Decarbonising diagnostic laboratories: key literature and steps towards a more sustainable future

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Atmospheric carbon-dioxide (CO_2) levels have risen by approximately 50% since the pre-industrial era to the current peak of 421 ppm in July 2023.[1] Climate data demonstrates that we have observed a 1.1°C increase in global average temperatures over the same period. It has been calculated that to avoid the worst consequences of climate change, we must limit the increase in average global temperatures to below 1.5°C.

Healthcare is a considerable contributor to global greenhouse gas emissions. It is estimated that the healthcare sector contributes 4.4% of total global emissions.[2] As such, the NHS has set targets to reach 'net zero' by 2040 for direct emissions and 2045 for emissions that it influences.

In this column, I aim to summarise three key papers focussed on carbon footprint calculations, and subsequently outline ways in which diagnostic labs can look to reduce their own environmental impacts.

Health care's response to climate change: a carbon footprint assessment of the NHS in England" Tennison *et al*, 2021

Starting broad, this 2021 paper by Tennison *et al* describes a carbon footprint assessment of the NHS at whole system level. The NHS has been performing quantification of its carbon footprint since 2008 with the establishment of the Sustainable Development Unit (SDU) (now Greener NHS). The analysis employs a hybrid modelling approach including scope 1, 2 and 3 emissions as per the GHG protocol as well as patient and visitor travel emissions. The analysis demonstrated that the NHS was responsible for 25 megatonnes (Mt) of CO_2e in 2019. This represents a reduction of 26% since 1990, primarily due to decarbonisation of the UK energy grid. The reduction has been achieved upon a backdrop of substantial population increase (17%) and a doubling in care provision by the NHS. This 25Mt value actually represents a 64% reduction in emissions per inpatient episode since 1990. Looking at a breakdown of emission data, 62% of CO_2e were associated with supply chain, with the vast majority of this being a result of the manufacture of goods. Twenty-four percent was accountable to direct care delivery, 10% due to staff commuting and patient or visitor travel and 4% due to private health delivery and NHS commissioned services. Interestingly, the construction of healthcare facilities and freight transport, often heavily implicated activities, were responsible for only 5% and 6% of total CO_2e emissions respectively.

The carbon footprint of pathology testing – McAlister *et al,* 2020

This paper, written by an Australian group based out of Melbourne was the first

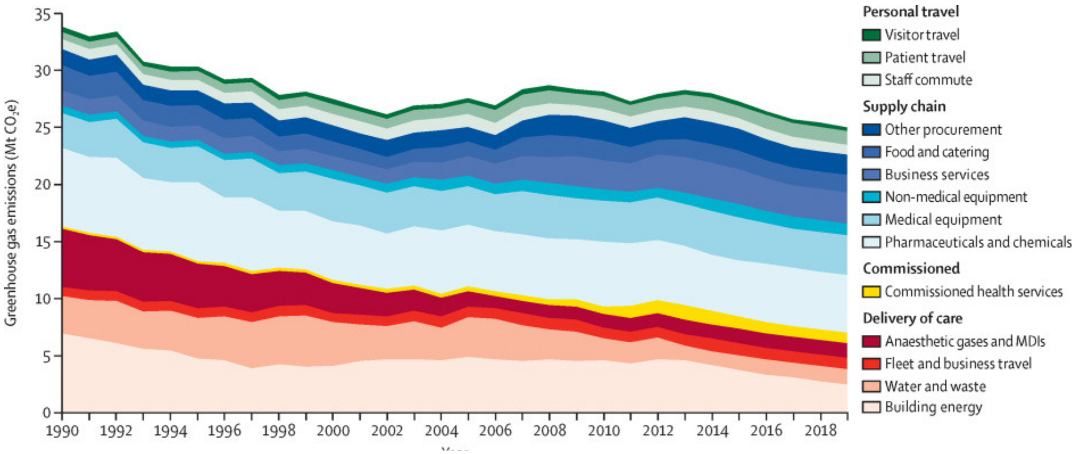

Figure 1: Time series for the greenhouse gas emissions of the NHS in England, broken down by source of emission, 1990-2019. MDI = Metered dose inhaler, Mt CO_2 = megatonnes of carbon dioxide equivalent. (From Tennison et al, 2021)

published carbon footprint analysis of pathology testing performed in accordance with ISO 14040 principles and framework. The study focusses on key blood sciences analytes: Full blood count (FBC), Coagulation profile, Urea and Electrolytes (U&E), C-reactive protein (CRP) and Arterial blood gas (ABG). The results show that a single Coagulation profile is responsible for 82 g CO_2e/test, with FBC = 116 g CO_2e/test, U&E = 99 g CO_2e/test, ABG = 59 g CO_2e/test and CRP coming in at 0.5 g CO_2e/test. These values correspond to the equivalent of between 3-770 km of car travel/1000 tests. Interestingly, the study found that the majority of the CO_2 emissions generated by pathology tests are associated with sample collection. This is most strikingly demonstrated by the stark difference between the carbon footprint of U&E testing and CRP, where the CRP value was calculated in an

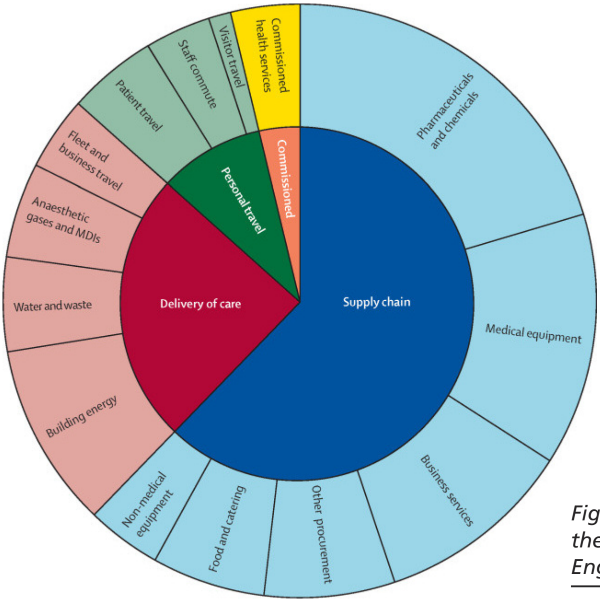

Figure 2: Contribution of different sectors to the greenhouse gas emissions of the NHS England, 2019 (From Tennison et al, 2021)

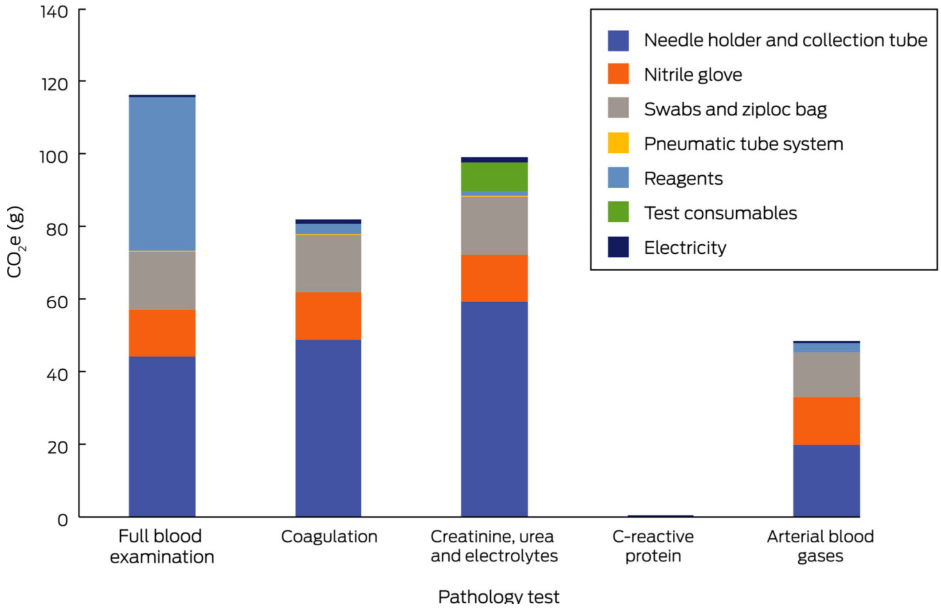

Figure 3: Carbon dioxide equivalent (CO_2e) emissions associated with single pathology tests, by test component. From McAlister et al, 2020

attributional analysis, foregoing the footprint associated with blood tube production and sampling as this test is frequently ordered alongside routine biochemical tests on the same primary sample. A further 2021 paper by the same group expanded the analysis to include urinalysis and found the carbon footprint to equal 538 g CO_2e/test, with the bulk of the carbon associated with additional test consumables (agar plates), compressed air for flow cytometry and culture incubation.[3]

The carbon footprint of waste streams in a UK hospital – Rizan *et al*, 2021

A group based out of Brighton and Sussex University Hospital NHS Trust aimed to estimate and compare the carbon footprint of hospital waste streams using a process-based carbon footprint analysis. The study found that the carbon footprint (per tonne) of hospital waste is lowest when recycled (21-65 kg CO_2e) followed by low temperature incineration with energy from waste (EfW) (172-249 kg CO_2e). When waste was additionally decontaminated using autoclave prior to low temp incineration with EfW, the carbon footprint = 569 kg CO_2e.

The waste disposal option with the highest carbon footprint was high temperature incineration (1,074 kg CO_2e/tonne). In addition, NHS data shows that the financial cost of the different waste streams mirrors that of the carbon footprint.

What can we do to reduce the carbon footprint of labs based on the evidence?

The data in the three papers described above provide evidence to support the implementation of specific laboratory practices. The heavy contribution of supply chain on the overall carbon footprint of the NHS illustrates the impact that green procurement decisions may have for clinical laboratories. Furthermore, the contribution of consumable items to the carbon footprint of individual pathology tests demonstrates the impact that optimising diagnostic testing algorithms and reducing unnecessary testing may have on a labs environmental footprint. Where laboratory testing is necessary, transitioning to re-usable labware will likely also have a significant impact vs single-use plastic items.

Promoting active travel, be that walking or cycling to and from work is another option for labs looking to reduce their overall carbon footprint. For longer journeys, advocation for the use of public transport can be adopted as buses or trains have a much lower carbon footprint than personal vehicles. Finally, when considering waste, auditing waste disposal practices in your laboratory may uncover some surprising results. Do you know how your various waste streams are disposed of? Are staff correctly disposing of items in the correctly identified bins? In Microbiology labs, limiting autoclave use for items contaminated with microbiological waste can reduce load size and the associated carbon footprint of waste disposal. Many NHS trusts now have a responsible "Waste Manager" who will be well placed to advice and support any initiatives relating to waste reduction.

If you have any suggestions or examples of good sustainable practice, please submit them to the Green Champions group via the following good practice form: **ACB Green Champions – good practice submission form**.

References

1. NASA Global Climate Change. Climate Change: Vital Signs of the Planet. 2023. Global Climate Change. Vital Signs of the Planet – Carbon Dioxide Concentration. Available from: **https://climate.nasa.gov/vital-signs/carbon-dioxide**
2. Lenzen M, Malik A, Li M, Fry J, Weisz H, Pichler PP, *et al*. The environmental footprint of health care: a global *assessment.* Lancet Planet Health. 2020 July 1; 4 (7): e271-9.
3. McAlister S, Grant T, McGain F. An LCA of hospital pathology testing. The International Journal of Life Cycle Assessment. 2021; 26(9):1753-63. doi:10.1007/s11367-021-01959-1

Key papers

- Tennison I, Roschnik S, Ashby B, Boyd R, Hamilton I, Oreszczyn T, *et al*. Health Care's response to climate change: A carbon footprint assessment of the NHS in England. *The Lancet Planetary Health.* 2021;5(2). **doi:10.1016/s2542-5196(20)30271-0**
- McAlister S, Barratt A L, Bell K J, McGain F. The carbon footprint of pathology testing. *Medical Journal of Australia*. 2020; 212(8):377-82. **doi:10.5694/mja2.50583**
- Rizan C, Bhutta MF, Reed M, Lillywhite R. The carbon footprint of waste streams in a UK hospital. *Journal of Cleaner Production*. 2021;286:125446. **doi:10.1016/j.jclepro.2020.125446** ■