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Impact of Paper Consumption in Radiology Departments on Carbon Footprint and Climate Change: A Retrospective Analysis and Future Projections

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Abstract

Introduction Climate change and global warming have major contributions from greenhouse gas emissions. Despite the introduction of digitalized systems, many health care systems still rely heavily on paper. The purpose of this study is to investigate paper usage in the radiology department of a single hospital institution over the last 3 years to forecast paper usage up to 2050.

Methodology This retrospective study was performed in the radiology department of our tertiary orthopaedic hospital. The study included forms used for diagnostic and interventional procedures in various departmental modalities. Diagnostic procedures require one to three forms and interventional procedures require three forms each. Based on the established ratio that 1.2 trees are cut for every 10,000 sheets of papers used, the study calculated the number of trees cut annually over the past 3 years and projected paper usage and tree loss until 2050.

Results Paper usage was distributed between diagnostic and interventional procedures, with 67% used in diagnostics and 33% in interventions. The corresponding number of trees cut during this period amounted to 53.729 trees, with 47.4 trees for diagnostic procedures and 6.4 trees for interventional procedures. A total of 57.8 trees for diagnostic procedures and 11.7 trees for interventional procedures were forecasted to be cut annually from 2024 to 2050, cumulatively being 1,227 trees by the year 2050.

Conclusion Our individual department had a significant contribution from paper usage in the carbon footprint of the department. Adoption of digitalized appointment, prescribing, and patient records is important in reducing this and achieving the NHS net zero targets.

Keywords
- green
- 2050
- carbon footprint
- radiology
- climate change

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Introduction

Climate change is an important global issue and is contributed to by global warming driven by greenhouse gas emissions. The Intergovernmental Panel on Climate Change (IPPC) issued its sixth assessment report predicting that it would catastrophically and irreversibly impact life on earth. Climate change and health are closely connected in that issues arising from climate change may affect the health of the general population. Health care systems themselves are a major contributor to carbon emissions; if health care services around the world were a country, they would be the fifth largest emitter of carbon dioxide (CO_2), contributing to 4.4% of global net emissions.[1,2] This places an important role on them to engage in preventative measures to mitigate the effects of climate change. In the United Kingdom, the National Health Service (NHS) is the largest emitter of CO_2 accounting for up to 5% of the country's carbon footprint.[3] The new NHS England and NHS improvement (NHSEI) climate change strategy launched in autumn 2020 sets out clear targets for NHS trusts to become net zero carbon by 2045.[4]

Trees are an important part of reducing carbon footprints as they are a major carbon "sink." Given that one tree can absorb an average of 10 to 40 kg of carbon dioxide per year, over a lifetime of 100 years, one tree can absorb a ton of CO_2.[5] However, for every 10,000 paper sheets produced, 1.2 trees on average are cut down.[6] Despite 77% of trusts in England being equipped with electronic patient record systems,[7,8] the NHS still uses a significant amount of paper, with one estimate placing this at 690,000 miles.[9] Diagnostic departments contribute approximately 9% to the carbon emission footprint in the medical field. Apart from paper consumption in the department, another main contributor is the high electricity consumption due to energy-intensive medical equipment like computed tomography (CT) scanners, magnetic resonance imaging (MRI) systems, and workstations.[10]

In this article, we analyze the annual paper usage in the radiology department of a tertiary orthopaedic hospital to understand the yearly trends and forecast paper consumption up to 2050 and explore the impact individual departments can have on the NHS net zero target.

Materials and Methodology

Audit Design

After local audit approval from the institutional review board, a retrospective observational study was performed by auditing the number of papers used in the radiology department of the hospital over the past 4 years utilizing the data from the computerized radiology information system (CRIS).

Audit Area/Population

This study was performed at Royal Orthopedic Hospital, Birmingham, a major tertiary orthopaedic referral center. This audit included the total number of forms used in the radiology department. The inclusion criteria included all the forms used in ultrasound (US), CT, MRI, and interventional lists such as CT-guided biopsy, cryotherapy, US-guided injection, vertebroplasty, and radiofrequency ablation

Sampling Size and Sampling Technique

The data were collected retrospectively applying a systemic simple random sampling method, during the period from 2021 to 2023, by extracting the data directly from CRIS.

Data Collection Method and Analysis

Data were collected retrospectively from each division within the department. The total number of procedures performed in each division over 3 years was analyzed. A projected number of paper forms for each diagnostic or interventional procedure was calculated based on current paper form usage. The papers were divided into diagnostic or interventional. Diagnostic procedures constituted US, MRI, X-ray, and CT, which required one paper appointment form. However, an additional form is required for female patients to document the last menstrual period (LMP) as well as a further form for a safety questionnaire for contrast administration for contrast-enhanced studies. For interventional procedures, a total of three forms are required: a referral form, a WHO (World Health Organization) questionnaire, and a drug chart. For each procedure of both diagnostic and interventional radiology, two more papers were added, one for the appointment and one for the patient information sheet.

Each form equates to one paper. Taking the calculation from recent studies, every 10,000 paper forms were translated into 1.2 trees. In this context, the "tree" refers to a standard-sized tree typically used in the paper industry, which is generally approximately 40 feet tall with a diameter of 6 to 8 inches. The paper sheets in question are usually of standard size, such as A4 (8.27×11.69 inches or 210×297 mm). This estimate emphasizes the importance of reducing paper usage to conserve trees within the NHS. It is an average measure and can vary based on factors such as the type and thickness of the paper, as well as the tree species used.

According to industry data, it takes 8 trees to produce 1,000 to 2,000 lb of paper. Using the average of this value, 8 trees is equal to 1,500 lb of paper, which means 1 tree is equal to 188 lb of paper. If 500 sheets of paper weigh 12 lb, 10,000 sheets weigh 240 lb. Based on this, if we save 10,000 sheets of paper, we have saved 1.2 trees in the forest. With this trust's original data, we can study the trends or patterns and arrive at an almost correct answer. It is nearly correct because we have different types of trees in the forest that weigh more than each other.

The total number of trees was calculated over the past 3 years. We extrapolated the trend in these data to project the total number of paper sheets that will be used by the year 2050. The data obtained were analyzed using Microsoft Excel 2016 and Statistical Package for Social Sciences (SPSS) version 25. The data analysis plan included a master sheet to organize the data, presentation of the data

through tables and figures, using descriptive and forecast statistics to predict the trend and prospectively determining the number of paper sheets that will be used up by 2050.

Results

The total number of paper sheets used in the last 3 years, including forms used in diagnostic and interventional studies, was analyzed separately. ►**Fig. 1A** shows the total number of papers consumed in the last 3 years as a yearly trend. Of the papers being used, 67% were for diagnostic procedures and 33% were for interventional procedures.

Using the equation of 10,000 paper sheets to 1.2 trees, a total of 53.729 trees were cut down over the past 3 years; 47.360 trees were for diagnostic procedures and 6.369 trees were for interventional procedures (►**Fig. 1**).

Using the trend over the last 3 years, a forecast graph was plotted to predict the number of trees that will be used up by 2050. This showed that in 2050, a total of 57.791 trees will be cut for forms for diagnostic procedures and 11.657 trees will be cut for interventional procedures. An average of 45.449 trees will be cut every year starting from 2024 to 2050 (►**Fig. 2**).

If the same trend of usage of paper in the department continues, by the end of 2050, a total of 1,227.145 trees will be cut.

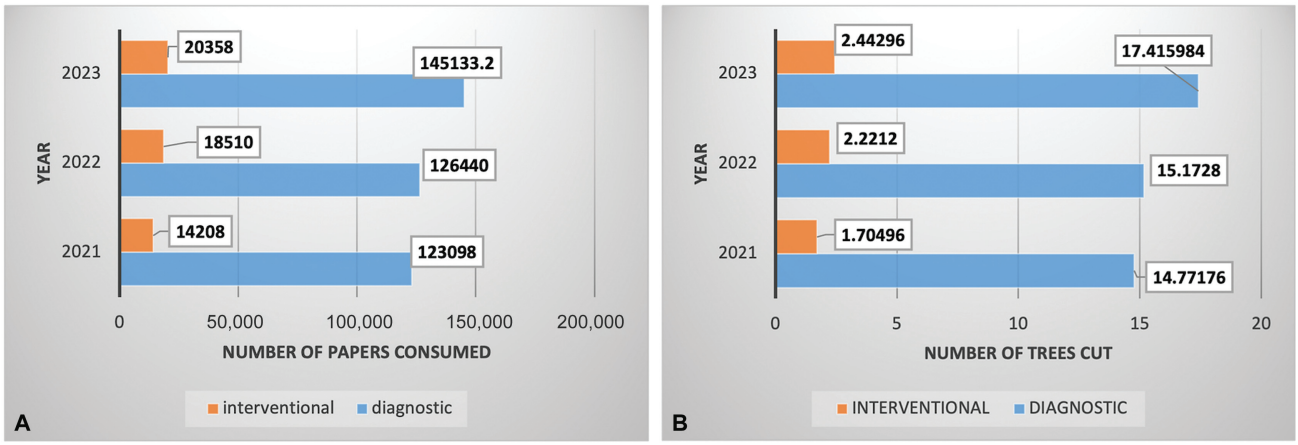

Fig. 1 (A) The total number of paper sheets used per year for the past 3 years and (B) estimate calculation (12,000 paper sheets = 1.2 trees) for the total number of trees cut per year for the past 3 years.

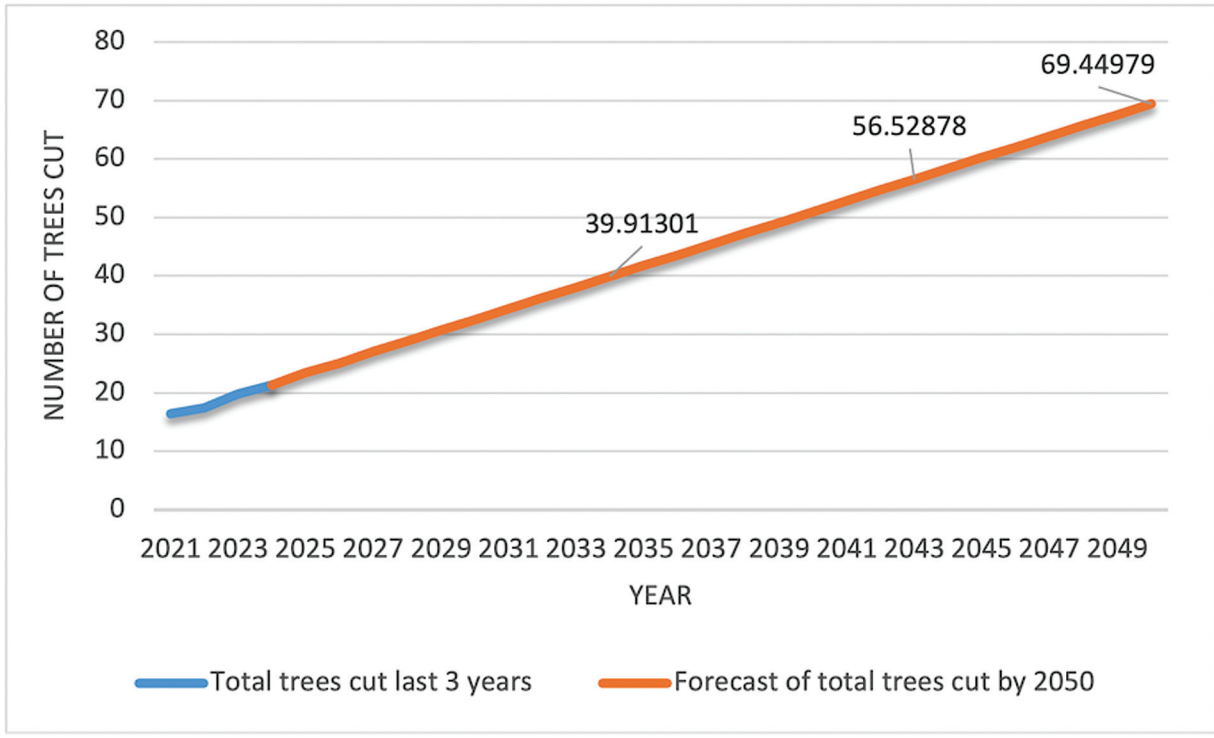

Fig. 2 A forecast of the total number of trees that will be cut by 2050 based on paper usage within the radiology department.

Discussion

The NHS has set out a target of being net zero carbon by 2050 and various strategies have been put in place to achieve this, with many hospitals optimizing the use of resources to reduce their carbon footprint. This study focused on how paper usage in the radiology department could contribute to this.

Our audit revealed that over the past 3 years, a total of 53.729 trees have been sacrificed to produce the paper required for forms in our hospital's radiology department. When projected over the next 17 years, by 2050, a total of 1,227.145 trees will be cut down. This finding aligns with a recent article published by NHS on February 18, 2020, involving 200 NHS trusts that switched to recycled paper, saving a total of 20,000 trees. This accounted for 58% reduction in NHS's carbon footprint. A similar audit of medical student admission done at University of California (UC) Davis showed that the number of photocopies used purely for medical student admission activities at the university was equivalent to 16 trees per year.[11] The adoption of an electronic system has significantly reduced this and also contributed to savings in cost, time, and resources. Changes at a national level should start in individual departments and the results of this audit reflect this.

An average of 7.69 kg (range: 10–14 kg) of CO_2 is absorbed by a tree per year over its lifetime.[12] Our audit shows that starting from 2024, an average of equivalent of 42.695 trees will be cut every year till 2050, which equates to an approximate net surplus of 426.95 to 597.73 kg of CO_2 every year. Recent studies have shown that the per capita carbon result of NHS in England was 540 kg.[13,14]

Digitalizing the radiology department is essential to reduce paper usage. However, we must consider the carbon footprint associated with running screens. Additionally, thorough training is required, as it can be challenging for long-term NHS employees to transition from traditional methods to this new system. A paperless health care service does pose certain challenges, for example, resistance from staff to adopt digitalization, workplace IT (information and technology) and connectivity problems, the initial investment in digital infrastructure, as well as its maintenance. However, they enable better patient management through electronic health records (EHRs), facilitate remote consultations and monitoring, and allow patients to easily cancel or reschedule appointments.

This audit highlights the potential carbon footprint of a single radiology department in one hospital when considering its usage of paper forms alone. Although many other factors also contribute to the overall carbon footprint of the department, the results do highlight that small steps can create a significant impact.

The audit was limited by several factors. Forms from associated departments, such as microbiology referral forms, were not included, which may be a selection bias. In addition to the use of paper for forms, there are other significant sources of paper consumption within the department. For example, extensive paper packaging used for interventional consumables and tissue paper used for various applications, such as covering US and CT couches, are also contributing to the overall paper usage in the radiology department. This has been excluded in the study. The paper usage projection for 2025 was based on recent trends, assuming it will remain constant in the future, although various factors, such as patient numbers or changes in the hospital capacity, could affect this. A higher percentage of forms is used for diagnostic procedures compared with interventional procedures, mainly because more patients undergo diagnostic procedures. However, given the number of forms used, the primary area of change should be the interventional procedure forms to start with. Switching entirely to digital systems means using more computers, which would use more electricity. This could reduce some of the environmental benefits we get from using less paper. So, finding a middle ground, like using energy-saving digital tools and cutting down on paper use, could be a better and more sustainable option.

Conclusion

This observational study reveals that there are a lot of opportunities to implement changes in the present practice that can significantly reduce our carbon footprint. Even small changes like reducing paper usage can demonstrate its vast potential to breathe new life into the vision of green radiology. This provides the scope for way more innovations, ideas, and research into various strategies for digitalizing the radiology department and addressing all obstacles on its way. These efforts will shape the future of the field. Small puddles form vast oceans; likewise, minor changes in each hospital department can save trees and collectively reduce the immense ocean of carbon emissions. This serves as an excellent example that extending this idea to other departments and trusts throughout the United Kingdom can bring about significant change and initiate a new revolution on the path to NHS's dream of achieving Green 2050.

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Conflict of Interest
None declared.

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