Investigating the Quantitative Effect of Integrating Environmental Impacts into Economic Evaluations: To What Extent Could Environmental Sustainability Influence Decision Making in Health Technology Assessment?

HTA251

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Objective

To identify published methods for incorporating environmental impacts into economic evaluations and to investigate how this might quantitatively affect cost-effectiveness results and influence HTA decision-making.

Background

- The healthcare sector produces 5% of greenhouse gas emissions globally.[1]
- Accordingly, HTA bodies are increasingly looking to consider environmental impacts associated with new technologies in decision making to promote greater sustainability in healthcare.
- Proposed methods to evaluate the impact of environmental impacts in economic analyses include information conduit, parallel evaluations and multicriteria decision analysis, in addition to integrated assessments, where clinical, economic and environmental data are synthesised in a single quantitative analysis. However, there are currently no standardised methods, and case studies remain scarce.

Methods

- Targeted searches of PubMed, Google Scholar and the ISPOR Presentations Database were conducted in May–June 2024 to identify published methods and case studies for incorporating environmental impacts into economic evaluations of health technologies.
- Studies were identified using key words such as 'health technology assessment', 'economic evaluation' and 'carbon footprint'. The top 25 hits from PubMed and Google Scholar and all relevant hits from the ISPOR Presentations Database for conferences taking place in 2022–2024 were assessed for inclusion. Any articles relevant to the research question were included.
- From the included studies, extracted information included types of environmental impacts quantified, metrics used in quantification, the methods used to integrate these outcomes into economic evaluations, and the impact on cost-effectiveness results, if applicable.

Results

- Of the 14 included studies, eight reported case studies and six proposed methods for integrating environmental impacts into economic evaluations.
- **Table 1** presents details of the eight reported case studies.

Calculation of Carbon Costs

- Types of environmental impacts quantified varied significantly across case studies, including direct emissions (related to technology manufacture, use and disposal) and indirect emissions (related to the impact of the technology on healthcare resource use) (**Table 1**).
- The most common outcome to quantify environmental impacts of health technologies was carbon dioxide equivalents (CO_2e) emissions. The method for converting between carbon and cost varied: three studies used an NHS carbon intensity factor (based on total NHS expenditure and carbon emissions), four used a "social cost of carbon". One case study did not report on methodology.
- Two studies applied different tariffs (low, medium and high) for CO_2e emissions. The proportion of the total cost attributed to carbon emissions increased with higher tariffs applied (**Figure 1**).
- The impact of tariff choice was most influential for inhaler technologies, where carbon costs typically constituted a substantially higher proportion of the total costs (0.1–84.7%) than for non-inhaler technologies (0.0–2.1%) (**Figure 1**).

Incorporation of Sustainability Considerations into ICERs

- Two studies reported incremental cost effectiveness ratios (ICERs) for technologies both with and without the incorporation of environmental impacts, with incorporation of environmental impacts resulting in a 0.3–15.7% change in magnitude of the ICER (**Figure 2**).
- Different tariffs used for carbon costs had minimal influence on the ICERs reported by Henscher (2020) for a non-inhaler technology (antidiabetic medication), with the magnitude of the ICER increasing from 0.3 –3.1% upon application of the lowest and highest tariffs (**Figure 2**).[4]

Novel Decision-Making Metrics and Methodologies

- Kindred (2024) employed novel decision-making metrics, incremental carbon footprint effectiveness/cost ratios (ICFERs/ICFCRs), to incorporate environmental impacts into economic evaluations.[5] The ICFERs/ICFCRs measured the change in cumulative carbon footprint over quality-adjusted life years gained/cumulative costs from baseline.
- Across the six non-case studies identified, proposed methods for integrating environmental impacts into economic evaluations included:[10-15]
  - A fully integrated approach, whereby environmental impact is fully quantified, for example as a modifier to an ICER.
  - Development of a new decision-making framework for technologies that are not expected to improve health-related outcomes, but have the potential to have relative environmental benefits.
  - The aggregation and distribution of environmental impact information provided by manufacturers to HTA bodies in a standardised format.

Conclusion

Evidence regarding the integration of environmental impacts into economic evaluations is limited, but for technologies with a high carbon footprint, such as asthma inhalers, integrating environmental impacts could be highly influential for decision making.

The proportion of the total costs attributed to CO_2e emissions varied significantly by technology and costing method(s), highlighting the need for standardised CO_2e emissions costing in HTA.

TABLE 1

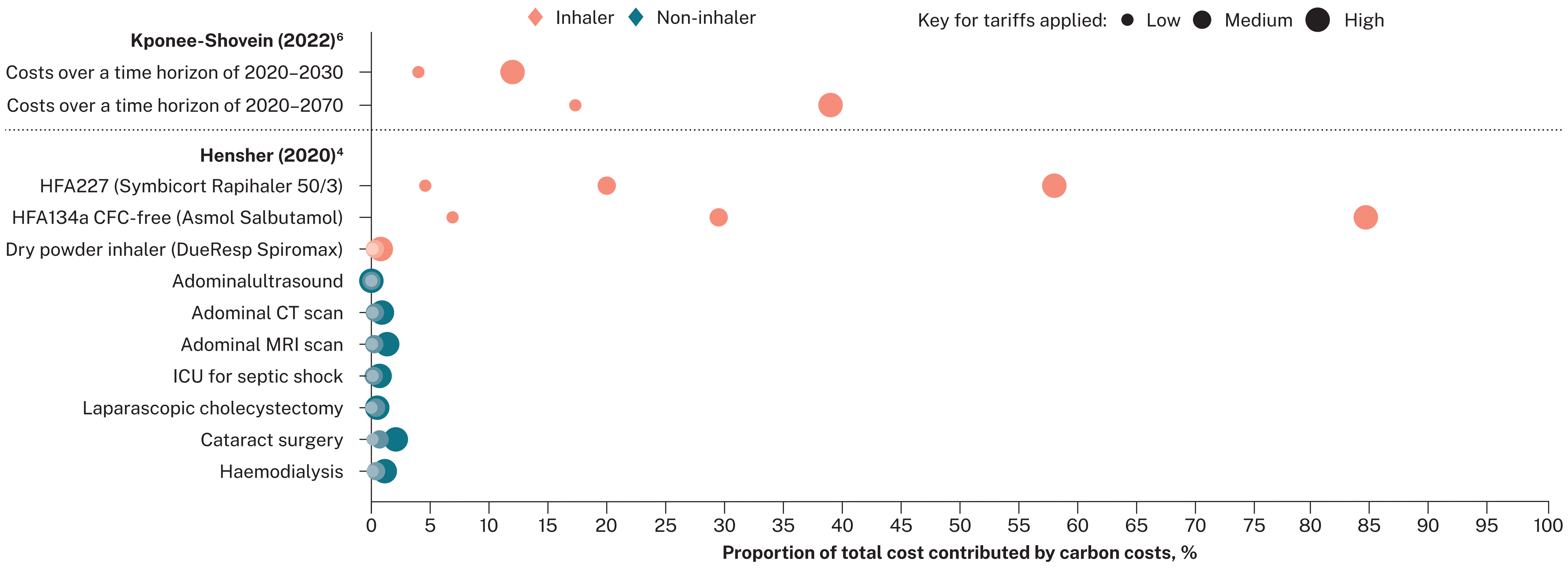
Overview of included case studies

Study name	Disease area	Intervention and comparator	Environmental impacts quantified	Sources/tariffs used for converting between carbon and cost
De Preux & Rizmie (2018)[2]	Chronic kidney failure	ICHD versus HHD and HNHD	Direct and indirect emissions derived from energy use, patient and staff travel, and procurement attributable to the provision of maintenance HD by ICHD and HHD	• Central value of non-traded price of carbon in 2010 (£52 per tonne of CO_2e)
Fordham (2020)[3]	Type 2 diabetes	Improved diabetes control versus unchanged glycemic control	Healthcare resources and services used in the management of type 2 diabetes complications, including building energy, patient travel, medication and equipment	• NHS carbon intensity factor (0.23 kgCO_2e/£)[a]
Henscher (2020)[4]	N/A[b]	N/A[b]	Case studies on diagnostic imaging, hospital care and common inhaler propellant types	• Low scenario: mid-range of current UK guidance for 2020 ($17.24 per tonne of CO_2e) • Mid-range scenario: International Monetary Fund's proposed carbon tax ($75.00 per tonne of CO_2e) • High scenario: upper Canadian guidance for 2050 ($216.07 per tonne of CO_2e)
Kindred (2024)[5]	Obesity	Semaglutide versus bariatric surgery	Bariatric surgery, semaglutide (estimated from information from the drug manufacturer, such as their global sales and carbon footprint and their current drug costs) and treatment of comorbidities	• For bariatric surgery and semaglutide: NR • For comorbidities: NHS carbon intensity factor (0.156 kgCO_2e/£)[a]
Kponee-Shovein (2022)[6]	Asthma	MDIs versus DPIs	Use and disposal of inhaler	• Low scenario: central SCC estimate from the US IWGSCGG • High scenario: high-impact SCC estimate from the US IWGSCGG
Marsh (2016a)[7]	Type 2 diabetes	Insulin in addition to an OAD versus OAD alone	Direct impacts including raw materials consumed, and waste and emissions generated during the manufacturing, distribution, and use of treatment. Indirect impacts, based on the impact of a treatment's health outcomes[c]	• NHS carbon intensity factor (direct impacts: 0.34 kgCO_2e/£; indirect impacts: 0.23 kgCO_2e/£)[a]
Ortsäter (2020)[8]	Respiratory illness	Reusable versus disposable inhalers	Inhaler life cycle including material acquisition and pre-processing, production, distribution and storage, use, and end of life	• SCC derived from three economic climate impact models (€40 per tonne of CO_2)
Siddiqui (2024)[9]	Respiratory illness	pMDIs versus DPIs	NR	NR

[a]Carbon intensity factor represents carbon emissions divided by healthcare expenditure. The carbon intensity factor was used to estimate carbon footprint based on total costs. [b]Henscher (2020) presents secondary analyses of a number of other studies which provide estimates of the carbon footprint of different health services or interventions. [c]Indirect effects including through manufacture, distribution, and use of other treatments and services.

FIGURE 1

The proportion of total costs attributed by carbon costs, by differing CO_2e tariffs

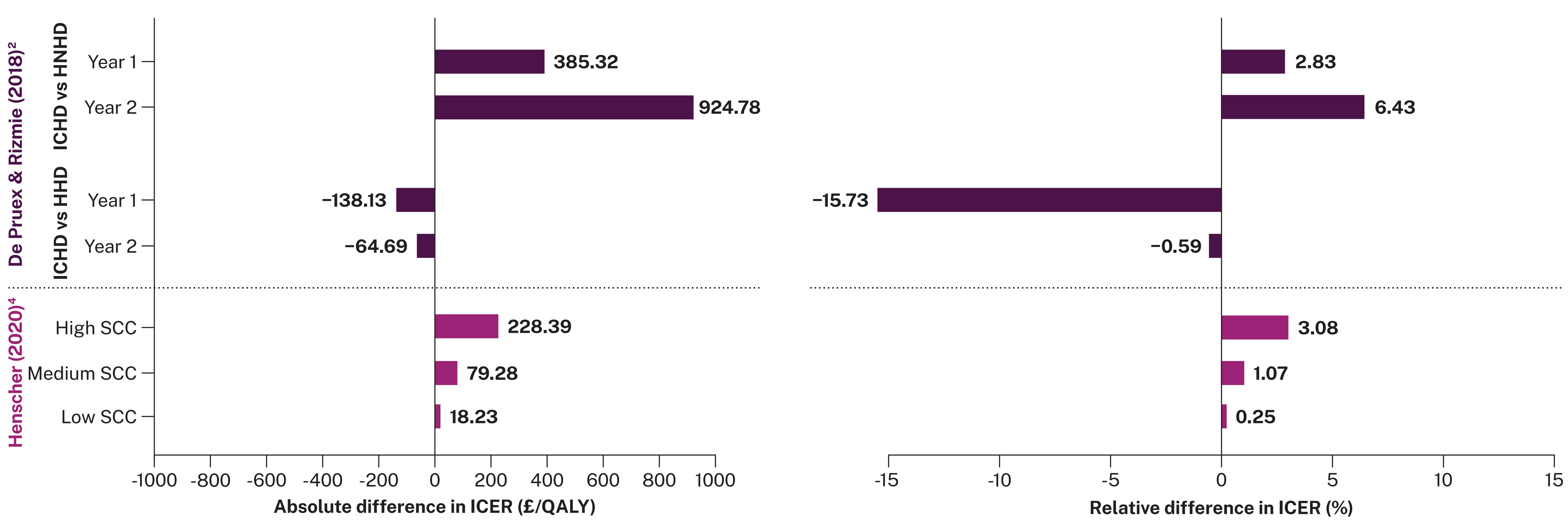


The De Pruex & Rizmie (2018) and Ortsäter (2020) studies also cost CO_2e emissions. However, for brevity, only those studies reporting carbon costs investigating differing CO_2e tariffs are presented. For brevity, results presented from Kponee-Shoevin (2022) are from Scenario A only.

FIGURE 2

Change in magnitude of ICERs when sustainability considerations are incorporated

A. Absolute difference in ICER (£/QALY) **B.** Relative difference in ICER (%)



Abbreviations: **CO_2e:** carbon dioxide equivalent; **CT:** computed tomography; **DPI:** propellant-free dry powder inhalers; **HHD:** home haemodialysis; **HNHD:** home nocturnal haemodialysis; **ICER:** incremental cost-effectiveness ratio; **ICFCR:** incremental carbon footprint cost ratio; **ICFER:** incremental carbon footprint effectiveness ratio; **ICHD:** in-centre haemodialysis; **ICU:** intensive care unit; **IWGSCGG:** interagency working group on the social cost of greenhouse gases; **(p)MDI:** (pressured) metered-dose inhalers; **MRI:** magnetic resonance imaging; **N/A:** not applicable; **NR:** not reported; **OAD:** oral antidiabetic regimen; **SCC:** social cost of carbon; **QALY:** quality-adjusted life year; **UK:** United Kingdom; **US:** United States.

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