

The NIHR Carbon Guidelines: Overview for the Consultation Phase, March 2010

Background to the project

This aim of this project is to develop sustainable research guidelines for researchers funded by the NIHR. The project was instigated at the request of Professor Dame Sally C. Davies, Director General of R&D Department of Health, following the success of the NETSCC Research on Research project, the Carbon cost of pragmatic randomised controlled trials: retrospective analysis of sample of trials ([BMJ](#). 2009; 339:b4187).

Development of the guidelines

A working group, Chaired by Professor Ian Roberts from the London School of Hygiene and Tropical Medicine (LSHTM), was set up to develop the guidelines. Membership of the working group includes:

Professor Deborah Ashby, Chair in Medical Statistics and Clinical Trials, Imperial College London
Sir Iain Chalmers, James Lind Initiative
Professor Ray Fitzpatrick, Programme Director, NIHR HSR Programme
Professor Adrian Grant, Director, NIHR Programme Grants for Applied Research
Dr David King, Director, NIHR Central Commissioning Facility
Dr Martin Landray, Reader in Epidemiology, MRC/Cancer Research UK/BHF Clinical Trial Service Unit & Epidemiological Studies Unit, University of Oxford
Professor Stuart Logan, Professor of Paediatric Epidemiology and Director, Institute of Health Service Research, Peninsula College of Medicine & Dentistry
Professor Jon Nicholl, Deputy Director NIHR Health Technology Assessment Programme, and Chair, HTA Commissioning and Clinical Trials Boards
Dr David Pencheon, Director NHS Sustainable Development Unit

The Working Group was supported by a secretariat at NETSCC:

Dr Ruairidh Milne, Director of External Relations, NETSCC
Dr Alison Mortlock, Senior Programme Manager, NETSCC (Project manager)
Dr Lisa Cashmore, (Project support)

Next Steps

An early draft of the guidelines was presented at a workshop on the 22nd January 2010 for clinical researchers, methodologists and other experts from across the NIHR. The guidelines will be revised following the electronic consultation phase, incorporating feedback from both the workshop and electronic consultation, before being presented to the NIHR board in May 2010. Once the guidelines have been signed off by the NIHR board, it is anticipated that researchers applying to the NIHR for funding will be asked to confirm that they have considered the guidelines before submission of a grant application.

For further information or for any queries regarding the project please contact the project team at NETSCC: Carbon@soton.ac.uk

The NIHR Carbon Guidelines - *DRAFT*

1. Introduction

High quality health services are one approach to tackle the increasing challenges that disease and ill health place on our society. However, the provision of health care, like other sectors of the economy, results in the emission of greenhouse gases into the atmosphere, the build-up of which presents a threat to the integrity of the ecosystems on which our health depends. The NHS has a carbon footprint of about 18 million tonnes of CO₂ per year which represents about 25% of public sector greenhouse gas emissions. It is vital that health services seek to minimise their impact on the global environment and the NHS Carbon Reduction Strategy documents how this will be achieved¹.

High quality clinical research, by ensuring that only safe and effective health care interventions are used within the NHS, clearly plays a key role in improving patient care but also helps protect the environment. For example, a significant part of the carbon footprint of the NHS is related to greenhouse gas emissions arising from the production of pharmaceuticals. High quality clinical research, by providing unbiased and reliable evidence on the safety and effectiveness of pharmaceuticals, protects NHS patients from harm whilst also protecting the global environment from unnecessary waste. Ensuring that only safe and effective treatments are used within the NHS is good for patients and good for the environment and this is what high quality clinical research aims to achieve.

Nevertheless, the clinical research endeavour itself must also take appropriate steps to minimise greenhouse gas emissions from research activities. Indeed, the need to exercise caution in the conduct of research that may harm the environment is enshrined in the World Medical Association (WMA) Declaration of Helsinki. This document is aimed at researchers conducting research funded by the National Institute for Health Research (NIHR) and outlines some approaches for reducing the greenhouse gas emissions from clinical research.

2. The need to reduce greenhouse gas emissions

Climate change is a reality. Greenhouse gases are changing the global climate, with serious implications for human health and for the integrity of the ecosystems on which human life depends. The Intergovernmental Panel on Climate Change predicts an increase of between 1.5°C and 6°C by 2100 depending on the extent of future emissions. The potential influences, both negative and positive, could be considerable. There are inevitably uncertainties in climate change predictions, particularly in regard to the timing, extent, regional patterns and health impacts of climate change. Nevertheless, it would be inappropriate to wait until there was complete scientific certainty and decisions necessarily have to be made now on the basis of the best available information. It is essential to do all we can to restrict any rises to 2 degrees or less in order to minimise the risk of runaway climate chaos, with all the profound health consequences that would entail. In recognition of this urgency, the UK Government has introduced the Climate Change Act, which stipulates that carbon emissions must be cut by at least 80% by 2050, with a minimum reduction of 26% by 2020.

3. Reducing the environmental impact of health care

Carbon management is an important consideration for all organisations. As the largest organisation in the UK, the NHS has made a commitment to meet the targets set by the Climate Change Act, and to be seen as a leading public sector exemplar¹.

The purchase by the NHS of goods and services for patient care comprise 60% of emissions, much of which is from pharmaceuticals and medical equipment.

4. Reducing the environmental impact of health research

The release of greenhouse gases into the atmosphere has a global effect although it is now increasingly recognised that global warming will have a far greater impact on poor people living in poor countries². Because the environmental impacts of clinical research have the potential to affect everyone, including future generations, it is important that the questions that clinical research studies seek to answer should have the widest possible patient and public relevance and that new knowledge produced by clinical research should be made publicly available.

Exercising appropriate caution in the conduct of research that may harm the environment would imply that new research should only be conducted if the answer to the research question is not already known. Environmental considerations thus reinforce the scientific and ethical arguments that all new studies should be underpinned by a systematic review of the existing research. Because the conduct of a scientifically valid systematic review requires that the existing research is publicly accessible, environmental considerations underscore the importance of good publication practice.

Healthcare itself is a major source of carbon emissions, therefore by ensuring that only safe and effective healthcare is provided, clinical research plays an important role in improving patient care and avoiding medical waste. The number of clinical study participants is typically only a fraction of the patient population, and the duration of most studies is often much shorter than that of the disease and any subsequent complications. As a consequence, the carbon cost of obtaining reliable information from well-conducted clinical studies is likely to be dwarfed by that of using treatments that are ineffective or potentially unsafe.

The aim of clinical research is to provide information that will improve patient care. When generating information, researchers should endeavour to minimise the environmental harm caused by their activities. Of course, these endeavours should not compromise the scientific validity of the research, since biased or unreliable research cannot be justified on scientific, ethical or environmental grounds. However, as outlined in this document, there are many ways that researchers can minimise the environmental impact of clinical research without compromising scientific validity.

5. What do we know about the environmental impact of health research?

Two recent studies have quantified the greenhouse gas emissions from clinical research^{3,4}.

Pragmatic trials funded by NIHR: A 2009 study calculated the CO₂ emissions from a sample of twelve randomised controlled trials (RCTs) funded by the NIHR Health Technology Assessment (HTA) programme, a leading funder of research in the NHS. The average CO₂ emission per RCT was 78.4 tonnes, corresponding to 306 kg of CO₂ per randomised participant. Across all of the trials, trial team commuting to work accounted for the most CO₂ emissions (26%), followed by fuel use at trial centres (23%) and trial team related travel (19%). Participant travel accounted for 16% of emissions, while trial technologies and IT equipment accounted for 14% and 2% of emissions respectively.

The MRC CRASH Trial: The CRASH trial was a multi-centre international randomised controlled trial of the effect of corticosteroids on death and disability in

10,008 adults with head injury. The trial generated a total of 630 tonnes of CO₂, corresponding to 63 kg of CO₂ per randomised participant. The trial centre accounted for the largest proportion of emissions (39%) followed by distribution of trial materials (28%) and trial related travel (23%). Just over 45 of the 50 tonnes of carbon dioxide equivalent emissions associated with the coordination centre were from the use of electricity. Most (94%) of the emissions related to travel were from air travel and hotel stays for site visits, on-site data verification, and collaborators' meetings. Although only 22% of the air travel mileage was short haul, because it produces more greenhouse gases per mile than long haul travel, it accounted for 31% of air travel emissions. Most (97%) emissions from the distribution of drugs and documents were from air freight of treatment packs and documents to hospitals.

6. What can clinical researchers do to reduce carbon emissions?

This document outlines strategies to reduce the carbon emissions from clinical research. Because most publicly funded clinical research is conducted in NHS hospitals and universities, general institutional strategies to reduce carbon emissions would also reduce the carbon emissions from clinical research. In both of the carbon audits outlined above, energy use by the trial centres and trial team commuting were important sources of carbon emissions. However, strategies to reduce carbon emissions from buildings and from travel to work have been outlined in previous guidance such as the NHS Carbon Reduction Strategy for England¹ and so are not considered here.

The focus of this document is on how methodological and practical aspects of clinical research impact on the associated carbon footprint. It has been developed in consultation with clinical researchers and methodologists and attempts to identify areas where sensible research design can reduce waste without adversely impacting on the validity and reliability of research. Many of the examples provided are drawn from clinical trials but the principles of good carbon management and sensible clinical study design apply to many studies funded by the NIHR.

6.1 Sensible study design

6.1.1 *Setting the research question and making full use of existing evidence*

Rationale

Answering the research questions that are most important to patients, making the best use of the available evidence before conducting new research and requiring that scientists cumulate scientifically through the continuous updating of systematic reviews will help to minimise the environmental harms of research as well as improving its scientific quality.

A number of questions of importance to clinicians and patients could potentially be answered using existing evidence. Adopting such an approach may help reduce carbon emissions associated with the production of research evidence. Based on the methods reported by Lyle et al.³, the average carbon footprint of 14 evidence synthesis projects currently ongoing within the HTA portfolio was estimated. The average CO₂ emission generated by an evidence synthesis project was 10.06 tonnes. This figure is nearly 13% that of the emissions from a clinical trial and is the equivalent saving of taking 27 cars off the road.

Key recommendations for researchers

- i. Involve patients and clinicians in shaping applied research agendas and specific questions;
- ii. Carry out systematic reviews of existing evidence before submission of new grant proposals.

6.1.2 Efficient study design

Rationale

'Efficiency' in trial design often relates to statistical efficiency, in other words, getting as much information on the question(s) of interest as possible within a given sample size. However, more generally, efficient trials make good use of scarce resources, such as patient populations, patients' time and resources. Sometimes it is possible to answer several questions through one trial, which, in addition to the efficiencies already described, can also yield a carbon saving relative to answering the components via separate studies through the use of common procedures such as follow-up visits, monitoring and so on.

There are currently 125 ongoing trials funded by the HTA programme, which would generate around 9,800 tonnes of CO₂ (125 x 78.4 tonnes³ CO₂ per trial). However, only a small percentage of these trials are factorial trials.

Key recommendations for researchers

- i. Make good use of resources such as patient populations and patient time;
- ii. Consider whether it is possible to answer several questions through one study (factorial design);
- iii. Involve methodologists in the design of research.

Case Study

The Women's Health Initiative (WHI)⁵ addressed three questions in preventive medicine simultaneously by offering each participant multiple randomizations (a 'factorial' structure), as well as building in an observational study. The WHI study had three components: an RCT, an observational study, and a community prevention study. The RCT enrolled a total of 68,132 postmenopausal women. By applying the figure for the average CO₂ emission per randomised participant obtained in the NIHR study³ (306 kg CO₂ per randomised participant), we estimated that this trial would have generated about 20,850 tonnes of CO₂. The WHI however study had three study components. Eligible women could choose to enrol in one, two, or all three of the components:

Hormone Therapy (HT): This component examined the effect of HT on the prevention of heart disease and osteoporosis, and any associated risk for breast cancer. Women participating in this component took hormone pills or a placebo (inactive pill). (n=27,347)

Dietary Modification: The Dietary Modification component evaluated the effect of a low-fat, high fruit, vegetable and grain diet on the prevention of breast and colorectal cancer and heart disease. Study participants followed either their usual eating pattern or a low-fat eating program. (n=48,835)

Calcium/Vitamin D: This component started up to 2 years after a woman joined one or both of the other studies. It evaluated the effect of calcium and vitamin D supplementation on the prevention of osteoporosis-related fractures and colorectal cancer. Women in this component took calcium and vitamin D pills or a placebo. ($n=36,282$)

If these studies had been carried out individually, recruiting separately 112,464 participants, then again using the NIHR estimate of CO₂ emissions per participant, a total of 34,400 tonnes of CO₂ would have been emitted. Encouraging women to enrol in more than one study therefore resulted in a saving of about 13,550 tonnes of CO₂.

6.1.3 Study set up and conduct

Rationale

Major components of CO₂ production by trials, such as study centre fuel use and trial team travel³, are related to the time it takes to complete a study. Timely delivery of a trial's findings would thus not only lead to early benefits for patients and the NHS through evidence-informed decision making but also substantially limit the associated carbon production. Currently, trials commonly take longer than anticipated, with reports of as many as 50% having time extensions due to a failure to achieve their original recruitment target¹⁴ or because of bureaucratic obstacles. While important steps have been taken to provide a more efficient research environment, such as the introduction of the Integrated Research Application System [IRAS], the NIHR Coordinated System for gaining Research Permission [CSP], and the Research Passport, delays remain, the reasons for which are multiple and sometimes complex.

Failure to recruit on schedule is a major reason for study delay. The success of the Cancer Research Network in promoting recruitment to trials has led to the development of six further NIHR topic specific networks which cover much of England and Local Comprehensive Research Networks covering all areas. The primary role of these networks is work with researchers to facilitate the delivery of high quality studies and there are encouraging signs of a positive effect on recruitment in those studies which have been adopted by the networks. Involvement of patients and public as well as relevant clinicians from appropriate disciplines in all aspects of study design and delivery is likely to improve recruitment and retention.

Key recommendations for researchers

- i. Work wherever possible with networks of researchers and research managers;
- ii. Work with the appropriate NIHR Topic Specific or Comprehensive Local Research Network if this can facilitate recruitment of research participants.

6.1.4 Avoiding unnecessary data collection

Rationale

Measuring patient outcomes is a key component of clinical studies and decisions about when, where, in whom and how to do this will impact on the carbon footprint of the trial. Many studies collect more outcomes and at more time points than are ever used in the analysis. This is not only bad science, leading to potential bias in the selection of outcomes, but produces unnecessary carbon. Study protocols should

therefore clearly set out what will be measured, when it will be measured, and how the measures will be used in the analysis, and any redundancy should be avoided.

Outcomes should be measured remotely by phone, mail, or the internet whenever possible. When patient contact is necessary, outcome assessors and patients should be close together using, for example, local GP surgeries to measure outcomes rather than in remote centres.

Case study

An HTA trial comparing 3 different treatments required each patient to visit the hospital a total of 24 times to have their dressings changed. This resulted in over 3394 hospital visits. We assumed that the average distance travelled for a secondary care visit was 17.4 km⁶ and, using a standard conversion factor of 0.25 to calculate the CO₂ emissions per kilometre travelled¹, calculated that patient travel in this trial produced 14.8 tonnes of CO₂. By contrast, the average distance travelled for primary care visits is only 2.4 km³ therefore changing the dressings locally at a GPs surgery would have produced 2.04 tonnes of CO₂, saving 12.76 tonnes of CO₂.

In the HTA Programme, 154,081 participants are currently involved in clinical trials, at an average of 306.2 kg of CO₂ per participant³, this equates to over 47 thousand tonnes of CO₂.

Information about the occurrence and nature of many outcomes can be obtained via record linkage (with participant consent) with routine data, as has been done in a number of previous clinical trials, such as the MRC/BHF Heart Protection Study⁷ and the West of Scotland Coronary Prevention Study⁸. The NHS Connecting for Health Research Capability Programme plans to provide a means of linkage to data on death, cancer, hospital admissions, prescription medicines, and procedures (such as renal dialysis or transplantation).

Not all outcomes may need to be measured in all patients at all times. When trials are powered on dichotomous outcomes, secondary continuously measured outcomes might be measured on a smaller sub-sample.

Key recommendations for researchers

- i. Study protocols should clearly set out what will be measured, when it will be measured, and how the measures will be used in the analysis;
- ii. Outcomes should be measured remotely by phone, mail, or the internet whenever possible;
- iii. When patient contact is necessary, outcome assessors and patients should be geographically close together where possible;
- iv. Depending on the study, not all outcomes need to be measured in all patients at all times.

Case study

In the ongoing Study of Heart and Renal Protection (SHARP), blood lipids were measured centrally at 1 year in only 10% of the 9438 participants at around 30% of the 380 participating hospitals in 18 countries. In the same study, measurements of liver and kidney function (safety assessments) have been made at every visit (an average of 10 visits per participant), but are measured in the local hospital laboratory, obviating the need for transport of over 900,000 samples from the site.

6.1.5 *Sensible clinical trial monitoring*

Rationale

In all clinical studies it is essential that the rights, wellbeing and safety of participants are maintained whilst ensuring that the data are sufficiently reliable to allow appropriate conclusions to be drawn. Although guidelines and regulations (such as ICH-GCP) permit flexibility in how studies are monitored, the traditional approach has been to rely on frequent site visits by clinical trial monitors, despite limited evidence on the effectiveness of this strategy. As a consequence, monitoring procedures have become increasingly expensive, bureaucratic and inefficient, making it harder for studies to succeed in answering important questions, whilst adding substantial financial and carbon cost. For studies of common disorders with hard clinical outcomes, undue emphasis on minor data or procedural discrepancies (often entailing frequent site visits) can be counter-productive. It may be more efficient to recruit a larger number of participants and use less intensive monitoring. Any monitoring that takes place must be effective in identifying and rectifying relevant problems, rather than simply checking aspects that are easy to inspect.

Quality should be “designed-in” to studies from the outset. The protocol, study procedures and data collection systems should be streamlined and focused. For example, only collecting data relevant to important baseline characteristics and clinical events; using computerised systems to enforce the protocol and to check completeness and validity of data (rather than relying on post hoc detection and correction of mistakes); avoiding re-keying of data by using electronic approaches to data transfer; and making full use of information already stored on routine systems, including laboratory data, clinical records and disease registries.

Key recommendations for researchers

- i. Focus on issues that are critical for the safety and wellbeing of study participants and the reliability of the results;
- ii. Avoid inefficient or ineffective monitoring practices, particularly those that require extensive travel to sites;
- iii. Use centralised, systematic methods to assess quality and identify issues;
- iv. Site visits should be targeted to sites where there are concerns or a need for additional training.

Case study

The international WOMAN trial¹¹ aims to recruit 15,000 women with post partum haemorrhage over 4 years. Patients will be recruited from about 400 hospitals in 40 countries. According to ICH-GCP “there is a need for on-site monitoring, before, during, and after the trial.” Such an approach in the context of a trial like WOMAN would mean a minimum of three site visits to all 400 hospitals, a total of 1,200 visits. However, by using a streamlined clinical trial protocol, an experienced network of trial collaborators, and multiple methods of providing training, including a video available on Youtube (www.youtube.com/watch?v=azFdyjyS-HQ), conference calls and on-line GCP training, the number of site visits can be dramatically reduced. The need for monitoring will be informed by the results from routine data checks and statistical data monitoring so that on site monitoring is conducted only where indicated.

In previous, similar trials, the use of such methods has meant that on-site monitoring is conducted in around 10% of hospitals. Based on unpublished data from the CRASH2 study regarding travelling distances, if all hospitals were visited three times, the carbon cost would be about 312.6 tonnes. However, if as a result of the use of extensive distance training, central monitoring of consent procedures, and statistical data monitoring, only 10% of hospitals were visited once only, the carbon cost would be reduced to about 4.8 tonnes, representing a saving of 307.8 tonnes of carbon. This carbon saving would be the equivalent to that emitted by 226 round trip flights between London and New York. Additional carbon savings could also be achieved by reductions in transport for study materials (such as study medication, documents and equipment).

6.1.6 Good practice in reporting research

Rationale

Insisting on good scientific practice in the reporting of research evidence is entirely compatible with reducing the carbon intensity of clinical research¹². Lyle et al.³ estimated that the average CO₂ emission of randomised trials is 78.4 tonnes. This carbon cost occurs whether or not a trial is published. The environmental cost of under-reporting of research is in addition to its scientific and ethical costs.

Key recommendations for researchers

- i. Set the results of new primary research in the context of updated systematic reviews of other relevant research;
- ii. Ensure that reports of research contain the information needed to make them usable to readers.

Case study

Poor publication practice can have serious environmental consequences. We estimate that every year, at least 12,000 trials are completed but remain unpublished. Using the recently published figure for the average CO₂ emissions per clinical trial of 78.4 tons³, we estimate that just under a million tons of carbon dioxide is wasted every year (12,000 x 78.4 = 940,800) in conducting clinical trials that do not contribute to the scientific knowledge base. This is equivalent to the carbon emissions from about 800,000 round trip flights between London and New York.

6.2 Reducing the environmental impact of the NHS through research

Rationale

Using ineffective interventions or failing to use effective ones can lead to inefficient use of NHS resources, consequently resulting in a negative impact on the environment. Good research which is appropriately communicated to NHS decision makers can be seen as a carbon sparing technology.

Moreover, if policy makers are to make sustainable decisions, it is important that they are able to consider the environmental impact of proposed interventions and services alongside clinical and cost effectiveness. Researchers can facilitate this decision making by considering the environmental impact when evaluating interventions. This

is likely to be particularly important where comparisons of different patterns of service provision are being carried out.

Key recommendations for researchers

- i. Ensure that the results of research are rapidly and appropriately disseminated.
- ii. Where appropriate, consider assessing the environmental impact of proposed interventions or changes in service provision within research studies.

7. Next Steps in the development of the NIHR Carbon Guidelines

The guidelines will be revised following the electronic consultation phase, incorporating feedback from both the workshop and electronic consultation, before being presented to the NIHR board in May 2010.

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