

# The carbon footprint of Australian health care

Arunima Malik, Manfred Lenzen, Scott McAlister, Forbes McGain



## Summary

**Background** Carbon footprints stemming from health care have been found to be variable, from 3% of the total national CO<sub>2</sub> equivalent (CO<sub>2</sub>e) emissions in England to 10% of the national CO<sub>2</sub>e emissions in the USA. We aimed to measure the carbon footprint of Australia's health-care system.

**Methods** We did an observational economic input–output lifecycle assessment of Australia's health-care system. All expenditure data were obtained from the 15 sectors of the Australian Institute of Health and Welfare for the financial year 2014–15. The Australian Industrial Ecology Virtual Laboratory (IELab) data were used to obtain CO<sub>2</sub>e emissions per AUSS spent on health care.

**Findings** In 2014–15 Australia spent \$161.6 billion on health care that led to CO<sub>2</sub>e emissions of about 35 772 (68% CI 25 398–46 146) kilotonnes. Australia's total CO<sub>2</sub>e emissions in 2014–15 were 494 930 kilotonnes, thus health care represented 35 772 (7%) of 494 930 kilotonnes total CO<sub>2</sub>e emissions in Australia. The five most important sectors within health care in decreasing order of total CO<sub>2</sub>e emissions were: public hospitals (12 295 [34%] of 35 772 kilotonnes CO<sub>2</sub>e), private hospitals (3635 kilotonnes [10%]), other medications (3347 kilotonnes [9%]), benefit-paid drugs (3257 kilotonnes [9%]), and capital expenditure for buildings (2776 kilotonnes [8%]).

**Interpretation** The carbon footprint attributed to health care was 7% of Australia's total; with hospitals and pharmaceuticals the major contributors. We quantified Australian carbon footprint attributed to health care and identified health-care sectors that could be ameliorated. Our results suggest the need for carbon-efficient procedures, including greater public health measures, to lower the impact of health-care services on the environment.

**Funding** None.

**Copyright** © The Author(s). Published by Elsevier Ltd. This is an Open Access article under the CC BY 4.0 license.

## Introduction

The health effects of climate change are becoming increasingly important, with more frequent direct effects such as heat stress and fires, water inundations, and storms, and indirect effects including malnutrition from crop failures, and altered infectious disease patterns.<sup>1</sup> Health care itself has been shown to contribute to climate change.<sup>2,3</sup> In particular, hospitals are highly energy intensive, consume large amounts of resources, and produce a large amount of waste.<sup>4</sup> There are personal, financial, and environmental benefits from reducing our reliance on hospital-based health care and improving availability of public health. For example, personal health benefits arise from more frequent exercise, reduced obesity, the consumption of more plant-based foods, and reduced smoking and alcohol intake. Such personal benefits give rise to environmental co-benefits through reduced car use, fewer methane-producing ruminants, and fewer hospital admissions from chronic ill health.<sup>4,5</sup>

Environmental footprinting of health-care activities is becoming more common; particularly through the use of lifecycle assessment (LCA), a tool for quantifying environmental effects.<sup>6–8</sup> A carbon footprint is measured in terms of the equivalent global warming potential of CO<sub>2</sub> over a 100-year period. These CO<sub>2</sub> equivalent (CO<sub>2</sub>e) emissions include the effects of greenhouse gases such as CH<sub>4</sub> and N<sub>2</sub>O, which have emissions that are seemingly

equivalent to varying CO<sub>2</sub>e emissions. In 2008, health care in the USA contributed to 8% of that country's entire carbon footprint,<sup>9</sup> which was updated in 2016 to 10%,<sup>2</sup> whereas in 2012, England reported a more modest 4% of their CO<sub>2</sub>e emissions being attributed to health care.<sup>3</sup>

In Australia, no such national carbon footprint (CO<sub>2</sub>e emissions) study of health care has been done to date. Knowledge of the carbon footprint attributed to health care would indicate the magnitude of this concern, identifying potential hotspots that might allow a more targeted approach to reducing CO<sub>2</sub>e emissions in a world that is producing increasing amounts of carbon. Furthermore, a top down knowledge of the total carbon footprint of Australian health care will give perspective to efforts to reduce CO<sub>2</sub>e emissions that stem from specific activities in health care (ie, the Australian ambulance service<sup>10</sup> and operating theatres<sup>9</sup>).

We had two aims. First, we asked what the total CO<sub>2</sub>e emissions were that arose from the actions of Australian health care in a single year (April, 2014–March, 2015) and what these were as a proportion of the entire Australian economy. Second, we asked what the CO<sub>2</sub>e emissions were that arose from subsets of Australian health care. We examined the 15 Australian Institute of Health and Welfare (AIHW) categories including public and private hospitals, primary health care (general practitioners), medicines, and patient transport.

*Lancet Planet Health* 2018;  
2: e27–35

See [Comment](#) page e8

Integrated Sustainability Analysis, School of Physics (A Malik PhD, Prof M Lenzen PhD), and School of Public Health (F McGain PhD), University of Sydney, Sydney, NSW, Australia; Ecoquantum Life Cycle Assessment, Melbourne, VIC, Australia (S McAlister MEngSci); and Departments of Anaesthesia and Intensive Care, Western Health, Footscray, VIC, Australia (F McGain)

Correspondence to  
Dr Forbes McGain, Departments of Anaesthesia and Intensive Care, Western Health, Footscray, VIC 3011, Australia  
[forbes.mcgain@wh.org.au](mailto:forbes.mcgain@wh.org.au)

### Research in context

#### Evidence before this study

Climate change is an existential threat to planetary health. The carbon footprint attributed to health care (CO<sub>2</sub> emissions) is large in the USA and the UK where it has been systematically studied. The USA's health-care system contributes to about 10% of the total US carbon footprint, whereas in the UK, health care is responsible for 4% of national UK CO<sub>2</sub> emissions. We searched the PubMed and Engineering Village databases from Jan 1, 1990, to June 1, 2017 using the terms "health care", "greenhouse emissions", "climate change", "life cycle assessment", "input output", and "environment". All article types and languages were included. We found no evidence of other lifecycle assessments of health-care systems.

Carbon emissions are classified as direct (emanating directly from energy used within an economic sector, eg, onsite natural gas use) and indirect (electricity generation elsewhere, plastics and drug manufacture). To begin the transition towards a lower carbon economy, each nation will require data about the contributions of different economic sectors to the total CO<sub>2</sub> emissions. Because climate change is ultimately a health problem, knowledge about the contributions of health care to the carbon footprint is becoming more useful. Furthermore, there might be substantial differences in the carbon footprint of different health-care systems. Finally, although Australia has a

relatively small population, Australia has one of the highest CO<sub>2</sub> emissions per person in the world.

#### Added value of this study

We found that the carbon footprint attributed to health care was 7% of Australia's total; that is, similar to the entire carbon emissions of all activities associated with 7% of Australians (eg, all people in the state of South Australia). Hospitals and the pharmaceutical industry were together responsible for two-thirds of the carbon footprint associated with health care in Australia. 90% of the carbon footprint stemmed from indirect CO<sub>2</sub> emissions due to purchases between multiple different economic sectors that fed into the health-care sector.

#### Implications of all of the available evidence

Our study indicates that health care contributes considerably to Australia's total carbon footprint and identifies the major contributors that could be ameliorated. Although at the federal government level, Australia has annulled a national carbon emissions trading scheme, several Australian states have programmes in place to achieve carbon neutral status by 2050. However, without data such as those we have now provided, these carbon neutral aspirations will be uncertain in outcome, and unclear in guidance. Our study begins the long path to carbon neutrality in Australian health care.

## Methods

### Rationale

There are two predominant approaches to environmental footprinting or lifecycle assessment (LCA): process-based LCAs and economic input–output LCAs. Process-based LCAs measure all material inputs along with all emissions to the environment of individual processes, with multiple processes combining to create a final service or product. Process-based LCAs are useful when examining small amounts of specific data,<sup>8</sup> but are impractical when examining the environmental effects of an entire supply chain in health care, because process-based LCAs require the selection of a system boundary. The supply chains falling within this system boundary are considered in a process LCA, whereas the rest are deemed negligible. Selection of a system boundary might result in so-called truncation errors.<sup>11</sup> These truncation errors can be avoided by scanning the entire upstream supply chain of a product, process, sector, or even a whole nation by use of input–output analysis.

Economic input–output LCA is a macroeconomic technique that describes the complex interdependencies between different sectors of an economy. All Organisation for Economic Co-operation and Development (OECD) countries and 27 non-member economies produce input–output tables to allow this economic analysis to occur. Economic input–output LCA takes into account all infinite upstream supply chains, without the need for the selection

of a system boundary, hence providing a comprehensive picture by ensuring that both the direct (on-site) and total (direct plus indirect) effects are captured.<sup>11,12</sup> An example of direct CO<sub>2</sub>e emissions would be the burning of fuel or gas at a hospital, whereas an indirect impact would be a hospital's electricity use, because that electricity was routinely generated elsewhere.

All economic activity has an environmental effect associated with it. Economic input–output LCAs assign an environmental effect to an item, process, or service via knowledge of a monetary value and its attribution to a specific economic sector. Economic input–output LCAs require a set of input–output matrices containing monetary information on the transactions between different economic sectors, and also physical data (for example on CO<sub>2</sub>e emissions) for every sector listed in the input–output table (appendix). Input–output calculations can then be used to find both the direct and the total CO<sub>2</sub>e emissions for all sectors (appendix).

The equation underlying the CO<sub>2</sub>e footprint relies on a so-called stressor that equates to money spent. In the case of the footprint calculation of health care, this stressor is the expenditure data (in million Australian dollars), which is multiplied with the CO<sub>2</sub>e emissions factor (eg, kilotonnes of CO<sub>2</sub>e per million dollars) to yield a CO<sub>2</sub>e emissions footprint. In this linear association, if the amount of expenditure data increases, so does the footprint.

See Online for appendix

متن کامل مقاله

دریافت فوری ←

**ISI**Articles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات