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Handbook for greener Healthcare Services

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Health services and ecological transition: an alliance between institutions

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Foreword

The topic of reducing the carbon footprint of health services is by no means new, but the activities that characterise a "green" health service are still not clear to everyone. On an international level, many hospitals and healthcare facilities are committing to specific plans for the reduction of greenhouse gas emissions. Some have long since launched well-structured programmes, while others have implemented targeted action, such as energy efficiency in buildings or waste disposal. However, for the majority of healthcare organisations, at least in Italy, this topic is still completely unexplored.

This handbook is, above all, for these organisations. It has been created as a working tool to assist organisation management teams wishing to engage in the decarbonisation of healthcare services, and to raise awareness among professionals of the need to conduct their daily activities in accordance with the principles of environmental sustainability. It is important to emphasise that measures to mitigate emissions come at no cost of any kind to patients. On the contrary, they contribute to improving the quality and safety of care.

The indications provided in this handbook are based on the experience gained by professionals from different areas, who are tangibly committed to this matter, and on the review of the vast quantity of scientific literature available. There is now an enormous quantity of information on this subject, which is why it can be difficult to identify the most relevant material, especially for those who do not have specific training or the time for in-depth study. This handbook has been created to respond to this need and is therefore presented as a practical tool, easy to apply, with concrete examples that enable "small wins" that motivate people and lead organisations towards a gradual and constant improvement in the quality of care.

The handbook is divided into three sections:

- ***Introduction**: a general examination of the climate crisis, including an overview of the risks to human health and to the environment posed by global warming, and the contribution of health services to greenhouse gas emissions.*
- ***Methodology**: ways in which organisations can address the decarbonisation of health services, measure and monitor the activities that generate greenhouse gases, and calculate emissions using international tools and databases.*
- ***Information relative to the areas of action**: a summary of initiatives that can be undertaken in the various areas of intervention.*
    1. *Leadership*
    2. *Energy supply and building management*
    3. *Transportation and mobility*
    4. *Digitalisation and telemedicine*
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    12. *Training and communication*

Introduction

Climate crisis and health

The climate crisis caused by global warming, whose effects on people's health and well-being are widely known, is considered the most serious health threat of the 21st century. It is, as a matter of fact, a dramatic phenomenon that dominates global news day after day. This is a phenomenon that affects everyone, that is progressively changing our lives and that will radically affect the health and the lives of generations to come.

Greenhouse gases released into the atmosphere through human activity caused 2023 to be the hottest year in the last 100,000 years (1). However, each new record set is destined to be short-lived. As shown in Figure 1, June 2024 was the 12th consecutive month in which the average global surface air temperature exceeded the threshold of 1.5°C higher than the pre-industrial average (2).

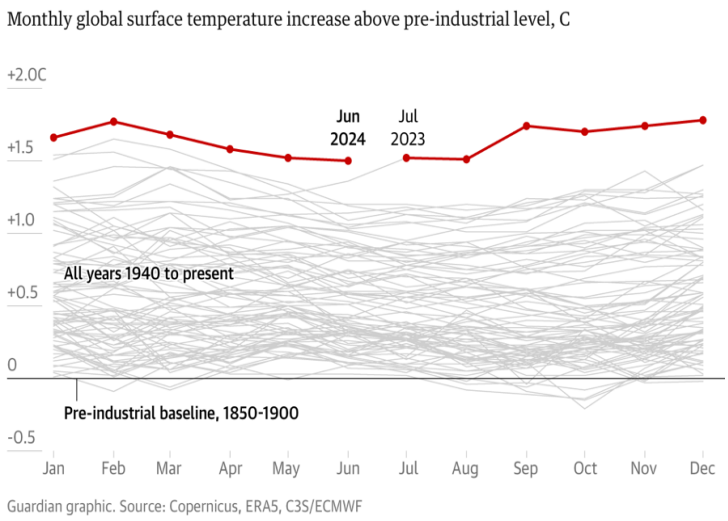

Figure 1: Average global surface air temperature: July 2023-June 2024 (2).

These data are alarming, and if we do not change course, by the end of the century the temperature will rise to 2.7°C higher than pre-industrial levels. This is an apparently insignificant number for living beings, but not for the environment in which they live.

A temperature increase of just a few degrees could, in fact, irreversibly compromise some of the Earth's most vulnerable ecosystems, such as coral reefs, tropical rainforests, permafrost and polar ice caps, with devastating consequences for the environment, wildlife and the lives of many millions of people. By the end of the century, a 3°C rise in temperature would render many areas of the planet uninhabitable and force a third of the world's population to migrate for climatic reasons, exacerbating the social and sometimes violent conflict generated by the unavoidable competition for access to sources of energy, water and food (3).

The contribution of health services to global warming

With a view to mitigating the rise in global temperature, in 2015, 194 member states of the United Nations signed the famous Paris Climate Agreement, in which governments around the world pledged to limit global warming to within 1.5°C higher than the pre-industrial period. To this end, a number of intermediate targets have been set and constantly updated, including a 55% reduction in human-made CO_2 emissions by 2030, with a reduction of the same to zero by 2050. These goals are undoubtedly challenging, but they are achievable, provided that coordinated, determined and rapid action is taken.

There are many feasible and effective solutions for each area of activity (energy, agriculture, transportation, urban environment, building, tourism, health), each characterised by promising

constructive collaboration and shared benefits, but it is essential that everyone play their part, including - of course - healthcare professionals. Indeed, as this latter group is dedicated to health-related problems, it should take the lead and set an example for everyone else. The truth, however, is that, apart from a few praiseworthy exceptions, the level of awareness among healthcare professionals on this issue remains fairly low, and certainly not because the provision of care does not have a significant impact on the environment. It is important to note that the health system is responsible for about 5.2% of total greenhouse gas emissions (4). This is a significant value, twice that of the entire global air transportation system, which sees healthcare activities at the top of the rankings of the various service sectors.

Reducing the ecological footprint of healthcare services is possible, but it is far from easy. Once awareness of the seriousness of the problem has been established, priorities for action need to be set, the entire organisation needs to be involved, many habits need to be changed, data needs to be collected, meetings need to be organised, staff need to be trained, and so on. There are numerous feasible and effective solutions for each specific area of activity, but these first need to be known and then put into practice with determination and without delay.

For a general idea of the emissions attributed to the different areas of activity in relation to the total emissions from the healthcare sector, the diagram below (Figure 2) shows data from the English health service, which should not, however, differ much from those related to the Italian health service.

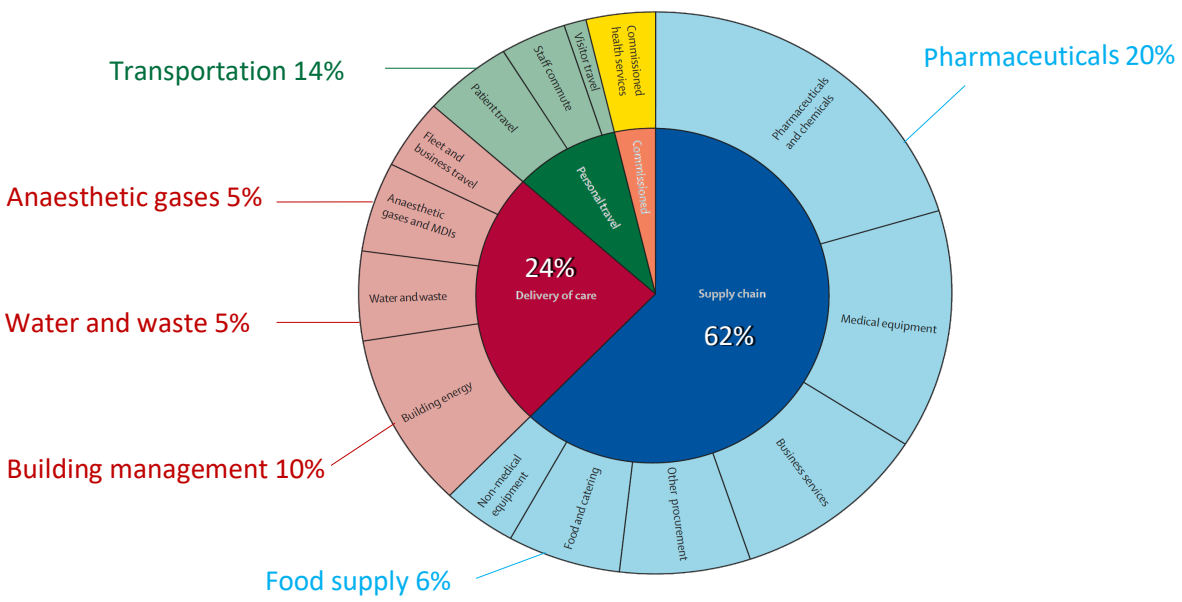

Figure 2: Percentage of CO_2e emissions, subdivided by sector of activity, related to total emissions attributed to the English health service in 2019 (5).

Methodology

Approach to the topic

The implementation and development of a healthcare decarbonisation programme is composed of a two-pronged approach: *top-down* and *bottom-up*.

The ***top-down*** approach, the main steps of which are described in figure 3, begins with the formal recognition by management that the climate crisis is a priority on which human and financial resources should be focused. This is followed by a number of development phases that aim to establish a framework for organisational structure, identify possible areas of intervention and their relative representatives, and launch specific initiatives together with reporting on the results achieved.

Figure 3: The main stages of the top-down approach

This is accompanied by the ***bottom-up*** approach, in which the main agents of change are individual operators, those most sensitive to climate change, who act independently on the basis of personal ideals and motivation. Drawing on their own experience, they promote ideas, suggest changes and improvements to daily activities, and work to ensure that environmental sustainability becomes a value shared by all.

The document also provides useful instructions and reference points for those wishing to further explore more challenging topics such as quantifying CO_2 equivalent or calculating the overall emissions of a hospital.

As we have already mentioned, there is abundant literature on these issues. Valuable information on how to start and manage a process for the decarbonisation of health services can be found, for example, on the websites of Health Care Without Harm Europe (6) or The Canadian Coalition for Green Health Care (7).

Evaluating activities that produce emissions

Quantifying the greenhouse gas emissions of a healthcare organisation and monitoring trends over time is a complex challenge. It is, first and foremost, necessary to identify the activities that generate emissions and select those on which to intervene. Action must then be taken to reduce emissions, and the results need to be evaluated.

Lastly, where possible, it is important to convert data on the improvements achieved through the initiatives taken into CO_2 equivalent (CO_2e), as described in the following section on "quantifying emissions". For example, if we decide to improve the waste collection and disposal process, the first step is to measure the amount of waste actually recycled rather than incinerated over a determined period of time. This amount is then converted into tons of CO_2e saved, using the relative emission factors (high-temperature incineration: 1074 kg CO_2e/t, recycling: 43 kg CO_2e/t). In practice, every ton of waste that is recycled instead of being incinerated saves 1,031 kg CO_2e.

As one can easily imagine, there are countless indicators that can be used to monitor a phenomenon as complex as the decarbonisation of a healthcare organisation's activities, and it would be impossible and impractical to provide a complete list. We have therefore chosen to propose a number of general considerations, leaving individual local organisations free to define a system of indicators best suited to their specific circumstances and needs.

This does not, however, preclude the possibility of sharing the definition of certain indicators with a view to allowing comparison of the results achieved by similar organisations and monitor the evolution of a certain phenomenon over time.

It is stressed that an indicator is understood to be a variable that provides a brief description of a certain phenomenon, to provide useful information for comparing different situations, identifying trends, assessing critical issues and successes, making decisions and planning any improvements necessary.

To this end, indicators must be clearly defined, reproducible, accurate, simple, and easy to both measure and analyse. Note that an indicator can be considered as reproducible when the same or similar values are attributed to a particular phenomenon by different observers, or by a single observer at different moments. An indicator is accurate when the observed value corresponds to the true value. Reproducibility and accuracy are fundamental to the ability to monitor a certain phenomenon and compare progress over time and space (between different organisations).

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Indicators can be expressed with an absolute number, such as the number of projects implemented to improve the environmental sustainability of the organisation, or the number of trees planted. Alternatively, they can be expressed by a formula such as the percentage of energy consumed from renewable sources or the percentage of sorted and recycled hospital waste. In these cases, care must be taken to clearly define the numerator and the denominator.

The following should also be specified for each indicator: the source of the data, the frequency of measurements, the person responsible for collection and the expected values (reference thresholds).

Quantifying emissions

Calculating CO_2e is crucial for assessing the environmental sustainability of a product or service, as different greenhouse gases (carbon dioxide, methane, nitrous oxide, anaesthetic gases) have different impacts on global warming. By converting the emissions of the various gases into CO_2e, their contribution can be evenly accounted for, enabling transparent reporting and measurement of progress in terms of mitigation goals.

Quantifying CO_2e results in the following benefits (figure 4):

- the obtaining of a **complete picture** of emissions, as it takes into account not only carbon dioxide but also other greenhouse gases, which may have a much more significant effect on the climate than CO_2.
- a **comparison** of different products, services or processes on the basis of a single unit of measurement, facilitating informed decisions and the identification of the option with the least environmental impact.
- a **full view** of environmental impact, as opposed to a simple estimate of energy and material consumption. For calculation purposes, one must consider **the entire life cycle** of a product or service: sourcing of raw materials, production, transportation, use and disposal.
- the **inclusion of emissions that are not immediately apparent**, providing a more accurate picture of overall impact. For example, when the energy used to create a product comes from a range of sources, each with a different emission intensity.

Figure 4: Benefits of quantifying CO_2e.

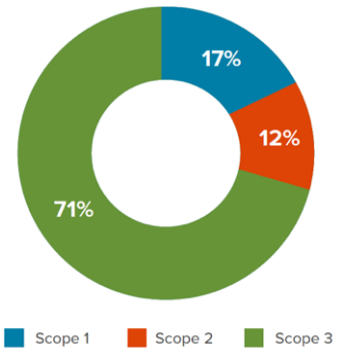
- the **comparison of emissions with a metric recognised by international standards**, participation in inter-organisation projects and regulatory activities.

Techniques and tools for calculating CO_2e

The Greenhouse Gas (GHG) Protocol (8) is the most widely used international framework for calculating greenhouse gas emissions. It provides guidelines and standards that organisations can use to accurately measure CO_2e related to their production processes.

The GHG Protocol classifies emissions into three different areas (Figure 5):

- **Scope 1 (17%):** includes direct emissions from sources owned or controlled by the organisation, such as vehicles, systems, equipment and anaesthetic gases.
- **Scope 2 (12%):** concerns indirect emissions from energy purchased by the organisation, such as electricity, heating, cooling and steam.
- **Scope 3 (71%):** includes all other indirect emissions occurring throughout the organisation's value chain, including purchased goods, transportation services, waste management, the supply chain, etc.



Health Care Without Harm 2019

Figure 5: Percentages of emissions attributed to different scopes of activity.

The emissions generated by the first two scopes are generally well defined and quantifiable, but only account for 15-35% of the total. Most emissions relate to scope three, but measuring them requires access to reliable data on the organisation's activities and suitable technical expertise to convert them into CO_2e. Moreover, the emission factors currently available have been acknowledged to be widely open to interpretation.

To calculate emissions, the GHG Protocol recommends collecting accurate data on organisational activities that represent a source of emissions, and applying emission factors to convert the data into CO_2e emissions. This can be done as shown in Table 1 (9).

Stages for the assessment of CO_2e	
Define the perimeter of the system	It is necessary to determine which activities, sources and types of emissions will be included in the calculation. This may vary depending on the organisation's goals and available resources.
Gather data	Data must be gathered on all activities that generate emissions. This may include fuel consumption, electricity, vehicle use, business travel, anaesthetic gas consumption, waste, food consumption, etc.
Calculate emissions	For assessment, appropriate emission factors must be applied in order to convert the data gathered into greenhouse gas emissions. Emission factors are values that quantify GHG emissions per unit of activity, such as tons of CO_2e per MWh of electricity consumed. *Emissions = product or consumption data x relative emission factor*
Aggregate emissions	Add up the emissions to get an overall total of CO_2e emissions.
Prepare a report and communicate results	Draw up a report documenting the organisation's total GHG emissions. This report can be used to communicate results to internal and external stakeholders and to identify areas for improvement.

Table 1: Stages for the assessment of CO_2e

Emission factors allow activity data to be converted into estimates of greenhouse gas emissions. Using the appropriate emission factors and activity data, carbon equivalents can be estimated throughout the entire value chain. Emission factors provide useful yet imprecise estimates of environmental impact. The variability of scenarios, the assumptions on which analysis is based, and the quality of the available data may, in fact, limit the accuracy of these estimates. It is therefore important to track complete and accurate activity data and to use emission factors that are reliable and that relate as closely as possible to the context of the analysis.

How are emission factors acquired?

To acquire emission factors and calculate CO_2e in a hospital on the basis of the GHG Protocol, it is essential to use reliable tools and resources that facilitate data collection and the correct application of emission factors.

This information can be obtained from databases freely available online, in accordance with the organisation's specific needs (table 2). In addition, commercial software is also available for calculating the greenhouse gas emissions associated with the various activities.

Sources for the acquisition of emission factors	
Emission factor databases	• The official website of the **GHG Protocol** provides a number of resources, including specific emission factors for various activities and sectors. You can access these resources directly from the GHG Protocol website. • The **IPCC** provides detailed emission factors in its guidelines, which are widely recognised and used internationally. These can be found in IPCC technical reports, such as the "Guidelines for National Greenhouse Gas Inventories". • In Italy, **ISPRA** (the Italian Institute for Environmental Protection and Research) provides up-to-date and specific emission factors for a range of activities. You can access this information via the website. • **ARPA** (the Regional Environmental Protection Agency) regularly publishes specific emission factors for relative areas.
Online tools	• **The EPA** (Environmental Protection Agency) in the US provides a wide range of emission factors used for several types of industrial activity, including those related to energy consumption, waste management and the use of specific gases, such as those used in hospitals. Although EPA emission factors are specific to the US, they can be useful for reference when local factors are not available. • **Defra** (the Department for Environment, Food & Rural Affairs), in the United Kingdom, publishes an annual set of emission factors for converting activities into CO_2 equivalent emissions. These are widely used throughout Europe and cover an extensive range of sources, including those typical for a hospital (energy, transportation, waste). These factors are particularly useful for hospitals located in Europe or that follow guidelines similar to those in Europe.
Other specific tools for the healthcare sector	• Among the various tools available online, **Global Green and Healthy Hospitals** (10) offers resources and instruments for measuring and reducing emissions in the healthcare sector.

Table 2: A selection of sources for the acquisition of emission factors.

In order to facilitate the conversion of consumption and activities into CO_2e emissions, Table 3 provides examples of conversion factors categorised by area of impact. Values are to be understood as average estimates to be adjusted in accordance with individual analysis specifications.

Examples of emission factors for various areas of impact	
Energy supply and building management	• 1 kWh electricity (average Italian mix): 0.307 $kgCO_2e$ (11) • 1 kWh heating (Italian mix): 0.333 $kgCO_2e$ (11) • 1 kWh (photovoltaic): 0.090 $kgCO_2e$ (11) • 1 kWh (hydro-electric): 0.006 $kgCO_2e$ (11) • 1 tree = -25 kg CO_2/year (12)
Transportation (13)	• 1 km (average petrol or diesel vehicle): 0.170 $kgCO_2e$ • 1 km (electric vehicle): 0.047 $kgCO_2e$
Telemedicine	• 1 A4 (paper and printing): 0.003 $kgCO_2e$ (12) • 1 in-person consultation (30 km round trip): 9 $kgCO_2e$ (14)
Waste	• High-temperature incineration: 1,074 kg CO_2e/t (15) • Autoclave + low temperature incineration 569 kg CO_2e/t (15) • Recycling reusable surgical devices: 43 kg CO_2e/t (15) • 1 cup/plate: 0.014/ 0.046 $kgCO_2e$ (16) • 1 cutlery set: 0.016 $kgCO_2e$ (16)
Food	• 1 kg bread: 0.573 $kgCO_2e$ (11) • 1 kg cheese: 7.046 $kgCO_2e$ (11) • 1 kg meat: 27.86 $kgCO_2e$ (17) • 1 kg chicken: 2.6 $kgCO_2e$ (11) • 1 kg pulses: 1 $kgCO_2e$ (11) • 1 kg vegetables: 0.560 $kgCO_2e$ (11)
Anaesthetic gases	• 1 l sevoflurane = 196 $kgCO_2e$ (18) • 1 l isoflurane = 760 $kgCO_2e$ (19) • 1 l desflurane = 3,691 $kgCO_2e$ (18)
Pharmaceuticals and medical devices (20)	• 1 powder inhaler = 0.009 $kgCO_2e$ • 1 gas propellant inhaler (HCF-227ea) = 0.227 $kgCO_2e$ • 1 bag (50 ml) = 0.130 $kgCO_2e$
Appropriateness of care	• 1 chest X-ray = 0.53 $kgCO_2e$ (21) • 1 CT scan = 9.2 $kgCO_2e$ (21) • 1 MRI scan = 17.5 $kgCO_2e$ (21) • 1 blood test (haemogram) = 0.116 $kgCO_2e$ (22)
Chemical products (11)	• 1 kg of H_2O_2 = 0.534 kgCO2e • 1 kg C12-C14 alcohol ethoxylates 3EO = 1.876 $kgCO_2e$

Table 3: Examples of emission factors for various areas of impact.

Information by area of work

The information provided covers 12 areas of work and has been prepared to help organisation management and professionals seeking to contribute to reducing the carbon footprint of healthcare services (Figure 6).

Each set of information consists of:

- **a brief introduction** concerning the main activities that characterise the area of work with an estimate (expressed as a percentage) of the impact on the overall emissions of a hospital (figure 2) and a bibliography for further study.
- **a list of actions** related to the thematic area that healthcare organisations can adopt to reduce greenhouse gas emissions. These actions should not be as a complete list of all possible measures to mitigate the impact of healthcare services on climate change. They merely provide an overview of the main indications proposed in international scientific literature for the various areas of action and are subject to ongoing revision to ensure that the actions are always in line with the best available knowledge. Obviously, the feasibility of initiatives depends on the level of awareness of the people involved and the organisational context in which operations are carried out.

Each healthcare organisation, taking into account the specific local operational context, chooses the areas of work to focus on and the relative actions to be initiated on the basis of the suggestions in each of the 12 sets of information. An Excel file can be used to describe and monitor the various decarbonisation actions undertaken by each organisation, with a worksheet dedicated to each of the areas concerned.

Table 4 provides examples of actions pertaining to various areas of work. Each organisation can customise the table by adding the information it deems useful, such as the costs incurred to implement the project, the operational units involved, the main critical issues encountered, further stages of development, and so on.

The handbook thus lends itself to easy and immediate interpretation, through practical examples based on actual operational situations. The prospect of having to take so many activities into consideration may be daunting, but the idea is to consider local circumstances, familiar themes, and projects that may already be in place, and then subsequently implement proposals and actions that involve an increasing number of work areas.

The handbook focuses on healthcare activities typically related to hospitals, but most of the actions are applicable in any healthcare setting: community centres, nursing homes and general practitioner clinics. Individual professionals can also find useful advice and guidance for their everyday activities.

Action title	Relative organisation	Organisation representative	Status	Activity related data
Establishment of a multidisciplinary green team for the organisation	Healthcare management	Name and surname	Resolution number… Dated…	Number of annual team meetings
Updating of external lighting with LED technology	Systems	Name and surname	Completed	Difference between annual consumption before and after replacement
Leasing of 5 electric cars for the organisation fleet to replace petrol cars	Logistics and supply services	Name and surname	Lease commenced	Difference between annual consumption of petrol and electric cars
Separation of hard and soft plastics	Medical Management	Name and surname	Started May 2023	Kg of separated hard plastics pre- and post-project
Meal reservations	Logistics and supply services	Name and surname	Consolidated and ongoing activity	Reduction in kg of organic waste
Replacement of desflurane with sevoflurane	Anaesthesia and Reanimation and Pharmacy	Name and surname	Replacement commenced in …	Difference in consumption of desflurane and sevoflurane before and after replacement

Table 4: Example of information to be collected for each of the activities implemented by the healthcare organisation.

1. *Leadership*

The process of decarbonisation of healthcare activities begins with organisation management acknowledging that, due to its serious effects on health, the climate crisis represents a health emergency and that the ecological sustainability of care, particularly in terms of decarbonisation initiatives in health services, is of strategic importance to the organisation.

Strategic management therefore needs to devote energy and resources to setting up a working group dedicated (not exclusively) to environmental sustainability, and create a physical and communicative environment in which all personnel are encouraged to adopt environmentally friendly behaviour in all operative situations (1).

Proposed actions

- Adopt a strategic organisational plan for climate change and appoint a figure to take responsibility for implementation (Climate Manager).
- Set up a multi-profession working group to define priority areas for action to reduce the carbon footprint of health services, implement action and evaluate the results achieved (Green Team).
- Participate in inter-company projects as well as national and international initiatives on sustainable care, such as "WHP" (Workplace Health Promotion), "Choosing Wisely Italy" or "Global Green and Healthy Hospitals".
- Promote research projects related to environmental sustainability.
- Include environmental considerations in the health technology assessment (HTA) process.
- Introduce environmental sustainability indicators in the evaluation of quality of care.

2. *Energy supply and building management*

The healthcare sector consumes an enormous amount of energy (2), much of which continues to be produced with fossil fuels. This is why it is essential to promote initiatives aimed at producing energy from renewable sources, through the installation of solar panels, photovoltaic panels and heat pumps, as well as the purchase of "green" energy from certified sources.

There is much that can be done in this field, and the implementation of action can be entrusted to the *Energy manager*, who is not only responsible for energy procurement, but also for defining of organisation strategies regarding energy sustainability (3).

The use of fossil fuels for heating, cooling and lighting in healthcare facilities contributes to approximately 10% of the emissions attributable to healthcare services. Therefore, improving the energy efficiency of buildings, optimising consumption, making the best use of space and promoting virtuous behaviour are essential steps towards decarbonising the health sector (4).

Proposed action

- Appoint an energy manager.
- Stipulate contracts for the supply of energy from guaranteed renewable sources.
- Install cogeneration and/or tri-generation plants for the combined production of electricity, heat and/or cooling.
- Obtain suitable energy management certification from accredited bodies.
- install solar panels and photovoltaic systems.
- Use LED light sources.
- Install sensors for automatic light control in communal areas (bathrooms, corridors, etc.).
- Take action to update the technology used in systems and increase the energy efficiency of buildings.

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- Favour natural lighting and ventilation for internal spaces.
- Install energy consumption monitoring systems and sensors to control heating, ventilation, lighting and water temperature.
- Optimise the use of space.
- Provide more green space for both employees and visitors.
- Launch information and educational initiatives aimed at reducing energy consumption.

3. *Transportation and mobility*

Transportation of staff and patients travelling to healthcare facilities accounts for approximately 14% of the emissions attributable to healthcare services and is a significant source of air pollution. This fully justifies the appointment of a mobility manager, who is responsible for optimising employee commutes and reducing, when possible, the need for patients and their carers to travel, as well as promoting the electrification of the company fleet (5).

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Private vehicles remain the means of transport most frequently used to reach healthcare facilities, particularly in rural areas (6). It is therefore essential to promote the use of public transport and encourage people to limit car use in favour of active mobility (walking or cycling) by creating protected pedestrian routes, cycle paths and parking space for scooters and bicycles (7), equipped with charging stations for e-bikes and spaces dedicated to bike-sharing.

Proposed actions

- Appoint a mobility manager.
- Plan the gradual replacement of the fleet of the organisation with electric or hybrid cars.
- Install electric vehicle charging stations for users, employees and visitors.
- Create protected parking space for bicycles and scooters complete with charging facilities.
- Promote the creation of footpaths and cycle paths leading to healthcare facilities.
- Negotiate discounts for the use of public transport.
- Encourage people to take the stairs instead of the lift.
- Encourage smart working wherever and whenever possible.

4. *Digitalisation and telemedicine*

The process of digitalising certain administrative and healthcare activities saw a sudden and not always appropriate acceleration during the COVID-19 pandemic. This process continues to grow as a result of the benefits that telemedicine offers, not only to patients, but also in terms of efficiency, cost and environmental sustainability (8). It has been estimated that travel by patients and their carers is responsible for 5% of the emissions attributed to healthcare services and that these emissions could be considerably reduced through the use of digital technology that is already available.

Digital healthcare services encompass a wide range of solutions including electronic check-ups and consultations, wearable sensors monitored remotely, Electronic Health Records (EHR), electronic medical files, distance learning and artificial intelligence. The adoption of these solutions requires significant changes to the organisation as well as the availability of dedicated investment, and also calls for cultural changes on the part of both patients and healthcare workers.

One essential aspect is the assessment of the appropriateness, clinical applicability, practical efficiency, safety and certification of digital health procedures within the healthcare service network, ensuring that care is personalised and that a trust-based relationship is maintained.

Proposed actions:

- Appoint a figure responsible for telemedicine development.
- Launch telemedicine, remote consultation and remote monitoring initiatives as possible alternatives to face-to-face interaction with patients.
- Adopt electronic medical files to replace paper-based medical files.
- Adopt electronic communication methods to deliver test results and use the Electronic Health Record (EHR) system as the main tool for the digital sharing of health-related data.
- Limit printed paper and replace fax or internal mail with email, shared folders, or other digital tools.
- Promote online conferences and training sessions.

5. *Waste*

Waste generated by healthcare activities accounts for 5% of the healthcare sector's emissions. The negative impact of waste on the environment may potentially be mitigated through initiatives to decrease quantity by limiting the use of single-use products when not strictly necessary for safety reasons. For example, gowns, caps, surgical drapes and towels made of linen or cotton are a valid alternative to single-use plastic-based textiles. These reusable materials are generally favoured by staff, offer similar protection against infections, reduce greenhouse gas emissions by up to 66% and are also more cost-effective in the long term (9). Similarly, disposable vaginal speculums made of acrylic material used for cervical examination can be replaced with reusable models made from stainless steel (10).

It is important to remember that only 15% of medical waste is considered as hazardous (infectious, toxic or radioactive). The remaining 85% is comparable to municipal waste and can therefore be recycled without any prior treatment, provided the waste is suitably separated. In addition to being much less expensive, recycling causes up to 50 times less pollution than incineration, which unfortunately remains the main method of disposing of hospital waste (11).

Particular attention should be paid to the sorting of plastic (bottles, packaging, protective wrappings) since plastic litter and the consequent formation of microplastics pose a serious threat to human health as well as to terrestrial and marine ecosystems.

Proposed actions:

- Set up a special working group for waste management and disposal.
- Draw up and communicate guidelines for the disposal of municipal and special waste.
- Begin waste separation in administrative and healthcare areas.
- In line with patient safety, limit the use of single-use medical devices (vaginal speculums, endoscopes, laryngoscopes...) and materials (gowns, drapes, towels...).
- Replace plastic plates, cups and cutlery with reusable alternatives.

- Do not use disposable gloves as an alternative to hand hygiene when measuring blood pressure, body temperature or pulse, dressing and transporting patients, administering oral or intramuscular medication, distributing meals, making beds...
- Do not routinely use gowns, masks, caps and gloves for access to intensive care units by relatives.
- Install drinking fountains connected to the mains water supply, and limit the distribution of water in plastic bottles (use only tap water whenever possible).

6. *Food*

The food we consume not only has a major influence on our health, but also represents about 6% of the greenhouse gas emissions of healthcare services. These emissions could be significantly reduced by adopting predominantly vegetarian diets, which are not only more sustainable for the environment, but also more beneficial to human health.

Vegetable-based diets have been associated with a significant reduction in the incidence of many diseases, such as cardiovascular disease, diabetes, cancer, tooth decay and obesity (12). Furthermore, vegetable production has a much lower impact on the environment than meat production. Livestock farming consumes most of the soya and maize cultivated in the world and intensive breeding generates 25% of the CO_2, 50% of the methane and 60% of the nitrous oxide released into the atmosphere (13).

To adopt a healthier and more sustainable diet, consumption of meat (especially red meat) should be reduced by at least 50%, while the consumption of vegetables, pulses and oil-rich nuts should be more than doubled.

Hospitals offer numerous opportunities to reduce the climate impact of food, including the management of catering contracts, the promotion of seasonal and local produce, the selection of menus for staff and patients, the methods used to prepare and distribute meals, and the collection of food waste.

Proposed actions:

- Reduce the presence of meat (especially red and processed meat) in favour of whole grains, pulses, seasonal fruit and vegetables in menus for staff and patients.
- Focus on local and organically grown products.
- Eliminate sugary drinks and ultra-processed products (sweet and savoury snacks) from vending machines, replacing them with nuts, fruit and cereal-based products such as crackers and breadsticks.
- Install water dispensers connected to the mains water supply.
- Implement projects for the collection and redistribution of unconsumed food.
- Promote awareness-raising campaigns on the adoption of nutritional habits that are beneficial to individual health and the environment, in line with the “One Health” approach.

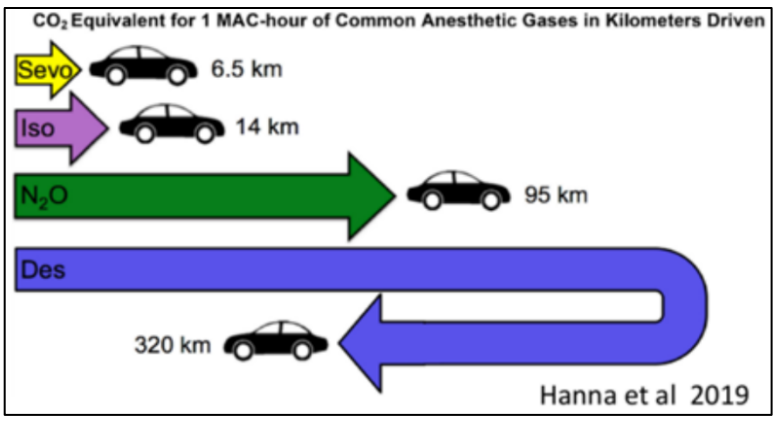
7. *Anaesthetic gases*

Anaesthetic gases are potent greenhouse gases and alone contribute to about 5% of greenhouse gas emissions related to healthcare services, equivalent to approximately half the emissions related to energy management in buildings. Of the various gases currently used in anaesthesiology, desflurane is by far the most harmful to the environment, with a GWP (Global Warming Potential) index of more than 2,500 times that of CO_2. Therefore, in obtaining the same clinical effects, it is better to favour anaesthetic gases that are less harmful to the environment, and to optimise their use through closed breathing circuits combined with low flow rates (14).

As a matter of fact, apart from a few exceptions, desflurane can be replaced with anaesthetic gases that are just as effective, safe and less harmful to the environment, such as sevoflurane, which causes 20 times less pollution. Alternatively, in line with the recommendations of the World Federation of Societies of Anaesthesiologists, alternative anaesthesia techniques such as intravenous or neuraxial anaesthesia (15), which have a significantly lower environmental impact than any anaesthetic gas, can be adopted.

Despite this, a recent study showed that, unlike in many other European countries, the use of desflurane in Italy is steadily increasing. Furthermore, there is a considerable disparity in the per-capita use of desflurane between Italian regions, with differences of up to 25 times, without any clinical justification. This not only suggests a lack of environmental awareness, but also represents an opportunity for reducing the use of this gas without compromising the quality and safety of care (16).

In view of the powerful greenhouse effect of this gas and the availability of safe alternatives, the new regulation approved by the European Parliament on the use of fluorinated gases sees a ban on the use of desflurane as an inhalation anaesthetic as of 1 January 2026, unless specific medical reasons mean that no other anaesthetic can be used. In these latter circumstances, the health organisation is required to keep evidence of medical justification and provide it to the competent authority of the Member State or to the European Commission (17).



Proposed actions:

- Replace desflurane with other anaesthetic gases (sevoflurane) that are equally effective and less harmful to the environment.
- Optimise the use of anaesthetic gases by using closed, low-flow-rate systems.
- Intravenous or neuraxial anaesthesia techniques should be used whenever possible.

8. *Pharmceuticals*

Pharmaceuticals are one of the most important achievements in the field of medicine, but they must be used correctly, as they can cause side effects and harm to the environment through soil and water contamination, even in remote areas such as Antarctica. The production, packaging, transportation, use and disposal of pharmaceuticals are also responsible for approximately 20-25% of the greenhouse gas emissions generated by healthcare services. The pharmaceutical sector, therefore, represents a major opportunity to reduce CO_2emissions, not least because an ageing population and scientific advances will inevitably lead to an increase in the consumption of pharmaceuticals and the number of new molecules released into the environment.

The most effective way to reduce the impact of pharmaceuticals on health and the environment is to address appropriateness, an issue that affects many pharmaceuticals used in current clinical practice. Consider, for example, antibiotics, antidepressants, NSAIDs (non-steroidal anti-inflammatory drugs), proton pump inhibitors, benzodiazepines and statins. Particular attention should also be paid to what is referred to as polypharmacy, a worrying and rapidly growing phenomenon affecting a sizeable proportion of the elderly population. Approximately one third of the population over the age of 65 takes 10 or more pharmaceuticals simultaneously, and often inappropriately (18).

It is important, whenever possible, to favour pharmaceuticals and methods of administration with a lower environmental impact. For the treatment of asthma and chronic bronchopathy, powder inhalers can be used as a substitute for inhalers with gaseous propellants, as the carbon footprint of the former is as much as 40 smaller than that of the latter, while providing the same effectiveness (19). Alternatively, instead of intravenous methods, oral administration can be used, which is known to have a far lower carbon footprint, while still being effective and safer for the patient (20).

Proposed actions:

- Implement deprescription and prescription appropriateness initiatives, particularly for pharmaceuticals for which there are substantial data regarding overuse, such as antibiotics, antidepressants, NSAIDs, proton pump inhibitors, benzodiazepines, statins, as well as for products such as vitamins and supplements.
- Without compromising effectiveness, favour less environmentally harmful pharmaceuticals, for example powder inhalers rather than sprays for the treatment of asthma.

- Whenever possible, use oral rather than intravenous administration.
- Do not accept or distribute pharmaceutical samples.
- Dispose of medicines correctly.
- Pharmaceutical environmental impact assessment: one example is the PREMIER project (21).

9. *Chemical products*

In addition to the decarbonisation of healthcare services, another area that deserves particular attention is chemical sustainability, as health care facilities see daily and widespread use of potentially harmful chemical substances. Indeed, many of the products used, either for therapeutic purposes or for personal hygiene and sanitation (pharmaceuticals, disinfectants, detergents, chemical reagents), can pose a serious threat both to the health of staff, patients and the community, and to the environment, if not handled and disposed of properly.

Taking on the matter of chemical sustainability entails adopting a preventive and responsible approach to selecting and using products in such a manner as to minimise the risks associated with exposure. The first step is to identify potentially harmful chemicals and replace them with certified eco-friendly products or safer alternatives, in line with the principles of "green chemistry".

This is a field that focuses on the design, production and use of chemicals that minimise risks and optimise resources, with the aim of mitigating any negative impact on people and the environment (22) in line with the relative indications set out in the European Green Deal (23).

Organisations wishing to embark on a gradual transition to safer and more environmentally friendly practices currently have access to a number of operational tools that provide support in identifying hazardous substances in use and replacing them with safer products. These tools have been developed as part of leading European projects. These include: PARC - Partnership for the Assessment of Risks from Chemicals (24) and LIFE VERMEER (25)

Proposed actions:

- Identify hazardous chemicals used within the organisation and replace them with less toxic or environmentally friendly alternatives.
- Reduce the excessive use of chemicals with automatic dosing systems or optimised procedures.
- Dispose of chemical waste in accordance with processes that comply with environmental regulations.

10. Appropriateness of care

The monitoring of appropriateness, particularly with regard to overprovision, is seen as one of the most important measures for mitigating the carbon footprint of healthcare services, and is also a valid method for reducing waste and improving the quality of care.

As a matter of fact, 20-30% of resources dedicated to healthcare are used to provide unnecessary services (26) and only 60% of treatment is based on guidelines of recognised effectiveness, while 30% are useless or of little clinical value and 10% are actually harmful (27).

Scientific literature provides abundant examples of overuse of healthcare services. For example, 21% of MRI scans, 40% of CT scans, 44% of X-rays and 56% of ultrasound examinations are not clinically justified (28), general health checks serve no purpose (29), most routine pre-operative tests are useless (30), as is arthroscopic surgery performed on patients with symptomatic knee osteoarthritis (31), and the list goes on, concerning all areas of medicine.

A number of important international initiatives have been launched in recent years to mitigate this phenomenon, including Choosing Wisely (32), launched in the United States in 2012 (now present in 35 countries on five continents) and adopted in Italy the same year by Slow Medicine with the project "*Doing more does not mean doing better*", also known as Choosing Wisely Italy. More than 50 national scientific societies of physicians and health professionals have joined the project, drawing up more than 300 recommendations concerning unnecessary tests, treatments and procedures, which can be readily accessed via the dedicated website (33).

Proposed actions:

- Set up systems to monitor the quality of performance, using prescriptive variability to identify operational priorities.
- Initiate peer clinical audits and the de-implementation of healthcare services that are unnecessary, needless or of low clinical value.
- Promote training initiatives for professionals on unnecessary prescriptions.

11. Procurement

It is estimated that over 70% of greenhouse gas emissions from healthcare services are related to the production, transportation, use and disposal of commercial products (34). This is due to the large quantity of instruments, medical devices, pharmaceuticals and materials used, of waste generated and of energy consumed during healthcare processes.

Although healthcare professionals do not have direct control over these emissions, they can still influence the quality of procurement. More sustainable products and services save time, space, energy and water; they generate less waste; they reduce the amount of toxic substances released into the environment; they require less maintenance and lead to longer periods of use. Sustainable procurement is therefore a powerful means of limiting the environmental impact of healthcare services.

Where available, reference should be made to the Minimum Environmental Criteria (MEC) established by current legislation (35). It is, in any case, advisable to consider the entire life cycle of products (extraction of raw materials, production, transport, use and disposal) before purchasing, ensuring that they are made of recyclable, biodegradable, reusable materials that do not contain any chemicals that pose a threat to health or to the environment.

Manufacturers often underscore the environmental credentials of their products, but in choosing suppliers, the focus should be on local companies that hold appropriate certification from accredited bodies, confirming their commitment to adopting ethical behaviour and to reducing the environmental impact of their manufacturing.

It should be noted that other countries have already issued mandates in this regard: for example, by 2027 all English Health Service providers will be required to publish a report on their emissions as well as a Carbon Reduction Plan in line with Health Service targets. As of 2030, procurement contracts will be granted exclusively to companies that have fulfilled the commitments established by this programme (36).

Proposed actions

- Before purchasing, consider the entire life cycle of products, and choose those that have the lowest environmental impact while offering the same functional characteristics.
- Where available, refer to the Minimum Environmental Criteria (MEC) established by current legislation.
- Choose equipment that meets high energy efficiency standards and that guarantees product repair even beyond the warranty period.
- Select products and suppliers, preferably local, with appropriate environmental certification.
- Adopt digital consumption monitoring systems.
- Ensure that personnel are aware of the need to adopt environmentally sustainable behaviour, and involve them in defining criteria for evaluating and selecting commercial products with the most favourable ecological footprint.

12. *Training and communication*

One of the key elements in building a healthcare system resilient to climate change is ensuring that everyone (administrators, professionals, patients and the general public) is aware that the climate emergency poses a serious threat to human health and to the planet, and that immediate action needs to be taken, because although feasible solutions exist, their effectiveness depends on the degree to which individuals participate and are involved (37).

To this end, it is beneficial to implement specific information and training activities, focusing not only on the harm to the planet that can be avoided in the long term, but also on the immediately acknowledgeable collateral benefits to individual health, such as, for example, action that affects air quality or dietary behaviour (38).

Proposed actions:

- Include specific initiatives in the annual training programme related to the climate crisis and to reducing the carbon footprint of healthcare services.
- Create an institutional web page, declaring the organisation's ecological commitment and describing the projects launched.
- Prepare information material for employees, patients and the general public on the importance of adopting behaviour in line with environmental sustainability goals in all circumstances, offering specific and practical examples: waste, food, plastics, single-use items, and so on.

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Bibliography

Introduction and methodology

1. Romanello M et al: The 2023 Report of the Lancet Countdown on health and climate change: the imperative for a health-centred response in a world facing irreversible harms. Lancet 2023; 402:2346-2394. doi: 10.1016/S0140-6736(23)01859-7.
2. Copernicus Climate Change Service (C3S): https://climate.copernicus.eu/
3. Romanello M et al: The 2022 report of the Lancet Countdown on health and climate change: health at the mercy of fossil fuels. Lancet 2022; 400(10363):1619-1654. doi: 10.1016/S0140-6736(22)01540-9.
4. Lenton t M et al: Quantifying the human cost of global warming. Nature Sustainability 2023; 6: 1237–1247. https://doi.org/10.1038/s41893-023-01132-6.
5. Tennison I et al: Health care's response to climate change: a carbon footprint assessment of the NHS in England. Lancet Planet Health 2021 Feb;5(2):e84-e92. doi: 10.1016/S2542-5196(20)30271-0.
6. Health Care Without Harm - Europe: https://europe.noharm.org
7. The Canadian Coalition for Green Health Care: https://greenhealthcare.ca
8. Greenhouse Gas (GHG) Protocol: https://ghgprotocol.org/
9. Greenhouse Gas Protocol – Governance process for developing standards and guidelines: https://ghgprotocol.org/sites/default/files/GHG%20Protocol_Governance%20and%20Decision-making%20Process.pdf
10. Global Green and Healthy Hospitals: https://greenhospitals.org/
11. FootprintCalc1.2: https://footprintcalc.org/
12. ForTomorrow: https://www.fortomorrow.eu/en
13. Tiseo A: Carbon footprint of travel per kilometer 2022, by transport mode. Statista 2024. https://www.statista.com/statistics/1185559/carbon-footprint-of-travel-per-kilometer-by-mode-of-transport/)
14. Savoldelli A, Landi D, Rizzi C: Exploring the Environmental Impact of Telemedicine: A Life Cycle Assessment. Stud Health Technol Inform. 2024 Apr. doi: 10.3233/SHTI240016.
15. Chantelle R et al: The carbon footprint of waste streams in a UK hospital, Journal of Cleaner Production, 2021. doi: 10.1016/j.jclepro.2020.125446.
16. Gold T: The Impacts of Single-use Plastics - A Life Cycle Assessment. DePaul Discoveries 2020, Volume 9, Article 5. https://via.library.depaul.edu/depaul-disc/vol9/iss1/5/
17. Jeong D et al: A case study of CO_2 emissions from beef and pork production in South Korea. J Anim Sci Technol. 2023 Mar;65(2):427-440. doi: 10.5187/jast.2022.e109
18. Wyssusek K, et al: Greenhouse gas reduction in anaesthesia practice: a departmental environmental strategy. BMJ Open Qual 2022 Aug;11(3):e001867. doi: 10.1136/bmjoq-2022-001867
19. Al Fannah et al: Towards a green hospital approach in Oman: A case study of quantifying an environmental impact. Int J Health Planning and Management 2023 Sep;38(5):1583-1589. doi: 10.1002/hpm.3662
20. Harish J et al: Life cycle environmental impacts of inhalers. Journal of Cleaner Production 2019. https://doi.org/10.1016/j.jclepro.2019.117733
21. McAlister S et al: The carbon footprint of hospital diagnostic imaging in Australia. The Lancet Regional Health - Western Pacific 2022. doi: 10.1016/j.lanwpc.2022.100459.
22. McAlister S et al: The carbon footprint of pathology testing. Med J Aust. 2020. doi: 10.5694/mja2.50583.

Work areas

1. Sergeant M et al: What healthcare leadership can do in a climate crisis. Healthcare Management Forum. 2023 Jul;36(4):190-194. doi: 10.1177/08404704231157035.
2. Alotaiby, R et al: Energy efficiency in healthcare institutions. Society and Economy, 2023; 45(4), 494-511. https://doi.org/10.1556/204.2023.00013
3. Borges de Oliveira K et al: Guidelines for efficient and sustainable energy management in hospital buildings. Journal of Cleaner Production, Volume 329, 2021, 129644. https://doi.org/10.1016/j.jclepro.2021.129644.
4. Vallée A: Green hospitals face to climate change: Between sobriety and resilience. Heliyon. 2024 Jan 17;10(2):e24769. https://doi.org/10.1016/j.heliyon.2024.e24769
5. Filho L et al: Climate-friendly healthcare: reducing the impacts of the healthcare sector on the world's climate. Sustain Sci 19, 1103–1109 (2024). https://doi.org/10.1007/s11625-024-01487-5.
6. Savoldelli A, et al: Exploring the Environmental Impact of Telemedicine: A Life Cycle Assessment. Stud Health Technol Inform. 2024 Apr 26;313:81-86. doi: 10.3233/SHTI240016
7. Tomson C: Reducing the carbon footprint of hospital-based care. Future Hosp J. 2015 Feb;2(1):57-62. doi: 10.7861/futurehosp.2-1-57
8. Brown MRD et al: Digital outpatient health solutions as a vehicle to improve healthcare sustainability - a United Kingdom focused policy and practice perspective. Front Digit Health 2023 Sep 26;5:1242896. doi: 10.3389/fdgth.2023.1242896
9. Vozzola E et al: An Environmental Analysis of Reusable and Disposable Surgical Gowns. AORN J. 2020;111(3):315-325. doi: 10.1002/aorn.12885
10. Rachel D et al: Sustainable practice: Switching to reusable vaginal speculums. BMJ 2023;383:e075779. Doi: 10.1136/bmj-2023-075779
11. Rizan C et al: The carbon footprint of waste streams in a UK hospital. Journal of Cleaner Production 2021. doi: 10.1016/j.jclepro.2020.125446.
12. Willett W et al. Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. Lancet 2019. doi: 10.1016/S0140-6736(18)31788-4
13. Harwatt H et al: Substituting beans for beef as a contribution toward US climate change targets. Climatic Change 2017; 143(1-2):261-270. doi: 10.1007/s10584-017-1969-1.
14. Shelton CL et al: Towards zero carbon healthcare: anaesthesia. BMJ 2022;379: e069030. doi: 10.1136/bmj-2021-06903010.1136/bmj-2021-069030.
15. White SM et al representing the World Federation of Societies of Anaesthesiologists Global Working Group on Environmental Sustainability in Anaesthesia. Principles of environmentally sustainable anaesthesia: A global consensus statement from the World Federation of Societies of Anaesthesiologists. Anaesthesia 2022 Feb;77(2):201-212. doi: 10.1111/anae.15598.
16. Ankle M et al: Use of halogenated anaesthetics in Italy and their associated carbon footprint: a country-wide study Anaesthesia 2023; 79(1), 96-97. doi: 10.1111/anae.16140
17. REGULATION (EU) 2024/573 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 7 February 2024 on fluorinated greenhouse gases, amending Directive (EU) 2019/1937 and repealing Regulation (EU) No. 517/2014.
18. National Observatory on the Use of Medicines. The use of pharmaceuticals in the elderly population in Italy. National Report 2019. Rome: Italian Medicines Agency, 2021.
19. Wilkinson AJK et al: Costs of switching to low global warming potential inhalers. An economic and carbon footprint analysis of NHS prescription data in England. BMJ Open 2019;9:e028763. doi: 10.1136/bmjopen-2018-028763
20. Min Na Eii et al: Sustainable practice: Prescribing oral over intravenous medications. BMJ 2023;383:e075297. doi: 10.1136/bmj-2023-075297.
21. PREMIER: https://imi-premier.eu/.

22. Kar et al: Green Chemistry in the Synthesis of Pharmaceuticals. Chem Rev. 2022 Feb 9;122(3):3637-3710. doi: 10.1021/acs.chemrev.1c00631

23. European Green Deal: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

24. PARC: https://www.eu-parc.eu/

25. LIFE VERMEER: https://www.life-vermeer.eu/

26. OECD: Tackling wasteful spending on health. OECD Publishing, Paris 2017. https://doi.org/10.1787/9789264266414-en.

27. Braithwaite et al: The three numbers you need to know about healthcare: the 60-30-10 Challenge. BMC Medicine 2020 May 4;18(1):102. doi: 10.1186/s12916-020-01563-4

28. Walther F et al: Measuring appropriateness of diagnostic imaging: a scoping review. Insights into Imaging 2023 Apr 13;14(1):62. doi: 10.1186/s13244-023-01409-6

29. Heneghan C et al: Is it time to end general health checks? BMJ Evidence-Based Medicine, BMJ Evid Based Med. 2020 Jun;25(3):115-116. doi:10.1136/bmjebm-2019-111227

30. NICE Guideline [NG45]: Routine preoperative tests for elective surgery, 2016.

https://www.nice.org.uk/guidance/ng45

31. O'Connor D et al: Arthroscopic surgery for degenerative knee disease (osteoarthritis including degenerative meniscal tears). Cochrane Database Syst. Rev. 2022 Mar 3;3(3):CD014328. doi: 10.1002/14651858.CD014328

32. Born KB et al: Choosing Wisely and the climate crisis: a role for clinicians. BMJ Qual Saf 2024 Feb 19;33(3):200-204. doi: 10.1002/14651858.CD014328

33. Choosing Wisely Italy: https://choosingwiselyitaly.org

34. Health care's climate footprint report – Health Care Without Harm 2019. Climate-smart health care series, Green Paper Number One

35. Ministry of the Environment and Energy Security: CAM https://gpp.mase.gov.it/CAM-vigenti

36. NHS England. Greener NHS: suppliers. https://www.england.nhs.uk/greenernhs/get-involved/suppliers/

37. Communicating on climate change and health: toolkit for health professionals. Geneva: World Health Organization; 2024.

38. Williams O et al: Responding to the climate crisis: applying behavioural science. 2022 Public Health Wales NHS Trust.