Care Pathways: Appraising Sustainability

A Life Cycle Assessment Method Document

Sustainable Healthcare Coalition

March 2026

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Sustainable Healthcare Coalition

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First Edition

March 2026

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ISBN 9781067674403

For and on behalf of Environmental Resources Management

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Date: 17 March 2026

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FOREWORD

Navigating the complexities of healthcare is a journey inherently centred around the patient. While the maxim 'you can only manage what you can measure' may not apply to every scenario, its wisdom rings true when seeking to untangle complex systems like healthcare pathways. Gaining clear insights through measurement is an essential starting point for focusing sustainability efforts and enacting truly impactful change. This document outlines the agreed method for assessing care pathways to quantify their environmental impact, an approach originally embedded within our core guidance*. However, to enhance the accessibility and applicability of the approach, we have now refined and separated it into this standalone document. This allows for easier reference and application by practitioners and researchers alike.

This robust method was originally developed in partnership with a broad range of stakeholders and technical experts and was endorsed by both the National Institute for Health and Care Excellence (NICE) and the National Health Service (NHS), reflecting its credibility and practical value in advancing environmentally sustainable healthcare. Since the guidance was published in 2015, the core principles and methods have been consistently applied and refined, contributing to numerous publications and studies.

The importance of this method cannot be overstated. Healthcare, while vital, has a substantial environmental footprint. Understanding and mitigating this impact is not only an ethical imperative but also a strategic necessity for the long-term resilience of our health services.

By examining the entire journey of care, from prevention and diagnosis to treatment and aftercare, we can identify all elements that contribute to the overall environmental impact of the pathway. Crucially, this approach moves beyond only considering the footprint of isolated interventions, devices or pharmaceuticals. It allows us to pinpoint opportunities for significant environmental improvements across the entire healthcare pathway and add context to our efforts to deliver more sustainable and efficient care through innovation and partnership, while maintaining and improving health outcomes for patients.

Dr Fiona Adshead

Chair, Sustainable Healthcare Coalition

*Sustainable Healthcare Coalition. Care Pathways: Guidance on Appraising Sustainability; Main Document; Second Edition. 2023, https://shcoalition.org/sustainable-care-pathways-guidance/.

1. INTRODUCTION

Health and care systems must undergo transformative change to adapt to the needs of patients and communities with an increasing need to be financially, socially and environmentally sustainable.

This document presents the method for appraising models of care that was developed and contained within *Care Pathways: Guidance on Appraising Sustainability; Main Document; Second Edition. Sustainable Healthcare Coalition 2023*[1].

The method allows users to understand the environmental impacts of new or existing models of care and ultimately to improve the sustainability of health systems. By applying the method, a user will gain a greater understanding of the environmental impacts of health services, including both direct impacts and those expressed across the whole care pathway.

1.1. THE PURPOSE OF THE METHOD DOCUMENT

The principal objective of this method document is to enable more consistent and accurate quantification of the environmental impact of care pathways globally through the application of life cycle assessment (LCA). This method document should be used alongside the supporting guidance[1] and the normative references to which it aligns, i.e. the:

- ISO 14040:2006, Environmental management – Life cycle assessment – Principles and framework[2] (hereafter referred to as ISO 14040);
- ISO 14044:2006, Environmental management – Life cycle assessment – Requirements and guidelines[3] (hereafter referred to as ISO 14044);
- BSI PAS 2090:2025 Pharmaceutical products. Product category rules for life cycle assessments. Specification[4] (hereafter referred to as PAS 2090);
- Greenhouse Gas Protocol, Product Life Cycle Accounting and Reporting Standard[5,6] (hereafter referred to as GHG Product Standard); and
- Greenhouse Gas Protocol, Greenhouse Gas Accounting Sector Guidance for Pharmaceutical Products and Medical Devices Summary Document[7].

This method is intended to be used alongside these standards and avoids replication of their content wherever practicable. The document is freely available and is intended to be updated as knowledge of this area of care pathway sustainability assessments increases.

(1) Sustainable Healthcare Coalition. Care Pathways: Guidance on Appraising Sustainability; Main Document; Second Edition. 2023, https://shcoalition.org/sustainable-care-pathways-guidance/.
(2) Technical Committee ISO/TC 207. (2006). ISO 14040. Environmental management Life cycle assessment Principles and framework (ISO 14040:2006). https://www.iso.org/standard/37456.html.
(3) Technical Committee ISO/TC 207. (2006). ISO 14044. Environmental management Life cycle assessment Requirements and guidelines (ISO 14044:2006). https://www.iso.org/standard/38498.html
(4) BSI. PAS 2090:2025 Pharmaceutical Products. Product Category Rules for Life Cycle Assessments. Specification. BSI, 30 Nov. 2025, knowledge.bsigroup.com/products/pharmaceutical-products-product-category-rules-for-life-cycle-assessments-specification.
(5) Greenhouse Gas Protocol. (2011). Product Life Cycle Accounting and Reporting Standard. https://ghgprotocol.org/product-standard.
(6) In alignment with the Greenhouse Gas Protocol Product Standard, ISO 14040 & ISO 14044 a care pathway should be considered a product. A care pathway is considered a product, as a product can include services.
(7) United Kingdom NHS Sustainable Development Unit (2012) Greenhouse Gas Accounting Sector Guidance for Pharmaceutical Products and Medical Devices Summary Document. https://ghgprotocol.org/sites/default/files/tools/Summary-Document_Pharmaceutical-Product-and-Medical-Device-GHG-Accounting_November-2012.pdf

2. GUIDING PRINCIPLES

2.1. WHAT IS A CARE PATHWAY?

"*A care pathway is a complex intervention for the mutual decision making and organisation of care processes for a well-defined group of patients during a well-defined period*," as defined by the European Pathway Association[8].

A care pathway is the journey patients take through the health system and is the result of all the healthcare within that journey. For example, a GP appointment, an outpatient appointment and a day surgery could make up a care pathway, as illustrated in Figure 1.

Figure 1. Care pathway

Care pathways may also be referred to as models of care, critical pathways, care paths, integrated care pathways, case management plans, clinical care pathways, service lines or care maps.

2.2. WHAT IS A CARE PATHWAY MODULE?

A care pathway module is one or more healthcare-related activities performed for, on behalf of, or by a patient. The modules are the building blocks that are combined to make up the care pathway. A care pathway module may also be referred to as a care process or healthcare activity and could be, for example:

- A GP appointment;
- A surgical procedure;
- Diagnostic imaging (e.g. an MRI);
- An accident and emergency department attendance; or
- Patient travel, etc.

2.3. WHAT IS A REPRESENTATIVE PATIENT?

A care pathway assessment is conducted in relation to a representative patient, which may be a single patient or a defined cohort of patients. It could also represent an average or a subset of a patient population. For example, the representative patient might be a single patient undergoing a series of care pathway modules or an assessment of the care pathway modules used by a population in the previous year. The representative patient should be selected to best meet the study's objective and should be clearly defined within the study.

2.4. WHAT IS A CARE PATHWAY ASSESSMENT?

A care pathway assessment evaluates the environmental impact of the care pathway and can range from the appraisal of a single module to an array of modules.

(8) European Pathway Association. "About Care Pathways." E-P-A.org, 19 Apr. 2021, e-p-a.org/care-pathways/.

Care pathway assessment may be performed to inform discussions regarding:

- The design of more sustainable care pathways and models of care;
- Comparison of alternative forms of care;
- Identification of environmental hotspots in the care pathway, i.e. where the environmental impact is greatest;
- The contribution of a product or service within its wider context, enabling the comprehensive evaluation of alternatives;
- Identification of potential opportunities to improve the sustainability of the care pathway; and
- Tracking the sustainability of a care pathway over time.

Reporting care pathway environmental metrics may also be undertaken for the purposes of:

- Informing discussion concerning the sustainability of a care pathway;
- Providing information on areas where the sustainability of a care pathway might be improved; and
- Designing more sustainable care pathways and models of care.

Comparisons between care pathways shall only be undertaken if the same conditions are used for the appraisals of the pathways being compared, including, but not limited to, system boundaries, units of analysis, activity data, allocation and emission factors. Further guidance on comparisons can be found in the ISO 14040/44 standards[2,3], Product Standard[5] and Sector Guidance[7].

2.5. ENVIRONMENTAL METRICS

The care pathway method can be used to appraise a wide range of environmental impacts/indicators as defined in the international standard for LCA ISO14044[3]. The environmental impact indicators that are selected shall be both justified and consistent with the objectives of the assessment.

In developing the supporting guidance[1], stakeholders[9] agreed that the guidance should focus on the appraisal of:

- Greenhouse gas (GHG) emissions – measured as kg CO_2 eq;
- Freshwater use – measured as m^3; and
- Waste generation – measured as kg.

Results shall be reported per functional unit (unit of analysis).

2.5.1. GHG emissions

Greenhouse gas (GHG) emissions are gases that contribute to the greenhouse effect by absorbing infrared radiation in the atmosphere, causing climate change. Common GHGs include

(9) Stakeholders and details of the development of the SHC care pathway guidance document are provided in the guidance document[1]

carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).

The emissions are expressed in terms of their global warming potential (GWP). This parameter combines the various GHGs that can contribute to global warming and expresses them as a mass of carbon dioxide equivalents (CO_2 eq). The 100-year GWP factors for GHG emissions shall be used when calculating inventory results for pharmaceutical products, based on the Intergovernmental Panel on Climate Change (IPCC) sixth assessment report[10], or the most recent version of these GHG factors.

If biogenic CO_2 emissions or direct land use change are included within the aggregated GHG inventory, these should be reported separately. Biogenic CO_2 refers to CO_2 sequestered or released by biogenic sources (e.g. plants). Further information is available in the GHG Protocol Product Standard[5]. Release of sequestered carbon through previous land use change within the last twenty years should be accounted for, following the recommendations in Appendix B of the Product Standard[5].

2.5.2. Freshwater use

Freshwater use reports the volume (m^3) of freshwater required to create and to deliver a product or service. It includes direct water use and indirect water use from activities upstream in the value chain of the care pathway module activities themselves. The total direct and indirect water use shall be reported separately for the modules and for the care pathway.

- **Direct use** is water used directly by the healthcare activity. For example, direct use includes water associated with handwashing, sterilising surgical instruments, patient hygiene, laundry and cooling systems. Data for direct water use can be sourced from water meters, water bills or estimated by using pump ratings and hours of operation.
- **Indirect use** is water used in activities upstream or downstream of the care pathway module. For example, indirect use includes water associated with the production of pharmaceuticals and medical equipment, food services and electricity. It is important to avoid double-counting when combining indirect with direct water consumption, e.g. water consumed in supplying freshwater.

Freshwater use includes:

- Fresh surface water (e.g. rivers, lakes and wetlands);
- Groundwater;
- Rainwater directly collected and used;
- Wastewater from another organisation; and
- Municipal water supplies or other water utilities.

Freshwater use does not account for factors such as resource stress based on geographic region and water quality. For further guidance regarding these factors, refer to ISO 14046[11] and the global water footprint assessment manual[12]. Furthermore, while this method does not

(10) IPCC (2021). AR6 report. Climate Change 2021: The Physical Science Basis. Available at: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_FullReport.pdf.
(11) Technical Committee ISO/TC 207. (2006). ISO 14046. Environmental management Water footprint Principles, requirements and guidelines (ISO 14046:2012). https://www.iso.org/standard/43263.html.
(12) Water Footprint Network, Water Footprint Assessment Manual Setting the Global Standard, https://www.waterfootprint.org/water-footprint-2/what-is-water-footprint-assessment/.

require a distinction to be made between blue, green and grey water use, as defined in the Global Water Footprint Standard, such distinctions may be reported if relevant to the study.

2.5.3. Waste generation

In this method, waste is defined as "*any substance or object which the holder discards or intends or is required to discard*"[13]. Waste generation shall be calculated for direct sources of waste only. Direct waste is waste generated from an activity within the care pathway boundary, for example, waste from an emergency department and operating theatres, including used surgical drapes, gloves and cotton pads.

Waste is to be reported by weight (kg). If data are available in volumetric terms, they must be converted to mass using the waste stream's known or estimated bulk density. Where known, the treatment route for each waste type should be reported. For example, recycling, incineration with or without energy recovery and landfill. The following categories of direct waste generated shall be reported:

- Hazardous waste;
- Non-hazardous waste (all other solid or liquid waste, excluding wastewater discharges); and
- Total waste generated, as the sum of hazardous and non-hazardous waste.

Indirect waste is not required to be appraised and reported due to the lack of consistent secondary emission factors. However, it may be reported separately if relevant to the study. Indirect waste is waste generated from an activity upstream or downstream of an activity within the care pathway boundary, for example, from the production of materials and energy.

Sharps disposal is typically included under hazardous waste. However, if particularly relevant to the study, it may be reported separately. Other categories that it may be beneficial to report separately include clinical waste, unused pharmaceuticals and waste electrical and electronic equipment (WEEE).

2.6. ALLOCATION

Allocation refers to the process of partitioning activities and resources consumed between modules and services. Although allocation shall be avoided where possible, in many cases, the type of data available necessitates allocation. For example, a hospital may only measure its total electricity use and not the usage per department or room.

Allocation based on physical relationships is preferred, as described in the Product Standard[5] and ISO14040[2]. When determining the allocation approach, a key consideration is the variable which is most significant in determining the level of activity. For example, is there a strong relationship between the consumption of electricity within a surgical operating room and floor space, number of staff, length of a surgical procedure, total number of surgeries completed or type of operation? Physical relationships that may be used to allocate resources between activities and modules may include the following.

- Floor space. This could be the area required in a facility to provide a service, such as the space taken by an emergency department in a hospital.

(13) European Commission Waste Framework Directive, Directive 2008/98/EC, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02008L0098-20180705.

- Relative intensity. This could be the number of staff or patients in different hospital wards.
- Time. This could be the time used to deliver the service based on the unit of analysis, e.g. hours taken for completion of a surgical procedure.
- Technical expertise. A technical expert with service knowledge/data, e.g. percentage use of an X-ray machine for an emergency department.

Should it not be possible to allocate based on physical relationships, other methods can be used and should be recorded. One example is allocating based on service costs. In the UK, the Patient Level Information and Costing Systems may be a method of performing resource allocation.

2.7. MATERIALITY

An activity or decision is considered to be material if it has a significant or meaningful influence on the environmental impact of the overall care pathway or module. For a care pathway assessment, materiality refers to ensuring that all activities that significantly impact the sustainability metric results and that could influence the principal findings of the assessment are included in the assessment. Particularly where resources are limited, activities estimated to be, or that are considered, immaterial can be excluded to improve the efficiency of the study. The basis for determining insignificance shall be stated, which may include a rule of thumb threshold or cut-off approach.

Cut-off approach

Cut-off rules are used to determine the threshold below which activities or data are considered insignificant for the purposes of materiality assessment and data screening. These rules help to limit the effort spent on collecting data and calculating environmental flows for inputs or outputs that have only minimal impact. Each study should define and report the cut-off percentage for each sustainability metric assessed. The rationale for selecting these thresholds must be clearly stated. This may include a rule of thumb threshold, for example, a mass flow that contributes less than 1% of the mass flow for the module or care pathway being appraised.

An upper limit for total exclusions should be defined. For instance, while individual flows below 1% may be excluded, the combined total of all excluded flows should not exceed 10% of the mass, energy, or overall contribution to the sustainability metric for the module or care pathway.

As part of the materiality assessment, activities and data should be evaluated based on their estimated contribution to the environmental performance of the care pathway or module for each metric. Any activity contributing more than the defined cut-off percentage (e.g. 10% of the total GHG emissions) should be considered material. For each material process, the study should provide details of data sources, data quality scores and whether the data are primary or secondary.

2.8. DATA QUALITY

The quality of a care pathway assessment is dependent on the quality of the data used to calculate its impact. It is critical to consider the quality of the primary and secondary data used and to demonstrate that they appropriately characterise the care pathway assessed.

Assessing data quality is not an exact science. There are many ways in which data quality assessments can be performed and different scoring approaches could be used in each case. The key principle is that due consideration is given to the quality of the data and that this is

carried out and reported transparently. Data quality should be assessed against five data quality indicators, as defined by the Product Standard[5]. These are:

1. **Technological representativeness**: the degree to which the data reflect the actual technology(-ies) used in the process;
2. **Geographical representativeness**: the degree to which the data reflect the actual geographical locations of the processes within the boundary (e.g. country or site);
3. **Temporal representativeness**: the degree to which the data reflect the actual time period or age of the process;
4. **Completeness**: the degree to which the data are statistically representative of the process sites; and
5. **Reliability**: the degree to which the sources, data collection methods and verification procedures used to obtain the data are dependable.

A semi-quantitative assessment is recommended to assess the quality of primary and secondary data. Where this is not possible or appropriate, a qualitative assessment is recommended.

2.8.1. Addressing uncertainty

All sustainability assessments involve some degree of uncertainty and variability in calculating performance against metrics. These uncertainties arise from limitations in measurement accuracy, use of standard emission factors, data collection and assumptions made to fill knowledge gaps. It is important to identify and to understand the sources of uncertainty in the results and to test this quantitatively, where appropriate, with sensitivity analysis. As a minimum and in line with the Product Standard[5] "*companies shall report a qualitative statement on sources of inventory uncertainty and methodological choices*."

2.9. INCLUSIONS AND EXCLUSIONS

2.9.1. Inclusion

The following categories of activity data should be included within all modules, unless they are shown to be immaterial to the study.

- **Consumables used**. Inclusive of medical (e.g. surgical masks) and non-medical (e.g. office paper) consumables.
- **Pharmaceuticals.** Inclusive of medication and devices.
- **Patient nutrition**. Inclusive of meals provided to a patient (e.g. food consumed during a hospital inpatient bed day), oral nutritional supplements and enteral nutrition feeds.
- **Equipment used**. Inclusive of medical (e.g. MRI machine) and non-medical (e.g. furniture) equipment.
- **Direct emissions**. These are emissions that arise directly from an activity (e.g. anaesthetic gases).
- **Utilities.** Inclusive of fuel, electricity, water, waste and other facilities data from buildings required to provide each activity service.
- **Staff travel.** Travel required for staff to provide the services of each activity (e.g. a surgeon's travel to a hospital to perform a surgical procedure).
- **Shared services.** Allocation of the support services and administrative functions required to provide the activity services (e.g. cleaning, maintenance, record keeping).

The cradle-to-gate impacts of single-use consumables (e.g. surgical masks) can be attributed directly to an activity. However, where reusable equipment (e.g. an MRI machine) is required, this shall be allocated to an activity for the unit of analysis based on the number of uses and the lifetime of the equipment. If it is unclear whether an activity or contribution should be included or excluded, then an assessment should be undertaken to determine whether it is material or immaterial.

2.9.2. Exclusion

Activity data that are immaterial to the study may be excluded. The activities below are typically immaterial, however, if they are thought to be material to the study, an assessment should be undertaken to determine their materiality.

- Capital equipment and infrastructure (e.g. hospital building, car park).
- Corporate services (e.g. marketing, R&D).
- Staff training (e.g. initial or ongoing training requirements for GPs).
- Administrative, regulatory or other functions not directly connected to the provision of each service (e.g. government agencies and centralised procurement).

3. ASSESSING A CARE PATHWAY

The following sections describe how to undertake a care pathway assessment.

3.1 Define the objectives.

3.2 Define the care pathway.

3.3 Define the functional unit (unit of analysis).

3.4 Create a detailed care pathway map.

3.5 Group activities into modules.

3.6 Complete a materiality assessment.

3.7 Calculate the environmental impact of each module.

3.8 Add the correct multiples of modules together.

3.9 Interpret and report the findings.

3.1. DEFINE THE OBJECTIVES OF THE ASSESSMENT

Define the objective of the assessment. Consider why this particular assessment should be carried out and how its findings will be applied. For example, is the assessment intended for the purposes of improving an existing pathway, informing the development of a new pathway or comparing alternative forms of care?

3.2. DEFINE THE CARE PATHWAY TO BE APPRAISED

The following questions should be addressed when defining the care pathway and the unit of analysis.

- What is the care pathway being appraised? For example, what is the condition and how severe is it?

- What are the characteristics of the patient being appraised? For example, patient age or gender?
- Where are the activities of the care pathway undertaken? For example, their location and setting?
- What is the duration of the care pathway? For example, what is the average length of time the patient is treated for, or what is the time period studied?

The duration of a care pathway may vary significantly, depending on the condition and type of patient. The selected time studied may substantially impact the results and, therefore, the study must define the time period of the assessment and justify this choice. This is particularly important when considering long-term conditions, for example, whether the unit of analysis is based on one year or 30 years of condition management.

3.3. Define the Functional Unit

The common unit of analysis for care pathways is known as the functional unit and it will be used as the basis for reporting results. The defined functional unit will include patient type and representativeness, condition and severity, geographical coverage, the age profile and the time period.

The representative patient or patient group shall always be specific to the care pathway assessed and reflect either an average, or a subset of an average, of a well-defined group of patients over a well-defined period of time.

3.4. Map the care pathway to be appraised.

Create a detailed map of the activities required and their frequency for the care pathway associated with the defined functional unit. For example, ten GP appointments and five outpatient appointments.

3.5. Group activities into modules

After mapping the care pathway, it is useful to group activities (e.g. all GP appointments that occur) into modules to simplify the care pathway and to focus data collection efforts. The scope of activities included within modules must be clearly documented. When attributing an activity to a module, consider the purpose of the activity, who is leading the decision-making and where the activity occurs.

Modules must not include activities already covered by other modules in the care pathway. Activity repetition is avoided so that the environmental impacts of modules can be added together without the risk of double-counting. To avoid repetition, patient travel should be its own separate module.

The following steps are suggested when defining the boundaries of a module:

- Identify the activities within the care pathway module that are directly connected to the studied care pathway system and its ability to perform its function;
- Group the activities into sub-modules if required;
- Identify the resources needed (e.g. materials, energy) or outputs released (e.g. direct emissions to air and water, waste) for each activity; and
- Illustrate the activities of a module through a process map.

Where it is unclear to which module an activity should be allocated, the activity should be allocated at the point of interaction with the patient. The point at which a patient interacts with the resource, or their treatment, is considered the point where the emissions should be attributed. For example, the upstream impacts of an MRI machine or a medicine are attributed to the point of patient use. Attributing the impact to the point of responsibility is not supported, for example, attributing the MRI scan to the GP consultation in which it has been prescribed.

3.6. COMPLETE A MATERIALITY ASSESSMENT

A materiality assessment is an initial, high-level assessment that will identify the areas that are material to the study, i.e. that contribute the most to the environmental impacts of the care pathway. This screening exercise shall be performed by estimating frequency, activity data and emission factors. The practitioner can then prioritise resources further to investigate the area(s) identified as material. The basis for determining materiality shall be stated, which may include a rule of thumb threshold.

Emission factors for care pathway modules are provided by the Sustainable Healthcare Coalition[14]. These emission factors are secondary data and, where appropriate, should be used in the materiality assessment as an indicator of performance for the environmental metrics of that module. For example, the care pathway may include a GP appointment and therefore the values provided in the SHC GP consultation module can be applied. If an appropriate module or activity is not included within the SHC module data provided, source emission factors from the literature, make estimates or use proxies.

The activities should be ranked to identify each activity's relative contribution to the care pathway module and to the care pathway as a whole.

3.7. EVALUATE THE ENVIRONMENTAL IMPACT OF EACH MODULE

Once the materiality assessment is complete and the material activities or modules have been identified, a more detailed assessment is conducted for each of these activities/modules.

3.7.1. Activity data

Activity data shall be collected for each module within the care pathway that is considered material to performance against the environmental metrics appraised. This method considers three types of activity data, as follows.

Process activity data

These data are physical measures of a process that result in a contribution to the environmental metrics appraised (e.g. kWh of electricity consumed in a process, kg of cleaning chemicals used to provide a service). Typically, they describe a unit of activity for a specific year (e.g. 100 latex gloves per patient per year). This also includes details of any transportation of staff, incoming materials, wastes or transport of samples for laboratory testing (e.g. distances travelled, vehicles used, etc).

Direct activity consumption, waste and emissions data

These data refer to the direct contribution to the environmental metrics of concern, i.e. use of water, the generation of waste and the emission of greenhouse gases from a process (e.g. leakage of refrigerant from cooling systems).

(14) Sustainable Healthcare Coalition. Sustainable Care Pathways Knowledge Hub | Sustainable Healthcare Coalition. 2025, shcoalition.org/sustainable-care-pathways-knowledge-hub/.

Financial activity data

These data are monetary measures of activities or flows that contribute to performance for the environmental metrics appraised (e.g. expenditure [£GBP, $USD, etc.] on electricity or cleaning chemicals). These data can then be combined with a financially-related emission factor (e.g. environmentally extended input-output [EEIO] emission factors for GHG emissions, water and waste).

Financial activity data cannot be used to meet primary data collection requirements. The use of financial activity data should be minimised to ensure greater accuracy and consistency between assessments.

3.7.2. Data collection

Primary activity data

Primary data are preferred where practicable. Primary data are activity data from specific activities within the boundary of the studied care pathway. The organisation conducting the assessment shall collect activity data for all processes under its control. A process is considered under an organisation's control if it falls within its operational or financial control.

Primary data collection must exclude any patient-identifiable information. To ensure high-quality data, all relevant stakeholders should be engaged and leadership support should be secured as early as possible in the care pathway assessment process. For activities occurring across a large number of sites, where comprehensive data collection would be resource-intensive, a sampling approach is recommended. Guidance on the sampling approach is provided in the Product Standard[5].

For activities outside the organisation's control, engaging with other organisations, such as suppliers for primary data, is recommended where practicable. Once supplier data are received, it is essential to assess their accuracy and quality.

Allocated data are defined as primary data, as long as they meet primary data requirements.

Secondary activity data

Secondary data should be identified where primary data are not available. Secondary data are data not from specific activities within the boundaries of the studied care pathway. They may take the form of average or typical information about an activity (e.g. energy requirements and refrigerant losses for chilled storage) from a published study or other source. For example, primary data may be those collected for a specific module (e.g. electricity use by a specific ward), whilst secondary data are generic (e.g. an estimate of electricity use by hospital wards not specific to the care pathway appraised) and might be of lower quality.

To determine whether the identified secondary data are appropriate, the quality of the data shall be appraised. The study should always use the highest quality data available. Therefore, if the available primary data are of lower quality than the corresponding secondary data, the secondary data should be used instead.

3.7.3. Calculate module/activity impact

Once activity data has been collected, the appropriate corresponding emission factors should be identified and multiplied by the activity data quantity. Emission factors are values that reflect the contribution made per unit of activity data to performance for a sustainability metric. For example, the GHG emissions (kg CO_2e), water (m^3) or waste generated (kg) per kWh of grid electricity or per dose of a medicine administered[15].

An emission factor should typically include all the relative environmental impacts from upstream activities. For example, the emission factor for a kWh of grid electricity should include:

(15) Medicine emission factors should be calculated by manufacturers applying the PAS 2090 specification.

- Combustion of the fuels needed to generate the electricity;
- Distribution of those fuels to the power generation facility;
- Extraction of those fuels from the ground or other sources; and
- Transmission and distribution of electricity losses to provide the electricity.

The following hierarchy for sourcing emission factors is recommended.

1. Critically reviewed emission factors that are compliant with ISO Life Cycle Assessment standards(2,3) and that are generated from average industry data and contained in life cycle inventory databases, industry association reports and government reports.
2. Emission factors from published, peer-reviewed life cycle studies or proprietary packages.
3. A proxy or substitute emission factor for a similar product, material, process or activity.

Where aggregated emission factors are applied, care must be taken to assure they are fit for purpose. The practitioner should consider whether the boundary of the emission factor is consistent with the study boundaries. Care should be taken when sourcing emission factors to ensure double counting is avoided, e.g. where patient travel and or consumables for administration have been included in medicine emission factors (e.g., as required in PAS 2090[4]).

3.8. ADD THE CORRECT MULTIPLES OF MODULES TOGETHER

Once each module's environmental impact has been evaluated for each metric, the care pathway as a whole should be assessed. The care pathway impact for an environmental metric is the sum of the frequency of each module, each multiplied by the corresponding module impact. Ensure that the frequency unit for each module aligns with the module impact-intensity and that the frequency reflects the same unit of analysis before adding them together, e.g. per patient, per hour of surgery.

3.9. INTERPRET AND REPORT THE FINDINGS

The results should be analysed and the findings reported. Interpretation and reporting requirements and further general guidance for reporting are provided in Chapter 13 of the Product Standard[(5)] and Section 5 of ISO 14044[(3)]. Recommendations for inclusion in a care pathway report are:

Introduction and scope:

- Contact information for the individual or organisation completing the study;
- Study completion date;
- The studied care pathway and its description;
- The unit of analysis;
- A declaration of conformance with this method document;
- The purpose and intended uses of the case study; and
- For subsequent analysis, a link to previous reports and a description of any methodological changes.

Boundary setting:

- A process map of the care pathway, identifying each of the modules used;
- A description of the care pathway process map, including its constituent modules;

- A description of the condition/illness and type of patient considered;
- The time period considered; and
- The geographical scope of the study.

Activity data:

- For material processes, a descriptive statement concerning the activity data should include:
    - Data sources;
    - Qualitative description of data quality; and
    - Where it was not possible to source primary activity data and those methods employed to overcome data gaps.

Allocation:

- A description of the approach used to allocate activity data to the care pathway and modules; and
- Disclosure and justification of the methods used to avoid or perform allocation.

Uncertainty:

- A qualitative statement concerning metric uncertainty and methodological choices, where methodological choices include:
    - The source of emission factors used; and
    - Calculation models.

Inventory results:

- The source and date of the emission factors used;
- Total results for the care pathway for each sustainability metric, according to the unit of analysis;
- A breakdown of the overall results according to the care pathway module; and
- Key contributions to each sustainability metric for the care pathway as a whole and for any significant individual modules as identified through the materiality assessment.

Findings and improvements

- Recommendations for improving the environmental performance of the care pathway and the material modules;
- Any information that may be useful to improve the sustainability of similar care pathways; and
- Discussion as to how the quality, accuracy and uncertainty of the study might be improved, therefore discussing the limitations of the study.

Assurance:

- A short assurance statement that includes:
    - Whether assurance has been undertaken;
    - Whether the assurance was performed by a first or third-party;
    - The level of assurance achieved (limited or reasonable) and an assurance opinion or the critical review findings;
    - A summary of the assurance process;
    - The relevant competencies of the assurance providers; and
    - How any potential conflicts of interest were avoided for first-party assurance.

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DEFINITIONS

Activity data: a physical measure of a process that results in emissions or removals relevant to the environmental metrics appraised.

Active Pharmaceutical Ingredient (API): any substance or combination of substances used in a finished pharmaceutical product (FPP), intended to furnish pharmacological activity or to otherwise have direct effect in the diagnosis, cure, mitigation, treatment or prevention of disease, or to have direct effect in restoring, correcting or modifying physiological functions in human beings.

Allocation: the partitioning of emissions and removals from a common process between the care pathways, modules or products that are the subject of study.

Assurance: the level of confidence that the inventory results and report are complete, accurate, consistent, transparent, relevant and without material misstatements.

Biogenic: produced by living organisms or biological processes but not fossilised or from fossil sources.

Carbon footprint: the sum of greenhouse gas emissions released in relation to a care pathway, product or service, expressed as carbon dioxide equivalents (expressed in terms of a mass of CO_2e).

Care pathway: a complex intervention for the mutual decision-making and organisation of care processes for a well-defined group of patients during a well-defined period.

Cradle-to-gate inventory - a partial life cycle of an intermediate product, from material acquisition through to when the product leaves the reporting company's gate (e.g. immediately following the product's production).

Cradle-to-grave inventory - removals and emissions of a studied product from material acquisition through to end-of-life.

Emission factor: Greenhouse gas emissions (GHG), or the value of another environmental metric, per unit of activity data.

End-of-life: a life cycle stage that begins when the used product is discarded by the consumer and ends when the product is returned to nature (e.g. incinerated) or allocated to another product's life cycle.

Environmental metric: the sum of resources and emissions relevant to a particular environmental issue and converted to a single value.

Freshwater use: summation of direct water use within a healthcare activity and indirect water use from activities upstream of the care pathway.

Functional unit: the quantified performance of the studied product.

Global warming potential (GWP): a factor used to calculate the cumulative radiative forcing impact of multiple specific greenhouse gases in a comparable way.

Greenhouse gas (GHG): a gas released to the atmosphere that absorbs and emits infrared radiation, contributing to the greenhouse effect. Sources of GHGs include combustion, emissions from chemical processes, waste degradation, etc.

Land use change: occurs when the demand for a specific land use results in a change in carbon stocks on that land, either due to a conversion from one land-use category to another or a conversion within a land-use category.

Life cycle: consecutive and interlinked stages of a product system, from raw material acquisition or generation of natural resources to end-of-life.

Life cycle assessment (LCA): a method of assessing the environmental impacts of a product, service or care pathway through relevant life cycle stages or activities.

Module: one or more distinct healthcare-related activities performed for, on behalf of, or by a patient.

Medical device: a product intended to be used for medical diagnosis, cure, treatment or disease prevention, but which does not achieve its principal intended action in or on the human body by pharmacological, immunological or metabolic means.

Patient: an individual or group with a specific condition, noting severity and further designated by age and location of care.

Pharmaceutical product: a substance used for medicinal purposes, for the purpose of medical diagnosis, cure, treatment or disease prevention.

Primary data: data collected from processes specific to the studied care pathway.

Product: any good, service, activity or care pathway.

Reference flow: the amount of studied care pathway or activity needed to fulfil the function defined in the unit of analysis.

Removal: the sequestration or absorption of GHG emissions from the atmosphere, which most typically occurs when CO_2 is absorbed by biogenic materials during photosynthesis.

Secondary data: data collected from processes that are not specific to the studied care pathway.

Unit of analysis: the basis on which the inventory results are calculated; the unit of analysis is defined as the functional unit for the care pathway and the reference flow for intermediate modules and activities.

Waste generation: substances or objects discarded or intended to be discarded, having arisen from the studied care pathway.