Word count: 961 words

Heba Butt

MBChB Year 3

University of Manchester

Judith Adams essay competition 2024

Sustainability in Medical Imaging: Reducing Environmental Footprint for Future Generations

MMS membership number: 6821

Word Count: 961 words

I, Heba Butt, confirm that my submission for the MMS Section of Imaging Judith Adams essay competition 2024 is my own work, is not copied from any other person's work (published or unpublished), and has not previously been submitted to the Manchester Medical Society or elsewhere. I understand that if I am found to have plagiarised work, any prizes will be rescinded, and I may be barred from entering in future competitions with the Manchester Medical Society.

Word count: 961 words

1.0 Introduction

Sustainability in healthcare has become an increasingly important issue as medical technologies, including medical imaging, continue to grow in both usage and environmental impact. Medical imaging, which encompasses techniques such as MRI, CT scans, and X-rays, play a crucial role in the diagnosis and treatment of various medical conditions. However, these technologies are energy-intensive and produce a variety of material and chemical waste, leading to concerns about their environmental footprint. This essay aims to explore the various ways the carbon footprint of these processes can be reduced to adopt sustainable practices in medical imaging.

2.0 Energy-hungry scanners

High-powered magnets, high-voltage x-ray beams, and constant cooling all cause medical imaging equipment to contribute heavily to the healthcare environmental footprint, however some imaging techniques contribute considerably more than others. In figure 1, it is evident that MRI scanners have considerably larger emissions of an average 17.5 CO_2e emissions per scan, followed by CT (9.2 CO_2e).[1] By contrast, chest x-ray and ultrasound imaging generated much smaller footprints per scan, using only 0.76 and 0.53 CO_2e, respectively. These scans remain essential for diagnostic accuracy and treatment of patients so must still be used, however developing more energy-efficient scanners and using renewable sources of energy could help to reduce emissions. Additionally, research has found that the amount of energy used for a single scan on a previously inactive system is far greater than that for any additional scans performed on an already-running system; operating imaging systems at full capacity whenever possible is more beneficial for the environment. Also, radiology systems use a significant proportion of energy in an idle state due to only entering stand-by mode after 4 hours of inactivity. Reducing this time to 1 hour can result in up to 45% of savings in energy.[2] Active staff participation in ensuring greater throughflow of MRIs and reducing all electronics on standby may present more implementable solutions to effectively reduce energy demands of medical imaging.

Word count: 961 words

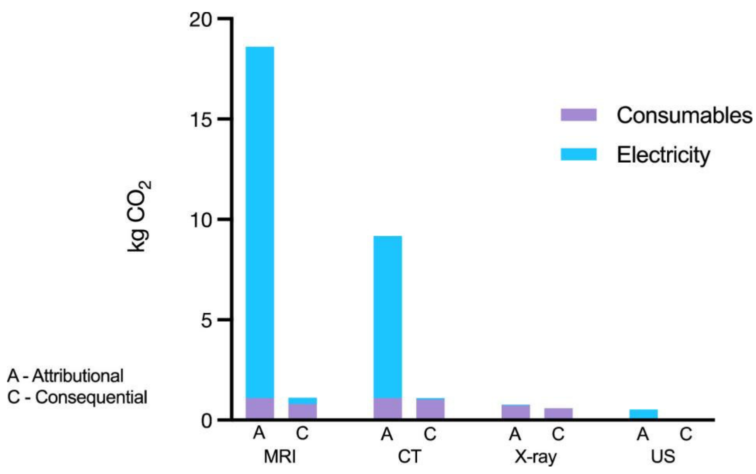

Figure 1: Shows Carbon emissions from electricity and consumables (in kg CO2e) of imaging modalities, as estimated by attributional (ALCA) and consequential (CLCA) life cycle analyses.[3]

3.0 Material and chemical waste

Medical imaging generates significant material and chemical waste, much of which comes from the use of single-use plastics, contrast agents, and radioactive materials. For example, sulphur hexafluoride (SF6), a contrast agent used in ultrasound imaging, has a global warming potential (GWP) 22,900 times greater than CO2. The entire life cycle of production, usage, and disposal contributes to the carbon emissions of these resources. Radioactive isotopes present further concerns in handling and disposal, and hazardous waste can lead to soil and water contamination, posing risks to sustainable ecosystems and public health. Improved waste management through educating staff on clinical waste could be used to decrease these emissions, for example, excess contrast media can be recycled instead of polluting the normal wastewater system. A case study in a radiology ward with 2 CT scanners where staff were trained in correct clinical waste disposal found a saving of over 20,000 CO2 equivalents per year.[4]

Both electricity consumption reduction and reduction of material and chemical waste, have different ways of decreasing carbon emissions, however it is evident that behavioural change is arguably the overarching the solution. Correct disposal of equipment, turning equipment on only when needed, and only performing scans, when necessary, all have the potential to result in significant reductions in carbon emissions, in a way that patient care is also still not compromised. A study found that 39% of CT, and 21% of MRI scans being performed were inappropriate/unnecessary.[5] This further highlights the need for a change from the staff operating these imaging facilities, as their contribution would dramatically change the current environmental footprint of medical imaging.

4.0 The future of radiology

Radiology is a field undergoing rapid change, and AI has promising applications to improve diagnostic accuracy and streamline workflows. This is very pressing with an increasing population and a decline in radiologists; the Royal college of radiologist's states there is currently a 29% deficit in staff, which is predicted to intensify to a critical 40% by 2027.[6] However, the processes of machine learning and deep learning techniques causes AI to demand extensive computational resources, leading to substantial energy consumption and an increase in greenhouse gas emissions for radiology as a whole. Therefore, the integration of AI into medical imaging is a balancing-act; a trade-off must be made between optimising efficiency and the environmental impact.

However, AI is not necessarily carbon positive. Optimising image acquisition and processing, automating shutdowns of scanners to minimise idle time, and reducing unnecessary imaging tests using AI recommendations can all contribute to reducing the energy consumption of power-hungry scanners. AI can also enhance contrast agents, reducing environmental contamination by contrast agents such as gadolinium and sulphur hexafluoride by up to 50%, leading to lower production and disposal-related emissions.[7]

5.0 Conclusion

In conclusion, medical imaging is pivotal in modern healthcare, providing essential diagnostic and therapeutic capabilities, however with growing usage, it's environmental impact cannot be overlooked. This essay has found that to achieve sustainable practice, simple behavioural changes: turning off machinery, correct disposal of equipment, and actively working to reduce HVAC emissions in the healthcare setting, is vital in achieving this goal. Despite the large emissions a scanner produces, a great deal of this energy is wasted, and is not used on the actual scan.

Word count: 961 words

The integration of AI presents both opportunities and challenges, and careful implementation is required to balance the increased energy demand for computational processes with optimized scanner efficiency and reduced environmental impact of contrast agents.

Sustainability of the healthcare sector is a continuous pursuit, however using focused efforts on behavioural changes, enhanced technology, and smarter resource management, it shows great promise to continue providing high-quality patient care in a greener way.

Word count: 961 words

References:

1. Sustainable radiology: why it takes more than “greener” imaging systems [Internet]. healthcare-in-europe.com. Available from: https://healthcare-in-europe.com/en/news/sustainable-radiology-greener-imaging-systems.html

2. Reducing the eco-footprint of radiology [Internet]. healthcare-in-europe.com. Available from: https://healthcare-in-europe.com/en/news/reducing-the-eco-footprint-of-radiology.html

3. McAlister S, McGain F, Breth-Petersen M, Story D, Charlesworth K, Ison G, et al. The carbon footprint of hospital diagnostic imaging in Australia. The Lancet Regional Health - Western Pacific. 2022 Jul;24:100459.

4. Mariampillai J, Rockall A, Manuellian C, Cartwright S, Taylor S, Deng MC, et al. Die grüne und nachhaltige Radiologieabteilung. Die Radiologie. 2023 Sep 18;

5. Bouëtté A, Karoussou-Schreiner A, Ducou Le Pointe H, Grieten M, de Kerviler E, Rausin L, et al. National audit on the appropriateness of CT and MRI examinations in Luxembourg. Insights into Imaging. 2019 May 20;10(1).

6. Clinical Radiology Workforce Census 2023 [Internet]. Available from: https://www.rcr.ac.uk/media/5befglss/rcr-census-clinical-radiology-workforce-census-2023.pdf

7. Doo FX, Vosshenrich J, Cook TS, Moy L, Eduardo P.R.P. Almeida, Woolen SA, et al. Environmental Sustainability and AI in Radiology: A Double-Edged Sword. Radiology. 2024 Feb 1;310(2).