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# Proposals for the mitigation of the environmental impact of clinical laboratories

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## Abstract

Laboratories should be aware of the carbon footprint resulting from their activities and take steps to mitigate it as part of their societal responsibilities. Once committed to a mitigation programme, they should announce an environmental policy, secure the support of senior management, initiate documentation, institute a staff training programme, schedule environmental audits and appoint an environmental manager. Laboratories may aspire to be accredited to one of the standards for environmental management, such as the ISO 14000. As environmental and quality issues are linked, the improvement in the environmental management of an organisation will ultimately lead to improved quality system performance. Indeed, environmental management could conceivably come under overall quality management. Although there will be initial costs, good environmental practices can bring savings. Environmental improvement should be based on the 3R concept to reduce, reuse and recycle. Several policy initiatives may be introduced. These include a green purchasing policy for equipment, laboratory furniture and reagents as well as the management of packaging wastes. There are several ways to reduce energy, water usage and wastage. A reduction of test numbers and collection tubes should be attempted. Paper management involves all aspects of 3R. The recycling of solvents and general wastes should be practised where feasible. The construction new laboratories or renovations to existing ones are opportunities to make them more environmentally-friendly. The advocacy of policies to associates and the inclusion of environmentally-friendly conditions on contractors are integral parts of the programme.

**Keywords:** environment; guidelines; impact; laboratories; reduction.

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## Introduction

All human activity impacts the environment. Many produce greenhouse gases that are directly or indirectly released during fossil fuel combustion contribute to global warming and climate change (1). Laboratories impact the environment in several ways (2) and have a responsibility to reduce the environmental consequences of their activities.

Our aim is to encourage environmental performance improvement beyond mandatory compliance, driven by motivation rather than regulatory compulsion. In addition, the introduction of good environmental practices eventually leads to less wastage and greater cost savings. The purpose of this document is two-fold: to create an awareness that clinical laboratories have a carbon footprint and to provide some guidance on how laboratories may mitigate it.

The guidelines we propose are not meant to be a substitute for a formally certified environmental management system. Rather, they are a few steps along the pathway to such a certification.

### Situational analysis

A survey of International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) members found that clinical laboratories in most of the countries which responded had not addressed the issue of the environmental impact of laboratories and consequently, did not have action plans to reduce their carbon footprint (Table 1). Most respondents were also of the view that that it would be helpful if the IFCC provided some basic guidelines to clinical laboratories on how they achieve this.

## Guidelines

### Environmental policy and action plan

Once the commitment is made to mitigate environmental impact, a laboratory should enunciate an environmental policy, an example of which is given in the Appendix 1 [and reference (3)]. A new initiative will only succeed with the support of the senior management of the organisation and with a public commitment to devote time and resources to this endeavour. The chances of management support will improve if the laboratory can prove that any initial implementation costs will be offset by a reduction of overall costs in the long-term.

The laboratory will need a plan of action along the following lines:

- *Creation of awareness.* Develop consciousness among the staff of the impact of the laboratory's activities on the

**Table 1** Survey of IFCC members on the mitigation of the environmental impact of laboratories December 2010.

| Question no. | Question | Yes | No | Don't know |
|---|---|---|---|---|
| 1 | Besides proper waste disposal, are you aware of clinical laboratories in your country that have Action Plans to reduce their environmental impact by way of reduced power and water usage, reduced utilisation of plastics, chemicals and paper, greater recycling of material, reduced use of fuels, encouraging staff to use less energy, etc.? | 11 | 16 | 4 |
| 2 | Have clinical labs in your country addressed the issue of carbon footprints of laboratories? | 3 | 21 | 6 |
| 3 | Do you think that it would be helpful if the IFCC provided some basic guidelines to clinical laboratories on how they could reduce their carbon footprint? | 29 | 0 | 2 |
| 4 | Are you aware of ISO14000 standards and what they relate to? | 14 | 17 | – |
| 5 | Do you know of any clinical laboratories in your country that have received ISO14000 certification? | 2 | 20 | 9 |

environment. Find ways to address the problem before attempting any kind of certification.

- *Preliminary environmental review.* Identify activities that significantly impact the environment.
- *Aim.* Establish overall goals, set targets and plan activities as part of an Environmental Management System (EMS).
- *Training.* Prepare a training programme for the laboratory staff.
- *Available legislation.* Identify legal requirements related to environmental aspects of the laboratory's activities and establish a register of these.
- *Audits.* Schedule audits and management reviews. The audits should identify areas of waste and opportunities for lessening the environmental foot-print.
- *Documentation.* Prepare the following documents:

a) An EMS manual;
b) Protocols for handling emergencies, such as spills;
c) A list of contractors and the contracts that the laboratory has entered into.

## Establishment of an EMS

Any management system should be based upon the Plan-Do-Check-Act cycle. The EMS is implicitly the same as other management systems, such as the ISO 15189. The ISO 14000 is the standard for environmental management. It helps organisations a) minimise the adverse environmental changes to air, water, or land as a result of their operations; b) comply with existing laws, regulations, and other environmentally-oriented requirements; and c) adopt steps to continually improve environmental performance (4).

## Integration of EMS with the Quality Management System (QMS)

Technically, the ISO standards for the quality and environment management have their basis in ISO 9000. There is also a philosophical link between the two standards and it is that laboratories should aspire to produce results that are reliable (hence the need for quality management) and in a manner that is ethical i.e., with as little impact to the environment as possible. The reduction of environmental waste is linked very closely to the principles of lean management. A lean laboratory is one which is focused on testing products and materials to deliver results in the most efficient way in terms of cost or speed or both (5). As the two are intimately related, an organisation that has been implementing a lean management approach to process improvement should readily see the benefits of including an environmental focus.

The EMS should be envisaged as a component of the existing quality management system. The principles and procedures to monitor the effectiveness of the implementation of environmental policies are the same as those used as in the quality system. As these processes are common, it makes sense to eventually integrate quality management (ISO 15189) with occupational safety and environmental systems into one management system, where the audits and training cover all the issues raised by these different themes. ISO 14000 is similar to ISO 9000 quality management in that both pertain to the process of how a product is produced, rather than to the product itself. The ISO 19011 audit standard applies when auditing for both 9000 and 14000 compliance at once (4).

## Staff training

The purpose of training is to raise awareness among the staff of the importance of reducing the laboratory's environmental impact and of the means of achieving this. Staff should be involved to identify areas of waste reduction. Management will need to provide leadership in this area. As with all educational activities, the example set by the senior staff will be critical.

The education programme should be integrated into normal training activity but with additional emphasis on team approaches. While audits and non-conformity processes should be used to identify problems and opportunities, staff feedback programmes should be instituted as these can be effective. A scheme of rewarding workable ideas will encourage participation.

## Audits

Audits and non-conformity procedures that are used in QMS can be used to assess performance against the stated

environmental policies. Trained auditors with some environmental awareness and focus on process improvement should be able to audit against specified criteria.

The ultimate goal should be to have auditors trained in both quality and environmental improvement, but in the short term it may be necessary to have separate audits. The most effective and productive approach would be to have fewer but broader audits. It may take time to properly train auditors to the required level of understanding of environmental issues.

### Laboratory environmental manager

It is important to appoint a laboratory environmental manager to be in-charge of the EMS. Initially this person could come from a member of the existing staff and it should be someone who works closely with the person in charge of the quality management system.

## Implementation

The implementation of an environmental policy involves cost. While it should be a routine, on-going activity, it should also be considered each time there is a capital expenditure, for example, at the construction of a new building or when renovating existing ones.

### Reduce, reuse and recycle (3R)

The 3R concept to reduce, reuse and recycle should be the main pillars of any effort to ensure environmental improvement. The first R should seek to *reduce* the consumption of energy, natural resources and unsafe products. The second R should aim to *reuse* items as much as possible before replacing them, as far as is possible, with reusable items. The third R, *recycle*, requires laboratories to ensure that items or their components are put to some new purpose as much as possible; they should seek to implement a recycling programme within sound financial parameters.

Each activity that is undertaken to mitigate environmental impact will come under one or more of these headings. *Reduce* and *reuse* have meanings that are obvious. The concept of *recycling* needs elaboration. It is the processing of used materials by way of collection, sorting, cleaning, treatment and reconstitution of these materials that would otherwise become wastes and returning them to the economic mainstream by way of new products to prevent waste of potentially useful materials. This would also in turn reduce the consumption of fresh raw materials, energy usage, air pollution (from incineration) and water pollution (from land-filling) by reducing the need for conventional waste disposal. It will also lower green-house gas emissions compared to virgin production directly from raw materials (6, 7).

### Mitigation of environmental impact

The following is a list of suggestions that a laboratory can implement to reduce its environmental impact. Many of these will be familiar since they are applicable to other spheres of life. The list is by no means exhaustive. Laboratories should not, initially, be too ambitious but the start with practices that are feasible. All efforts should be seen as a process of continuing improvement.

1. Green purchasing policy

The adoption of a green purchasing policy involves the selection and acquisition of products and services that most effectively minimise negative environmental impacts over their life-cycle of manufacturing, transportation, packaging, ordering patterns, use and recycling or disposal. Essentially, it requires the laboratory to commit to buy recyclable, recycled, less toxic, and locally produced products whenever it is feasible. It also entails buying goods and services in the following areas, from manufacturers and vendors who share the laboratory's commitment to the environment (7).

1.1. Equipment selection

Consider the following points at the time of equipment selection:

- Purchase energy-efficient equipment (e.g. refrigerators) every time the opportunity arises.
- At evaluation prior to purchase, factor in the environmental impact of the equipment. Give priority to equipment with a lesser environmental footprint in the following areas:

a) Analysers with large water and power requirements should be given a lesser priority. Contaminated water from the washing of cuvettes that goes down the drain is a point of concern.
b) Analysers with significant air-conditioning or heating requirements incur installation and recurrent costs that may be significant.

1.2. Reagent selection

Review the following points in the selection of reagents:

- Use alternatives to reagents with harmful ingredients where it is feasible.
- Avoid larger test kits with more packaging as such kits use more refrigerator and storage space, and therefore have greater energy requirements.
- Where possible, purchase locally produced reagents as these leave a smaller carbon footprint when transported.

1.3. Packaging wastes

Laboratories produce a large amount of solid wastes and should make every effort to reduce its volume. Examine the following factors:

- Negotiate to reduce the amount packaging when engaging a supplier.
- Request vendors to use biodegradable or recyclable packaging as much as possible. Keep non-recyclable components to a minimum.
- Where possible, ask vendors to take back their packaging for reuse. Alternatively, laboratories should reuse packaging boxes for sending out items.
- Attempt to persuade disposal contractors to provide reusable containers for the disposal of laboratory sharps. In

the US, this may be achieved by the use of Stericycle® bio boxes (8).

1.4. Laboratory furniture

- Purchase used or reusable office and laboratory furniture, where possible.
- Where this may not possible, purchase environmentally-friendly furniture. Thermo Fisher Scientific Inc. has introduced the Thermo Scientific Hamilton Distinction® II Adaptable Laboratory Furniture System (9). This range of workstations is constructed from materials and manufacturing processes that are environmentally friendly.

2. Reducing energy usage and wastage

Laboratories consume far more energy per square foot, often five times as much, than non-laboratory buildings, such as offices. In the case of clean-rooms, consumption can be 10–100-fold higher (10, 11). There are several ways to reduce energy usage.

2.1. Policy initiatives

Introduce some of the following cost-saving policy initiatives:

- Practices:

a) Conduct daily "end of day" laboratory and office walk-throughs and manually close fume hoods, switch off lights, instruments, computers and office equipment.
b) Manually adjust chiller/heat supply temperature and humidity controls relative to the seasonal demands.

- Equipment and instruments:

a) Identify analytical equipment and processes which can be shut down when not in use and/or batch processed when constant operation is not necessary.
b) Undertake regular maintenance of equipment.
c) Consolidate equipment and instruments (e.g., refrigerators, freezers, incubators) of different units of the laboratory where feasible. Remove obsolete or under-utilised items.

- Transportation:

a) Vehicles: select fuel-efficient fleet vehicles and undertake regular reviews of their routes and usage.
b) Staff**:** encourage and provide incentives to laboratory staff to use public transport or bicycles.

2.2. Fume hoods

Fume hoods use an enormous amount of energy. A typical fume hood in the US that runs 24 h a day, 365 days a year uses 3.5-fold more energy than the average house. New models are significantly more energy efficient. Shutting the sashes of hoods reduces the amount of exhaust, resulting in less air being conditioned and released into the room to replace it (10).

3. Recycling

3.1. Recycling of solvents

Reduce the use of organic solvents by recycling. This in turn reduces environmental exposure and chemical wastes. Both xylene and alcohol may be recycled by the use of a CBG Biotech Supreme Solvent Recycler (Thermo-Fisher Scientific, 10L capacity); CBG also has a formalin recycler. Small volumes need to be purchased intermittently to replace the dead volume lost during the recycling process. One of us (TB) has estimated that the pay back period of the initial cost of about US$31,300 is 5–7 years.

3.2. Recycling of general wastes

Recycling is a key component of any environmental programme. Laboratories produce tremendous amounts of wastes, much of which is recyclable. Items which can be recycled include printer cartridges, mobile phones, polystyrene, IT wastes, batteries, etc.

4. Reduction

Identify high usage consumables to reduce their consumption. Perform process analysis to see if there are "greener" alternatives or ways that their usage can be minimised. The following are some ways to reduce consumption.

4.1. Reduction of test numbers

Decrease the number of tests performed. Perform audits of tests requested and their usefulness to identity unnecessary requests.

4.2. Reduction in the use of collection tubes

Specify the minimum sample volumes required and encourage the use of fewer tubes to achieve a net reduction in the use of collection tubes. The benefits include reduced cost, less wastage, less storage, less volume to transport.

4.3. Paper management

The management of paper usage involves reduction, reuse, and recycling. Reduction may be achieved by the introduction of paperless systems and non-paper options where possible. Re-usage involves double-sided printing and photocopying where possible. Recycling is achieved by the use of clean paper waste recycling bins.

Paper usage audits should indicate efficiency improvements. It should be noted that the environmental cost of paper extends to the associated usage of printer consumables, energy usage for copiers and printers, the transport cost for delivering reports to doctors, etc.

4.4. Waste reduction and disposal

Reduce laboratory-ware wastage through the purchase of glass or other reusable laboratory ware. Avoid the use of disposable plastic items where possible.

Use specific, well labeled bins for clinical wastes, recycled paper and other wastes. Organisations should identify ways to ensure that the correct waste enters the correct bin.

4.5. Water usage

- *Analyser requirements.* Give priority to instruments with less water requirements during selection, especially in countries where water is in short supply.
- *Deionised water.* This is a critical laboratory requirement for high quality assays. It can be expensive and wasteful to produce. Reverse osmosis systems, in particular, are wasteful of water and energy. Consider the introduction of resin technologies instead.

- *General usage.* Perform an audit of water usage and introduce control measures or alternatives. The following are some ways by which water usage can be reduced:

a) Review frequency and methods of washing of fleet vehicles.
b) Install automatic or sensor taps.
c) Repair leaking taps or malfunctioning cisterns
d) Install dual flush toilets, water saving nozzles and fittings for sinks and showers.
e) Select drought resistant plants when landscaping.
f) Capture rain water from roofs for use in toilets or gardens.

5. Building design

The construction of new laboratories or renovations to existing ones are opportunities to make them more environmentally-friendly.

5.1. Environmentally-friendly buildings

The Leadership in Energy and Environmental Design (LEED) is an internationally-recognised green building certification system (12). The LEED standard has been adopted nationwide in the US as the industry standard of measurement for green buildings. Such buildings use environmentally preferable materials and reuse building materials. Energy reduction is achieved by way of building modifications and operational changes. They also have improved water-usage efficiency and waste handling (13).

5.2. Lighting

Design buildings to use of natural light where possible. Install energy efficient lighting, such as compact fluorescent lighting. Light emitting diodes (LED) have a longer life, are more energy efficient and appear to be the technology of the future.

6. Advocacy – influencing others

Environmental issues have widespread support in the community. Groups associated with the laboratory, such as patients, contractors, the community at large and the government should be targets for advocacy. Environmental improvement may not be seen to be as important as the quality of the laboratory results, but, with time, it is likely that it will become significant. After the initial phase of implementation of good environmental practices, the laboratory should work to influence others. The following are some suggestions:

- Encourage staff members to engage in carbon-offsetting activities where it is feasible.
- Lobby vendors to supply produce instruments that consume less energy, water, and, produce less waste.
- Examine the feasibility of using powdered reagents requiring reconstitution as it leaves a smaller carbon footprint when transported compared with solutions.
- Impose contractual conditions on suppliers and contractors to be more environmentally friendly in their business dealings with the laboratory, e.g., cleaning staff should be encouraged to switch to bio-degradable cleaning products or use cleaning methods that consume less water and electricity.

## Conclusions

Currently, very few clinical laboratories in the world are ISO 14001-certified. Indeed, most laboratories have yet to adopt measures to reduce their impact on the environment. Once started, these efforts should be regarded as an on-going activity. It is important not to be too ambitious at the start. Management should be persuaded to see the wisdom of these activities from the perspective of corporate social responsibility and financial benefits from cost savings in the long run. Good environmental practices should enhance a laboratory's reputation with customers and the community at large.

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## Appendix 1

### Example of an environmental policy

The ABC Pathology Laboratory recognises that we have a corporate responsibility of stewardship to our environment. We pledge to mitigate the environmental impact of associated with our activities through the identification, measurement and evaluation of factors detrimental to the environment and the implementation of strategies to remove or minimise them.

We are committed to heighten environmental awareness. Our company is committed to meet all relevant environmental regulatory and legislative requirements, to achieve continual improvement in environmental performance and to prevent pollution.

In addition, we pledge to:

- Minimise consumption and reduce waste through the reduction, reuse or recycling of materials.
- Implement and maintain best practice waste management systems for specialised pathology waste.

- Provide education and training for staff on environmental matters.
- Prepare disaster mitigation protocols for emergencies to reduce adverse environmental outcomes.

Staff and community awareness of ABC Pathology's commitment to the environment will be achieved through provision of information to internal and external interested parties. We will establish and maintain procedures which specify our environmental objectives and targets. We will direct our efforts towards continual improvement. Our environmental practices will be reviewed at least once a year.

We will also encourage our customers, suppliers and other stakeholders to mirror our commitment to environmental responsibility.

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