# Virtual Health Service Emissions Measurement

A framework and tools to support the transition to sustainable healthcare delivery

Version 2.0

healthdirect Australia

# Contents



Version 2.0 August 2025: Updates made to all emission factors due to updated national and jurisdictional level data on population data, public transport usage, electric vehicles sales plus minor amendments from original version.

*Healthdirect Australia acknowledges the Traditional Owners of Country throughout Australia and their continuing connection to land, sea and community. We pay our respects to the Traditional Owners and to Elders both past and present.*

# 1. Executive Summary

This document has been created to support the work of all Australian healthcare providers in measuring and evaluating the role of virtual health services in supporting their emission reduction targets and policy goals. Healthdirect has supported a series of applied research activities to develop a toolkit for measuring the emissions savings of multi-modal virtual health services. The toolkit includes the description of the framework, technical summary data, calculator, and a set of localised emissions factors for each Australian jurisdiction, alongside a how-to guide on its application in estimating the emissions of a range of healthcare consultation services, both in person and virtual.

By providing a standardised approach to measuring and evaluating the emissions savings opportunity of transitioning clinically appropriate services to virtual or hybrid delivery pathways, health service providers can actively demonstrate their impact to overall health service sustainability targets.

A high-level introduction and contextual information about climate change, emissions measurement, and virtual health emission measurement have been provided to support a broad range of stakeholders in engaging with the contents of this document. The document is provided in sections so that others who may be well-versed in the subject matter may skip directly to the toolkit, emission factors or any other section they seek to read.

The report includes:

- **Introduction:** An overview of climate change and healthcare and a summary of Australia's carbon footprint and climate action plans.
- **Details of the framework** developed to measure emissions of multi-modal virtual health services, the sources of the input data used, and the creation of localised emission factors for in-person and virtual health consultations across Australian jurisdictions.
- Jurisdiction specific **emission factors.**
- **How to guide** with example use cases for applying the framework methods and emissions factors in local regions, as well as details of the input data used if users wish to update or modify for their purposes.
- Appendix A: **Technical summary of method**, provides an overview of the emissions calculations used to develop the localised emission factors and provides a description of the acronyms that are referenced throughout the framework.

For more information about this report please contact **sustainability@healthdirect.org.au**.

# 2. Introduction

## 2.1 Climate change and healthcare

Climate change is one of our most pressing global challenges, posing significant risks to the balance of planetary systems that interact to support life on Earth. It is well accepted that climate change has accelerated, driven primarily by anthropogenic (man-made) activities such as burning fossil fuels, deforestation, and industrial processes, which increase the concentration of greenhouse gases in the atmosphere. These emissions are causing long-term changes in temperature, weather patterns, and the frequency of extreme weather events, which in turn increase risks to human health and the core infrastructure and systems required to deliver health and care services.

The health sector faces a dual challenge in the context of climate change. On the one hand, it must address how to identify, treat and manage the growing health impacts caused by rising temperatures, changing disease patterns, and increased frequency of climate-related disasters. On the other hand, the sector is itself a major contributor to climate change, responsible for an estimated 5-7% of Australia's total greenhouse gas emissions. Recognising this impact, Australia released its first National Health and Climate Strategy in December 2023, emphasising the need to reduce emissions in healthcare and promote sustainable practices. This strategy aligns with broader efforts to act on climate change across all sectors, including new emission measurement and reporting regulations, increased commitments to net-zero targets and shifts to implement policies to support a circular and regenerative economic approach.

## 2.2 Australia's Carbon Footprint and Climate Action

Australia reports its emissions under the National Greenhouse Gas Inventory, which provides regular updates on the nation's carbon footprint across key sectors such as energy, transport, agriculture, and waste. These reports form part of Australia's obligations under the Paris Agreement, an international treaty aimed at limiting global warming to well below 2°C, with efforts to pursue a limit of 1.5°C above pre-industrial levels. As a signatory, Australia has committed to achieving net-zero emissions by 2050, with interim targets of reducing emissions by 43% below 2005 levels by 2030.

To support these commitments, the Australian Government has implemented several key policies, such as the Safeguard Mechanism, which regulates emissions from large industrial facilities, and the Rewiring the Nation Plan, aimed at accelerating the transition to renewable energy. Investments in low-emission technologies, including hydrogen and carbon capture and storage, are also part of the Government's broader strategy. These efforts are complemented by initiatives at the state and territory levels, which often set even more ambitious climate goals.

Despite these actions, Australia faces criticism for its continued reliance on coal and gas exports, significantly contributing to global emissions. However, growing pressure from international partners and public demand for climate action have driven an increase in renewable energy adoption, with renewables now accounting for around 30% of Australia's electricity generation. Several states have implemented bold initiatives to transition to 100% renewable energy. For example, South Australia has achieved periods where it generates more than 100% of its electricity needs from renewable sources like wind and solar, supported by advancements in energy storage systems. Similarly, Tasmania reached 100% renewable energy generation in 2020, primarily due to its reliance on hydroelectric power. The Australian Capital Territory (ACT) has also achieved its target of sourcing 100% of its electricity from renewables by 2020, primarily through investments in wind and solar projects.

This achievement underscores the potential for state-level initiatives to lead the way in Australia's energy transition, showcasing innovative grid management and energy storage solutions that enable surplus energy to be exported or stored for future use. These findings suggest actions led by jurisdictions in their efforts to reduce the health sector's environmental impact through the provision of low-carbon care including telehealth services, may also lead the way in achieving national targets.

In the healthcare sector, Australia's National Health and Climate Strategy (2023) represents a critical step toward aligning health system operations with broader climate objectives.

The majority of environmental sustainability efforts in the health sector to date have focused on infrastructure improvements; such as shifting to renewable energy, targeting waste streams and moving away from high emissions impact anesthetics. However, as the strategy highlights, there are significant benefits to be realised in the transition to low-carbon healthcare delivery models, from a reduction in emissions and resource waste, as well as providing a pathway for continued access to care for forecasted extreme weather and biologic events and integrating increased climate resilience into health service infrastructure planning.

These actions are likely to deliver improved environmental outcomes as well as social and economic metrics of sustainability as low carbon care models, such as virtual health, have demonstrated a range of direct and indirect benefits for patients, providers and workforce.

We believe these measures are essential to meet both the immediate and long-term goals of mitigating climate risks while maintaining sustainable and equitable health services for all Australians.

However, a critical missing piece addressed by this applied research is the lack of standardised metrics for emissions from individual healthcare consultations, hindering accurate assessment and targeted reduction strategies.

# 3. Measuring emissions of virtual health services

## 3.1 Virtual health service overview

The benefits of virtual health services, often referred to as 'telehealth' or 'telemedicine', are well-established. These services leverage technology to provide remote access to consultations, advice and monitoring; enabling patients and providers to connect via phone or video. Virtual health services have proven instrumental in improving accessibility, particularly for rural and remote communities, while reducing travel barriers and enhancing convenience for patients.

### 3.1.1 Synonyms and broader context

The terms “telehealth,” “telemedicine,” and “virtual health services” are often used interchangeably. However, they collectively describe a range of remote healthcare services that utilise technology to deliver care at a distance. These services are adaptable to various healthcare contexts and are increasingly recognised for their ability to enhance care delivery while supporting sustainability goals.

### 3.1.2 Emissions impact of virtual health

The most significant contributor to emissions savings in virtual health services is the reduction in the need for transportation, referred to herein as Avoided Transport Emissions (ATE). Eliminating or reducing patient travel to healthcare facilities and, in some cases, provider travel for home visits or outreach services, as well as virtual health services, such as telehealth, can significantly reduce greenhouse gas emissions associated with the provision of care. This benefit can be particularly pronounced in rural and remote regions where travel distances are greater, there is a higher likelihood of emission-intensive transport modes such as air travel, and alternative travel options may be limited. However, the volume of consultations, implications of traffic and congestion times, and availability and access to care providers mean that due to higher density population in these areas and volume of consutlations, there are significant emission savings to be made in virtual health services provided in metro-urban areas as well.

In addition to transportation-related savings, telehealth reduces the consumption of diagnostic and treatment supplies, referred to as Avoided Supply Emissions (ASE). In-person consultations often involve single-use medical items such as gowns, gloves, and other materials, contributing to a rise in healthcare-related waste streams and associated increased emissions. Virtual health services may minimise the reliance on these resources, providing additional environmental benefits.

Virtual health services require energy and generate their own emissions in the service provisioning from the use of energy (often fossil fuel generated) required to power the computers, data servers and end-user devices, including mobiles and personal computers required to interact with the service. These are referred to here as Virtual Consultation Emissions (VCE). Studies have been undertaken to provide an average emission cost per telephone or video consultation; however, it is important to note that these were done before the prevalence of embedded Artificial Intelligence tools in clinical decision software, which is likely to create an increase in the average emissions per virtual health consultation or one activity unit.

### 3.1.3 Literature review findings

A literature review was conducted to gain a more comprehensive understanding of the current state of emissions measurement in telehealth. The review is available open source at: de Sain, Rachel, and Amanda Irwin. “Analysing telehealth emissions and variations in primary care settings-A scoping review.” *The Journal of Climate Change and Health* (2024): 100340. https://www.sciencedirect.com/science/article/pii/S2667278224000439

The literature review identified three key variables consistently used to estimate emissions associated with virtual health services: avoided transport emissions (ATE), avoided supply emissions (ASE) and virtual call emissions (VCE).

At minimum, ATE is necessary for a basic emissions estimate. Including ASE and VCE provides a more comprehensive assessment. Based on these findings, we propose the following calculation pathway to determine virtual health emissions savings.

**Method:**

| ATE | + | ASE | - | VCE | = | VHES |
|---|---|---|---|---|---|---|
| Avoided transport emissions | | Avoided supply emissions | | Virtual call emissions | | Virtual health emissions savings |

All studies included at least transport emissions, with a high degree of variability in how the transport emissions were developed, with some studies using a national average for travel distance and use of public transport. In contrast, others, usually small-scale studies of one clinic, used precise distances from patients' homes to the clinic to determine the associated transport emissions.

Some studies also included allocations for the typical supplies or diagnostics performed in an in-person visit and avoided for remote consultations. Others included the associated emissions generated in the provision of virtual consultations, either by telephone, audio over IP, or video over IP.

This review revealed several key insights and gaps in the existing body of knowledge:

- **Single pathway focus:** The majority of telehealth emissions measurement studies compared a single clinical pathway, such as an in-person consultation versus a virtual consultation. While these studies provide valuable insights, they do not reflect the complexity of modern healthcare delivery, which often involves multiple modes of care, including a combination of remote and in-person services.

- **Lack of models for multi-modal services:** There is currently no standardised model for measuring the emissions associated with multi-modal virtual health services. This gap limits the ability to comprehensively assess telehealth's environmental benefits and trade-offs within complex healthcare systems.

- **Absence of public emission factors:** No standardised, publicly available emissions factors exist for either in-person or virtual healthcare consultations in Australia. This absence creates a significant barrier for healthcare providers and researchers seeking to calculate the carbon footprint of their services or to compare the environmental impact of different care delivery models. More importantly, it leaves health departments without a practical method to analyse the emissions profiles of various service options. Consequently, they are unable to strategically implement and evaluate interventions aimed at reducing emissions, nor can they readily demonstrate their achievements in environmental sustainability to the public or governing bodies.

Addressing these gaps is essential for enabling accurate, consistent, and actionable emissions assessments across diverse healthcare contexts. The development of standardised models and emission factors would provide the foundation for robust comparisons and drive innovation in sustainable healthcare delivery.

### Developing a framework for multi-modal virtual health emission measurement

To mitigate the gap identified in the literature review, a further study was undertaken to develop a standardised model to estimate the emissions impact of multi-modal virtual health services in Australia, using Healthdirect as a case study. The objective was to quantify emissions across different consultation types and regions, creating a framework for localising telehealth emission factors.

A mixed-methods explanatory sequential design was implemented, integrating quantitative data from Healthdirect's service records alongside publicly available travel and emission data, with qualitative insights from stakeholder interviews, and a Delphi panel of clinical and service usage experts. Emissions were estimated based on changes to travel, supply use, and virtual consultation costs, with adjustments for geographic remoteness and types of clinical consultation.

Analysing Healthdirect's service data allowed categorisation of interactions into seven clinical pathways based on the patients' **Original Intent** and **Final Outcome** after triage. This categorisation enabled flexible modelling of emissions associated with different pathways, reflecting the varied patient interactions within a multi-modal service.

- **000 Ambulance:** Ambulance transport to an emergency department.
- **Emergency Department (ED) presentation:** Presentation to an emergency department, whether by private or public transport.
- **General Practitioner (GP) consultation:** Presentation to a general practitioner (GP) clinic, with reallocation options applied to virtual consultations.
- **Other Healthcare Provider (HCP) consultation:** Presentation to a healthcare provider who is not a general practitioner or emergency department physician. This includes specialist, allied health and pharmacy advice consultations, with reallocation options applied to virtual consultations
- **Virtual consultation - audio:** Consultations undertaken via telephone.
- **Virtual consultation - video:** Consultations undertaken via video.
- **Self-care:** Self-management of symptoms without seeking further consultation, may be provided with links to online health information and support tools.

In a single clinical pathway calculation, the emissions associated with the baseline scenario (an in-person consultation) are compared to those of the intervention (a virtual consultation), where the service type of both the baseline and the comparator remains consistent.

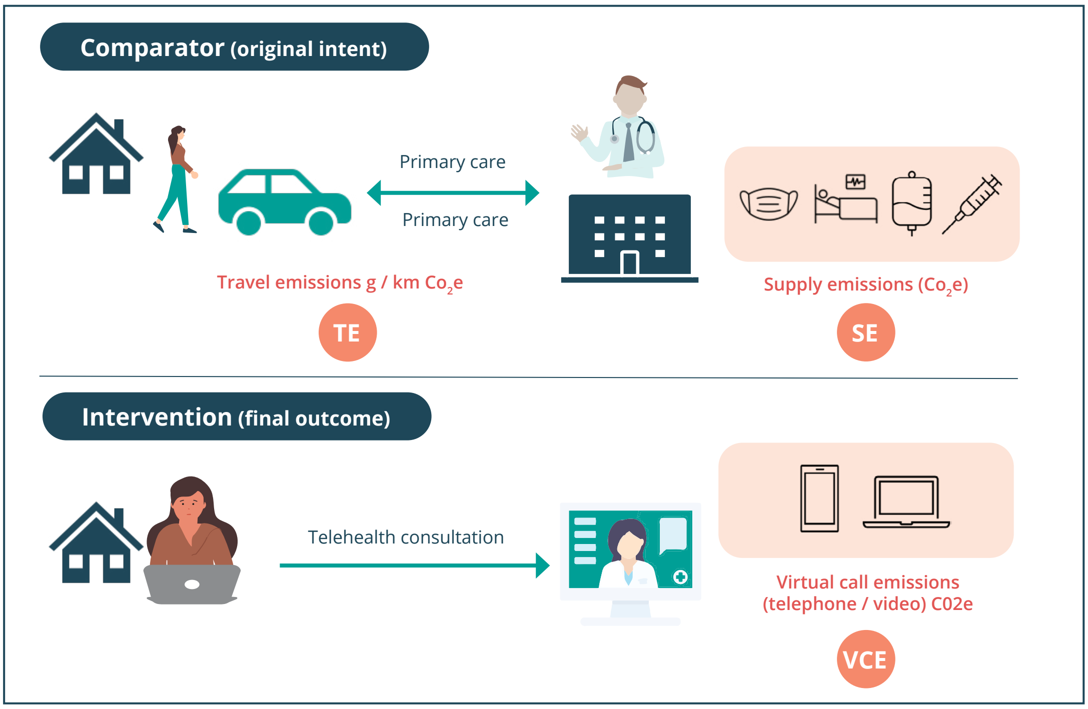


**Figure 1:** Singular Clinical Pathway comparison of impacts on virtual health emissions

Singular clinical pathway calculations can be used for calculating the estimated emissions of an existing service, for example; 100,000 patient non-ambulatory presentations to the Emergency Department. These can be compared to the estimated emissions of an alternative single pathway, such as 50,000 Virtual consultations (audio) to evaluate the comparative net impact.

However, the baseline (original intent) and the intervention (final outcome service type) can vary for a multi-modal service offering.

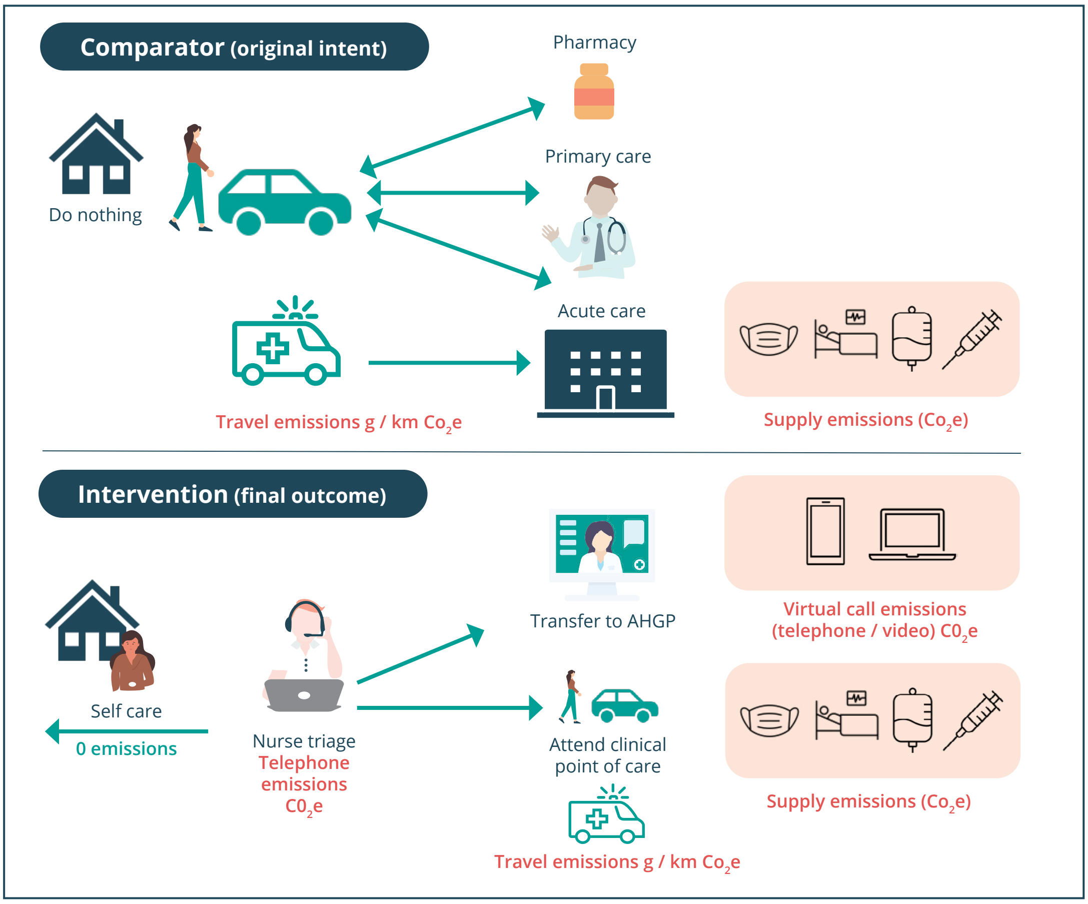


**Figure 2:** Multi-modal Clinical Pathway comparison of impacts on virtual health emissions

Multi-modal pathway services support a variety of user needs. When asked "What would you have done, or where would you have gone to seek advice if you had not used this service", people may reply with options ranging from do nothing, stay at home, to call an ambulance.

In addition, after triage, users may be directed to safely self-manage their symptoms at home, visit their local GP, or in some cases an ambulance may be the recommended directive. As such, there are a variety of pathways that a user may experience when interacting with the service that need to be considered when estimating the associated emissions.

A matrix-based framework was developed to address this complexity. This approach enables a consistent calculation approach for any combination of clinical pathways within a multi-modal virtual service offering.

The net impact of the service provided results from comparing the emissions associated with the consultation type of the original intent of the patient/caller, with the emissions associated with the consultation type of the final outcome that was undertaken after the consultation or triage with the multi-modal service, and accounting for the emissions associated with the virtual consultation provided.

The model applies a matrix-based structure, comparing original intent and final outcome pathways for each consultation type. Each matrix cell represents a unique pathway; its associated emissions calculations are presented in Figure 3 below.

- **Green cells:** Represent pathways where emissions are avoided by redirecting callers to lower acuity or virtual care options.
- **Orange cells:** Indicate pathways involving net higher-emission pathways, such as ED referrals, however early intervention for some clinical presentations has shown economic and social savings, these have not yet been quantified in environmental metrics.
- **Grey cells:** Indicate pathways with the same original intent to final outcome, whereby the emissions of the virtual consultations would generate a minor cost.

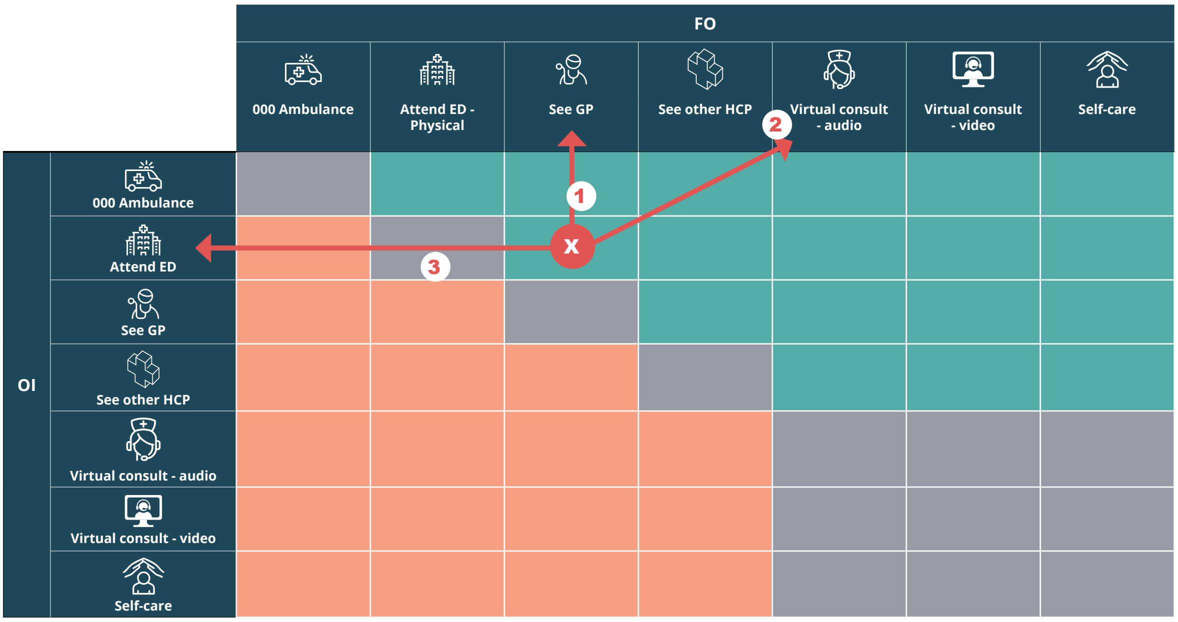


**Figure 3:** Conceptual model of Original Intent to Final Outcome map for computation of virtual health emissions.

The model uses the following formula: Net Emissions Impact

$$= VOL \times (E\,(FO) + E(VC) - E(OI))$$

Where:

- **VOL:** Volume of calls for each pathway,
- **E (FO):** Emissions of the final outcome clinical pathway,
- **E (VC):** Emissions of the virtual consultation,
- **E (OI):** Emissions of the original intent clinical pathway.

In Figure 3 (above), an example pathway is shown whereby:

1. Shows the final outcome after triage as "see GP".
2. Shows the type of the virtual call – in this example audio.
3. Shows the original intent of the caller as "attend ED".

Therefore, to calculate this interaction's net impact, we need to know the emission factor or estimate per consultation type for each of the seven identified consultation types.

The emission calculation description for each consultation type is provided at Appendix A.

# 4. Localised virtual health emission factors

As per the literature review findings, some studies applied national average inputs, such as average distance (kilometres) to a general practitioner, average use of public transport, etc. Other smaller studies analysing one specific clinic or hospital used the patient's address and calculated the exact travel distance per patient. Given the data privacy implications of accessing and storing secure private information of a patient's address, in addition to the manual data load of calculating each individual travel distance for the large volume of calls received, it was agreed amongst stakeholders involved in the study that a balance would need to be found.

The Healthdirect business intelligence platform used to provide insights and improve the service does not store any private data about the patient. The call is logged with the jurisdiction code – e.g. WA, postcode of the caller, Modified Monash Model (MMM) rural and remote classification code, date and lists the caller's original intent if they had not called Healthdirect and the final outcome of service or self-care pathway the caller is advised to take after the triage.

Based on the current set of metadata captured for each service interaction, the MMM classification was determined to be the most effective localisation filter to apply to create a localised set of emissions factors to use within the model.

The MMM, developed by the Australian Government Department of Health, is a refined version of the Australian Standard Geographical Classification - Remoteness Areas (ASGC-RA) system 21. It offers a more detailed classification of geographical areas to reflect the challenges healthcare providers face in rural and remote settings. By categorising areas based on factors like remoteness, population size, and access to services, the MMM informs policy decisions and resource allocation, helping to identify disparities in healthcare access across urban, regional, and remote areas. There are seven MMM classifications, ranging from M1 for major cities to M7 for very remote areas, with approximately 70% of Australia's population living in M1 areas.

Input data on travel distance to health service type, registered cars on road by jurisdiction and their associated emissions, uptake of electric vehicles and use of public transport were sourced.

Local data sources, and further technical source data details may be provided upon request.

The emissions data inputs were categorised into the 48 jurisdictional MMM categories, and calculations were made. Noting that not all Jurisdictions have all seven levels of MMM categories.

The output of these calculations provides a set of 8 Jurisdiction-specific virtual health emissions factors that provide the estimated average emissions generated per consultation type and can be used as inputs into the multi-modal virtual health emissions estimate calculations to determine the net impact of the virtual health service when compared to in-person services.

The following provides the estimated C02e emissions generated for each type of healthcare consultation based upon an estimate of the travel and supplies associated with the consultation type.

| Health consultation type | Description |
|---|---|
| Ambulance | Indicates a patient who is transported to an emergency department by ambulance. |
| ED | A presentation to ED whereby the patient takes their own transport, be it personal, public or active to travel to and from the emergency department. |
| Other HCP | An average estimate based on a return trip by personal, public or active transport to any other healthcare provider that is not at a hospital or a general practice clinic. |
| GP (any) | Refers to consultation provided by GPs that provide any type of funding mix, including those who provide mixed funding of bulk-bill and private, those who do not provide any bulk-bill services and those who only provide bulk-billed services. |
| GP (bulk) | Refers to GP practices that only provide bulk bill services – these represent only 19% of the service listings within the National Health Services Directory (NHSD). However, for many patients who cannot afford the gap fee, these are the only available options, and they are likely to travel further to access. |
| GP (ave) | Is a weighted average of GP (any) and GP (bulk) based on the volume of their listings in the directory. |

The weighted average creates a jurisdictional average based upon population density by Modified Monash Model for each health consultation type.

As noted, not all Jurisdictions have the full range (n=7) of regional and remoteness classifications as defined in the Modified Monash Model categorisations; these are shaded within the grids.

## 4.1 Australian Capital Territory (ACT)

**ACT estimated $C0_2e$ emissions per health consultation type**

**kg $C0_2$-e**

| | | Ambulance | ED | Other HCP | GP (any) | GP (bulk) | GP (ave) |
|---|---|---|---|---|---|---|---|
| M1 | Metro | 9.84 | 7.30 | 6.63 | 1.30 | 6.15 | 2.22 |
| M2 | Regional centres | 26.71 | 20.23 | 18.69 | 11.85 | 17.32 | 12.89 |
| M3 | Large rural towns | | | | | | |
| M4 | Medium rural towns | | | | | | |
| M5 | Small rural towns | 36.75 | 30.27 | 26.35 | 17.25 | 22.61 | 18.27 |
| M6 | Remote communities | | | | | | |
| M7 | Very remote communities | | | | | | |

**ACT estimated population weighted average $C0_2e$ emissions per health consultation type**

**kg $C0_2$-e**

| | Ambulance | ED | Other HCP | GP (any) | GP (bulk) | GP (ave) |
|---|---|---|---|---|---|---|
| Weighted average | 9.87 | 7.32 | 6.65 | 1.32 | 6.16 | 2.24 |

## 4.2 New South Wales (NSW)

**NSW estimated $C0_2e$ emissions per health consultation type**

**kg $C0_2$-e**

| | | Ambulance | ED | Other HCP | GP (any) | GP (bulk) | GP (ave) |
|---|---|---|---|---|---|---|---|
| M1 | Metro | 7.44 | 5.97 | 4.23 | 1.05 | 2.82 | 1.38 |
| M2 | Regional centres | 17.67 | 14.40 | 11.69 | 3.29 | 9.33 | 4.44 |
| M3 | Large rural towns | 9.26 | 7.64 | 6.25 | 2.71 | 5.07 | 3.16 |
| M4 | Medium rural towns | 10.36 | 8.57 | 14.76 | 2.77 | 21.05 | 6.24 |
| M5 | Small rural towns | 25.01 | 20.87 | 26.68 | 11.47 | 32.59 | 15.48 |
| M6 | Remote communities | 22.11 | 19.00 | 26.59 | 21.68 | 34.30 | 24.08 |
| M7 | Very remote communities | 42.39 | 37.14 | 47.08 | 43.81 | 57.64 | 46.44 |

**NSW estimated population weighted average $C0_2e$ emissions per health consultation type**

**kg $C0_2$-e**

| | Ambulance | ED | Other HCP | GP (any) | GP (bulk) | GP (ave) |
|---|---|---|---|---|---|---|
| Weighted average | 9.96 | 8.12 | 7.45 | 2.54 | 7.08 | 3.40 |

## 4.3 Northern Territory (NT)

**NT estimated $CO_2e$ emissions per health consultation type**

**kg $CO_2$-e**

| | | Ambulance | ED | Other HCP | GP (any) | GP (bulk) | GP (ave) |
|---|---|---|---|---|---|---|---|
| M1 | Metro | | | | | | |
| M2 | Regional centres | 9.89 | 5.33 | 3.38 | 1.15 | 1.84 | 1.28 |
| M3 | Large rural towns | | | | | | |
| M4 | Medium rural towns | | | | | | |
| M5 | Small rural towns | 46.34 | 31.81 | 26.55 | 21.56 | 21.74 | 21.60 |
| M6 | Remote communities | 31.14 | 23.90 | 16.21 | 8.38 | 8.92 | 8.48 |
| M7 | Very remote communities | 314.71 | 254.20 | 161.57 | 37.09 | 70.43 | 43.42 |

**NT estimated population weighted average $CO_2e$ emissions per health consultation type**

**kg $CO_2$-e**

| | Ambulance | ED | Other HCP | GP (any) | GP (bulk) | GP (ave) |
|---|---|---|---|---|---|---|
| Weighted average | 80.35 | 63.03 | 40.36 | 10.63 | 18.34 | 12.10 |

## 4.4 Queensland (QLD)

**QLD estimated $C0_2e$ emissions per health consultation type**

**kg $C0_2$-e**

| | | Ambulance | ED | Other HCP | GP (any) | GP (bulk) | GP (ave) |
|---|---|---|---|---|---|---|---|
| M1 | Metro | 9.93 | 8.22 | 7.36 | 1.48 | 6.70 | 2.47 |
| M2 | Regional centres | 12.40 | 10.61 | 11.45 | 2.85 | 12.40 | 4.67 |
| M3 | Large rural towns | 8.97 | 7.56 | 14.05 | 3.75 | 20.71 | 6.97 |
| M4 | Medium rural towns | 6.41 | 5.62 | 25.95 | 3.03 | 45.94 | 11.18 |
| M5 | Small rural towns | 26.93 | 23.46 | 29.09 | 12.79 | 34.93 | 16.99 |
| M6 | Remote communities | 29.37 | 26.37 | 42.94 | 17.84 | 59.55 | 25.77 |
| M7 | Very remote communities | 47.29 | 42.56 | 59.00 | 30.03 | 75.61 | 38.69 |

**QLD estimated population weighted average $C0_2e$ emissions per health consultation type**

**kg $C0_2$-e**

| | Ambulance | ED | Other HCP | GP (any) | GP (bulk) | GP (ave) |
|---|---|---|---|---|---|---|
| Weighted average | 12.80 | 10.89 | 12.63 | 3.72 | 14.52 | 5.79 |

## 4.5 South Australia (SA)

**SA estimated $C0_2e$ emissions per health consultation type**

**kg $C0_2$-e**

| | | Ambulance | ED | Other HCP | GP (any) | GP (bulk) | GP (ave) |
|---|---|---|---|---|---|---|---|
| M1 | Metro | 7.10 | 5.62 | 4.71 | 1.18 | 3.98 | 1.72 |
| M2 | Regional centres | 20.04 | 16.53 | 17.84 | 5.03 | 19.27 | 7.73 |
| M3 | Large rural towns | 7.80 | 6.36 | 13.40 | 2.92 | 20.57 | 6.27 |
| M4 | Medium rural towns | 7.98 | 6.76 | 24.81 | 2.76 | 42.54 | 10.32 |
| M5 | Small rural towns | 18.92 | 15.76 | 49.41 | 9.05 | 83.47 | 23.19 |
| M6 | Remote communities | 12.43 | 10.61 | 45.10 | 10.87 | 80.13 | 24.03 |
| M7 | Very remote communities | 81.13 | 70.06 | 156.23 | 38.36 | 242.57 | 77.16 |

**SA estimated population weighted average $C0_2e$ emissions per health consultation type**

**kg $C0_2$-e**

| | Ambulance | ED | Other HCP | GP (any) | GP (bulk) | GP (ave) |
|---|---|---|---|---|---|---|
| Weighted average | 9.38 | 7.62 | 12.38 | 2.68 | 17.33 | 5.46 |

### 4.6 Tasmania (TAS)

**TAS estimated $C0_2e$ emissions per health consultation type**

**kg $C0_2$-e**

| | | Ambulance | ED | Other HCP | GP (any) | GP (bulk) | GP (ave) |
|---|---|---|---|---|---|---|---|
| M1 | Metro | | | | | | |
| M2 | Regional centres | 12.91 | 10.48 | 10.35 | 2.49 | 10.40 | 4.00 |
| M3 | Large rural towns | 13.75 | 11.30 | 9.60 | 2.80 | 8.09 | 3.80 |
| M4 | Medium rural towns | 39.50 | 34.04 | 31.94 | 7.56 | 29.86 | 11.80 |
| M5 | Small rural towns | 39.09 | 32.69 | 38.05 | 10.22 | 43.60 | 16.57 |
| M6 | Remote communities | 38.12 | 32.84 | 64.94 | 10.69 | 97.71 | 27.23 |
| M7 | Very remote communities | 14.49 | 12.39 | 13.71 | 10.27 | 15.20 | 11.21 |

**TAS estimated population weighted average $C0_2e$ emissions per health consultation type**

**kg $C0_2$-e**

| | Ambulance | ED | Other HCP | GP (any) | GP (bulk) | GP (ave) |
|---|---|---|---|---|---|---|
| Weighted average | 20.19 | 16.79 | 19.71 | 4.60 | 22.84 | 8.07 |

## 4.7 Victoria (VIC)

**VIC estimated $C0_2e$ emissions per health consultation type**

**kg $C0_2$-e**

| | | Ambulance | ED | Other HCP | GP (any) | GP (bulk) | GP (ave) |
|---|---|---|---|---|---|---|---|
| M1 | Metro | 8.59 | 6.39 | 4.17 | 1.04 | 2.25 | 1.27 |
| M2 | Regional centres | 14.58 | 10.93 | 7.86 | 2.49 | 5.07 | 2.98 |
| M3 | Large rural towns | 11.09 | 8.47 | 6.60 | 2.38 | 4.94 | 2.87 |
| M4 | Medium rural towns | 14.18 | 10.90 | 13.56 | 2.48 | 16.39 | 5.12 |
| M5 | Small rural towns | 30.03 | 23.18 | 24.42 | 9.96 | 25.85 | 12.98 |
| M6 | Remote communities | 85.71 | 67.71 | 73.70 | 16.28 | 79.88 | 28.36 |
| M7 | Very remote communities | | | | | | |

**VIC estimated population weighted average $C0_2e$ emissions per health consultation type**

**kg $C0_2$-e**

| | Ambulance | ED | Other HCP | GP (any) | GP (bulk) | GP (ave) |
|---|---|---|---|---|---|---|
| **Weighted average** | 11.37 | 8.56 | 6.75 | 1.98 | 5.21 | 2.60 |

## 4.8 Western Australia (WA)

**WA estimated $C0_2e$ emissions per health consultation type**

**kg $C0_2$-e**

| | | Ambulance | ED | Other HCP | GP (any) | GP (bulk) | GP (ave) |
|---|---|---|---|---|---|---|---|
| M1 | Metro | 10.79 | 9.49 | 8.90 | 1.38 | 5.54 | 2.17 |
| M2 | Regional centres | 16.79 | 14.49 | 14.08 | 3.55 | 8.80 | 4.54 |
| M3 | Large rural towns | 8.02 | 6.84 | 6.56 | 3.11 | 17.10 | 5.77 |
| M4 | Medium rural towns | 4.39 | 3.75 | 3.45 | 2.73 | 65.26 | 14.61 |
| M5 | Small rural towns | 24.69 | 21.87 | 21.45 | 11.94 | 60.47 | 21.16 |
| M6 | Remote communities | 14.70 | 12.42 | 12.50 | 9.47 | 102.20 | 27.09 |
| M7 | Very remote communities | 94.77 | 81.25 | 83.59 | 68.85 | 160.26 | 86.22 |

**WA estimated population weighted average $C0_2e$ emissions per health consultation type**

**kg $C0_2$-e**

| | Ambulance | ED | Other HCP | GP (any) | GP (bulk) | GP (ave) |
|---|---|---|---|---|---|---|
| Weighted average | 14.58 | 12.73 | 12.29 | 4.64 | 18.90 | 7.35 |

### 4.9 National average emissions factors

For broader applicability, a national average emissions factor per consultation type was calculated by weighting emissions data from each jurisdiction based on population distribution across MMM classifications. This provides a standardised emissions factor for each consultation type, useful in scenarios where location-specific data is unavailable.

Note that the average emissions associated with a virtual consultation video or audio are taken from the academic literature for telehealth emissions costs of service from energy of the associated software, hardware and data infrastructure.

**Australian jurisdictions and national average estimated $C0_2e$ emissions per health consultation type**

**kg C02-e**

<table>
<tr><th></th><th>Ambulance</th><th>ED</th><th>Other HCP</th><th>GP</th><th>Virtual consult - audio</th><th>Virtual consult - video</th></tr>
<tr><td>Australian jurisdiction</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>ACT</td><td>9.87</td><td>7.32</td><td>6.65</td><td>2.24</td><td rowspan="8">0.02</td><td rowspan="8">0.04</td></tr>
<tr><td>NSW</td><td>9.96</td><td>8.12</td><td>5.37</td><td>3.40</td></tr>
<tr><td>NT</td><td>80.35</td><td>63.02</td><td>40.36</td><td>12.10</td></tr>
<tr><td>QLD</td><td>12.80</td><td>10.89</td><td>12.63</td><td>5.77</td></tr>
<tr><td>SA</td><td>9.38</td><td>7.62</td><td>12.38</td><td>5.46</td></tr>
<tr><td>TAS</td><td>20.19</td><td>16.79</td><td>19.71</td><td>8.07</td></tr>
<tr><td>VIC</td><td>11.37</td><td>8.56</td><td>6.75</td><td>2.60</td></tr>
<tr><td>WA</td><td>14.58</td><td>12.73</td><td>12.29</td><td>7.35</td></tr>
<tr><td>Population weighted average (kg C02e)</td><td>12.24</td><td>9.95</td><td>9.76</td><td>4.41</td><td>0.02</td><td>0.04</td></tr>
</table>

# 5. How-to guide

The primary goal of this applied research activity is to provide a standardised framework and tools for jurisdictions and health services to use in their emission measurement activities. A calculator has been developed in Excel for use in estimating single pathway or multi-modal pathway virtual health emissions impact.

The following section provides a summary for how to use the framework and localised emission factors in calculating an estimate of your own virtual health service emissions.

Please also note that Healthdirect is planning to provide a series of data deep dive's and education sessions on the use of the framework. Please contact our Director of Sustainability Measurement and impact, Rachel de Sain via email (Rachel.desain@healthdirect.org.au) if you wish to be informed of these events.

### 5.1 Step-by step-guide

#### Step 1: Define your aim

Before you begin, it is helpful to define the scope and aim of your work.

- What service do you want to measure the associated emissions for?
- Do these service types match the current emission factors available?
- What questions or insights are you hoping to answer by undertaking the calculation?
- Will you be reporting this information internally or externally?

#### Step 2: Gather and analyse the format of your data

Once you have defined the aim of your analysis and the scope of your estimate, you will need to gather the relevant data and synthesise its format to meet the criteria for calculation. You will need the volume of activity for each service type for each MM zone you wish to calculate the estimated emission for, sourced from your internal service logs or reporting data for the period under analysis, or, if you are using this framework for future predictions, have the estimated volume of consultations by health service type by locations available.

The emissions factors provided are reported by Modified Monash (MM) geographic category. If MM zone data is unavailable, determine whether to:

- Use a national or jurisdictional average or hybrid value – if so, provide documentation detailing your rationale for the emissions factor applied.
- Reallocate activity data to MM categories based on other location data using concordance files (e.g., postcode, SA2).
  - Help and guidance on tools and ways to achieve this can be provided by Healthdirect upon request.

#### Step 3: Adjust inputs into emission factors (Optional)

*Supplies or diagnostics*

- If specific consultation types involve additional consumables or diagnostics, calculate the emissions associated with these supplies.
  - Example: A respiratory specialist outpatient program for COPD patients has a protocol for conducting a spirometry test with a single-use mouthpiece that is thrown away after each use.
- Look up either in academic studies, EMS software or databases such as ecoinvent, the associated emissions for this item or a relevant unit or material, plastic, by weight in grams.
- Adjust the emissions factor for the specific consultation type to reflect the additional emissions.
  - Example: Adjusted Emissions Factor = Standard Emissions Factor for that consultation type + Additional Supply Emissions

*Transport*

- Suppose the service you are analysing has specific transport associated data points that vary from the inputs used to create the Healthdirect standardised emission factors. In that case, you can use the raw data provided to calculate an adjusted transport emissions input and recalculate the emissions factor.
    - Example: you are providing a virtual health consultation outpatient program for a residential aged care village whereby the residents have a much higher use of public transport or shared vehicle use ( LAT) to get to the appointments, and the travel distance is known to be 40km return trip.
    - Using the formulas provided, you adjust the transport emissions and then apply them to the standardised supply emission and virtual call emission data to derive a new emission factor per consultation.

*Virtual call emissions*

- The data inputs for the virtual call emissions are based on the reported average energy-associated emission of an audio-only (telephone) or video over IP call estimated to be 5-10 minutes long.
- If the service you are analysing has a much longer or shorter consultation time, you can adjust this input to derive an adjusted emission factor for your calculations.

### Step 4: Perform the emissions calculation

**Apply emissions factors:**

For each MM zone, multiply the VOL (number of consultations) by the corresponding emissions factor provided in the framework or adjust as per step 3 if you have made any adjustments.

**Aggregate the results:**

Sum the emissions across all MM zones to calculate the total emissions for the service over the period under analysis.

## 5.2 Use case examples

Please note that all these scenarios, including names, locations, and figures in terms of emission factors, volumes or travel distances, are made up purely as examples and are not intended to reflect actual service volumes or estimated emissions.

**Use case 1:** Simon is running a Chronic Disease Management program from an Local Health Network (LHN) in South Australia. Six months ago, they transitioned several outpatient consultations to be virtual, provided 80% by telephone and 20% by video calls. Simon wants to understand the emission impact of this shift and uses the framework and emission factor to do so.

Simon has the patient ID reference number for the 500 consultations delivered virtually under the new program. The patient records profile provides the MM for each patient ID, and he is able to filter the 500 calls by MMzone to get the following.

| | |
|---|---|
| MM1 | 400 |
| MM2 | 30 |
| MM3 | 20 |
| MM5 | 40 |
| MM7 | 10 |

Simon uses the emissions factor provided in Section 4 and applies the ED emissions factor to represent a person travelling to a hospital.

| VOL. | | EF | EMISSIONS |
|---|---|---|---|
| MM1 | 400 | 5.71 | 2,284 |
| MM2 | 30 | 16.78 | 503 |
| MM3 | 20 | 6.45 | 129 |
| MM5 | 40 | 15.91 | 795 |
| MM7 | 10 | 70.06 | 701 |
| | | | **4,412kg $C0_2e$** |

Simon must then calculate the cost of the virtual service – which is 0.026kg $C0_2e$ per call x 500 calls = 13kg $C0_2e$.

He deducts this from the emissions estimate to suggest that transitioning these 500 calls to a virtual service may avoid 4.4tonnes of $C0_2e$.

The analysis estimates that transitioning these 500 calls to a virtual service avoided 4.4 tonnes $C0_2e$.

**Use case 2:** Mehti runs an outpatient Chronic Obstructive Pulmonary Disease (COPD) clinic at her hospital and they are investigating partnering with the local Primary Health Network (PHN) to run satellite hybrid clinics at primary care practices in suburbs with a high volume of patients. The clinic will offer both virtual and in-person consultations, in partnership with the hospital based COPD service. She wants to understand what the potential carbon emissions avoidance might be for patients who will visit a local GP practice rather than come to the hospital, and for those that opt to attend virtually.

Mehti is able to look up the emissions factors for her local area for:

- An ED visit – which represents a trip to the hospital for an appointment
- A GP appointment
- A virtual appointment

Using these emissions factors she is able to model an estimate for how the service may contribute to reducing patient transport emissions as part of the broader net-zero commitments for the PHN.

# Appendix A: Emissions calculation framework

The method for calculating the emissions of a health consultation can be taken from the literature as a combination of the following three primary emissions variable calculations.

The three calculations:

- **Avoided Transport Emissions (ATE):** Emissions avoided by avoiding or reducing travel to healthcare facilities.
- **Avoided Supply Emissions (ASE):** Reductions from avoided medical supplies and diagnostics use.
- **Virtual Consultation Emissions (VCE):** Emissions generated by audio and video consultations.

Each of these inputs requires its own set of calculations and supporting data.

### Transport emissions

You can apply the following calculation to estimate the associated transport emissions generated or avoided relating to an in-person or virtual consultation.

Transport Emissions (TE) estimate the emissions generated by travel to a healthcare facility. They are referred to as Avoided Transport Emissions (ATE) when travel is reduced or avoided due to the use of virtual service delivery pathways. TE is calculated using the following formula:

$$TE = \left(VOL \times TD_{type} \times TEF_{type}\right) \times (1 - LAT)$$

Where:

- **VOL:** The volume of consultations for the clinical pathway under review.
- **TD:** Average round-trip travel distance in kilometres (KM) to the nearest healthcare facility, which varies by consultation type (e.g., GP, emergency department) and geographic location of the caller.
- **TEF:** Transport Emissions Factor, representing the estimated emissions per kilometre for ambulance and private passenger vehicles.
- **LAT:** Likelihood of Alternate Transport, which adjusts the emissions estimate to reflect trips that would have been taken using public transport, active transport (walking or cycling), or a non-emitting electric vehicle.

The likelihood of using alternate transport (LAT) is created by first deducting the likelihood the trip would have been undertaken using public transport or active transport; then, we apply the percentage of electric vehicles (EVs) to the remaining amount to deduct for non-emitting vehicles.

The formula for LAT can be expressed as:
LAT = $100\% \times (1 - PT\%) \times (1 - EV\%)$

Where:

- PT represents the percentage of trips that would use public transport

- EV represents the percentage of trips undertaken in a non-emitting electric vehicle.

This comprehensive methodology provides a pathway for scalable, localised variations so that transport emissions calculations may incorporate jurisdictional variations in travel distances, transport modes, and vehicle emissions factors. This approach aims to provide a robust and accurate estimation of emissions generated or avoided by healthcare travel that is scalable to any region.

Variables impacting the calculation of transport emissions are highly localised, with high variability in the travel distances and the types of vehicles on the road, use of public transport and uptake in electric vehicles. Some of the studies identified in the literature review applied a national or whole-of-state average for inputs into transport emissions, such as travel distance, car emissions and the likelihood of using alternate non-emitting transport such as public transport.

As part of the study, the discussions with representatives from the Australian jurisdictions identified that national or whole-of-state averages were not the preferred approach and that a more localised set of emission factors would be preferred. This is discussed further in section 6.

## Supply emissions

While the literature demonstrates that the bulk of telehealth emission avoidance is due to a reduction in transport emissions, the majority of studies did not include a provision for changes in supplies. Accordingly, it is assumed that the majority of avoided emissions from the transition to virtual services will continue to be derived from the reduction in travel, but the inclusion of supplies and the modular, scalable approach to the calculation of different inputs for supplies in this novel approach provides a pathway for reviewing their impact over time. It is important to note that preventative diagnostics will likely incur an initial cost (carbon and economic). Still, over time, they can lead to potential savings through the identification and ability to treat, manage, and ideally cure health conditions at their earliest onset.

The supply emissions represent an estimate of the associated emissions from the use of medical consumables, supplies, and diagnostics typically needed in in-person consultations. Healthdirect Medical Directors[1] informed the selection and quantities of supplies and diagnostics for each consultation type. The Avoided Supply Emissions (ASE) calculation input data was informed by Life Cycle Assessment (LCA) studies and includes emissions from standard consumables and diagnostic equipment. It is calculated as:

$$ASE = \sum (EF_{items} \times IR_{item} \times PR_{item})$$

Where:

- **EF_item:** Summary of the emission factor for each medical supply item, such as gloves, masks, or diagnostic equipment, derived from LCA data studies. For instance, a Peripheral Intravenous Cannula (PIVC) has an emission factor of 416 g $CO_2$e per unit.
- **IR_item:** Incidence Rate, or the average frequency of each item used per consultation type. This rate was estimated based on standard medical practices for each consultation type and derived in consultation with clinical advisors from the Delphi panel and reviewed by Healthdirect's clinical governance leadership team.
- **PR_item:** Percentage Reduction, representing the proportion of the item's usage that can be avoided in virtual consultations, based on expert input from the Delphi panel.

ASE calculations differ by consultation type, with higher ASE values assigned to emergency department visits and specialist consultations (contained within Other HCP) that are likely to require more extensive use of supplies and diagnostic interventions.

Unlike the transport emission variability among jurisdictions, there is much stronger consistency in the approach to supplies and diagnostics used for different healthcare consultations across the country. A national approach was agreed upon to determine the supply emission input data.

1 Dr Darran Foo, Medical Director of the Virtual GP Service and Dr Todd Miller Medical Director Healthdirect both reviewed and provided clinical governance oversight and assurance on the estimated clinical supplies and types of diagnostics based on their extensive clinical experience in primary, tertiary and emergency care services.

### Virtual consultation emissions

The VCE accounts for emissions generated by the digital infrastructure and energy use in virtual consultations. It is a direct calculation based on the energy consumption of audio or video consultations. The formula for VCE is as follows:

$$VCE = VOL \times EF_{VC}$$

Where:

- **VOL:** Volume of virtual consultations, either audio or video, as recorded by Healthdirect.

- **EF_VC:** Emissions Factor per virtual consultations. Audio consultations were assigned an emissions factor of 20 g $CO_2$e, and video consultations were assigned 40 g $CO_2$e, based on average energy consumption for digital communication in healthcare contexts reported in the literature.

The VCE provides a consistent emissions estimate for each virtual consultation, standardising emissions across regions while distinguishing between audio and video calls with different energy requirements.

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