RESEARCH ARTICLE

Do clinical practice guidelines follow sustainable healthcare principles? A review of respiratory guidance

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Abstract

Background

Respiratory care is an important site for climate action, given that common treatments for conditions such as asthma and COPD produce significant greenhouse gas emissions, even as respiratory health is negatively impacted by climate change. Clinical guidelines provide key information for healthcare professionals and can promote approaches to healthcare that can mitigate negative environmental impacts, and optimise patient treatment, care delivery, and equitable outcomes, and bring awareness and legitimacy to sustainable healthcare practices.

Methods

Twenty national and international clinical respiratory guidelines were purposively selected and screened for inclusion of four principles of sustainable clinical practice: prevention, patient empowerment and self-care, lean service delivery, and low carbon alternatives. A screening framework specific to respiratory care implications was developed and used to review each guideline for mention of relevant topics, recommendations, and explicit links to sustainability in relation to each principle.

Findings

Sustainable clinical care principles were evident in most guidelines reviewed, environmental sustainability was mentioned infrequently. Many guidelines emphasised prevention (more secondary than primary) and support for patient preference and streamlining care, yet there was rarely mention of how these recommendations could contribute to lowering the environmental impacts of health systems. Low carbon alternatives were mentioned in only three guidelines.

Conclusions

While many clinical respiratory guidelines make recommendations in accordance with the principles of prevention, patient empowerment and self-care, and lean service delivery,
reducing the carbon footprint of healthcare was rarely mentioned in the guidelines. Including explicit attention to the environmental impact of clinical care in guidance could support efforts to reduce the wider harms of healthcare, meanwhile, noting the clinical benefits of sustainable approaches could promote the uptake of recommendations.

Author summary

Why was this study done?

• This study aimed to assess the extent to which clinical respiratory guidelines align with principles of sustainable healthcare.

• Healthcare systems are a source of significant carbon emissions and established clinical guidance on providing environmentally sustainable care could aid in the reduction of emissions.

• Respiratory care is an important area for climate action in healthcare, given the high carbon footprint of metered-dose inhalers and the implications of climate change for respiratory health.

What did the researchers do and find?

• Researchers reviewed 20 national and international clinical respiratory guidelines to assess the inclusion of four sustainable healthcare principles: prevention, patient empowerment and self-care, lean service delivery, and low carbon alternatives.

• Many guidelines included recommendations in alignment with principles of prevention, patient empowerment and self-care, and lean service delivery, but rarely mentioned environmental co-benefits or included a discussion of low carbon alternatives.

What do these findings mean?

• Clinical respiratory guidelines lack inclusion of recommendations related to carbon reduction and low carbon alternatives, despite the high carbon emissions associated with respiratory care.

• There is an opportunity to intentionally incorporate sustainable healthcare principles in clinical guidelines, and support efforts to reduce the carbon footprint of health systems.

Introduction

Addressing climate change is critically important for health and health systems. Human health is adversely affected by climate change in multiple ways, including injuries from abrupt weather events, increased incidence of zoonoses, and elevated cardiovascular risk due to temperature rise exacerbating air pollution effects [1,2]. The climate crisis also contributes to the burden of mental health disorders, which have already been worsened by the COVID-19
pandemic [3]. Ironically, however, healthcare is a major contributor to climate change, estimated at 5.2% of global emissions. Actions are needed to minimise the environmental impacts of healthcare including from policymakers, industry, and the public (users of healthcare and their families and carers).

The Centre for Sustainable Healthcare (CSH) in the UK has defined four principles of sustainable healthcare: prevention, patient empowerment and self-care, lean service delivery, and low carbon alternatives [4]. These principles are presented in order of importance, starting from the most important principle, prevention, which—as primary prevention in particular—may have the greatest influence on healthcare sustainability by reducing the need for healthcare services. Patient empowerment and self-care allow for patients to be supported in managing their health and care, thereby improving adherence and health outcomes. Lean service delivery refers to the streamlining of healthcare services to minimize low-value care and improve ease of access. Lastly, the prioritization of effective low carbon alternatives and technologies for treatment aims to reduce the environmental impact of necessary activities [4]. The principles are intended to reform clinical practice to be of high-value and low-carbon intensity. To achieve this, such principles would need to feature in clinical guideline recommendations to influence clinician and patient decision-making. There is particular potential to do so in the context of respiratory care [4].

Respiratory care is an important area of action to improve healthcare sustainability, in part due to the particularly high carbon footprint of metered-dose inhalers [5]. Metered-dose inhalers (pMDI) contain hydrofluorocarbon propellants (HFAs) which are potent greenhouse gases and so these inhalers are a significant contributor to the global carbon footprint of healthcare [6,7]. As with care related to many other chronic diseases, there are multiple opportunities to reduce the environmental impacts of respiratory care, such as using remote clinic appointments where clinically appropriate. Respiratory care has the additional opportunity to reduce carbon footprint through careful diagnosis and disease management [5]. Visits to the emergency department due to asthma and COPD exacerbations, and intensive treatment with bronchodilators, are often the result of suboptimal respiratory disease management including inadequate use of long-acting (preventive) medications, overuse of short-acting medicines, and poor control of triggers (including exposure to environmental pollutants, and active and passive smoking) [8,9]. Ensuring precise diagnosis of respiratory diseases, preventing exacerbating factors and optimising medication choice is of fundamental importance when launching a patient on a life-long journey of using inhalers [10]. Propellant-free dry powder and soft mist inhalers (DPIs and SMIs) are medically appropriate for use in many patients. Their use can reduce the carbon footprint of care and improve clinical outcomes [11,12]. Inhaler choices ideally result from a consensus between a clinician and a patient, bearing in mind the potential impact on the environment [13]. Reductions in carbon footprint can also be achieved by changing the MDI used, for example from high volume pMDI to small volume pMDI or from an HFA227ea containing MDI to an HFA134a containing MDI, and by reducing the number of actuations by using higher dose actuations [12]. Recycling used inhaler devices and their parts is another intervention to reduce carbon emissions without compromising care quality [14]. Sustainable solutions are oftentimes attainable in healthcare without compromising patient care or curtailing economic resources, and instead serving both medical and environmental purposes.

Given the gravity of the climate crisis and the profound health co-benefits of climate action, there is a “need to capitalise upon every opportunity to introduce and embed GHG [greenhouse gas] emissions reductions, and adaptation to projected impacts, into decisions at every level,” with clinical practice guidelines being one site for healthcare transformation [15]. Yet, while healthcare sustainability has been evaluated at the practice- and facility-level, little has been done to investigate the embedding of sustainability into clinical practice guidelines [16].
Aim
This study aimed to assess the extent to which environmental sustainability opportunities are incorporated within national or international guidelines for the management of asthma and COPD, using the four principles of sustainable healthcare (prevention, patient empowerment and self-care, lean service delivery, and low carbon alternatives) to account for both express and tacit opportunities to improve clinical outcomes and environmental sustainability.

Methods
Selection of guidelines for analysis
The Organisation for Economic Collaboration and Development (OECD) was selected as a sampling frame to capture respiratory guidelines from high income country settings. To capture guidelines related to respiratory care, the two most common chronic respiratory conditions globally, asthma and COPD, were selected and web searches were used to identify guidelines on each from each OECD country and encompassing regions. The search was conducted in April and May of 2022.

Guidelines were screened by title according to the inclusion/exclusion criteria (Fig 1). Guidelines were identified from national, regional, and international respiratory/thoracic/pulmonary societies and organizations, journal publications, and web searches, using search terms containing the target country/region, disease (asthma or COPD), and variations of “clinical practice guideline”. The full-text documents for all included guidelines were downloaded or screenshotted where not in downloadable format (Appendix).

![Fig 1. Inclusion/exclusion criteria for clinical respiratory guidelines.](https://doi.org/10.1371/journal.pstr.0000078.g001)
Appendix.

Included Guidelines

1. Asthma + Respiratory Foundation New Zealand: Adolescent and Adult Asthma Guidelines 2020
2. Asthma + Respiratory Foundation New Zealand: COPD Guidelines 2021
3. Australian Asthma Handbook
5. Canadian Thoracic Society 2021 Guideline update: Diagnosis and management of asthma in preschoolers, children, and adults
7. European Respiratory Society: Guidelines for the Diagnosis of Asthma in Adults
8. French Pulmonary Society: Update of the 2021 recommendations for the management and follow-up of adult asthmatic patients
9. Global Initiative for Asthma (GINA) 2021
11. Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2022
12. National Institute for Health and Care Excellence (NICE) Chronic obstructive pulmonary disease in over 16s: diagnosis and management 2018
15. Revised (2018) COPD Clinical Practice Guideline of the Korean Academy of Tuberculosis and Respiratory Disease
16. Spanish COPD guidelines (GesEPOC) 2021
18. Swiss Respiratory Society: Diagnosis and Management of Chronic Obstructive Pulmonary Disease: The Swiss Guidelines
19. Swiss Respiratory Society: Diagnosis and Management of Asthma – The Swiss Guidelines
20. The COPD-X Plan: Australian and New Zealand Guidelines for the management of Chronic Obstructive Pulmonary Disease 2021

Do clinical practice guidelines follow sustainable healthcare principles?


(Continued)
Appendix. (Continued)

Excluded Guidelines

**Not in English, French, or Polish language (Excluded recommendations were in Czech, Danish, Dutch, Finnish, German, Hungarian, Italian, Korean, Norwegian, Portuguese, Spanish and Turkish)**

1. Chile Ministry of Health – Adult Bronchial Asthma Clinical Guide

2. Columbia Ministry of Health and Social Protection – Evidence-based clinical practice guideline for the prevention, diagnosis, treatment and follow-up of chronic obstructive pulmonary disease (COPD) in the adult population

3. Czech Pulmonological and Phthisiological Society – Recommended procedure for diagnosis and treatment of stable COPD

4. Czech Pulmonological and Phthisiological Society – Recommended Procedure for Diagnosis and Treatment of Bronchial Asthma

5. Danish Society for Respiratory Medicine – Asthma: Diagnosis

6. Danish Society for Respiratory Medicine – Asthma: Monitoring and treatment of mild to moderate asthma

7. Danish Society for Respiratory Medicine – COPD: Guidance

8. Finnish Medical Association and Finnish Pulmonary Association: Asthma Current Care Recommendation


10. German Society for Pneumology and Respiratory Medicine – S2k guideline for the diagnosis and therapy of patients with asthma

11. German Society for Pneumology and Respiratory Medicine: Diagnosis, prevention and therapy of chronic obstructive pulmonary disease

12. German Nationale Versorgungs Leitlinien: National care guideline Asthma
    Bundesärztekammer (BÄK), Kassenärztliche Bundesvereinigung (KBV), Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften (AWMF). Nationales Versorgungs-Leitlinien Asthma–Langfassung. 4. doi: 10.6110/AZQ/000469

13. German Nationale Versorgungs Leitlinien: National care guideline COPD

14. Hungarian Respiratory Society: On the principles of diagnosis, treatment and medical care of asthma in adulthood

15. Italian Respiratory Society: Integrated Clinical Management of COPD

16. Korean Academy of Tuberculosis and Respiratory Disease: Asthma treatment guideline

17. The Korean Academy of Asthma, Allergy and Clinical Immunology: Korean guideline for asthma

18. Mexican Asthma Guide: GUIMA

19. Dutch College of General Practitioners: Asthma in adults

20. Dutch College of General Practitioners: COPD

(Continued)
Appendix. (Continued)

21. Norwegian Association for Pulmonary Medicine: COPD – National professional guideline and guide for prevention, diagnosis, and follow-up


22. Norwegian Association for Pulmonary Medicine: Practical guide for severe asthma in adults

23. Portuguese National Health Service: Integrated Care Process for Asthma in Children and Adult


24. Portuguese National Health Service: Diagnosis and treatment of chronic obstructive pulmonary disease in adults


25. Turkish Thoracic Society: Asthma Diagnosis and Treatment Guidelines


Focusing on specific severity of diseases, not generalised


2. 2021 Canadian Thoracic Society Guideline – A focused update on the management of very mild and mild asthma


Focusing on one specific aspect of care

1. Management of COPD exacerbations: a European Respiratory Society/American Thoracic Society guideline


5. Turkish Guideline for the Management of COPD Exacerbations


https://doi.org/10.1371/journal.pstr.000078.t001

Screening framework

The Centre for Sustainable Healthcare’s sustainable healthcare principles were selected as parameters to guide analysis [4]. Within each principle, guidelines were assessed for (a) whether topics related to the principle were mentioned, (b) whether any recommendation was made in relation to the principle, and (c) whether mention of the principle was explicitly about the link to environmental sustainability.

A screening framework was developed by listing the topics that might be found in respiratory guidelines related to each of the four principles (Table 1). Analysis of the guidelines and the screening framework was piloted on a sample of four guidelines screened by all authors.

Two authors independently conducted a detailed review of each included guideline using the screening framework for mention of each of the four sustainability principles as related to the identified topics. If mention of any sustainability principle was identified, authors further analysed whether there was an associated recommendation supporting the principle and if there was explicit reference to environmental sustainability. Where a mention of a related
topic, recommendation, or reference to environmental sustainability was present, this text was copied into a spreadsheet. Spreadsheets completed by each author were combined and any discrepancies were discussed by all authors to reach an agreement. This study did not receive specific funding and ethical approval was not required.

Results

The most recently updated guidelines on asthma were identified from 25 of 38 OECD countries, and those on COPD from 20 of 38 OECD countries [17]. The publishing dates of the selected guidelines ranged from 2007 to 2022. Countries that did not have a unique guideline were assumed to use regional and/or international guidelines, with the Global Asthma Network Asthma Guidelines Survey results used as a reference [18]. After screening 52 guidelines on asthma and COPD, 32 were excluded because of a specialized rather than generalized focus, e.g., focused on very mild or mild asthma (7), or due to the language restrictions of researchers, which limited guidelines to those available in English, French or Polish (25) (Appendix).

Eleven guidelines on asthma and nine guidelines on COPD were included to be analysed in the study. The majority of publications included in the study were available in English, thus reducing the effect of language barriers. A single review (rather than double) was used for one guideline (Polish COPD Guidelines) given language limitations.

The results of the assessment of each guideline are charted in Table 2, where it is indicated if each guideline included mention of, recommendation supporting, and/or explicit reference to environmental sustainability in relation to each of the four sustainability principles. The findings were summarized by principle to determine common themes and gaps.

Prevention

The principle of prevention was mentioned in 19 out of 20 guidelines. Mentions and recommendations related to prevention predominantly attended to secondary prevention, to prevent the worsening of conditions in patients who had already been diagnosed. Despite 11 out of 19 guidelines including primary prevention, these mentions were often brief in comparison to secondary prevention strategies. The most common recommendation with relevance to both

Table 1. Screening framework for the four principles of sustainable health care in clinical respiratory guidelines.

<table>
<thead>
<tr>
<th>Principle</th>
<th>Demonstration of the principle in respiratory care</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevention</td>
<td>Reducing exposure to in- and/or outdoor air pollution, Smoking cessation/reduction, Vaccination, Hand hygiene and covering mouth/nose esp. when ill, Promoting protective equipment (e.g., masks) when working with aerosols/powders, Preventing antimicrobial resistance by reducing infection toll.</td>
</tr>
<tr>
<td>Self-care, Autonomy</td>
<td>Supporting patients to use appropriate inhaler techniques, Supporting patient to understand and avoid triggers.</td>
</tr>
<tr>
<td>Streamlining</td>
<td>Streamlining visits to healthcare facilities, Mention of remote consulting and when different sorts—phone, video, in-person—are appropriate, Ensuring appropriate prescribing (based on robust diagnosis), Optimising care—particularly identifying high SABA use, Clarity about the diagnostic process, The expertise of health professionals in the right place in system e.g., primary care.</td>
</tr>
<tr>
<td>Low carbon</td>
<td>Inhaler choice: High emissions (MDI) → Lower emissions (DPI/SMI), Advice about disposal and recycling options.</td>
</tr>
</tbody>
</table>

https://doi.org/10.1371/journal.pstr.0000078.t002
<table>
<thead>
<tr>
<th>Guideline</th>
<th>Mention</th>
<th>Recommendation</th>
<th>Explicit</th>
<th>Sustainability</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevention</td>
<td>Patient Empowerment and Self-Care</td>
<td>Lean Service Delivery</td>
<td>Low Carbon Alternatives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asthma</td>
<td>Australian Asthma Handbook 2022</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Management of Asthma 2019</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
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<tr>
<td></td>
<td>ERS Asthma 2022</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<tr>
<td></td>
<td>French Pulmonary Society Asthma 2022</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Global Initiative for Asthma 2021</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Japanese Asthma Guidelines 2017</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td></td>
<td>NICE Asthma Guidelines 2019</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td></td>
<td>Swiss Asthma Guidelines 2018</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>COPD</td>
<td>Canadian Thoracic Society COPD 2007</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
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<tr>
<td></td>
<td>Global Initiative for Chronic Obstructive Lung Disease 2022</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td></td>
<td>Korean COPD Clinical Practice Guideline 2018</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td></td>
<td>New Zealand COPD Guidelines 2021</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Guideline</td>
<td>Prevention</td>
<td>Patient Empowerment and Self-Care</td>
<td>Lean Service Delivery</td>
<td>Low Carbon Alternatives</td>
<td>Mention Recommendation</td>
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<tr>
<td>NICE COPD 2018</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Polish Respiratory Society COPD Guidelines 2014</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Spanish COPD Guidelines 2021</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Swiss COPD Guidelines 2013</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>The COPD-X Plan Australia and New Zealand</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Reference: https://doi.org/10.1371/journal.pstr.0000078.

Do clinical practice guidelines follow sustainable healthcare principles?
primary and secondary prevention for both COPD and asthma was smoking cessation, with 19 guidelines highlighting its importance. Other secondary prevention recommendations were the promotion of influenza vaccinations, avoidance of allergens, occupational exposure, and in- and outdoor air pollution.

In regard to primary prevention, similar factors, such as smoking, were mentioned as potential risk factors for developing asthma and COPD. The GEMA (Spanish Asthma Management Guidelines) guideline mentioned that “exposure to environmental pollutants and passive smoking have a negative effect on the course of the disease and, in addition, they are a risk factor for developing asthma in childhood”, emphasising how pollution and smoking have a role in both primary and secondary prevention. The GOLD (Global Initiative for Chronic Obstructive Lung Diseases) guideline reinforced the role of air pollution as a significant risk factor by highlighting that “reducing exposure to indoor and outdoor air pollution requires a combination of public policy, local and national resources, cultural changes, and protective steps taken by individual patients”.

Some guidelines considered the impact of social factors. The New Zealand COPD guideline recommended “addressing risk factors such as poor housing, overcrowding, health literacy, obesity, smoking and poor access to pulmonary rehabilitation and healthcare services” as part of primary prevention. The depth to which different asthma and COPD guidelines addressed prevention varied greatly despite being mentioned in nearly all. Besides a brief mention of biofuel stove emissions in the Polish Respiratory Society COPD Guidelines, none of the other mentions or recommendations made in relation to the principle explicitly noted that prevention contributes to environmental sustainability.

Patient empowerment and self-care

The sustainable healthcare principle of promoting patient empowerment and self-care was mentioned in all 20 guidelines reviewed. The most common themes amongst the recommendations related to patient empowerment were inhaler technique, patient device preference, and patient understanding of treatment decisions. Many guidelines stressed the importance of correct inhaler technique, often prompting clinicians to check the patient’s inhaler skills at frequent intervals. The Swiss Guidelines for the Diagnosis and Management of Asthma recommended the following strategies for ensuring correct inhaler usage: “choosing the most appropriate device based on available options, patient skills and cost; showing the patient how to use the device correctly; and checking (and eventually correcting) inhaler technique, and re-check it regularly”. Inhaler choice and appropriateness are based upon multiple factors, and guidelines, such as the Canadian Thoracic Society guideline for asthma, mention that “it is important to consider the type of inhaler device that a patient prefers to use and can use properly”, as including patients in device and medication choice was cited in many guidelines as being instrumental to improving patient adherence and condition outcomes.

Shared decision-making, in addition to self-management ‘action’ plans, was mentioned in many guidelines as being important in increasing patient awareness of their condition and treatment, emphasising the importance of patients having an active role in their care. While most guidelines made no explicit mention that patient empowerment contributes to healthcare sustainability, the New Zealand guideline for asthma encouraged prescribers to consider “the lower carbon footprint of dry powder devices (less than 10% of pMDIs) . . . alongside other factors”, tying in inhaler emissions with patient device choice.

Lean service delivery

The principle of lean service delivery was mentioned in 19 out of 20 guidelines and had the most variety across the four principles analysed. All the guidelines in which lean service
delivery was referred to emphasised the importance of confirmatory diagnostic testing for asthma and COPD. Many of the guidelines detailed clinical indicators of each condition. The GINA guideline was among those that emphasised the importance of avoiding “unnecessary treatment or over-treatment, and to avoid missing other important diagnoses.” Moreover, the theme of avoiding over-treatment was mentioned in many guidelines, which advocate the use of the fewest inhalers required for the patient; for example, in the Japanese guidelines for adult asthma: “The goal of treatment is to maintain good asthma control using the minimum of drugs”. Similarly, some guidelines mentioned the issue of SABA (short-acting beta agonist) over-use, with the GINA guideline indicating that “reducing and, ideally, eliminating the need for SABA reliever is both an important goal in asthma management and a measure of the success of asthma treatment”.

Furthermore, some mention was made of streamlining healthcare visits for asthma and COPD patients, including mention of telehealthcare and telemonitoring as well as the role of primary care clinics in making testing more readily available within the clinic. The Australia and New Zealand COPD guidelines summarise many studies regarding telehealth interventions for COPD patients yet conclude that the results are conflicting and make it “difficult to make recommendations regarding the essential elements of telehealth programs in COPD”. As such, none of the mentions or recommendations made in relation to the principle explicitly noted that lean service delivery contributes to healthcare sustainability.

Low carbon alternatives
Lastly, the principle of low carbon alternatives was mentioned in 3 out of 20 guidelines, distinctly fewer than the other principles reviewed. The BTS/SIGN Asthma guidelines promoted provider and patient awareness of the carbon footprint of MDIs, recommending that “inhalers with low global-warming potential should be used when they are likely to be equally effective,” and “where there is no alternative to MDIs, lower volume HFA134a inhalers should be used in preference to large volume or HFA227ea inhalers”. The BTS/SIGN Asthma guidelines also encouraged patients to enquire with their pharmacies if used inhalers can be recycled. The New Zealand Asthma and COPD guidelines also briefly mention the carbon footprints of inhalers as important considerations for inhaler choice, linking it to other factors such as patient preference and ability to correctly use the device. The recommendations made in line with this principle were frequently the only recommendations that made explicit mention of environmental sustainability.

Discussion
While sustainable healthcare principles were widely present in the reviewed guidelines, specific references to environmental sustainability, and attention to interventions with lower environmental impacts, were limited. The vast majority of guidelines mentioned disease prevention, usually secondary prevention (19 out of 20), patient empowerment and self-care (20 out of 20), and lean service delivery (19 out of 20). The principles were typically referenced in the context of best practices for care provision and benefits to patients and cited relevant clinical evidence. Most guidelines did not acknowledge the environmental co-benefits of these recommendations, nor the relationship between respiratory healthcare’s emissions and the harms of climate change for patient and population health [2] The fourth sustainability principle, low carbon alternatives, had few recommended actions (3 out of 20).

As more sustainable solutions are often better for clinical outcomes, it may be unsurprising that, even without reference to sustainable healthcare or evidence that environmental sustainability was considered in their development, the recommendations that we assessed aligned
well with sustainable healthcare principles. However, there is room for significant improvement concerning explicitly accounting for environmental impact in recommending interventions, notably recommendations regarding inhaler type and inhaler disposal. For instance, transitioning to low carbon inhalers would allow improved care for many patients, and over-emphasis on MDIs in asthma guidance can undermine the effectiveness of DPIs and lower-carbon inhalers [19].

Interpreting results in the context of other literature

Respiratory care has a disproportionately high carbon footprint due to hydrofluorocarbon propellants used in metered dose inhalers, which is why it was selected as the focus of this review. The finding of widespread omission of explicit discussion of low carbon treatment options is concerning but in keeping with other studies. A recent study on the integration of planetary health into clinical guidelines concluded that environmental sustainability was rarely mentioned in guidelines; using a keyword screening of 49 clinical guidelines from various countries, the study found that most keywords were present in less than 5% of guidelines [16]. In the study, “air pollution” was identified as an exception, being mentioned in 20% of guidelines, with “environmental protection” and “emissions” in 10%; however, these mentions were often not attached to actions to reduce the carbon footprint of healthcare. This is a missed opportunity, and the authors argue that planetary health should be instated as a mandatory dimension of clinical guideline development.

The principal benefit of clinical guidelines has been described as an improvement in the quality of patient care [20]. Guidelines may also positively inform public policy and improve efficiency. However, clinical guidelines have been shown to have substantial variability in the magnitude of improvements and adherence resulting from their implementation, in part due to gaps in evidence and a clear prioritisation of interventions [21–23]. Motivation to make practice changes, amongst other factors, has been identified as a barrier to adherence to clinical guidelines [24,25]. Seeing medical care as part of a wider ecosystem and understanding the health consequences of environmental degradation is urgently needed from both physicians and healthcare managers; this could function to improve adherence to clinical practice guidelines.

The inclusion of environmental information may provide additional motivation for clinicians to engage with respiratory care given escalating levels of concern among health professionals to respond to the health threats of climate change [26]. Studies have shown that health professionals around the world feel a responsibility to bring public awareness to the health effects of climate change [26,27]. Therefore, there may be a benefit of mentioning the alignment of recommendations with sustainable healthcare principles, as clinicians and patients concerned about the health of both the patient and the wider public may see sustainability benefits as further motivation to implement the recommendations. It has been suggested that “the codification of rational resource use into evidence-based clinical practice guidelines confers the added benefits of standardising best practices and augmenting medicolegal protection”, encouraging the uptake of sustainability principles through legitimization [28]. Additionally, providing specific recommendations that include the rationale for inclusion improves the practicality of clinical guidance and translation into behaviour change [29].

When making recommendations about the prevention of respiratory diseases, many guidelines did not explicitly indicate whether the recommendations were for primary or secondary prevention. In some cases, it was apparent that guidelines were discussing primary prevention, but in some guidelines, primary prevention recommendations were lacking. Healthcare that is lacking in primary and preventative care services leads to increased patient interaction with
resource-intensive services [30]. Rather than prioritising secondary prevention, primary, population-based, strategies that support shared decision making can be more cost-effective and equitable in the long term when supplemented with secondary prevention [31,32].

Implications for policymakers and clinicians

The guidelines that we reviewed provide many examples of opportunities to promote environmentally sustainable care with benefits to the population as well as individual health. These opportunities lie in the design of health systems and care pathways, as well as in specific treatment decisions, and could be taken up across guidelines in different specialties.

Firstly, we recommend that creators of clinical guidelines pay attention to the principles of sustainable healthcare, and where recommendations are expected to have sustainability benefits, these can be highlighted to promote implementation.

Secondly, given the health and sustainability benefits of reducing demand for health services through disease prevention, primary as well as secondary prevention advice could be included in all guidelines. This could emphasise the trusted position of clinicians in delivering health advice, and the role of specialists not only in providing treatment but also in contributing to efforts to prevent ill health.

Finally, as well as promoting more sustainable care pathways, it is important that guideline development considers the environmental impacts of health products across their lifecycle and encourages more environmentally sustainable product options where there is a positive or neutral impact on patient health. This may include options in the purchase of products, use of products, or disposal. For example, for inhalers, less carbon emitting DPIs can be selected where appropriate; for patients on MDIs spacers can be used to minimise the wastage of medication; and more environmentally safe disposal by incineration or recycling can be recommended.

Strengths and limitations of this study

Among the strengths of this study is the evaluation of a topic that is yet to be widely explored. Viewing respiratory care guidelines through the lens of sustainable healthcare and extracting healthcare recommendations in line with carbon-saving policies are research directions that have gained traction in recent years amid increased attention to planetary health. This study considered multiple pulmonary care recommendations from high-income countries, which allowed for a thorough review of available global medical expertise on asthma and COPD management. Another strength is the analysis of most guidelines by two independent reviewers applying the predefined screening framework. To the best of the researchers’ knowledge, this is the most thorough review analysing sustainability in guidance for medical inhalers and preventative care methods in respiratory medicine.

While using academic search engines, no other established and validated reviewing tool was found for sustainability aspects in respiratory guidelines that could be applied in the study. A novel approach to examining guidelines was developed, and this may be considered a limitation. Clinical review methods and academic principles described in the literature from other medical fields were used to model the review system applied in the article. Inconsistencies in interpretation, such as whether a link to environmental sustainability was explicit enough, were discussed by all researchers during live calls to reach a consensus.

Following online searches, 25 clinical practice guidelines were not analysed due to language barriers and thus could not be included in the study. The reviewing process was undertaken in the first half of 2022, thus findings are specific to that time. It is to be hoped that newer
versions of respiratory care recommendations on asthma and COPD management will demon-
strate a more substantive inclusion of environmental sustainability issues.

**Conclusion**

The researchers found that several principles of sustainable healthcare, namely disease preven-
tion, streamlining of services, and patient empowerment are already commonly reflected in
national and international respiratory guidance even if they are not explicitly linked to envi-
ronmental sustainability. This study demonstrated that there is a clear lack of inclusion of rec-
ommendations related to carbon reduction and low carbon treatments amongst clinical
respiratory guidance, despite their high carbon footprint. By using sustainable healthcare prin-
ciples to develop a screening framework for analysis, the recommendations within clinical
practice guidelines can be assessed for their benefits to both patient health and planetary
health. Greater explicit inclusion of sustainability principles, particularly recommendations
related to lower carbon treatments, could strengthen guidelines. This could have the impact of
permitting and increasing the implementation of sustainable healthcare practice changes and
motivating health professionals to improve guideline uptake. This study can serve as a bench-
mark for the future implementation of environmental sustainability as a dimension of clinical
best practices in respiratory care and can serve as an approach for clinical guideline develop-
ment and review.

**Supporting information**

S1 PRISMA Checklist. Preferred Reporting Items for Systematic reviews and Meta-Analy-
ses extension for Scoping Reviews (PRISMA-ScR) Checklist.

(PDF)

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**References**

detail/climate-change-and-health


27. Quitmann C, Sauerborn R, Danquah I, Herrmann A. ‘Climate change mitigation is a hot topic, but not when it comes to hospitals’: a qualitative study on hospital stakeholders’ perception and sense of responsibility for greenhouse gas emissions. J Med Ethics. 2022; medethics-2021-107971. https://doi.org/10.1136/medethics-2021-107971 PMID: 35459742


