convention	C (1) M R PBTw		H220: Extremely flammable gas [1] H280: Contains gas under pressure; may explode if heated H301: Toxic if swallowed [3] H315: Causes skin irritation [2] H317: May cause an allergic skin reaction [1] H319: Causes serious eye irritation [2A] H331: Toxic if inhaled [3] H340: May cause genetic defects [1A, 1B] H350: May cause cancer [1A, 1B] H360: May damage fertility or the unborn child [1A, 1B] H370: Causes damage to organs [1] H372: Causes damage to organs through prolonged or repeated exposure [1] H402: Harmful to aquatic life [3]	Agricultural product fumigant, disinfectant (hospital equipment), thermobaric weapons; organic chemical synthesis (ethylene glycol and higher glycols), production of detergents, solvents, plastics, adhesives, antifreeze, pharmaceuticals; component of tobacco smoke	Ethylene oxide is used as a sterilizing agent in health care facilities and commercial facilities to sterilise syringes and other medical instruments as part of the production process.

Chemical:

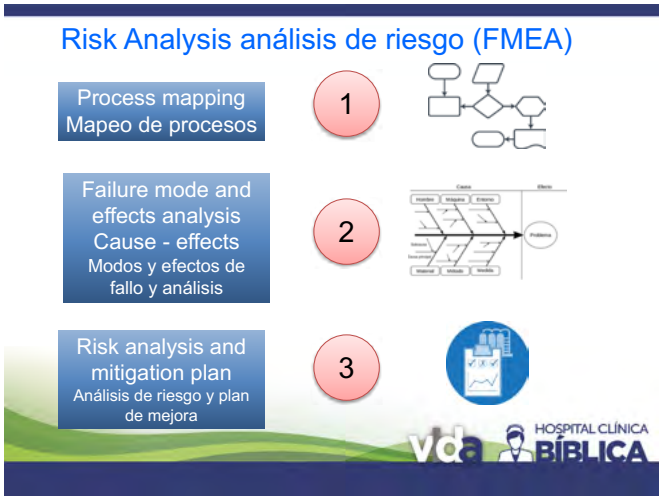
Ethylene oxide

Use:

Disinfecting and sterilising agent in health systems

Health and environmental hazards:

Carcinogen, mutagen and reproductive hazard
H220: Extremely flammable gas H280: Contains gas under pressure; may explode if heated H301: Toxic if swallowed H315: Causes skin irritation H317: May cause an allergic skin reaction H319: Causes serious eye irritation H331: Toxic if inhaled H340: May cause genetic defects H350: May cause cancer H360: May damage fertility or the unborn child H370: Causes damage to organs H372: Causes damage to organs through prolonged or repeated exposure H402: Harmful to aquatic life



(The FMEA system followed for risk assessment: Hospital Clínica Bíblica, Costa Rica)

Case study:

Replacement of ethylene oxide steriliser in Hospital Clínica Bíblica, Costa Rica[21]

Due to the highly hazardous nature of ethylene oxide, in 2010, the hospital decided to replace ethylene oxide (EtO) sterilisers with safer alternatives. A risk assessment using the Failure Mode and Effects Analysis (FMEA) was commissioned which identified a series of failure modes and effects during sterilisation cycles with ethylene oxide. A work plan was then designed to reduce these risks.

The FMEA process incorporates clinical and technical criteria to perform a comprehensive risk assessment, with the participation of staff working in the service chosen being key. FMEA team members then evaluated each of the failure modes and their effects by considering the following variables:

- Severity: seriousness of risk in case failure occurs.
- Occurrence: probability of failure occurrence.
- Detection: detection range of a potential failure.

Risk priority numbers (RPN) are then calculated by multiplying the three variables mentioned above.

Based on the FMEA analysis, the hospital was able to foresee and correct potential operational risks. Thus, following its quality and safety strategy, the hospital decided to eliminate ethylene oxide and replace it with hydrogen peroxide sterilisers. Although the hydrogen peroxide steriliser uses very specific supplies unique to this technology, the level of safety and protection delivered by this equipment warranted its use from a quality and safety point of view.

Within two years, the use of ethylene oxide was completely replaced with a hydrogen peroxide steriliser, which can sterilise thermosensitive materials. This alternative is safer for both the operator and the environment.

21 https://www.hospitalesporlasaludambiental.net/wp-content/uploads/2019/11/Hospitals-that-heal-the-planet-2018-selected-case-studies.pdf

Shortlisted chemicals and mixtures	CAS number	Authoritative lists containing the chemicals	Hazard potential	GHS symbol	GHS hazard statements	Occurrence/ use	Occurrence/ use in health sector
Formaldehyde	50-00-0	IARC and California Proposition 65 list, Stockholm phase out list	C (1)		H301: Toxic if swallowed [3] H311: Toxic in contact with skin [3] H314: Causes severe skin burns and eye damage [1A, B, C] H317: May cause an allergic skin reaction [1] H331: Toxic if inhaled [C 3] H341: Suspected of causing genetic defects [2] H350: May cause cancer [1A, 1B]	Disinfectant (anti bacterial, fungicide), tissue fixative, photography (colour negative stabilizer), textile treatment; precursor to poly functional alcohols; production of urea and melamine resins, phenolic resin, plastics, adhesives, preservatives, pressed wood products, automobile components; byproduct of combustion, component of tobacco smoke	Formaldehyde is used as a disinfectant and sterilant in both its liquid and as a tissue fixative in laboratory settings and gaseous states. Formaldehyde is used in composite wood products.
Furazolidone	67-45-8	IARC and California Proposition 65 list	C (3) S		H341: Suspected of causing genetic defects [Warning Germ cell mutagenicity] H361: Suspected of damaging fertility or the unborn child [Warning reproductive toxicity]	Medicine (antibacterial), veterinary medicine	It is used in human and veterinary medicine as an antibacterial and antiprotozoal agent.
Gamma-Radiation (also X- and Gamma-Radiation)		IARC	C(1)			X-rays are used in many medical and technical applications. The most common are diagnostic X-ray examinations of the human body and the analysis of materials.	For radiation diagnostics and for radiation therapy used to treat tumors and vascular malformations
Glutaraldehyde	111-30-8	AOEC, Stockholm phase out list	A, S		H301: Toxic if swallowed H314: Causes severe skin burns and eye damage H317: May cause an allergic skin reaction [Warning Sensitisation, Skin] H330: Fatal if inhaled H334: May cause allergy or asthma symptoms or breathing difficulties if inhaled [danger sensitisation, respiration] H335: May cause respiratory irritation H400: Very toxic to aquatic life H411: Toxic to aquatic life with long lasting effects	Glutaraldehyde is used for industrial, laboratory, agricultural, medical and some household purposes, primarily for disinfecting and sterilisation of surfaces and equipment. X-ray processing.	High level disinfectant, commonly used to disinfect endoscopy equipment, fixative agent for X- Ray and microscopy
Griseofulvin	126-07-8	IARC and California Proposition 65 list	C (2b) R S		H340: May cause genetic defects [1A, 1B] H351: Suspected of causing cancer [2] H360: May damage fertility or the unborn child [1A, 1B] H371: May cause damage to organs [2] H373: Causes damage to organs through prolonged or repeated exposure [2]	Griseofulvin is an antibiotic fungistatic drug administered orally in the treatment of dermatophyte and ringworm infections.	Medicine (antifungal)

Chemical:

Formaldehyde and Glutaraldehyde

Used:

Extensively used in the health sector for surface and instrument disinfection and as a fixative in the laboratory

Health and environmental hazards:

Glutaraldehyde: sensitiser and asthmagen H301: Toxic if swallowed H314: Causes severe skin burns and eye damage H317: May cause an allergic skin reaction, H330: Fatal if inhaled, H334: May cause allergy or asthma symptoms or breathing difficulties if inhaled, H335: May cause respiratory irritation H400: Very toxic to aquatic life H411: Toxic to aquatic life with long-lasting effects

Formaldehyde: Carcinogen, sensitiser and asthmagen H301: Toxic if swallowed H311: Toxic in contact with skin H314: Causes severe skin burns and eye damage H317: May cause an allergic skin reaction H331: Toxic if inhaled H341: Suspected of causing genetic defects H350: May cause cancer

Health professional safely operating the hydrogen peroxide steriliser. Photo credit: University Hospital of Nariño, Colombia.

Case study:

Substitution of glutaraldehyde in University Hospital of Nariño, Colombia

The hospital decided to replace glutaraldehyde with safer alternatives due to the occupational and environmental risks linked to the chemical. The journey of substitution started in 2009-2010, when the need arose to implement a sterilisation system for some medical devices to replace glutaraldehyde with a more efficient and less toxic alternative for the staff and the environment.

In the process of alternatives assessment, one of the alternatives analyzed was a low-temperature sterilisation method using formaldehyde and ethylene oxide. However, this alternative was found to be more toxic and generated hazardous waste. Later, a hydrogen peroxide plasma sterilisation system was chosen to replace glutaraldehyde after considering the high levels of contact and exposure of staff from the sterilisation agents.

The first system for low-temperature sterilisation with hydrogen peroxide was purchased in 2010. By the end of 2018, the new and completely renovated sterilisation plant was inaugurated, with six new pieces of equipment for sterilisation: two hydrogen peroxide plasma sterilisation processors, three steam autoclaves for a conventional high-temperature process and two ultrasonic washers that automate and optimize the washing process. The old sterilisation system with ethylene oxide was completely dismantled and replaced with safer options.

Advantage: The use of this technology allows a safe and efficient sterilisation process and the hospital monitors this by keeping track of microbiological control indicators in the batches that are autoclaved. The alternative sterilisation process generates oxygen and water vapour emissions with no toxic residues. Staff contact with hydrogen peroxide is completely avoided during the injection phase because the hydrogen peroxide capsules are tightly sealed. Staff only need to introduce the capsules in the compartment. The device automatically breaks the capsule and injects the peroxide into the sterilisation chamber.

Shortlisted chemicals and mixtures	CAS number	Authoritative lists containing the chemicals	Hazard potential	GHS symbol	GHS hazard statements	Occurrence/ use	Occurrence/ use in health sector
Hexachloroethane	67-72-1	IARC, California Proposition 65 list and REACH resticted list	C (2b)		H303: May be harmful if swallowed [5] H316: Causes mild skin irritation [3] H320: Causes eye irritation [Category 2B] H351: Suspected of causing cancer [2] H373: Causes damage to organs through prolonged or repeated exposure [2] H400: Very toxic to aquatic life [Category 1] H410: Very toxic to aquatic life with long lasting-effects [1]	Solvent, combustion retardant in pyrotechnics and smoke-producing devices, veterinary medicine (anthelmintic); polymer additive, ingredient in fungicide and insecticide; metal and alloy production. Additionally it is a byproduct of many industrial chlorination processes. It can be a component of fungicidal and insecticidal formulations as well as a moth repellent and a plasticizer for cellulose esters.	Used in veterinary medicine (anthelmintic)
Medroxyprogesterone acetate	71-58-9	IARC and California Proposition 65 list	C (2b) M		H302 : Harmful if swallowed H312: Harmful in contact with skin H332 : Harmful if inhaled H351 : Suspected of causing cancer [Warning Carcinogenicity] H360 : May damage fertility or an unborn child H362: May cause harm to breast-fed children H413: May cause long-lasting harmful effects to aquatic life	A synthetic progestin used as a contraceptive that is effective both orally or by intramuscular injection and also used to treat breast and endometrial neoplasms	Medicine (contraceptive; antineoplastic)
Mercury and inorganic mercury compounds	7439-97-6(CAS numbers are included for 43 chemicals	IARC, California Proposition 65 list, REACH candidiate list, Rotterdam and Minamata convention	C (3) MR		H317: May cause an allergic skin reaction [1] H319: Causes serious eye irritation [2A] H330: Fatal if inhaled [1, 2] H360: May damage fertility or the unborn child [1A, 1B] H370: Causes damage to organs [1] H372: Causes damage to organs through prolonged or repeated exposure [1] H400: Very toxic to aquatic life [1] H410: Very toxic to aquatic life with long lasting effects [1]	Thermometers, sphygmomanometers, barometers, mirrors, lubricant, laboratory reagent; catalyst in oxidation of organic compounds, extraction of gold and silver from ores; manufacture of pulp, paper, switching devices, chlorine, caustic soda; component of batteries, dental amalgams; component of tobacco smoke.	Mercury containing measuring devices: thermometers, blood pressure instruments, dental amalgam are very common in health care facilities. Other mercury containing products include thermostats, fluorescent tubes, batteries, manometers, gastrointestinal tubes.
Nitrofural (Nitrofurazone)	59-87-0	IARC and California Proposition 65 list.	C (3)		H302: Harmful if swallowed [4] H317: May cause an allergic skin reaction [1]	Veterinary medicine (antibiotic) for dogs, cats and horses not intended for human consumption. Medical use in humans discontinued in the United States.	A topical anti-infective agent effective against gram-negative and gram-positive bacteria. It is used for superficial wounds and injuries and skin infections. Nitro furazone has also been administered orally in the treatment of Trypanosomiasis

Chemical/element:

Mercury

Use:

Medical devices, like sphygmomanometers, thermometers and dental amalgam

Health and environmental hazards:

A neurotoxin, carcinogen, mutagen and reproductive hazard
H317: May cause an allergic skin reaction H319: Causes serious eye irritation H330: Fatal if inhaled H360: May damage fertility or the unborn child H370: Causes damage to organs H372: Causes damage to organs through prolonged or repeated exposure H400: Very toxic to aquatic life H410: Very toxic to aquatic life with long lasting-effects

Mercury-free medical devices. Photo Credit: Faye V. Ferrer

Case study:

Mercury substitution at St. Paul Hospital, The Philippines[22]

St. Paul Hospital in Tuguegarao, Philippines completely phased out and replaced all mercury-containing sphygmomanometers (blood pressure measuring devices) and thermometers during 2007-2010. The hospital began its journey in 2006, when it attended the Health Care Without Harm Southeast Asia Conference tackling mercury-containing medical devices and their harmful effects. The hospital was inspired to phase-out mercury after learning about the risks posed by mercurial devices during usage, breakage, storage and disposal.

St. Paul Hospital formed a task team that mapped the existing mercury-containing sphygmomanometers and thermometers, included the elimination of mercury into procurement criteria and phased-out mercury-containing devices from the hospital. Staff received extensive training on the hazards of the use and disposal of mercury-containing devices and the benefits and ease of using non-mercury devices.

All collected mercurial devices were properly sealed and placed in a separate well-ventilated storage area to ensure safety from breakage and improper use/disposal.

The results at St. Paul were shared widely, which inspired other health care facilities to successfully shift to mercury-free devices.

Later, as a result of continuous dialogue and engagement between HCWH and the Philippines' National Department of Health (DoH), the DOH issued an Administrative Order (DOH-AO no. 21) in August of 2008 requiring all hospitals in the Philippines to gradually phase-out mercury-containing medical devices in 2010. The movement to phase-out mercury was replicated in other regions of the world leading to the establishment of a joint WHO and Health Care Without Harm mercury-free health care initiative and subsequently to the Minamata Convention on Mercury.

22 https://www.greenhospitals.net/wp-content/uploads/2018/12/Case-Study-Phasing--out-Mercury-Containing-Devices-St.-Paul-Hospital-Tuguegarao-.pdf

Shortlisted chemicals and mixtures	CAS number	Authoritative lists containing the chemicals	Hazard potential	GHS symbol	GHS hazard statements	Occurrence/ use	Occurrence/ use in health sector
Nitrofurantoin	67-20-9	IARC and California Proposition 65 list	C (3) R		H302: Harmful if swallowed [4] H317: May cause an allergic skin reaction [1] H334: May cause allergy or asthma symptoms or breathing difficulties if inhaled [1] H361: Suspected of damaging fertility or the unborn child [2]	An antibacterial agent	A urinary anti-infective agent effective against most gram-positive and gram-negative organisms. Although sulfonamides and antibiotics are usually the agents of choice for urinary tract infections, nitrofurantoin is widely used for prophylaxis and long-term suppression.
o,p'-DDT and p,p'-DDT		California Proposition 65 list	MR			See DDT	
Outdoor air pollution		IARC	C (1)			The major sources of air pollution include coal fired thermal power plants, energy generated using fossil fuels (oil, gas)	In addition to the general sources of air pollution, incineration/ open burning of medical waste, diesel powered generator sets are a major source of air pollution
Oxazepam	604-75-1	IARC and California Proposition 65 list	C (2b), R		H351: Suspected of causing cancer	Oxazepam is a benzodiazepine used in the treatment of anxiety, alcohol withdrawal and insomnia.	Drug for treatment of anxiety
Phenobarbital	50-06-6	IARC and California Proposition 65 list	C (2b), R, S		H301: Toxic if swallowed [3] H336: May cause drowsiness or dizziness [3] H340: May cause genetic defects [1A, 1B] H351: Suspected of causing cancer [2] H361: Suspected of damaging fertility or the unborn child [2] H372: Causes damage to organs through prolonged or repeated exposure [1]	Used as a medicine (sedative), laboratory reagent	Phenobarbital is a sedative, hypnotic and anti-epileptic drug.
Polybrominated biphenyls(PBBs)	59536-65-1, 13654-09-6, 27858-07-7, 36355-01-8	IARC and California Proposition 65 list REACH authoritaive list and Rotterdam Convention	C (2a)			Formerly used as flame retardant in synthetic fibers, lacquers and molded plastics. Manufacturing in the United States stopped in 1976.	PBBs are used as flame retardants of the brominated flame retardant group. They are added to plastics used in products like home electrical appliances, textiles, plastic foams, laptop cabinets, etc. to make them difficult to burn.

Shortlisted chemicals and mixtures	CAS number	Authoritative lists containing the chemicals	Hazard potential	GHS symbol	GHS hazard statements	Occurrence/ use	Occurrence/ use in health sector
Polychlorinated biphenyls (PCBs) including dioxin-like, with a Toxicity Equivalency Factor (TEF) according to WHO (PCBs 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169, 189) including polychlorinated dibenzo-para-dioxins (PCDDs) (other than (2,3,7,8-tetrachlorod-ibenzo-para-dioxin)	1336-36-357653-85-7, 57653-85-8	IARC, California Proposition 65 list, Stockholm and Rotterdam Convention	C (1) M R PBT		H373: Causes damage to organs through prolonged or repeated exposure [2] H400: Very toxic to aquatic life [1] H410: Very toxic to aquatic life with long-lasting effects [1]	PCBs have commonly been synthesized commercially by catalytic chlorination of biphenylThese chemicals are produced unintentionally due to incomplete combustion, as well as during the manufacture of pesticides and other chlorinated substances. They are emitted mostly from the burning of hospital waste, municipal waste, and hazardous waste, and also from automobile emissions, peat, coal, and wood. These compounds are used in industry as heat exchange fluids, in electric transformers and capacitors and as additives in paint, carbonless copy paper and plastics.	PCBs were used in hundreds of industrial and commercial applications including: electrical, heat transfer and hydraulic equipment, plasticizers, in paints, plastics and rubber products pigments, dyes, and carbonless copy paper.
Polychlorinated dibenzofurans	PBT C(3)	IARC, California Proposition 65 and Stockholm Convention	MR			These compounds are produced unintentionally from many of the same processes that produce dioxins and also during the production of PCBs. They have been detected in emissions from waste incinerators and automobiles. Furans are structurally similar to dioxins and share many of their toxic effects. Other major sources of PeCDF are metal smelting, refining and processing; chemical manufacturing/processing (production of chlorophenols, PCBs, vinyl chloride); pulp bleaching	Polychlorinated dibenzofurans are byproduct of medical waste incineration and listed as a POP by Stockholm Convention.
Polyvinyl chloride	9002-86-2	IARC	C (3)		H220: Extremely flammable gas [1] H280: Contains gas under pressure; may explode if heated H315: Causes skin irritation [2] H341: Suspected of causing genetic defects [2] H350: May cause cancer [1A, 1B] H361: Suspected of damaging fertility or the unborn child [2] H370: Causes damage to organs [1] H372: Causes damage to organs through prolonged or repeated exposure [1] H402: Harmful to aquatic life [3]	Polyvinyl Chloride (PVC) is a major plastics material which finds widespread use in buildings, transportation, packaging, electrical/electronic and Health care applications.	PVC is extensively used in medical devices including in IV products, catheters, blood bags and tubing, respiratory therapy products, gastrointestinal tubes, etc.

Shortlisted chemicals and mixtures	CAS number	Authoritative lists containing the chemicals	Hazard potential	GHS symbol	GHS hazard statements	Occurrence/ use	Occurrence/ use in health sector
Primidone	125-33-7	IARC and California Proposition 65 list	C (2b) R		H302: Harmful if swallowed, Acute oral toxicity H351: Suspected of causing cancer [Warning Carcinogenicity]	An anti-epileptic drug	An anti-epileptic drug
Shale-oils	68308-34-9	IARC and California Proposition 65 list	C (1)			Early applications of shale oils included use as a source of parafin waxes and burning oils for lamps, as well as for medicinal purposes.	Formerly used for medicinal purposes
Surgical implants (dental materials, implanted foreign bodies, metallic implants, orthopaedic implants, polymeric implants, silicone breast implants)		IARC	C (2b) (3)			Used for surgical implants	Surgical implants
Tetrachloroethylene	127-18-4	IARC and California Proposition 65 list	C (2a)		H315: Causes skin irritation [2] H320: Causes eye irritation [2B] H332: Harmful if inhaled [4] H350: May cause cancer [1A, 1B] H361: Suspected of damaging fertility or the unborn child [2] H370: Causes damage to organs [1] H372: Causes damage to organs through prolonged or repeated exposure [1] H400: Very toxic to aquatic life [1] H410: Very toxic to aquatic life with long-lasting effects [1]	Solvent for organic materials used in dry-cleaning, textile processing and vapour-degreasing; chemical intermediate. Formerly used in medicine as a hookworm vermifuge	Tetrachloroethylene was used in medicine as a hookworm vermifuge.
Toluene	108-88-3	IARC, California Proposition 65 and REACH restricted list	C (3) M		H225: Highly flammable liquid and vapour [2] H304: May be fatal if swallowed and enters airways [1] H315: Causes skin irritation [2] H320: Causes eye irritation [2B] H332: Harmful if inhaled [4] H360: May damage fertility or the unborn child [1A, 1B] H370: Causes damage to organs [1] H372: Causes damage to organs through prolonged or repeated exposure [1] H401: Toxic to aquatic life [2] H412: Harmful to aquatic life with long -lasting effects [3]	This substance is used in the following products: fuels, lubricants and greases, anti-freeze products, biocides (e.g., disinfectants, pest control products), non-metal-surface treatment products, inks, and toners, leather treatment products, polishes and waxes, textile treatment products, dyes, adhesives and sealants	Used as a lab chemical among many other uses
Toxaphene	8001-35-2	IARC, California Proposition 65 list, Stockholm and Rotterdam Convention	PBT		H301: Toxic if swallowed H312: Harmful in contact with skin H315: Causes skin irritation H335: May cause respiratory irritation H351: Suspected of causing cancer [Warning Carcinogenicity] H400: Very toxic to aquatic life H410: Very toxic to aquatic life with long-lasting effects	This insecticide is used on cotton, cereal grains, fruits, nuts and vegetables. It has also been used to control ticks and mites in livestock.	A veterinary medicine

Shortlisted chemicals and mixtures	CAS number	Authoritative lists containing the chemicals	Hazard potential	GHS symbol	GHS hazard statements	Occurrence/ use	Occurrence/ use in health sector
Trichloroethylene	79-01-6	IARC, California Proposition 65 and REACH authoritaive list	C (1) MR		H305: May be fatal if swallowed and enters airways [2] H315: Causes skin irritation [2] H319: Causes serious eye irritation [2A] H332: Harmful if inhaled [4] H336: May cause drowsiness or dizziness [3] H341: Suspected of causing genetic defects [2] H350: May cause cancer [1A, 1B] H360: May damage fertility or the unborn child [1A, 1B] H372: Causes damage to organs through prolonged or repeated exposure [1] H401: Toxic to aquatic life [2] H411: Toxic to aquatic life with long-lasting effects [2]	Metal degreasing, extraction solvent, cleaning kerosene-fueled rocket engines; production of refrigerants; component of tobacco smoke. Other release to the environment of this substance is likely to occur from: indoor use in close systems with minimal release (e.g. cooling liquids in refrigerators, oil-based electric heaters). Formerly used in medicine (inhaled analgesic), film cleaning, dry-cleaning solvent, and fumigant.	Used as a lab chemical among many other uses. Formerly used in medicine (inhaled analgesic)
Vinyl chloride	75-01-4	IARC, California Proposition 65 and REACH restricted list	C (1)		H220: Extremely flammable gas [1] H280: Contains gas under pressure; may explode if heated, H315: Causes skin irritation [2] H341: Suspected of causing genetic defects [2] H350: May cause cancer [1A, 1B] H361: Suspected of damaging fertility or the unborn child H370: Causes damage to organs [1] H372: Causes damage to organs through prolonged or repeated exposure [1] H402: Harmful to aquatic life [3]	Chemical intermidieate for production of PVC	Same as PVC
Vinyl fluoride	75-02-5	IARC and California Proposition 65 list	C (2A)		H220: Extremely flammable gas [1] H280: Contains gas under pressure; may explode if heated, H336: May cause drowsiness or dizziness [3] H341: Suspected of causing genetic defects [2] H350: May cause cancer [1A, 1B] H373: Causes damage to organs through prolonged or repeated exposure [2]	Used for production of poly vinyl fluoride (PVF), sunlight resistant and used for solar transmission in solar panels. result of sulfuryl fluoride (pesticide, fumigant) decay. Compounds may be used as metal treatment, glass etching, aluminum smelting, pesticides and chemical synthesis	Used for fluoridation (prevent bone loss), dental care products, or municipal public health water additive (prevents tooth decay)
Xylenes	1330-20-7	IARC and California Proposition 65 list	C (3)		H226 - Flammable liquid and vapour H315 - Causes skin irritation H401 - Toxic to aquatic life	Solvent for paints, varnishes, inks, dyes, adhesives, pharmaceuticals, detergents and rubber; production of polymer fiber (mylar and dacron); component of gasoline and fuel oils; component of tobacco smoke	Used as a lab chemical among many other uses

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The document, consolidated from authoritative list from United Nations -WHO, IARC, European Union and United States, Sweden and international environmental agreements (conventions), contains the Chemical Abstracts Service (CAS) registry number, hazard statements from the UN Globally Harmonized System of labeling of chemicals (GHS), and health products containing the chemicals where known.

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UNDP/Health Care Without Harm Sustainable Health in Procurement Project (SHiPP) as one of the tools developed to guide the procurement of safer alternatives to products containing hazardous chemical to protect health-care workers, patients, communities, and the environment.

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