EE629

# Estimating the Carbon Intensity Profile of a Biologic for the Treatment of Chronic Obstructive Pulmonary Disease in the United Kingdom

Megan D'Souza[1], Priscille de la Tour[2], Richard D. A. Hudson[1]

[1]Sanofi, Reading, United Kingdom, [2]Sanofi, Lyon, France

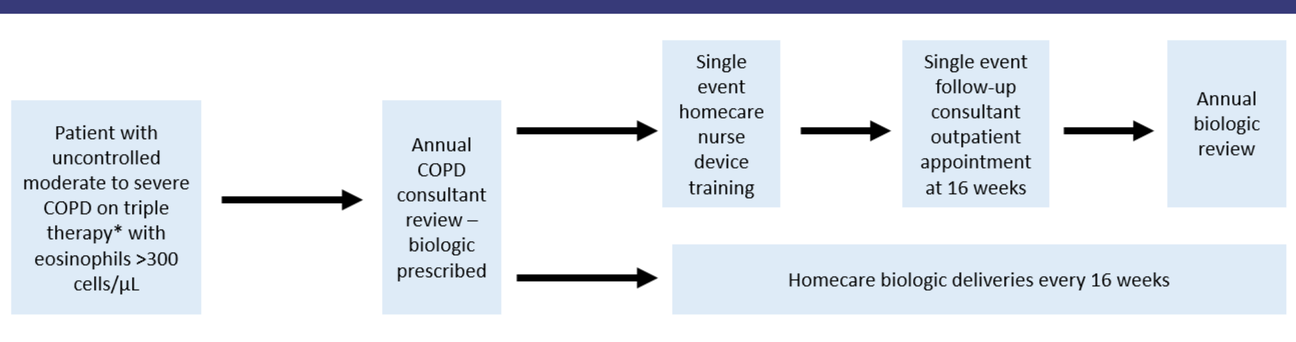
## BACKGROUND

- The National Health Service (NHS) is estimated to produce **~4%** of annual United Kingdom (UK) carbon emissions (1).
- The NHS has committed to achieving **net zero by 2040** for its direct emissions (2).
- There are several biologics in development for the treatment of Chronic Obstructive Pulmonary Disease (COPD), which accounts for **1 in 10** UK emergency hospital admissions (3).
- This study estimates the care pathway **impact** of implementing a **biologic therapy** for COPD (using dupilumab as an exemplar) versus current standard of care on **carbon emissions** due to COPD treatment.

## METHODS

- Based on the **sustainable healthcare coalition methodology**, the care pathway was mapped across four defined areas for dupilumab versus standard of care and validated through internal interviews (Figure 1 and 2)
- The dupilumab eligible population (~ 14,000) was defined as patients who are prescribed **triple therapy***, with a **severe event** in the past 12 months and **eosinophils >300 cells/µL**.
- The base case annual number of moderate and severe exacerbations in the **standard of care arm** was calculated from Whittaker *et al* (5).
- The NOTUS study reported **34%** reduction in exacerbations was applied to calculate the number of moderate and severe exacerbations in the **dupilumab arm** (6).
- A confidence interval of **±20%** was applied to calculate upper and lower boundaries of exacerbations
- **Modelling assumptions** outlined in Table 1 were validated through internal interviews and used to calculate **healthcare resource utilisation** for standard of care versus dupilumab

Figure 1. Pathway for a patient prescribed a biologic for COPD.




*Triple therapy is defined as treatment with an inhaled corticosteroid, long-acting beta agonist and long-acting muscarinic antagonist.

Figure 2. Pathway for a patient with moderate or severe exacerbation of COPD.

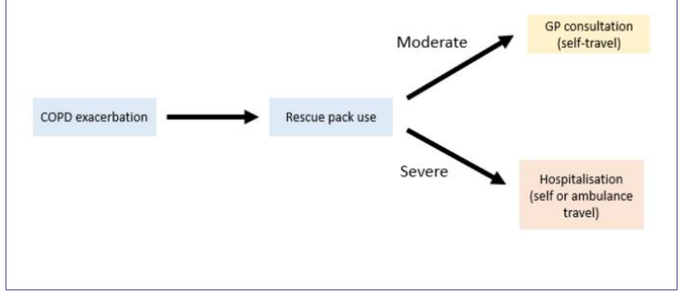


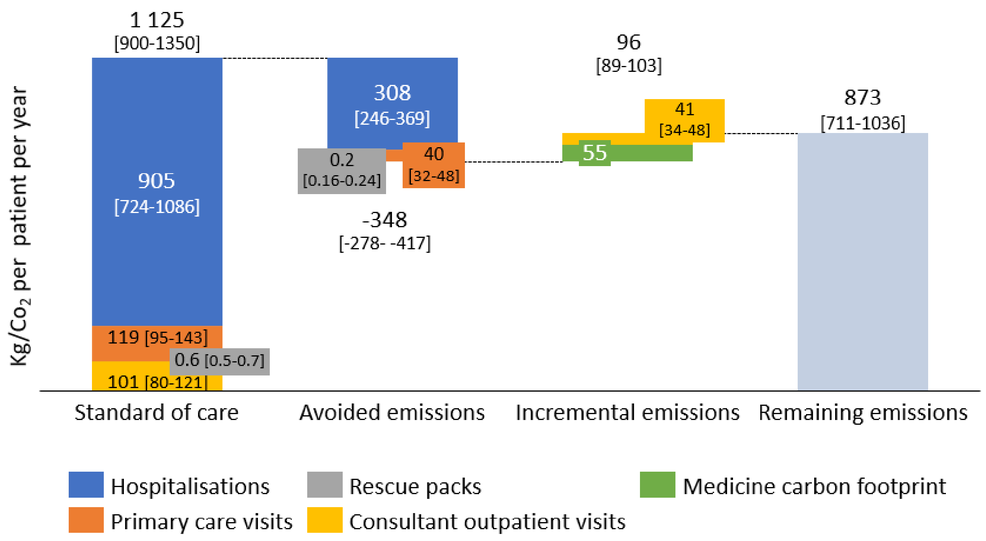

Table 1. Modelling assumptions.

| Assumptions | |
|---|---|
| **Duration** | 12 months is considered as the reference time. |
| **Primary care visits** | 1 primary care visit is assumed per moderate exacerbation. |
| **Hospitalisations** | 1 hospitalisation is assumed per severe exacerbation. |
| **Rescue packs** | Utilisation of 1 rescue pack is assumed per moderate or severe exacerbation. |
| **Consultant outpatient visits** | 1 outpatient follow up visit is assumed per severe exacerbation. 1 outpatient visit is assumed per patient prescribed dupilumab due to the annual biologic review. The 16-week follow-up consultant appointment following dupilumab initiation is excluded from the model as this is a one-off event. |
| **Homecare** | Emissions from homecare are accounted for in the lifecycle assessment for dupilumab. |
| **Nurse visits** | Nurse visits are excluded from the model as this is a one-off event when dupilumab is initially prescribed. |

## RESULTS

The implementation of dupilumab for the treatment of COPD was estimated to result in total annual net carbon savings of **176-329** kg carbon dioxide equivalent ($CO_2e$) per patient, due to reductions in healthcare resource utilisation.

Figure 3. Annual avoided emissions per patient in Kg $CO_2e$ (upper and lower boundaries in brackets)




- **Avoided hospitalisations** alone had the most significant impact on carbon emissions, accounting for **246-369 kg $CO_2e$** annual net carbon savings per patient (Figure 3).
- For the estimated **total patient population**, annual net carbon savings of **2.4-4.5 kt $CO_2e$** were estimated. This is equivalent to **~5,500 return flights** from London to New York (7) or the lifecycle carbon footprint of **~2 million plastic bags** (8). In the healthcare sector, this can be compared with **~30%** of the annual fuel consumption from the **London Ambulance Fleet Service** (9) or the lifecycle carbon footprint of **~120,000 metered dose inhalers** (10).

## DISCUSSION

- The estimated annual base case carbon emissions from the use of dupilumab is **96** kg $CO_2e$ per patient. However, the estimated annual carbon savings of **348** kg $CO_2e$ per patient from reductions in healthcare resource utilisation offset this, resulting in net annual carbon savings of **252** kg $CO_2e$ per patient.
- The majority of avoided emissions come from the reduction in COPD-related healthcare resource use burden, in particular, fewer **hospitalisations**.
  - **Hospitals** are one of the highest GHG emitters within public health settings (11) and COPD accounts for **1 in 10** UK emergency hospitalisations (3). Thus, dupilumab not only offers significant environmental advantages but may also help to release hospital capacity.
- Sanofi is committed to achieving net zero carbon emissions across all scopes by 2045 (12).
  - The dupilumab **lifecycle** was specifically **eco-designed** in 2024 to achieve a 47% reduction in emissions (13).
  - The eco-designed lifecycle has resulted in an additional total annual carbon saving of **~0.7kt $CO_2e$**.
- Pollution and climate change pose a significant threat to public health and may be detrimental to the **quality of life** of patients with respiratory conditions (14)
  - To date, no UK Health Technology Appraisal (**HTA**) has considered the **environmental impact** of therapeutics.
  - The reduction in carbon emissions from novel therapeutics could be expressed in terms of increased **life years saved** or **quality-adjusted life years** (QALYs) and considered in cost-effectiveness evaluations.
- The population considered in this study are those readily identifiable with a **hospitalisation event**. However, dupilumab is licensed in patients with 2 or more moderate COPD exacerbations in the past 12 months, thus, this study may underestimate the carbon benefits of dupilumab.
- This study is limited by the availability of **specific data** regarding emissions associated with the treatment pathways for COPD.
  - Most existing data are either **outdated**, focused on **single healthcare outcomes**, or derived from **local case studies**, which may not be generalisable (4).
  - Future research should aim to fill these gaps by providing more **detailed and current data** on the environmental impact of various treatment pathways. This would enable a more accurate assessment of the environmental benefits of innovative medicines like dupilumab and support their inclusion in cost-effectiveness evaluations.

## CONCLUSIONS

- **The implementation of a biologic for the treatment of COPD may be carbon neutral or carbon saving through reductions in healthcare resource utilisation as a consequence of improved outcomes.**
- **Aligned with the NHS ambition to achieve net zero by 2040 (2) and the impact of climate change on quality of life (15), health authorities should consider the environmental impact of therapeutics as part of the HTA process.**
- **Collaboration across industry, academia and the public sector will be essential for addressing data gaps and establishing industry-wide reporting standards for exploring the environmental benefits of novel therapeutics.**

## REFERENCES

1. Tennison I, et al. 2021. Health care's response to climate change: a carbon footprint assessment of the NHS in England. The Lancet Planetary Health, 5(2):e84-e92.
2. National Health Service. Delivering a net zero NHS [Online]. Available: https://www.england.nhs.uk/greenernhs/a-net-zero-nhs/ [Accessed 17/09 2024].
3. Morton K, et al. 2019. Evaluation of 'care bundles' for patients with chronic obstructive pulmonary disease (COPD): a multisite study in the UK. BMJ Open Respir Res. 2019;6(1):e000425.
4. Coalition for Sustainable Pharmaceuticals and Medical Devices. Care Pathways: Guidance on Appraising Sustainability. 2015 Oct.
5. Whittaker H, et al. 2022. Frequency and Severity of Exacerbations of COPD Associated with Future Risk of Exacerbations and Mortality: A UK Routine Health Care Data Study. Int J Chron Obstruct Pulmon Dis, 17, 427-437.
6. Bhatt S. P. R, et al. 2024. Dupilumab for COPD with Blood Eosinophil Evidence of Type 2 Inflammation. N Engl J Med, 390, 2274-2283.
7. International Civil Aviation Organisation.2023. Carbon emissions calculator. [Online]. Available: https://www.icao.int/environmental-protection/Carbonoffset/Pages/default.aspx. [Accessed: 20/09/2024].
8. Environment agency. 2011. Life cycle assessment of supermarket carrierbags: a review of the bags available in 2006. [Online]. Available: https://www.gov.uk/government/publications/life-cycle-assessment-of-supermarket-carrierbags-a-review-of-the-bags-available-in-2006. [Accessed: 20/09/2024].
9. London Ambulance Service. LAS Carbon Neutral Plan: April 2022 – March 2025. 2021 Dec.
10. Wilkinson A. Inhalers and the environment. [Online]. Available: https://greeninhaler.org/the-problem-with-inhalers/. [Accessed: 20/09/2024].
11. Keil M, et al. 2024. Carbon footprint of healthcare systems: a systematic review of evidence and methods. BMJ Open.14(4):e078464. doi: 10.1136/bmjopen-2023-078464. PMID: 38688670; PMCID: PMC11086491.
12. Sanofi. 2024. Environmental sustainability and resilience. [Online]. Available: https://www.sanofi.com/en/our-company/social-impact/environmental-sustainability-and-resilience [Accessed 20/09/2024].
13. Sanofi 2024. Data on file.
14. Santos UP, et al. 2021. Environmental air pollution: respiratory effects. J Bras Pneumol. 47(1):e20200267. Published 2021 Feb 8. doi:10.36416/1806-3756/e20200267

## DISCLOSURES & CONTACT

MD, RH and PT are employees of Sanofi and may hold shares or stock options in the company. The authors report no other conflicts of interest in this work. This work was funded by Sanofi. Dupilumab has been developed and commercialized in partnership between Regeneron and Sanofi.
Name: Megan D'Souza
Job Title: Health outcomes and pricing analyst, Sanofi UK and Ireland
Email: megan.dsouza@sanofi.com