Many of our everyday actions have a carbon footprint – meaning they cause carbon dioxide (CO2) to be released into the atmosphere – and, therefore, contribute to climate change. Driving to work, using a refrigerator, flying to go on holiday, eating meat, using aerosols, plastics waste, and heating and cooling our houses all come with a carbon footprint. We can also have a negative impact on the environment at work – the NHS has a large carbon footprint.

Pressurised metered-dose inhalers (pMDIs), which are commonly prescribed to people with respiratory conditions such as asthma and chronic obstructive pulmonary disease (COPD), are a significant contributor to the NHS’s carbon footprint. Both the production and disposal of pMDIs have a carbon footprint, while the propellants used to deliver the drug to patients are fluorinated gases (F-gases); known as ‘greenhouse gases’, these also contribute to climate change.

This article aims to raise nurses’ awareness of how inhalers affect the environment and consider the scale of the issue, the alternatives and the nurse’s role. It also explores the challenges and practicalities of responding to the House of Commons Environmental Audit Committee’s (2018) target of a 50% reduction in the global warming potential (GWP) of pMDIs by 2022.

What is global warming?
Global warming occurs when CO2 and other air pollutants and greenhouse gases collect in the atmosphere and absorb sunlight and solar radiation that have bounced off the earth’s surface. Normally this radiation would escape into space, but these pollutants – some of which can remain in the atmosphere for centuries – trap the radiation and increase the global temperature; this is known as the ‘greenhouse effect’ (MacMillan, 2016).

Global warming increases the risk of drought, wildfires and heatwaves, and changes rain and snow patterns, causing less snow and ice, stronger storms and flooding. Warmer oceans and melting glaciers; changes in plant and animal lifecycles result in the extinction of some species, the possibility of new pests, and more asthma, allergies and infectious disease outbreaks (MacMillan, 2016).

The standard unit for measuring a carbon footprint is CO2-equivalent; each
greenhouse gas is calculated in terms of the amount of CO2 that would create the same amount of GWP. A carbon footprint can stem from CO2, methane, nitrous oxide and also the F-gases used in pMDIs.

**Inhalers and the environment**

The most commonly prescribed inhaler in the UK is the pMDI, followed by the dry-powder inhaler (DPI), then a small proportion of other types such as the soft-mist inhaler (SMI). It is commonly stated that >65 million inhalers are prescribed every year in the UK (Public Health England and NHS England, 2018); however, the HCEAC’s (2018) parliamentary report states that the PHE and NHSE gave an annual figure of 35 million pMDIs and 15 million DPIs, and it is unlikely that other devices accounted for the remaining 15 million.

The F-gas used in pMDIs accounts for only a very small proportion of the global use of F-gas; the majority is used in refrigeration, fire extinguishers and air-conditioning equipment. However, the impact of the propellant gases released from inhaler use each year in England is estimated to be equivalent to around 850,000 tonnes of carbon emissions; this is comparable to the annual carbon emissions of all NHS road mileage in England, including business travel and emergency vehicles, or the carbon footprint of a small country (PHE and NHSE, 2018). A typical pMDI with 10g of propellant can have a carbon footprint of 13-33kg, depending on the type of propellant. This is estimated to be the equivalent of driving an average car for 45-115 miles, depending on inhaler type (Department for Business, Energy and Industrial Strategy, 2018; PHE and NHSE, 2018).

**Advantages and disadvantages of the alternatives**

Alternatives to pMDIs are DPIs and SMIs, which do not include F-gases. However, inhalers are not interchangeable and the delivered dose of medication varies between types: one device should not be switched for another on the basis of pharmaceutical drug dose equivalence, as the engineering characteristics and formulation properties of an inhaler determine the actual dose that reaches the lungs (Usmani et al, 2019).

The inspiratory flow rate necessary to deliver the medication to the lungs also differs between inhalers and – while errors are common with all inhalers – if patients cannot achieve a sufficient inspiratory flow rate, they cannot activate a DPI. Even if a patient is able to inspire with sufficient effort to activate a DPI, good practice requires a face-to-face review before any change of device, which comes with its own costs. Any change must also be safe for the patient and made with their consent. The disadvantages arising from switching inhaler type on non-medical grounds without the patient’s consent can lead to:

- **A deterioration of disease control**;
- **Increased symptoms**;
- **An increase in the use of healthcare resources** (Melani and Paleari, 2016; Björnsdottrir et al, 2013).

Studies also show that stable patients receiving pMDI maintenance treatment for asthma and COPD achieve better health outcomes than those receiving the same drug through a DPI (Jones et al, 2017; Price et al, 2011).

The pMDI is the most commonly prescribed inhaler type for a number of reasons. It is the most commonly used reliever inhaler containing salbutamol which gives emergency relief during an asthma attack, and can be used with a spacer, which can make it easier for users to inspire the right amount of medicine. PMDs are often the only licensed inhaler type for children of certain ages and are commonly prescribed for older people who may have insufficient inspiratory flow to activate a DPI. For these patients, there are currently no alternatives to pMDIs.

Levy et al (2019) argued that the intervention that would make the biggest difference in reducing the overall GWP of respiratory treatments would be to improve overall standards of care for people using inhalers, reducing wasted resources and improving health outcomes. This requires nurses to consider, not just the issues of propellants and plastic waste, but also the potential waste and environmental damage caused by poorly managed asthma and COPD. These can lead to time off school or work, unnecessary use of emergency healthcare, and more trips to GP surgeries and hospitals. Resources would be saved if nurses taught patients more about effective self-management, both for routine treatment and exacerbations (Levy et al, 2019).

Evidence suggests that the correct delivery of drugs by an inhaler device, which a patient can use efficiently and reliably improves symptoms and quality of life, and reduces morbidity, mortality and hospital acute care costs (Lavorini et al, 2008; Melani and Paleari, 2016; Press et al, 2011). Usmani et al (2019) also discussed reducing the impact of inhalers on climate change through more general measures (Box 1).

Industry has a role too in reducing the carbon footprint of inhalers: the development of inhaler propellants that have a lower impact on climate change should be considered alongside innovation in device efficiency (Usmani et al, 2019). For example, producing inhalers that can be reused for longer would reduce the carbon footprint of manufacturing, packaging and waste. Recycling of inhalers is also important.

**The nurse’s role**

Nurses – often the patient’s advocate and the health professional most often involved in inhaler choice – should never switch an inhaler type without consulting the patient. Usmani et al (2019) stated that switching a patient’s inhaler(s) without consent may:

- **Increase symptoms**;
- **Reduce good disease management**;
- **Damage the relationship between the patient and the health professional**;
- **Increase the use of resources**;
- **Waste medication**.

Before considering any change of device, nurses should assess the patient’s

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**Box 1. How to reduce inhalers’ environmental impact**

- **Primary prevention**
- **Reduce over-prescribing, especially of short-acting beta-agonist (SABA) inhalers**
- **Promote adherence**
- **Train health professionals in device use**

current inhaler technique to ensure it is being used correctly, as errors in technique are common. This should be assessed alongside the patient’s current level of symptom control. If inhaler technique and symptom control are good, it would be difficult to justify a change in inhaler.

The Royal College of Physicians (2015) highlighted an overreliance on SABA inhalers as an important factor in asthma deaths. It is important that nurses:

- Consider overall inhaler use;
- Ensure patients understand their corticosteroid inhaler used to prevent inflammation is the most important inhaler. This includes explaining the risks of overreliance on their SABA inhaler and how only using it when necessary could also help to reduce the overall carbon footprint of pMDIs.
- Nurses could discuss with asthma patients the option of using a combination inhaler containing formoterol and inhaled corticosteroid; this can be used as both a maintenance and reliever treatment, and reduces the need for a SABA inhaler. However, combination inhalers containing salmeterol or vilanterol cannot be prescribed in this way, as these drugs are not fast-acting. There are also cumulative effects of additional salmeterol including:
  - Chest pain or tightness;
  - Confusion;
  - Decreased urine output;
  - Dry mouth;
  - Feeling faint or lightheaded when getting up suddenly from a lying or sitting position;
  - General feeling of discomfort or illness;
  - High blood pressure;
  - Loss of appetite;
  - Mood changes;
  - Nervousness.

We do not know if these effects apply to vilanterol as the drug is only licensed in combination with fluticasone, but it is likely because of a similar dose–response curve (Lötvall, 2001).

Nurses can ensure the minimal number of inhalers are prescribed to deliver the required medication; additionally stratiﬁng devices to the same ’type’ helps, so different inspiratory flow rates are not required for the different inhalers. The use of multiple respiratory inhalers has been shown to have an adverse effect on COPD outcomes (Rosnic-Anticevich et al, 2016).

SABA pMDIs are the most commonly prescribed inhalers used to relieve symptoms and exacerbations; nurses can consider prescribing the smaller-volume hydrofluoroalkane (HFA) 134a inhalers (for example, Salamol) in preference to larger-volume or HFA227ea-containing inhalers (for example, Ventolin). Larger inhalers are associated with almost double the GWP compared with smaller devices (Janson, 2020), so offering pMDIs requiring fewer actuations (or puffs) per dose can help reduce the overall GWP load.

“A typical pMDI with 10g of propellant can have a carbon footprint equivalent to driving an average car for 45-115 miles”

Prescribing inhalers with visible dose meters, or ensuring patients whose inhalers do not have this feature know how many doses their inhaler contains, helps them to avoid running out or throwing away half-full inhalers. pMDIs are often returned or replaced without all the doses being taken – indeed, many are returned half full (Conner and Buck, 2013). Encouraging patients to return used inhalers to pharmacies for proper disposal would also help – some propellant remains in pMDIs when they are ﬁnished and this could be recycled.

Perhaps most important for nurses is to ensure patients requiring an inhaler do not feel stigmatised or blamed for the environmental footprint of taking what, for them, is a necessity not a luxury. Long-term conditions can be difﬁcult enough for patients to deal with, without them also being made to feel responsible for global warming.

Conclusion

All inhalers have a carbon footprint associated with their manufacture, packaging, emissions from F-gases, and ultimate disposal into landfill or through recycling. As they constitute around 0.1% of the UK’s total carbon footprint, considering their appropriate prescription can have a positive impact – however, non-prescription should not be at the expense of patient safety or choice (HCEAC, 2018).

Nurses need to consider many factors when selecting the most appropriate medication and inhaler device. Where clinically appropriate, they may offer lower-carbon options, but it is crucial to ensure the selected device is suitable for the individual patient’s needs, both when they are well and during an exacerbation. Any change should not just be based on the cost of the device and its effect on the environment, but also on the cost to the healthcare system, and with each patient’s safety and best interests at heart (Bjernér, 2014).

● Declaration of interests: Jane Scullion is director of education for UK Inhaler Group, a member of the Aerosol Drug Management Improvement Team (ADMIT), and has worked with or received support from Boehringer Ingelheim, Teva, Nursing in Practice, the Association of Respiratory Nurse Specialists, Napp Pharmaceutical Group, Chiesi and the Monthly Index of Medical Specialities. This article was initiated and written independently.

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