INTEGRATING THE CARBON FOOTPRINT INTO ECONOMIC MODELLING IN FRANCE: THE EXAMPLE OF THE HEALTHCARE PATHWAY FOR CHRONIC LYMPHOCYTIC LEUKAEMIA

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CONTEXT

8% Of total greenhouse gas (GHG) emissions in France comes from the healthcare system, equivalent to

50M Tonnes of CO2 equivalent (The Shift Project, 2023) [1]

- Nowadays, the **carbon footprint** of a healthcare product is not included in the health technology assessment (HTA) process in Europe as in France. The European Regulation did not incorporate this environmental criterion in the five non-clinical assessment areas of HTA. However, it will become increasingly important in the decisions taken by health authorities, as the recently published institutional roadmaps suggest.
- This type of study would inform healthcare professionals about their therapeutic choices. For example, it is interesting to compare the carbon footprints of different oncology treatments, which do not necessarily have the same duration or the same mode of administration.

OBJECTIVES

The aim of this research is to assess the feasibility of integrating the carbon footprint indicator into health technology assessments and to illustrate such an approach on the example of the first line chronic lymphocytic leukaemia (CLL) treatments in France.

METHODS

- The various methods of integrating carbon impact into the results of a medico-economic study were analysed through a literature review, which also facilitated the **structural choices** for the modelling (see Figure 1).

FIGURE 1: Structural choices of the cost-carbon model

Patients with symptomatic CLL without TP53 abnormalities and mutated IGHV status

Partitioned survival model with 3 health states (Progression Free Survival, Relapse, Death)

Comparators (First line treatment):
- Ibrutinib + Venetoclax (I+V)
- Fludarabine + Cyclophosphamide + Rituximab (FCR)
- Venetoclax + Obinutuzumab (V+G)
- Ibrutinib monotherapy (I mono)

Time horizon of 3 years
(maximum treatment duration of less than 2 years)

Payer perspective (Health insurance + patients)

Results: Total costs, Total carbon footprint, Incremental cost-carbon ratio

→ **An economic model combining costs and carbon emissions** was developed to compare various healthcare path-ways associated with the different treatment options in first line of chronic lymphocytic leukaemia (CLL).

- In order to estimate the overall carbon footprint of the pathway (see Figure 2), **emission factors** associated with the various activity data were collected (see Table 1).

FIGURE 2: Estimation of carbon footprint

Carbon emissions (Carbon footprint of a health product/pathway) = **Activity data** (€, km, day, unit,...) X **Emission factor** (kgCO2e/activity data)

TABLE 1: Emission factors associated to major source of emissions

Major source of emissions	Emission factor	Unit	Source
Hospital stays	220,40	kgCO2e / hosp. day	AP-HP carbon assessment [2]
Home hospitalisation stays	9,24	kgCO2e / hosp. day	The Shift Project / ADEME [1]
Medical consultations	3,80	kgCO2e / consultation	Coustal thesis, 2023 [3]
Imaging procedures	2,53	kgCO2e / procedure	AP-HP carbon assessment [2]
Transport (to lab)	2,09	kgCO2e / transport	Laville et al., 2016 [4]
Pharmacy consultations	1,20	kgCO2e / consultation	The Shift Project, 2023 [1]
Biological tests	0,19	kgCO2e / test	Spoyalo et al., 2023 [5]
Mailing	0,049	kgCO2e / mailing	La Poste / Quantis [6]

RESULTS

- Total costs are higher for healthcare pathways with I mono and I+V than for FCR, where treatment costs account for a much lower proportion (see Figure 3 and Table 2). Conversely, **when drugs carbon footprint (CF) is not considered in estimating overall emissions**, the estimated carbon footprint of the I mono and I+V pathways is significantly lower than that of the FCR pathway (see Figure 4 and Table 2).

FIGURE 3: Cost drivers breakdown for each healthcare pathway

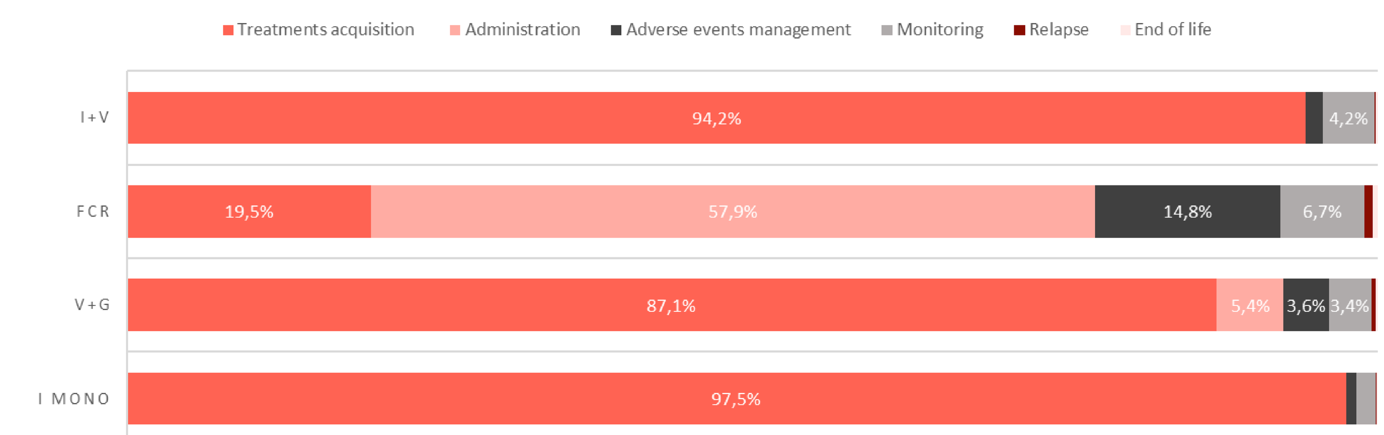

FIGURE 4: Carbon footprint of the different pathways (without drugs CF) for each treatment, in kgCO2e

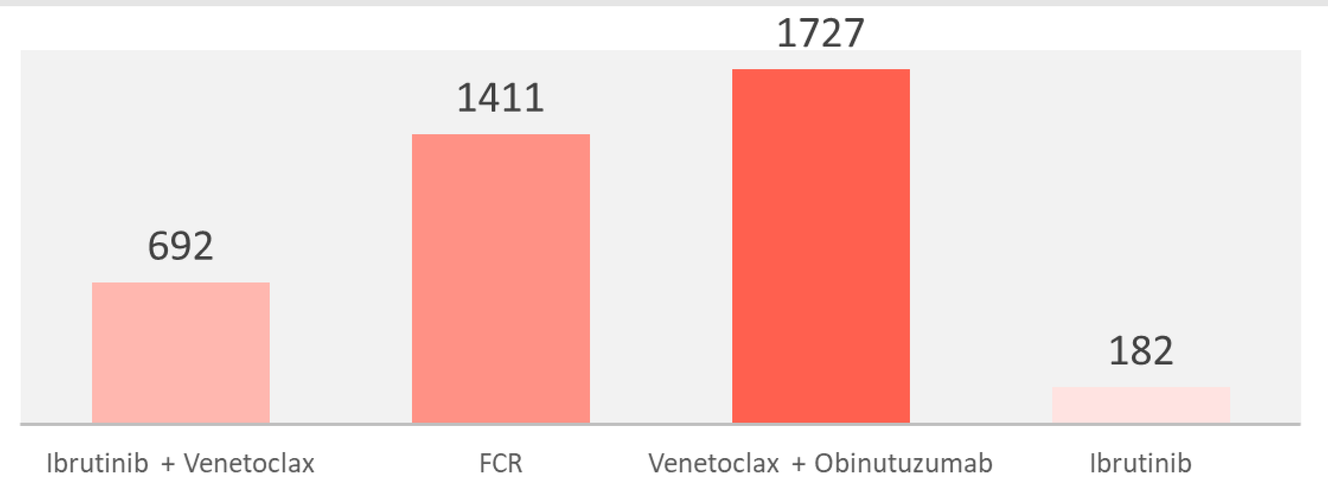

TABLE 2: Disaggregated results in terms of costs, life years and carbon footprint of each pathway (for an average patient over 3 years)

	I+V	FCR	V+G	I mono
Costs (*in proportion to I mono*)	0,68	0,22	0,46	1
Life years	2,72	2,51	2,51	2,72
Carbon footprint (kgCO2e)	692	1411	1727	182

However, drugs contribute to a significant part of to the carbon footprint associated with an overall healthcare pathway. Various estimation methods for estimating the drug emission factor have therefore been explored:

- **Proxy by monetary ratio: 0.5 kgCO2e/euro** → Value based on an average basket of medicines and therefore difficult to apply to a specific treatment [7]
- **Medicine Carbon Footprint method:** Unreliability because methodology doesn't integrate all stages of the life cycle [8]
- **Common method for calculating drugs CF such as Life Cycle Assessment/EcoVamed database/Standardised drugs CF methodology:** Data not yet available [9]

- **To date, without reliable data for estimating the drugs CF, conclusions about the global environmental impact of each pathway are not robust.** The incremental cost-carbon ratio (ICCR), expressed as a cost per unit of CO2 equivalent (CO2e) avoided, is also difficult to interpret.
- **Incorporating the carbon footprint into the usual incremental cost-effectiveness ratio – ICER (with the shadow carbon price or a conversion into QALYs/DALYs lost)** would make it easier to interpret the results, provided that the available data is robust.

DISCUSSION

To date, this study is **one of the first examining** the carbon footprint of an oncology treatment pathway in France.

Drugs CF and drugs costs are the parameters whose associated uncertainty has the strongest impact on the aggregated results. Drugs CF are currently associated with **high degree of uncertainty** or not available. Standard methods and tools that are pragmatic and easy to understand for healthcare decision-makers are therefore required.

Because of the **lack of harmonisation of methods to compare environmental impact of treatment pathways**, even if drugs carbon footprint were available, it remains difficult to benchmark them due to heterogeneity of methods.

New methods are under investigation to calculate aggregated ratios directly including the carbon footprint, but **comparison and interpretability remain limited.** As such, carbon footprint can be estimated independently or integrated in cost-effectiveness analyses, resulting in an alternative ICER easier to interpret.

CONCLUSION

The publication of guidelines on integrating the carbon criterion into health technology assessments and the availability of more comprehensive emission factor data should enable decision-makers to use these models more widely. To date, the development of this type of model can help the various stakeholders gain experience in measuring and considering environmental impacts.

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