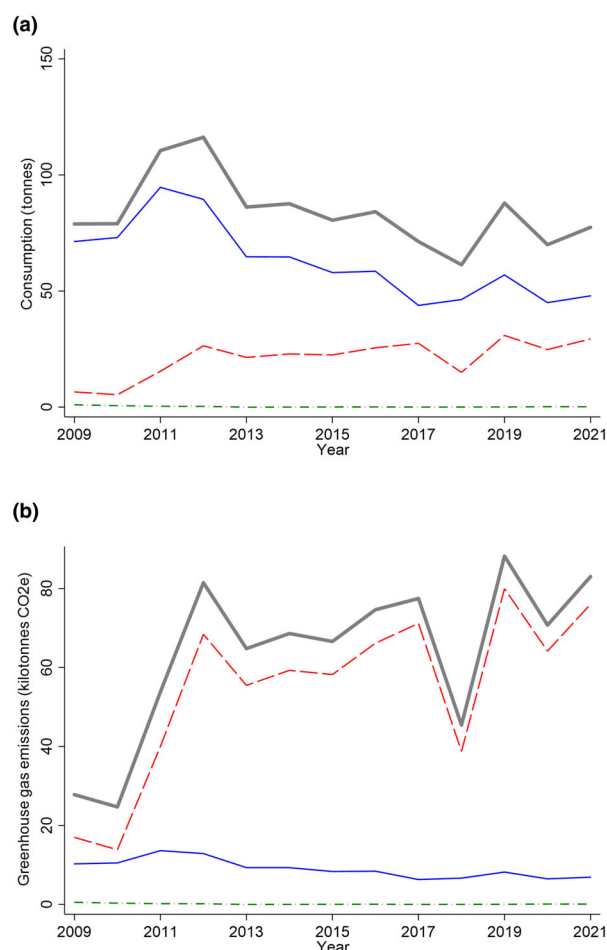


## Science Letter

# Use of halogenated anaesthetics in Italy and their associated carbon footprint: a country-wide study

Desflurane has a high global warming potential when compared with other halogenated anaesthetics such as sevoflurane. For this reason, the World Federation of Societies of Anaesthesiologists (WFSA) issued guidelines to encourage the substitution of this gas with alternative options that have a lesser environmental impact, including the use of total intravenous anaesthesia (TIVA) [1]. Over the past few months, Scotland, Ireland and England have announced their commitment towards the rapid decommissioning of desflurane and the European Commission is currently discussing whether to prohibit or impose severe restrictions on its use from 2026 onwards [2, 3]. However, the proposal has been met with concerns from various scientific societies of anaesthesia and individuals [4]. Indeed, it is still unclear what portion of the carbon footprint of anaesthetics can be specifically attributed to the use of desflurane. This limitation arises from the fact that most existing studies on the carbon footprint of healthcare systems rely on environmentally extended economic input–output models, which do not consider the actual consumption of anaesthetic gases for their calculations [5]. In the present study, we filled this gap using drug consumption data from Italy to estimate greenhouse gas emissions associated with the use of different anaesthetic gases.

The Italian Medicine Agency periodically collects information from all regions on the consumption of drugs used in public healthcare. We extracted these data for the period 2009–2021 and applied the global warming potential proposed by Sulbaek Andersen et al. [5] to calculate greenhouse gas emissions associated with the use of halogenated agents (i.e. desflurane, isoflurane and sevoflurane) in Italy. We found there has been a significant decline in the consumption of sevoflurane over time, although it is still the predominant gas employed (Fig. 1a). In contrast, desflurane has gained popularity. The use of isoflurane is negligible. Figure 1b shows that desflurane is responsible for over 90% of greenhouse gas emissions associated with the use of halogenated agents. At a regional level, our analysis showed a substantial heterogeneity in the usage patterns of anaesthetics (online Supporting



**Figure 1** Consumption of different types of (a) halogenated anaesthetics in Italy and (b) associated greenhouse emissions. Green, isoflurane; red, desflurane; blue, sevoflurane; grey, total.

Information Figure S1). A variation of three to four times in the overall consumption of halogenated agents was observed among the Italian regions. The contribution of desflurane to the overall consumption of halogenated agents ranged between 5% and 50% in the different regions. These differences translated into a 25-fold difference in emissions per capita among the Italian regions (online Supporting Information Figure S2).

Desflurane currently plays a major role in greenhouse gas emissions related to halogenated agents, at least in Italy. Although desflurane may have possible advantages in certain situations (e.g. obese and older patients, or prolonged anaesthesia), its environmental effects should be carefully considered. Despite the significant emphasis in recent years on the potential to substitute desflurane with sevoflurane or TIVA without any adverse clinical effects on patients, the observed variation in desflurane usage across the Italian regions suggests that these recommendations have been inconsistently implemented. This also underlines that there is room for a substantial reduction in the use of this gas while delivering high-quality care. Replicating this study in other countries could be useful to inform future policies on this subject.

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## Supporting Information

Additional supporting information may be found online via the journal website.

**Figure S1.** Variation in the overall consumption of halogenated agents and contribution of desflurane in Italian regions.

**Figure S2.** Greenhouse emissions per capita associated with halogenated anaesthetics in Italian regions.