



Health care without harmful flame retardants

An inventory of brominated flame retardants in electrical and textile products at Karolinska University Hospital

Project report

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1 Project

Karolinska University Hospital currently has general environmental goals that are intended to reduce the use of chemical products that are harmful to health and the environment, and reduce the environmental impact of goods and services. The hospital also works consistently to impose environmental requirements during its own procurement.

Karolinska is administered by Stockholm County Council. Under Step 5 of the Council's Environmental Programme, corresponding aims are outlined in target 5, Products. In Environmental Step 5 the goal is formulated as follows: "the purchase of goods and consumables that contain chemicals to be phased out by the county council should cease" (by 2011). Measures are being taken by the county council to draw up a list and action plan for the chemicals that are to be phased out.

In an earlier project an inventory was carried out on the use of PVC and phthalates, and an action plan was drawn up to phase out PVC and phthalates where viable alternatives exist. In this project, the working hypothesis was that after plasticised PVC products, the product groups we use that are likely to have the greatest impact on the environment and health are those containing brominated flame retardants. An inventory was therefore carried out on the amounts of brominated flame retardants that are brought into the hospital in the form of procured goods.

The main goal of this project in the long term is to stop the influx of flame retardants that are harmful to health and the environment in the goods we buy. One target was to find methods of checking the availability of information, such as the type and concentration of flame retardants in goods. Other targets of the work were to spread awareness of the effects of brominated flame retardants in consumables on health and the environment, and to identify the need to inform employees who procure, requisition and work with such products.

The product groups covered by the inventory are:

1. Photocopiers
2. Personal computers
3. Medical devices
4. Small electronic devices
5. Mattresses and bed equipment
6. Furniture upholstery
7. Interior textiles

The work also involved

8. An external survey of the state of knowledge regarding flame retardants
9. Summary of existing legislation and regulations (not included in this report)
10. Recommended environmental requirements designed to improve the environmental performance of procured goods

The project was conducted in collaboration between the Department of Environment and Sustainability, at Karolinska University Hospital, and Magnus Hedenmark, Hedenmark Ecoprofits.

2 Summary

Flame retardants are chemical compounds that are added to flammable materials, generally plastics and other synthetic materials, to inhibit combustion. Attention has been focused on the harmful characteristics of brominated flame retardants because they have been found to cause impairments in behaviour, learning and memory, among other things.

An inventory was carried out on a number of product groups that would be expected to contain brominated flame retardants or other types of retardants. The inventory was conducted using questionnaires sent to manufacturers, interviews and by examining environmental product declarations and documentation obtained during procurement by Stockholm County Council.

The results of the inventory show that the quality of replies from suppliers is inconsistent regarding the use of flame retardants that are not permitted under the existing agreements. One case of non-permissible use of decaBDE was identified for a mattress supplier. Most suppliers were unable to give convincing answers regarding the alternatives they use. Suppliers do not have adequate knowledge on the subject and there is a high risk of unintentionally incorrect certification. One conclusion is therefore that environmental requirements for procurement should contain requirements for reliable documentation, such as documentation from a competent third party.

Photocopier suppliers have standardised environmental product declarations that contain a limited amount of information. To obtain the information we requested during this project the suppliers have to contact their manufacturers, usually Japanese, to get more detailed answers. The results indicate that at least 900 kg of brominated flame retardants from photocopiers have been acquired by Karolinska Hospital. The annual influx is estimated at 300 kg. In addition to brominated flame retardants it is likely that a significant amount of organic phosphate esters are used in photocopiers. The second conclusion is that requirements should be set for phasing out all halogenated flame retardants, and that requirements should also include the phasing out of other harmful flame retardants, particularly phosphate ester additives.

The amount of brominated flame retardants supplied to Karolinska University Hospital in the form of PCs and displays is estimated at up to 160 kg per year. The main retardant is TBBP-A. No information is available on the quantities of brominated substances that were present in earlier versions of PCs. It is therefore not possible to make any comparison that shows improvements due to product development and stricter legislation.

The state of knowledge among manufacturers and suppliers of medical devices also varies. One complication is that legislation and the RoHS directive do not apply to medical devices. Nevertheless some manufacturers already report that they comply with the content of the legislation. It was not possible to estimate the actual weight of input from flame retardants added in medical devices.

According to new agreements for furniture and interior goods, brominated flame retardants should not be present in these products. The suppliers confirm that their products meet this requirement.

Interior textiles that are purchased by Karolinska Hospital's sewing workshop do not normally contain any flame retardants at all. The textiles are naturally flameproof due to the

properties of the material. No textiles or textile accessories contain brominated flame retardants.

The total amount of brominated flame retardants supplied to the hospital at present is estimated not to exceed two tonnes per year. This is considerably less than the amount of phthalates supplied in soft plastics. Because staff and patients rarely come into contact with the flame-resistant components of products, the content of brominated flame retardant poses a minor threat to health and the environment. However, this does not mean that we should ignore the amounts of brominated substances that are supplied. Their hormone-disrupting, environmentally harmful characteristics mean that we need a strategy and plan of action for systematically phasing out these harmful substances from our products. An effective method of phasing them out is by setting relevant environmental requirements for new procurement contracts. Where possible, similar requirements can be applied to direct purchases and requisitions. The report recommends one way that such requirements could be applied. The implementation of procurement requirements will make it easier to quantify the amounts of flame retardants that are supplied.

The current lack of knowledge regarding the impact of halogenated flame retardants on health and the environment can be countered by various forms of information-spreading activities within the hospital and externally.

3 Brominated flame retardants

3.1 What are flame retardants?

Flame retardants are used to inhibit the ignition of materials and reduce the spread of fire. Products that can be treated to be flame-resistant include textiles and furniture for public use, protective clothing, rubber cables, insulation materials and electrical and electronic products.ⁱ

There are around 350 different flame retardants, of which 70 are brominated. Of the flame retardants that are not brominated, the majority are metal compounds, organic phosphorus and nitrogen compounds or inorganic salts. There is no general picture to show which flame retardants are in use in Sweden today. There are no requirements to register whether products are treated with flame retardants, or which retardants are used.

From the viewpoint of risk, chemical flame retardants cover the entire scale of possible hazard. Apart from a few substances that can be identified as hazardous, there are many substances whose properties are poorly known. Risk assessments and regulations are normally based on a misplaced burden of proof, where the absence of information is taken as a reason for allowing a substance, rather than prohibiting it. This means that the safest choices are generally those that do not require any additives at all. Fire safety can also be achieved in many other ways that do not require the addition of chemical flame retardants.

3.2 Brominated flame retardants

Most attention has been focused on the harmful properties of brominated flame retardants. They have attracted attention partly because they have been found in the blood and breast milk of humans. There are around 70 brominated flame retardants, and our understanding of their effects on health and the environment varies. The five brominated flame retardants that have been most widely used are:

- Pentabromodiphenyl ether (pentaBDE, CAS no. 32534-81-9)
- Octabromodiphenyl ether (octaBDE, CAS no. 32536-52-0)
- Decabromodiphenyl ether (decaBDE, CAS no. 1163-19-5)
- Tetrabromobisphenol A (TBBP-A, CAS no. 79-94-7)
- Hexabromocyclododecane (HBCDD, CAS no. 25637-99-4)

In 2003 around 300 tonnes of brominated flame retardants came into Sweden as raw materials for industry. TBBP-A accounted for the largest share.

PBDE is a collective name for polybrominated diphenylethers, which include pentaBDE, octaBDE and decaBDE. Brominated and chlorinated flame retardants are also known as halogenated flame retardants and are expected to have similar characteristics with regard to function and harmfulness.

3.2.1 Why are brominated flame retardants harmful?

Concentrations of PBDEs in people and in nature have been rising rapidly for several decades and in large parts of the world. Newly born mice that are given PBDEs suffer from impairments in behaviour, learning ability and memory in adulthood.ⁱⁱ These symptoms also increase with age. Researchers compare PBDEs with PCBs, which produce similar effects in people. In North America, the levels of PBDEs in breast milk are now approaching the same levels as PCBs.

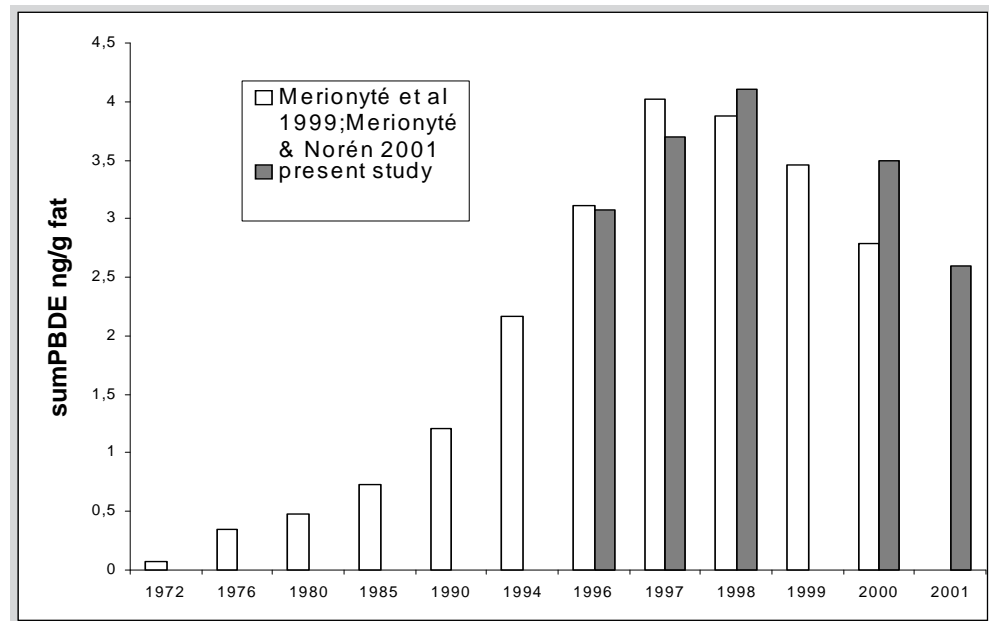


Figure 1. Brominated flame retardants, PBDEs, in breast milk from women giving birth for the first time.ⁱⁱⁱ

3.2.2 PBDE flame retardants (penta, octa and deca BDE)

Concentrations of pentaBDE in the breast milk of Swedish women doubled every five years between 1972 and 1997. In the case of pentaBDE at least, the trend appears to have flattened out since then. In the USA, levels are considerably higher than in Sweden and there has been no sign of the trend levelling off. The health effects could be very serious for future generations. The main cause of concern is the ability of these substances to disrupt our hormone systems and the development of embryos. The effects of such disruptions are difficult to predict, but the development of unusual forms of cancer, interference with the development of the brain and impaired immune response are among the most widely discussed effects.

The debate and resulting restrictions surrounding pentaBDE and octaBDE have led the industry to market decaBDE instead. This substance has also proved to be persistent and bioaccumulating. It has been found, for example, in the eggs of peregrine falcons. DecaBDE can also degrade to produce pentaBDE.

3.2.3 Polybrominated biphenyls

PBB (polybrominated biphenyl) flame retardants are carcinogenic. Scandals over the poisoning of cattle have occurred in the USA and led to the end of production of these substances.

3.2.4 TBBP-A and HBCDD flame retardants

TBBP-A and HBCDD are two flame retardants that have been produced in larger quantities than PBDEs. These substances are very persistent in nature. HBCDD is known to be bioaccumulating and can be found in sediment, fish, human blood and guillemots. TBBP-A has been found in sediment, mussels and human blood^{iv}. In laboratory tests it has been shown to have high potential to disrupt thyroid activity.

Risk assessments are being conducted on TBBP-A and HBCDD in the EU. A decision to limit its use in the EU or solely in Sweden is unlikely to be taken before 2008, when discussions on risk management strategies are expected to be completed.

3.3 Other flame retardants considered

In the late 1970s 2,3-dibromopropanol was found in the urine of children who wore pyjamas impregnated with tris(2,3-dibromopropyl) phosphate. Both substances are mutagens^v. The discovery led relatively quickly to a ban.

Antimony trioxide is used in combination with brominated flame retardants and is classified as carcinogenic. Dust is generated during application and the main objection to its use is the occupational health aspect.

Chloroparaffins are used as plasticisers and flame retardants. They are widely present in the environment and are now prohibited.^{vi}

Phosphate esters are a group of flame retardants that are growing in use as halogenated flame retardants are replaced. Like chloroparaffins, they are also used as plasticisers. Their presence has been reported in air samples from schools, nurseries and office environments.^{vii}

3.4 What are the authorities doing?

Polybrominated biphenyls (PBBs) and polybrominated diphenyl ethers (PBDEs) are prohibited from use in electrical and electronic products from 1 July 2006. This ban is laid down in the ROHS directive^{viii} (directive 2002/95/EG) and has been incorporated in Swedish regulations SFS 2005: 209^{ix} and SFS 2005:217.^x

A possible exemption from the ban for decabromodiphenyl ethers is currently being discussed in the EU.

The German and Danish environmental authorities consider that priority should be given to phasing out brominated flame retardants.^{xi} Reports from bodies that include WHO, point out that brominated dioxins pose a considerable unknown threat, due to the use of brominated flame retardants.^{xii}

3.5 Which flame retardants should be avoided?

3.5.1 Halogenated substances

There are good reasons to avoid all brominated flame retardants and to reject chlorinated flame retardants as substitutes.

In the EU, risk assessments are generally used as a basis for assessing chemical substances and deciding on action. A more appropriate method would be to use life cycle assessments. This makes it possible to take into account likely breakdown products.

Instead of assessing each brominated flame retardant individually, an alternative approach is to look at the common denominator, the bromine atom. Bromine belongs to the halogen group in the periodic table, which also includes fluorine and chlorine. Elements of this type easily form stable, persistent compounds with organic carbon compounds. Brominated or chlorinated dioxins and furans can be formed when products containing bromine or chlorine are burned. Harmful dioxins and furans can be formed almost regardless of which brominated flame retardants or other brominated or chlorinated substance was originally added. The risk of formation of these unwanted compounds is greatest in poorly controlled combustion processes, such as in accidental fires or waste incineration at too low a temperature.

3.5.2 Flame retardant additives – such as phosphate esters

Phosphate esters, such as triphenyl phosphate ester (TPP), are widely occurring^{xiii}, and often associated with harmful effects on nerve systems and/or bioaccumulating characteristics. Global consumption of organic phosphate esters (OP) as flame retardants and plasticisers has grown rapidly in recent years. The widespread use of these additives carries a risk that they can be given off by the products to which they are added and spread to the general environment^{xiv}. Following the principle of caution, there is good reason to regard all phosphate ester additives as harmful or unsuitable until there is convincing documentary evidence to the contrary.

There are two ways of applying flame retardants, by reaction or addition. Additives do not react with the plastic and can therefore evaporate from equipment more easily, and hence subject users to direct exposure. Inexplicably high levels of flame retardants in individual test subjects are presumably explained by exposure to flame retardant emissions in the home or at work.

3.5.3 Substances of Very High Concern

The new REACH chemicals legislation includes a category for substances that are especially harmful: SVHCs – Substances of Very High Concern. The criteria for these substances is that they are either

- vPvB substances (very persistent, very bioaccumulating) or,
- CMR substances (carcinogenic, mutagenic and reproduction disruptors) or,
- have other characteristics that are difficult to define, but can lead to similar problems (such as hormone disruption and ozone breakdown).

For most substances, no comprehensive information is available about SVHC characteristics. It is however possible to carry out literature surveys and database searches to obtain theoretically based QSAR^{xv} data, for different substances.

There is no single list of substances to turn to. Anyone who recommends or checks new products should check that the substitute chemicals are not just as harmful as the originals. The presence of substances of this type should be considered when procurement requirements are drawn up.

3.5.4 Other criteria to consider when selecting flame retardants

A report^{xvi} from the German Ministry of the Environment, UBA, gives much the same criteria as above, but also adds other criteria to describe an ideal flame retardant in order to encourage the substitution principle. The substances that are used must not impair the ability to recycle or cause acute health effects (mostly skin-related) for workers in the manufacturing chain or recycling industry.

4 Inventory of selected product groups

The main focus of the project was to produce an inventory of the amounts of brominated flame retardants that arrive at Karolinska University Hospital each year in the form of purchased goods. Knowledge of the quantities involved provides a basis for prioritising how environmental requirements should be formulated for future procurement.

Part of the work involved finding methods of checking the availability of information such as the types and amounts of flame retardants present in goods.

The product groups covered by the inventory are:

- Photocopiers
- Personal computers
- Medical devices
- Small electronic devices
- Mattresses and bed equipment
- Furniture upholstery
- Interior textiles

4.1 Electronic office equipment – photocopiers

Results: Karolinska University Hospital, with 600 offices, has around 900 kg of brominated flame retardants in photocopiers. If these products are replaced every three years it means that around 300 kg of new brominated flame retardants are brought in each year. More than 90 per cent of these retardants consist of aromatic compounds in addition to TBBP-A and PBDEs.

Availability: Today's IT products do not normally contain PBDEs or PBBs in plastic components that weigh over 25g. The suppliers certify this fact in IT environmental declarations that can be downloaded from the suppliers' websites. They also state that they do not use flame retardants that are classified as hazardous, which is not a very reliable guarantee that harmful substances are not present. Phosphate ester additives are usually used in the casings. One manufacturer supplied information on the amount of flame retardants used in its photocopiers. Other manufacturers can probably supply information on the amounts of flame retardants in their products.

Conclusion: The results indicate that the requirements for TBBP-A, PBDEs and PBBs do not cover the most widely used brominated flame retardants. During procurement it should be possible to ask suppliers to provide declarations of contents and ensure that brominated substances are not present.

4.2 Electronic office equipment – personal computers

Results: Information about purchased volumes varies. Based on the actual purchased volume, the amount of brominated flame retardants supplied each year in office PCs will range between 80 and 160 kg. In a couple of years, when all PCs are replaced, the content of brominated flame retardant in existing equipment will not exceed 500 kg. Information from suppliers indicates that the majority of brominated flame retardant in PCs, laptops and flat monitors consists of TBBP-A, while the rest consists of unspecified brominated compounds.

Availability: These products already comply with the RoHS directive that came into effect on 1 July 2006. The IT environmental declarations state specifically that these products do not contain PBDEs or PBBs. The environmental declarations can easily be downloaded from the suppliers' websites. It is also stated there that certain products contain TBBP-A. No information is available on the amounts of brominated substances that were present in earlier PCs. Manufacturers can supply information on the amounts of flame retardants in their products.

Conclusion: In contrast to photocopiers, we can achieve a considerable change by specifying products that are free from TBBP-A in future. It is just a matter of ensuring that the alternative that is supplied is less harmful to health and the environment.

During procurement it should be possible to ask suppliers to provide declarations of contents and ensure that brominated substances are excluded.

4.3 Electronic office equipment – small electronic devices

Mobile phones were chosen as an example of small electronic devices. The intention was that this example would give an estimate of the quantity of additives present in one unit. It was expected that suppliers of mobile phones would be aware of this issue and be knowledgeable enough to supply the information.

Results: These products are free from PBDEs and PBBs. No information was available regarding other brominated flame retardants.

Availability: These products comply with the RoHS directive and therefore do not contain PBDEs or PBBs. As with larger electrical products, IT environmental declarations can be downloaded from the suppliers' websites. They are not as easy to find as was the case for photocopiers and PCs. The IT environmental declarations do not give any guidance on substances other than those already regulated by the RoHS directive. Calls made to several larger manufacturers did not yield any contacts that could supply more specific information. Less time was set aside for this product group than for PCs and photocopiers, and it is therefore not possible to quantify the total content of brominated substances at present.

Conclusion: Because suppliers now have to comply with the RoHS directive, companies have to be aware of which additives their products contain. Since there is greater consumer demand for mobile telephones they may have developed faster than items such as pagers and other cordless telephones. Mobile telephones may be expected to meet stricter environmental requirements than other goods in this group. When procuring mobile phones it should be possible to ask suppliers to provide declarations of contents and ensure that brominated substances are excluded. Requirements can be set at a lower level for other products in this group, at least initially.

4.4 Medical devices

Results: It was not possible to obtain information on the content of brominated flame retardants. Because these products are not covered by the RoHS directive and the quantities purchased are at most equal to the volume of PCs or photocopiers, the flame retardant content has been estimated to be no more than twice the content of office equipment, i.e. around one tonne.

Availability: The state of knowledge among suppliers and manufacturers of medical devices varies. One complication is that medical devices is exempt from the RoHS directive. Nevertheless, some manufacturers say that they already comply with the requirements of the new legislation.

Conclusion: If we at the hospital aim to gather information about all halogenated flame retardants that are present in the medical devices we purchase, we must expect that it will take one or two years before the industry as a whole is mature enough to provide this information. Since procurement is carried out at intervals of two to three years, it will take almost the entire implementation period for the County Council's Environment Step 5 before we have full control over the products that are supplied to the hospital.

During procurement, requirements can initially be imposed on communication and the exchange of information. Requirements for declarations of content or limiting the content of brominated substances can only be applied in exceptional cases.

4.5 Purchased beds and bed equipment

The foam cores of mattresses consist mainly of polyurethane. Air mattresses are often made from PVC. Mattress covers may be made from fluorinated polymers, such as Gore-Tex, to make them breathable and resistant to bed-wetting, etc.

Results: We can effectively assume that this type of product does not contribute brominated flame retardants to the hospital. One case of the disallowed use of decaBDE by a mattress supplier was discovered. The purchasing unit has been informed of this.

Availability: None of the suppliers admit that they use brominated flame retardants, and they refer to the procurement requirements. However, the procurement requirements, which are based on ecologically sustainable requirements (EKU) for textile and leather, state specifically that PBBs, penta, octa and decaBDE and TRIS^{xvii} and TEPA^{xviii} may not be used. Other brominated flame retardants exist that are not listed, so the purchasing requirements do not provide a guarantee against the presence of all types of brominated flame retardants.

One of the suppliers who was questioned, stopped using brominated flame retardants several years ago and does not use any flame retardant at all except on those mattresses that have the highest risk classification and are intended for psychiatric care, or the like. Several other suppliers use the same manufacturer. It should therefore be easy for them to obtain credible documentation that they meet the environmental requirements.

The chlorinated phosphate esters, tris(1,3-dichloro-2-propyl) phosphate (TDCP) and tris(2-chloroisopropyl) phosphate (TCPP) are, however, commonly used in mattresses and furniture upholstery according to the Swedish Chemicals Agency^{xix}, and are used by the current suppliers.

According to the procurement agreement, Etac Sverige AB and Medicarrier AB are allowed

to supply pillows containing flame retardants. However, neither of these companies can inform us which flame retardant is used, apart from the statement that “it is not brominated”. In order to get a credible answer the purchasing unit should ask the manufacturer to provide documentation to show that environmental requirements are met in the future.

No assessment was carried out regarding the use of flame retardants in electronic bed equipment.

Conclusion: We may receive inaccurate information as a result of suppliers not knowing which chemical additives may be present in their goods. It may be necessary to adapt the requirements we set so that they are both clear and verifiable. There is a lack of knowledge among suppliers in many product areas, but it can apply to different types of additives.

During procurement it should be possible to specify that products are free from brominated substances. Compliance should be documented in a way that is traceable for the purchaser.



Figure 2: An air mattress that is used to spread pressure and prevent pressure sores.

4.6 Furniture upholstery

Results: Upholstered, fabric-covered furniture that is bought under procurement agreements does not contain brominated flame retardants.

Availability: The textiles and upholstery that are used meet the relevant fire safety requirements by other means than through additions of flame retardants. It is easy to obtain material declarations that confirm the composition of these products.

Conclusion: Freedom from brominated substances can be set as a requirement during procurement.

4.7 Interior textiles

Results: Interior textiles that are purchased by Karolinska Hospital’s sewing workshop do not normally contain any flame retardants at all. Only one textile, which is used in very small quantities, contains a flame retardant. No textiles or textile accessories contain brominated flame retardants.

Availability: The most widely used textile is polyester, which meets fire safety requirements without the need for flame retardant chemical additives. The properties of these materials make them naturally flame-resistant. A flame-resistant grade of cotton is used, but not very often. According to the supplier, the flame retardant is based on phosphorus and nitrogen, and is not classed as environmentally harmful.

Polyurethane (also known as polyether) foam is also used with textiles. This material is flame-resistant without the need for flame retardant chemical additives.

It is easy to obtain material declarations that confirm the composition of these products.

Conclusion: Freedom from brominated substances can be set as a requirement during procurement.

4.8 Total amount of brominated flame retardants supplied

Table 1 shows a summary of all the brominated flame retardants supplied in goods to Karolinska Hospital. The conclusion is that the total supply is less than two tonnes of brominated substances per year. The area that is most difficult to estimate is the content of brominated flame retardants in medical devices. We expect that it will be two years or more before we can obtain good data on the content of medical devices, since suppliers and manufacturers have little information themselves about the content of their products today. It is also important that we start to request this type of information now, during procurement.

Table 1. Brominated flame retardants supplied in goods to Karolinska University Hospital.

Product type	Brominated substance per unit	Total of brominated substances supplied each year	Total TBBP-A
Photocopiers		Around 300 kg	<30 kg
PCs + displays	24 / 8.5 g	80–160 kg	70–140 kg
Small electronic devices	Inadequate information on brominated compounds other than PBDE and PBB.	Probably 0 for PBDE and PBB. Inadequate information on other brominated compounds.	No information
Medical devices		Estimated amount included in total.	
Beds and bed equipment	Present. Information on content not available		
Furniture upholstery	Probably 0	Probably 0	
Interior textiles	0	0	0
Total		Maximum 2 tonnes per year	

5 Materials and risk analysis

5.1 Which are the high-volume products?

Of the total amount of brominated flame retardants, it appears that the majority arrives at the hospital in the form of photocopiers and, probably, in medical devices.

This study did not attempt to assess the amounts of brominated flame retardants that may be incorporated in the property. Such an inventory will not be part of future plans either, since the hospital neither owns nor manages the property. A comparison between the property and its equipment cannot therefore be made.

5.2 Which products have the highest potential risk?

The risk of brominated flame retardants spreading from products is considerably lower than for phthalate plasticizers in PVC. There is no major potential for spreading directly to patients in this case.

The greatest risk of spreading harmful substances from the goods that come into the hospital is through waste, after use.

It is important that we always safeguard the disposal of electronic waste so that no products with hazardous content end up in the “wrong place”. Small products are more likely to end up in the wrong waste fraction than very large items. Training and information will continue to be important activities in this respect in the future. Information activities should therefore be focused on small products.

5.3 Potential influence of departments

The goal to phase out brominated flame retardants affects several groups of employees. Many goods are widely used by all types of departments, but there are a few groups of employees who have a greater opportunity to influence development at the hospital. The Department of Clinical Engineering, procurement department and IT department are among those with the best opportunities to influence decisions that govern which products are procured by the hospital. In the case of medical products, technical development and patient risk versus cost must be weighed up to determine how quickly it is actually possible to start demanding products that are totally free from brominated substances.

6 Recommendations

6.1 Aim to phase out all halogenated flame retardants

Although there are halogen-free alternatives that are environmentally questionable, it appears a logical first step to consistently phase out halogenated flame retardants (not just PBBs and PBDEs) and materials for the following reasons:

- There are around 70 different brominated compounds, and they cannot be managed by listing some of them as prohibited or to be avoided.
- The presence of halogenated substances always entails a risk of formation of dioxins when products reach the end of their life.
- Chlorinated phosphate esters may, for example, be present in mattresses that are bought by hospitals. Chlorinated flame retardants carry roughly the same risks as brominated retardants and have the same common denominator – halogens.
- It should be in the interests of product developers to move towards safer products, and there are therefore grounds to believe that the alternatives will be better.

6.2 Set stricter documentation requirements for phosphorus-based additives

After halogenated compounds, organic phosphorus compounds, usually phosphate esters, are the second most widely debated and questioned group in the literature. The reason is that this group contains some substances that have been found in the environment and/or are believed to have harmful characteristics. Phosphate esters have been used as military nerve toxins and are often used as insecticides because they can suppress nerve systems. This group unfortunately contains a number of phosphorus-based flame retardants, including triorthocresyl phosphate (TOCP; CAS 78-30-8), triphenyl phosphate (CAS 101-02-0), trimetacresyl phosphate (CAS 563-04-2) and triparacresyl phosphate (CAS 78-32-0). Nine phosphorus-based (often chlorine- and phosphorus-based)^{xx} flame retardants have been found in Swedish schools, nurseries and offices. In contrast to halogenated compounds there is no reason to apply general restrictions to this group of chemicals. It is sufficient to maintain a list of the known harmful substances.

6.3 Require documentation of all flame retardants

Because the range of flame retardants is larger (350–400 substances) and our knowledge of most of them is limited, it is important to keep a check on what is present in products. This makes it easier to react if there are new scares or findings, and at the same time use knowledge about the content of other products to decide what demands can be made regarding substitutes.

6.4 Recommended procurement requirements for flame retardants

Recommendations are given here for requirements that are intended to lead to the phasing out of brominated and halogenated flame retardants from products. The recommendations are ranked in four levels, with Level 1 representing the strictest requirements. The requirements cover information and environmental performance, as well as the actual properties of the product. In many cases, suppliers may find it just as difficult to provide documentary proof of Level 2 requirements as Level 3 and 4 requirements. Two requirement levels may therefore be used in combination, with one referring to information, and the other to improved environmental characteristics.

- Level 4. The tendering supplier must consult with Karolinska Hospital and where necessary help to produce information regarding the flame retardant content of the products.
- Level 3 Electronics. The tendering supplier MUST/ OUGHT to be able to state the content of all flame retardants. State the total content of halogenated flame retardants in grams for the product or products, if such information is available.
- Level 3 Textiles. The tendering supplier MUST state which substances are actively added to the materials in the product to inhibit combustion. State, where possible, the CAS numbers and amounts of each substance.
- Level 2. The product OUGHT not to contain additions of brominated flame retardants in concentrations higher than 0.1 weight per cent. Where relevant, state the total amount of brominated flame retardants in grams per product.
- Level 1. The product MUST not contain additions of brominated flame retardants in concentrations higher than 0.1 weight per cent.

Table 2 shows how the requirements can currently be applied to different types of goods.

Table 2. Recommended environmental requirements for procuring each product type.

Product type	Level 4 Information	Level 3 Information	Level 2 Properties	Level 1 Properties
Photocopiers		X Must		X
PCs + displays		X Must		X
Small electronic devices		X Must/Ought	(X)	X
Medical devices	X	(X)	(X)	
Beds and bed equipment		(X)		X*
Furniture upholstery		(X)		X*
Interior textiles		(X)		X*

* To be verified by means of clear traceability or supplemented with Level 3 requirement.

For medical devices in the Swedish market it will probably not be possible to set requirements at Levels 1 or 2 yet. The ability to set stricter requirements could improve relatively quickly, so we need to watch out for changes in the state of knowledge. In the case of small electronic devices, the chemical content and level of supplier knowledge may vary between different products in the group. For other products that are sold to Swedish hospitals, we can probably already set high requirements regarding the documentation of content and freedom from brominated flame retardants today.

6.5 Recommended future measures

6.5.1 Further study

The flame retardant content of medical devices should be monitored continuously for a few years, as most manufacturers and suppliers still have inadequate knowledge. A good time to gather more information is when placing new procurement contracts.

The flame retardant content of small electronic devices should be checked when new procurement agreements are made.

Changes in legislation are already monitored continuously.

6.5.2 Prioritising goals

The goal should be health care that is free from all substances that are harmful to health and the environment. To achieve this goal it may be necessary to work systematically in stages. The rate at which this work proceeds may depend partly on what is included on the phasing out list of Stockholm County Council, and when this is published.

Order of priority for flame-resistant goods should generally be:

- Exclude PBBs and PBDEs (only present now in medical devices)
- Exclude all brominated compounds
- Exclude all other halogenated compounds
- Exclude other known substances that are harmful to health and the environment
- Request information on remaining flame retardant substances

Additional priorities:

- Prioritise high-volume products.
- Procure products from several market suppliers.

It is difficult to give advice on the importance that should be assigned to factors such as the higher cost of goods that meet stricter environmental requirements, since this is an issue that is governed by politics and other guiding bodies.

6.5.3 Training and information

There is a lack of knowledge regarding which products contain substances that are harmful to health and environment. This is because priority has not been given to such environmental issues in the past, and information about the procured goods is scarce. This lack of knowledge is not restricted to Karolinska Hospital. It is a reflection of the level of knowledge in the rest of society, which includes our manufacturers and suppliers.

There is a need to increase our knowledge of what is being bought by the individual departments and what environmental effects these products entail. This information can be passed on in the form of general environmental training, theme seminars, department-specific feedback on purchases, and information on different types of consumables and their content, as well as communications with manufacturers and suppliers.

For most groups of employees, the most important requirement is clear information on the disposal of waste, combined with straightforward routines for managing waste in various parts of the hospital.

6.5.4 Continuous follow-up

In the case of PVC products, we were able to monitor most of the products supplied using purchasing statistics from MediCarrier, our central warehouse. Electronic products are not so easy to monitor, since they are almost exclusively procured through other channels. It would probably be possible to monitor purchases of electronic office equipment through purchasing reports from Logistics. The Department of Clinical Engineering keeps a register of medical devices. It has already been recommended that a register is kept of the environmental characteristics of products, but initial finance is required to introduce such a system.

A third approach would be to improve the monitoring of established procurement contracts and make this information more accessible.

6.5.5 National and international collaboration

No major resources have been allocated to the task of phasing out brominated flame retardants in health care. In many countries, efforts are still being made to phase out mercury thermometers and other products that contain mercury. This is work that has largely been completed in Sweden. In Health Care Without Harm, brominated flame retardants are an area of special focus, but we have not found any ideal partners to promote this issue. Because the problems encountered are largely the same and the market is global, for electrical products at least, there is a lot to gain from collaborating nationally and internationally. This could include the spreading of information, seminars, exchanging information on alternative materials and looking at opportunities for coordinating procurement requirements.

7 Conclusions

The amount of brominated flame retardants supplied in goods to departments at Karolinska Hospital is moderately large. The total amount is estimated not to exceed two tonnes per year.

The largest amount of brominated flame retardants we have been able to trace so far is present in electrical/electronic products.

The most common single substance that we have been able to verify in our products is TBBP-A – a substance that can disrupt thyroid activity, among other things.

It is most difficult of all to estimate the content of brominated flame retardants in medical devices. We will have to wait one or two years or more to obtain really useful information on the flame retardant content of medical devices, since the manufacturers and suppliers do not have much information themselves about the content of their products today. The content of products should be reviewed continuously during procurement.

Textile materials appear to be free from brominated flame retardants. However, we should watch out in future for the possibility that protective covers on trolleys and mattresses may contain other halogenated substances, such as PVC or polyfluorinated substances that can also have harmful effects on the environment and people's health.

It is desirable to increase information activities regarding harmful chemicals, in the form of internal training and effective written information.

This report recommends priorities and approaches to ensure that phasing out is successful. The most effective way of influencing development is through setting requirements during procurement and purchasing. National and international collaboration through common networks may be an effective way of encouraging manufacturers to put proactive efforts into the development of better products.

8 References

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