Towards sustainable clinical trials

Few researchers think about the carbon footprint of their trial. The **Sustainable Trials Study Group** reports that clinical trials are carbon intensive and suggests ways to make them more efficient

Greenhouse gases are changing the global climate, with serious implications for health and ecosystems.[1 2] All sectors of the economy, including the health sector, must act to reduce greenhouse gas emissions.[3] High income countries need to cut emissions by about 90% by 2030 to limit the global average increase in temperature to 2°C, and thus reduce the risk of the most serious consequences.[4]

The Sustainable Trials Study Group was convened by the London School of Hygiene and Tropical Medicine to find ways of reducing greenhouse gas emissions from clinical trials. This international health research institution has an extensive research programme on the links between environment and health. A sustainability group was established to reduce the institution's carbon footprint, and this study is a product of its work.

The CRASH trial case study

We conducted a carbon audit of the Medical Research Council (MRC) CRASH trial (www.crash.lshtm.ac.uk) with the Edinburgh Centre for Carbon Management (www.eccm.uk.com). The CRASH trial is a multicentre international trial of the effect of corticosteroids on death and disability in 10 008 adults with head injury.[5] The trial was coordinated from the London School of Hygiene and Tropical Medicine, and patients were recruited in 49 countries over five years (1999-2004). The drug was made by Pfizer in the United States and the placebo was made in France. Drug and placebo were packed in Wales. Treatment packs were sent to London for distribution to hospitals around the world.

Emissions were estimated for a one year period (August 2003 to July 2004). We collected data on operational activities according to the greenhouse gas reporting protocol developed by the World Business Council for Sustainable Development.[5-7] This protocol provides a choice of three "scopes." Scope 1 covers direct emissions from company vehicles and facilities. Scope 2 includes indirect emissions from energy imports and exports. Scope 3 includes other indirect emissions such as employees' travel, transport by third parties, outsourcing of core activities, and off-site waste disposal or management activities.

We estimated all fuel use and refrigerant loss by the trial coordinating centre (scope 1 emissions); fuel use off-site for generating electricity used by the coordinating centre (scope 2 emissions); and fuel use for travel (including site visits, data audits, and staff commuting), deliveries (delivery of drugs and placebo to the packing company and delivery of treatment packs and trial documents to hospitals), and waste disposal (scope 3 emissions). Energy used in preparing the trial treatments and other materials was excluded.

We could not calculate the energy consumption of the coordination centre directly because other activities take place there. Instead, energy consumption was assessed from typical energy consumption values per square metre of air conditioned office space. The global warming potential (in carbon dioxide equivalents) of emissions of methane and nitrous oxides from electricity generation and travel were calculated using conversion factors published by the Intergovernmental Panel on Climate Change.[8]

Findings

During the one year audit period, the total emission of greenhouse gases related to the trial was 126 tonnes (carbon dioxide equivalents). This is equivalent to that produced in one year by 32 people on the basis of global per capita estimates, or six people on the basis of US per capita estimates (www.dti.gov.uk). If the audit year is representative, the entire trial was responsible for about 630 tonnes of carbon dioxide equivalents. This corresponds to about 525 round trip flights from London to New York for one passenger. In total, 10 008 patients were recruited and there were 1945 primary endpoint events, corresponding to greenhouse gas emissions of 63 kg per participant or 324 kg per primary endpoint event.

The coordination centre accounted for the largest proportion of emissions (39%, 50 tonnes), followed by distribution of drugs and documents (28%, 35 tonnes),

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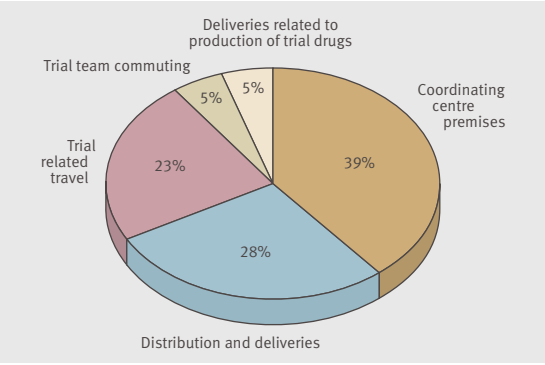
SUMMARY POINTS

- Clinical trials contribute substantially to greenhouse gas emissions
- The main sources are energy use in research premises and air travel
- Renewable energy sources and more efficient energy use would reduce emissions from premises
- Simplified trial designs, reduced bureaucracy, and videoconferencing would reduce air travel

EUROPA

Carbon emissions from the trial corresponded to about 525 round trips from London to New York for one passenger



Proportions of greenhouse gas emissions due to different activities in the CRASH trial

and travel (23%, 29 tonnes) (figure). Just over 45 of the 50 tonnes of carbon dioxide equivalent emissions associated with the coordination centre were from the use of electricity (table), the remainder came from the disposal of office waste. 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 (table). Although only 22% of the air travel mileage was short haul, because it produces more greenhouse gases 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.

Implications of the case study

Clinical trials are energy intensive and produce substantial greenhouse gas emissions. The figure of 14 tonnes per employee each year is high compared with other service industries, which average around 4-6 tonnes per employee each year (Edinburgh Centre for Carbon Management, personal communication, 2007). The CRASH trial was an international trial and our estimates may not be representative of trials in general. The trial had a simple design with no extra tests, the primary end point was mortality, and data collection was minimal. For this reason, emissions per primary endpoint event, arguably the best measure of emissions per unit of statistical information, may be low compared with other trials. However, the trial was conducted in 49 countries and the distribution of drug and placebo was complex, so emissions from air travel and distribution may be higher than for other trials.

Greenhouse gas emissions in the CRASH trial

Source of emissions	Equivalent emissions of carbon dioxide (tonnes per year)
Coordinating centre	
Electricity	45.4
Refrigerant gas losses	0.0
Waste disposal	4.2
Business travel	
Taxi	1.0
Air	16.3
Train	0.5
Hotel stays	10.9
Commuting	
Rail	4.7
Bus	0.9
Underground	1.0
Deliveries related to production of trial drugs	
Light goods vehicles	0.2
Air	5.8
Distribution of trial materials	
Light goods vehicles	0.9
Air	33.9

Reducing the carbon footprint of clinical trials

Saving electricity

Our audit provides insights into how to reduce the carbon intensity of clinical trials. Even though this was an international trial, electricity use by the trial coordinating centre accounted for the largest share of emissions. Organisations could reduce such emissions to zero by installing on-site renewable energy sources or by buying electricity from renewable energy companies.[9] Reductions might also be achieved by fitting voltage optimisation devices (which reduce power consumption by around 10%) to the incoming electricity supply and by using energy efficient lighting—motion sensors and light sensitive dimming, low energy light bulbs, and timers to turn off appliances at night.

Making trials simpler and more efficient

Energy use in trials could be reduced by employing fewer people. Reducing bureaucracy and using simple designs with no unnecessary data collection would be helpful. The bureaucracy associated with applications to ethics committees and other regulatory bodies has been highlighted by many trialists and has a big impact on the carbon footprint of trials.[10 11] Electronic remote collection of data may reduce staffing levels, although the energy use of such technologies must be taken into account.

Simple designs with statistical checks for data irregularities can reduce the need for on-site data verification and reduce trial related travel.[12-14] Conducting trials within networks of trialists may reduce training needs, and building local capacity for trials may be more energy efficient than visiting experts. Providing the infrastructure for teleconferencing and videoconferencing could reduce travel. However, frequent interruptions in the electricity supply occur in many health facilities in poor countries. Renewable energy sources such as photovoltaic energy could provide a more stable source of electricity in such situations, with minimal or zero greenhouse gas emissions. The health research community should encourage such technologies and help pilot and evaluate their use in research.

The research community must ensure that trials look at questions of greatest priority using methods compatible with broader strategic objectives in relation to environment and health. Because emissions have a global effect and have the greatest impact on the poor, trials of global relevance should be prioritised.[15] All new trials should be underpinned scientifically by a systematic review of the existing research.[16] Indeed, by making the best use of existing informa-

tion, systematic reviews are an energy efficient way of answering research questions. Trial results should be made publicly available, as the environmental consequences affect us all.

Raising awareness and commitment

Conducting carbon audits on clinical trials will not guarantee success in reducing emissions in the short term. The impact of audit in clinical environments is modest at best.[17] However, we need to establish awareness about the broader consequences of health care and research, and through awareness increase the pace of action to avert one of the most important global challenges of our time.[18] Long term change will require sustained commitment by research institutions and funding bodies. This may have other benefits, such as increased pragmatism in trial designs, better choice of research questions, and increased likelihood that trials produce important results for global health.

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This work was stimulated by the efforts of LSHTM to reduce the greenhouse emissions associated with its activities, which include clinical trials. IR is guarantor.

Funding: London School of Hygiene and Tropical Medicine.

Competing interests: None declared.

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Accepted: 30 January 2007

New doctors

I could tell that we had had changeover day; the referral that last week would probably have read, "Funny turns—?seizures," now gave a full, detailed history, the space allowed filled completely with tiny but scrupulously neat handwriting.

As a medical student working in the neurophysiology department of a busy hospital to earn some money, I took a telephone call from a young doctor making her first referral. She'd filled in the form but had a question about the process, could she come and see us? I said yes—we have a policy of encouraging all doctors to come and see us if they want to talk something over. In fact, she asked her question immediately, and I was able to answer her. Should she still come to visit us? I gave her the option of coming over whenever she had a minute or of putting the referral form into the internal post. The next day she dropped into our main office, introduced herself, handed in the referral form, waited while I made the appointment for her patient, and went cheerfully on her way.

In the meantime, I had taken a call from another foundation year 1 doctor in a hospital about 30 miles away. It was late afternoon, and I could hear the note of panic in his voice. He needed to speak to the consultant neurophysiologist urgently. I explained that neither she nor her secretary was available—could I help? Obviously on the verge of tears, he told me that he had been given a list of tests to arrange and given the consultant's name, but beyond that had no idea how to go about doing this. I reassured him that he was talking to the right person, guided him through finding and then filling in the referral form, and stopped another panic attack when he interpreted something I'd said to mean that he needed to specify individual nerves for testing.

Finally, I told him how to address the envelope so that it would get to us speedily through the internal mail system. It was only his second day at work in the hospital, and he was already so stressed that he was nearly overwhelmed.

I am uneasy that he thought he needed to talk to the consultant herself to arrange the tests rather than her secretary or someone else in the office. Had he just got the wrong end of the stick or had he been deliberately misled? Are there still some people who think that getting the F1 doctor into trouble with a consultant is fun? Many consultants would not be pleased to be interrupted with trivia like booking appointments.

In a few years time it will be me struggling to learn how to be an effective member of a team. Will I be lucky, like the first young doctor, busy but given sufficient support that I can cope with the new environment and its pressures—or will I end up like the second doctor, in a situation where I am not supported and guided appropriately, exhausted and demoralised by the second day?

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