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Incorporating Environmental Impacts Into Budget Impact Models: A Case Study of CAR-T Therapies

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Study Objective

Context

Growing interest and reflections in France on the integration of environmental impacts of health care technologies:

> **HAS' health-environment roadmap[1]**

> **Propositions in Social Security Bill[2]**

Objectives

Explore and illustrate how environmental impacts can be:

> **Identified**
> **Quantified**
> **Integrated into** budget impact models (BIMs)

How?
We conducted **a case study comparing CAR-T therapy with conventional chemotherapy** in the French healthcare context.

[1]HAS, Feuille de route santé-environment, 2023. https://has-sante.fr/jcms/p_3475967/fr/la-has-adopte-une-feuille-de-route-sante-environnement
[2]PLFSS 2024. https://www.legifrance.gouv.fr/loda/id/JORFTEXT000048668665

Methods

A targeted literature review was conducted to **identify key frameworks for integrating environmental impacts** into health technology assessments.
➔ We identified the NICE typology,[1] article by Williams et al. (2023)[2], and the French ECOVAMED tool.[3]

A budget impact model was built:
- **To measure financial impact** for the French national health insurance
- **And adapted to incorporate environmental impact** through **transport-related emissions**

We measured and valued transport-related emissions:
- Using **data on travel patterns** (mean distance from hospital depending on therapy[4]) and **standard carbon intensity factors.**[5]
- Emissions were **expressed in kgCO_2-equivalent** and **valued using the official national carbon price**[6] (€83.56/ton).

1.Toolan M, Walpole S, Shah K, et al. Environmental impact assessment in health technology assessment: principles, approaches, and challenges. International Journal of Technology Assessment in Health Care. 2023;39(1):e13. https://doi.org/10.1017/s0266462323000041
2. Williams, Jake T.W. et al. Methods to Include Environmental Impacts in Health Economic Evaluations and Health Technology Assessments: A Scoping Review. https://doi.org/10.1016/j.jval.2024.02.019
3. ECOVAMED. https://www.ecovamed.com
4. Bonastre J, Mobillion V, Or Z, Touré M. L'accès aux soins en cancérologie : évolution de l'offre et recours aux soins entre 2005 et 2012. Questions d'économie de la santé 2017, n°221
5. BPI France https://bigmedia.bpifrance.fr/nos-dossiers/quelle-est-lempreinte-carbone-dune-voiture-electrique-vs-thermique-tout-savoir
6. Journal Officiel https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000048728032.

Results: Methods for Integrating Environmental Impact in HTA From Literature

Results From Published Literature

NICE identified **four approaches to account for environmental impacts in HTA.**[1]

1. **Information Conduit:** republishing information in the public domain or submitted, in a standardized way or as provided
2. **Environment-Focused Evaluation:** environmental impact assessment outside specific evaluation of health economics outcomes
3. **Parallel Evaluation:** specific environmental assessment communicated alongside health economics assessment
4. **Integrated Evaluation:** framework enabling clinical, financial and environmental assessment in a quantitative and synthetic analysis

[1]Toolan M, Walpole S, Shah K, et al. Environmental impact assessment in health technology assessment: principles, approaches, and challenges. International Journal of Technology Assessment in Health Care. 2023;39(1):e13. https://doi.org/10.1017/s0266462323000041

Results: Methods for Integrating Environmental Impact in HTA From Literature

Literature review illustrates those approaches with published evaluations[1]:

Parallel Evaluation

Five methods identified:

- Consideration of environmental impacts **during HTA deliberative decision-making process**
- Calculation of **costs and DALY integrating environmental impact**, with or without synthetic indicator (ICER) computation
- Calculation of an **incremental carbon footprint effectiveness ratio** (Co2-e / efficacy unit)
- Calculation of an **incremental carbon footprint cost ratio** (Co2-e/$)
- **Multi-criteria decision analysis** (MCDA), including environmental impact and other criteria, weighted according to decision-maker preferences to construct a unique quantitative indicator

Integrated Evaluation

Three methods identified:

- Consider **environmental impacts costs** in CEA or CUA
- Include environmental impacts **in health outcomes**
- **Adjust willingness-to-pay thresholds** to reflect environmental impact

[1]Williams, Jake T.W. et al. Methods to Include Environmental Impacts in Health Economic Evaluations and Health Technology Assessments: A Scoping Review. https://doi.org/10.1016/j.jval.2024.02.019

Results: Methods for Integrating Environmental Impact in HTA From Literature

Literature review illustrates those approaches with published evaluations[1]:

Main Impacts Identified

Greenhouse gas emissions

Energy consumption

Water consumption

Waste production

Measures

- 27% of studies bases on **life cycle analyses** (LCA) from raw material extraction, production, usage, to disposal
- A majority of publications (46%) used **carbon footprint estimations** for one or several parts of healthcare product lifecycle
- 25% of publications were based on **published literature** to estimate environmental impact
- One article **converted healthcare costs in carbon footprint** from NHS carbon intensity estimate (0.566 kg CO2-e /£)

[1]Williams, Jake T.W. et al. Methods to Include Environmental Impacts in Health Economic Evaluations and Health Technology Assessments: A Scoping Review. https://doi.org/10.1016/j.jval.2024.02.019

Results: Methods for Integrating Environmental Impact in HTA From Literature

Conclusions From Literature

- **Several methodologies to measure, value, and assess environmental impacts**
- **Which framework to consider for the analysis:**
  - **Perspective**: national, regional?
  - **Life-cycle scope**: from production, usage only, until disposal?
  - **Time horizon**: within product lifecycle, long enough to account for potential environmental consequences?
- **Result criteria:**
  - **Costs, health outcomes, carbon dioxide equivalent?**
  - **Aggregated indicator, ponderations?**
- **How do we choose: health gains or strong environmental value?**

We propose a simple, practical (and limited) **approach using a budget impact model** through a case study estimating **transport-related emissions.**

Results: Case Study

Why considering CAR-T Therapies for the case study?

Innovative treatment approach, archetypal case: one-off injection compared to chronic treatment by chemotherapy.

Eligibility Assessment (27 days)[1]

Adult patient with relapsed or refractory diffuse large B-cell lymphoma (DLBCL)

1. Hematological consultation including several tests to **assess the patient's eligibility for CAR-T therapy**

→ 2. Multidisciplinary meeting to **decide on the patient's eligibility**

→ 3. Eligibility confirmed and **CAR-T therapy prescribed** to the patient

9 days[1]

Pre-Treatment (32 days)[1]

4. Apheresis: collection of T-cells from the patient's blood

4 days[1]

← **5.Bridging therapy**: treatment aimed to stabilize the disease while awaiting the production of CAR-T cells

26 days[1]

← **6. CAR-T cells bag** reception by the hospital **and storage** in liquid nitrogen (< - 150°C)

2 days[1]

← **7. Lymphodepletion:** chemotherapy aimed to create an environment favorable to CAR-T cells by reducing the number of "natural" T lymphocytes

6 days[1]

Treatment and Follow-Up

8. CAR-T cell infusion after thawing of the bag

17 days[1]

→ 9. The patient is **housed near the hospital** for two weeks **to monitor adverse events**

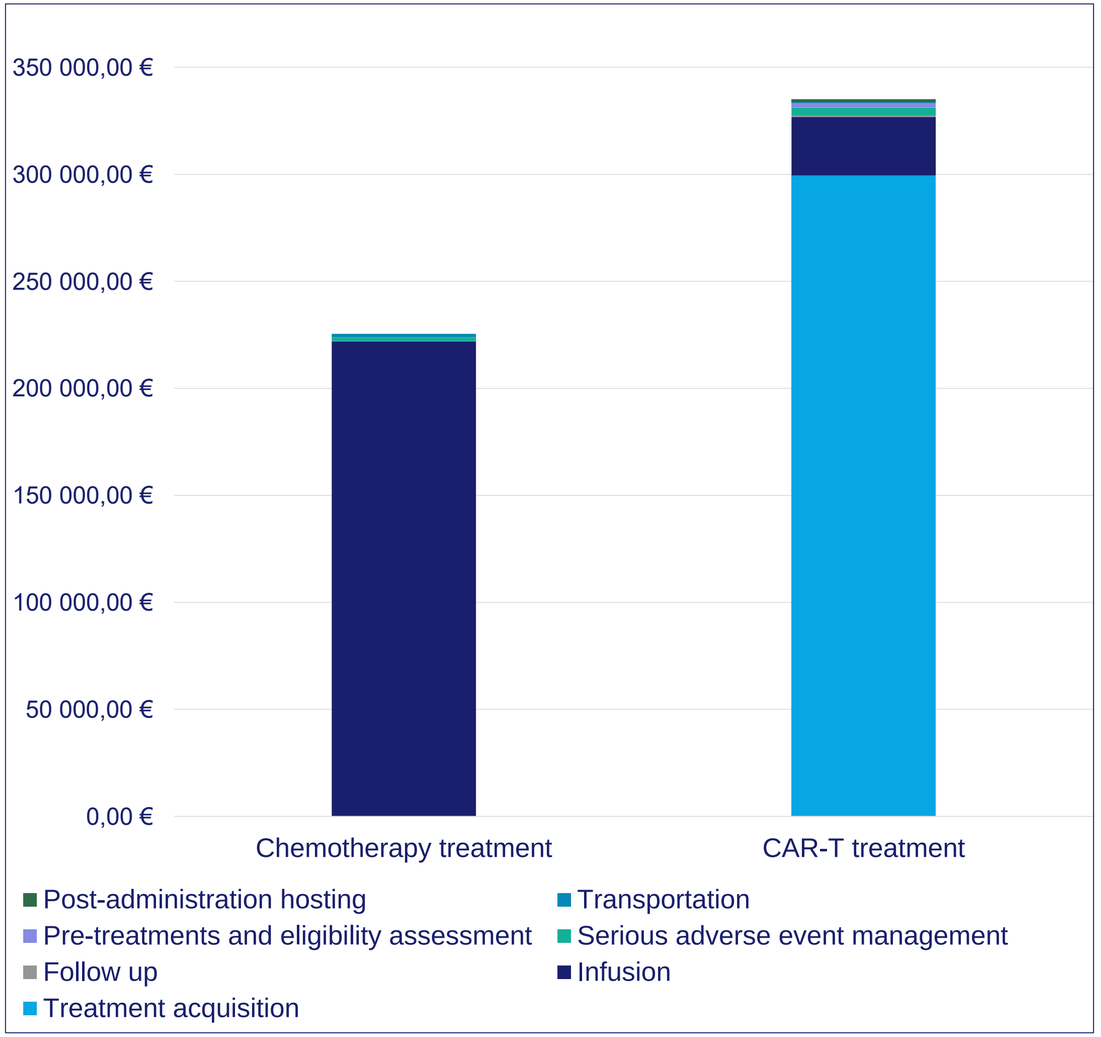
→ **10. Strict patient follow-up** at 1, 3, 6, 9 and 12 months after CAR-T cell administration

Source: [1]IMPA-CT study, «Délais médians des étapes du parcours de soins de YESCARTA»

Results: Standard Budget Impact Estimations

Case study: chemotherapy versus CAR-T for a patient treated over one year.

National Health Insurance Perspective		
Costs	**Chemotherapy treatment**	**CAR-T treatment**
Transportation	€1,515.19	€466.21
Pre-treatments and eligibility assessment	€0.00	€2,082.72
Infusion	€221,871.86*	€27,310.83*
Treatment acquisition	€0.00 (included in infusion cost)	€299,500.00
Serious adverse event management	€2,006.97	€3,674.10
Follow up	€53.08	€778.70
Post-administration hosting	€0.00	€1,200.00
Total	**€225,447.10**	**€335,012.56**



*GHM 17M154 «Lymphomes et autres infections malignes lymphoïdes» ,13 cycles of chemotherapy.*GHM 17M154 «Lymphomes et autres infections malignes lymphoïdes» + supplément «CTC».

Results: Estimating Transport-Related Impact

Case study: chemotherapy versus CAR-T for a patient treated over one year.

National Health Insurance Perspective		
Costs	**Chemotherapy treatment**	**CAR-T treatment**
Transportation	€1,515.19	€466.21
Carbon Emissions	**€10,320.00**	**€7,939 .00**
Pre-treatments and eligibility assessment	€0.00	€2,082.72
Infusion	€221,871.86	€27,310.83
Treatment acquisition	€0.00	€299,500.00
Serious adverse event management	€2,006.97	€3,674.10
Follow up	€53.08	€778.70
Post-administration hosting	€0.00	€1,200.00
Total	**€235,767.10**	**€342,951.56**

Measure:

- Mean distance for **chemotherapy treatment** in France: **25 km**[1]/journey
- **CAR-T** infusion at reference centers: assumption of a doubled distance compared to chemotherapy services[2]: **50 km**/journey

Valuation:

- **Carbon footprint** per km (car) = **190 kgCO2e/km** (BPI France)[3]
- **Monetary valuation**: 83,56 € per ton of CO2[4]

	Chemotherapy	CAR-T
Patient	Anual frequency of administration **13 roundtrip:** 13 x 25 x 2 = **650 km** > **123,500 kgCO2e** > **€10,320**	**4 roundtrip** (eligibility assessment, apheresis, bridging therapy, lymphodepletion & infusion): 4 x 50 km x 2 = **400 km** > **76,000 kgCO2e** > **€6,351**
Caregiver	No specific additional roundtrip considered	At least **1 roundtrip** during infusion: 2 x 50 km = 100km > **19,000 kgCO2e** > **€1,588**
Total	**€10,320 each year**	**€7,939 at infusion only**

Exploratory analysis:

- Using parisian public hospitals' tool[5]

	Chemotherapy	CAR-T
Hospital stay	> **151.12 kgCO2e** > **€12.63**	> **339.82 kgCO2e** > **€28.40**

1 Bonastre J, Mobillion V, Or Z, Touré M. L'accès aux soins en cancérologie : évolution de l'offre et recours aux soins entre 2005 et 2012. Questions d'économie de la santé 2017, n°221. 2 YESCARTA - Avis CEESP du 29 août 2023 https://www.has-sante.fr/upload/docs/application/pdf/2023-11/yescarta_29082023_avis_economique.pdf. 3 BPI France https://bigmedia.bpifrance.fr/nos-dossiers/quelle-est-lempreinte-carbone-dune-voiture-electrique-vs-thermique-tout-savoir. 4 Journal Officiel https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000048728032. 5 Outil Carbone ® https://www.aphp.fr/careboner-un-outil-pour-decarboner-le-soin-mis-la-disposition-de-tous-les-professionnels-de-sante

Conclusions

- Incorporating environmental externalities **change the net budget impact** and highlight **societal costs not captured** in standard models
- Environmental and societal impacts **can differentiate a treatment from its comparators**
- These impacts can **influence health economic outcomes and decision-making**
- This approach should **extend to other lifecycle stages** (e.g., production, distribution, disposal) to derive relevant information
- To document these impacts, **appropriate data collection is key**
- These analyses enable **extending the scope** of budget impact analysis **beyond a payer** perspective (hospitals, healthcare professionals, caregivers…)
- **Broader integration** into BIMs could support more **sustainable health decision-making**, especially as French institutions are reflecting to move toward environmental inclusion in HTA and pricing
- **Standardized guidance will be essential** to ensure comparability and avoid methodological variability

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