

Initial comparison of the carbon footprint of radiotherapy across cancer centres

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Background

- Radiotherapy (RT) uses radiation to treat 120,000 cancer patients each year, amounting to half of all cancer patients in the UK.
- Linear accelerators (linacs – see Figure 1) are used to deliver high energy radiation in typically 15-30 separate visits over 3-6 weeks.
- Linacs are expected to have high energy consumption
- Radiotherapy treatments also involve consumables and imaging.
- Sulphur Hexafluoride (SF₆), a gas used in the linacs has GWP of 22,000.

Aim

- To provide an initial estimate for the environmental impact of RT and to identify the footprint “hotspots” in the treatment pathway.
- This can be used as a comparator to other cancer treatments to identify opportunities for reducing the environmental impact of RT and cancer treatment.

Method

- Data for 10 prostate patients (treated with 60 Gy in 20 fractions) were collected at four radiotherapy centres, along with information on technical equipment and patient transport, where available.
- Each centre collected the patients' post codes from their records and used an online mapping tool to calculate the distance travelled. A questionnaire of 99 patients was conducted at one centre to help determine how patients travelled for treatment – as most studies assume travel was by car.
- The power used to deliver the treatments was measured in 3 centres.
- The number of CT scans was collated from patient records in 3 centres, and MR scans in 2 centres.
- The number of Personal protective equipment (PPE) items and SF₆ gas leakage was also measured at 1 centre.

→ This activity data was then converted into a carbon footprint using government databases or literature.

Results

- Figure 2 shows the carbon footprint of the parts of the radiotherapy pathway observed at each centre.
- Among the variables assessed, patient travel is the largest contributor making up 70-80% of the total radiotherapy carbon footprint.
- At Centre 3 60% of patients travelled via public transport for treatment whereas at Centre 1 this was only 27% which makes a large difference to the carbon footprint of travel.
- The linac power used during treatment also varies between centres with two Elekta centres (Centres 1 and 4) using less than the Varian centre (Centre 3).
- Linac power when idle was only measured at centre 1; it could also be a significant source of emissions.
- Leaking SF₆ gas formed about 5% of the observed carbon footprint.

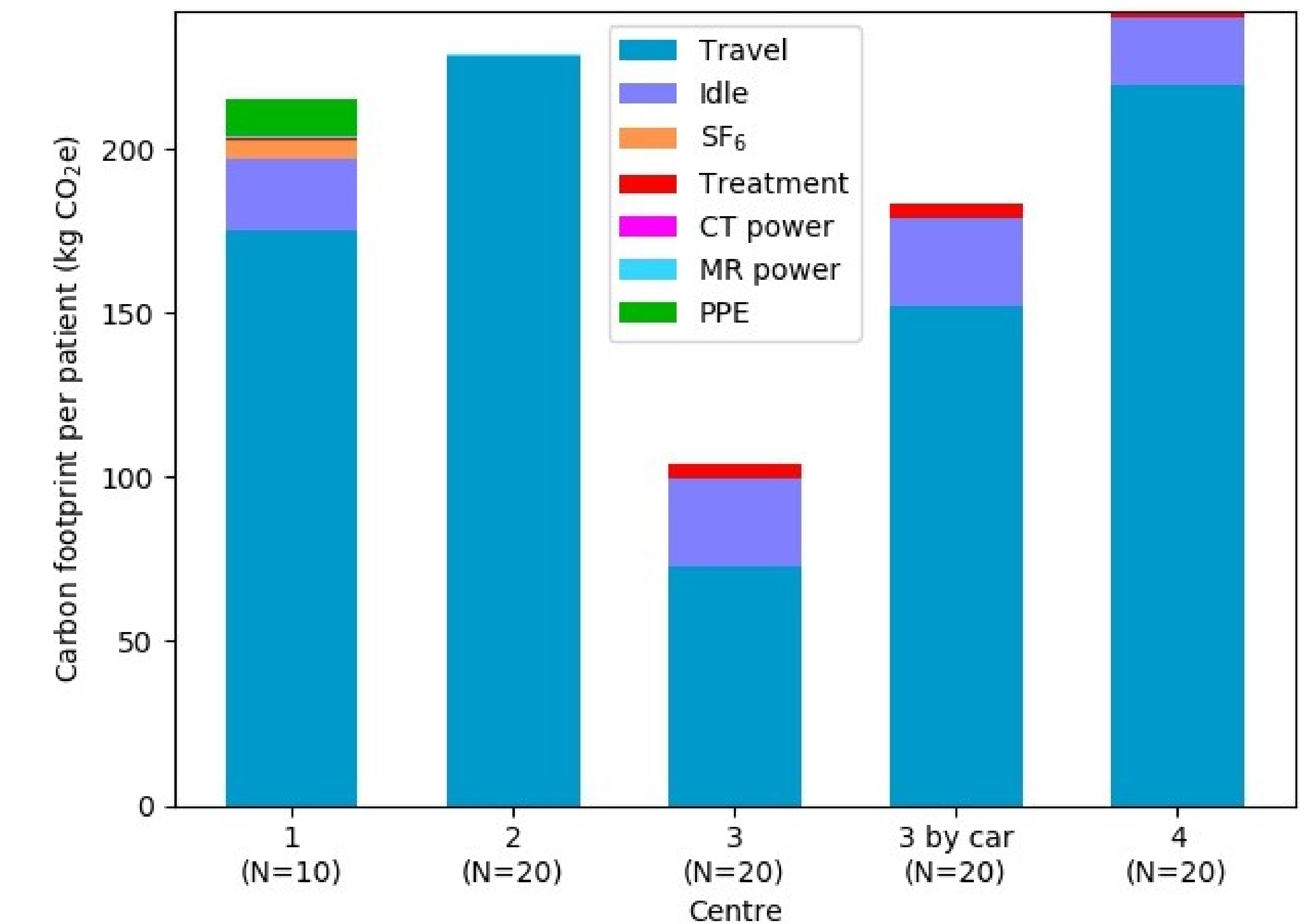


Figure 2. Carbon footprint in kgCO₂e per patient of the observed parts of the patient pathway across the four centres. Centre 1 = The Christie, Centre 2 = Mount Vernon, Centre 3 = Guys and St Thomas and Centre 4 = South West Wales Cancer Centre, Swansea



Figure 1. An example of a linac radiotherapy treatment machine

Conclusions

These initial results (now published [1]) have shown the carbon footprint of radiotherapy is about 215 kg CO₂e per prostate patient, and preliminary results of a comparison between four cancer centres shows large variation. Patient travel is the largest contributor (70-80%) to this but if public transport is used by a large fraction of patients this is significantly reduced (as seen for Centre 3). However, the lack of standardisation between approaches, low number of patients and incomplete datasets across centres illustrates the need for ongoing work in this area.

Solutions to the large carbon footprint of patient travel could be reduced by:

1. hypofractionated radiotherapy which uses fewer, higher dose treatments (3-5 days).
2. More satellite/local radiotherapy centres
3. Improved public transport for patients or better hospital transport services.

References

¹Chuter R. *et al.* (2023) 'Towards estimating the carbon footprint of external beam radiotherapy', Phys Med. doi: <https://doi.org/10.1016/j.ejmp.2023.102652>.