PLASTICS IN HEALTH CARE

HEALTH PROFESSIONALS AS ADVOCATES TO REDUCE PLASTIC POLLUTION TECHNICAL REPORT

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Foreword

Health Care Without Harm - Asia wishes to acknowledge first and foremost the leadership and staff of the 5 hospitals that freely allowed the conduct of plastic waste audit in their facilities, the results of which made this whole report possible. These hospitals are Alabang Medical Clinic, Mary Johnston Hospital, and St. Paul Hospital Cavite in the Philippines; and RSUD R. Syamsudin S.H. and the Rumah Sakit Akademik Universitas Gadjah Mada in Indonesia. To the medical directors, doctors, nurses and non-medical staff who volunteered to oversee and perform the actual waste audits, opening the hospital waste bags and counting/ classifying/weighing the plastic items in every bag: your efforts are well appreciated as this report elaborates the results of your endeavor.

We also acknowledge the support of Health Care Without Harm global colleagues from the time the project was conceptualized, negotiated, revised and as it's being implemented. Plastics waste in hospitals has been tackled in the HCHW for close to 20 years now, but this is the first time that it's being approached from the perspective of global concerns on plastic pollution.

The support from Break Free from Plastic Movement is also vital, and is fully acknowledged. The inspiration taken from Tagaytay Declaration to the time when the role of healthcare in addressing plastic pollution is being contemplated, up until when this report is to be made as part of the activities in Our Ocean Conference in Bali. The guidance from BFFP is well appreciated.

We also acknowledge the vital support from Plastic Solutions Fund, the partnership from which makes this project entirely possible.

Lastly, we thank the work of the staff of Health Care Without Harm Asia, the leadership of our Board of Trustees, and of course my colleagues in the Project Team. To Faye Ferrer, Ruth Stringer, Moresa Tolibas and Ma. Paz Oliva, thank you so much for your perseverance, the hard work and expertise poured into this project.

Thank you.

Ramon San Pascual, MPH

Executive Director, HCWH Asia

Introduction

Plastic is a versatile material, cheap, light and resilient. Its use has transformed many aspects of modern life, including healthcare. To cite just a few uses, single use syringes have been instrumental in preventing the spread of disease, dialysis tubing saves the lives of kidney patients, and surgical gloves protect patient, carer, and laboratory scientist from infection.

However, plastic is also seriously overused and its very resilience means that if it is not properly disposed of, it will contaminate the environment for decades or even centuries. It is estimated that, of the 8,300 million metric tonnes (Mt) of plastics produced to date, 6,300 Mt have become waste and almost 5,000 Mt have been accumulated in the environment or landfills[1]. Plastics consumption in Asia currently stands at around 20kg per person per year, and is expected to rise rapidly[2]. Overconsumption of plastics contributes significantly to climate change: approximately 8% of global oil consumption is used to make plastics, or power the factories that do so[3].

Some of this waste will inevitably find its way into the sea, and many of the rivers that carry the heaviest loads of plastic pollution are in Asia. The Pasig in the Philippines and the Brantas, Solo, Serayu and Progo in Indonesia are all in the top twenty. Yet more comes from dumping or littering in coastal areas, and wind transport. Overall, between 4.8 and 12.7 million tonnes of plastic waste are estimated to enter the global oceans every year[4].

Although it has only come to public prominence recently, the problem of plastics in the marine environment has been recognised for decades[5],[6].

All sectors of society will have to examine and improve the choices they make about the products they use, how, they are packaged, and how they are disposed of when they are no longer needed. The healthcare sector is no exception.

Healthcare uses many unique, specialist devices, some of which are created with plastics made from toxic materials, despite the availability of safer alternatives. Healthcare waste is not properly treated in many parts of the world[7],[8],[9]. It is frequently burned in the open, or in poorly controlled incinerators, or dumped either in uncontrolled landfills or the open.

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[1] Geyer et al. (2017) Production, use, and fate of all plastics ever made. Science Advances 3(7) e1700782, http://advances.sciencemag.org/content/advances/3/7/e1700782.full.pdf

[2] EC (2018) Plastic Strategy in Europe: The transition to a circular economy https://www.europeanfiles.eu/wp-content/uploads/2018/03/Plastic-Strategy-in-Europe-The-transition-to-a-circular-economy-March-April-2018-Issue-51.pdf

[3] Worldwatch Institute (2015) Global Plastic Production Rises, Recycling Lags. Press Release, January 2018. http://www.worldwatch.org/global-plastic-production-rises-recycling-lags-0 Accessed 10 Oct 2018.

[4] Lebreton et al. (2017) River plastic emissions to the world's oceans. Nature Communications 8: 15611-15620

[5] Maes et al. (2018) Below the surface: Twenty-five years of seafloor litter monitoring in coastal seas of North West Europe (1992–2017) Science of the Total Environment 630: 790-798 https://reader.elsevier.com/reader/sd/pii/S0048969718306442?token=7342147D1BCA5896CE5D6E0C5C535126DA9C6564AD675AEBBD46AE1075E82E8DB809D2C97C015982B1A60B59B61E0497

[6] Moore (2008) Synthetic polymers in the marine environment: A rapidly increasing, long-term threat. Environmental Research 108(2): 131-139

[7] Harhay et al. (2009) Health care waste management: a neglected and growing public health problem worldwide. Tropical Medicine and International Health 14(11): 1414-1417, http://onlinelibrary.wiley.com/doi/10.1111/j.1365-3156.2009.02386.x/pdf

[8] UNEP (2017) Global Mercury Waste Assessment: Review of Current National Measures. 49pp,https://www.unep.org/ietc/sites/unep.org.ietc/files/Global-Mercury-Waste-Assessment-web.pdf

Medical waste is regularly reported washed up on beaches[10],[11], sometimes having been transported huge distances. For example, healthcare waste from the South Indian state of Kerala have been identified in Sri Lanka, over 500km away[12]. The Asia Waste Management Outlook, published by UNEP in collaboration with the International Solid Waste Association (ISWA) and the Asia Institute of Technology (AIT), recognises both marine litter as posing very high risks, despite their comparatively small volumes[13].

As well as contributing the marine plastics crisis, improperly disposed healthcare waste also risks the spread of disease, contamination the wider environment, air pollution and greenhouse gases.

These audits provide a snapshot of the waste in healthcare facilities of differing sizes and complexity in two countries in the region. The audits were conducted over the course of one day, as such, it was not possible to audit the entire waste stream. Instead, a representative sample of the waste was audited and used to estimate daily quantities of waste. However, since the waste from will vary from ward to ward, and with weekly, seasonal cycles of clinics, holidays, climate and disease fluctuations, extrapolations do carry an element of error. Nevertheless, the results are broadly indicative of the trends in plastic waste in healthcare and provide valuable insight into areas where positive actions can be taken immediately, and others where there is potential if products or waste systems can be improved or technical or legislative barriers removed.

Audit Goals

The audit aims to assess ways by which the health care sector can improve its waste management procedures, use its purchasing power and its voice to address health and environmental impacts of plastics from production to use, treatment and disposal.

1. Identify products used within the healthcare sector which cause harm during manufacture, use, and due to indiscriminate disposal which impacts our lands and, oceans and society in general and the healthcare sector in particular;

2. Identify practical steps that to reduce the consumption of harmful and/or non-recyclable plastics in the healthcare sector including:
    a) Actions that hospitals can take
    b) Policy actions that governments can take
    c) Actions that manufacturers can take.

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[9] WHO & UNICEF (2015) Water, sanitation and hygiene in health care facilities. Status in low- and middle-income countries and way forward: WASH IN HEALTH CARE FACILITIES. Publ: WHO, Geneva, 52pp, http://apps.who.int/iris/bitstream/10665/154588/1/9789241508476_eng.pdf?ua=1

[10] Stringer et al. (2011) Medical Waste and Human Rights Submission to the UN Human Rights Council Special Rapporteur, 68pp, https://noharm-global.org/documents/medical-waste-and-human-rights-report

[11] Paavola (2018) Influx of medical waste washes up on Florida beach. Becker's Hospital Review, https://www.beckershospitalreview.com/supply-chain/influx-of-medical-waste-washes-up-on-florida-beach.html accessed 10 Oct 2018

[12] Srinivasan, M. (2018) Medical waste from Kerala spotted on Sri Lankan shore. The Hindu, 15 August 2018, https://www.thehindu.com/news/international/medical-waste-from-kerala-spotted-on-sri-lankan-shore/article24693729.ece accessed 21 August 2018

[13] UNEP (2017) Asia Waste Management Outlook: summary for decision makers. Publ: UNEP IETC, Osaka, 12pp, https://www.iswa.org/index.php?eID=tx_iswaknowledgebase_download&documentUid=5072

Research Partners

The Global Green and Healthy Hospitals (GGHH) program of Health Care Without Harm partnered with hospitals from both Philippines and Indonesia who were members of the GGHH for this audit.

For the Philippines

- Alabang Medical Clinic, Muntinlupa City
- Mary Johnston Hospital, Manila City
- St. Paul Hospital Cavite, Dasmarinas City

For Indonesia

- RSUD R. Syamsudin S.H., Syamsudin, West Java
- Rumah Sakit Akademik Universitas Gadjah Mada, Yogyakarta

Each hospital was given orientation about the project, and an introduction to the project, why plastic is also a healthcare issue were prepared for the hospitals. Philippine hospitals received on-site orientation by the project team. Indonesian hospitals were oriented through an online call. The audits were carried out according to the following schedule:

- **Day 1** - Orientation on the project and training of waste audit participants
- **Day 2** - Collection of waste - The hospital was required to collect 24-hour worth of waste for the audit.
- **Day 3** - Audit day. Steps followed for the audit are the following:
    - Count all the bags collected from previous day's collection. Separately count yellow, black, and other color bags.
    - The number of bags of each type needed to create a representative sample of at least 10% of the waste was calculated.
    - The requisite number of bags from each of the colors available were selected randomly by the HCWH documenter.
    - Selected bags were then processed by the segregation team. There are two stages for the waste segregation. In the first stage, each bag was weighed, and then the plastics were be separated from non-plastic waste and weighed again to give the % weight of plastics in the waste stream.
    - In the second stage, the audit teams categorised the plastic fraction of the waste stream into product types. They were then further categorised into groups of identical or near identical products.
    - For each product, information about product type, product, polymer, manufacturer name and location, number and weight were all recorded in an electronic audit form developed by HCWH for this project.

The audit orientation and training on day 1 was held in all the hospitals and collection of the waste on day 2 were conducted without any problems. Audit day starts early at 8 in the morning in order to avoid the heat from midday until early afternoon. Each hospital were responsible for assembling members of the audit team. Most team members were orderlies and waste management teams of the hospitals. Other departments of the hospitals like the laboratory, central supply, and even administration participated in the audit.

All types of waste bags were opened for the purpose of the audit - the Philippines had green bag (food waste) black bag (residual waste) and yellow bag (infectious) bags, while Indonesia had black bag (general waste) purple bag (cytotoxic) and yellow bag (infectious). Sharps bags are separate from the other bags and are also part of the audit. Yellow bags are generally not allowed to be opened once sealed, however, the audit required all type of bags to be opened and be audited including yellow bags.

It should be noted that proper precautions were established in order to safeguard the volunteers working on the yellow bag. Aware of the threat of infection with opening the yellow bag poses, participating volunteers for the waste audit were required to wear proper protective equipments that will ensure safety as yellow bags are opened and audited. Audit teams wore masks, gloves, apron and boots for the audit. To ensure that safety of the volunteers, we also requested that the head of the waste management team and the infection control head oversee the audit process as well.

Alabang Medical Clinic (AMC), Philippines

The Alabang Medical Clinic, or AMC, was established in 1982 as a 10-bed primary care hospital. Today, with 3 clinics connected under its name has increased its bed capacity to 30 and has been established as a secondary level hospital. Services include inpatient, outpatient and diagnostic healthcare services delivered onsite and at home, 24 hours, 7 days a week.

The hospital averages 172 bags per day - with 15 yellow bags, 115 black bags, 39 green bags and 3 sharps container.

In the Philippines, incineration of any type of waste, including that of hospital waste, is prohibited by law (RA 9003). Consequently, all hospitals need to ensure that they are managing their with non-combustion methods. The law specifies that infectious and pathological waste should be treated through either through steam or microwave technologies. Food and general waste are to be managed with special emphasis on proper segregation, recycling, reusing, reduction and then disposal.

The AMC, utilizes a private contractor, Integrated Waste Management Inc. (IWMI), for waste treatment. IWMI is accredited by the Philippine government through the Environment and Natural Resources Department to transport, treat and dispose infectious waste of hospitals in the country. Autoclaves are used to disinfect the waste.

Sample of medical related plastics in the hospital would include gloves, oxygen mask, IV tubing and IV bottles

Sample of both medical and non-medical plastics in the hospital would include water bottles, liners, sample containers, and different types of packaging

Treatment of infectious and pathological waste or yellow bags is priced at Php 25.00 (US$0.46) per kilo. Yellow bags are collected twice a month with an average of 150-200 kilo per month.

AMC sells six types of recyclables, including PET bottles and IV bottles and averages about Php 17,000 (US$310) annually from sales of their recyclables. The hospital is exploring building a biodigester for food waste.

They currently have no policy in terms of green or sustainable purchasing, however, the hospital has already implemented several waste minimization strategies.

Mary Johnston Hospital, Philippines

Mary Johnston Hospital (MJH) is a non-stock, non-profit Healthcare Institution with 120-bed capacity. It is licensed by the Department of Health and accredited by the Philippine Hospital Association and Philippine Health Insurance Corporation Association. It has six major clinical departments and is recognized by the different specialty societies for its Residency Training Program for Department of Internal Medicine, Pediatrics, Surgery, Obstetrics and Gynecology. MJH is also accredited as Mother-Baby Friendly Hospital.

The hospital averages 717 bags per day - with 251 yellow bags, 285 black bags, 137 green bags and 24 sharps container.

Yellow (infectious) waste bag containing food waste

Sample yellow bag wastes opened for audit

The waste is autoclaved by an external company. Treatment of infectious and pathological waste or yellow bags is priced at PHP 26.00 (Usd 0.48) per kilo. Yellow bags are collected three times a week with an average of 628 kilo per collection.

Mary Johnston Hospital recycles plastic bottles, and two other categories of waste, and in 2017 earned Php 37,436.00 (Usd 693) from recyclables.

St. Paul Hospital Cavite (SPHC), Philippines

St. Paul Hospital Cavite (SPHC) is a non-stock, non-profit, religious - owned hospital is a Level 2 Philippine hospital with a capacity of 100 beds. The Laboratory and Diagnostic Imaging Units are accredited as Tertiary Level. Among the medical specialties in the hospital are: Internal Medicine, Surgery, OB-Gyn, Pediatrics, Ophthalmology, Orthopedics, Anesthesia, Radiology, Pathology and Physical Therapy and Rehabilitation Medicine. Available facilities are: 10 beds Emergency Room including a Minor OR/ Traumas room. ER Delivery Room, and an Isolation Room. The Operating Room Complex is composed of three (3) major OR Theaters, one (1) Minor Room, two (2) Delivery Rooms, one (1) Labor Room, High Risk Pregnancy Unit, Post Anesthesia Care Unit (PACU) and the Neonatal ICU (NICU). Other floors are allotted for Private Rooms and Wards for both adult and pediatric patients; six (6) beds Intensive Care Unit, Hemodialysis Unit, Endoscopy Unit and Ophtha Laser Unit.

The hospital produces, on average, 94 bags per day - with 45 yellow bags, 44 black bags, and 5 sharps containers. Annual sales of recyclables bring in an average of Php 147,000 annually (Usd 2,725) from sales of their recyclables.

The hospital uses an autoclave to disinfect its own waste. It recycles twelve separate categories of waste, including PET bottles, syringe barrels and plungers, and mixed plastic items, such as buckets and microwavable food containers, the majority of which are likely to be polypropylene.

The hospital has recently installed a biodigester for all the food waste coming from patient rooms and other sources inside the hospital including those that of housing for the nuns and some employees. The biodigester averages about 20-25kg per day and gas produced from the biodigester is used for several hours for cooking in their kitchen.

They currently have no green purchasing policy, but have already implemented several waste minimization strategies also aligned with their city's own local law on the ban of use of styropor (polystyrene) for any type of food packaging.

The hospital also provides water fountains with both hot and cold water for each of the hospital floors.

Sample mixed medical and non-medical waste from hospital

RSUD R. Syamsudin, S.H., Indonesia

Regional General Hospital (RSUD) R. Syamsudin, S.H.was established in the city of Sukabumi – West Java at the beginning on September 9, 1920. Formerly called the St. Hospital Lidwina (Bunut), the efforts to provide social services to the community was established by the Municipal Government Sukabumi. The hospital has a bed- capacity of 800 beds.

Its services and offices include Administration of Medical Services Management, Emergency Services, Hospital Information System and Medical Records, Outpatient and Inpatient Departement, Radiology, Clinical Pathology Laboratory and Anatomy Pathology, Nursing Services, Pharmacy, Occupational health, Operating Wards, Intensive care unit, Perinatal High Risk wards, Hospital Infection Control and health promotion department.

The hospital averages 257 bags per day - with 126 yellow bags, 129 black bags and 2 sharps container.

The Indonesian government regulation number 101 of 2014 or the regulation regarding hazardous and toxic waste management, mandates all hospitals to have their infectious and pathological waste (otherwise known as type B3 waste) to be incinerated. but currently it is not permissible to carry out burn in the hospital area, so the hospital must collaborate with the private sector that is certified in carrying out hospital waste management.

Syamsudin hospital was carried out in collaboration with PT Watec for hospital waste management. PT Watec is a waste treatment company certified by the Ministry of Health. The hospital also has an autoclave to disinfect some plastic waste and also has a counter to chop plastic waste into plastic ore. currently 15% of medical plastic waste, especially infusion bottles, is managed with aoutoclave and then chopped into plastic ore which is then sold. every year produces USD2500 from the sale of the plastic ore. while organic type waste is managed to be compost with an average monthly gain of 45 kg of compost used to fertilize hospital plants. Some food waste is disposed of together with general (black bag) waste, however, leftovers from inpatient rooms are collected and are given to farmers that use the food waste for livestock. Syamsudin also sells twenty-three separate categories of waste to a local recycler, but no specific information was available on the types of plastic sold or related incomes.Water dispensers are available in each floor wards for access by patients, visitors and hospital personnel. These are prominently sited for easy access.

Sample medical plastic waste from hospital

Labelling used by Health Care Without Harm for the waste audit will identify the hospital, the room where the bag was taken, the time and person in charge during collection

Collected previous 24-hour worth of waste are opened for random selection before audit

RSA University Gadjah Mada, (UGM), Indonesia

The Rumah Sakit Akademik Universitas Gadjah Mada was built to answer the challenges in delivering excellence in service, education and research in accordance with the vision of the University of Gadjah Mada. The hospital currently has 120 beds.

Its services include primary and specialist health care service, outpatients, emergency, laboratory, radiology, pharmacy, and non-medical supports. Extension development of inpatient and outpatient, and the development of education and research building from basic up to community level, adding other supporting facilities such as guesthouse for patients' families and building for hospital management.

The hospital averages 180 bags per day - with 60 yellow bags, 113 black bags, and 7 sharps container. All infectious wastes are incinerated.

Treatment of infectious and pathological waste or yellow bags is priced at IDR 72,800 (US$ 4.80) per kilo. Yellow bags are collected twice a week with an average of 50-60 kilo per collection.

Counted black waste bags lined up for audit

Counted yellow waste bags lined up for audit

The hospitals recycles paper and some non-infectious plastics: infusion or IV bottles and hemodialysis fluid containers. This earns an annual income of approximately IDR 157,300,00 (Usd 1,035) annually from sales of their recyclables.

The hospital has not yet implemented any purchasing initiatives that would promote green purchases. The hospital is exploring the possibility of building a biodigester for food waste.

Results and discussion

Facility Name	Waste/day (kg)	Plastics/day (kg)	% plastic
Alabang Medical Clinic	72	33	46%
Mary Johnston Hospital	1096	597	54%
St. Paul Hospital Cavite	219	158	72%
Syamsudin Hospital	1398	689	49%
UGM Hospital	568	292	52%

Table 1. Amount of waste produced per day at each facility.

The audits clearly demonstrate the significance of plastics in the healthcare waste stream, representing between 46 and 72 percent. Other research has found it to represent between 12% and 46% (see table 2 below).

Table 4.1. Average Material Constituents of Healthcare Waste[49]

Jordan*		Peru		Turkey		Taiwan		Kuwait		Italy	
Constituent	**%**	**Constituent**	**%**	**Constituent**	**%**	**Constituent**	**%**	**Constituent**	**%**	**Constituent**	**%**
Paper	38	Mixed paper	22	Paper	16	Paper	34	Paper	24	Paper	34
		Cardboard	5	Carton	5			Cardboard	8		
Plastic	27	Plastic	12	Plastic	41	Plastic	26	Plastic	18	Plastics	46
Glass	10	Glass	8	Glass	7	Glass	7	Glass	10	Glass	8
Metals	5			Metal	2	Metal	4	Metal	9	Metal	0.4
				Food	17	Food	15	Food	12		
Textiles	11	Cotton/gauze	18	Textiles	10	Textiles	9	Textiles	11		
		Placenta	8							Anatomical	0.1
Garbage	9	Other	27	Other	3	Other	3	Other	8	Liquids	12

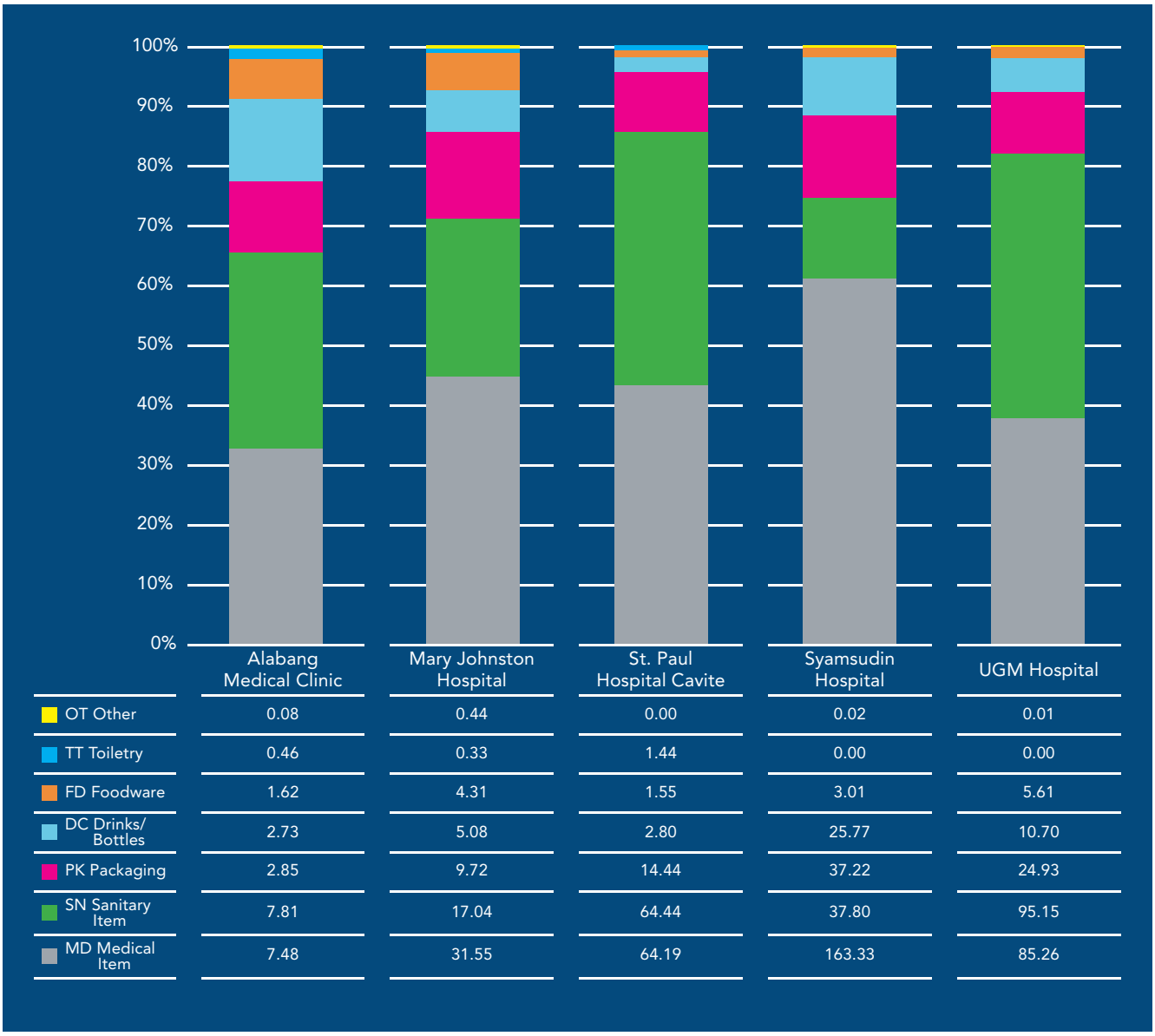
* excluding kitchen waste

Table 2. Material constituents of healthcare waste[14].

The high percentage of plastics in the waste streams from the audited hospitals may also be partly due to the separate treatment of organic waste, which can form a significant fraction of the whole waste stream. As described above, Syamsudin Hospitals separate food wastes for livestock feed. St. Paul Hospital Cavite produces approximately 20kg of food waste per day, equivalent to 10% of the audited waste stream. The food waste is biodigested and produces methane gas for the kitchens. Alabang and UGM are also considering biodigestion systems. All hospitals should adopt systems to minimise and treat food waste to reduce their carbon footprint. Mixing food waste with general waste during collection also contaminates any recyclables and makes them less attractive to recyclers.

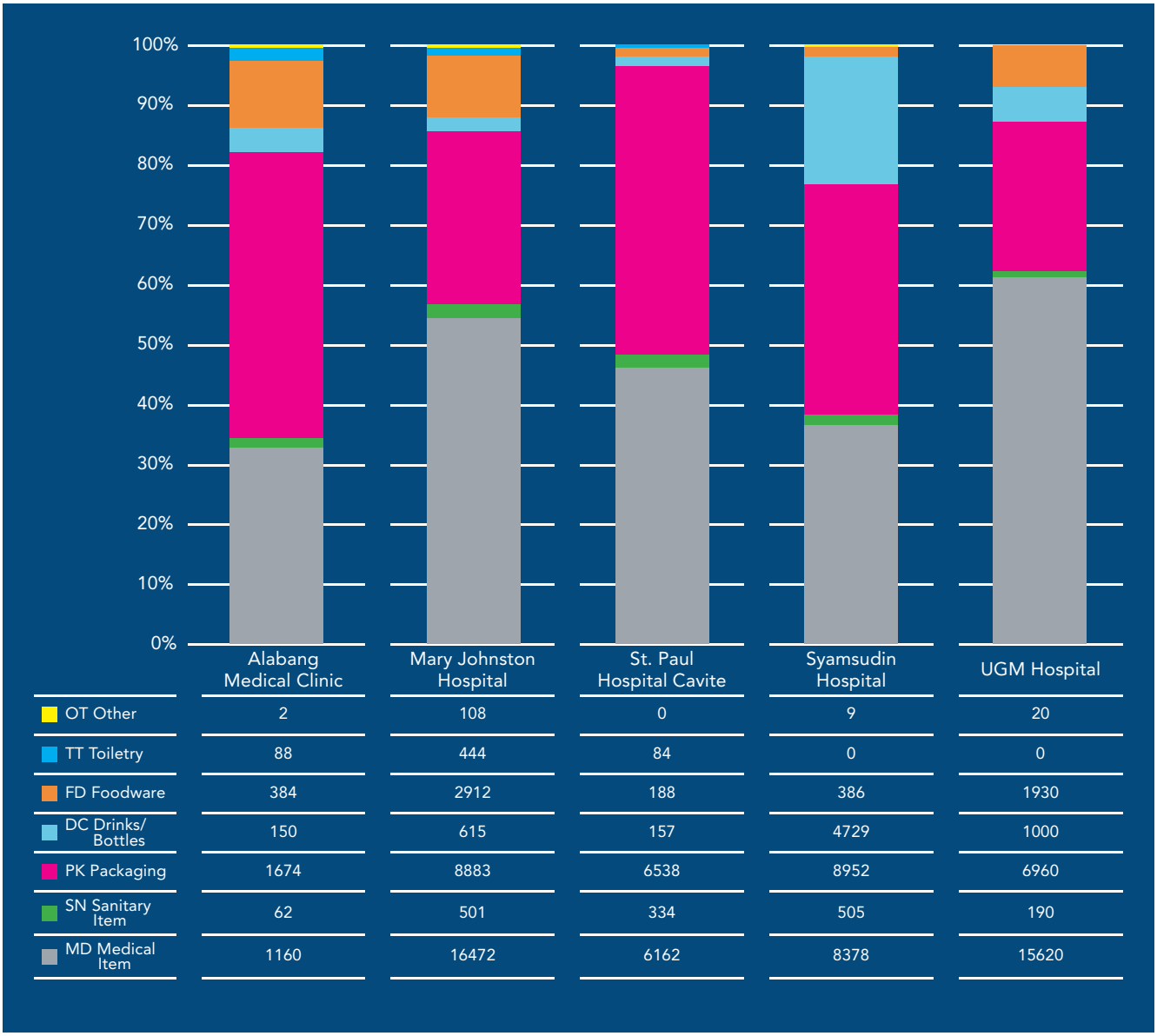
[14] UNEP (2012) Compendium of Technologies for Treatment/Destruction of Healthcare Waste. Publ: UNEP IETC, Osaka, 233pp. http://wedocs.unep.org/handle/20.500.11822/8628?show=full

Figures 1 and 2 below show the different types of products in the plastics waste streams in each of the project facilities; figure 1 shows the data according to weight and figure 2 according to number of items.



	Alabang Medical Clinic	Mary Johnston Hospital	St. Paul Hospital Cavite	Syamsudin Hospital	UGM Hospital
OT Other	0.08	0.44	0.00	0.02	0.01
TT Toiletry	0.46	0.33	1.44	0.00	0.00
FD Foodware	1.62	4.31	1.55	3.01	5.61
DC Drinks/ Bottles	2.73	5.08	2.80	25.77	10.70
PK Packaging	2.85	9.72	14.44	37.22	24.93
SN Sanitary Item	7.81	17.04	64.44	37.80	95.15
MD Medical Item	7.48	31.55	64.19	163.33	85.26

Figure 1. Amounts (kg) of different types of plastic waste generated per day in each facility.



	Alabang Medical Clinic	Mary Johnston Hospital	St. Paul Hospital Cavite	Syamsudin Hospital	UGM Hospital
OT Other	2	108	0	9	20
TT Toiletry	88	444	84	0	0
FD Foodware	384	2912	188	386	1930
DC Drinks/ Bottles	150	615	157	4729	1000
PK Packaging	1674	8883	6538	8952	6960
SN Sanitary Item	62	501	334	505	190
MD Medical Item	1160	16472	6162	8378	15620

Figure 2. Number of items in each category of waste per day.

By weight, the three largest categories are medical devices, sanitary items and packaging. However, the sanitary items are generally far heavier than other waste plastic items, so they are only a small fraction of the waste if items are counted individually.

Packaging

Packaging is one of the top uses for plastics[15]. According to the EU plastics strategy 95% of packaging is wasted, and the strategy envisions that, by 2030, all plastic packaging should be either reusable or recyclable in a cost effective manner[16]. Five trillion plastics bags are produced each year[17], the vast majority of which are not recycled. Consequently, numerous governments, starting with Bangladesh in 2002, have banned or restricted plastic bags[18].

The European directive to reduce plastics bags was has resulted in a reduction in the amount of them littering the sea floor in northwest Europe[19], demonstrating the need for similar legislation elsewhere.

Packaging for medical devices can be made from many different polymers and is designed with ease of use, barrier properties and sterilisation in mind[20]. Manufacturers should strive to avoid unnecessary packaging and ensure that what is used can be recycled.

Healthcare facilities should consider the amount of packaging in the products they purchase and avoid over-packaged products as part of a sustainable purchasing program. In-house shops should cease to provide plastic shopping bags.

Diapers and sanitary products

Diapers and sanitary products are generally treated as municipal waste, not infectious waste, but in the Philippines, they are regarded as infectious medical waste. For that reason, they were included in the audit. Sanitary items found in the healthcare waste streams were adult and infant diapers, and absorbent pads for beds.

Disposable diapers are made of multiple materials, including plastics outers and absorbents including cotton, food pulp and super-absorbent polymers (SAPs). Recycling is technically possible but it is expensive and few reliable facilities exist anywhere in the world[21],[22]. One company recycling absorbent hygiene products (AHPs) commissioned a life cycle analysis that estimated it reduces greenhouse emissions by up to 71% compared to landfill and incineration, and *"toxicity impacts to humans reduced by up to 97%, toxicity impacts to animals and plants reduced by up to 99%, acid rain impacts reduced by up to 48%, resource depletion reduced by up to 54%, eutrophication reduced by up to 93%"*[23].

[15] Plastics Europe (2016) Plastics – the Facts 2014/2015 An analysis of European plastics production, demand and waste data. 34pp, http://www.plasticseurope.org/documents/document/20150227150049-final_plastics_the_facts_2014_2015_260215.pdf

[16] EU (undated) A EUROPEAN STRATEGY FOR PLASTICS IN A CIRCULAR ECONOMY. Publ: European Union, Brussels, 3pp, https://ec.europa.eu/commission/sites/beta-political/files/plastics-factsheet-challenges-opportunities_en.pdf accessed 9 Oct 2018

[17] The World Counts Website http://www.theworldcounts.com/counters/waste_pollution_facts/plastic_bags_used_per_year accessed 10 October 2018

[18] Wikipedia (2018) Phase-out of lightweight plastic bags. https://en.wikipedia.org/wiki/Phase-out_of_lightweight_plastic_bags Accessed 10 October 2018.

[19] Maes et al. (2018) Below the surface: Twenty-five years of seafloor litter monitoring in coastal seas of North West Europe (1992–2017) Science of the Total Environment 630: 790-798. https://reader.elsevier.com/reader/sd/pii/S0048969718306442?token=7342147D1BCA5896CE5D6E0C5C535126DA9C6564AD675AEBBD46AE1075E82E8DB809D2C97C015982B1A60B59B61E0497

[20] Bix and de la Fuente (2009) Medical device packaging. In: The Wiley Encyclopedia of Packaging Technology Edition: 3rd edition, Publisher: John Wiley & Sons, Inc.: Hoboken, NJ, USA. Editors: Kit L. Yam, DOI: 10.13140/RG.2.1.1717.2964

[21] Green Bottoms (2018) US-based recycling company: We've cracked the nappy recycling process. http://greenbottoms.co.uk/2017/08/terracycle/, accessed 29 September 2018.

[22] Knowaste (2018) Healthcare and Hygiene Waste Management. Publ: Knowaste, Bromsgrove, UK, 2pp. http://www.knowaste.com/wp-content/uploads/2018/02/knowaste_healthcare.pdf. Accessed 1 Oct 2018

[23] Deloitte (2011) Absorbent Hygiene Products Comparative Life Cycle Assessment. Knowaste Ltd: Summary of Findings. Publ: Knowaste, Bromsgrove, UK 12pp. http://www.knowaste.com/wp-content/uploads/2018/02/Deloitte-dcarbon8_Knowaste-LCA_Exec_Summary.pdf accessed 1 Oct 2018

Given the scarcity of recycling facilities, however, and the general need to prioritise waste reduction and reuse over recycling (see figure 5 about the waste hierarchy), the best action healthcare facilities in Asia can take is to promote and use alternatives to disposables wherever possible. Reusable diapers range from simple cloth wraps secured with a pin, to more sophisticated systems with outer pants and absorbent liners. St. Paul Hospital has been trialling reusable cloth diapers for newborns to reduce their sanitary waste. Legal reclassification of sanitary waste as general rather than non-infectious waste would also reduce the legal and waste management burden on Philippine hospitals.

Medical Devices

The most common medical devices in the waste stream were: surgical gloves, syringes and accessories, IV tubing and accessories, saline bottles, medical bottles and saline bottles.

Disposable medical gloves

	Alabang Medical Clinic	Mary Johnston Hospital	St. Paul Hospital Cavite	Syamsudin Hospital	UGM Hospital
Number of items	379	6041	2340	7316	7970
% weight of medical items	33%	37%	38%	61%	53%
Weight (kg)	1.48	30	7	26	44
% weight of medical items	20%	15%	11%	21%	52%

Table 3. Numbers, weight and percentage of surgical gloves.

Disposable surgical gloves are an essential item, which will continue to be used in large quantities. Between them, the audited hospitals dispose of approximately 24,000 surgical gloves per day weighing almost 110kg. Over the course of a year, this would add up to almost 40 tonnes of gloves.

Disposable gloves can be made of PVC (vinyl), latex (natural rubber), nitrile (synthetic rubber) or PE[24], but the vast majority of surgical gloves are made of the first three materials. Each has their downsides.

PVC are the least favoured from an environmental point of view and should be avoided wherever possible. They are also the least flexible in use and provide the least protection against chemicals. Latex is highly flexible, and gives good dexterity. However, it does not provide a good barrier to chemical or drug exposure, and some users can become allergic to latex, in which case synthetic rubbers like nitrile are recommended[25]. Nitrile rubber is generally regarded as the best option for users but one of the precursors, acrylonitrile[26], is highly toxic.

[24] Reports and Intelligence (2017) World Medical Glove Market by Product Type, Market, Players and Regions-Forecast to 2021. http://www.reportsandintelligence.com/world-medical-glove-by-product-type-players-and-regions-forecast-to-2021-reports-market

[25] WHO & ILO (2014) HealthWISE - Work Improvement in Health Services - Action Manual. Publ: World Health Organization, Geneva, 178pp, http://www.ilo.org/global/docs/WCMS_237276/lang--en/index.htm http://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/instructionalmaterial/wcms_237276.pdf

[26] Wikipedia (2018) Nitrile rubber. https://en.wikipedia.org/wiki/Nitrile_rubber accessed 13 Oct 2018

None of the three main materials are regularly recycled, though there are some examples: recycling companies that take latex gloves[27]; latex gloves have been recycled into tyres[28], and and manufacturers collecting nitrile gloves from customers to recycle into items like park benches[29],[30].

Healthcare facilities should eliminate PVC gloves, take measures to ensure that non-latex gloves and powder-free gloves are provided for those with a latex allergies, and investigate opportunities for recycling. Governments and manufacturers should take a policy decision to cease the manufacture of PVC medical gloves.

Syringes

	Alabang Medical Clinic	Mary Johnston Hospital	St. Paul Hospital Cavite	Syamsudin Hospital	UGM Hospital
Number of items	0	2373	804	1174	3450
% weight of medical items	0%	14%	13%	10%	23%
Weight (kg)	0	11	3.2	8	13
% weight of medical items	0%	6%	5%	6%	15%

Table 4. Numbers, weight and percentage of syringes.

Syringes are another essential, life-saving, single use item. No sharps container was opened at Alabang. Between them, the other four sites consumed an estimated 7,800 syringes in a single day, representing some 35kg of high grade plastic. Over the course of a year, this would add up to nearly 13 tonnes of plastic. The manufacturer of syringes was not always known, but where it was, the manufacturers were BD and Terumo. They are among the largest global manufacturers[31].

The combination of the potential to pierce the skin and likelihood of containing pathogens, syringes are one of the most hazardous of medical waste. Three of the audited hospitals- Alabang, SPHC and Syamsudin- use needle cutters to prevent needle stick injuries and subsequent infections during and after disposal. Most of these devices also remove the tip of the syringe, making it impossible to reuse. This can prevent injury and infection in anyone handling syringes, such as waste handlers. They are rag pickers are particularly vulnerable to needle stick injuries[32] and is particularly important in contexts where waste ragpickers may access landfills, or search out syringes to be sold on for recycling or illicit reuse[33].

[27] Hunker (2018) How to recycle latex gloves. https://www.hunker.com/12464967/how-to-recycle-latex-gloves Acessed 10 Oct 2018
[28] Mahesh Nakarmi, Director, Healthcare waste programme, Health Care Foundation Nepal, pers. comm.
[29] Labconscious (2015) Case study: recycling nitrile gloves vs single use latex. http://www.labconscious.com/blog/2015/2/25/case-study-recycling-nitrile-gloves Accessed 10 Oct 2018
[30] Kimberley Clarke (2018) RightCycle by Kimberly-Clark Professional: Turn previously hard-to-recycle products into useful, eco-responsible items. https://www2.kcprofessional.com/brands/kimtech/rightcycle accessed 10 Oct 2018
[31] Reports and Intelligence (2017)Global Disposable Syringe Market by Product Type, Market, Players and Regions-Forecast to 2021. http://www.reportsandintelligence.com/global-disposable-syringe-by-product-type-players-and-regions-forecast-to-2021-reports-market
[32] Blenckharn and Odd (2008) Sharps Injuries in Healthcare Waste Handlers. Ann Occup Hyg. 52(4): 281-286
[33] Stringer

Once the needles and syringe tips are removed, syringes can be disinfected in an autoclave or similar technology, making them safe to recycle. Syringes are sent for treatment/disposal in all facilities except St. Paul Cavite, which has an in-house autoclave.

Syringes are "prequalified" by the World Health Organization, a form of certification for vital medical products, and those produced by the manufacturers identified at these facilities are described as made of polypropylene[34], though others may also contain high density polyethylene. These two plastics have among the least toxic life cycles and are recyclable. The combination of the well defined plastic content, the huge number made per year, and the fact that also frequently collected separately from other waste, this a potentially valuable recyclable waste stream.

IV tubing and accessories

	Alabang Medical Clinic	Mary Johnston Hospital	St. Paul Hospital Cavite	Syamsudin Hospital	UGM Hospital
Number of items	117	1739	522	1139	270
% weight of medical items	10%	11%	8%	9%	1.8%
Weight (kg)	2.5	17	41	35	11
% weight of medical items	33%	8%	64%	28%	12%

Table 5. Numbers, weight and percentage of IV tubing and accessories.

Altogether, the five hospitals in the audit disposed of almost 3,800 items of IV tubing or related equipment. Together, these added up to some 106 kg of waste per day, or over 38 metric tonnes per year. These products are not recycled.

Historically, IV tubing (or lines) was almost exclusively made of DEHP-plasticised PVC. Alternatives do exist[35], though there is little evidence that they are widely used in the Philippines or Indonesia. Although vital, until alternatives are in place, patients will be exposed to softeners, particularly DEHP, leaching from these products. All stakeholders in the healthcare sector should act to enable a transition to PVC-free IV products and devices.

[34] WHO (2018) Immunization standards http://www.who.int/immunization_standards/vaccine_quality/pqs_prequalified_devices_e08/en/ accessed 10 Oct 2018
[35] HCWH (2018) PVC-Free Alternatives. https://noharm-uscanada.org/content/europe/pvc-free-alternatives, accessed 16 October 2018.

IV bottles and other sterile liquid containers

	Alabang Medical Clinic	Mary Johnston Hospital	St. Paul Hospital Cavite	Syamsudin Hospital	UGM Hospital
Number of items	163	520	251	1542	50
% weight of medical items	14%	3.2%	4.1%	13%	0.3%
Weight (kg)	2.3	57	6	46	2.0
% weight of medical items	30%	28%	9.0%	66%	2.4%

Table 6. Numbers, weight and percentage of IV bottles and other sterile liquid containers.

IV infusion bottles and other medical bags, such as urine bags, make up a significant amount of the plastics waste stream. The high variation between hospitals seen in this case may partly be an effect of subsampling the waste and partly because of the different practices at the participating facilities, but regardless of whether they are they will remain an important set of medical devices.

Based on the audit data, together, these five hospitals would generate over 2,500 items a day, weighing 113kg and adding up to more than forty tonnes of these products every year. Some of these can be profitably recycled. Many IV saline and other infusion bottles are made from polyethylene, which is one of the world's most recycled plastics. Critically, as they contain liquids that are for infusion into the body, they do not come into contact with infectious materials and can be segregated for recycling without treatment.

Medical bottles

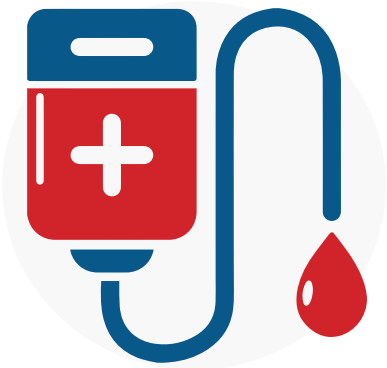
	Alabang Medical Clinic	Mary Johnston Hospital	St. Paul Hospital Cavite	Syamsudin Hospital	UGM Hospital
Number of items	157	1193	439	308	760
% weight of medical items	13%	7%	7%	2.6%	5.0%
Weight (kg)	0.78	13.48	0.64	3.80	8.43
% weight of medical items	10%	7%	1.0%	3.0%	10%

Table 7. Numbers, weight and percentage of medical bottles.

Together the five facilities dispose of around 2,800 items in this category every day, weighing 27kg and adding up to almost ten tonnes a year.

Medical bottles include a variety of items from medicine bottles to specimen bottles and cups. This is a diverse waste stream, but there is potential for waste reduction. For example, some facilities are disposing of many single use specimen containers. These could be disinfected and recycled, but it would be environmentally preferable for them to be designed for disinfection and reuse so that the waste stream would be permanently reduced.

Blood bags/other medical bags



In contrast with infusion containers (see above) medical bags such as blood and urine bags are more difficult to deal with in the short term. Some, such as urine bags, may be infectious. Blood bags will also be classified as infectious, though in fact, it is screened for infection at the blood bank and so only rejected blood donations pose a significant threat. Many of these bags will also be made of non-recyclable or toxic materials such as EVA or PVC.

Alternatives to PVC and/or DEHP are are potentially available for most medical bags[36], though it is not known whether they are avaialble on the market in the Philippines or Indonesia. Even in markets where DEHP alternatives are offered, though, products may contain an unpredictable mixture of other additives[37].

In the short term, healthcare facilities should investigate the products least likely to expose patients to leachable plasticisers.Ultimately, the only way to eliminate exposure is to substitute PVC entirely.

One of the hardest products to substitute has been the blood bags for red blood cells. However, a European project has designed a PVC-free blood bag which should be able to offer the same performance at an equivalent price. The Karolinska University Hospital in Sweden is inviting hospitals to sign a letter of intent to catalyse large scale production[38]. This and other similar innovations should be embraced by manufacturers and purchasers at all levels to provide these essential products in a safe and environmentally sustainable fashion.

Oxygen masks

Oxygen masks may be made of a PVC, silicone or other materials. PVC oxygen masks are not able to withstand high temperatures, but silicone ones are more resilient and hence can be autoclaved and reused. Reusing silicone masks both saves money and reduces plastic waste.

[36] HCWH (2018) PVC-Free Alternatives. https://noharm-uscanada.org/content/europe/pvc-free-alternatives, accessed 16 October 2018.
[37] Malarvannan et al. (2018) Phthalate and Alternative Plasticizers in indwelling Medical Devices in Pediatric Intensive Care Units. Journal of Hazardous Materials, https://doi.org/10.1016/j.jhazmat.2018.09.087
[38] PVCfreeBloodBag.eu (2018) Karolinska University Hospital takes the next step for a PVC-free blood transfusion. http://www.pvcfreebloodbag.eu/?p=1401, accessed 20 Oct 2018

Rapid test kits

Rapid test kits provide a fast and reliable analysis of everything from pregnancy to blood sugar level, to presence or absence of life threatening infections. Cheap and easy to use, they deliver enormous benefits to the healthcare professional and patient alike, and use will continue to grow for the foreseeable future. Consequently they will represent an increasing fraction of the plastic waste stream, especially in small or rural healthcare facilities that lack conventional laboratories.

The manufacturers need to act jointly to design rapid tests in non-hazardous plastics and develop methods of collecting and recycling them in a sustainable fashion.

Wipes and disposable plastic-based fabric items.

Disinfectant, cleaning and moisturising wipes, disposable surgical gowns and drapes, and surgical masks represent a growing element in the plastics waste stream: non-woven plastic-based fabrics also known as olefin fibres[39]. Although some materials such as blue surgical wrap are technically recyclable, much of this could better be avoided[40].Disposable wipes flushed into the sewers are a factor in blockages and should also be avoided wherever possible.

Pharmaceutical blister packs

Pharmaceutical blister packs mixed materials- plastic blisters to hold the pills, covered with aluminium foil. They are mostly made of PVC, which is not recyclable. Moreover, the chlorine in PVC contributes to the formation of dioxins and furans if it is incinerated, open burned or involved in landfill fires. At present, recyclable blister packs are not foreseen, but there are an increasing number of options to substitute the PVC with a less environmentally harmful plastic.

[39] Wikipedia (2018) Olefin fibres. https://en.wikipedia.org/wiki/Olefin_fiber Accessed 16 Oct 2018

[40] Babcock et al. Cut the wrap: How to reduce hospital waste and emissions. https://www.greenbiz.com/blog/2013/03/28/cutting-hospital-waste-emissions-blue-wrap Accessed 16 Oct 2018

Drinks Bottles

DRINKS BOTTLES	Alabang Medical Clinic	Mary Johnston Hospital	St. Paul Hospital Cavite	Syamsudin Hospital	UGM Hospital
Number of bottles	150	615	157	848	1000
% total items	4.3%	2.1%	1.2%	3.2%	3.9%
Weight of bottles (kg)	2.7	32	2.8	11	11
% plastic waste	12%	7%	1.9%	4.7%	4.8%

Table 8. Estimated number, weight and percentage of plastic waste represented by single use drinks bottles.
**Hospitals providing drinking water for staff, patients and visitors.*

The waste from each hospital contains hundreds of drinks bottles per day. Taken together, they add up to more than 2,750 a day, and over a million bottles a year, weighing over 21 tonnes.

	Alabang Medical Clinic	Mary Johnston Hospital	St. Paul Hospital Cavite	Syamsudin Hospital	UGM Hospital
No water bottles	93	286	52	411	710
% bottles	62%	46%	33%	48%	71%
Weight water bottles	1.9	18.1	0.6	4.1	6.6
% water bottles	68%	56%	22%	39%	61%

Table 9. Numbers, weights and percentage of water bottles.
**Hospitals providing drinking water for staff, patients and visitors.*

Overall, about 55% of the bottles were water bottles- 1500 per day, constituting over 11 tonnes per year. The lowest percentage of water bottles (33%) were found at St Paul Hospital, which is one of three which provides drinking water. However, across the audited hospitals, there was no consistent relationship between the provision of water and the number of water bottles or drinks bottles of all types. Tap water in the Philippines is generally safe to drink, but few people feel confident in it; they have become accustomed to drinking bottled water and more action will be needed to change habits. Similarly, soft drinks, often carbonated and containing high levels of sugar, are still very popular despite increasing concern about the link with obesity. A combination of education and offering healthier choices in facility catering would simultaneously reduce waste and offer health benefits.

Foodware

FOODWARE	Alabang Medical Clinic	Mary Johnston Hospital	St. Paul Hospital Cavite	Syamsudin Hospital	UGM Hospital
Number of items	384	2912	188	4266	2610
% total items	11%	10%	1.4%	16%	10%
Weight of foodware (kg)	1.6	27.3	1.5	18.1	8.9
Weight % of plastic waste	7%	6%	1.0%	8%	4.0%

Table 10. Numbers and weights and percentage of foodware items.

Disposable foodware includes plastic knives, forks and spoons, plates, bowls, cups and lids, stirrers. Together, the audited facilities disposed of an estimated ten thousand separate items of plastic foodware on in one day, weighing almost 60kg. Over the course of a year, this would add up to 3.8 million items, and over 21 tonnes of plastic waste.

Much of this is completely unnecessary, and could be replaced with reusable plates and cutlery/silverware. Reusable personal takeout coffee cups are increasingly popular and their use should be encouraged. The EU is planning to ban most disposable foodware[41] and the Philippine and Indonesian authorities should consider similar legislation.

[41] EU (2018): proposal for a directive on the reduction of the impact of certain plastic products on the environment https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:52018PC0340, http://europa.eu/rapid/press-release_IP-18-3927_en.htm

Manufacturers

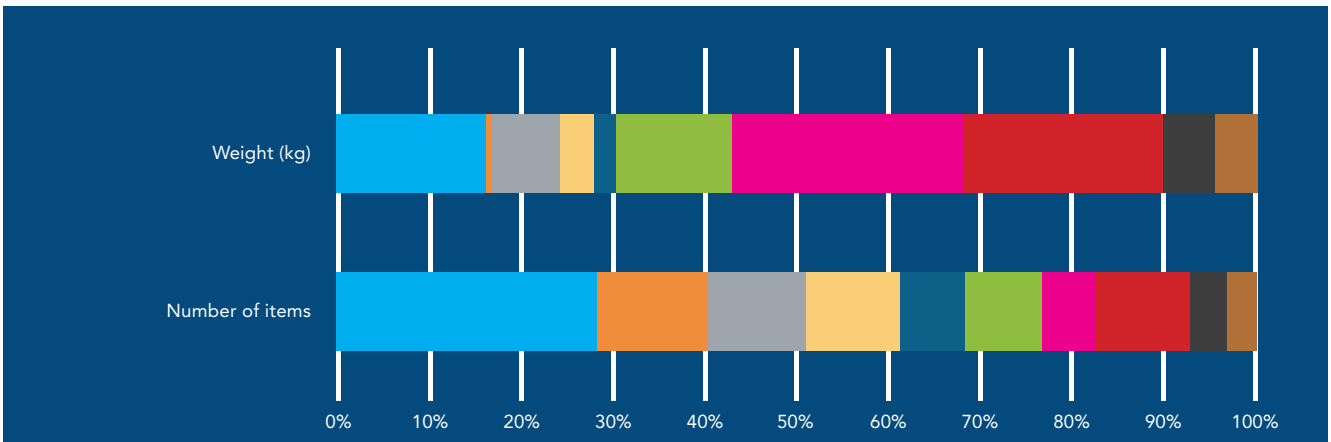
	Alabang Medical Clinic		Mary Johnston Hospital		St. Paul Hospital Cavite		Syamsudin Hospital		UGM Hospital	
Rank	Manufacturer	% of items	Manufacturer	% of items	Manufacturer	% of items	Manufacturer	% of items	Manufacturer	% of items
	Unknown	46%	Unknown	48%	Unknown	48%	Unknown	59%	Unknown	78%
1	BD	12%	Terumo	12%	Mayora	19%	La Vida (Darusyifa Hikmah)	9%	Terumo	4%
2	Euro-Med Laboratories	4%	Euro-Med Laboratories	7%	Terumo	12%	Nipro	8%	Danone*	3%
3	Pfizer	3%	Mcare	9%	BD	8%	Indomart	6%	Onemed Healthcare	2%
4	Monde Nissin*	2%	RGL	2%	Nestlé*	1%	Otsuka	4%	China Minzhhing Food	2%
5	Jollibee	2%	KingMed	2%	Nipro	1%	Good Day Foods	2%	JMS Group	2%
6	Universal Robina	2%	ADVENTA	2%	Universal Robina	1%	Essity	1%	Otsuka	1%
7	LIFE SYSTEM	2%	BD	1%	Euro-Med Laboratories	1%	Danone*	1%	Sunder biomedical Tech	1%
8	Quanta	2%	True Lab	1%	Sea Pharma Options	1%	China Minzhhing Food	1%	PT Cokro Tirta Klaten Indonesia	1%
9	Mayora	2%	Indoplas	4%	B Braun	1%	B Braun	1%	Mayora	0%
10	Philippine Spring Water	1%	Bio-Rad Laboratories	46%	Biotech pharma	46%	Kapal Api (Santos)	46%	B Braun	0%
	Top 10 known manufacturers	32%	Top 10 known manufacturers	41%	Top 10 known manufacturers	46%	Top 10 known manufacturers	34%	Top 10 known manufacturers	16%

Table 11. Top manufacturers identified at each facility.
**Company identified as major contributor to ocean plastics contamination[42].*

[42] BFFP (2018) Branded: In search of the world's top corporate plastic polluters. Volume 1. https://www.breakfreefromplastic.org/globalbrandauditreport2018/ Accessed 10 Oct 2018

The majority of products were not labelled with the manufacturers' name. The top identified manufacturers varied greatly between facilities. In each, there was a mixture of medical and general (mostly food manufacturers) amongst the top 10. Leading syringe manufacturers (BD or Terumo) featured in the top 10 of all sites except Syamsudin. Labelling medical and other products with the manufacturers' name is a positive step towards transparency which will make it easier to identify and solve environmental problems along the supply chain.

The Break Free From Plastics campaign group recently published the results of a brand audit which catalogued the manufacturers of waste washed up on beaches in 42 countries. The most frequently encountered brands were: Coca-Cola, PepsiCo, Nestlé, Danone, Mondelez International, Procter & Gamble, Unilever, Perfetti van Melle, Mars Incorporated, and Colgate-Palmolive. Three of these: Monde Nissin, Danone and Nestlé were also among the top 10 for at least one of the audited facilities.



	Number of items	Weight (kg)
Terumo	6309	18.6
Mayora	2664	0.3
La Vida (Darusyifa Hikmah)	2382	7.8
Nipro	2151	5.9
BD	1791	1.6
Indomart	1713	14.2
Otsuka	1200	28.4
Euro-Med Laboratories	2371	25.1
Danone	1001	6.4
China Minzhhing Food	724	5.0

Figure 3. Top 10 manufacturers for plastic waste from all sites combined.

Combining the data from all facilities, 78% of the waste items were not identified. Of the remaining items, the greatest number (6309) came from the syringe manufacturer Terumo. Over 18kg/day were recorded in the audit.

However, the greatest weight (28.4kg) was recorded from manufacturer Otsuka, based mostly on the large amount of saline bottles in the waste at Syamsudin, underscoring the variability between facilities. It is worth noting that both the syringes and saline bottles are potentially recyclable; indeed some of the facilities are already recycling one or both.

Polymer labelling and choice

Figure 4. Recycling symbols for different plastics

	Alabang Medical Clinic	Mary Johnston Hospital	St. Paul Hospital Cavite	Syamsudin Hospital	UGM Hospital
Drink bottles	100%	96%	60%	72%	83%
Foodware	37%	4.5%	17%	99%	19%
Medical item	0.6%	0.1%	0.0%	2.5%	10%
Other	0.0%	0.0%	no items	0.0%	0.0%
Packaging	0.8%	0.1%	0.5%	3.1%	0.7%
Sanitary item	0.0%	0.0%	0.0%	10%	0.0%
Toiletries	0.0%	2.4%	0.0%	no items	no items

Table 12. Percentage of items in each category which were labeled with the polymer of construction

The majority of products were not labelled, either with the manufacturers' name (see previous section) or the plastics code for recycling.

Drinks bottles, particularly, water bottles, were the most likely items to be labelled, followed by foodware. The drinks bottles were predominantly PET, with the rest being LDPE, HDPE, PP or PS. The two most common polymers for foodware were PP and PS, with some items also being labelled as PET. Disposable coffee cups are often made of paper coated with plastic, which are non-recyclable.

Aside from drinks bottles and foodware, no more than 10% of the items in any category at any site were labelled, and in most cases, the percentage was less than 1%. The lack of labelling of medical devices has potential repercussions for medical professionals, who are not able to make informed choices about the products they are using, and for waste disposal and recycling operations.

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In the medical context, some products, particularly those made of PVC and containing plasticisers such as diethyl hexyl phthalate (DEHP) hold potential risks for patients. The European Commission's Scientific Committee on Emerging and Newly Emerging Health Risks (SCENIHR) highlights the following problems with DEHP: 1) Reproductive and developmental effects; 2) Testes toxicity; 3) Endocrine disruption; and 4) Peroxisome proliferation-related liver cancer in rodents[43].

Vulnerable patients include the unborn and newborn, and peripubertal boys, whose developing reproductive systems can be damage by the endocrine disruption and testicular toxicity exhibited by DEHP[44]. DEHP is classified as a reproductive toxin, and an endocrine disrupting substance with repercussions for human health and the environment. It is toxic to aquatic life[45], (Type 1B, May damage fertility. May damage the unborn child).

In 2008, Philippines Department of Health published an advisory recommending that health care facilities use PVC-free products when high exposure risk procedures are to be performed, particularly on the most sensitive groups, including male neonates, pregnant women carrying male fetuses and peripubertal males[46]. Similar advisories have been published by the American Medical Association, the US FDA, and the The German Federal Institute for Drugs and Medical Devices (BfArM), amongst others, and the Government of India has mandated the phase-out of chlorinated plastic bags, gloves and blood bags[47].

Under EU law (Regulation (EC) No 1272/2008) medical devices containing more than 0.1% w/w must be labelled[48]. This labeling allows doctors and buyers in Europe to choose whether they use medical devices containing PVC or DEHP, but in other parts of the world, this is not nearly so common.

Substituting PVC medical devices has direct health benefits for patients. In 2009, German doctors published research showing that incidence of liver problems (cholestasis) dropped from 50% to 13% when PVC infusion systems for newborn children receiving total parenteral nutrition (TPN) were replaced with non-PVC ones[49].

[43] SCENIHR (2016) Opinion on the safety of medical devices containing DEHP-plasticized PVC or other plasticizers on neonates and other groups possibly at risk (2015 update). Publ: European Commission Scientific Committee on Emerging and Newly-Identified Health Risks, Brussels, 170pp., http://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_047.pdf

[44] SCENIHR (2016) Opinion on the safety of medical devices containing DEHP-plasticized PVC or other plasticizers on neonates and other groups possibly at risk (2015 update). Publ: European Commission Scientific Committee on Emerging and Newly-Identified Health Risks, Brussels, 170pp., http://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_047.pdf

[45] ECHA (2018) Candidate List of substances of very high concern for Authorisation. https://echa.europa.eu/candidate-list-table, accessed 9 Oct 2018

[46] Philippine Department of Health (2008) Advisory Medical Devices containing DEHP plasticised DEHP. Publ: DoH, 3pp.

[47] Government of India (2016) Bio-medical waste rules, 2016, Publ: MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE, 37pp, http://www.cpcb.nic.in/divisionsofheadoffice/hwmd/Bio-medical_Waste_Management_Rules_2016.pdf

[48] Fernandez-Canal et al. (2018) Patients' exposure to PVC plasticizers from ECMO circuits. Expert review of medical devices 15(5): 377-383, https://www.ncbi.nlm.nih.gov/pubmed/29658331#

[49] von Rettberg, H. et al. (2009) Use of Di(2-Ethylhexyl)Phthalate-Containing Infusion Systems Increases the Risk for Cholestasis. Pediatrics 124(2): 710-716, http://pediatrics.aappublications.org/content/124/2/710.full.pdf+html

The European Commission's Scientific Committee on Emergency and Newly Identified Health Risks[50] summarises the toxicity of various plasticisers in comparison to DEHP (see figure XX), including toxicity to the foetus, reproductive system, liver, kidney and more. As well as DEHP, the EU ECHA list of substances of very high concern contains nine other phthalates, all of which are toxic for reproduction and four of which have endocrine disrupting properties which might affect human health[51].

Ultimately the only sure way to avoid harm from PVC additives is to substitute the plastic entirely, wherever possible.

NOAEL[1] of Ortho-Phthalate and Alternative Plasticizers

Plasticizer	Chemical Type	NOAEL, mg/kg/bw[2]	Reproductive Toxicity	Critical Endpoint
Ortho-Phthalate Plasticizers				
DEHP	Ortho-Phthalate Ester	4.8	Yes	Reproduction
DINP	Ortho-Phthalate Ester	15 (88)[3]	No / Yes[3]	Liver
Alternative Plasticizers				
TOTM	Trimellitate Ester	100	Yes	Reproduction
ATBC	Citrate Ester	100	No	Decreased body weight
DINCH	Aliphatic Diester	107	No	Kidney
DEHA	Adipate	200	Yes	Foetotoxicity
BTHC	Citrate Ester	250	No	Liver weight
DOTP	Terephthalate Ester	500-700	No	Developmental
COMGHA	Vegetable Oil-Based Ester	5000	No data	Decreased body weight

Source: EU Health & Consumer Protection Directorate-General, Scientific Committee on Engineering and Newly-Identified Health Risks
[1]No Observable Adverse Effect Level. [2]Body weight. [3]Varying results of multiple studies

Table 13. Toxicity of DEHP and alternate plasticisers for PVC[52].

[52] Galland (2016) Determining the Best Alternative to DEHP for PVC Medical Devices. Medical Design Technology https://www.mdtmag.com/article/2016/04/determining-best-alternative-dehp-pvc-medical-devices

Lack of labelling also makes it harder for facilities to know what is recyclable and hampers segregation. Recycling companies need well segregated waste streams; the effort of extracting and disposing of non-recyclable products can make the difference between a waste stream being viable and non-viable for them. In Nepal recently, recyclers working with HCWH strategic partner Health Care Foundation Nepal (HECAF) notified them that they were finding polypropylene (PP) IV bottles in the waste stream that had previously been polyethylene (LDPE). The value of the PP bottles was 7 NPR/kg (approx 7 US cents/kg), compared with 60 NPR/kg (approx 60 US cents/kg). The bottles were not labelled and hard to tell apart visually, so medical staff would not be able to segregate them at source.

In this case, the recyclers were still able to process the bottles, but this may not be possible elsewhere. PET recycling can be completely damaged by the presence of PVC in the mixture because the PVC chars at the PET processing temperature. Conversely, PET forms solid lumps in recycled PET, reducing its value[53].

The way forward

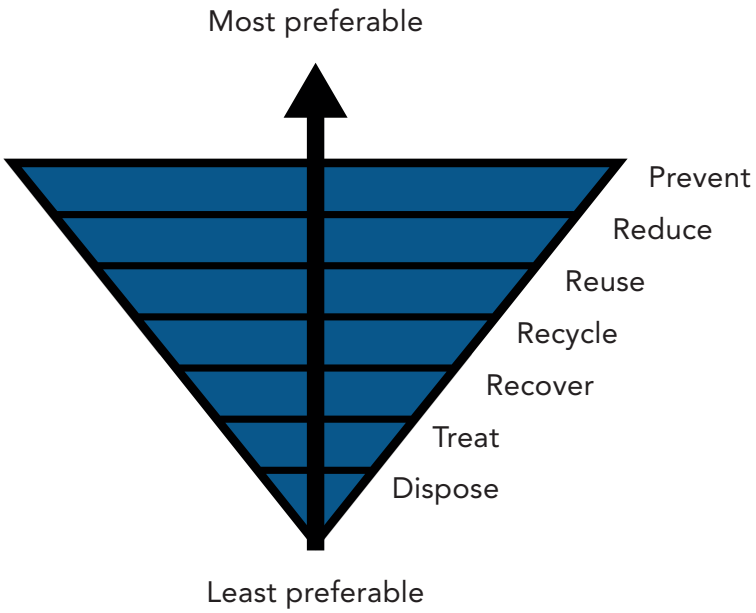

Figure 5. The waste hierarchy helps prioritise the most environmentally sustainable method of dealing with waste.

The waste hierarchy prioritises actions to solve waste problems. The most environmentally sustainable option is not to produce waste at all, for example by drinking tap water rather than bottled water. Secondly, waste can be reduced, for example by minimising plastic packaging. Only then is recycling advisable. Disposal - landfilling and incineration - is the last option.

[53] Ignatyev et al. (2014) Recycling of polymers: a review. ChemSusChem 7(6): 1579-1593

Waste elimination and waste reduction

As noted above, eliminating waste is the highest priority action to solve the plastics crisis. Many plastic products can be eliminated by replacement with other materials, and in particular, disposable products should should be replaced with reusable ones.

The EU is proposing a directive to ban/restrict certain single use plastics[54] [55]. Plastic foodware, including plates, knives, forks, spoons, straws and stirrers will all be banned, as well as plastic sticks for balloons. Drinks containers will only be allowed if the lid remains attached. Similar legislation will help reduce waste generation in Asia, but must not contain loopholes allowing single use items simply to be rebranded as reusable[56].

Many drinks bottles are also unnecessary, particularly water bottles. In the Philippines, tap water is largely potable, so there is no need to buy bottled water to drink. Healthcare actors should educate staff and public about safe sources of water, promote the use of reusable water bottles and discontinue the sale of sugary drinks.

Based on the results of the audit, if the participating hospitals were able to avoid single use drinks bottles and disposable foodware, over 40 tonnes of waste each year would be eliminated.

Similarly, halving the amounts of disposable diapers and plastic packaging would avoid 40 and 16 tonnes of waste per year respectively.

Potential reduction or elimination options in the medical context could include substituting single use PVC oxygen masks with autoclavable silicone ones. Reusable surgical instruments, gowns and drapes can be employed, rather than disposable ones.

Packaging is another area where reductions can be made, either by controlling the packaging used within the hospital, such as no longer supplying plastic shopping bags in facility shops and canteens or selecting products which only have the minimum packaging necessary.

Waste elimination/reduction initiatives should aim to reduce the toxicity of materials, including targeting products that pollute at any stage of the life cycle.

[54] EU (2018): proposal for a directive on the reduction of the impact of certain plastic products on the environment https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:52018PC0340, http://europa.eu/rapid/press-release_IP-18-3927_en.htm

[55] Scott & Tullo (2018) Europe to ban some single-use plastics. Chemical and Engineering News 96(23). https://cen.acs.org/environment/pollution/Europe-ban-single-use-plastics/96/i23

[56] BFFP (2018) Plastic producers could market single-use items as reusable to dodge EU ban. https://www.breakfreefromplastic.org/2018/10/10/plastic-producers-could-market-single-use-items-as-reusable-to-dodge-eu-ban/, accessed 11 Oct 2018

PVC is made from vinyl chloride monomer, which is a known human carcinogen, contains toxic additives, to which patients and staff are exposed, is very hard to recycle, and spreads environmental contamination during disposal. This should, therefore, be a priority for elimination.

Other plastics with human and environmental hazards include polycarbonates, which are made from the endocrine disruptor, BPA, polystyrene, polyurethane, and some chemical rubbers. Where plastics cannot be eliminated, less toxic polymers such as polyethylene and polypropylene should be employed wherever possible. SPHC has already demonstrated what is possible by banning polystyrene packaging from the facility.

Recycling

The global plastics recycling industry is under extreme stress. Multiple factors, including taxes imposed to discourage landfilling in Europe and the low value of recycled plastics, have caused much of the world's plastics recycling to concentrate in China, where labour and environmental protection costs were lower. However, from the beginning of 2018, China stopped importing many low grades of materials for recycling, including plastics. Some waste exporting countries are finding themselves with backlogs of plastic waste needing a destination, and others are seeking out alternate destinations for their waste.

Analysis of data from the US census bureau found that while exports to Hong Kong and China dropped by 77%-99%, exports to Thailand increased by 2000%, exports to Malaysia increased by 273% and Vietnam by 46%[57]. By 2030, an estimated 111 million metric tonnes of plastic waste will have been displaced as a result of the Chinese import[58] ban and unless drastic reductions in the generation of plastic waste are achieved, much of this waste will end up in the environment, or in damaging processes such as resource recovery or incineration, either with or without energy recovery. Consequently, it has been argued that trade of this type runs counter to circular economy principles[59].

To prevent non-OECD countries being inundated with unwanted plastic waste from wealthier nations, the upcoming Conference of Parties of the Basel Convention, the UN forum dealing with the international trade in hazardous wastes, will consider a recommendation to reclassify plastic waste so that it can no longer be traded as a non-hazardous waste and transboundary movements cannot take place without formal notification[60].

[57] McVeigh (2018) Huge rise in US plastic waste shipments to poor countries following China ban https://www.theguardian.com/global-development/2018/oct/05/huge-rise-us-plastic-waste-shipments-to-poor-countries-china-ban-thailand-malaysia-vietnam Accessed 6 Oct 2018

[58] Brooks et al. (2018) The Chinese import ban and its impact on global plastic waste trade. SCIENCE ADVANCES 4:eat0131, http://advances.sciencemag.org/content/4/6/eaat0131/tab-pdf

[59] Liu et al. (2018) Are exports of recyclables from developed to developing countries waste pollution transfer or part of the global circular economy? Resources, Conservation and Recycling 136: 22-23

[60] Basel Convention (2018) UN convention on waste makes breakthrough recommendations to address global marine litter and other types of waste. Publ: Secretariat of the Basel Convention, Geneva, http://www.basel.int/Implementation/PublicAwareness/PressReleases/OEWG11Pressrelease/tabid/7655/Default.aspx Accessed 12 Oct 2018

Some recycling may not be as environmentally friendly as it seems. The highest standard of recycling is mechanical recycling which returns plastics to use in the same or similar application. Downcycling is where a product of high quality plastic is recycled into a low-grade use, such as infill for road construction. Chemical or feedstock recycling can mean breaking the plastic down into a tarry mixture from which some materials can be extracted for use in other manufacturing processes. This is dirty and inefficient, an carries little real environmental benefit. Finally, burning plastic waste can be branded as "feedstock recycling", making it appear more environmentally acceptable than it is.

The most commonly recycled plastics globally are PET and polyethylene (both high density polyethylene, HDPE and low density polyethylene (LDPE). Others, including biodegradable polymers, are recycled little or not at all.

PVC in healthcare is almost never recycled. One healthcare PVC recycling project in Australia processes 200 tonnes per year, producing garden hoses and playground matting[61]. In the UK, a similar industry driven project included six hospitals in 2015 and collected 719.5 kg of PVC[62]. These "successful" recycling projects are also dependent on a high quality waste stream. The VinyLoop factory in Italy was intended to recycle more difficult PVC waste streams[63], but concerns over plasticisers in recycled materials- known as "legacy toxics"- made the Vinyloop recycling factory in Italy non-viable and it closed in June 2018[64]. High concentrations of toxic metals have also been found in PVC products as a consequence of recycling waste from the electronics industry[65].

These issues underscore the need to eliminate plastic waste wherever possible, but also show how important it is that healthcare facilities include criteria in their purchasing procedures to make sure that, wherever possible, supplies are made from recyclable plastics, and that as many waste streams as possible are segregated and recycled.

In some cases, there are policy barriers to increasing recycling. Indonesian healthcare waste management legislation promotes incineration of infectious wastes such as syringes. Amending the law to allow steam disinfection would reduce emissions of dioxin, mercury and greenhouse gases, and allow for increased resource recovery.

One or more of the audited facilities are recycling PET bottles, IV bottles and other sterile liquid containers, syringes, and miscellaneous plastic products (probably PP). As noted above, the 21 tonnes per year of single use drinks bottles generated by these 5 sites should be eliminated as far as possible, but those that cannot be should be recycled.

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[61] Messenger (2018) 150 Hospital Target for Australian PVC Recycling Scheme in 2018. Waste Management World https://waste-management-world.com/a/150-hospital-target-for-australian-pvc-recycling-scheme-in Accessed 10 Oct 2018

[62] VinylPlus (2016) Progress report 2016: Reporting on 2015 activities. Publ: VinylPlus, Brussels, 17pp. http://www.vinylplus.eu/uploads/downloads/VinylPlus_Progress_Report_2016.pdf

[63] Vinyloop (2012) Vinyloop White Paper. Publ: 2 VinyLoop Ferrara S.p.A., Italy, 8pp, https://pieweb.plasteurope.com/members/pdf/p223847a.PDF

[64] PlastEurope (2018)VINYLOOP: Closure of operation in Italy / Phthalates issue under REACH brings down European PVC recycling project https://www.plasteurope.com/news/VINYLOOP_t240095/, Accessed 23 Oct 2018

[65] Turner (2018) Black plastics: Linear and circular economies, hazardous additives and marine pollution. Environment International 117: 308-318

Disposal

Both landfilling and incineration waste resources, pollute and and generates greenhouse gases. Incineration with energy recovery is used in many countries, but is extremely costly if it is to meet internationally accepted standards. Even when they most advanced air pollution control devices are installed, toxic metals such as mercury and persistent organic pollutants are inevitably released. Data from the USA show that incineration, or "waste to energy" is both the most expensive and polluting form of energy production[66]. Worldwide, it is estimated that plastics production and the incineration of plastic waste cause the emission of approximately 400 million tonnes of CO2 a year[67]. 95% of plastic packaging is wasted[68].

The amount of pollution caused by plastic is not just a factor of how much is produced, but how it is handled. Wealthier countries, such as the USA, tend to have more established waste management systems compared to the newly industrialised countries such as Indonesia and the Philippines. The combination of inadequate waste management infrastructure with expanding economies and large coastal populations make these two countries among the largest contributors to ocean plastic pollution[69]. It is vital that governments mandate and implement improvements in the national waste infrastructures. Healthcare facilities, as respected microcosms of the wider society, can play their part in practical terms, by minimising and safely managing their waste, and an educational and inspirational role by setting an example to society.

However, given the scale of the plastics problem and gap between the amount of waste, simply improving waste management infrastructure will never fully resolve the problem. As recognised by an expanding cohort of thinkers in government, industry and the healthcare sector, the "take, make, dispose" linear model of production and consumption needs to be replaced with a more circular economic model.

The circular economy

A circular economy is one in which recognises that we have a finite amount of resources and need to use them in the most efficient way aims to deliver a healthy economy while preserving the environment. It is linked most closely with the UN Sustainable Development Goal 12 (Sustainable Consumption and Production[70] but crucially overlap with other goals including decent work and sustainable growth (Goal 12), protecting life on land (Goal 15), below water (Goal 14), and taking climate action (Goal 13). Within the healthcare sector, waste management is part of the drive to provide adequate water and sanitation[71],[72], which in turn links to to Goal 6 on clean water and sanitation.

[66] USEIA (2013) Updated capital cost estimates for utility scale electricity generating plants. Publ: U.S. Energy Information Administration, 201pp. https://www.eia.gov/outlooks/capitalcost/pdf/updated_capcost.pdf

[67] EC (2018) A European Strategy for Plastics in a Circular Economy. Publ. European Commission, 21pp, http://ec.europa.eu/environment/circular-economy/pdf/plastics-strategy.pdf

[68] Basel Convention (2018) Marine plastic litter and microplastics. http://www.basel.int/Portals/4/download.aspx?d=UNEP-CHW-LEAFLET-PUB-Brochure-MarineLitter-2018.English.pdf Accessed 10 Oct 2018

[69] Tibbetts (2015) Managing Marine Plastic Pollution Policy Initiatives to Address Wayward Waste. Environmental Health Perspectives 123(4): A90-A93 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4384192/pdf/ehp.123-A90.pdf

[70] UN (2018) Goal 12: Ensure sustainable consumption and production patterns https://www.un.org/sustainabledevelopment/sustainable-consumption-production/ Accessed 15 Oct 2018

[71] WHO & UNICEF (2015) Water, sanitation and hygiene in health care facilities. Status in low- and middle-income countries and way forward: WASH IN HEALTH CARE FACILITIES. Publ: WHO, Geneva, 52pp, http://apps.who.int/iris/bitstream/10665/154588/1/9789241508476_eng.pdf?ua=1

[72] WHO (2018) Health care facilities and waste http://www.who.int/water_sanitation_health/facilities/en/ Accessed 10 Oct 2018

Figure 6: the circular economy[73]

The circular economy seeks to eliminate waste through better design of products and systems. The concept includes the elimination of unnecessary products and toxic materials which hamper recycling and materials recovery. Products are designed to be reusable, repairable, and, once they have reached the end of their useful life, they are recyclable. Business models are built around long-term plans, collective responsibility through the value chain and extended producer responsibility[74],[75] . It is at the heart of the latest strategies for dealing with plastics[76],[77] and as such, should be at the heart of policy initiatives by Asian governments.

Within this context therefore, it is important to set ambitious goals for dealing with plastics in the healthcare sector. They need to include and extend beyond action within the healthcare facility and be backed up with action by manufacturers and government.

[73] http://www.wrap.org.uk/about-us/about/wrap-and-circular-economy accessed 16 Oct 2018
[74] Ellen MacArthur Foundation and Fung Global Institute (2014) Towards a Circular Economy in Asia. ISSUES AND OPPORTUNITIES. 29pp, http://www.asiaglobalinstitute.hku.hk/en/wp-content/uploads/2016/06/Circular-economy_tnv3.pdf
[75] ISWA (2017) Extended Producer Responsibility. Publ: ISWA, Vienna, 10pp, https://www.iswa.org/index.php?eID=tx_iswaknowledgebase_download&documentUid=4202
[76] EC (2018) A European Strategy for Plastics in a Circular Economy. Publ. European Commission, 21pp, http://ec.europa.eu/environment/circular-economy/pdf/plastics-strategy.pdf
[77] World Economic Forum, Ellen MacArthur Foundation & McKinsey & Company (2016) The New Plastics Economy — Rethinking the future of plastics. Publ: Ellen MacArthur Foundation, 61pp, https://www.ellenmacarthurfoundation.org/assets/downloads/EllenMacArthurFoundation_TheNewPlasticsEconomy_15-3-16.pdf

Recommendations

There are three sets of actions that healthcare can take to help solve the plastics crisis. First are the recommendations for hospitals and other healthcare facilities to undertake. Second are policy recommendations addressed to officials in the Health Ministry or other national agencies, officials in local government or sub-national units, and to the Parliament. The third set of recommendations are addressed to industries that supply healthcare with various plastic products.

A. Hospital Actions

- Eliminate single use plastic products in healthcare facilities such as disposable knives forks, spoons, straws, fast food clamshells, PET bottles, sachets, wipes, blister packs, shopping bags
- Install water stations across hospitals and edicate staff to eliminate use of PET water bottles
- Educate and train staff to improve waste segregation
- Organize and educate waste management team on plastic waste reduction
- Negotiate with manufacturers to reduce amount of packaging in the products they purchase and avoid over-packaged products
- Maximise recycling of non-toxic plastics
- Promote and use alternatives to disposable diapers such as simple cloth wraps secured with a pin, to more sophisticated systems with outer pants and absorbent liners.
- Create facility level policies on plastics
- Healthcare facilities should consider the amount of packaging in the products they purchase and avoid over-packaged products as part of a sustainable purchasing program. In-house shops should cease to provide disposable plastic bags.
- Minimise the use of plastics which contain hazardous components or which have toxic manufacturing or disposal processes.
    - Substitute PVC wherever possible,
    - Replace PVC medical gloves with safer and environmentally friendly alternatives
- Develop a sustainable procurement policy that will facilitate replacement of unnecessary plastic products with safer and environmentally friendly alternatives
- Join the Global Green and Healthy Hospitals network and sign up for the GGHH Waste Challenge, which promotes sustainable health care waste management
- Use HCWH waste tracking tools which records plastics recycling information
- Assist facilities to recycle by connecting recyclers with hospitals where polyethylene, polypropylene and PET are recycled and other types of plastics
- Choose healthcare essential products that best fit with the circular economy
- Hospitals must adopt system for treatment of food waste which will help reduce volume of waste and will therefore isolate how plastic waste can be reduced

B. Policy Actions for governments

- Submit clear position paper on health effects of plastic as it impacts human population, the environment, the oceans, and climate
- Gov't of Indonesia should eliminate incineration, starting with healthcare waste incinerators which do no meet the guidelines of the Stockholm Convention
- Legislate to reduce consumption of single use plastics
    - For the Philippines, this includes:
        - SB 1948 – Plastic Bag Regulatory Act
        - SB 430 – Single Use Plastic Ban
- Support recommendations of the Basel Convention to prevent plastics pollution[78] [79]
    - amend the Annexes to the Convention to allow for better control, and minimisation of transboundary movements of plastic waste
    - enact legislation to prevent the import of low-grade plastic waste from other countries
- Require extended producer responsibility: ensure that companies throughout the plastics value chain shoulder the costs of collection recycling and safe disposal
- Eliminate the use of hazardous additives in plastics manufacturing.

C. Industry Actions

- Phase out the use of toxic plastics, such as PVC, polycarbonates and polyurethane
- Phase in new non-toxic polymers such as thermoplastic elastomers (TPEs).
- Redesign products including medical products, to maximise reusability
- Redesign products and packaging for recyclability
    - avoiding mixtures of materials eg plastics and paper, multiple polymers
    - avoiding use of leachable additives
- Create recycling schemes for your products if they are not already easy to recycle
- Label products with the manufacturers' name and the polymer and recycling classification
- Label products that contain more than 0.1% of DEHP or any substance on the REACH Substances of Very High Concern list[80]
- Reduce volume and density of plastic packaging

[78] Basel Convention (2018) Marine Plastic Litter and Microplastics: Overview. http://www.basel.int/Implementation/MarinePlasticLitterandMicroplastics/Overview/tabid/6068/Default.aspx Accessed 10 Oct 2018

[79] Basel Convention (2018) UN convention on waste makes breakthrough recommendations to address global marine litter and other types of waste. Publ: Secretariat of the Basel Convention, Geneva, http://www.basel.int/Implementation/PublicAwareness/PressReleases/OEWG11Pressrelease/tabid/7655/Default.aspx accessed 10 Oct 2018,

[80] ECHA (2018)Candidate List of substances of very high concern for Authorisation (published in accordance with Article 59(10) of the REACH Regulation) https://echa.europa.eu/candidate-list-table Accessed 15 Oct 2018

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