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Incorporating Environmental Sustainability Into Health Technology Assessments: Two Adapted Cost-Utility Analyses of Insulin Icodec versus Degludec for Type 2 Diabetes Management in England

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As sustainability gains prominence, incorporating the environmental impact of healthcare interventions into HE modeling becomes key to shaping future healthcare practices that promote both long-term patient outcomes and environmental health

Initiating icodec results in carbon savings of

4,1% improvement in ICER*

533,5 kgCO2e/QALY gained*

In comparison to the chosen comparator.

Aim

- The growing interest from HTA bodies in including environmental sustainability in HE modeling is evident, yet the lack of a methodological framework is impeding progress. Icodec, the first once-weekly basal insulin that reduces the number of injections from seven to one per week, offers an opportunity for assessing EI in HE modelling. This study proposes two methods for evaluating this EI through a CUA.

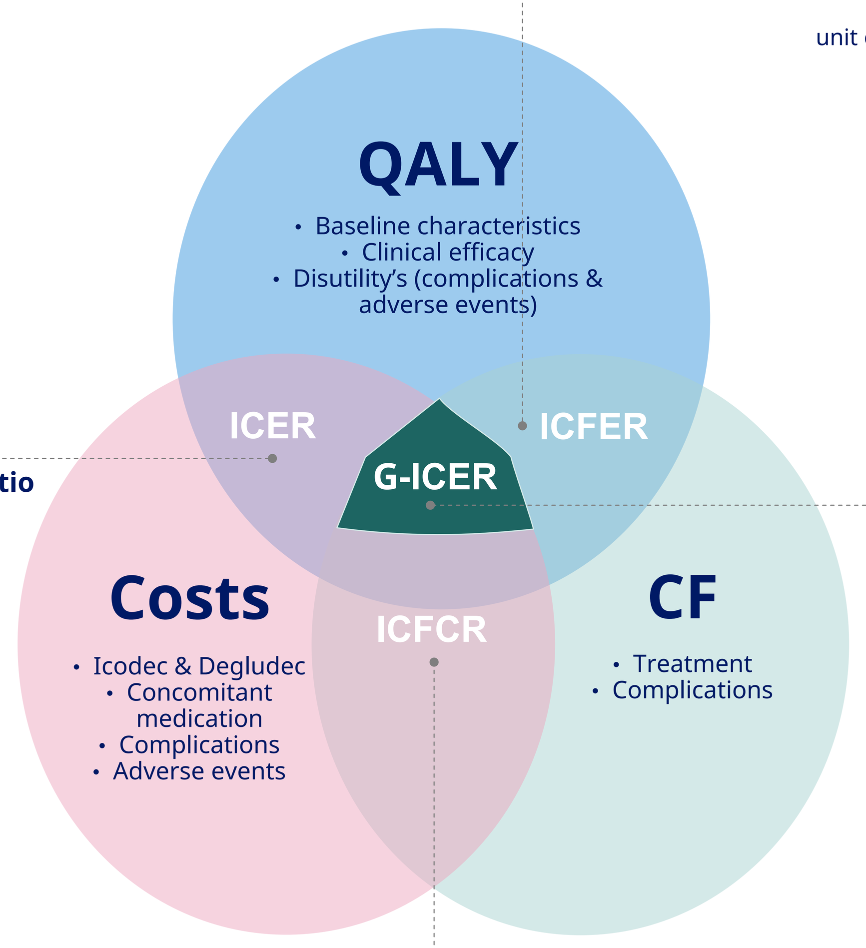
Methodology

- The long-term EI of icodec, compared to degludec (a once-daily basal insulin using a similar pen-injector), was assessed through two adapted CUAs using the PRIME T2D model, incorporating CO2e emissions. This study analysed two T2D populations, insulin-naïve and insulin-switch, derived from clinical trials, over a 60-year time horizon using the NHS perspective. The key metrics employed in the analysis are presented in *Figure 1.*
- The first method showcased the environmental benefits of icodec through an integrated CUA, in which CO2e emissions were monetized and incorporated into the overall cost alongside traditional cost parameters. This adaptation led to the creation of a modified measure termed Green Incremental Cost-Effectiveness Ratio (G-ICER), expressed in £ per QALY gained.
- The second method involved a parallel approach focused on EI, using two new metrics derived from the literature: the Incremental Carbon Footprint Effectiveness Ratio (ICFER) expressed in kgCO2e per QALY gained, and the Incremental Carbon Footprint Cost Ratio (ICFCR) expressed in kgCO2e per £ spent. [1-3]

Key methods

Incremental Carbon Footprint Effectiveness Ratio (ICFER) [1]
The environmental impact per unit of health outcome (kgCO2e/QALY gained)

$$ICFER = \frac{\Delta\, CF}{\Delta\, Effectiveness} = \frac{CF\ icodec - CF\ degludec}{QALY\ icodec - QALY\ degludec}$$



Incremental Cost Effectiveness Ratio (ICER)
Cost per QALY gained (£/QALY gained)

$$ICER = \frac{\Delta\, Costs}{\Delta\, Effectiveness} = \frac{Costs\ icodec - Costs\ degludec}{QALY\ icodec - QALY\ degludec}$$

Green Incremental Cost Effectiveness Ratio (G-ICER) [1]
Cost per QALY gained (£/QALY gained)

$$G - ICER = \frac{\Delta(Costs + CF\ costs)}{\Delta\, Effectiveness} = \frac{(Cost\ icodec + CF\ costs\ icodec) - (Cost\ degludec + CF\ costs\ degludec)}{QALY\ icodec - QALY\ degludec}$$

Incremental Carbon Footprint Cost Ratio (ICFCR) [1]
The environmental impact per unit of cost (kgCO2e/£ spent)

$$ICFCR = \frac{\Delta\, CF}{\Delta\, Costs} = \frac{CF\ icodec - CF\ degludec}{Costs\ icodec - Costs\ degludec}$$

Figure 1: *Primary metrics.*
To gather these metrics, data on the carbon footprint of the two interventions, including the API, device, and needle, was obtained from a life cycle assessment. In contrast, the carbon footprint of self-monitoring blood glucose strips, concomitant medications, and diabetes-related complications was estimated using a carbon intensity factor within a cost-based approach. The CO2e emissions were monetized in accordance with the UK government's carbon valuation guidance, which sets the carbon valuation at £256 per ton of CO2e.[2,3] CF: Carbon Footprint; Costs: Traditional healthcare costs; G-ICER: Green Incremental Cost Effectiveness Ratio; QALY: Quality-Adjusted Life Years; [1]: Kindred et al. (2024).

Results

- Both initiating and switching to an icodec regimen was associated with carbon footprint savings compared to a degludec regimen, as seen in *Figure 2*.
- The integrated approach improved cost-effectiveness, lowering the ICER by 4,1% for the insulin-naïve population and 7,8% for the insulin-switch population, compared to the baseline traditional CUA.
- The parallel approach demonstrated that initiating an icodec regimen resulted in an ICFER of -533,48 kgCO2e per QALY gained (equivalent to a CO2 reduction comparable to that of a round-trip economy-class flight from Copenhagen to Barcelona per QALY gained). Additionally, with an ICFCR of 0,4 kgCO2e per £ spent compared to a degludec regimen, the icodec regimen demonstrated dominance over degludec.

Key results

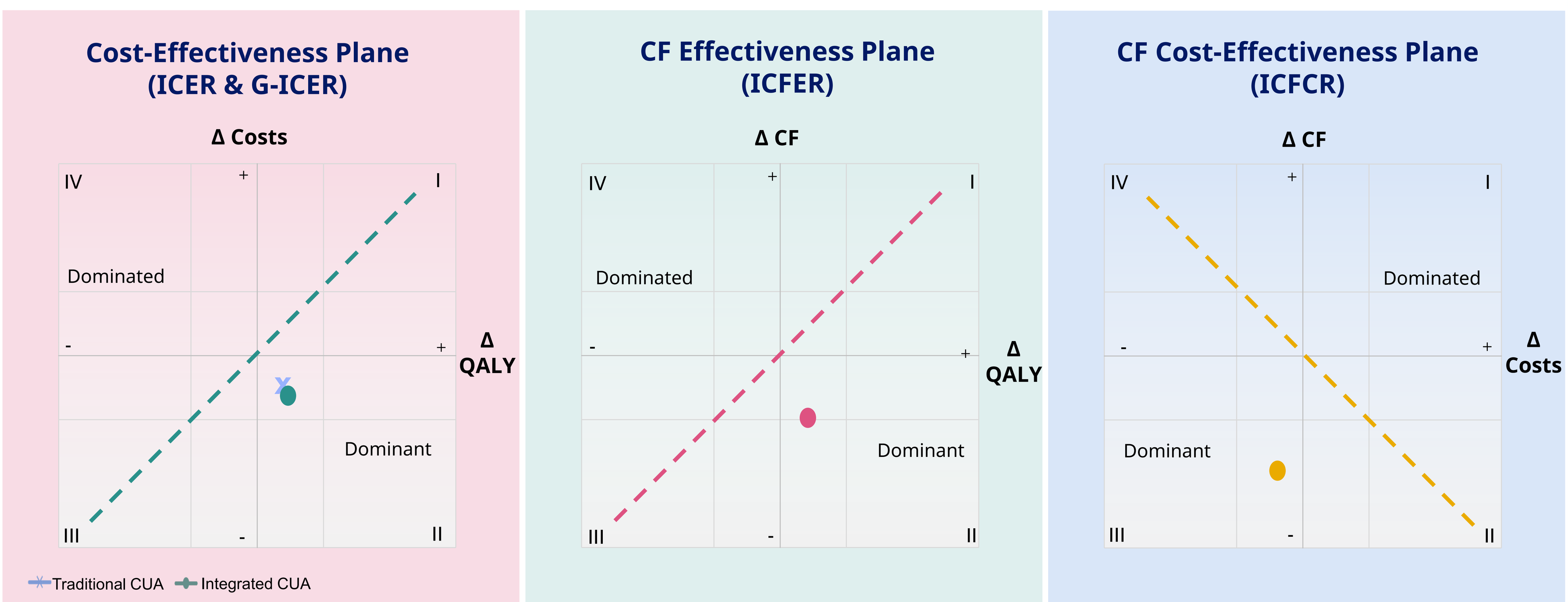


Figure 2: *Effectiveness planes. A. Classic Cost-Effectiveness. Plane. B. & C. Environmental Effectiveness Planes. The effectiveness planes highlight icodec´s dominance in both the traditional and adapted analyses. CF: Carbon Footprint; CUA: Cost-Utility Analysis; G-ICER: Green Incremental Cost-Effectiveness Ratio; ICER: Incremental Cost-Effectiveness Ratio; ICFCR: Incremental Carbon Footprint Cost Ratio; ICFER: Incremental Carbon Footprint Effectiveness Ratio.*

Discussion

- The incorporation of new metrics in this study reflects an evolution in health economic evaluations by combining health and environmental outcomes, thereby challenging traditional interpretations that focus solely on cost-per-QALY or clinical benefits.
- Accurate carbon footprint assessments rely on comprehensive life cycle assessments, and achieving consensus among stakeholders on the valuation of environmental impacts within economic models would greatly facilitate future comparisons across different technologies and companies.

Conclusion

- The findings demonstrate that icodec offers cost-effective and carbon footprint-reducing benefits compared to degludec, thus advancing T2D treatments towards a more sustainable direction. The methodology employed in this study proposes a comprehensive framework where EI is incorporated within existing HE modelling tools, capturing a broader societal implications of healthcare technologies.

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Abbreviations: *CF: Carbon Footprint; CO2e: Carbon Dioxide Equivalent; CUA: Cost Utility Analysis; EI: Environmental Impact; G-ICER: Green Incremental Cost Effectiveness Ratio; HE: Health Economics; HTA: Health Technology Assessment; ICFER: Incremental Carbon Footprint Effectiveness Ratio; ICER: Incremental Cost-Effectiveness Ratio; ICFCR: Incremental Carbon Footprint Cost Ratio; NHS: National Health Service; T2D: Type 2 Diabetes.*

References: *(**1**) Kindred, Max, et al. 'Exploratory Approach to Incorporating Carbon Footprint in Health Technology Assessment (HTA) Modelling: Cost-Effectiveness Analysis of Health Interventions in the United Kingdom'. Applied Health Economics and Health Policy, vol. 22, no. 1, Jan. 2024, pp. 49–60. PubMed, https://doi.org/10,1007/s40258-023-00839-z.; (**2**) I, Tennison, et al. 'Health Care's Response to Climate Change: A Carbon Footprint Assessment of the NHS in England'. The Lancet. Planetary Health, vol. 5, no. 2, Feb. 2021. pubmed.ncbi.nlm.nih.gov, https://doi.org/10,1016/S2542-5196(20)30271-0. (**3**) 'Valuation of Greenhouse Gas Emissions: For Policy Appraisal and Evaluation'. GOV.UK, https://www.gov.uk/government/publications/valuing-greenhouse-gas-emissions-in-policy-appraisal/valuation-of-greenhouse-gas-emissions-for-policy-appraisal-and-evaluation.*