Reducing the environmental impact of medicines from procurement to disposal

A White Paper from the health management perspective

EHMA
European Health Management Association

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Executive summary

Medicines are crucial to save human and animal lives and improve wellbeing. However, when prescribed, used or disposed inappropriately, they can negatively impact human health as well as wildlife and ecosystems. Like every industrial sector, the production of medicines can impact the environment through CO2 emissions emitted by the medicine supply chain or through pharmaceutical effluents from the production and use of medicines.

For instance, the high costs of advanced wastewater treatment combined with the difficulty of scaling up technology that removes the majority or entirety of pharmaceuticals can result in the presence of pharmaceuticals in wastewater that have an ecological effect. Of particular concern is the presence of antibiotics and antifungals in the environment which, along with a concentration of antibiotic resistance genes and antibiotic resistant bacteria and their ubiquitous presence in the environment, increases the risk of antimicrobial resistance. In the EU/EEA alone, there is an estimated 33,000 annual human deaths linked to antibiotic-resistant bacteria [1].

Multi-stakeholder and multi-sectoral engagement with a **One Health approach** across the medicine's lifecycle is thus urgently needed to address this issue. So far, existing recommendations and strategies to reduce the environmental impact of medicines have primarily been focusing on the actions that can be taken by industries, community pharmacists, and practitioners. Yet, **targeted recommendations for health managers** are lacking. This White Paper is written from a health management perspective and focuses on the stages of the medicines' lifecycle that can be influenced by health managers. These include: 1) procurement, 2) logistic planning and distribution, 3) prescription, 4) consumption and use, and 5) disposal. The White Paper exhibits case studies and associated recommendations and best practices that health managers can put in place to help reduce the environmental impact of medicines in these five stages.

Health managers are also key to leading on the green transition and reducing the direct and indirect environmental impacts resulting from emissions and waste within the healthcare sector. They play a crucial role in bringing different actors together to guarantee a joined up, single systems approach. Ensuring environmental sustainability of health services and medicines is necessary to safeguard the health of future generations and ensure continuous access to effective medicine.

[1] Organisation for Economic Co-operation and Development. (2019). Antimicrobial Resistance–Tackling the Burden in the European Union.

The European Health Management Association (EHMA) recommends the following set of actions to be taken by health managers to reduce the environmental impact of medicines:

- Foster and incentivise a standardised data collection at European level about emissions from greenhouse gases, wastewater, and solid waste related to the health and care sectors and more concretely to medicines and medical equipment.

- Establish a European database of good practices on how to minimise the environmental impact of medicines and facilitate exchange and networking opportunities among stakeholders involved.

- Adopt a multistakeholder approach to reduce the environmental impact of medicines across their lifecycle: establish shared responsibility among all actors (health managers, healthcare professionals, pharmacists, pharmaceutical industries, policymakers, patients, community at large) and clear governance structures (Case study 3, 10, 12).

- Leverage technology to prevent disposal of undistributed medications, facilitate transparency in the supply and demand of medicines, monitor prescription behaviours, and improve medication adherence (Case study 4, 7, 9).

- Increase environmental health literacy in physicians, patients, and consumers of self-care products to influence medication-taking behaviours, reduce over-prescription, and enhance physician-patient communication (Case study 6, 11).

- Centralise processes in procurement, supply chain, and logistics to favour the purchase of medicines with low environmental impact where medicines are interchangeable; create a market demand for environmentally friendly healthcare products and services; reduce medicine stockpiling; and manage internal waste such as solid waste and wastewater (Case study 1, 2, 4, 5).

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About this White Paper

Background

This White Paper highlights case studies and associated best practices that can be used in health management to reduce the environmental impact of medicines.

EHMA defines **health management** as providing guidance and leadership to administer health at the individual, organisational and systemic level. Health management embraces a holistic vision of health, in which health is impacted by behavioural, social, and environmental determinants. Health management includes and goes beyond healthcare management, which comprises community, primary, secondary, and tertiary care provision. It also happens outside of care settings and builds synergies with other related policy and societal areas in line with the 'One Health' concept. Health management encompasses the entire health ecosystem in which health managers collaborate with patients, informal and formal caregivers, patient organisations, legislators, policy makers and regulators, public health experts, researchers, health insurance experts, and pharmaceutical industries. Together, they aim to create a clear health vision and alignment strategy, as well as lay down the organisational, societal and technological conditions to achieve optimal health outcomes for individual patients and the entire community. Health managers are jointly responsible for establishing effective and holistic governance structures, built on a co-design and co-production model.

Some of the job positions that fall within the scope of 'health managers' are medical director, clinical manager, nursing home administrator, laboratory manager and office manager. Health managers carry out six core functions, namely planning, organising, staffing, controlling, directing, and decision-making. Health care managers ensure that their organisation or department improves its efficiency, financial strength, and service quality to ultimately deliver the best possible care to patients. Health managers are thus strategically placed to connect stakeholders across the health ecosystem and implement solutions that can lower the environmental impact of medicines.

Methodology

The framework and content of this White Paper was built using both primary (focus group discussion) and secondary data sources (peer-reviewed literature, grey literature). The **focus group** - composed of five between health managers, patient representatives, public health experts and industry representatives from different European countries - provided insights into possible strategies to reduce the environmental impact of medicines. The focus group discussion was also used to reach consensus on the five stages of the medicines' lifecycle that can be influenced by health managers and gather relevant case studies for each of these stages (*see 'Recommendations and best practices to reduce the environmental impact of medicines from a health management perspective'*).

The case studies recommended by the focus group members were included in the White Paper if they met the **criteria for best practices** as outlined by the European Commission [2] (see 'Case study selection'). To ensure that the paper offers a comprehensive view on existing best practices, **secondary data sources** were screened for additional relevant case studies. Peer-reviewed articles on case studies were found through a search on Google Scholar and Research Gate with a combination of the following **key words**: '(Reducing) Environmental impact' + 'medicines' + 'Procurement' / 'Logistics' / 'Distribution' / 'Prescription' / 'Consumption' / 'Use' / 'Disposal'. Lastly, grey

[2] European Commission. Criteria to select best practices in health promotion and disease prevention and management in Europe. https://ec.europa.eu/health/system/files/2021-01/sgpp_bestpracticescriteria_en_0.pdf

literature published by health-related NGOs on the topics of pharmaceuticals in the environment, green and sustainable pharmacy, 'Safer Pharma', and antimicrobial resistance were also screened for case studies meeting the selection criteria and relevant to health management.

Recommendations in this White Paper derived from (i) the case studies recommended by the focus group members and (ii) the researched case studies, and were refined through (iii) a consultation which allowed the participating stakeholders to propose modifications to the proposed list of recommendations during 15 calendar days. During the consultation, the paper was circulated to 20 stakeholders representing hospital managers, pharmacists, procurement experts, primary care physicians, patient representatives, and environmental health experts.

Case study selection

The case studies included in this White Paper were selected from the European region based on the European Commission's updated criteria for best practices (2021). The criteria include **evidence-base, sustainability, transferability, and intersectoral collaboration** [3].

The working definition of 'best practice; is proposed by the European Commission as "*a relevant policy or intervention implemented in a real life setting and which has been favourable assessed in terms of adequacy (ethics and evidence) and equity as well as effectiveness and efficiency related to process and outcomes. Other criteria are important for a successful transferability of the practice such as a clear definition of the context, sustainability, intersectorality and participation of stakeholders*".

The **sustainability criteria** have core implications for the environment and are central to our discussion. Sustainability refers to the practice's ability to be maintained long-term with the available resources, adapting social, economic, and environmental requirements of the context in which it is developed. Moreover, the practice should be aligned with a sustainability strategy that considers a range of contextual factors such as health and social policies, epidemiological trends, and environmental impact.

The case studies were selected with additional consideration of **duration, context, scope of intervention, and geographical representation**. Interventions of varying duration can be found where the 'older' practices may allow assessment of sustainability over time. With regards to the context, both national and transnational case studies have been included to demonstrate transferability potential. The case studies have been organised according to their scope of intervention within the medicine's lifecycle which could be influenced by health managers (i.e., procurement, distribution, prescription, consumption, and disposal). Lastly, efforts were made to appropriately capture the heterogeneity of European health systems by extracting case studies from as many countries as possible.

[3] European Commission. Criteria to select best practices in health promotion and disease prevention and management in Europe. https://ec.europa.eu/health/system/files/2021-01/sgpp_bestpracticescriteria_en_0.pdf

Policy context

At the European level, environmental sustainability is high on the agenda of policy debates. To lead on the green transition, the EU has adopted and launched several initiatives to counteract the world's escalating environmental crisis [4].

In this context and with a view to the health sector, in March 2019 the European Commission launched the **'European Union Strategic Approach to Pharmaceuticals in the Environment'** which encouraged the pharmaceutical industry to design and manufacture their products in a more environmentally friendly way, all the way from design and production to use and disposal [5].

As a next step, the European Commission launched its **'Pharmaceutical Strategy for Europe'** in November 2020 aimed at ensuring safe and quality medicines while boosting the sector's competitiveness [6]. The Pharmaceutical Strategy also includes an environmental sustainability angle as it aims to reduce the impact of pharmaceutical components and their residues on the environment and encourage pharmaceutical industries to commit to climate neutrality [7].

The Pharmaceutical Strategy is thus aligned with the **'European Green Deal'**, a package of policy initiatives launched by the European Commission in 2020 as part of the EU strategy to reach its 2050 climate goals [8]. In particular, the strategy is aligned with the Zero Pollution ambition for a toxic-free environment, one of the political priorities of the European Green Deal [9]. The Zero Pollution ambition aims to minimise the negative environmental impact of chemical substances, including pharmaceutical residues.

At global level, the United Nations adopted the 2030 Agenda for Sustainable Development in 2015. The agenda contains 17 Sustainable Development Goals (SDGs) focused, amongst other, on the following thematic issues: good health and well-being, clean water and sanitation, and climate action [10].

While the COVID-19 pandemic underlined the importance of ensuring safe and effective medicines, it also highlighted the need for sustainable supply chains and responsible consumption. In particular, it showed the interconnection between human health, animal health and healthy environments. In fact, limiting people's exposure to potentially harmful biological, chemical, or physical agents protects their health and wellbeing, and reduces the emergence of future pandemics [10].

[4] European Council. European Green Deal. https://www.consilium.europa.eu/en/policies/green-deal/
[5] European Commission. COM(2019) 128. European Union strategic approach to pharmaceuticals in the environment. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019DC0128&from=EN
[6] European Commission. Pharmaceutical Strategy for Europe. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0761&from=EN
[7] European Commission. Pharmaceutical Strategy for Europe. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0761&from=EN
[8] European Council. European Green Deal. https://www.consilium.europa.eu/en/policies/green-deal/
[9] European Parliament. The EU's zero pollution ambition. https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2022)729404
[10] Resolution, A. (2015). RES/70/1. Transforming our world: the 2030 agenda for sustainable development. Seventieth United Nations General Assembly, New York, 25, 86-97.

Impact of medicines on the environment

The last decades have, on the one hand, seen increased investment in healthcare, advances in pharmaceutical research and development, and increased availability of treatments through the emergence of generic medicines, and, on the other hand, a change in lifestyle with more sedentary habits, higher air pollution and an ageing population in developed countries. These trends have inevitably led to a growing consumption of medicines [11, 12].

The misuse of pharmaceuticals is detrimental to the health of individuals, but also severely impacts wildlife and ecosystems, especially when they are incorrectly disposed of or use natural resources during the production phase. While up-to-date data is missing, WHO estimates from 2002 highlighted that over half of the medicines sold across the globe are prescribed or dispensed inappropriately [12]. Likewise, half of all patients do not take their medicines in accordance with prescription guidelines [12].

There are various ways in which pharmaceuticals impact the environment. Firstly, the medicine and medical equipment supply chain releases large amounts of greenhouse gas emissions [13, 14]. In England, for example, the National Health Service (NHS England) has identified that medicines prescribed in primary care account for 65% of the total emissions emitted by primary care [14]. However, comprehensive global studies on health care emissions and emissions linked specifically to medicines and medical equipment are lacking [15]. Secondly, wastewater from the production and usage of medicines is detrimental to wildlife and expedites the emergence and spread of antimicrobial resistance (AMR) [16]. In fact, pharmaceutical effluents contain an important concentration of various antibiotics and antibiotic resistance genes that are released into the environment if effluents are not adequately treated. Their continuous presence in the environment is conducive to the alteration of the bacteria's' genomic expression, which results in an increase of AMR [17]. Besides manufacturing waste streams, AMR also arises from misuse of antimicrobials in human and veterinary medicine and insufficient hygiene practices in healthcare settings [18]. A report published in 2019 by the Organisation for Economic Co-operation and Development estimated 33,000 annual human deaths linked to antibiotic-resistant bacteria in the EU/EEA [19]. If no further action is taken, by 2050 the global AMR death toll could be higher than the expected number of deaths from cancer and diabetes combined [20]. The number of animal deaths linked to antibiotic-resistant bacteria is unclear.

Medicines are also found in surface and groundwater, as well as in soil. Components of medicines enter the environment in two ways: 1) the sewage system through human waste, and 2) inappropriate disposal methods. Sewage containing pharmaceutical components then reaches treatment plants that generally do not have adequate equipment to eliminate or filter pollutants from wastewater, resulting in adverse environmental impacts [21].

So far, the strategies put in place to address environmental issues arising from healthcare practices have often proven to be ineffective. This is partly due to the different priorities and working practices that exist between environmental science and health care sectors.

[11] aus der Beek, T., Weber, F. A., Bergmann, A., Hickmann, S., Ebert, I., Hein, A., & Küster, A. (2016). Pharmaceuticals in the environment—Global occurrences and perspectives. Environmental toxicology and chemistry, 35(4), 823-835.
[12] World Health Organization. (2002). Promoting rational use of medicines: core components (No. WHO/EDM/2002.3). World Health Organization.https://apps.who.int/iris/bitstream/handle/10665/67438/WHO_EDM_2002.3.pdf
[13] Belkhir, L., & Elmeligi, A. (2019). Carbon footprint of the global pharmaceutical industry and relative impact of its major players. Journal of Cleaner Production, 214, 185-194.
[14] Cussans, A., Harvey, G., Kemple, T., & Tomson, M. (2021). Interventions to Reduce the Environmental Impact of Medicines: A UK perspective. The Journal of Climate Change and Health, 4, 100079.
[15] Healthcare without harm. Health care's climate footprint. https://noharm-global.org/sites/default/files/documents-files/5961/HealthCaresClimateFootprint_092319.pdf
[16] Kotwani, A., Joshi, J., & Kaloni, D. (2021). Pharmaceutical effluent: a critical link in the interconnected ecosystem promoting antimicrobial resistance. Environmental Science and Pollution Research, 1-14.
[17] Kotwani, A., Joshi, J., & Kaloni, D. (2021). Pharmaceutical effluent: a critical link in the interconnected ecosystem promoting antimicrobial resistance. Environmental Science and Pollution Research, 28(25), 32111-32124.
[18] European Commission. A European One Health Action Plan against Antimicrobial Resistance (AMR). 2017.
[19] Organisation for Economic Co-operation and Development. (2019). Antimicrobial Resistance–Tackling the Burden in the European Union.
[20] O'Neill, J. (2016). Tackling drug-resistant infections globally: final report and recommendations. https://amr-review.org/sites/default/files/160525_Final%20paper_with%20cover.pdf
[21] Thomas, F., & World Health Organization. (2017). Pharmaceutical waste in the environment: a cultural perspective. Public health panorama, 3(01), 127-132.

Recommendations and best practices to reduce the environmental impact of medicines from a health management perspective

To reduce the environmental impact of medicines, the European Health Management Association (EHMA) calls for multisectoral engagement across the medicine's lifecycle by mobilising healthcare professionals, health managers, pharmaceutical industries, policymakers, pharmacists, patients, and the community at large. The European Health Management Association also underlines the importance of adopting the 'One Health' approach and encourages human health professionals to work closely with animal health professionals and environmental experts.

In the context of this White Paper, the focus was put on the stages of the medicine's lifecycle that can be influenced by health managers, namely in the areas of procurement, logistic planning and distribution, prescription, consumption and use, and disposal. Stages outside the scope of activities and responsibilities of health managers – such as production or wastewater treatment – were therefore not included in this paper.

Figure 1. Medication lifecycle - stages in the scope of this study

The following case studies illustrate interventions that were implemented at each of these stages of the medication lifecycle in different European countries and that directly or indirectly resulted in a reduction of the impact of medicines on the environment. These interventions can be implemented by health managers in close collaboration with practitioners, patients, industry, researchers, pharmacists and policymakers. While this White Paper is written for health managers, similar pathways could and should be established and analysed for each stakeholder group. In particular, further research should consider the impact of the patient pathway, as actions at this level could be particularly impactful.

Case studies

Procurement

Procurement in healthcare refers to purchasing medicines, equipment, or services from a supplier, and includes choosing the quantity to be ordered [i]. Health managers play an important role in advancing value-based procurement, in purchasing solutions rather than supplies, and in incentivising innovation, efficiency, and effectiveness. Procurement practices are highly contextual. They vary depending on the care setting, the health context, and national regulations. During health crises such as the COVID-19 pandemic, health managers and procurement experts face an increased and unexpected demand for medical equipment and supplies and must, therefore, put in place emergency procurement procedures.

Unpredictability in needs can result in excess purchasing, with the risk of surplus going to waste, thus potentially impacting the environment. Procurement practices for chronic diseases or for routine child and adolescent vaccines are different from those applied to infectious diseases, as needs can be more easily predicted. However, procurement and supply chains for chronic diseases and routine immunisation also face the risk of being disrupted in times of pandemic.

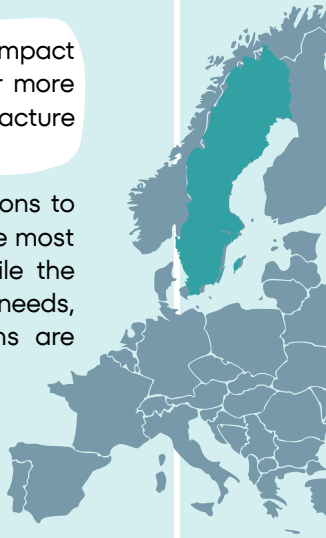
We selected three cases studies from Sweden, Norway, and the United Kingdom to illustrate interventions at the procurement level to create market demand for environmentally friendly healthcare products, prioritise suppliers that have low-impact manufacturing and production practices, and integrate sustainability principles into healthcare activities at governance level. Sweden and Norway were referred to by focus group members as pioneering countries for their environmental efforts in healthcare, as is evident in the two case studies below. Focus group members also stressed the importance of having enabling governance structures in place that support environmental changes, upon which the case study of the United Kingdom was researched and selected.

Case study #1
Environmental classification of pharmaceuticals to support the selection of environmentally friendly medicines (Sweden)

The Stockholm County Council possesses an environmental classification of pharmaceuticals, initiated in 2003 and created from a joint initiative between producers, authorities, and public health professionals. The classification indicates the risk and environmental hazards of medicines [22]. The environmental hazard of the medicine is determined based on the active pharmaceutical ingredient's persistence, bioaccumulation potential, and toxicity. The risk refers to the likelihood that a medicine is toxic for aquatic organisms.

Health managers can use the classification to procure medicines with less environmental impact when choosing between two fully equivalent generics [23]. Creating a market demand for more environmentally friendly products will also encourage industries to produce and manufacture future medications in a more environmentally friendly manner.

In Sweden, the classification is used by regional authorities to recommend which medications to use in public health care. The data can also be utilised by physicians that wish to choose the most environmentally friendly medicine amongst generics of the same originator product. While the choice of the medicine chosen should be based first and foremost on the patients' needs, physicians can make a choice based on environmentally friendly criteria when options are interchangeable.



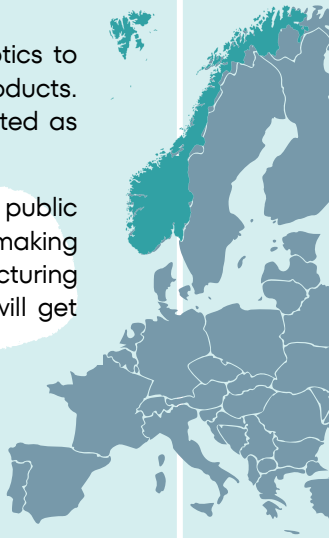
Case study #2
Responsible procurement of antibiotics in a Norwegian hospital – environment as a criterion for procurement (Norway)

Norway has introduced a system of environmental criteria to facilitate the procurement of environmentally friendly medicines, particularly antibiotics.

The Norwegian Hospital Procurement Trust, also called Sykehusinnkjøp HF, is an agency responsible for purchasing all goods and services for Norwegian public hospitals [24]. In collaboration with the environmental group of the Norwegian Association of Pharmaceutical Manufacturers and the Norwegian Medicines Agency, the Norwegian Hospital Procurement Trust procures pharmaceutical products at national level for all health authorities.

In 2019, the agency included a new environmental criterion for the procurement of antibiotics to reduce emissions and pollution associated with the manufacturing of these products. Environmentally friendly production and manufacturing of antibiotics are, therefore, weighted as 30% of the allocation criteria [25].

Centralised pharmaceutical procurement results in stronger bargaining power for public purchasers. By introducing environmental criteria as an integral part of their decision-making process for choosing their supplier, procurement trusts can also drive innovation in manufacturing and production practices. In fact, suppliers who comply with the environmental criteria will get rewarded in the procurement process.



[22] http://www.janusinfo.se/
[23] Wennmalm, Å., & Gunnarsson, B. (2009). Pharmaceutical management through environmental product labelling in Sweden. Environment International, 35(5), 775-777.
[24] Procura Plus Network. https://procuraplus.org/public-authorities/norwegianhospitalprocurement/
[25] Sykehusinnkjop. New environmental criteria for the procurement of pharmaceuticals. https://sykehusinnkjop.no/nyheter/new-environmental-criteria-for-the-procurement-of-pharmaceuticals

Case study #3
Towards a Net Zero Carbon NHS – how governance structures can help (United Kingdom)

The United Kingdom National Health Service (NHS) has recently committed to a 'Net Zero Carbon NHS' initiative with the goal of becoming the world's first carbon net zero national health system by 2050 [26]. To reach their ambition, the NHS Net Zero report has identified medicine and supply chains as two critical areas of intervention, and procurement as a tool to drive sustainability [27]. Regarding medicine, the NHS Net Zero report hones in on two groups in particular: aesthetic gases and inhalers. Interventions to reduce emissions from these two medicines have already been identified in the NHS Long Term Plan and are underway. The interventions leading to the largest reductions have been commitments to reduce anaesthetics and pressurised metered-dose inhalers, capture and reuse of anaesthetic gas, and a shift to low carbon inhalers [27]. The scope of these interventions ranges from the operating room to primary care networks including community pharmacists [28]. Further, The North of England Commercial Procurement Collaborative (NOE CPC)'s internal project group on Sustainable and Ethical Procurement seeks ways to integrate sustainability principles into all activities. To date these have included the development of a new Supplier Code of Conduct [29] which communicates expectations and supplier's obligations regarding the environment and social value, and incorporation of specific criteria within the tender evaluation and weighting framework.

Adopting a system-wide, strategic approach on environmental efforts led by a clear governance infrastructure can pave the way to implement sustainability initiatives in the healthcare sector and reduce the environmental impact of medicines.

[26] Sustainability, NHS Procurement and NOE CPC. https://www.noecpc.nhs.uk/news/sustainability-nhs-procurement-and-noe-cpc
[27] National Health Service. (2020). Delivering a 'Net Zero' National Health Service. https://www.england.nhs.uk/greenernhs/wp-content/uploads/sites/51/2020/10/delivering-a-net-zero-national-health-service.pdf
[28] Dodge I, Watts N, Bailie P. Delivering a net zero NHS—one year progress. October 2021. www.england.nhs.uk/wp-content/uploads/2021/09/item4-delivering-net-zero-nhs-updated.pdf.
[29] https://www.noecpc.nhs.uk/pages/suppliers-code-of-conduct

Logistic planning & distribution

Logistics and distribution are key instruments for health managers to ensure quality, efficiency, cost-containment, and sustainability within their care setting. Logistics include receiving supplies, managing stocks, overseeing activities though information management systems, and transportation amongst other. Distribution refers to the delivery of medical supplies from storage locations to the points of consumption and use.

We highlight two interventions that health managers can implement to have more sustainable logistics and distribution activities. The following two case studies from The Netherlands and Italy respectively look at stock management and at centralised distribution systems to reduce waste of medications.

Case study #4
Leveraging digital technologies for stock management (The Netherlands)

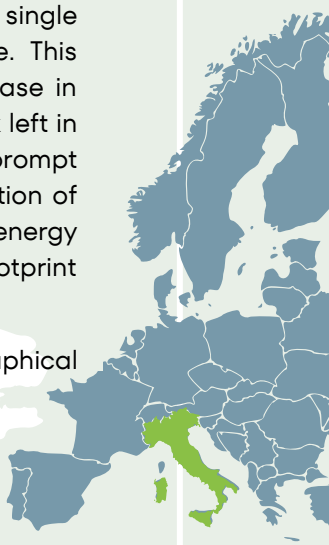
Appropriate management of the stock life cycle is essential for managing internal waste in pharmacies [30]. Utilisation of technology such as automatised expiry date checks, accelerated dispensing of near-expired medications, and exchange with other pharmacies to prevent disposal of undistributed medications are strategies that support this. PharmaSwap [31] is a Dutch online platform that achieves the latter; it essentially provides a sharing marketplace for pharmacists, hospital-based or otherwise, and facilitates transparency in the supply and demand of medication with low demand but high cost [32]. With the right regulation of product conditions, PharmaSwap also enables the shipment of traded goods in a manner that is safe and complies with good distribution practice, while guaranteeing quality at every stage [32]. To date, it has served 2,000 pharmacies in the Netherlands alone and prevented 175 medication packages from being wasted - valued at EUR 184,000 [32]. If adopted on a larger scale in line with national regulations, initiatives like PharmaSwap could create a significant circular impact in the reduction of medical waste.

Leveraging technology can help create transparency in the supply and demand of medication and mitigate wastage, especially for medication that is high cost with low demand. This prevents potentially hazardous medicines from unnecessarily entering waste streams.

Case study #5
Centralisation of supply chain management and distribution warehouses (Italy)

Ente per i Servizi Tecnico-amministrativi di Area Vasta (ESTAV) [33] is an interorganisational agency that functions as a procurement and logistical platform for a network of public healthcare organisations in Tuscany, Italy. It serves 4 Local Health Authorities, 2 Independent Trusts and 17 hospital facilities. It underwent a centralisation process whereby 18 single hospital warehouses were replaced by one warehouse centrally located in Florence. This change in supply chain management saw a 50% reduction in stock and a 57% increase in turnover rate (ratio between the value of distributed supplies and average value of stock left in the warehouse) [34]. These outcomes have a significant environmental impact as they prompt a reduction in the risk of medication expiry and forced disposal. Further, the centralisation of stock also resulted in a significant reduction in warehouse management costs including energy consumption, which is an essential component of green warehousing and carbon footprint reduction in supply chains [35].

Centralising distribution and supply chain management of medicines within a geographical area reduces stockpiling, which in turn lowers the likelihood of medication expiry.



[30] Smale EM, Egberts TCG, Heerdink ER, van den Bett BJF, Bekker cl. (2021). Waste-minimising measures to achieve sustainable supply and use of medication. Sustainable Chemistry and Pharmacy, 20(100400). https://doi.org/10.1016/j.scp.2021.100400.
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[35] Lewczuk,K.;Kłodawski, M.; Gepner, P. Energy Consumption in a Distributional Warehouse: A Practical Case Study for Different Warehouse Technologies. Energies 2021,14,2709. https://doi.org/ 10.3390/en14092709

Prescription

Physicians can take actions in their everyday practices to limit environmental harm, for example by prescribing the correct amount of medicines and adopting environmentally sustainable prescription practices. While environmental considerations are important, they should by no means compromise patient care and access to essential medicines. In fact, medicines are crucial to save human lives and improve wellbeing. Patient safety and the effectiveness of medicines must, therefore, always remain the first consideration when treating patients.

Interventions to ensure correct prescription practices must be coupled with effective health promotion and prevention programmes amongst the general population. This will reduce the need for medication in the first place, and address the problem at its roots.

Prescription practices are highly contextual and vary depending on the health system structure. General practitioners who have private practices are more likely to comply to patients' wishes of medicines prescribed as they need to maintain patient loyalty. On the contrary, in countries where health professionals are contracted by the national health system, GPs are incentivised and measured by national priorities and thus less likely to give in when faced with patient demand [36].

Focus group members suggested three case studies from France, Portugal, and The Netherlands to illustrate the diversity of interventions targeting prescribing practices as a way to lower the environmental impact of medicines. The case studies below show that practices can be changed by enhancing environmental health literacy amongst physicians and citizens, by introducing monitoring systems to rationalise medicine use, and by using testing tools to avoid unnecessary prescription of antibiotics.

[36] Oxford, J., Goossens, H., Schedler, M., Sefton, A., Sessa, A., & van der Velden, A. (2013). Factors influencing inappropriate antibiotic prescription in Europe. Education for Primary Care, 24(4), 291-293.

Case study #6
Improving communications between physicians and patients (France)

ASOQS, the French Association for Quality of Care of the department of Vosges, started an initiative called EcoPRESCRIPTION [37]. This initiative aims to change prescribing practices amongst physicians by encouraging them to prescribe medicines with low environmental impact when they are interchangeable. This implies that a medicine has the same active ingredient, and is as safe and effective as the original medicine. The project also aims to promote the return of unused medicines to a safe disposal location [38].

To implement the initiative, the EcoPRESCRIPTION project leaders organised one-on-one discussions with 43 physicians of the region to give them the tools and information needed to raise awareness amongst their patient on the importance of returning unused medicines. Leaflets for both health professionals and patients were distributed in primary care centres, with two respective prevention messages: "Choose drugs with a low environmental impact score" and "Treat without polluting, Bring back your unused medication." Physicians were given a special stamp to put on prescriptions to encourage and remind patients to bring back unused medication for proper disposal.

EcoPRESCRIPTION also encouraged physicians to use the Swedish environmental classification of pharmaceuticals (see *Case study #1: Environmental Classification of Pharmaceuticals to support the selection of environmentally friendly medicines (Sweden)*) to choose environmentally friendly medicines, while simultaneously encouraging physicians to limit prescriptions to the minimum necessary.

Awareness-raising activities were simultaneously organised amongst 55,483 patients on the importance of accepting that GPs' adjust the quantity of prescribed medicine to the actual quantity needed.

Greener prescribing practices can be achieved through training prescribers to recognise and prescribe medicines with lower environmental impact scores among interchangeable generics. Improving physician-patient communication can result in correct disposal practices amongst physicians and reduced patients' expectations for medicines.

[37] http://sesoignersanspolluer.com/
[38] Publications – EcoPrescription (sesoignersanspolluer.com)

Case study #7
Monitoring system for prescribing practices (Portugal)

Portugal's Shared Services of Ministry of Health (Serviços Partilhados do Ministério da Saúde) implemented a software application in 2016 called Prescrição Electrónica de Medicamentos (PEM) [39]. PEM is a comprehensive platform for the electronic prescription of medicines, mandated for the public sector and available in primary health care institutions and in hospital settings. It records and accounts for the entire "medication path" from prescription to dispensation; each step is communicated to the Control and Monitoring Centre of the Portuguese Public National Health Service (Centro de Controlo e Monitorização do Sistema Nacional de Saúde) [40]. The prescriber's citizen identification card is used to authenticate and verify the prescription against the online database maintained in collaboration with the medical or dental professional registration body [41]. Besides medication safety, the objective of PEM includes the assurance of appropriate prescribing practices as well as rationalisation and control of medicine use in healthcare. Currently, PEM represents 83% of prescriptions prepared throughout the Portuguese National Health Service and about 64% of the total prescriptions nationally, including private practices.

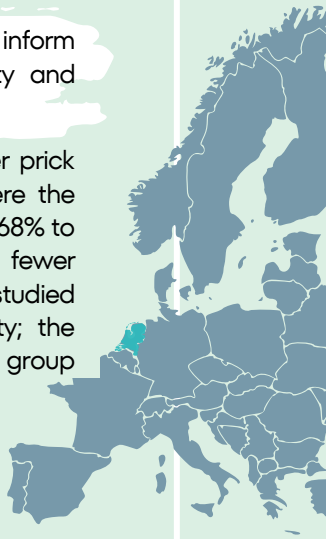
Having a system-wide mechanism to track medicine prescription and dispensation can help to monitor physicians with high prescription rates or prescribing patterns that lack prudence. The collected data has then the potential to be applied in further research and interventions against medical waste reduction and to drive integration of sustainability considerations directly into prescribing practices.

Case study #8
Point of Care Testing to inform antibiotic prescription (The Netherlands)

Antibiotic residue can have negative effects on biota at different trophic levels; between 40- 90% of administered antibiotic dose is excreted and eventually reaches the environment – contaminating soils, waters, plants, etc. [42]. Reduction of this impact is an integral part of antimicrobial stewardship interventions that aim to stop the current spread of antimicrobial resistance. C-reactive protein (CRP) Point of Care Test (POCT), a diagnostic tool that differentiates between viral and bacterial infections, combined with enhanced communication skills training is an intervention shown to address the major drivers of unnecessary antibiotic prescriptions: diagnostic uncertainty and patient expectations [43, 44, 45]

Using Point of Care Testing tools can indicate when antibiotic treatment is unnecessary. This can inform the decision-making process around antimicrobial prescription, especially in the community and primary care settings.

The CRP [EW1] test itself is quick (3-minute turnaround time for results) and non-invasive (finger prick blood sample). The effectiveness of the test has been investigated in the Netherlands, where the reduction in the number of antibiotic prescriptions was clinically and statistically significant (from 68% to 23%). If adopted nationwide, this result would translate to approximately 150,000 – 240,000 fewer antibiotic prescriptions annually. Transferability and cost-effectiveness of CRP POCT was studied across four other countries: UK, Poland, Spain, Belgium. The study confirmed transferability; the antibiotic prescription rate in intervention groups was significantly lower (33%) than the control group (48%).



[39] Serviços Partilhados do Ministério da Saude. Prescriçao Electronica Médica. https://www.omd.pt/content/uploads/2017/12/spms-manual-n3.pdf
[40] https://algorithmwatch.org/en/portugal-automated-verification-prescriptions-medical-fraud/
[41] Patrao, L., Deveza, R., & Martins, H. (2013). PEM-A new patient centred electronic prescription platform. Procedia Technology, 9, 1313-1319.
42] Polianciuc SI, Gurzău AE, Kiss B, Ştefan MG, Loghin F. Antibiotics in the environment: causes and consequences. Med Pharm Rep. 2020;93(3):231-240. doi:10.15386/mpr-1742
[43] Oberjé EJM, Tanke MAC, Jeurissen PPT. Antimicrobial Stewardship Initiatives Throughout Europe: Proven Value for Money. Infect Dis Rep. 2017;9(1):6800. Published 2017 Mar 30. doi:10.4081/idr.2017.6800
[44] Coenen S, Michiels B, van Royen P, et al. Antibiotics for coughing in general practice: a questionnaire study to quantify and condense the reasons for prescribing. BMC Fam Pract 2002;3:16.
[45] Martínez-González, N. A., Keizer, E., Plate, A., Coenen, S., Valeri, F., Verbakel, J. Y. J., ... & Senn, O. (2020). Point-of-care c-reactive protein testing to reduce antibiotic prescribing for respiratory tract infections in primary care: Systematic review and meta-analysis of randomised controlled trials. Antibiotics, 9(9), 610.

Consumption & use

Once medicines leave clinical practices for the home of the patient, they are no longer under close control. Medicines are crucial to improve patients' health, however, when misused, they can have detrimental effects on the environment [46]. Misuse can refer to taking unnecessary medication or not finishing the medication as prescribed, thus resulting in expiration and waste, and potentially affecting the environment. There is thus a need for multi-component interventions targeting citizens, healthcare providers, and systems to address this problem.

Examples of interventions include increasing health literacy amongst citizens, improving patient-provider communication, and introducing policies and legislation that optimise medical waste reduction. Education at population level is key to reshaping social norms and expectations for responsible medicine use. In case of misuse, it is also important that the clinician seeks to understand the reasons for which the treatment does not suit the patient. The case study at European level found and selected below shows how technology can be used to enhance medication adherence.

[46] Hovstadius, B., Petersson, G. Non-adherence to drug therapy and drug acquisition costs in a national population - a patient-based register study. BMC Health Serv Res 11, 326 (2011). https://doi.org/10.1186/1472-6963-11-326

Case study #9
Influence and improve patients' medication taking behaviour (Europe)

Non-adherence is a risk factor for wasting medication, which makes interventions to improve patients' behaviour closely related to medicinal waste reduction [46]. It affects up to 20-50% of patients who use medication for chronic diseases [47]. Behaviour such as abandoning a prescription or not using a medication as prescribed lead to expiration and wastage of the medication. The European Network to Advance Best practices and technology on medication adherence (ENABLE) is a collaborative effort between 39 European countries to utilise technology in enhancing medication adherence [48]. It seeks to 1) raise awareness of adherence enhancing solutions, 2) foster knowledge on medication adherence, 3) accelerate clinical application of novel technologies and 4) work collaboratively towards economically viable policy and implementation of adherence enhancing technology across health systems [48]. ENABLE engages key stakeholders from each country to pave the way for such technology to be implemented in European health care settings, including analyses of health system organisation and health technology reimbursement pathways [49].

Set to end in 2024, ENABLE can potentially provide European countries with the necessary insight to leverage technological advancements and address challenges of managing chronic diseases, which would decrease medical waste resulting in a positive impact on the environment.

[46] Hovstadius, B., Petersson, G. Non-adherence to drug therapy and drug acquisition costs in a national population - a patient-based register study. BMC Health Serv Res 11, 326 (2011). https://doi.org/10.1186/1472-6963-11-326
[47] World Health Organization (2003). Adherence to Long-Term Therapies: Evidence for Action. Geneva: World Health Organization. Available at: http://apps.who.int/medicinedocs/pdf/s4883e/s4883e.pdf.
[48] van Boven JFM, Tsiligianni I, Potočnjak I, Mihajlović J, Dima AL, Nabergoj Makovec U, Ágh T, Kardas P, Ghiciuc CM, Petrova G, Bitterman N, Kamberi F, Culig J, Wettermark B and European Network to Advance Best Practices and Technology on Medication AdherencE (ENABLE)(2021) European Network to Advance Best Practices and Technology on Medication Adherence: Mission Statement. Front. Pharmacol. 12:748702.
[49] Memorandum of Understanding for the implementation of the COST Action "European Network to Advance Best practices & technoLogy on medication adherencE" (ENABLE). https://e-services.cost.eu/files/domain_files/CA/Action_CA19132/mou/CA19132-e.pdf

Disposal

Incorrect disposal of unused or expired medicine poses direct environmental threats. Multi-component efforts are needed to ensure correct disposal of medicines.

At population level, we must increase environmental health literacy amongst patients to increase awareness on the importance of safe disposal. This can be done through public awareness raising campaigns and through better communication between providers and patients. Clear disposal guidelines on medication labels would help users know how to proceed with the disposal of that medication. However, the current regulatory framework makes packaging and leaflet harmonisation difficult as requirements are different from country to country.

At hospital level, which is probably the most relevant environment from a health management point of view, waste management, including pharmaceutical waste is key. Effective surveillance programmes are needed. Such programmes should monitor the release of toxic gases that are harmful to the environment within care settings. A monitoring system will indicate the emissions or releases that are not well controlled and highlight potential problems to solve. Disposal practices in hospitals are highly controlled, and health managers must ensure that procedures are properly implemented.

Lastly, at policy level, it is important to engage all stakeholders (healthcare professionals, health managers, procurement experts, industry representatives, policymakers, patients, and the community at large) and ensure multisectoral cooperation to reduce waste at every stage of the medicines lifecycle, from conception and production to disposal and wastewater treatment.

Three case studies have been selected from Serbia, Belgium, and Europe to show how literacy, infrastructures, and regulations can help ensure medicine waste collection and safe disposal.

Case study #10
Improving household pharmaceutical waste management through community infrastructure and awareness raising (Serbia)

Perception about and practices for drug disposal are influenced by various factors. While the Serbian population generally agreed that unused medicines should be returned to the pharmacy, over half reported throwing unused or expired medicines in the garbage, which is contrary to national disposal guidelines. The majority had never received information about correct disposal practices and had never participated in an organised collection program.
The study in Serbia shows the importance of education campaigns raising awareness on environmentally friendly disposal practices and ensuring that physicians advise patients on proper medicine disposal after prescribing a medicine. To make disposal easily accessible, familiar locations such as community pharmacies should be used as collection location for disposal. It also highlighted the importance of involving manufacturers in the disposal process, especially for unresolved financial issues at the last stage of disposal. Manufacturers would thus have to make sure that medicines are properly managed during the entire lifecycle of the medicine - including end stages such as disposal - and implement and fund take-back programs [50].

Using community infrastructures can help facilitate the disposal of medicines. Involving all stakeholders, including pharmaceutical industries, health managers, physicians, and the community is crucial to ensure that medicines are properly managed and used over their lifecycle.

Case study #11
Increasing environmental health literacy in patients (Europe)

The Global Self-care Federation (GSCF) which represents associations and manufacturers in the self-care industry, launched the Charter for Environmentally Sustainable Self-Care in late 2021 [51 , 52]. The Charter is the first global commitment from the consumer health industry to drive sustainable self-care and prioritises three main areas: plastics and packaging; pharmaceuticals in the environment (PIE); and CO2 footprint [52].

Of particular relevance to health managers are the main efforts related to pharmaceuticals in the environment: to encourage safe disposal of pharmaceuticals; promote the use of appropriate take-back schemes; and provide a platform for sharing knowledge related to PIE [52]. To be effective, these must be coupled with efforts to increase sustainability literacy and use communication campaigns to influence consumer behaviour, specifically pertaining to consumers of self-care products.

These action items have already gathered support from national consumer healthcare associations such as the Proprietary Association of Great Britain (PAGB) that represents manufacturers of self-care products in the UK [53]. PAGB's commitments to the Charter echo that of GCSF and include the promotion of pharmacy take-back schemes as the correct disposal method of out-of-date or unused medicines, to avoid the risk of environmental contamination through inappropriate discarding of products (e.g. in drains) [53]. Given that the success of these measures relies on the sustainability literacy of consumers of self-care products, health managers can incorporate these principles into consumer-facing strategies and contribute to the reduction of unnecessary consumption (purchase) and improper disposal (e.g. clear and informative product labelling or communication campaigns targeted towards points of purchase).

[50] Paut Kusturica, M., Ostojic, T., Kresoja, M., Horvat, O., Tomas, A., & Jevtic, M. (2021). Household pharmaceutical waste (example from Serbia). European Journal of Public Health, 31(Supplement_3), ckab165-333.
[51] https://www.selfcarefederation.org/
[52] Charter for Environmentally Sustainable Self-Care. https://www.selfcarefederation.org/sites/default/files/media/documents/2021-11/03_GSCF%20Env%20Charter%20Visual%20Identity.pdf
[53] PAGB. PAGB pledges support for environmental protection in new global charter. 25 November 2021. https://www.pagb.co.uk/latest-news/self-care-sustainability-charter/

Case study #12
Shared responsibility between the pharmaceutical industry and pharmacies in medical waste collection (Belgium)

The Belgian system of pharmaceutical waste collection and disposal is a national one, organised through a partnership between pharmaceutical wholesalers, the pharmaceutical industry, and pharmacies in collaboration with the regional environmental agencies [54]. This responsibility extends across the costs of removal, storage and transport of waste from pharmacies to disposal sites and the incineration of pharmaceutical residues [54]. The percentage that each pharmaceutical company pays is representative of their market uptake.

The existence of such a system with shared responsibilities, complemented by statutory guidance and robust education and communication campaigns, can help countries define the entities accountable for medical waste.

In Brussels, 62% of respondents reported being unaware of the possibility to return unused medicines to a pharmacy, however 95% expressed they would be either very likely or likely to use the system having had the information [54]. This system saw the amount of recovered pharmaceutical residue increasing by 33% over a 11-year period, at a total disposal cost of EUR 0.50 per kg [54]. Policy and decision-makers can look to implement such systems either at the regional or national level by identifying the accountable entities and supporting them with clear legislation and investment in communications.

Case study #13
Platform on disposal schemes in European countries (Europe)

#medsdisposal is a multi-stakeholder campaign created by European health NGOs, industry and student organisations to raise awareness amongst the general public on how to dispose of unused or expired medicines appropriately in Europe [55]. It provides information on current disposal schemes in European countries compiled within one place as well as links to national level information on appropriate disposal practices. The campaign helps to increase public awareness, influence patients' behaviour on the prudent use of medicines, and promote correct disposal of pharmaceuticals.

Compiling information in a centralised manner can facilitate appropriate disposal practices in European countries.

[54] Pharma.be (2013). Médicaments périmés et non utilisés. www.bonusage.be/vervallengeesmiddelen.aspx.
[55] http://medsdisposal.eu/

Conclusions

While medicines are essential to improve human health and well-being, they can also impact the environment in direct or indirect ways. As showcased by these thirteen case studies, good practices to address the environmental impact of medicines exist. The aim of this White Paper is to centralise some of the good practices available to make them accessible to health managers across Europe, and thus enable the sharing of knowledge between stakeholders.

The White Paper also proposes a series of recommended actions that health managers can take to reduce the environmental impact of medicines. These include encouraging data collection of emissions linked to medicines and medical equipment, facilitating exchange of best practices between different stakeholders, establishing shared responsibility, leverage technology to avoid wastage of medicines, increase environmental health literacy, and centralise processes in procurement, supply chain, and logistics to favour the purchase of medicines with low environmental impact where medicines are interchangeable. This issue can nevertheless only be solved through effective multi-stakeholder and multi-sectoral collaboration.

[i] EHMA also acknowledges the relation of medicine procurement with the procurement of other goods and services, such as food served in hospitals, as well as the actions that hospital food procurers could take to engage with producers and help them reduce their need for antibiotics. However, as this paper focuses on medicines, no case study on food was included..

Abbreviations

AMR: Antimicrobial resistance
EC: European Commission
EHMA: European Health Management Association
EU: European Union
EU/EEA: European Union/ European Economic Area
GPs: General practicioners
NHS: National Health System
OECD: Organisation for Economic Co-operation and Development
SDGs: Sustainable Development Goals
UN: United Nations

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