

Towards sustainable pharmaceuticals

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No Declarations of Interest



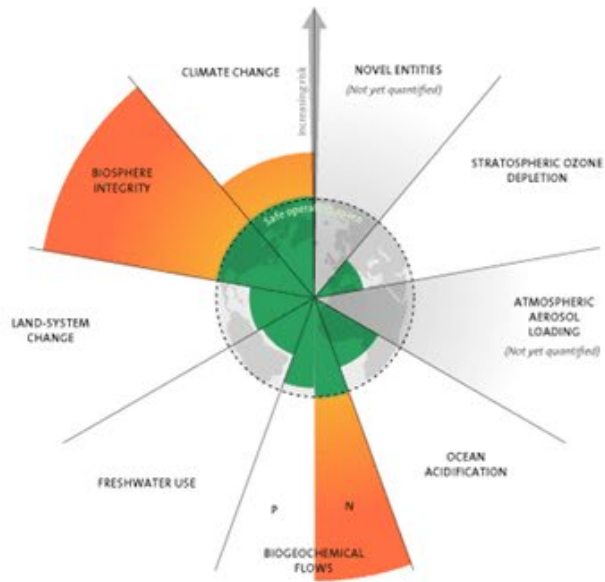


1. Why should we care about the environmental impact of pharmaceuticals?
2. What are pharmaceutical companies doing to reduce this impact?
3. What can oncologists (and other health care providers/prescribers) do to reduce this impact?

A small, vibrant green plant with several leaves is growing out of a crack in a grey asphalt surface. The background is a blurred, bright, hazy sky, suggesting a sunny day. The overall scene is a metaphor for resilience and growth in a harsh, man-made environment.

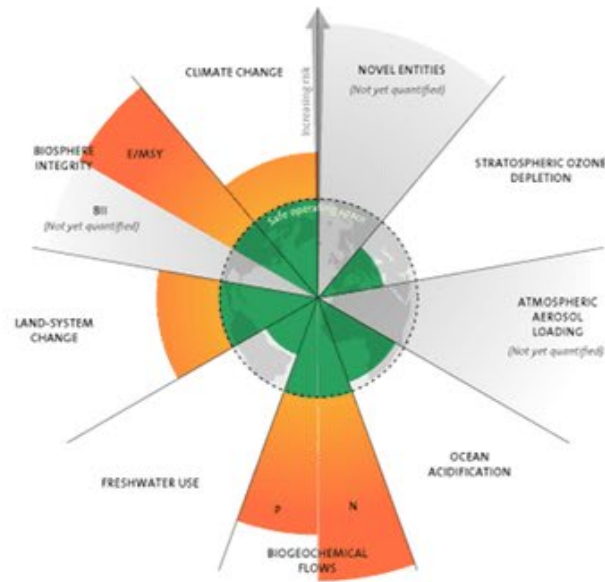
Why should we care about the
environmental impact of
pharmaceuticals?

2009



3 boundaries crossed

2015



4 boundaries crossed

2023



6 boundaries crossed

A photograph of an industrial facility, likely a pharmaceutical plant, at dusk. The sky is a deep blue, and the facility's structures, including tall distillation columns and pipes, are illuminated with warm yellow lights. The foreground shows a field of dry grass and rocks.

GHG Emissions

Pharmaceuticals in the Environment

Packaging Waste

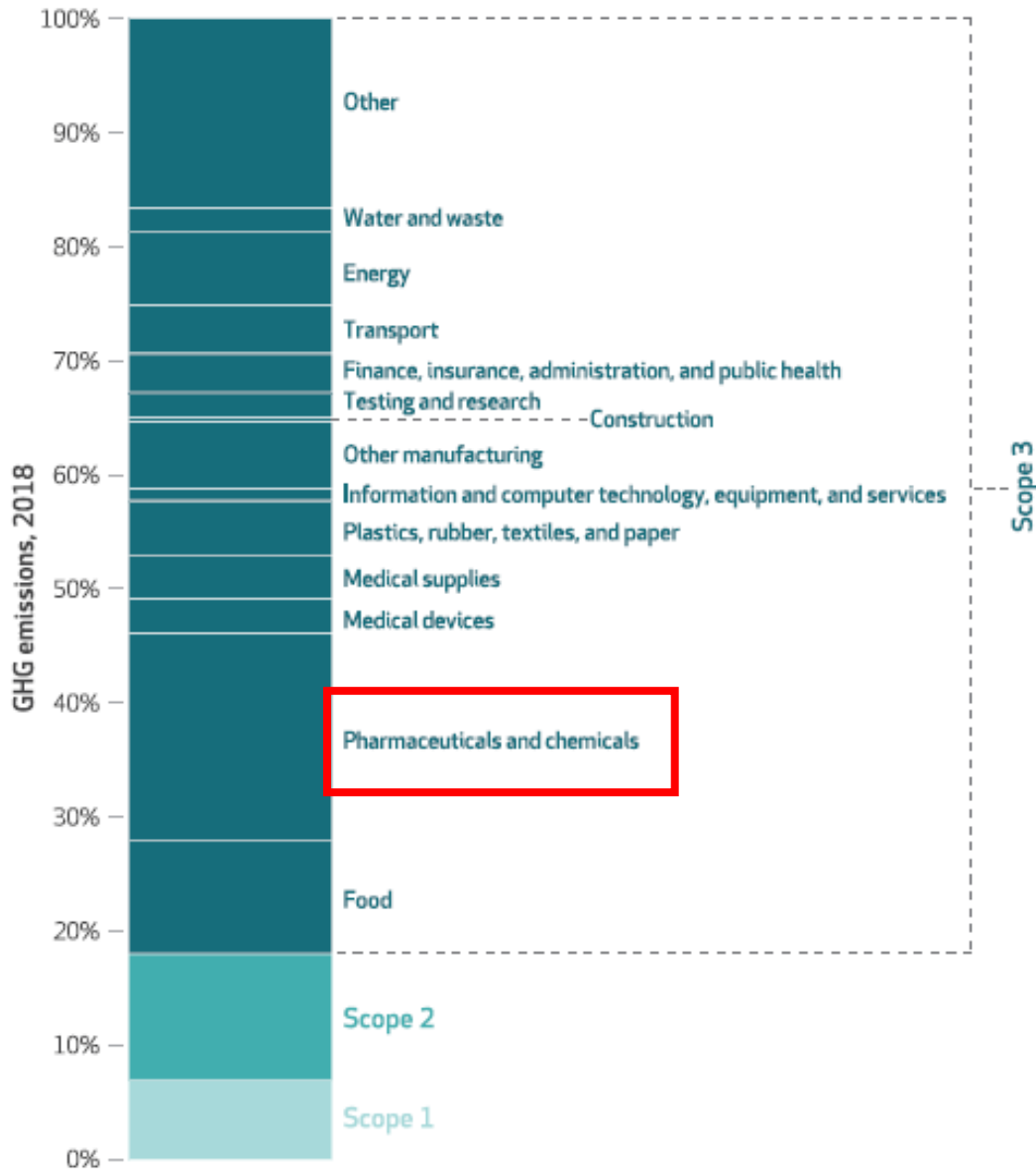
A photograph of an industrial facility, likely a pharmaceutical plant, at dusk. The sky is a deep blue, and the facility's structures, including tall distillation columns and piping, are illuminated with warm yellow lights. The foreground shows a field of dry, brownish vegetation.

GHG Emissions

Pharmaceuticals in the Environment

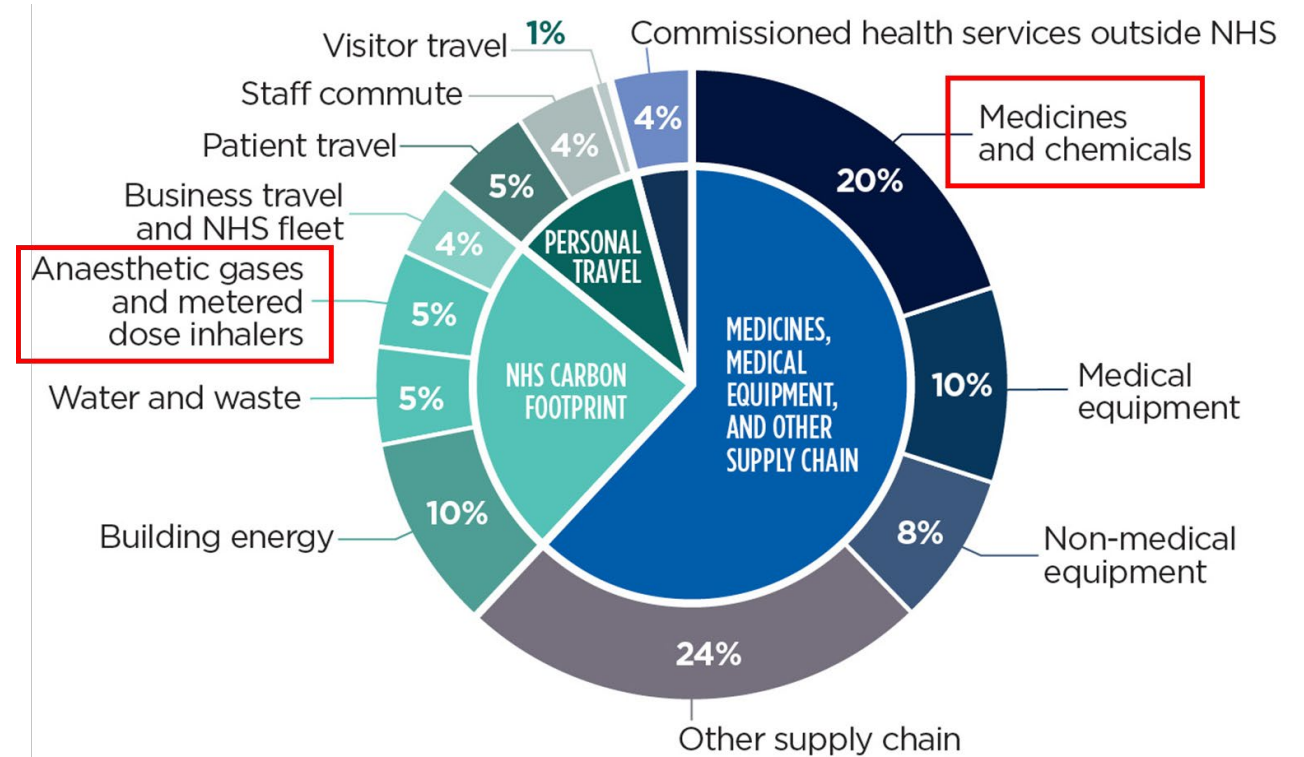
Packaging Waste

US national health care greenhouse gas (GHG) emissions by GHG Protocol Scope, 2018



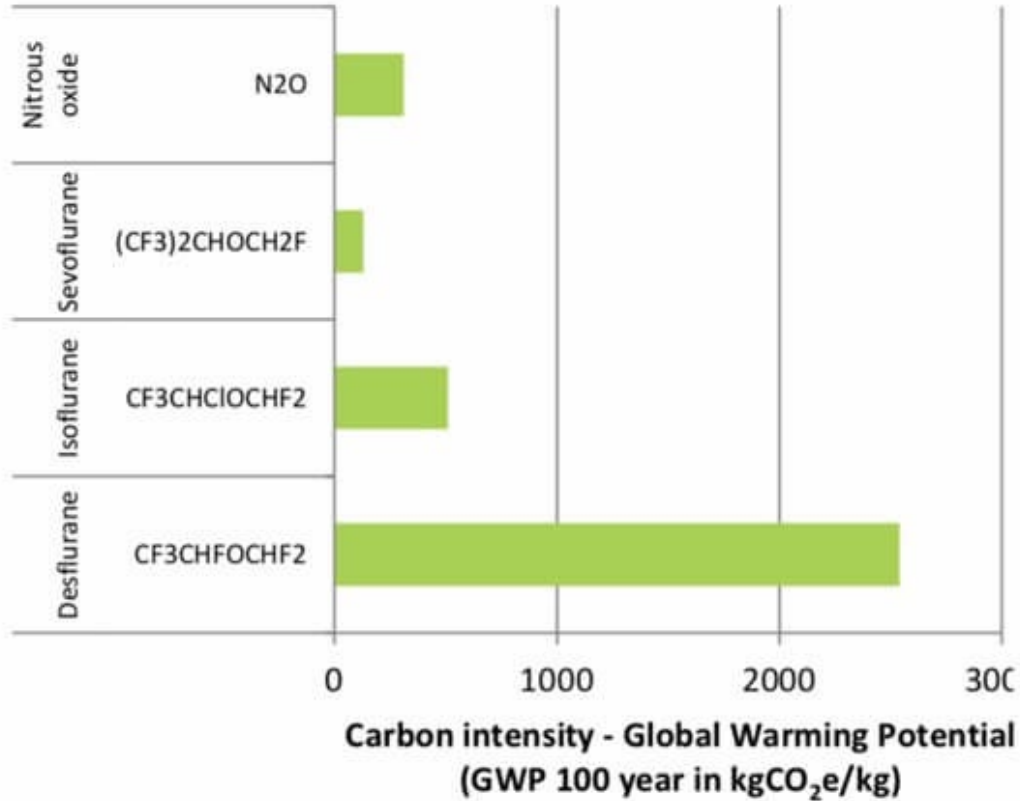
USA

Pharmaceutical and chemical products are a considerable portion of health systems carbon footprints

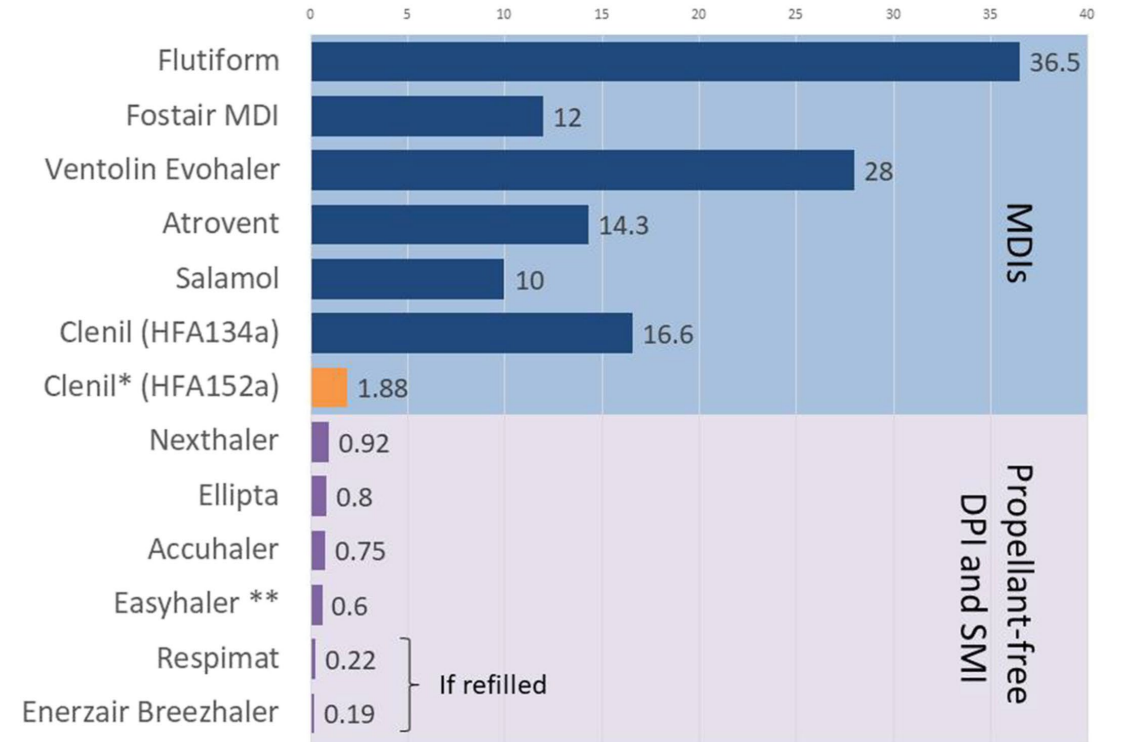


UK

Carbon intensity Global Warming Potential



Carbon footprint per inhaler (or per month) (kg CO₂e)





Journal of Environmental Chemical Engineering

Volume 9, Issue 4, August 2021, 105734





Journal of Cleaner Production

Volume 76, 1 August 2014, Pages 55-63



Case study on environmental safety and sustainability of pharmaceutical production based on life cycle assessment of enrofloxacin

[Weixin Kong](#), [Bihong Lv](#)  , [Siqi Yang](#), [Huazhen Shen](#), [Guohua Jing](#), [Zuoming Zhou](#)

Assessing the sustainability of a manufacturing process using life cycle assessment technique—a case of an Indian pharmaceutical company







[Rachit Kumar Sharma](#), [Prabir Sarkar](#)  & [Harpreet Singh](#)

Clean Technologies and Environmental Policy **22**, 1269–1284 (2020) | [Cite this article](#)




Sustainable Chemistry and Pharmacy
Volume 18, December 2020, 100329

Cradle-to-grave life cycle assessment of an ibuprofen analgesic

[Marc-William Siegert](#) , [Peter Saling](#) , [Pascal Mielke](#) , [Carolin Czechmann](#) , [Yasmine Emara](#) , [Matthias Finkbeiner](#) 



Counting the carbon cost of heparin: an evolving tragedy of the commons?

[Bingwen Eugene Fan](#)  & [Emmanuel J Favaloro](#)

Cradle-to-Gate Greenhouse Gas Emissions for Twenty Anesthetic Active Pharmaceutical Ingredients Based on Process Scale-Up and Process Design Calculations

[Abhijeet G. Parvatkar](#), [Huseyin Tunceroglu](#), [Jodi D. Sherman](#), [Philip Coish](#), [Paul Anastas](#), [Julie B. Zimmerman](#), and [Matthew J. Eckelman](#)*

A photograph of an industrial facility, likely a pharmaceutical plant, at dusk. The sky is a deep blue, and the facility's structures, including tall distillation columns and piping, are illuminated with warm yellow lights. The foreground shows a field of dry, brownish vegetation.

GHG Emissions

Pharmaceuticals in the Environment

Packaging Waste

Pharmaceutical production

Veterinary pharmaceuticals

Human pharmaceuticals



Pets



Aquaculture



Livestock



Households, hospitals,
healthcare facilities



Wastewater



Solid waste disposal



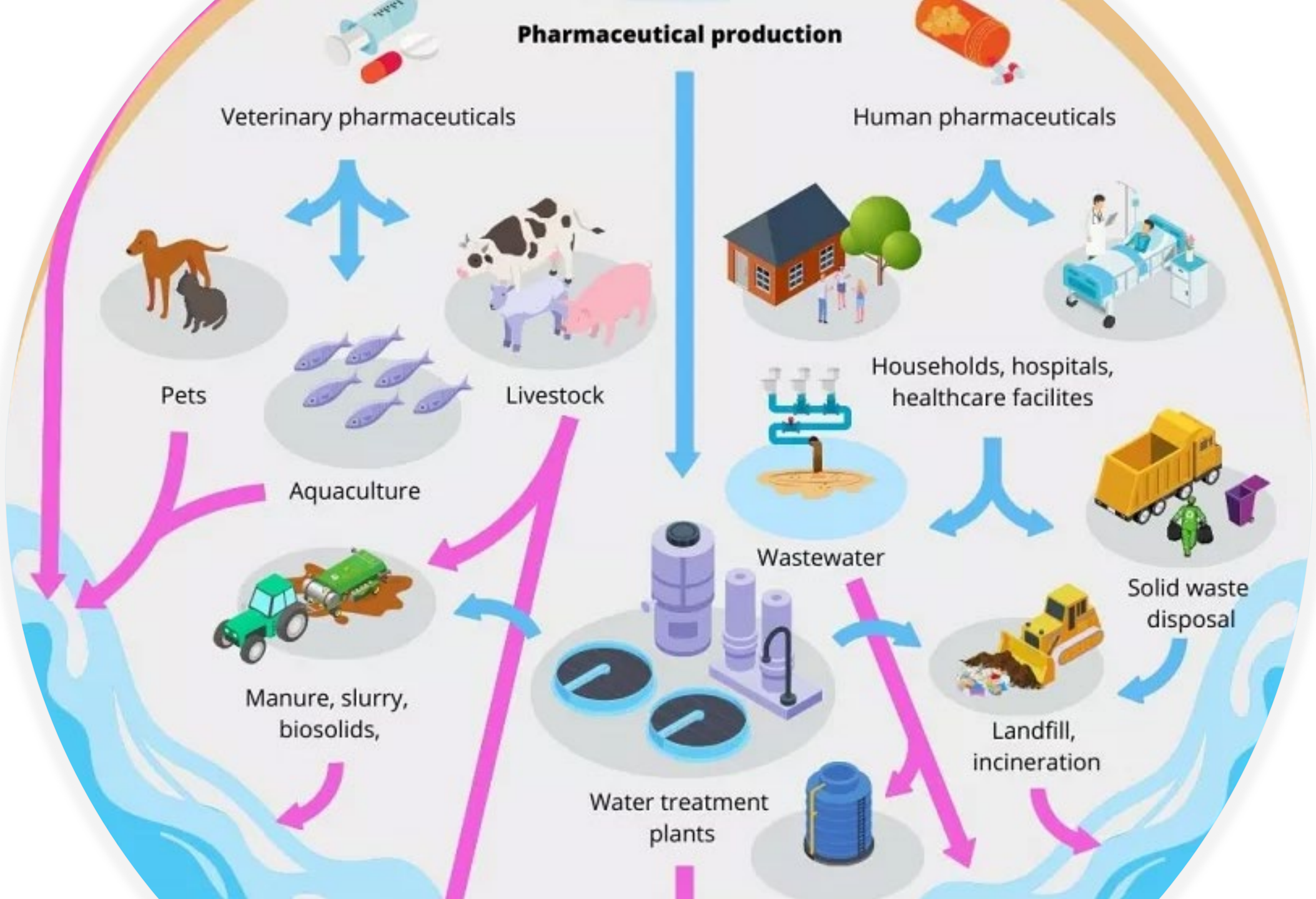
Manure, slurry,
biosolids,



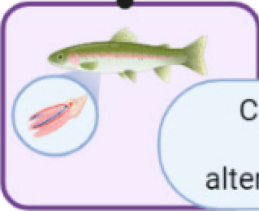
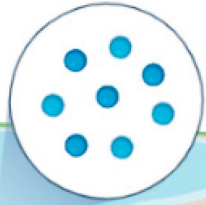
Water treatment
plants



Landfill,
incineration

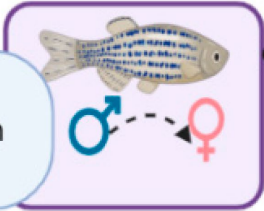


Water body contaminated with
Pharmaceutical products



Carbamazepine induced oxidative stress.
Diclofenac induced renal lesion, gill
alterations and organ damage in rainbow trout

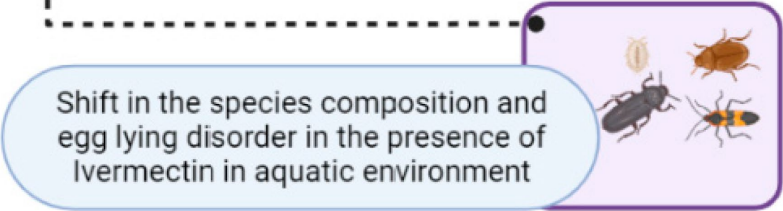
Ethinylestradiol causes feminizing
effects on male fish due to alteration
in male gonads of zebra fish



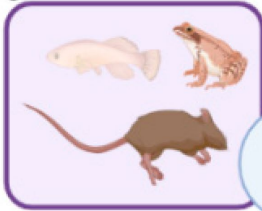
Propranolol induced Disorders in
reproduction, reduction in viable eggs
in the Mexican shrimp



Antibiotic resistance (General), Bacterial
community alterations (Sulfadiazine)

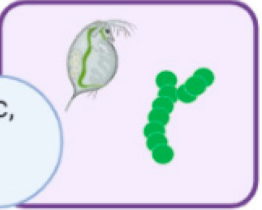


Shift in the species composition and
egg lying disorder in the presence of
Ivermectin in aquatic environment



Gene expression alterations, abnormal
protein and enzyme activities, and growth
malformations in rats, fish, and frogs

Acute toxic pharmaceutical effects (diclofenac,
carbamazepine, ibuprofen, fluoxetine) in
Daphnia, cyanobacteria, and algae





A photograph of an industrial facility, likely a pharmaceutical plant, at dusk. The sky is a deep blue, and the facility's lights are glowing. Several tall, cylindrical towers and pipes are visible, some with small lights on them. The foreground is a grassy field.

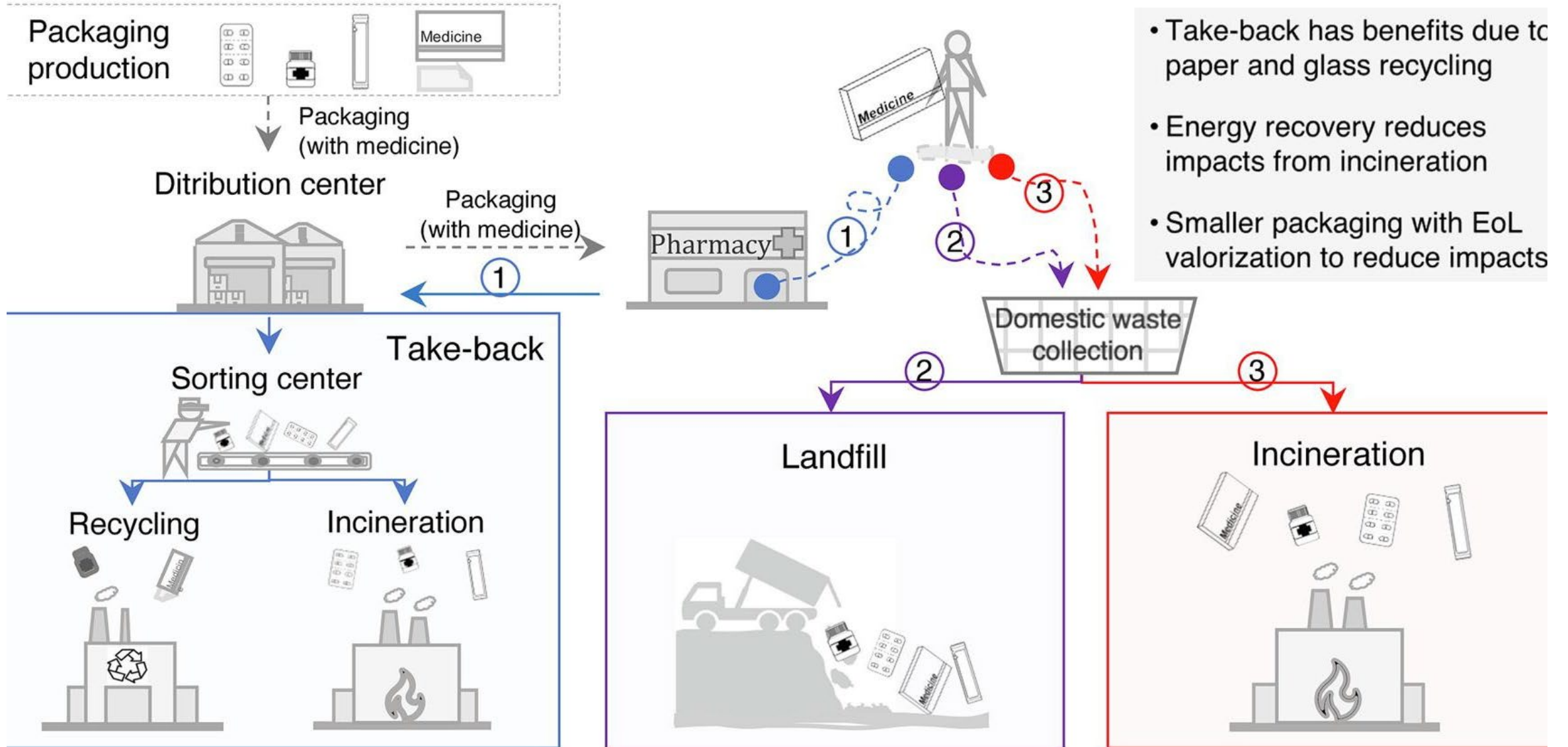
GHG Emissions

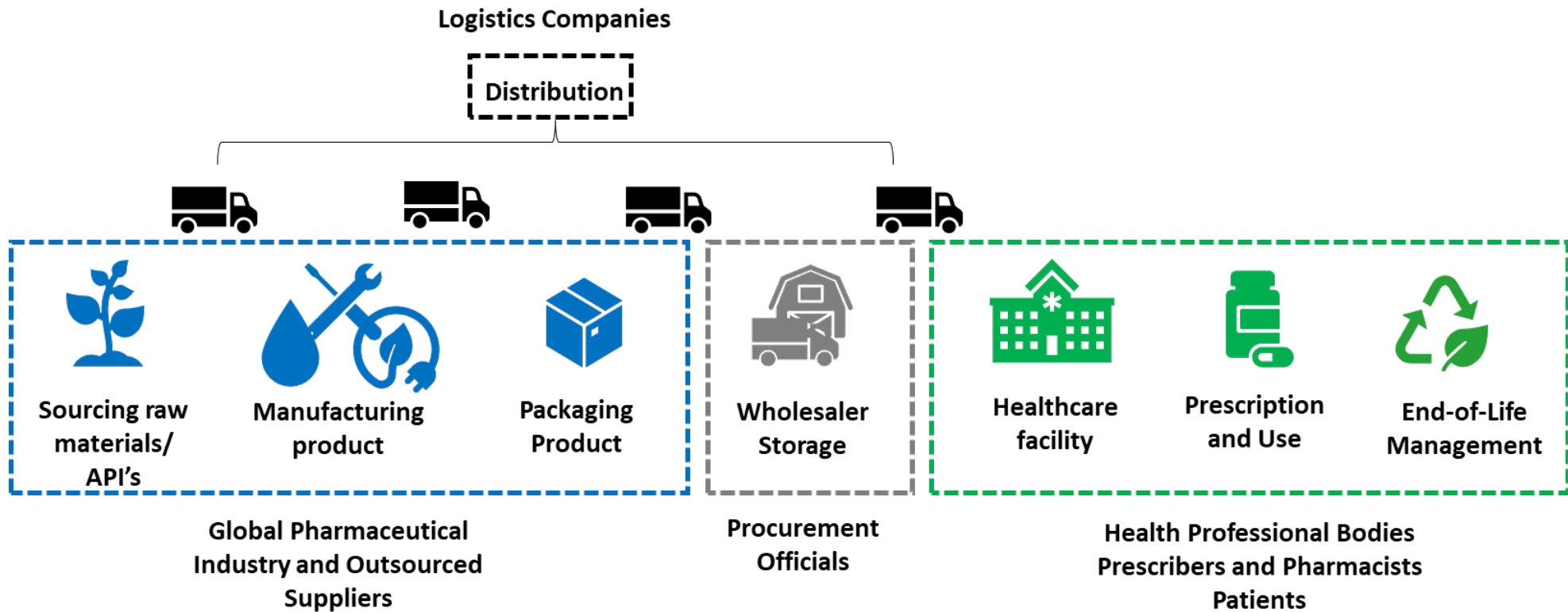
Pharmaceuticals in the Environment

Packaging Waste



Pharmaceutical packaging life-cycle







 Environmental impact

A small, vibrant green seedling with several leaves is growing out of a crack in a dark, textured asphalt surface. The background is a blurred, light-colored ground with some reddish-brown stains. The text is overlaid on the image in a white, sans-serif font with a slight drop shadow.

What are pharmaceutical
companies doing to reduce this
impact?

2027

CARBON NEUTRAL

Amgen (1, 2)

2030

NET ZERO

Cilead (1, 2)

2030

CARBON NEUTRAL

Johnson & Johnson (1, 2) Eli Lilly (1, 2) Boehringer Ingelheim (1, 2)

2040

NET ZERO

Novartis (1, 2, 3) Pfizer (1, 2, 3) Takeda (1, 2, 3)

2040

CARBON NEUTRAL

BMS (1, 2) Merck & Co (1, 2)

2045

NET ZERO

Sanofi (1, 2, 3) GSK (1, 2, 3) AstraZeneca (1, 2, 3) Novo Nordisk (1, 2, 3)

2030

ABSOLUTE REDUCTION






Teva (1, 2: -46%; 3: -25%) Viatris (1, 2: -42%; 3: -25%) Merck & Co (3: -52%) Johnson & Johnson (3: -16%)

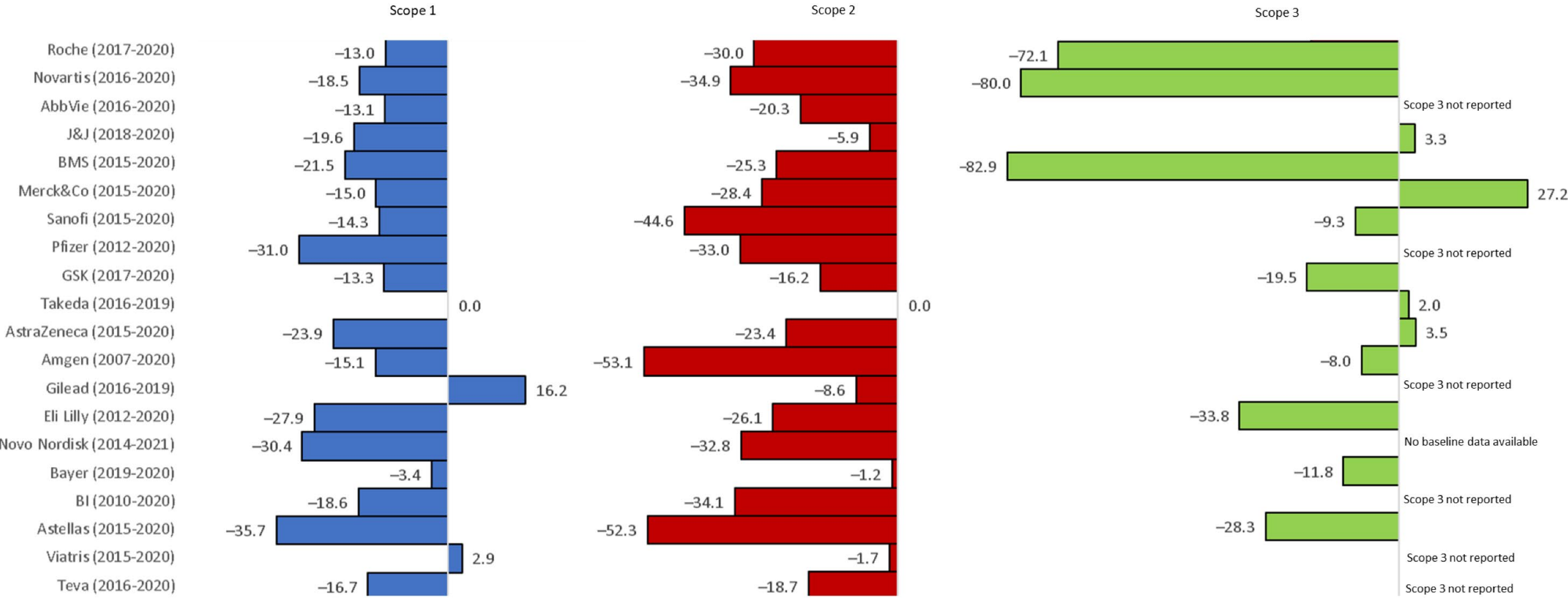
2050

NET ZERO

Roche (1+2) AbbVie (1, 2, 3) Bayer (1, 2, 3) Astellas (1, 2, 3)

Pharmaceutical Company Targets and Strategies to Address Climate Change: Content Analysis of Public Reports from 20 Pharmaceutical Companies

by Amy Booth ^{1,*} , Alexandra Jager ¹ , Stuart D Faulkner ¹ , Christopher C Winchester ²  and Sara E Shaw ¹ 



Renewable energy

Energy optimisation

Sustainable logistics

Reduce employee/business travel

Product eco-design

Sustainable sourcing

EOL programmes

Supplier engagement

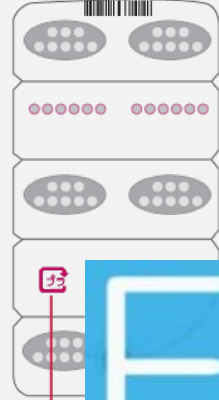
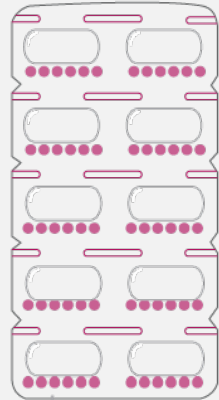
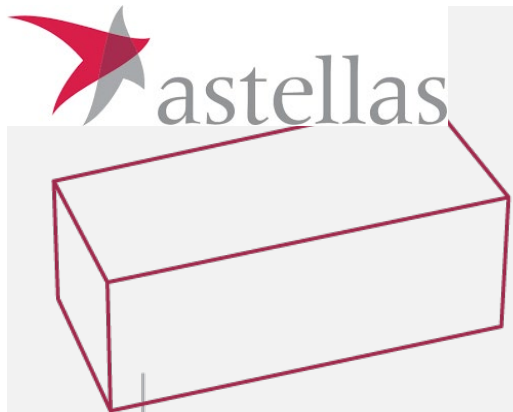
Carbon offsetting*

🕒 20 September 2021

GSK announces major renewable energy investment and low carbon inhaler programme alongside Life Sciences sector. Race to Zero 'breakthrough' at NYC Climate Week



Health Systems Task Force



(Material)
Use cardboard made from recycled paper

(Material)
Use thin plastic sheets wherever possible
Use biomass-based plastic for some products

(Labeling)
Label materials for recycling at the

Green chemistry in the lab — AstraZeneca
Nature as inspiration for oncology medicine chemical development

Nature is a source of inspiration for sustainability. In biology, plants employ photosynthesis to convert raw materials like water and carbon dioxide...



Energize

A Program to Increase Access to Renewable Energy for Pharmaceutical Supply Chains





Challenges

- Conflicting corporate priorities
- Regulation
- Infrastructure
- Geopolitics
- Global net zero transition






Financial

‘If you hit them in the wallet, that’s when they pay attention.’

(Senior Scientific Director, Regulatory Agency)



Regulatory

‘Rule number one is: comply with the regulation—you have to.’

(Senior Sustainability Director, Pharmaceutical Company)



Reputational

‘The general public matter because we want to have a good corporate image.’

(Senior Sustainability Director, Pharmaceutical Company)

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What can oncologists (and other health care providers/prescribers) do to reduce this impact?



Prevention

Health promotion

Rational prescribing

- Best clinical efficacy
- Lowest dose, shortest amount of time (“deprescribing”)

Social prescribing

Personalised medicine

Reuse of medicines

Safe disposal (take-back programmes)

Digital innovation

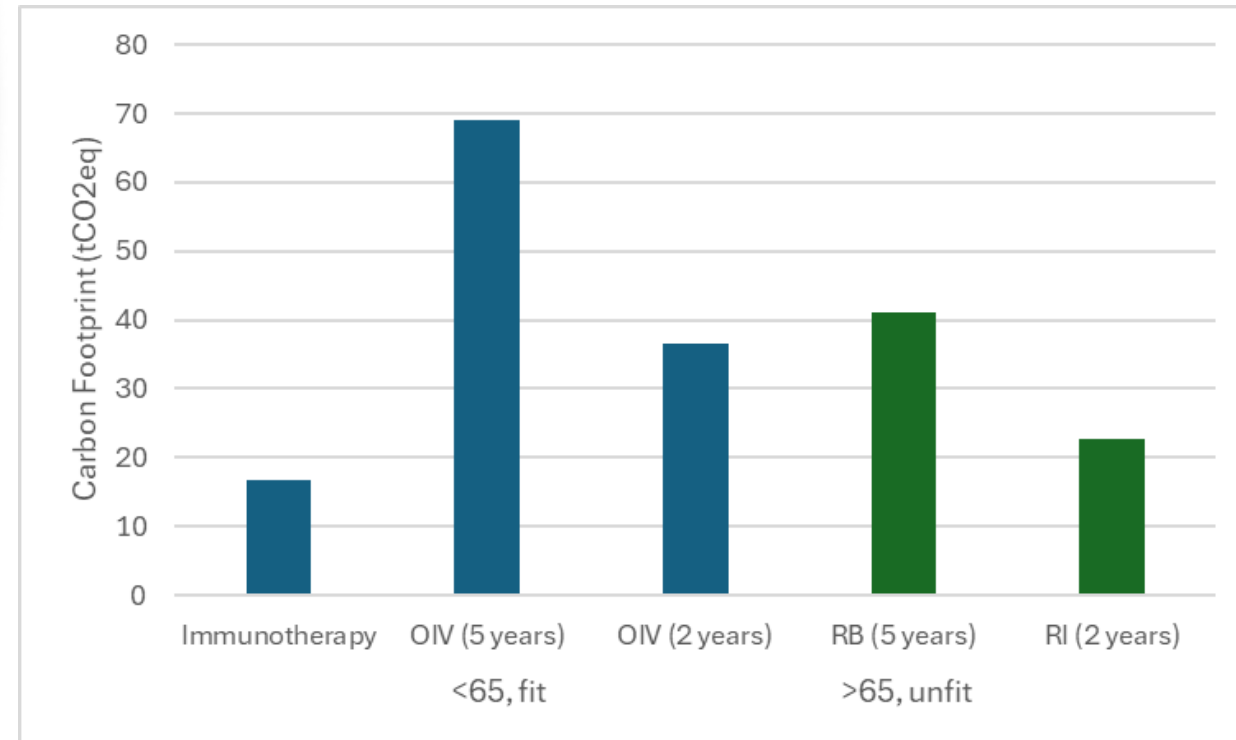
Educate colleagues and patients

Should the Carbon Footprint of Care be Taken into Account When Choosing a Treatment for Lymphoma? a Case Application on Mantle Cell Lymphoma

Max Piffoux¹, Aurélie Cabannes-Hamy², Hajer Ben Souda³, Olivier Hermine MDPH^{4 5}, Caroline Besson⁶

Evaluated the carbon footprint of various Mantle Cell Lymphoma treatments

- Immunochemotherapy vs obinituzumab, ibrutinib, venetoclax (OIV) (<65, fit)
- Rituximab, bendamustine (RB) vs rituximab, ibrutinib (RI) (>65, unfit)



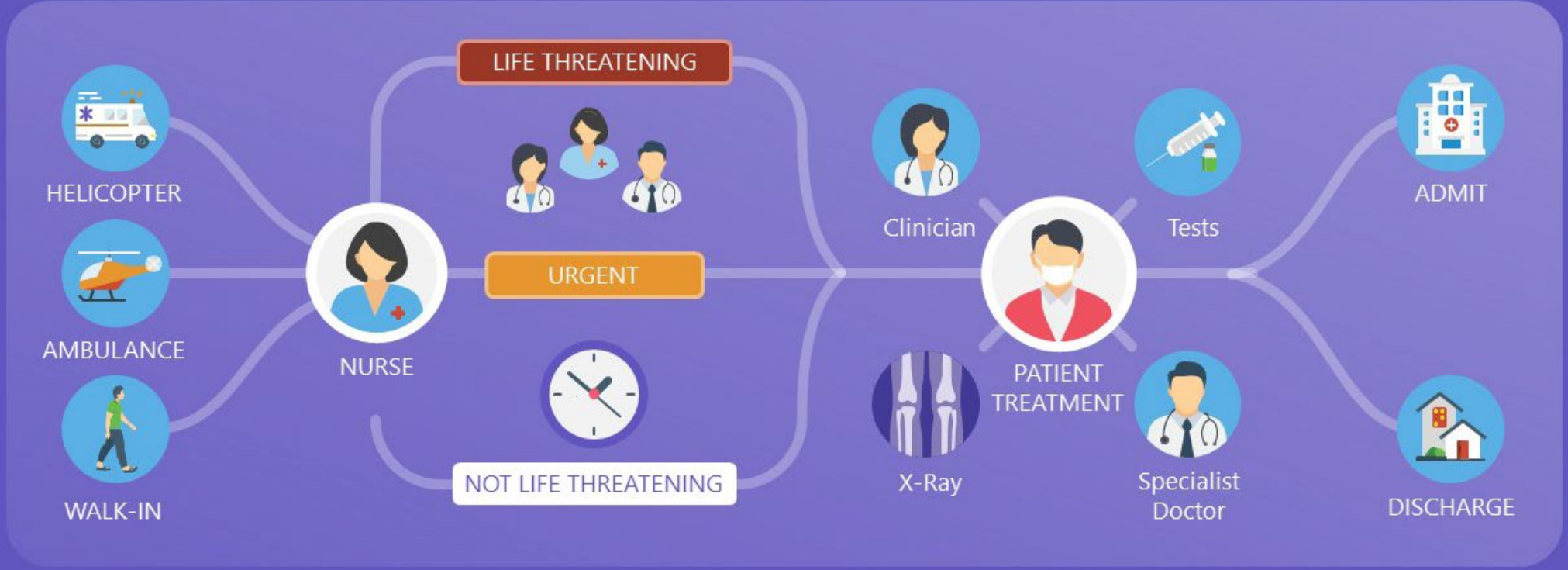
Effect of alternative dosing strategies on sustainable healthcare: A carbon footprint analysis of nivolumab and pembrolizumab treatment in the Netherlands.

Authors: [Ruben Malmberg](#), [Jurrien Loosveld](#), [Hans-Peter Schilte](#), [Roelof W.F. van Leeuwen](#), and [Alex Burdorf](#) | [AUTHORS INFO & AFFILIATIONS](#)

	FDA/EMA Approved Dose	Hybrid Dosing	Reduction in GHG Emissions (% CO ₂ e)
Drug			
Pembrolizumab	Triweekly: 2 mg/kg 200 mg	Triweekly: <65 kg 100 mg ≥65 kg 150 mg*	26.2%**
	Six-weekly: 400 mg	Six-weekly: <65 kg 200 mg 65-90 kg 300 mg ≥90 kg 400 mg	21.4%
Nivolumab	Biweekly: 3 mg/kg 240 mg	Biweekly: 3 mg/kg max. 240 mg***	9.3%**
	Triweekly: 360 mg	Triweekly: 4,5 mg/kg max. 360 mg***	10.7%
	Four-weekly: 480 mg	Four-weekly: 6 mg/kg max. 480 mg***	11.3%

'So, asking the difference in the environmental impact of one medicine versus another is kind of a goofy question when in fact, if I had the vaccine, I don't need either medicine, right. So how do you compare that health outcome or let me take it one step further, if you take better care of yourself, you don't need any of those things.'

(Sustainability Executive, Pharmaceutical Company)



Consider it within the context of the patient care pathway

THANK YOU



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