

Prescription for the Planet:

Enhancing Green Pharmacy through a Quintuple Helix Approach in Malaysia

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THE ENVIRONMENTAL IMPACT OF PHARMACEUTICAL PRODUCTS

Pharmaceutical wastes presence in the environment is a growing public health and environmental concern worldwide. Studies consistently show that the most common disposal method among the general public is discarding medications in household trash or flushing them down the toilet, leading to contamination of water systems and soil with active pharmaceutical ingredients. Consequently, uncontrollable release of these pollutants to the environment has been identified to be associated with aquatic toxicity, disruption of wildlife hormone systems, and the rise of antimicrobial resistance, mainly towards the aquatic ecosystem. For example, the presence of an antidiabetic drug, metformin and its derivatives in the environment has been linked to the increase of male compared to the female broods observed in a small planktonic crustacean, *Daphnia magna*. In another example, zebrafish *Danio rerio* embryos exposed to the similar substances exhibited morphological changes such as scoliosis and, heart and yolk sac oedema. This is based on a single report, identifying the effect of a drug and its derivatives on a few aquatic organisms. The active pharmaceutical ingredients (APIs) that are present in the water bodies amount to more than hundreds – perhaps even thousands of drugs may be present at one location. By integrating sustainability into the entire lifecycle of a drug, from prescription to disposal, we can mitigate the impact of pharmaceutical waste. Green pharmacy is a way forward.

THE MALAYSIAN LANDSCAPE: CURRENT CHALLENGES & OPPORTUNITIES

More than two decades ago, researchers throughout Malaysia found the prevalence of APIs in several water bodies. In fact, the most surprising finding was reported in 2019, pharmaceutical residues including ciprofloxacin, caffeine and others were substantially present in the drinking water supply from a residential area in Kajang and Putrajaya. The compilation of these findings was also highlighted in a local newspaper, *The Star*, in early 2025. The dissemination of this information serves as a wake-up call for Malaysians to realise that the water we have always believed to be safe to drink is actually tainted with invisible toxicants, which is concerning.

Highest concentration of pharmaceuticals found in different locations in Malaysia			
Location	Source	Pharmaceutical	Concentration (ng/l)
Sungai Lui, Selangor	River	Ciprofloxacin	112.40
Sungai Gombak, Selangor	River	Ciprofloxacin	267.20
Sungai Selangor, Selangor	River	Ciprofloxacin	198.91
Putrajaya	Drinking water	Ciprofloxacin	0.32
Kajang, Selangor	Drinking water	Ciprofloxacin	0.667
Sungai Langat (Sungai Semenyih, Sungai Beranang, Sungai Labu), Selangor	River	Furosemide	109
Langat basin, Selangor	STPs effluent	Norethindrone	7,135
Sungai Langat, Selangor	Tap water	Ethinylestradiol	130
Sungai Klang, Selangor	River	Caffeine	20.62
Nilai & Seremban, Negri Sembilan	Surface water	Caffeine	821
Nilai & Seremban, Negri Sembilan	STP effluent	Caffeine	1,190
Nilai & Seremban, Negri Sembilan	Hospital effluent	Theophylline	3,314

Note: STP (sewage treatment plant) ng/l (nanograms (ng) per litre (L)) | Source: Tropical Aquatic and Soil Pollution journal | *TheStar*graphics

Figure 1: Pharmaceutical residues detection in various locations in Malaysia (source: *The Star*, published 11 January 2025)

It is well accepted that pharmacy-based take-back programmes are widely regarded as a good practice for medication disposal because they channel pharmaceutical waste toward proper incineration or chemical deactivation, thereby preventing environmental release. Such initiatives also align with the eco-pharmacovigilance framework, which emphasises source control of pharmaceutical pollutants through responsible drug administration and disposal practices. Nonetheless, it may not be the best method there is due to certain aspects such as community pharmacy accessibility, pharmaceutical waste management cost and perhaps something more subtle - enculturation of a civilised society. Medicine is a gift of science. Understanding how to use and store it not only reduces waste but also demonstrates our respect for its value.

In response to this situation, under Thematic Working Group (TWG) 4 of the National Environmental Health Action Plan (NEHAP), a cross-ministry collaboration mainly involving the Ministry of Health (MOH) and the Ministry of Natural Resources and Environmental Sustainability (NRES), the MyMediSAFE initiative was established to encourage the public to return unused, unwanted, or expired medications to participating community pharmacies rather than disposing them through environmentally harmful routes.

There are things that Malaysia can learn from other countries when it comes to understanding the environmental impact of medicine. For example, the National Institute for Health and Care Excellence provided a patient aid in choosing inhalers. Different type of inhalers exhibits different carbon footprints. Furthermore, the National Health Service of the United Kingdom encourages the use of dry powder inhalers (DPIs), which have a reduced carbon footprint compared to pressurised metered-dose inhalers (pMDIs), to provide ecologically responsible respiratory care. And a recent study in Spain also corroborated this practice. Meanwhile, Sweden's "Wise List" directs medical practitioners to prescribe medications with reduced environmental toxicity and permanence in water systems. On the other hand, The Pharmaceutical Group of the European Union has provided a complete guideline for a sustainable and green approach to be utilised in the pharmaceutical sector, particularly for the community pharmacy. These programs and others emphasise the significance of a risk-based approach to healthcare that takes ecological impact and patient outcomes into account. Adapting these strategies could support Malaysia's transition toward green pharmacy and more sustainable pharmaceutical waste management.

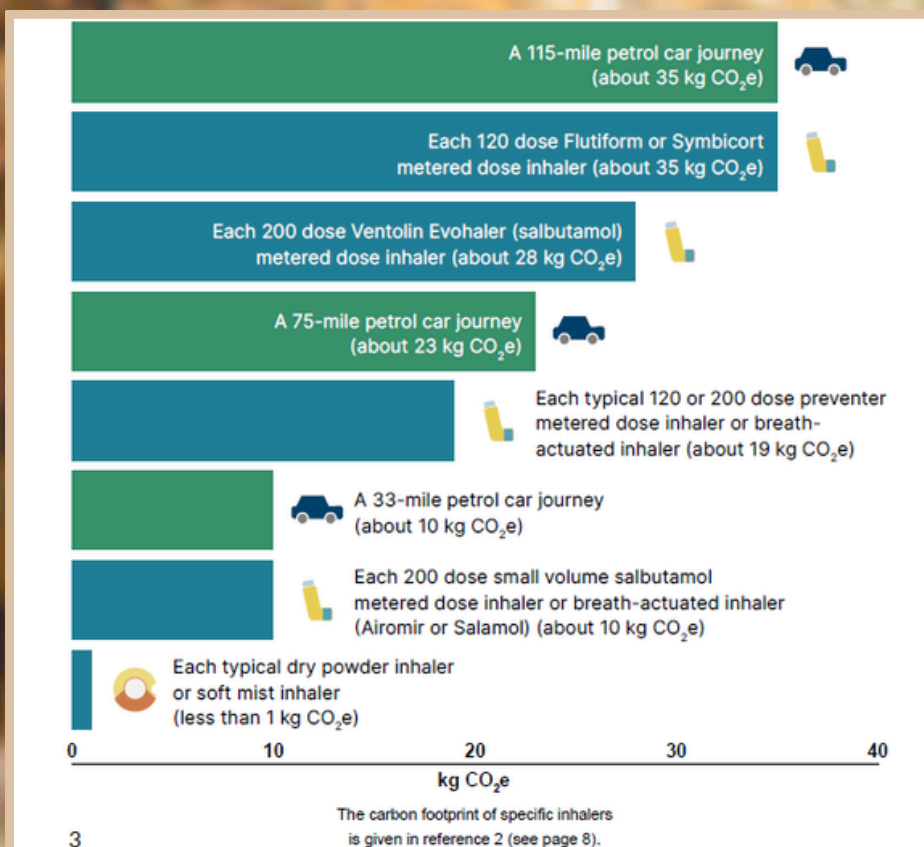


Figure 2: The carbon footprint of inhalers (adapted from "Asthma inhalers and climate change", National Institute for Health and Care Excellence, NICE, 2024)

QUINTUPLE HELIX APPROACH: SHARED RESPONSIBILITY IN HANDLING PHARMACEUTICAL WASTE

Pharmaceutical waste management in Malaysia is more than just policy; it necessitates a quintuple helix approach where academia, industry, government, the public, and the environment communicate in a symbiotic ecosystem. The government provides a more robust "Medicine Return Program", more environmentally friendly production practices in industry, and the data needed to propel change from academia; these are all components of this cooperative framework.



Figure 3: Collaborative action between Dr. Hisyam Abdul Hamid and a local influencer, Ajar channel, in disseminating information about pharmaceutical waste issue in Malaysia.

However, the public helix is the core of this system, where education acts as the primary catalyst for sustainable living. The evolution of the citizens from being passive consumers to active environmental stewards can be done through education and efficient information dissemination about the risks associated with leaching APIs. Community pharmacists play a pivotal role here, turning every consultation into an opportunity for behavioural change.

Empowering the public with the knowledge to properly use, store, and dispose of medicines transforms the vision of a green pharmacy ecosystem into reality. Ultimately, fostering this collective responsibility is the only way to effectively reduce pharmaceutical waste and ensure long-term sustainability for our environment.

FUTURE DIRECTIONS: MALAYSIA'S TRANSITION TOWARD GREEN PHARMACY

Despite several challenges that Malaysia is facing, it is also undeniable that the Malaysian government is taking a proactive and progressive step towards a sustainable country. Looking ahead, Future Directions: Malaysia's Transition toward Green Pharmacy must focus on embedding environmental stewardship into the core of our national medicines Policy. By adopting risk-based dispensing frameworks and strengthening the quintuple helix collaboration, we can revolutionise how pharmaceutical waste is managed nationwide. This journey requires a cultural shift where the public, healthcare providers, and policymakers work in unison.



Figure 4: Implementation Committee Meeting on the Patient Medication Disposal Initiative for Environmental Sustainability (MyMediSAFE), a platform established by Pharmaceutical Services Programme to ensure that this initiative can be planned, implemented, and monitored based on policies and mechanisms that are practical and relevant to each stakeholder

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