

Concept of Health Carbonomics[®]: Measure net carbon emissions associated with new drug vs comparator in terms of patient care pathway for 1/ vaccine administration and 2/ incremental avoided healthcare utilization

Modelling the impact on carbon emissions of using a high dose influenza vaccine instead of standard dose among 65 years and older adults in France

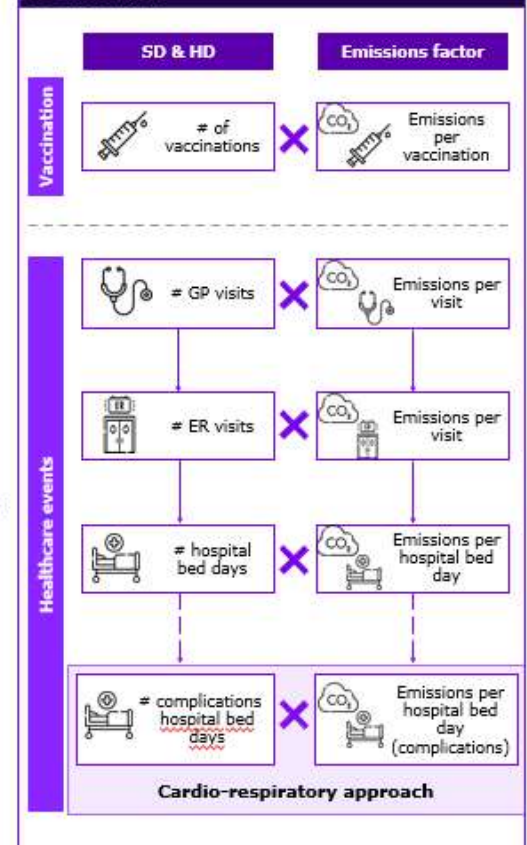
BACKGROUND

- The healthcare sector accounts for **~8% of French carbon emissions**, a large part of which is related to the delivery of care and patient care pathways.
- France's commitment to achieve **carbon neutrality by 2050** implies utilizing **all possible levers** to reduce the carbon footprint of the health sector, as recalled in the New Deal presented in August 2023.
- Seasonal influenza epidemics contribute significantly to the **saturation of the health system** following severe forms and complications developed by the elderly, who are more vulnerable.
- The high-dose (HD) vaccine contains **4 times more antigens** than the standard-dose (SD) influenza vaccine and has been shown to be clinically superior in individuals 65 years of age and older.

METHODS

- This study aimed **to assess the environmental impacts** on the French healthcare system **of using a HD influenza vaccine instead of a SD**, by modelling carbon emissions along the care pathway for adults 65+ in France.
- 2 scenarios** were considered, assuming a **Vaccination Coverage Rate (VCR)** of, **60%** based on flu VCR for 65+ in 2021 and **75%** considering the World Health Organization (WHO) aspirational target.
- 2 approaches** were applied to model the burden of influenza, i) considering hospitalizations for **influenza only**, and ii) including potentially influenza-associated **cardiorespiratory complications**
- The study focuses on carbon emissions related to **3 types of avoided healthcare events: general practitioner (GP) visits, emergency room (ER) visits, and hospitalizations.**
- The avoided health events were calculated using a health economic model and then assigned a **carbon emission factor.**
- French emission factors were used where available or extrapolated from the Tennison et al. study on the carbon footprint of the National Health Service (NHS) and then adjusted by a carbon intensity ratio.
- Due to uncertainty in the emission factors, a sensitivity analysis was conducted
 - **The lower boundary** relies on NHS England emission factors and applies France-UK ratio of carbon intensity of healthcare systems and is time-adjusted.
 - **The Base case** is based on the hospitalization emission factor of the Assistance Publique-Hôpitaux de Paris (AP-HP), whose France-UK ratio was applied to the other factors.
 - **The Upper boundary** adjusted by a ratio based on the emission factor of the Montpellier University Hospital (CHU).
- In the sensitivity analysis, the avoided emissions were compared to the incremental carbon footprint to produce the HD vaccine.

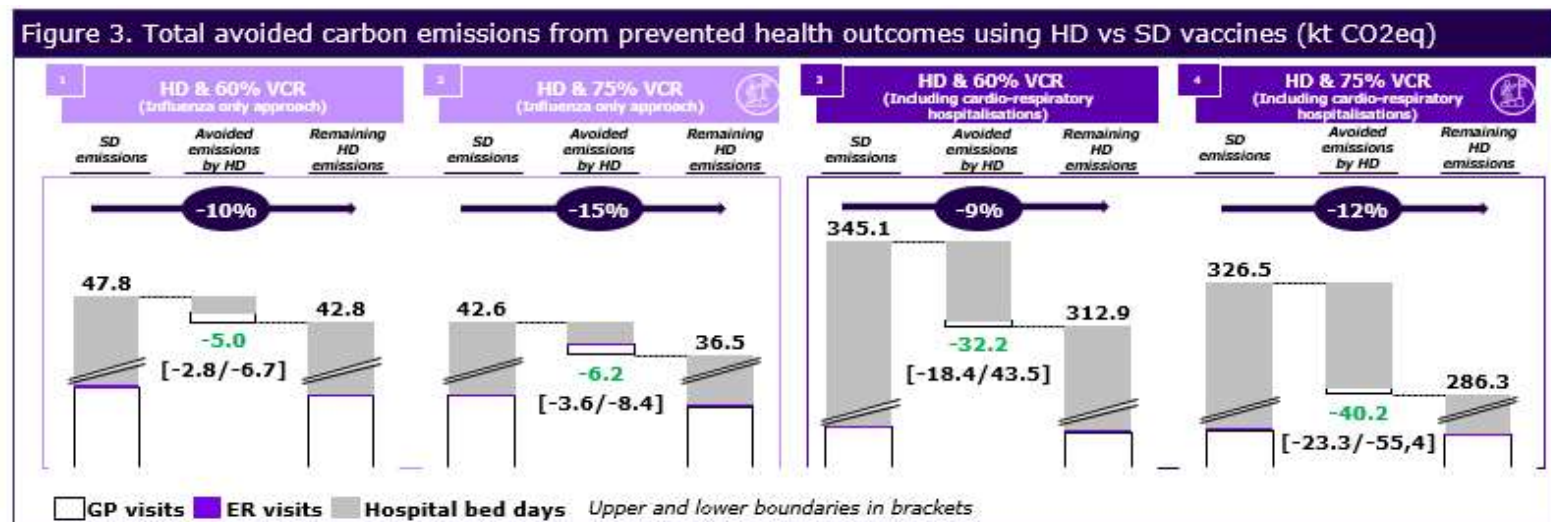
Figure 1. Diagram of the calculation of carbon emissions along the patient care pathway analyzed in the study for HD and SD vaccines



The adoption of a more effective influenza vaccine for populations aged 65 years and older would reduce health sector carbon emissions.

RESULTS

- Regardless of the scenario, substituting the HD vaccine for the SD vaccine avoids a public health burden of ~16-20,000 GP visits and ~400-500 emergency room visits. **The influenza approach would avoid ~2,000 hospital admissions and the cardio-respiratory approach ~20,000 hospital admissions.**
- Considering a **VCR ranging from 60% to 75%**, using the HD vaccine instead of the SD vaccine avoids ~5-6 kilotonnes of carbon dioxide equivalent (**kt CO₂eq**) when considering only hospitalizations for influenza and ~32-40 kt CO₂eq when also considering hospitalizations for **cardiorespiratory complications**.



DISCUSSION

Strengths

- Emissions avoided through the **use of more efficient vaccines are integrated to measure the full impact of immunization campaigns.**
- The results presented include **4 cases to consider influenza-associated complications and to explore different levels of VCR.**
- French data, adapted to the study setting, were used.**
- A **sensitivity analysis carried out on each scenario**

Limitations

- Vaccine effectiveness may vary with seasons.**
- Emission factors have sometimes been **extrapolated from those of the NHS in the UK (England)**. Emission factors are **not specific to influenza or the elderly**.
- The correlation between health system use and carbon emissions **was assumed to be linear since the data do not distinguish between fixed and variable emissions.**