ONTARIO HEALTH TECHNOLOGY ASSESSMENT SERIES

Home-Based Heated Humidified High-Flow Therapy for Respiratory Conditions

A Health Technology Assessment

NOVEMBER 2025

Ontario Health

Key Messages

What Is This Health Technology Assessment About?

Respiratory conditions include a range of disorders that affect the lungs and other parts of the respiratory (breathing) system, such as chronic obstructive pulmonary disease, bronchiectasis, sleep apnea, and pulmonary fibrosis. They can involve the airways, the lung tissue, or the blood vessels in the lungs. Some are mild and last for only a short time; others are long-lasting and life-threatening.

Treatment options for respiratory conditions may include medications, pulmonary rehabilitation (education and exercises), surgery, and respiratory therapies. One type of respiratory therapy is heated humidified high-flow therapy (HHHFT), which uses a blend of heated and humidified air and oxygen. HHHFT can provide more precise levels of oxygen, make it easier to breathe, and reduce the discomfort and condensation issues that come with traditional oxygen therapy. HHHFT is already used widely in Ontario hospitals and is considered standard care for people who require it. Recently, home-based devices have also become available. However, the costs of the device and its supplies make it difficult for people to access home-based HHHFT.

This health technology assessment looked at how safe and effective home-based HHHFT is for 2 groups of people: (1) children with obstructive sleep apnea who cannot cope with other types of respiratory therapy at home, and (2) adults and children in hospital with respiratory conditions who will need treatment at home once they are discharged and who have no other at-home options that work as well. It also looked at the budget impact of publicly funding home-based HHHFT and at the experiences, preferences, and values of people and care partners of people with respiratory conditions.

What Did This Health Technology Assessment Find?

We did not find any comparative studies that met the inclusion criteria for our clinical review. However, several studies conducted in other contexts have shown the benefits of HHHFT when used in hospital and at home.

We estimate that publicly funding home-based HHHFT for children with obstructive sleep apnea in Ontario over the next 5 years would lead to cost savings of $185,981. Savings were due to an estimated 99 fewer hospital visits and 127 fewer emergency department visits. We estimate that publicly funding home-based HHHFT for adults and children with respiratory conditions in Ontario over the next 5 years would cost an additional $2.5 million. For some people, access to home-based HHHFT would result in earlier discharge from the hospital. We estimated a total of 653 inpatient days avoided as a result of access to home-based HHHFT.

Parents of children with respiratory conditions talked about the positive effects home-based HHHFT had on managing their child's respiratory symptoms, improving their child's overall quality of life and reducing the number of hospital and specialist visits. They said that the up-front and ongoing costs of home-based HHHFT make it difficult to access.

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The statements, conclusions, and views expressed in this report do not necessarily represent the views of those we consulted.

Citation

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Abstract

Background

Respiratory conditions encompass a wide range of disorders that affect the lungs and other parts of the respiratory system. These conditions vary greatly in severity and impact, from mild, transient issues to chronic, life-threatening diseases. Treatment options include medications, pulmonary rehabilitation, surgery, and respiratory therapies such as mechanical ventilation, continuous positive airway pressure, bilevel positive airway pressure, conventional oxygen therapies, and heated humidified high-flow therapy (HHHFT). We conducted a health technology assessment of home-based HHHFT for (1) children with pediatric obstructive sleep apnea (OSA) who cannot tolerate conventional respiratory therapies at home, and (2) adults and children hospitalized for respiratory conditions who will need treatment at home once they are discharged and who have no at-home alternatives that offer an equivalent level of support. This assessment included an evaluation of effectiveness, safety, the budget impact of publicly funding home-based HHHFT, and patient preferences and values.

Methods

We performed a systematic literature search of the clinical evidence of the effectiveness and safety of home-based HHHFT for the populations described above. We performed a systematic economic literature search, but we did not conduct a primary economic evaluation because of a lack of evidence. We analyzed the budget impact of publicly funding home-based HHHFT in children with pediatric OSA and in adults and children with other respiratory conditions in Ontario. To contextualize the potential value of home-based HHHFT, we aimed to speak with adults and care partners of children in Ontario who had lived experience of respiratory conditions, including those with and without direct experience of HHHFT.

Results

We did not identify any studies that met the eligibility criteria for our clinical evidence review. The estimated annual budget impact of publicly funding home-based HHHFT in Ontario over the next 5 years ranges from cost savings of $185,981 for children with pediatric OSA to an additional $2.5 million for adults and children with other respiratory conditions. We estimate that publicly funding home-based HHHFT would result in 99 fewer inpatient visits and 127 fewer outpatient visits related to pediatric OSA. It would also result in 653 inpatient days avoided for adults and children with other respiratory conditions. Due to data limitations, these budget impact estimates are highly uncertain. Care partners discussed the difficulties of caring for a child with complex care needs – particularly those of caring for a child with a tracheostomy. They shared their experiences with alternative treatment options that were ineffective in managing their child's symptoms. People with direct experience using home-based HHHFT highlighted its positive impact on their child's respiratory symptoms, improving quality of life and reducing hospital and specialist visits. Initial and ongoing costs were the biggest barriers to accessing HHHFT.

Conclusions

We did not identify any studies that specifically evaluated the comparative effectiveness and safety of home-based HHHFT in relation to our research questions, but we did identify several studies conducted in other contexts that demonstrated the benefits of HHHFT, including improved oxygenation, reduced

respiratory rates, decreased OSA severity, and fewer acute exacerbations of chronic obstructive pulmonary disease when used in hospital and at home. As well, HHHFT is used widely in Ontario hospitals, is generally considered to be clinically effective, and is standard care in such settings. We estimate that publicly funding home-based HHHFT in Ontario over the next 5 years would result in cost savings for children with pediatric OSA and additional costs of $2.5 million for adults and children with other chronic respiratory conditions. We estimate that publicly funding home-based HHHFT would result in fewer inpatient visits, fewer outpatient visits, and inpatient days avoided. Care partners of children with respiratory conditions viewed home-based HHHFT positively; for many, it became an essential treatment when other options failed. However, cost was a substantial barrier to accessing this treatment.

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Objective

This health technology assessment evaluates the effectiveness and safety of home-based heated humidified high-flow therapy (HHHFT) for people with respiratory conditions who lack alternative treatment options to provide equivalent respiratory support at home, and for children with obstructive sleep apnea who cannot tolerate conventional respiratory therapies at home. It also evaluates the budget impact of publicly funding home-based HHHFT and the experiences, preferences, and values of people with respiratory conditions.

Background

Health Condition

Respiratory conditions encompass a wide range of disorders that affect the lungs and other parts of the respiratory system, including chronic obstructive pulmonary disease (COPD), bronchiectasis, obstructive sleep apnea (OSA), and idiopathic pulmonary fibrosis (IPF), to name a few.[1,2] These conditions vary greatly in severity and impact – from mild, transient issues to chronic, life-threatening diseases. They can involve the airways (bronchi and bronchioles), the lung tissue, or the blood vessels in the lungs.[2]

Health Technology Under Review

Heated humidified high-flow therapy is a noninvasive respiratory therapy used to treat a broad range of respiratory conditions.[3] It was introduced to address several limitations and challenges associated with traditional oxygen therapy, which often delivers dry, cool, or insufficiently humidified oxygen. These shortcomings can lead to patient discomfort, mucociliary dysfunction (i.e., problems clearing the airways), impaired gas exchange (i.e., problems getting enough oxygen into the body or getting carbon dioxide out), rainout (i.e., condensation of water vapour inside the tubing or mask used to deliver oxygen to the patient), and noise.

HHHFT improves upon traditional oxygen therapy by delivering a blend of heated, humidified air and oxygen at moderate to high flow rates.[3] It has been shown to provide more precise oxygen control, reduce the work of breathing, minimize therapy discomfort and condensation issues, and offer an alternative noninvasive method of support. The HHHFT systems currently on the market provide a flow rate of up to 60 or 70 L/min of room air, and supplemental oxygen can be blended in when required, depending on the brand.[3,4] The systems feature a mixing chamber or flow controller that precisely combines room air and oxygen. This air–oxygen mixture is then heated to body temperature and humidified as closely as possible to physiological levels to enhance comfort and prevent drying of the airways.[3] The fraction of inspired oxygen (FiO_2) can be adjusted from 21% (room air) to 100% (pure oxygen). HHHFT can be administered through a nasal cannula[3] or a tracheostomy tube.[5]

At present, the myAirvo 2 and myAirvo 3 systems from Fisher & Paykel Healthcare are the only brands of HHHFT designed specifically for use at home and in long-term care facilities.[6,7] The myAirvo 2 delivers heated and humidified flows of air and oxygen (when required) of between 2 and 60 L/min, with an advanced humidity algorithm that maintains optimal humidity levels at 37, 34, or 31°C.[6] The device air

pathway is designed to accurately condition the air and oxygen mixture before it is heated and humidified in the water chamber. The heated and humidified gas mixture is then delivered to the patient using an AirSpiral tube and an Optiflow interface. The tube and interface are designed to minimize condensation and maximize the delivery of humidity to the patient. The system can be equipped with an autofill chamber for extended therapy sessions, or a manual-fill reusable chamber that lasts up to 2 years and is dishwasher-safe.

The myAirvo 3 builds on the technology of the myAirvo 2, offering more advanced features. It includes an optional battery and a large touchscreen.[7] It also includes a wireless modem that allows for telemonitoring. A pulse oximeter connected to the device can be used to acquire additional information, such as oxygen saturation and heart rate. The myAirvo 3 is not currently available in Canada, but plans are underway to make it available in the near future (Fisher & Paykel Healthcare Inc. telephone communication, July 29, 2024).

Current Treatment Options

Treatment options for respiratory conditions depend on the type and severity of the condition and may include medications such as bronchodilators or corticosteroids; pulmonary rehabilitation; surgical interventions such as lung transplantations or removal of damaged lung tissue; and respiratory therapies such as mechanical ventilation, continuous positive airway pressure (CPAP), bilevel positive airway pressure (BiPAP), conventional oxygen therapies, or HHHFT.

This health technology assessment focused specifically on respiratory conditions that require HHHFT in the home or long-term care setting (referred to as home-based HHHFT). At present, HHHFT is standard care for people who have strict needs for it in hospitals across Ontario. However, people who could benefit from home-based HHHFT may need to remain hospitalized if alternative treatments are unavailable to provide the same level of respiratory support at home (Kali Barrett, MD, telephone communication, June 28, 2024). This is particularly true for some adults who have lung transplants, COPD with frequent exacerbations, bronchiectasis, or IPF who would require HHHFT delivered through a nasal cannula (Fisher & Paykel Healthcare Inc., telephone communication, July 29, 2024), as well as for adults with a tracheostomy in rare cases (Kali Barrett, MD, telephone communication, June 28, 2024).

For children who could benefit from home-based HHHFT with oxygen delivered via a nasal cannula, the current publicly funded standard care includes alternatives such as CPAP, BiPAP, oxygen masks, non-rebreather masks, or portable oxygen concentrators, depending on the child's condition (Reshma Amin, MD, telephone communication, June 27, 2024). However, these alternatives may not be effective or tolerable for all children because of issues such as mask discomfort, pressure intolerance, claustrophobia, skin irritation, or nasal congestion.[8] In some cases, children may receive no treatment if none of these options is suitable or effective for their needs. Figure 1 shows the current clinical pathway for treating respiratory conditions that require home-based HHHFT for adults and children in Ontario.

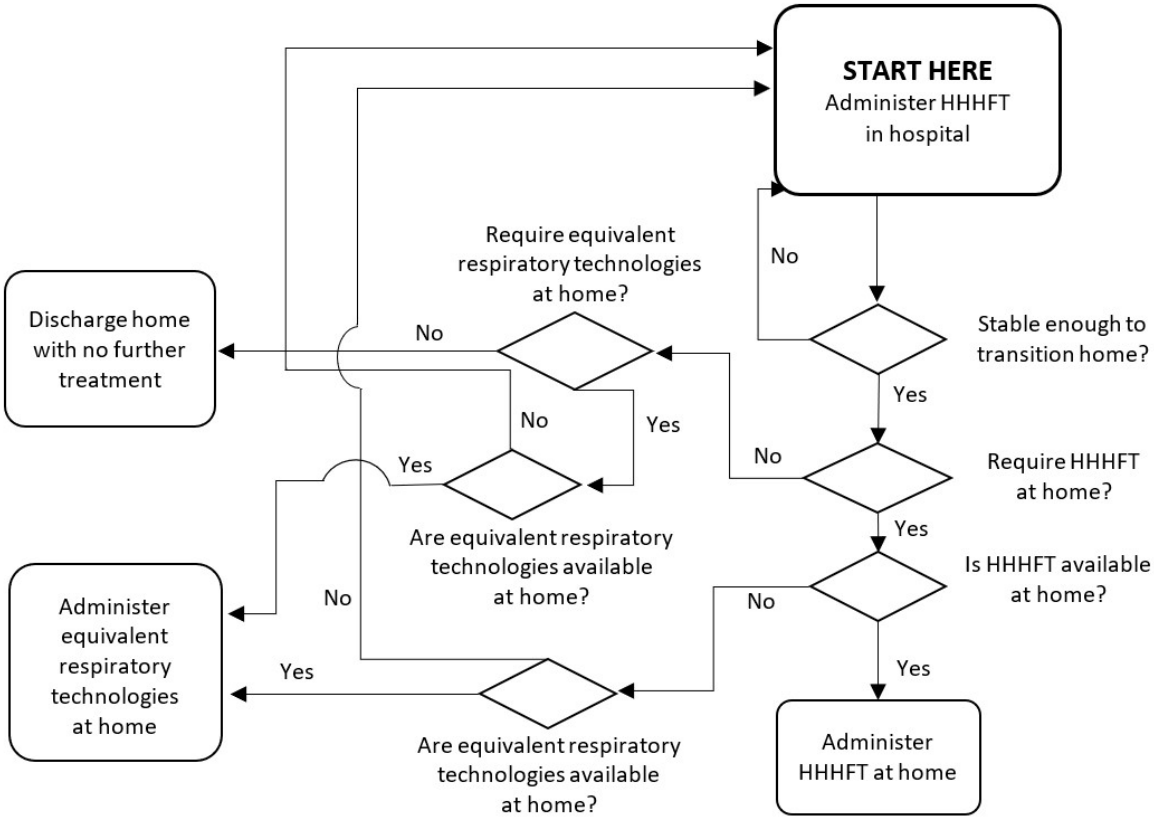

Figure 1: Current Clinical Pathway in Ontario for Home-Based HHHFT

Clinical pathway flowchart that shows the decision process for transitioning patients receiving HHHFT from hospital to home. Decision points are as follows: Is the patient stable enough to transition home? Does the patient require HHHFT at home? Is HHHFT available at home? Are equivalent respiratory technologies available at home? Patients may remain in hospital, be discharged home with no further treatment, be discharged home with HHHFT, or be discharged home with an equivalent respiratory technology.
Abbreviation: HHHFT, heated humidified high-flow therapy.

Clinical Need and Population of Interest

One in five Canadians has a serious respiratory condition,[9] but in Ontario, approximately 50 to 100 children (Reshma Amin, MD, telephone communication, June 27, 2024) and a similar number of adults (Kali Barrett, MD, telephone communication, June 28, 2024) require home-based HHHFT. This therapy may also be beneficial for certain people who are currently on long-term oxygen therapy but experience frequent exacerbations (Fisher & Paykel Healthcare Inc., email communication, August 30, 2024), although other treatment options may be available.

This health technology assessment focused on people who strictly need home-based HHHFT. Among adults, this group includes those who currently use HHHFT in hospital settings but could transition to home care if HHHFT were available. Children who require HHHFT include those for whom standard care in the home setting is not sufficiently effective, such as those who cannot tolerate CPAP or BiPAP devices,[8] or those who require both respiratory support and oxygen. This group also includes children with a tracheostomy.

Regulatory Information

The myAirvo 2 has been licensed by Health Canada as a class 2 medical device since 2009 (licence no. 81367). The myAirvo 3 received its class II device licence from Health Canada in 2022 (licence no. 108131).

Ontario, Canadian, and International Context

Ontario and Canada

In Ontario, hospital-based HHHFT has been prescribed for children for over a decade, using a nasal cannula or a tracheostomy tube. To date, when patients are transitioning to home-based HHHFT, the devices have been funded out of pocket by family or care partners, through charitable sources, through private insurance, or in rare cases by hospital clinical operations. Currently, The Hospital for Sick Children (SickKids) in Toronto is monitoring 50 pediatric patients who have been prescribed home-based HHHFT, and it is anticipated that each year 5 to 10 pediatric patients at SickKids – and 15 to 20 pediatric patients across Ontario, including those at SickKids – will begin home-based HHHFT (Reshma Amin, MD, telephone communication, June 27, 2024). Hamilton Health Sciences treats 41 children in hospital with HHHFT; at least 6 of these require home-based HHHFT but do not have access to it, and another 5 are using home-based devices donated by McMaster Children's Hospital and loaned to families (Lesley Smith, RRT, email communication, October 8, 2024). HHHFT is considered to be standard care for these children in Ontario (Reshma Amin, MD, email communication, January 29, 2025).

Adults in Ontario who require HHHFT are primarily those who no longer need mechanical ventilation but still require humidification, often combined with oxygen support. These people often remain in hospital because home-based HHHFT is not publicly funded and they cannot afford to pay out of pocket for therapy at home (Kali Barrett, MD, telephone communication, June 28, 2024). HHHFT is considered to be standard care for these adults in Ontario (Kali Barrett, MD, telephone communication, June 28, 2024). Hamilton Health Sciences discharges approximately 16 patients per year on home-based HHHFT (Lesley Smith, RRT, email communication, October 8, 2024).

In Saskatchewan, home-based HHHFT is publicly funded for children under 18 years of age through the Saskatchewan Aids to Independent Living respiratory equipment program.[10] This coverage is available for children with chronic conditions, OSA, and cardiopulmonary issues. To qualify for this benefit, home-based HHHFT must be prescribed by a pediatric respirologist (Fisher & Paykel Healthcare Inc., telephone communication, July 29, 2024).

International

In Japan, home-based HHHFT is publicly funded for people with COPD who are on oxygen therapy and who exhibit signs of hypercapnia. This funding is provided through a rental model (Fisher & Paykel Healthcare Inc., telephone communication, July 29, 2024).

In Italy, home-based HHHFT is also publicly funded for people who have used it in hospital prior to discharge. This funding operates on a rental model based on a daily cost (Fisher & Paykel Healthcare Inc., telephone communication, July 29, 2024).

In 2018, the United Kingdom's National Institute for Health and Care Excellence released a Medtech innovation briefing on the use of myAirvo 2 to treat COPD. The briefing highlighted uncertainties about which patient groups would benefit most from this technology in a community setting, and whether it should be used alongside or in place of current treatments.[11] In the Norfolk and Waveney region of the United Kingdom, the National Health Service currently funds home-based HHHFT for approximately 10 to 12 patients per year (Phillip Humphreys, email communication, October 30, 2024). This funding supports certain patients with any of the following conditions: COPD, end-of-life illnesses, conditions that require tracheostomy or laryngectomy, and conditions that lead to discharge from hospital on HHHFT, including COVID-19.

The 2021 Danish Respiratory Society guidelines include considerations for home-based HHHFT for people who have interstitial lung disease with hypoxic failure, severe bronchiectasis with frequent exacerbations, or persistent hypercapnic COPD and who cannot tolerate long-term noninvasive ventilation.[12]

Equity Context

We use the PROGRESS-Plus framework[13] to help explicitly consider health equity in our health technology assessments. PROGRESS-Plus is a health equity framework used to identify population and individual characteristics across which health inequities may exist. These characteristics include place of residence; race or ethnicity, culture, or language; gender or sex; disability; occupation; religion; education; socioeconomic status; social capital; and other key characteristics that stratify health opportunities and outcomes. We looked for studies identified during the clinical literature search that assessed the influence of PROGRESS-Plus factors on access to care with the purpose of discussing their findings.

Expert Consultation

We engaged with experts in the specialty areas of respirology, critical care medicine, and respiratory therapy to help inform the development and refinement of the research questions, review methods, and review results, as well as to contextualize the evidence on HHHFT to Ontario.

PROSPERO Registration

This health technology assessment has been registered in PROSPERO, the international prospective register of systematic reviews (CRD 42024594417), available at crd.york.ac.uk/PROSPERO.

Clinical Evidence

Research Questions

1) What are the effectiveness and safety of home-based HHHFT for children (aged < 18 years) with pediatric obstructive sleep apnea (OSA) compared with other home-based oxygen therapies or no therapy?
2) What are the effectiveness and safety of home-based HHHFT compared with hospital-based HHHFT for the treatment of respiratory conditions?

Methods

Clinical Literature Search

We performed a clinical literature search on September 11, 2024, to retrieve studies published from database inception until the search date. We used the Ovid interface in the following databases: MEDLINE, the Cochrane Central Register of Controlled Trials, the Cochrane Database of Systematic Reviews, and the National Health Service Economic Evaluation Database (NHS EED).

A medical librarian developed the search strategies using controlled vocabulary (e.g., Medical Subject Headings) and relevant keywords. The final search strategy was peer-reviewed using the PRESS Checklist.[14]

We created database auto-alerts in MEDLINE and monitored them until January 20, 2025. We also performed a targeted grey literature search of the International HTA Database, the websites of health technology assessment organizations and regulatory agencies, and clinical trial and systematic review registries, following a standard list of sites developed internally. See Appendix 1 for our literature search strategies, including all search terms.

Eligibility Criteria

Studies

Inclusion Criteria

- English-language full-text publications
- Randomized controlled trials, cohort studies

We considered leveraging existing systematic reviews, meta-analyses, and health technology assessments, accounting for factors such as recency, quality, or relevance to the research question.

Exclusion Criteria

- Animal and in vitro studies
- Nonsystematic reviews, narrative reviews, abstracts, editorials, letters, case reports, and commentaries

Participants

Question 1

- Children (aged < 18 years) with pediatric OSA

Question 2

- Children (aged < 18 years) with pediatric OSA, tachypnea, chronic respiratory insufficiency, plastic bronchitis, bronchiolitis, or refractory hypoxemia
- Adults (aged ≥ 18 years) with a lung transplant, chronic obstructive pulmonary disease (COPD) with frequent exacerbations, bronchiectasis, or interstitial lung disease with hypoxic failure

Interventions

Question 1

- Home-based HHHFT administered through a nasal cannula

Question 2

- Home-based HHHFT administered through a nasal cannula or tracheostomy tube

Comparators

Question 1

- Home-based continuous positive airway pressure (CPAP) or bilevel positive airway pressure (BiPAP) administered through a nasal mask, nasal pillows, or full-face mask
- No treatment

Question 2

- Hospital-based HHHFT administered through a nasal cannula or tracheostomy tube

Outcome Measures

- Quality of life
- Readmission
- Exacerbations
- Frequency of medication use
- Oxygen saturation
- Hypercapnia
- Adverse effects (e.g., sialorrhea, seizures, gastroesophageal reflux disease, technical complications with oxygen supply or tubing, acute lower respiratory infections, tracheostomy tube occlusions, bronchial stenosis, barotrauma)

Setting

Question 1

- Home

Question 2

- Home or community versus hospital

Literature Screening

Two reviewers screened titles and abstracts to assess the eligibility of a sample of 100 citations to validate the inclusion and exclusion criteria. A single reviewer then screened all remaining citations using Covidence[15] and obtained the full texts of studies that appeared eligible for review according to the inclusion criteria. The same reviewer then examined the full-text articles in order to select studies eligible for inclusion. The reviewer also examined reference lists and consulted content experts for any additional relevant studies not identified through the search.

Data Extraction

We planned to extract relevant data on study characteristics and risk-of-bias items using a data form to collect information on the following:

- Source (e.g., citation information, study type)
- Methods (e.g., study design, study duration and years, participant allocation, allocation sequence concealment, blinding, reporting of missing data, reporting of outcomes, whether the study compared 2 or more groups)
- Outcomes (e.g., outcomes measured, number of participants for each outcome, number of participants missing for each outcome, outcome definition and source of information, unit of measurement, upper and lower limits [for scales], time points at which the outcomes were assessed)

Equity Considerations

Potential equity issues related to the use of home-based HHHFT for people with respiratory conditions were not evident during scoping or during the screening of citations.

Statistical Analysis

We did not conduct statistical analysis due to an absence of eligible studies.

Critical Appraisal of Evidence

We did not perform a critical appraisal of evidence due to an absence of eligible studies.

Results

Clinical Literature Search

The clinical literature search yielded 324 citations, including grey literature results and after removing duplicates, published from database inception until September 11, 2024. No studies met our inclusion criteria. See Appendix 2 for a list of selected studies excluded after full-text review. Figure 2 presents the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flow diagram for the clinical literature search.

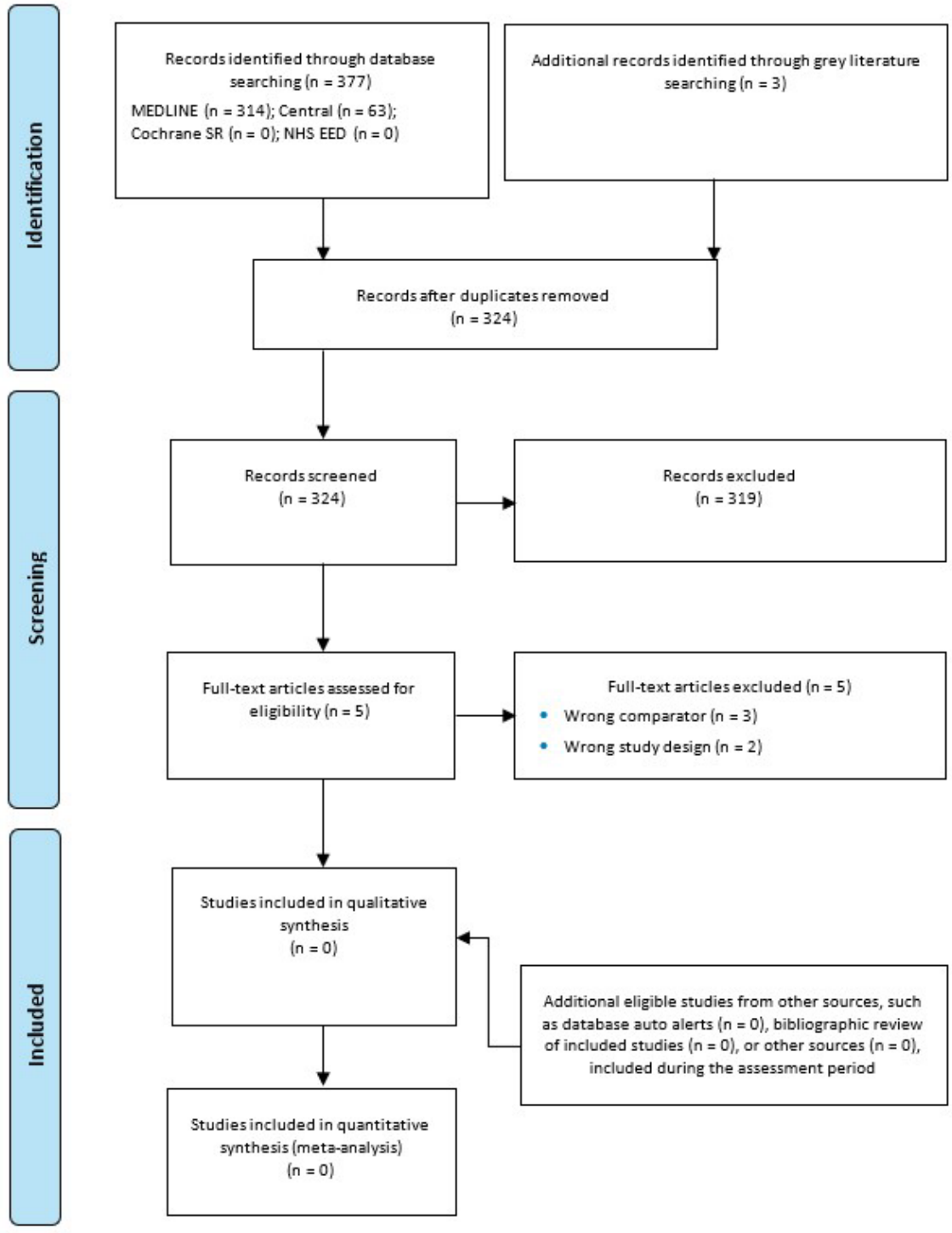

Figure 2: PRISMA Flow Diagram – Clinical Systematic Review

PRISMA flow diagram showing the clinical systematic review. The clinical literature search yielded 324 citations, including grey literature results and after removing duplicates, published between database inception and September 11, 2024. We screened the abstracts of the 324 identified studies and excluded 319. We assessed the full text of 5 articles and excluded all of them. In the end, we did not identify any articles eligible for the qualitative synthesis.

Abbreviation: PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-analyses.

Source: Adapted from Page et al.[16]

Ongoing Studies

We are not aware of any ongoing studies that have potential relevance to our research questions.

Relevant Studies That Did Not Meet Our Inclusion Criteria

We did not identify any studies that met the inclusion criteria for our review. However, several studies conducted in other contexts have highlighted the benefits of HHHFT in both hospital and home settings. Appendix 2 shows the list of selected excluded studies that assessed the benefits of HHHFT but did not meet the eligibility criteria for our review.

Hospital-Based HHHFT in Excluded Studies

In hospital settings, HHHFT has shown particularly promising results for people with acute respiratory failure who have "do not intubate" (DNI) or "do not resuscitate" (DNR) orders. For example, Wilson et al[17] conducted a systematic review demonstrating that HHHFT improved oxygenation and reduced respiratory rates compared with other therapies, such as noninvasive ventilation and conventional oxygen therapy. A crossover randomized study by Ruangsomboon et al[18] found that HHHFT reduced dyspnea severity within the first hour of treatment for patients with palliative needs who had DNI status and hypoxemic respiratory failure. However, the primary focus of our review was to assess the benefits of HHHFT when used at home.

Stripoli et al[19] conducted a crossover randomized controlled trial (RCT) evaluating the effectiveness of hospital-based HHHFT in people with a tracheostomy who had been recently weaned from a ventilator; they found no improvement in neuroventilatory drive, respiratory rate, or gas exchange compared with conventional oxygen therapy. However, the study did not assess other potential benefits of HHHFT, such as reduced tracheal trauma, improved patient comfort, or lower risk of tracheostomy tube occlusion. Consequently, this study did not meet the inclusion criteria for our review: our focus was on comparing home-based and hospital-based HHHFT specifically for patients with a tracheostomy who relied on HHHFT as their only treatment option.

Fishman et al[20] conducted a crossover RCT at the Hospital for Sick Children in Toronto to compare the effectiveness of HHHFT and CPAP in treating OSA among children with obesity or medical complexities. Participants were monitored for adverse effects – particularly intolerance to the pressures used during titration. The study found that both therapies produced similar reductions in OSA severity, as measured by polysomnography. However, we excluded this study from our review because the therapy was administered in a monitored hospital setting rather than in a home-based environment.

Home-Based HHHFT in Excluded Studies

In the home setting, HHHFT has shown benefits for people with chronic respiratory conditions, particularly those with COPD. For example, an RCT by Nagata et al[21] found that compared with long-term oxygen therapy (LTOT) alone, 6 weeks of HHHFT plus LTOT improved health-related quality of life and reduced hypercapnia in people with stable hypercapnic COPD. Similarly, an RCT by Storgaard et al[22] demonstrated that adding HHHFT to usual care (including LTOT) reduced acute exacerbations, hospital admissions, and respiratory symptoms in people with COPD and chronic hypoxemic failure. Another RCT by Rea et al[23] reported that compared with usual care, long-term HHHFT improved lung function and quality of life in people with COPD and bronchiectasis, and it extended the time to first exacerbation. However, although the results of these studies underscored the potential of home-based HHHFT, our

review focused specifically on adults with COPD for whom HHHFT is the only viable treatment option. Because of this narrow focus, we looked for studies that compared home-based HHHFT with hospital-based HHHFT, rather than studies that compared HHHFT with other home-based respiratory technologies. Our approach stemmed from a need for comparability between treatment and control groups, and to align studies with our population of interest. Including studies that involved comparison with other home-based technologies would have suggested that people receiving home-based HHHFT would qualify for alternative respiratory treatments, and this was outside the scope of our research questions. The populations studied by Nagata et al,[21] Storgaard et al,[22] and Rea et al[23] did not meet our inclusion criteria.

Dolidon et al[24] conducted a retrospective study to evaluate the use patterns and outcomes of long-term HHHFT in their hospital, focusing on people receiving therapy via nasal cannula or tracheostomy tube. They found that HHHFT delivered via tracheostomy tube reduced exacerbations in people with neuromuscular disease, chest-wall disease, cancer, or chronic airway disease. However, these findings on exacerbations did not distinguish between home and hospital settings. The authors did attempt to separate data by setting for arterial blood gas results, but the potential lag between hospital discharge and the initiation of home-based HHHFT was unclear. These limitations prevented us from accurately evaluating and comparing the effectiveness of HHHFT between the 2 settings, so we excluded this study from our review.

Home-based HHHFT has also shown promise in pediatric populations and people with a tracheostomy, including children with OSA and people weaning from mechanical ventilation. For instance, a retrospective review by Ignatiuk et al[25] assessed the use of home-based HHHFT in infants and young children with OSA who were poor surgical candidates, who had residual OSA following surgery, or who did not tolerate CPAP. The authors found that home-based HHHFT not only reduced OSA severity but also provided a more comfortable alternative for respiratory support. As well, a retrospective study by Ehrlich et al[26] reported that home-based HHHFT was associated with improved weight gain, fewer hospitalizations, and high parental satisfaction for children with various respiratory conditions, including OSA, airway malacia, chronic lung disease, neuromuscular disease, and post-extubation support needs. However, both of the above studies were noncomparative (i.e., single-arm) and therefore did not meet the inclusion criteria for our review.

Summary

Because the above studies did not meet the inclusion criteria for our review, we did not conduct a formal evidence appraisal. Consequently, we cannot comment on the quality of the evidence or the methodological rigour of these studies. Although the findings from most of these studies suggest potential benefits with HHHFT across populations, comparators, and settings, they should be interpreted cautiously. Without a structured assessment of study quality – such as evaluating risk of bias, or Grading of Recommendations Assessment, Development, and Evaluation (GRADE) assessment – we cannot draw firm conclusions about the quality or generalizability of the findings. As well, it remains uncertain whether home-based HHHFT would have demonstrated similar effectiveness and safety in the specific populations targeted by our review, as outlined in our research questions. However, several of the clinical experts we consulted were able to share their experiences treating patients who did fall within the population of our review, and they indicated that HHHFT has proven to be both safe and effective in these groups.

Discussion

One of the primary challenges in this review was to identify studies that met our eligibility criteria. For instance, 1 population of interest was people with a tracheostomy who have been weaned from mechanical ventilation, have transitioned to hospital-based HHHFT, and rely on HHHFT as their only viable treatment option. The clinical experts we consulted highlighted this group as one that would benefit considerably from home-based HHHFT because they would otherwise require prolonged hospital stays. However, identifying this population is challenging because patient needs can vary based on factors such as respiratory stability, comorbidities, and the progression of specific conditions such as COPD or interstitial lung disease. The suitability of home-based HHHFT may fluctuate depending on these and other factors, making it challenging to precisely define the population that would benefit most. Similarly, for children who cannot tolerate standard therapies such as CPAP, it can be challenging to find comparative studies because controls are not clearly defined for this population. This complexity likely contributed to our inability to identify studies that met our eligibility criteria.

Conclusions

- We did not identify any studies that compared home-based HHHFT versus hospital-based HHHFT for the treatment of respiratory conditions.
- We did not identify any studies that compared home-based HHHFT versus other home-based oxygen therapies or no therapy for the treatment of OSA in children.
- Although we did not identify any studies that specifically evaluated the comparative effectiveness of home-based HHHFT in relation to our research questions, we did identify several studies conducted in other contexts that demonstrated benefits of HHHFT, including improved oxygenation, reduced respiratory rates, decreased OSA severity, and fewer acute COPD exacerbation, when used in hospital and at home. As well, HHHFT is used widely in Ontario hospitals, is generally considered to be clinically effective, and is standard care in such settings.

Economic Evidence

Research Questions

1) What is the cost-effectiveness of home-based heated humidified high-flow therapy (HHHFT) in a community setting for children (aged < 18 years) with pediatric obstructive sleep apnea (OSA)?
2) What is the cost-effectiveness of home-based HHHFT for inpatients with the following conditions?
   - Children (aged < 18 years) with chronic respiratory insufficiency, plastic bronchitis, bronchiolitis obliterans, or refractory hypoxemia
   - People of all ages with a tracheostomy
   - Adults (aged ≥ 18 years) with a lung transplant, chronic obstructive pulmonary disease (COPD) with frequent exacerbations, bronchiectasis, interstitial lung disease with hypoxic failure (e.g., idiopathic pulmonary fibrosis)

Methods

Economic Literature Search

We performed an economic literature search on September 18, 2024, to retrieve studies published from database inception until the search date. To retrieve relevant studies, we developed a search using the clinical search strategy with an economic and costing filter applied.

We created database auto-alerts in MEDLINE and monitored them until February 3, 2025. We also performed a targeted grey literature search following a standard list of websites developed internally, which includes the International HTA Database and the Tufts Cost-Effectiveness Analysis Registry. See Clinical Literature Search, above, for further details on methods used. See Appendix 1 for our literature search strategies, including all search terms.

Eligibility Criteria

Studies

Inclusion Criteria

- English-language full-text publications
- Cost-benefit analyses, cost-effectiveness analyses, cost-consequence analyses, cost-minimization analyses, cost–utility analyses, noncomparative costing studies, budget impact analyses, or systematic reviews of economic analyses

Exclusion Criteria

- Studies in which the outcomes of interest were not reported or could not be extracted
- Nonsystematic reviews, editorials, case reports, commentaries, conference abstracts, letters, or unpublished studies
- Feasibility analyses

Population

- HHHFT for children: children (aged < 18 years) with respiratory conditions
- HHHFT for adults: adults (aged ≥ 18 years) with chronic respiratory insufficiency

Interventions

- Home-based HHHFT

Comparators

- Other respiratory therapies, such as noninvasive ventilation, bilevel positive airway pressure (BiPAP), or oxygen therapy
- Home-based continuous positive airway pressure (CPAP) or BiPAP administered through a nasal mask, nasal pillows, or full-face mask
- Standard care

Outcome Measures

- Costs
- Health outcomes (e.g., quality-adjusted life-years [QALYs])
- Incremental costs
- Incremental effectiveness
- Incremental cost-effectiveness ratios

Literature Screening

A single reviewer conducted an initial screening of titles and abstracts and then obtained the full texts of studies that appeared eligible for review according to the inclusion criteria. The same reviewer then examined the full-text articles and selected studies eligible for inclusion. The reviewer also examined reference lists and consulted content experts for any additional relevant studies not identified through the search.

Data Extraction

We extracted relevant data on study characteristics and outcomes to collect information about the following:

- Source (e.g., citation information, study type)
- Methods (e.g., study design, analytic technique, perspective, time horizon, population, intervention[s], comparator[s])
- Outcomes (e.g., health outcomes, costs, incremental cost-effectiveness ratios)

Study Applicability

We determined the usefulness of each identified study for decision-making by applying a modified quality appraisal checklist for economic evaluations originally developed by the National Institute for Health and Care Excellence (NICE) in the United Kingdom.[27] The NICE checklist has 2 sections: the first is for assessing study applicability, and the second is for assessing study limitations. We modified the wording of the questions of the first section to make it specific to Ontario. Using this checklist, we assessed the applicability of each study to the research question (directly, partially, or not applicable).

Results

Economic Literature Search

The economic literature search yielded 30 citations, including grey literature results and after removing duplicates, published between database inception and September 18, 2024. We identified 1 additional eligible study from other sources, including database alerts (monitored until February 3, 2025). In total, we identified 5 studies that met our inclusion criteria. See Appendix 3 for a list of selected studies excluded after full-text review. Figure 3 presents the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flow diagram for the economic literature search.

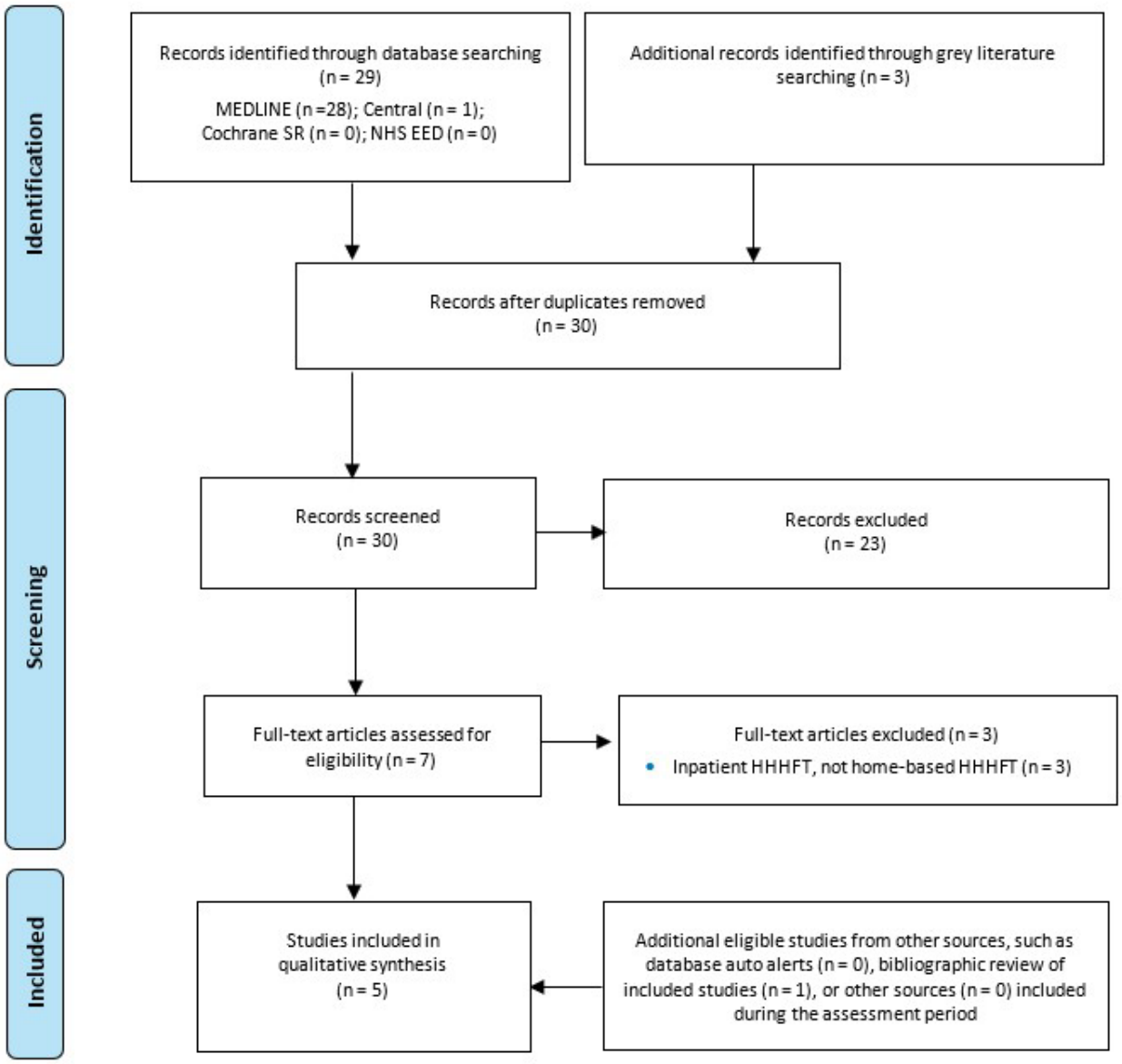

Figure 3: PRISMA Flow Diagram – Economic Systematic Review

PRISMA flow diagram showing the economic systematic review. The economic literature search yielded 30 citations, including grey literature results and after removing duplicates, published between database inception and September 18, 2024. We screened the abstracts of the 30 identified studies and excluded 23. We assessed the full text of 7 articles and excluded a further 3. We identified 1 additional study via bibliographic review of the included studies. In the end, we included 5 articles in the qualitative synthesis.

Abbreviations: HHHFT, heated-humidified high-flow therapy; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-analyses.

Source: Adapted from Page et al.[16]

Overview of Included Economic Studies

We identified 5 relevant studies published from database inception to September 18, 2024.[24,28-31] None of the studies used a Canadian health care payer perspective, and none of the studies included children. One study evaluated home-based HHHFT for adults with chronic respiratory failure or for adults with tracheostomies,[24] 3 studies evaluated home-based HHHFT for adults with COPD and chronic respiratory

failure,[28-30] and 1 study evaluated home-based HHHFT for adults with moderate to severe COPD or with bronchiectasis.[31] All 5 studies were deemed partially applicable to our research question. Table 1 describes the study design, population, interventions, comparators, and results of the included studies.

Canadian Evidence

We were unable to identify any Canadian evidence for home-based HHHFT.

International Evidence

We identified a French noncomparative costing study by Dolidon et al[24] that evaluated home-based HHHFT for people with hypoxemic respiratory failure and for people with a tracheostomy. The authors conducted a retrospective chart review of people who had been prescribed home-based HHHFT at a single centre. Costs were considered from the perspective of a home health care service provider and reported in 2019 euros. The authors included costs related to HHHFT device acquisition, setup costs, oxygen costs, and consumables. Device acquisition costs were amortized at a daily rate. Health outcomes included the tolerability of home-based HHHFT, the number of exacerbations, and survivorship. The maximum follow-up duration was 6 years.

Overall, 71 people were treated with home-based HHHFT (43 with hypoxemic respiratory failure and 28 with tracheostomies).[24] One person discontinued therapy because of an inability to tolerate warmness. Home-based HHHFT facilitated discharge for people with hypoxemic respiratory failure who otherwise would have remained in hospital. People with a tracheostomy had 0.78 fewer exacerbations per year compared to the year before initiating home-based HHHFT. The median survival for people who received home-based HHHFT was 7.5 months. The mean cost of device acquisition and setup was €2,455; people who received tracheal home-based HHHFT had higher setup costs. The mean monthly cost for home-based HHHFT was €476 (€520 in the hypoxemic respiratory failure group and €296 in the tracheostomy group). The authors indicated that for those in the hypoxemic respiratory failure group, costs for home-based HHHFT were likely to be lower than inpatient costs.

We also identified 3 studies[28-30] that conducted trial-based analyses or sourced their effectiveness parameters from a Danish randomized clinical trial conducted by Storgaard et al.[22] The clinical trial compared home-based HHHFT plus usual care (including long-term oxygen therapy) with usual care alone in 200 people who were randomized to a treatment group or a control group and followed for up to a year.

Sørensen et al[30] conducted a trial-based cost–utility analysis comparing home-based HHHFT plus usual care to usual care alone for people with COPD and chronic respiratory failure in Denmark. The authors matched resource utilization from trial participants in Storgaard et al[22] to unit costs sourced from physician fee schedules, administrative databases, and drug formularies. The authors took the perspective of a health care payer. They included costs related to inpatient visits, emergency department visits, general practitioner visits, and prescription medicines. They amortized device costs for home-based HHHFT using an interest rate of 5%, and they assumed a 5-year lifetime for the device. The analysis had a time horizon of 1 year, and all costs were reported in 2018 British pounds. Utility data were sourced from responses to the St. George's Respiratory Questionnaire and mapped to EQ-5D using a previously developed algorithm. The authors also sourced baseline utility estimates and costs incurred during the year prior to enrolment in the clinical trial, adjusting cost and QALY outcomes for these factors. People who received home-based HHHFT plus usual care had higher costs in the year prior to

enrolment, as well as a lower baseline utility. The study authors also adjusted for baseline characteristics and adherence to home-based HHHFT.

The authors reported that people who received home-based HHHFT plus usual care had an increase in costs of £788.[30] This was due primarily to the 1-year cost of home-based HHHFT (£1,235), which included consumables and amortized device acquisition costs. The authors also estimated savings related to general practitioner visits and outpatient visits. They found that the group receiving home-based HHHFT plus usual care had higher inpatient costs than the usual care group. In the study, 14% of those receiving home-based HHHFT discontinued its use after the first month. The authors estimated improvements in QALYs for the group receiving home-based HHHFT plus usual care. Adjustments for baseline characteristics and the number of days receiving home-based HHHFT resulted in an adjusted incremental cost estimate of £212 and an incremental QALY gain of 0.059, for an estimated incremental cost-effectiveness ratio (ICER) of £3,605 per additional QALY. The unadjusted analysis resulted in an incremental cost of £789 and a QALY gain of 0.036, for an ICER of £22,010 per additional QALY. The authors conducted scenario analyses for the intervention cost, the trial inclusion and exclusion criteria, and without adjusting for days on treatment.

Milne et al[28] conducted a trial-based budget impact analysis of home-based HHHFT for people with COPD and chronic respiratory failure using effectiveness data from Storgaard et al.[22] The authors estimated the 5-year budget impact of home-based HHHFT from the perspective of a New Zealand hospital. They sourced hospitalization costs from administrative databases and considered the costs of setup and consumables. Consumables consisted of 6 breathing tubes, 6 autofill chambers, and 12 Optiflow nasal cannulas per year. The authors used a 5-year time horizon and discounted device acquisition costs at 5%, assuming a 90% usage rate for the device. Costs were reported in 2020 New Zealand dollars.

The authors estimated a reduction in hospitalization costs of $5,535 NZD per patient for those receiving home-based HHHFT[28]; cost savings were estimated adjusting for adherence to home-based HHHFT treatment. The authors estimated that over 5 years, a home-based HHHFT device would be associated with cost savings of $18,626 NZD. They conducted scenario analyses varying the cost of home-based HHHFT, the rate of hospitalization, and the usage rate for the device. In scenario analyses, 5-year budget impact estimates per device ranged from cost savings of $43,371 NZD to a cost increase of $6,118 NZD.

We identified a United States cost–utility analysis conducted by Groessl et al[29] that compared home-based HHHFT with long-term oxygen therapy alone. The authors used a Markov model, sourcing key model parameters from Storgaard et al.[22] The Markov model had 4 health states (no exacerbations, moderate exacerbation, severe exacerbations, and death). The authors took the perspective of a US health care payer. Costs were reported in 2021 US dollars and included costs related to respiratory therapists, emergency department visits, and hospital admission visits. Similar to Milne et al,[28] the authors amortized the home-based HHHFT cost of $7,800 over 5 years and assumed a 90% utilization rate. They sourced utility parameters from previously published COPD studies, and they modelled device discontinuation based on the values observed in Storgaard et al.[22]

The authors found that home-based HHHFT plus long-term oxygen therapy was associated with an increase in QALYs of 0.058 and cost savings of $3,939 compared to long-term oxygen therapy alone.[29] Scenario analyses found that the model was most sensitive to the utility parameters, the cost of hospitalizations, and the frequency of exacerbations for both strategies. At a willingness-to-pay value of

$50,000 per additional QALY, the probability that home-based HHHFT plus long-term oxygen therapy was cost-effective compared to long-term oxygen therapy was 84%.

We identified a New Zealand trial-based cost–utility analysis also conducted by Milne et al[31] in which the authors compared home-based HHHFT plus usual care with usual care alone for people with moderate to severe COPD or bronchiectasis. The authors used a 1-year time horizon and took the perspective of a health care payer, which included patient out-of-pocket expenditures. They estimated costs by matching the observed resource utilization of 87 trial participants to costs sourced from administrative databases and drug formularies. Costs were reported in 2013 New Zealand dollars and included home-based HHHFT equipment costs, inpatient admissions, emergency department visits, general practitioner visits, and the use of antibiotics and prednisone. The cost of home-based HHHFT devices was amortized assuming an equipment lifespan of 5 years and a 3.5% discount rate. Utilities were estimated by mapping trial participant responses on the St. George's Respiratory Questionnaire to EQ-5D estimates using a previously developed algorithm.

Home-based HHHFT plus usual care was associated with a total cost of $5,390 NZD, compared to $3,974 NZD for usual care alone.[31] The increase in cost for home-based HHHFT was due primarily to device costs (a $984 NZD capital expenditure and $1,075 NZD consumables). The authors estimated savings for home-based HHHFT plus usual care that were related to lower antibiotic usage, fewer general practitioner consultations, fewer emergency department visits, and reduced inpatient admission costs. They estimated that people who received home-based HHHFT plus usual care had an increase in QALYs of 0.068. Using bootstrapping methods, the authors estimated that the probability of home-based HHHFT plus usual care being cost-effective at a willingness-to-pay value of $20,000 NZD per additional QALY was 49%. The cost-effectiveness results were not substantially affected by varying the cost of home-based HHHFT or modifying the study inclusion criteria.

Table 1: Characteristics of Studies Included in the Economic Literature Review

Author, year, country	Analytic technique, study design, perspective, time horizon	Population	Intervention(s) and comparator(s)	Results		
				Health outcomes	Costs	Cost-effectiveness
Milne et al, 2014,[31] New Zealand	Cost–utility Trial-based Health care payer (including patient costs) 1 year	People with moderate to severe COPD or bronchiectasis	Intervention: home-based HHHFT plus usual care Comparator: usual care only	*QALYs* Home-based HHHFT plus usual care was associated with a 0.068 increase in QALYs (95% CI 0.001 to 0.135)	2013 NZD *Total costs* Home-based HHHFT plus usual care: $5,390 Usual care: $3,974 *Device-related costs* Home-based HHHFT plus usual care: $2,059 Usual care: $0 *Health resource utilization costs* Home-based HHHFT plus usual care: $3,331 Usual care: $3,974	The ICER per additional QALY was $20,902 for home-based HHHFT plus usual care compared to usual care only At a WTP of $20,000 per QALY, the probability that home-based HHHFT plus usual care was cost-effective was 49% Scenario analyses found that the cost-effectiveness results were not significantly affected by the price of home-based HHHFT or the study inclusion and exclusion criteria
Dolidon et al, 2019,[24] France	Costing study Retrospective chart review Home health care service provider 6 years maximum	People with hypoxemic respiratory failure or tracheostomy	Intervention: home-based HHHFT Comparator: before initiation of home-based HHHFT	*Discharge from inpatient facility* Home-based HHHFT facilitated discharge for people with hypoxemic respiratory failure *Exacerbations* After initiation of home-based HHHFT, people had 0.78 fewer exacerbations compared to before initiation of home-based HHHFT	2019 euros *Setup costs* All people: €2,455 People with hypoxemic respiratory failure: €1,712 People with tracheostomy: €4,005 *Monthly costs* All people: €476 People with hypoxemic respiratory failure: €520 People with tracheostomy: €296	No formal cost-effectiveness analysis was conducted Study authors indicated that home-based HHHFT costs were likely to be lower than inpatient costs for people with hypoxemic respiratory failure

Author, year, country	Analytic technique, study design, perspective, time horizon	Population	Intervention(s) and comparator(s)	Results		
				Health outcomes	Costs	Cost-effectiveness
Sørensen et al, 2021,[30] Denmark	Cost–utility Trial-based Public health payer 1 year	People with COPD and chronic respiratory failure	Intervention: home-based HHHFT plus usual care Comparator: usual care only	*Adjusted QALYs* Accounting for baseline characteristics and adherence, home-based HHHFT plus usual care was associated with a 0.059 QALY gain (95% CI 0.017 to 0.101) compared to usual care alone *Unadjusted QALYs* Not accounting for baseline characteristics and adherence, home-based HHHFT plus usual care was associated with a 0.036 QALY gain (95% CI −0.007 to 0.036) compared to usual care alone	2018 GBP *Adjusted costs* Accounting for baseline characteristics and adherence, home-based HHHFT plus usual care was associated with a £212 increase in costs (95% CI −£1,572 to £1,995) compared to usual care alone *Unadjusted costs* Not accounting for baseline characteristics and adherence, home-based HHHFT plus usual care was associated with a £789 increase in costs (95% CI −£1,009 to £2,586) compared to usual care alone	The ICER for home-based HHHFT plus usual care was £3,605 per additional QALY compared to usual care alone Without adjusting for adherence or baseline characteristics, the ICER estimate increased to £22,010 per additional QALY compared to usual care alone The study cost-effectiveness results were consistent, even when varying the cost of home-based HHHFT, the study inclusion criteria, and the methods used to adjust QALY and cost estimates
Milne et al, 2022,[28] New Zealand	Budget impact Trial-based Health care payer 5 years	People with COPD and chronic respiratory failure	Intervention: home-based HHHFT plus usual care Comparator: usual care only	NA	2020 NZD *5-year budget impact* $18,626 in savings per home-based HHHFT device over 5 years compared to usual care	In scenario analyses, the budget impact per device ranged from cost savings of $43,371 to a cost increase of $6,118
Groessl et al, 2023,[29] United States	Cost–utility Markov model US health care payer 5 years	People with COPD and chronic respiratory failure	Intervention: home-based HHHFT plus usual care (including long-term oxygen therapy) Comparator: usual care only (including long-term oxygen therapy)	*QALYs* Home-based HHHFT plus usual care was associated with an increase in QALYS of 0.058	2021 USD Home-based HHHFT plus usual care was associated with a decrease in cost of $3,939 compared to usual care alone	Home-based HHHFT plus usual care was more effective and less costly than usual care alone. At a WTP value of $50,000 per additional QALY, the probability that home-based HHHFT plus usual care was cost-effective was 84% Scenario analyses found that the model was most sensitive to utility parameters, the cost of hospitalizations, and the frequency of exacerbations

Abbreviations: CI, confidence interval; COPD, chronic obstructive pulmonary disease; HHHFT, heated humidified high-flow therapy; ICER, incremental cost-effectiveness ratio; NA, not applicable; QALY, quality-adjusted life-year; WTP, willingness to pay.

Applicability and Limitations of the Included Studies

Appendix 4 provides the results of the quality appraisal checklist for economic evaluations applied to the included studies. All 5 studies were deemed partially applicable to the research question, owing primarily to uncertainty about whether cost and effectiveness estimates would be applicable to the Ontario context.

Discussion

We identified 5 international studies that evaluated home-based HHHFT and were partially applicable to the Ontario context. All 5 studies evaluated home-based HHHFT for adults; we did not identify any pediatric evidence for home-based HHHFT. Three of the studies evaluated home-based HHHFT for COPD and chronic respiratory failure,[28-30] 1 for people with moderate to severe COPD or bronchiectasis,[31] and 1 for people with a tracheostomy or hypoxemic respiratory failure.[24] The included studies varied in their analytical techniques: 1 was a noncomparative costing study, 3 were cost–utility analyses, and 1 was a budget impact analysis.

The study by Dolidon et al[24] was a noncomparative costing study; the remaining studies compared home-based HHHFT plus usual care with usual care only; usual care often included long-term oxygen therapy. The included studies varied in their study designs: 3 conducted a trial-based cost-effectiveness analysis, 1 used a Markov model, and 1 was a retrospective registry study. Milne et al[28] and Groessl et al[29] estimated cost savings related to use of home-based HHHFT. Although Dolidon et al[24] did not conduct a formal comparison of home-based HHHFT devices, the authors indicated that the estimated cost of home-based HHHFT would likely be lower than the inpatient costs that people with hypoxemic respiratory failure would have incurred. Sørensen et al[30] and Milne et al[31] estimated modest cost increases associated with home-based HHHFT use. For all 4 comparative studies,[28-31] the reduced costs were related to decreased hospitalization use. Four studies amortized capital and equipment costs associated with home-based HHHFT. This modelling decision implied that when someone was finished using a home-based HHHFT device, someone else could use it. It is unclear what the cost-effectiveness of home-based HHHFT would be if public funding meant that people owned the device.

The 3 cost–utility analyses[29-31] all estimated that home-based HHHFT would be associated with increases in health-related quality of life. The QALY benefits ranged from an increase of 0.058 over 5 years in Groessl et al[29] to 0.068 over 1 year in Milne et al.[31] Two of the cost–utility analyses[30,31] sourced utility inputs from previously published trials and mapped responses from the St. George's Respiratory Questionnaire to EQ-5D estimates using a previously developed algorithm. One study[30] adjusted for baseline utility estimates, which varied across the intervention and control groups. This adjustment resulted in higher QALY benefits compared to the unadjusted estimates. It is unclear what effect the added uncertainty of mapping utility estimates had on cost-effectiveness results.

Three of the included studies[28-30] sourced effectiveness parameters from Storgaard et al,[22] a Danish randomized clinical trial in which 200 individuals with COPD and chronic respiratory failure were randomized to home-based HHHFT plus usual care or usual care alone. In the clinical trial, the hospitalization rate for the home-based HHHFT group in the year prior to enrolment was higher than in the comparator group. The clinical trial and the subsequent economic studies adjusted for resource use prior to trial enrolment. Scenario analyses using unadjusted estimates resulted in less favourable cost-effectiveness results.

Strengths and Limitations

We conducted a review of the economic literature evaluating home-based HHHFT. The primary strength of this review was its comprehensiveness in providing a summary of the latest economic evidence for home-based HHHFT. We were able to identify evidence from a variety of jurisdictions evaluating home-based HHHFT use for a wide range of adult chronic conditions.

This review also had several limitations, including the fact that our results were limited in their applicability. We did not identify any cost-effectiveness evidence for home-based HHHFT use in pediatric patients. We also did not identify any Canadian evidence for adults or pediatric patients. Further, we were unable to quantify how modelling decisions, and the internal validity of pivotal clinical trials affected economic outcomes for several of the studies.

Conclusions

We identified 5 economic studies that evaluated home-based HHHFT for various chronic respiratory conditions in adults; none were conducted in Canada. The studies varied in methods, settings, and findings. Overall, most studies found that home-based HHHFT was associated with cost savings or only modest cost increases, largely due to a reduction in hospitalizations. The studies also found improvements in health-related outcomes. However, none of the studies was directly applicable to our research questions. We did not identify any studies evaluating the use of home-based HHHFT in children.

Primary Economic Evaluation

We did not conduct a primary economic evaluation for several reasons. First, the clinical evidence review did not identify any comparative effectiveness estimates to support such an analysis. Additionally, the economic evidence review did not identify any studies directly applicable to our research questions. Given these limitations, a primary economic evaluation would likely produce estimates too uncertain to draw meaningful conclusions about the cost-effectiveness of home-based HHHFT. However, we incorporated potential changes in resource utilization and costs into a budget impact analysis and assessed the uncertainty of these estimates through a wide range of scenario analyses.

Budget Impact Analysis

Research Questions

1) What is the potential 5-year budget impact for the Ontario Ministry of Health of publicly funding home-based heated humidified high-flow therapy (HHHFT) in a community setting for children (aged < 18 years) with pediatric obstructive sleep apnea (OSA)?
2) What is the potential 5-year budget impact for the Ontario Ministry of Health of publicly funding home-based HHHFT for inpatients with the following conditions?
   - Children (aged < 18 years) with chronic respiratory insufficiency, plastic bronchitis, bronchiolitis obliterans, or refractory hypoxemia
   - People of all ages with a tracheostomy
   - Adults (aged ≥ 18 years) with a lung transplant; chronic obstructive pulmonary disease (COPD) with frequent exacerbations and unable to tolerate noninvasive ventilation; bronchiectasis; or interstitial lung disease with hypoxic failure (e.g., idiopathic pulmonary fibrosis)

Methods

Analytic Framework

For each of the 2 research questions we estimated the budget impact of publicly funding home-based HHHFT using the cost difference between 2 scenarios: (1) current clinical practice without public funding for home-based HHHFT (the current scenario) and (2) anticipated clinical practice with public funding for home-based HHHFT (the new scenario). Figure 4 presents the budget impact model schematic.

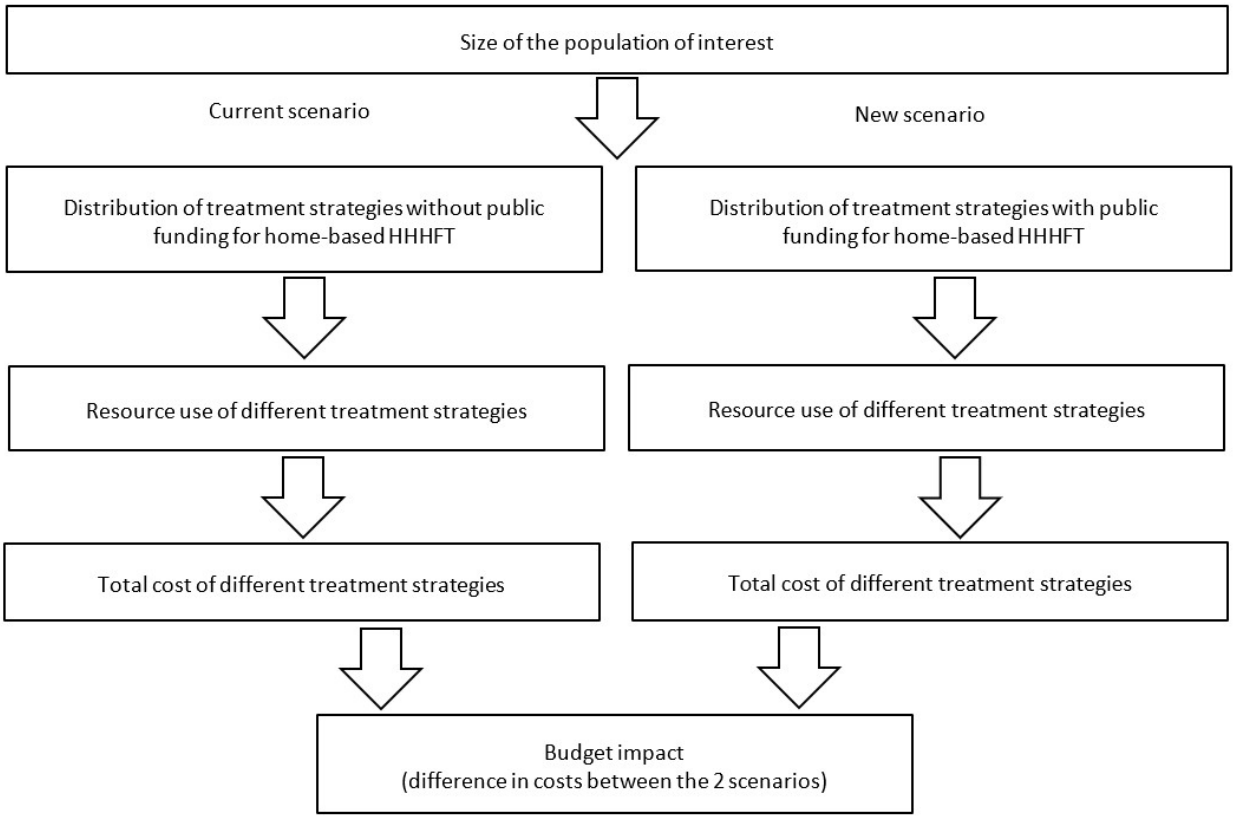

Figure 4: Schematic Model of Budget Impact

Flow chart describing the model for the budget impact analysis. Based on the size of the population of interest, we created 2 scenarios: the current scenario, which would explore the distribution of treatment strategies, resource use, and total costs without public funding for home-based HHHFT; and the new scenario, which would explore the distribution of treatment strategies, resource use, and total costs with public funding for home-based HHHFT. The budget impact would represent the difference in costs between the 2 scenarios.
Abbreviation: HHHFT, heated humidified high-flow therapy.

We developed 2 distinct clinical pathways. The first was for children under 18 years of age with pediatric OSA. In the current scenario for this pathway, those with moderate to severe pediatric OSA who are nonadherent to continuous positive airway pressure (CPAP) treatment either remain nonadherent to CPAP or receive privately funded (via private insurance or out-of-pocket expenditures) home-based HHHFT; those receiving home-based HHHFT may be either adherent or nonadherent. In the new scenario, home-based HHHFT is publicly funded, and patients may similarly be adherent or nonadherent. Figure 5 outlines the clinical pathway for pediatric OSA.

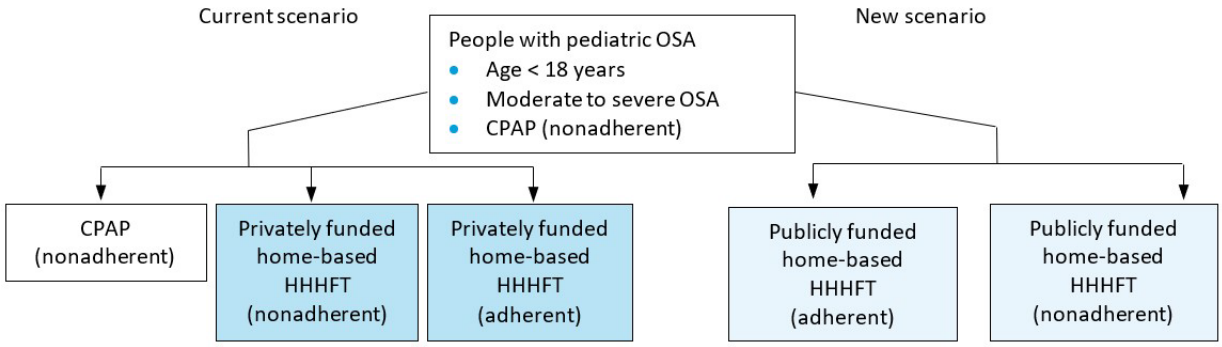

Figure 5: Clinical Pathway, Pediatric OSA

Clinical pathway for pediatric OSA. In the current scenario, children with moderate to severe pediatric OSA can be nonadherent to CPAP therapy, or they can be adherent or nonadherent to privately funded home-based HHHFT. In the new scenario, children with moderate to severe pediatric OSA can be adherent or nonadherent to publicly funded home-based HHHFT.
Abbreviations: CPAP, continuous positive airway pressure; HHHFT, heated humidified high-flow therapy; OSA, obstructive sleep apnea.

The second pathway relates to adults and children who are transferred home or to community-based care with the support of home-based HHHFT. In the current scenario, people remain as inpatients until they can be discharged home, or until death. We also modelled access to privately funded (via private insurance or out-of-pocket expenditures) home-based HHHFT. In the new scenario, access to home-based HHHFT may facilitate earlier discharge for some. Figure 6 outlines the pathway for home-based HHHFT after inpatient discharge.

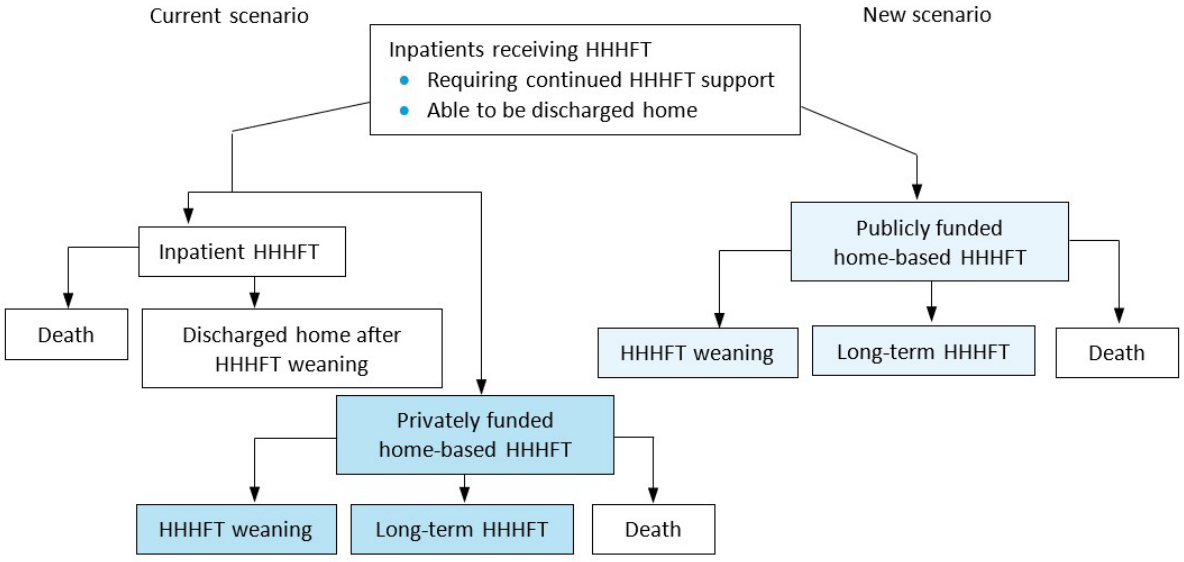

Figure 6: Clinical Pathway After Inpatient Discharge, Adult and Pediatric (Other Chronic Respiratory Conditions)

Clinical pathway for adults and children who can be discharged home or to the community with the support of home-based HHHFT. In the current scenario, people remain as inpatients until they can be discharged home without HHHFT, or until death. They can also be discharged home with privately funded home-based HHHFT. In the new scenario, people are discharged with publicly funded home-based HHHFT. Once they are in the community, they can wean off home-based HHHFT, receive home-based HHHFT over the long term, or die.
Abbreviation: HHHFT, heated humidified high-flow therapy.

Key Assumptions

- We assumed that all cost inputs – including the cost of home-based HHHFT – would remain constant during the 5-year time horizon. We conducted extensive scenario analyses varying the value of cost inputs.
- We assumed that if home-based HHHFT were to be publicly funded, the funding model would be determined by the Ministry of Health and could encompass a variety of approaches. We have provided budget impact estimates for several potential funding scenarios, recognizing that there are multiple pathways for implementation. These options should be viewed as part of a broader health care system perspective, rather than being tied to any specific existing programs or funding structures.
- We assumed that home-based HHHFT for moderate to severe pediatric OSA would have an effectiveness similar to CPAP therapy, with respect to emergency department visits and inpatient hospitalizations. We conducted scenario analyses modifying the effectiveness of home-based HHHFT relative to CPAP treatment.
- Given the limited comparative clinical evidence, we assumed that the model parameters informed by noncomparative international studies would resemble current clinical practice in Ontario. We conducted extensive scenario analyses on key model parameters.
- We assumed that adults discharged earlier because of access to home-based HHHFT would be discharged from a long-term rehabilitation bed. It is also possible that they could be discharged from acute care beds, depending on local availability. The costs avoided are likely to be higher for those discharged from acute care beds.

Population of Interest

We sourced the population of interest from previously published studies, expert opinion, and uptake of home-based HHHFT devices in comparable jurisdictions.

Children (Aged < 18 Years) With Pediatric OSA

Home-based HHHFT devices are publicly funded for children in Saskatchewan under the Saskatchewan Aids to Independent Living (SAIL) program.[10] To be eligible for home-based HHHFT, a child must be under the age of 18 years; be prescribed HHHFT by a pediatric respirologist; be diagnosed with pediatric OSA that has not improved with low-flow oxygen; and not be tolerating noninvasive ventilation masks or have severe chronic lung disease or congenital cardiopulmonary anomalies with increased work of breathing or hypoventilation that is not well controlled with low-flow oxygen or noninvasive ventilation masks. This closely resembles the pediatric population in our research questions; as well, similar to our population of interest for pediatric OSA, it excludes those who are CPAP-adherent.

We assumed that if home-based HHHFT were publicly funded, the number of pediatric patients receiving it in Ontario would resemble the number in Saskatchewan under the SAIL program (Saskatchewan Ministry of Health, email communication, September 11, 2024). A clinical expert indicated that they would expect an increase in the pediatric population receiving home-based HHHFT (Reshma Amin, MD, email communication, February 4, 2025); thus, we increased the size of the

population of interest by 10% per year over the model time horizon. The same clinical expert also indicated that 80% to 85% of home-based HHHFT prescriptions would be for sleep-disordered breathing, which includes pediatric OSA (Reshma Amin, email communication, September 18, 2024). Table 2 provides our estimate for the population with pediatric OSA that would receive HHHFT (detailed calculations are provided in Appendix 5). We conducted scenario analyses in which the number of patients receiving home-based HHHFT for pediatric OSA was varied by ± 25%, ± 50%, and ± 75%.

Table 2: Population of Interest, Children (Aged < 18 Years) With Pediatric OSA

Population	Year 1	Year 2	Year 3	Year 4	Year 5	Source
New home-based HHHFT prescriptions per year	32	35	40	44	49	Calculated (Appendix 5, Table A2)
New home-based HHHFT prescriptions for pediatric OSA (80%–85%)[a]	27	29	33	37	40	Calculated[b]

Abbreviations: HHHFT, heated humidified high-flow therapy; OSA, obstructive sleep apnea.

[a] Assumption.

[b] Calculated using the midpoint percentage for sleep disordered breathing (82.5%).

Children (Aged < 18 Years) With Other Chronic Respiratory Conditions

We used an approach similar to the above to estimate the size of the pediatric population that would receive home-based HHHFT for other chronic respiratory conditions. We assumed that 15% to 20% of pediatric patients receiving home-based HHHFT would have other chronic respiratory conditions, such as those requiring a tracheostomy. Table 3 provides our estimate of the pediatric population that would receive HHHFT for other chronic respiratory conditions (detailed calculations are provided in Appendix 5). We conducted scenario analyses in which the number of pediatric patients receiving home-based HHHFT for other chronic respiratory conditions was varied by ± 25%, ± 50%, and ± 75%.

Table 3: Population of Interest, Children (Aged < 18 Years) With Other Chronic Respiratory Conditions

Population	Year 1	Year 2	Year 3	Year 4	Year 5	Source
New home-based HHHFT prescriptions per year	32	35	40	44	49	Calculated (Appendix 5, Table A2)
New home-based HHHFT prescriptions for other chronic respiratory conditions (15%–20%)[a]	6	6	7	8	9	Calculated[b]

Abbreviation: HHHFT, heated humidified high-flow therapy.

[a] Assumption.

[b] Calculated using the midpoint of other respiratory conditions (17.5%).

Adults (Aged ≥ 18 Years)

Home-based HHHFT is funded by the National Health Service (NHS) in the Norfolk and Waveney Integrated Care System, and approximately 10 to 12 patients receive it each year (Norfolk and Waveney Integrated Care Board, freedom of information response, October 30, 2024). Home-based HHHFT is funded to support the goal of fewer hospital admissions for COPD and early discharge from hospital for patients who can be managed at home or in another care setting who otherwise might have spent more days in hospital.[32] This resembles the adult population in our research questions.

To scale these estimates to the Ontario population, we sourced the age range of adults receiving home-based HHHFT (56 to 74 years) from Dolidon et al.[24] We also sourced the Norfolk and Waveney population aged 56 to 74 years from the UK Office for National Statistics.[33] We then estimated that the use of home-based HHHFT would be 4.04 per 100,000 people aged 56 to 74 years. We sourced population projections from the Ontario Ministry of Finance for people aged 56 to 74 during our model time horizon and multiplied the rate of 4.04 per 100,000 by those population projections to obtain an estimate of the number of adults who would receive home-based HHHFT (Table 4; detailed calculations are provided in Appendix 5). We assumed that 80% of HHHFT prescriptions would be related to tracheostomy, and the rest would be for other respiratory conditions. Because of uncertainty in the size of the population of interest, we conducted scenario analyses in which we varied the size of the population by ± 25%, ± 50%, and ± 75%.

Table 4: Population of Interest, Adults

Population	Year 1	Year 2	Year 3	Year 4	Year 5	Source
New home-based HHHFT prescriptions per year	142	143	144	145	145	Calculated (Appendix 5, Table A3)
Prescriptions for tracheostomy (80%)	114	114	115	116	116	Assumption
Prescriptions for other respiratory conditions (20%)	28	29	29	29	29	Assumption

Abbreviation: HHHFT, heated humidified high-flow therapy.

Current Intervention Mix

People are currently accessing home-based HHHFT via private insurance, out-of-pocket expenditures, or compassionate access. Of the total estimated number of candidates for HHHFT (142 adult and 32 pediatric patients in year 1), we estimated that 26% (44 patients) would be accessing it. Table 5 presents the intervention mix for the current scenario. We conducted scenario analyses varying current access to home-based HHHFT via private insurance, out-of-pocket expenditures, or compassionate access. We assumed that use of home-based HHHFT via these pathways would be split evenly between pediatric and adult patients.

Table 5: Current Intervention Mix[a]

Population	Year 1	Year 2	Year 3	Year 4	Year 5
Total candidates for home-based HHHFT	174	178	184	189	194
Patients accessing home-based HHHFT via private insurance or out-of-pocket expenditures (26%)	44	45	46	47	49
Patients not accessing home-based HHHFT	131	134	138	142	146
Patients accessing home-based HHHFT via public funding	0	0	0	0	0

Abbreviation: HHHFT, heated humidified high-flow therapy.

[a] Values may appear inexact due to rounding.

Intervention Mix in the New Scenario

In the new scenario, we assumed that uptake of home-based HHHFT would be 100% if it were publicly funded (Table 6). We conducted scenario analyses that varied the uptake of home-based HHHFT.

Table 6: Intervention Mix in the New Scenario

Population	Year 1	Year 2	Year 3	Year 4	Year 5
Total candidates for home-based HHHFT	174	178	184	189	194
Patients accessing home-based HHHFT via private insurance or out-of-pocket expenditures	0	0	0	0	0
Patients not accessing home-based HHHFT	0	0	0	0	0
Patients accessing home-based HHHFT via public funding	174	178	184	189	194

Abbreviation: HHHFT, heated humidified high-flow therapy.

Resources and Costs

We sourced information on resource utilization and costs from expert opinion, published studies, physician fee schedules, and administrative databases. Costs are reported in 2024 Canadian dollars and adjusted for inflation using Statistics Canada's Consumer Price Index.[34] Detailed descriptions of the inputs for resource utilization and costs are provided in Appendix 5.

Device Costs

We sourced device acquisition costs for home-based HHHFT ($2,400) from a manufacturer (Fisher & Paykel Healthcare Inc., email communication, October 10, 2024). We sourced consumables costs ($800 per year) from the same manufacturer. Consumables included a water chamber, a heater tube, an interface, and a filter.

A wide range of funding models are possible if home-based HHHFT were to be publicly funded; we considered 3 of these:

- A loan funding model, in which device acquisition and consumables costs are publicly funded. For this model, yearly device acquisition costs were $578, calculated using a device lifespan of 5 years and a device utilization rate of 83%, similar to Groessl et al.[29]
- A 75% public funding model, in which 75% of device and consumables costs are publicly funded and the remaining 25% are covered by patients out of pocket or via private insurance.
- A 100% public funding model, in which 100% of device and consumables costs are publicly funded.

Table 7 lists the device and consumables costs. We conducted scenario analyses in which these costs were varied by ± 25%.

Table 7: Model Parameters, Device Costs

Model parameter	Unit cost, $[a]	Source
Device acquisition costs	$2,400	Manufacturer[b]
Consumables costs, per year	$800	Manufacturer[b]
Loan program scenario, per year		
Device acquisition, public funding	$578	Calculated, Groessl et al[29]
Device acquisition, out of pocket	$0	Calculated, Groessl et al[29]
Consumables, public funding	$800	Calculated, Groessl et al[29]
Consumables, out of pocket	$0	Calculated, Groessl et al[29]
75% public funding scenario		
Device acquisition, public funding	$1,800	Calculated
Device acquisition, out of pocket	$600	Calculated
Consumables, public funding	$600	Calculated
Consumables, out of pocket	$200	Calculated
100% public funding scenario		
Device acquisition, public funding	$2,400	Calculated
Device acquisition, out of pocket	$0	Calculated
Consumables, public funding	$800	Calculated
Consumables, out of pocket	$0	Calculated

[a] Costs are in 2024 Canadian dollars.

[b] Fisher & Paykel Healthcare Inc., email communication, October 10, 2024.

Pediatric OSA

We sourced the number of outpatient and inpatient visits from Radhakrishnan et al[35] for pediatric patients who are nonadherent (to CPAP or home-based HHHFT) and for those who are adherent to home-based HHHFT. The authors evaluated the number of unscheduled emergency department visits and hospitalizations from a cohort of pediatric patients with moderate to severe OSA who were prescribed CPAP. The study did not differentiate between those who were adherent and nonadherent. To estimate outpatient and inpatient resource utilization, we assumed a CPAP adherence rate of 37%. We also assumed that resource utilization for pediatric patients who were adherent to home-based HHHFT or CPAP would be comparable. See Appendix 5 for detailed calculations.

We assumed that adherence to home-based HHHFT would be 62%. We sourced the duration of OSA treatment from Castro-Codesal et al,[36] who conducted a retrospective analysis of pediatric patients who started long-term noninvasive ventilation (CPAP, bilevel positive airway pressure [BiPAP], or automated positive airway pressure [autoPAP]) in Alberta from 2005 to 2018. Using published, deidentified, patient-level data from this study, we were able to estimate the percentage of pediatric patients who continued noninvasive ventilation 1, 2, 3, 4, and 5 years after treatment initiation. We assumed that the duration of OSA treatment in our population would resemble the findings from Castro-Codesal et al.[36] We also assumed that after the end of treatment for pediatric OSA, costs and resource utilization would be comparable for those who had received home-based HHHFT and those who did not.

We sourced outpatient visit costs by querying the National Ambulatory Care Reporting System using IntelliHealth Ontario for outpatient visits with a main problem diagnosis (MPDx) associated with pediatric OSA.[37] We assumed that Ontario Health Insurance Plan (OHIP) fee codes related to an outpatient assessment would also be incurred. We sourced inpatient costs by querying the Discharge Abstract Database using IntelliHealth Ontario for inpatient visits with a most responsible diagnosis (MRDx) associated with pediatric OSA.[38] We also sourced OHIP fee codes related to an inpatient stay. We included OHIP fee codes related to ventilation home monitoring. We conducted a wide range of scenario analyses, modifying each parameter for resource utilization and costs. Table 8 lists the model parameters for pediatric OSA.

Table 8: Model Parameters, Pediatric OSA

Parameter	Value or unit cost, $[a]	Source
ED visits per year		
Nonadherent (CPAP or home-based HHHFT)	1.13	Radhakrishnan et al[35]
Adherent (home-based HHHFT)	0.40	Calculated
Hospital visits per year		
Nonadherent (CPAP or home-based HHHFT)	0.76	Radhakrishnan et al[35]
Adherent (home-based HHHFT)	0.19	Calculated
Percent of patients continuing pediatric OSA treatment		
Year 1	100.0%	Castro-Codesal et al[36]
Year 2	87.0%	Castro-Codesal et al[36]
Year 3	72.2%	Castro-Codesal et al[36]
Year 4	49.2%	Castro-Codesal et al[36]
Year 5	41.7%	Castro-Codesal et al[36]
Adherence, home-based HHHFT	62%	Assumed
Adherence, CPAP	37%	Assumed
Cost of an ED visit with pediatric OSA as the MPDx	$1,384.80	NACRS,[37] OCCI[39]
OHIP fees for an ED visit with pediatric OSA as the MPDx	$51.03	OHIP Schedule of Benefits[40] fee codes H103, H123, H133, H153
Cost of an inpatient visit with pediatric OSA as the MRDx	$6,065.71	DAD,[38] OCCI[39]
OHIP fees for an inpatient visit with pediatric OSA as the MRDx	$297.03	OHIP Schedule of Benefits[40] fee codes C265, E082, C122
OHIP fees per year for home monitoring	$1,342.00	OHIP Schedule of Benefits[40] fee code G101 × 40 claims
Device acquisition and consumables costs for home-based HHHFT	Various	Table 7

Abbreviations: CPAP, continuous positive airway pressure; DAD, Discharge Abstract Database; ED, emergency department; HHHFT, heated humidified high-flow therapy; MPDx, main problem diagnosis; MRDx, most responsible diagnosis; NACRS, National Ambulatory Care Reporting System; OCCI, Ontario Case Costing Initiative; OHIP, Ontario Health Insurance Plan; OSA, obstructive sleep apnea.

[a] Costs are in 2024 Canadian dollars.

Adults and Pediatric Patients With Other Chronic Respiratory Conditions

We sourced the proportion of adults for whom access to home-based HHHFT would have facilitated an earlier inpatient discharge from Dolidon et al,[24] who indicated that 72% (31/43) of the population receiving home-based HHHFT via nasal cannula obtained an earlier discharge as a result of access to home-based HHHFT (Table 9). We also assumed that home-based HHHFT would facilitate earlier discharge for a small percentage (6%) of people receiving home-based HHHFT via tracheostomy (Appendix 5). We had a wide range of responses from clinical experts about whether access to home-based HHHFT would facilitate earlier discharge for some patients. Given the substantial uncertainty in our estimates, we conducted scenario analyses that varied the proportion of adults receiving earlier discharge from 0% to 100%. We were unable to source similar estimates for pediatric patients with other chronic respiratory conditions and assumed that home-based HHHFT would facilitate a proportion of earlier discharges similar to that of adults.

It is unclear how many inpatient days would be avoided for adults who would receive an earlier discharge as a result of home-based HHHFT. Dolidon et al[24] estimated a survival of 15.7 weeks after initiation of home-based HHHFT via nasal cannula, providing an upper estimate for the potential number of days avoided. From IntelliHealth Ontario, we were able to source a mean length of stay of 30 days for an inpatient admission associated with chronic respiratory failure or COPD at an inpatient rehabilitation facility. There is a lack of literature about how much inpatient length of stay could be reduced as a result of access to home-based HHHFT, so we assumed that adults who received earlier discharge would have a 20% (6-day) reduction in length of stay. We tested this assumption in scenario analyses, varying the number of inpatient days avoided from 0 to 30 days. We were unable to source information about reduced inpatient days related to the initiation of home-based HHHFT in pediatric patients; we assumed that this value would be comparable to that of adults (i.e., 6 days).

We sourced the duration of home-based HHHFT use for adults from Dolidon et al.[24] The authors also reported survivorship after initiation of home-based HHHFT for those receiving it via nasal cannula and via tracheostomy, and we assumed that survivorship for home-based HHHFT in adults would resemble those reported values.[24] We estimated home-based HHHFT use for pediatric patients with other chronic respiratory conditions using information from Castro-Codesal et al,[36] similar to the way we estimated use for pediatric OSA.

We sourced adult inpatient costs for an inpatient rehabilitation hospital stay from the National Rehabilitation Reporting System, accessed through IntelliHealth Ontario.[41] For pediatric patients, we sourced the cost of an inpatient stay for a chronic respiratory condition at a pediatric hospital. We also considered physician fees related to an inpatient stay. Given the lack of published evidence, we did not consider potential reductions in outpatient visits or hospitalizations as a result of home-based HHHFT use. Apart from OHIP fee codes for home monitoring, we did not consider any additional at-home costs.

Table 9: Model Parameters, Adult and Pediatric (Other Chronic Respiratory Conditions)

Parameter	Value or unit cost, $[a]	Source
Proportion of adults with earlier discharge		
HHHFT via nasal cannula	0.72	Dolidon et al[24]
HHFFT via tracheostomy	0.06	Dolidon et al[24]
Proportion of pediatric patients with earlier discharge		
HHHFT via nasal cannula	0.72	Assumed to be similar to adults
HHFFT via tracheostomy	0.06	Assumed to be similar to adults
Inpatient days avoided in those with an earlier discharge		
Adults	6	Assumed and highly uncertain
Pediatric patients	6	Assumed and highly uncertain
Percent of adults continuing home-based HHHFT		
Year 1	100%	Dolidon et al,[24] assumed 80% of patients with tracheostomy
Year 2	57.8%	Dolidon et al,[24] assumed 80% of patients with tracheostomy
Year 3	50%	Dolidon et al,[24] assumed 80% of patients with tracheostomy
Year 4	47.2%	Dolidon et al,[24] assumed 80% of patients with tracheostomy
Year 5	47.2%	Dolidon et al,[24] assumed 80% of patients with tracheostomy
Percent of pediatric patients continuing home-based HHHFT		
Year 1	100.0%	Castro-Codesal et al[36]
Year 2	81.4%	Castro-Codesal et al[36]
Year 3	68.2%	Castro-Codesal et al[36]
Year 4	41.8%	Castro-Codesal et al[36]
Year 5	35.4%	Castro-Codesal et al[36]
Inpatient cost per day, facility costs		
Adults	$912.71	NRS,[41] OCCI[39]
Pediatric patients	$2,786.94	DAD,[38] OCCI[39]
Inpatient cost per day, OHIP physician fees		
Adults	$34.00	OHIP Schedule of Benefits[40] fee code W132
Pediatric patients	$61.15	OHIP Schedule of Benefits[40] fee code C122
OHIP fees per year for home monitoring per year	$1,342.00	OHIP Schedule of Benefits[40] fee code G101
Device acquisition and consumables costs for home-based HHHFT	Various	See Table 7

Abbreviations: DAD, Discharge Abstract Database; HHHFT, heated humidified high-flow therapy; NRS, National Rehabilitation Reporting System; OCCI, Ontario Case Costing Initiative; OHIP, Ontario Health Insurance Plan.

[a] Costs are in 2024 Canadian dollars.

Equity Considerations

At present, those who have private insurance coverage or who can pay out of pocket have access to home-based HHHFT. Access may facilitate discharge from inpatient facilities earlier than for those who do not have private coverage or cannot otherwise afford the cost of home-based HHHFT. We estimated and reported changes in the number of inpatient hospitalizations, as well as changes to out-of-pocket costs as a result of public funding for home-based HHHFT. We did not consider other costs or out-of-pocket expenditures that would result from caring for the complex medical conditions of those who may require home-based HHHFT.

Internal Validation

The secondary health economist conducted formal internal validation. This process included checking for errors and ensuring the accuracy of parameter inputs and equations in the budget impact analysis.

Analysis

We conducted a reference case analysis and scenario analyses. Our reference case analysis represents the analysis with the most likely set of input parameters and model assumptions. Because of uncertainty in how home-based HHHFT would be funded, we have presented results for 3 potential funding models (loan program, 75% public funding, and 100% public funding). For readability, we have provided the results for the loan program funding model in the main report, and the results for the other funding models in Appendix 6.

Our scenario analyses explored how the results were affected by varying input parameters and model assumptions. Because of wide uncertainty in our model input parameters, we conducted a range of scenario analyses. Table 10 summarizes the scenario analyses conducted.

We also conducted an exploratory analysis for the adult and pediatric (other chronic respiratory conditions) model that varied both the probability that a patient would have a shorter inpatient stay and the subsequent inpatient days avoided.

Table 10: Scenario Analyses

Scenario	Parameter	Reference case	Scenario analysis
1–6	Pediatric population size	Table 2	± 25%, ± 50%, ± 75%
7–8	Percent of population with pediatric OSA	80%–85%	± 10%
9–14	Adult population size	Table 3	± 25%, ± 50%, ± 75%
15–18	Year uptake reaches 100%	Year 1	Year 2, year 3, year 4, year 5
19–20	Adherence to home-based HHHFT, pediatric OSA	62%	± 25%
21–22	Reduction in outpatient visits, pediatric OSA	1.13–0.4 (Table 8)	± 25% change in size of reduction
23–24	Reduction in inpatient visits, pediatric OSA	0.76–0.19 (Table 8)	± 25% change in size of reduction
25–26	Proportion of patients continuing treatment for pediatric OSA	Table 8	± 25% relative change in the number of patients continuing to receive home-based HHHFT
27–28	Outpatient facility costs	Table 8	± 25%
29–30	Inpatient facility costs	Table 8 and Table 9	± 25%
31–34	Home-based HHHFT monitoring costs	Table 8 and Table 9	± 25%, ± 50%
35–36	HHHFT device costs	Table 7	± 25%
37–38	HHHFT consumables costs	Table 7	± 25%
39–44	Proportion of adults for whom home-based HHHFT resulted in earlier discharge	Table 9	Proportion ranging from 0 to 1 (by 0.2 increments)
45–50	Proportion of pediatric patients for whom home-based HHHFT resulted in earlier discharge	Table 9	Proportion ranging from 0 to 1 (by 0.2 increments)
51–60	Inpatient days avoided for adults whose earlier discharge was facilitated by home-based HHHFT	6 days	Days ranging from 0 to 30 (by 3.3-day increments)
61–70	Inpatient days avoided for pediatric patients whose earlier discharge was facilitated by home-based HHHFT	6 days	Days ranging from 0 to 30 (by 3.3-day increments)
71–72	Proportion of adults continuing to receive home-based HHHFT	Table 9	± 25% relative change in the number of adults continuing to receive home-based HHHFT
73–74	Proportion of pediatric patients continuing to receive home-based HHHFT	Table 9	± 25% relative change in the number of pediatric patients continuing to receive home-based HHHFT

Abbreviations: HHHFT, heated humidified high-flow therapy; OSA, obstructive sleep apnea.

Results

Reference Case

Table 11 and Table 12 report the number of patients starting home-based HHHFT in the current and new scenarios for the pediatric OSA model and the adult and pediatric (other chronic respiratory conditions) model. Over 5 years, publicly funding home-based HHHFT for pediatric OSA would result in 123 additional patients starting home-based HHHFT. Publicly funding home-based HHHFT for adults and pediatric patients with other chronic respiratory conditions would result in 566 additional patients starting home-based HHHFT. The majority of the adult population (80%) would be people with a tracheostomy.

Table 11: Patients Starting Home-Based HHHFT, Pediatric OSA

Population	Year 1	Year 2	Year 3	Year 4	Year 5	Total[a]
Current scenario						
Accessing home-based HHHFT via private insurance or out-of-pocket expenditures	7	7	8	9	10	41
Not accessing home-based HHHFT	20	22	25	27	30	123
Accessing home-based HHHFT via public funding	0	0	0	0	0	0
New scenario						
Accessing home-based HHHFT via private insurance or out-of-pocket expenditures	0	0	0	0	0	0
Not accessing home-based HHHFT	0	0	0	0	0	0
Accessing home-based HHHFT via public funding	26	29	33	36	40	164

Abbreviations: HHHFT, heated humidified high-flow therapy; OSA, obstructive sleep apnea.

[a] Results may appear inexact due to rounding.

Table 12: Patients Starting Home-Based HHHFT, Adult and Pediatric (Other Chronic Respiratory Conditions)

Population	Year 1	Year 2	Year 3	Year 4	Year 5	Total[a]
Adults						
Current scenario						
Accessing home-based HHHFT via private insurance or out-of-pocket expenditures	36	36	36	36	36	180
Not accessing home-based HHHFT	107	107	108	109	109	539
Accessing home-based HHHFT via public funding	0	0	0	0	0	0
New scenario						
Accessing home-based HHHFT via private insurance or out-of-pocket expenditures	0	0	0	0	0	0
Not accessing home-based HHHFT	0	0	0	0	0	0
Accessing home-based HHHFT via public funding	142	143	144	145	145	719
Pediatric patients (other chronic respiratory conditions)						
Current scenario						
Accessing home-based HHHFT via private insurance or out-of-pocket expenditures	2	2	2	2	2	9
Not accessing home-based HHHFT	5	5	5	6	7	27
Accessing home-based HHHFT via public funding	0	0	0	0	0	0
New scenario						
Accessing home-based HHHFT via private insurance or out-of-pocket expenditures	0	0	0	0	0	0
Not accessing home-based HHHFT	0	0	0	0	0	0
Accessing home-based HHHFT via public funding	6	6	7	8	9	36

Abbreviation: HHHFT, heated humidified high-flow therapy.

[a] Results may appear inexact due to rounding.

Table 13 and Table 14 outline resource utilization for the pediatric OSA model and the adult and pediatric (other chronic respiratory conditions) model. Over 5 years, publicly funding home-based HHHFT for pediatric OSA would result in 99 inpatient admissions avoided and 127 fewer outpatient visits (see Appendix 6, Table A5, for detailed results). Publicly funding home-based HHHFT for adults and pediatric patients with other respiratory conditions would result in 653 inpatient days avoided – a direct result of the population size, the probability that access to home-based HHHFT would result in shorter inpatient stays, and the average number of inpatient days avoided (see Appendix 6, Table A6, for detailed results). However, these model parameters were highly uncertain.

Table 13: Estimated Resource Utilization, Pediatric OSA

Resource utilization	Year 1	Year 2	Year 3	Year 4	Year 5	Total[a]
Current scenario						
Number of inpatient visits	17.5	34.7	51.7	66.1	80.8	250.7
Number of outpatient visits	26.4	52.5	78.3	100.1	122.3	379.6
New scenario						
Number of inpatient visits	10.6	21.0	31.3	40.0	48.9	151.8
Number of outpatient visits	17.6	35.0	52.2	66.7	81.5	252.9

Abbreviation: OSA, obstructive sleep apnea.

[a] Results may appear inexact due to rounding.

Table 14: Estimated Resource Utilization, Adult and Pediatric (Other Chronic Respiratory Conditions)

Resource utilization	Year 1	Year 2	Year 3	Year 4	Year 5	Total[a]
Current scenario						
Inpatient days avoided, adults	40.9	41.2	41.5	41.8	41.8	207.3
Inpatient days avoided, pediatric patients	1.7	1.7	2.0	2.3	2.6	10.4
New scenario						
Inpatient days avoided, adults	163.7	164.9	166.0	167.2	167.2	829.1
Inpatient days avoided, pediatric patients	6.9	6.9	8.1	9.2	10.4	41.5

[a] Results may appear inexact due to rounding.

Table 15 and Table 16 present the results of the reference case analysis, in which home-based HHHFT is publicly funded via a loan program (see Appendix 6, Table A7 and Table A8, for results when home-based HHHFT is covered via a 75% funding program or a 100% funding program). We estimate that over 5 years, publicly funding home-based HHHFT for pediatric OSA would likely result in savings of $185,981 (ranging from savings of $185,981 to a budget increase of $112,776, depending on the funding model). Publicly funding home-based HHHFT for adults and pediatric patients with other chronic respiratory conditions would likely require an additional $2.5 million (ranging from $2.5 million to $3.9 million, depending on the funding model). See Appendix 6, Table A9 and Table A10, for average costs and resource utilization per person; see Appendix 6, Table A11 and Table A12, for detailed budget impact analysis results.

For all models, we estimated cost savings related to reduced resource utilization. We estimated increased costs related to device acquisition, consumables, and physician monitoring. For the pediatric OSA model, costs related to device acquisition and consumables ranged from $329,865 to $628,622 depending on the funding model. For the adult and pediatric (other chronic respiratory conditions) model, costs related to device acquisition and consumables ranged from $1.6 million to $3 million. Appendix 6, Table A13, provides estimated out-of-pocket costs in the current and new scenarios. We estimated reductions in out-of-pocket expenditures as a result of public funding for home-based HHHFT.

Table 15: Budget Impact and Total Costs, Pediatric OSA

Scenario	Budget impact, $[a]					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total[b,c]
Current scenario						
Inpatient and outpatient costs						
Hospital costs	$142,536	$282,989	$422,138	$539,664	$659,263	$2,046,591
Physician fees	$6,536	$12,977	$19,358	$24,747	$30,231	$93,849
Home monitoring costs	$8,723	$14,435	$20,224	$25,066	$30,114	$98,562
Total cost	$157,795	$310,401	$461,720	$589,478	$719,609	$2,239,002
New scenario						
Inpatient and outpatient costs						
Hospital costs	$88,514	$175,734	$262,144	$335,127	$409,397	$1,270,916
Physician fees	$4,039	$8,019	$11,962	$15,292	$18,681	$57,992
Home monitoring costs	$34,892	$57,739	$80,897	$100,265	$120,456	$394,249
Device acquisition costs	$15,036	$16,771	$19,084	$20,819	$23,133	$94,843
Device consumables costs	$20,800	$34,420	$48,225	$59,770	$71,807	$235,022
Total cost	$163,281	$292,682	$422,312	$531,273	$643,473	$2,053,022
Budget impact[d]						
Inpatient and outpatient costs						
Hospital costs	−$54,022	−$107,255	−$159,994	−$204,537	−$249,866	−$775,675
Physician fees	−$2,497	−$4,958	−$7,396	−$9,455	−$11,551	−$35,858
Home monitoring costs	$26,169	$43,304	$60,673	$75,198	$90,342	$295,687
Device acquisition costs	$15,036	$16,771	$19,084	$20,819	$23,133	$94,843
Device consumables costs	$20,800	$34,420	$48,225	$59,770	$71,807	$235,022
Total budget impact	$5,485	−$17,719	−$39,407	−$58,205	−$76,135	−$185,981

[a] In 2024 Canadian dollars.
[b] Negative costs indicate savings.
[c] Results may appear inexact due to rounding.
[d] New scenario − current scenario.

Table 16: Budget Impact and Total Costs, Adult and Pediatric (Other Chronic Respiratory Conditions)

Scenario	Budget impact, $[a]					
	Year 1	Year 2	Year 3	Year 4	Year 5	Total[b,c]
Current scenario						
Reduced inpatient costs						
Hospital costs	−$42,183	−$42,446	−$43,513	−$44,579	−$45,383	−$218,103
Physician fees	−$1,502	−$1,512	−$1,539	−$1,566	−$1,584	−$7,703
Home monitoring costs	$49,654	$79,165	$105,223	$129,857	$154,413	$518,311
Total cost	$5,969	$35,207	$60,171	$83,711	$107,447	$292,506
New scenario						
Reduced inpatient costs						
Hospital costs	−$168,732	−$169,784	−$174,050	−$178,316	−$181,530	−$872,412
Physician fees	−$6,007	−$6,046	−$6,156	−$6,266	−$6,336	−$30,810
Home monitoring costs	$198,616	$316,658	$420,891	$519,426	$617,653	$2,073,245
Device acquisition costs	$85,590	$86,169	$87,325	$88,482	$89,060	$436,627
Device consumables costs	$118,400	$188,768	$250,904	$309,643	$368,198	$1,235,914
Total cost	$227,868	$415,765	$578,915	$732,970	$887,045	$2,842,562
Budget impact[d]						
Reduced inpatient costs						
Hospital costs	−$126,549	−$127,338	−$130,538	−$133,737	−$136,148	−$654,309
Physician fees	−$4,505	−$4,535	−$4,617	−$4,699	−$4,752	−$23,108
Home monitoring costs	$148,962	$237,494	$315,669	$389,570	$463,240	$1,554,934
Device acquisition costs	$85,590	$86,169	$87,325	$88,482	$89,060	$436,627
Device consumables costs	$118,400	$188,768	$250,904	$309,643	$368,198	$1,235,914
Total budget impact	$221,899	$380,558	$518,743	$649,258	$779,599	$2,550,057

[a] In 2024 Canadian dollars.
[b] Negative costs indicate savings.
[c] Results may appear inexact due to rounding.
[d] New scenario − current scenario.

Scenario Analysis

Table 17 provides a summary of the results of the scenario analyses (see Appendix 6, Table A14, for detailed results). The pediatric OSA model was most sensitive to adherence to home-based HHHFT, the reduction in number of inpatient visits as a result of adherence to OSA treatment, and inpatient facility costs. The adult and pediatric (other chronic respiratory conditions) model was most sensitive to the size of the adult population of interest, home-based HHHFT monitoring costs, and the proportion of patients for whom home-based HHHFT facilitated an earlier inpatient discharge. See Appendix 6, Table A15, for the results of our exploratory analysis that varied the average number of inpatient days avoided as a result of access to home-based HHHFT in the adult and pediatric (other chronic respiratory conditions) model. Results from this analysis indicated that if patients avoided an average of 5.5 inpatient days as a result of home-based HHHFT (reference case average of 1.154 inpatient days avoided), publicly funding home-based HHHFT for this population would result in cost savings.

Table 17: Scenario Analysis Results

Scenarios	Parameter	Reference case	Pediatric OSA, 5-year BIA estimate[a,b]		Adult and pediatric (other chronic respiratory conditions), 5-year BIA estimate[a,b]	
			Minimum	Maximum	Minimum	Maximum
1–6	Pediatric population size	Table 2	−$328,247	−$46,844	$2.50 m	$2.60 m
7–8	Percent of population with pediatric OSA	80%–85%	−$205,589	−$169,502	$2.51 m	$2.58 m
9–14	Adult population size	Table 3	−$185,981	−$185,981	$0.69 m	$4.41 m
15–18	Year uptake reaches 100%	Year 1	−$144,447	−$36,969	$1.26 m	$2.17 m
19–20	Adherence to home-based HHHFT, pediatric OSA	62%	−$330,253	−$41,708	$2.55 m	$2.55 m
21–22	Reduction in outpatient visits, pediatric OSA	1.13–0.4 (Table 8)	−$231,469	−$140,493	$2.55 m	$2.55 m
23–24	Reduction in inpatient visits, pediatric OSA	0.76–0.19 (Table 8)	−$343,376	−$28,585	$2.55 m	$2.55 m
25–26	Proportion of patients continuing treatment for pediatric OSA	Table 8	−$209,658	−$162,303	$2.5 5m	$2.55 m
27–28	Outpatient facility costs	Table 8	−$202,426	−$125,654	$2.55 m	$2.55 m
29–30	Inpatient facility costs	Table 8 and Table 9	−$337,354	−$36,729	$2.55 m	$2.55 m
31–34	Home-based HHHFT monitoring costs	Table 8 and Table 9	−$333,824	−$38,137	$1.77 m	$3.33 m
35–36	HHHFT device costs	Table 7	−$209,691	−$162,270	$2.44 m	$2.66 m
37–38	HHHFT consumables costs	Table 7	−$244,736	−$127,225	$2.24 m	$2.86 m
39–44	Proportion of adults for whom home-based HHHFT resulted in earlier discharge	Table 9	−$185,981	−$185,981	$0.08 m	$3.14 m
45–50	Proportion of pediatric patients for whom home-based HHHFT resulted in earlier discharge	Table 9	−$185,981	−$185,981	$2.18 m	$2.64 m
51–60	Inpatient days avoided for adults whose earlier discharge was facilitated by home-based HHHFT	6 days	−$185,981	−$185,981	$0.20 m	$3.14 m
61–70	Inpatient days avoided for pediatric patients whose earlier discharge was facilitated by home-based HHHFT	6 days	−$185,981	−$185,981	$2.20 m	$2.64 m
71–72	Proportion of adults continuing to receive home-based HHHFT	Table 9	−$185,981	−$185,981	$2.21 m	$2.86 m
73–74	Proportion of pediatric patients continuing to receive home-based HHHFT	Table 9	−$185,981	−$185,981	$2.55 m	$2.57 m

Abbreviations: BIA, budget impact analysis; HHHFT, heated humidified high-flow therapy; OSA, obstructive sleep apnea.

[a] In 2024 Canadian dollars.

[b] Negative costs indicate savings.

Discussion

We conducted a budget impact analysis of publicly funding home-based HHHFT for pediatric OSA and for adults and pediatric patients with other chronic respiratory conditions who could benefit from home-based HHHFT after inpatient discharge. We estimate that over 5 years, over 900 people (164 with pediatric OSA, 719 adults, and 36 pediatric patients with other chronic respiratory conditions) would receive home-based HHHFT if publicly funded. We estimate that inpatient and outpatient visits would be reduced as a result of publicly funding home-based HHHFT for pediatric OSA, and that inpatient days would be reduced for adults and pediatric patients who could benefit from home-based HHHFT after inpatient discharge. We estimate that over 5 years, publicly funding home-based HHHFT for pediatric OSA would likely result in savings of $185,981 (ranging from a savings of $185,981 to a budget increase of $112,776, depending on the funding model). Publicly funding home-based HHHFT for adults and pediatric patients with other chronic respiratory conditions would likely require an additional $2.5 million (ranging from $2.5 million to $3.9 million, depending on the funding model). Scenario analyses found that the budget impact analysis was most sensitive to the following: a reduction in inpatient visits as a result of adherence to OSA treatment; the size of the adult population of interest; monitoring costs for home-based HHHFT; and the proportion of people for whom home-based HHHFT facilitated an earlier inpatient discharge.

We sourced the population of interest to resemble the use of home-based HHHFT in peer jurisdictions, taking into consideration the relative size of the Ontario population. We sourced the size of the population of interest for pediatric patients to resemble the uptake of home-based HHHFT in Saskatchewan. Access to home-based HHHFT in Saskatchewan requires a diagnosis from a pediatric respirologist, and differences in access to pediatric respirologists between Saskatchewan and Ontario introduce uncertainty about the size of the population of interest. We sourced the size of the adult population of interest to resemble the use of home-based HHHFT in the NHS Norfolk and Waveney Integrated Care System; we were unable to source Canadian estimates for this population. Although the NHS Norfolk and Waveney Integrated Care System covers 1.1 million people, health system and demographic differences between the United Kingdom and Ontario add further uncertainty to our estimate of the population size. We restricted the adult population to include only inpatients who would benefit from home-based HHHFT after discharge. This excluded individuals for whom home-based HHHFT could be added to the current standard care for COPD, and most of the evidence identified in the economic evidence review was for this excluded population. We did not consider this population in our analysis and given the large number of people with COPD in Ontario, publicly funding home-based HHHFT for this indication would likely result in a substantially larger budget impact than estimated.

Due to a lack of published effectiveness studies, we sourced model inputs from expert opinion and previously published noncomparative international studies. The budget impact model for pediatric OSA relied on effectiveness estimates sourced from Radhakrishnan et al.[35] To estimate reductions in resource utilization associated with adherence to OSA treatment, we required estimates of adherence to CPAP, which we sourced from expert opinion. Our estimates of resource utilization for adult and pediatric patients who would benefit from home-based HHHFT after discharge relied on the probability that access to home-based HHHFT would result in reduced time to discharge and fewer inpatient days. We sourced the probability that home-based HHHFT facilitated earlier discharge from Dolidon et al,[24] but it is unclear whether the results of a French noncomparative, retrospective study would be applicable to the Ontario context. During the development of our analysis, experts provided a wide range of responses about whether home-based HHHFT would result in earlier inpatient discharge. One clinical expert indicated that 100% of pediatric patients would have a shorter inpatient stay if home-based

HHHFT were publicly funded (Reshma Amin, MD, email communication, February 4, 2025). A scenario analysis in which all pediatric patients had a shorter inpatient stay with access to home-based HHHFT resulted in a decrease in the budget impact of $388,309. Another clinical expert indicated that the reference case model inputs likely underestimated the number of pediatric inpatient days avoided as a result of access to home-based HHHFT (Lesley Smith, RRT, email communication, February 6, 2025). These model parameters were highly uncertain, and the resulting estimated cost savings related to reduced resource utilization are also highly uncertain.

The results of the budget impact analysis are best understood in the context of early health economic modelling or early HTA. Early HTA can be defined as the methods used to inform stakeholders about the potential value of promising new health technologies that have limited clinical evidence.[42] Given the limited clinical evidence available to inform our model parameters for this analysis, we conducted scenario analyses in which the benefits of home-based HHHFT to facilitate inpatient discharge varied substantially (Table 17). In turn, this resulted in budget impact estimates for the adult and pediatric (other chronic respiratory conditions) model that ranged from $0.1 million to $4.4 million. For more precise estimates of budget impact, further research into the benefits of home-based HHHFT are required.

If home-based HHHFT were publicly funded, a number of potential funding approaches could be considered. These may include full public coverage, partial coverage, or other alternative models. However, the economic impact across these options did not show substantial variation. Expert consultations also highlighted the potential role of hospitals as key stakeholders in funding and implementation pathways. Since home-based HHHFT is already in use in the province through private insurance or out-of-pocket expenditures, we do not foresee significant barriers to broader public adoption. Any decisions regarding funding structure and program design would need to be further evaluated and defined by the Ministry of Health as part of the overall health care system strategy.

Some of the estimated savings related to resource utilization are unlikely to be realized as direct savings, and instead as reduced bed occupancy or reduced inpatient and outpatient wait times. Apart from home-based HHHFT monitoring, we did not consider any additional costs (e.g., air supply) that may be incurred as a result of access to home-based HHHFT. As well, because of limited data we did not consider the potential benefits of home-based HHHFT in terms of reducing the number of hospital readmissions or outpatient visits for adults and pediatric patients with other chronic respiratory conditions. The cost savings estimated in the pediatric OSA model are not a result of replacing CPAP therapy with home-based HHHFT; they are the result of providing an alternative treatment option for those who are nonadherent to CPAP therapy. This matches the current funding criteria for home-based HHHFT in Saskatchewan under the SAIL program.

We estimated that out-of-pocket costs would be reduced if home-based HHHFT were to be publicly funded. We did not consider additional out-of-pocket expenses that are likely to be incurred by patients and care partners, such as time off work because of an inpatient visit for a child with pediatric OSA. As well, those who require home-based HHHFT often have complex medical conditions that involve other out-of-pocket costs we did not consider (see Preferences and Values Evidence section). We also note that the 25% out-of-pocket costs in the 75% public funding model may make home-based HHHFT cost-prohibitive for some.

Strengths and Limitations

Our analysis has several strengths. To our knowledge, this is the first budget impact analysis of home-based HHHFT for pediatric OSA and for adults and pediatric patients with other chronic respiratory conditions who have been discharged from hospital. We sourced estimates of the size of the population of interest from peer jurisdictions and used Canadian inputs when feasible. However, our analysis is limited by the lack of available effectiveness estimates for home-based HHHFT. We relied on expert opinion, assumptions, and noncomparative retrospective studies to parameterize the budget impact model. Uncertainty related to the effectiveness of home-based HHHFT led to substantial uncertainty for the estimates of budget impact. We conducted a wide range of scenario analyses with extreme values, further highlighting the uncertainty of the budget impact of publicly funding home-based HHHFT.

Conclusions

We estimate that over 5 years, publicly funding home-based HHHFT for pediatric OSA would result in:

- 123 additional patients starting home-based HHHFT
- 127 fewer outpatient visits and 99 fewer inpatient visits
- Savings of $185,981 (ranging from savings of $185,981 to a budget increase of $112,776, depending on the funding model)

We estimate that over 5 years, publicly funding home-based HHHFT for adults and pediatric patients with other chronic respiratory conditions would result in:

- 566 additional patients starting home-based HHHFT
- 653 inpatient days avoided
- Additional costs of $2.5 million (ranging from $2.5 million to $3.9 million, depending on the funding model)

Due to the substantial uncertainty of several model parameters, these estimates of budget impact are highly uncertain.

Preferences and Values Evidence

Objective

The objective of this analysis was to explore the underlying values, needs, and priorities of adults and care partners of children who have lived experience of respiratory conditions and of home-based heated humidified high-flow therapy (HHHFT).

Background

Exploring patient preferences and values provides a unique source of information about people's experiences of a health condition and the health technologies or interventions used to manage or treat that health condition. It includes the impact of the condition and its treatment on the person with the health condition, their family and other care partners, and their personal environment. Engagement also provides insights into how a health condition is managed by the province's health system.

Information shared from lived experience can also identify gaps or limitations in published research (e.g., outcomes important to those with lived experience that are not reflected in the literature).[43-45] Additionally, lived experience can provide information and perspectives on the ethical and social values implications of health technologies or interventions.

Because the needs, preferences, priorities, and values of those with lived experience in Ontario are important to consider to understand the impact of a technology or intervention in people's lives, we may speak directly with people who live with a given health condition, including those with experience of the technology or intervention we are exploring.

For this analysis, we examined the preferences and values of adults and care partners of children who had lived experience of respiratory conditions via direct engagement through interviews.

Direct Patient Engagement

Methods

Partnership Plan

The partnership plan for this health technology assessment focused on consultation to examine the experiences of people with respiratory conditions and those of their families and other care partners. We engaged people via telephone interviews.

We used a qualitative interview, as this method of engagement allowed us to explore the meaning of central themes in the experiences of people with respiratory conditions, as well as those of their families and care partners.[46] The sensitive nature of exploring people's experiences of a health condition and their quality of life are other factors that support our choice of an interview methodology.

Participant Outreach

We used an approach called purposive sampling,[47-50] which involves actively reaching out to people with direct experience of the health condition and health technology or intervention being reviewed. We approached a variety of clinical experts to spread the word about this engagement activity and to contact people with respiratory conditions, family members, and care partners, including those with experience of home-based HHHFT.

Inclusion Criteria

We sought to speak with adults with respiratory conditions and with care partners of children who had lived experience of respiratory conditions. We included those with and without direct experience of home-based HHHFT.

Exclusion Criteria

We did not set exclusion criteria.

Participants

For this project, we spoke with 8 care partners of children with respiratory conditions. Seven participants had direct experience with home-based HHHFT, and 1 had had home-based HHHFT recommended for their child. We were unable to recruit adult participants.

Approach

At the beginning of the interview, we explained the role of our organization, the purpose of this health technology assessment, the risks of participation, and how participants' personal health information would be protected. We gave this information to participants both verbally and in a letter of information (Appendix 7). We then obtained participants' verbal consent before starting the interview. With participants' consent, we audio-recorded and then transcribed the interviews.

Interviews lasted approximately 30 to 60 minutes. Interviews were semistructured and consisted of a series of open-ended questions. Questions were based on a list developed by the Health Technology Assessment International Interest Group on Patient and Citizen Involvement in Health Technology Assessment.[51] Questions focused on the impact of respiratory conditions on their quality of life, their experiences with treatments to manage respiratory conditions, their experiences with home-based HHHFT, their perceptions of the benefits or limitations of home-based HHHFT, and the impact of the person's respiratory conditions and treatments on family members and care partners. See Appendix 8 for our interview guide.

Data Extraction and Analysis

We used a modified version of a grounded-theory methodology to analyze interview transcripts. The grounded-theory approach allowed us to organize and compare information on experiences across participants. This method consists of a repetitive process of obtaining, documenting, and analyzing responses while simultaneously collecting, analyzing, and comparing information.[52,53] We used the qualitative data analysis software program NVivo[54] to identify and interpret patterns in the data. The patterns we identified allowed us to highlight the impacts of respiratory conditions on the people we interviewed.

Results

Participants were parents of children with various respiratory conditions, including bilateral vocal cord paralysis, tracheomalacia, laryngomalacia, birth defects, genetic disorders, and sleep apnea. In certain cases, some children required a tracheostomy. These diagnoses were often identified at birth or during infancy. In addition to their respiratory conditions, most of these children also faced a range of other complex care needs, such as cognitive impairments, mobility challenges, and the use of feeding tubes. As a result, they required around-the-clock care to manage their conditions.

> *They did an MRI at a day old, and then a nonoptional tracheostomy at 2 days old. And then he got a feeding tube inserted when he was about a month old.*
>
> *I have a very medically compromised child with a very precarious airway … who requires 24/7 care and in-home nursing.*
>
> *[My child] has severe … hypotonia, and he has an abnormal brain.*

Participants discussed how their children experienced dry secretions, making it difficult to clear the airway and increasing the risk of complications. This was particularly highlighted by care partners of children with a tracheostomy: dry secretions can thicken and block the tracheostomy tube, obstructing airflow and worsening respiratory issues. Participants also noted that their children had breathing difficulties (such as laboured and distressing breathing) and sleep challenges (including disrupted sleep patterns and frequent night-time awakenings).

> *He wakes up in the morning and all his nasal passages, mouth, throat, everything, was so dry.*
>
> *You could see it because he had tracheal tugging. He was tugging in his ribs.*
>
> *She would turn grey all of a sudden and have problems breathing.*
>
> *He'd wake up upset and screaming and sounding like he's gasping for air.*

Impact on Day-to-Day Living

Participants described their caregiving responsibilities, highlighting physical demands such as providing sleep support, particularly for children with sleep apnea, in which parents would hold their child upright during sleep to help with breathing, often sacrificing their own rest. Those caring for children with a tracheostomy discussed the need to clear blockages or mucus buildup regularly. They also mentioned the challenges of assisting with personal care, such as bathing, and particularly the difficulty of getting their child in and out of the bathtub.

> *I had to hold him the entire time when he was sleeping.*
>
> *During the winter, in an hour we might be suctioning maybe 20 times, depending on if he's sick or how cold it is.*
>
> *I cannot bathe him because at this moment he's heavy for me to put in the bathtub, and it's dangerous.*

Participants also spoke about the care coordination required to manage, track, and clean medical equipment, as well as scheduling appointments with multiple specialists.

> *[My child] is seen by 15 different specialists.*
>
> *I manage a massive administrative load, managing all of our nurses and inventory ordering.*
>
> *I have it written down there on different schedules. Some things have to be replaced monthly, some every 2 months, and some every 3 months.*

Participants described hospital stays and visits to the emergency department as highly stressful, requiring substantial coordination and organization. Many noted that they couldn't visit local hospitals, instead having to go to the nearest pediatric hospital. This often required 2 care partners: 1 to monitor the child in the back seat and 1 to drive.

> *[My child] is outside of the scope of anywhere but SickKids [hospital]. But in traffic, we're 3 hours away. You can't drive with him on your own.*
>
> *There's no point in going to our local hospital. We'll be airlifted anyway.*
>
> *The pediatric surgeon that we were dealing with is in a different city … so we just decided to just put her in the car and drive down the highway as fast as we could.*

Participants also described the challenges they faced when their child was hospitalized, highlighting the difficulty of figuring out food options and the strain of driving back and forth between home and hospital. They also mentioned the inconvenience of personal care.

> *My husband had to go back and forth to bring food. You're spending more money in gas, parking, and time.*
>
> *I'm not showering at home, eating out all the time, driving all the time, being so exhausted.*

Several participants noted that they tried to avoid taking their child to the hospital, noting the precautions required due to their child's immunocompromised condition. As well, their child faced many difficulties in hospital, such as being checked repeatedly for vitals and the constant noise, which didn't allow them to rest.

> *He's severely immunocompromised. You've got to make sure he's got his private room.*
>
> *We try to avoid hospital stays because it's going to be worse being in the ER [emergency room] with other kids with contagious illnesses.*
>
> *They're being bugged every 2 to 3 hours for vitals, or somebody coming in to talk to us.*

Participants also discussed the considerable employment challenges they faced while looking after a child with complex care needs. Frequent medical appointments and hospital visits disrupted their work schedules, making it difficult to maintain steady employment and highlighting the need for flexible work hours. Such demands also limited career opportunities: many care partners were unable to explore new job prospects or advancements because of the need for health benefits and schedule flexibility. In many cases, one parent had to leave their job to provide full-time care because daycare options were not available that could meet their child's complex medical needs.

> *My husband misses a ton of work. He's used up all his vacation time and all his sick entitlement because we have all these hospital appointments.*
>
> *The [medical] benefits are worth more than my paycheque. [He] can't switch jobs.*
>
> *We're on just 1 income from my husband … I can't take [my child] to a daycare, and any person who watches him has to be trained on all of his equipment.*

Participants discussed the profound impact of their child's medical needs on their mental health, noting that the emotional strain of providing constant care often led to feelings of overwhelm and burnout. This was particularly true for those caring for a child with a tracheostomy because it requires continuous monitoring and management.

> *We are a community that is very underserviced and very burnt out.*
>
> *He doesn't know how to swallow properly, so we're constantly suctioning him because he's unable to manage his saliva. It's so stressful.*
>
> *I didn't sleep for months because I felt like he was not breathing properly.*

Participants shared the trauma they experienced during their child's diagnostic journey and the distress of facing unexpected medical interventions. They also expressed how the ongoing stress and worry about their child's future contributed to their depression and anxiety.

> *I was on suicide watch when [my child] was born because I knew this was a million-dollar child and I had no idea how I was going to pay for it.*
>
> *It was very traumatic. I'm still in therapy. I couldn't seek therapy at the time because I just didn't have time.*
>
> *They said that she had to have another surgery again … It definitely wasn't something that I was prepared to deal with.*

Participants highlighted other substantial impacts, including the financial strain of caring for a child with complex needs. They discussed the high costs associated with both medical and essential nonmedical items. For example, several participants mentioned the need to purchase a minivan to accommodate their child's medical equipment and to allow someone to sit in the back to monitor their child during transport.

We put about $50,000 last year through benefits for [my child's] medical stuff. I'm not even exaggerating.

We had to get a minivan … I had to be in the second row with [my child], and I couldn't fit my second child in the second row plus all the medical equipment.

His physical therapist is covered by insurance, but not the occupational therapist or the speech therapist.

Participants described how caring for a child with complex needs deeply affected family dynamics, shifting priorities and daily routines to focus on ensuring the child's survival. The impact extended beyond immediate care partners. Care partners also faced personal sacrifices, such as missing important events.

There was so much focus on [my child's] survival that was really hard on our family.

[My in-laws] ended up selling their house and moving closer to us.

My mom went into the hospital, and I'm the only one that can't be there because of our responsibilities.

Experience With Home-Based HHHFT

Participants discussed the factors that influenced their decision to use home-based HHHFT, noting that alternatives were often unsuitable. One key factor was insufficient humidification, which resulted in dry secretions.

I would have to do an emergency [tracheostomy] change for her as soon as she woke up in the morning, because she was so dry and the secretions in her airway were so thick it was difficult for her to breathe.

The other thing is that with the secretions, with the trach[eostomy], you don't want it to plug. And if the secretions dry out, they can plug.

Another factor was the use of masks with continuous positive airway pressure (CPAP) machines: some children found these difficult to tolerate, often pulling them off. In one instance, a participant mentioned having to sedate her child to prevent him from removing the mask. In another case, the care team noted that because of the child's cognitive impairment, the mask posed a suffocation risk because the child wouldn't be able to remove it in an emergency. A child with a cleft palate had issues with mask fit. Other concerns included the loud noise produced by the compressor, which was disruptive and raised worries about its effects on the child's hearing.

They had to heavily sedate him because he would try to rip off the mask.

Because of his cognitive delays, he could not remove a full CPAP mask by himself in an emergency.

Her nose was just too tiny, so it wasn't useful. After the nasal trumpet trial, one of our team members suggested using an Airvo [home-based HHHFT device].

Participants specifically highlighted their use of the home-based HHHFT device, noting its user-friendliness and ease of management. They appreciated how simple it was to operate. A key point many care partners emphasized was the ease of cleaning and disinfecting the device. Participants explained that the process of cleaning the home-based HHHFT device was straightforward.

In the morning, all I have to do is detach the mask, press a button on the machine, and it actually goes through its own disinfecting and drying cycle.

It was fairly easy. The settings were already on. They gave me instructions for if I ever needed to change the settings, so I felt comfortable managing that.

It's very easy to use day-to-day, and we had great training from [the hospital].

Use of home-based HHHFT varied among participants, depending on their child's specific needs and condition. Some used the device only overnight to provide support with respiratory difficulties during sleep; others relied on it 24/7 for continuous care. In all cases, the device was used especially during periods when their child was ill, such as with the flu or a cold, to offer additional respiratory support and help manage symptoms more effectively. The duration of use also varied widely: some families used the device for as little as 4 months, and others had been relying on it for over 10 years.

She was on it 24/7 until she was 3 months old. And then for another month, we used it only at night.

My daughter uses the MyAirvo [home-based HHHFT device] every single night, and then she's off it during the day unless she's sick, when we keep her on the MyAirvo 24/7.

It's been years and years, and we haven't had really any complications with the product. I would say over 10 years.

Impact of Home-Based HHHFT

Participants discussed the substantial positive impact of home-based HHHFT on the management of their child's symptoms. They noted that the device helped loosen secretions, making suctioning easier for children with a tracheostomy; the reduction in dryness provided greater comfort. Home-based HHHFT also improved their child's breathing, especially at night for those with sleep apnea.

That warm air was like day and night. As soon as she started using [home-based HHHFT], if I had to suction the secretions, they were loose, and she could continue breathing.

He wakes up and he isn't gasping … He coughs less during the day. He doesn't have the stridor sounds, which is like high-pitched wheezing.

He was able to sleep more comfortably than with the CPAP.

> *The Airvo [home-based HHHFT device] is exactly what she needed … It took all the work of breathing away from her, which is exactly what she needed to grow and thrive. The other options were causing more irritation.*

In addition to the positive effects on respiratory symptoms, participants reported noticeable improvements in other areas of their child's health, particularly in terms of weight gain and oral care, because the reduced dryness in the mouth seemed to lower the occurrence of cavities.

> *Because his mouth was so dry, he was more susceptible to cavities … Now that we're keeping his mouth more moist, his oral care has improved.*

> *He was able to breathe normally … It was that it was night and day and then a result of that was that his weight gain started to pick up.*

Participants noted that home-based HHHFT played a crucial role in their successful transition from hospital to home. They described how the intervention provided the necessary support manage their child's respiratory condition at home. They shared the immense benefits of being able to bring their child home from the hospital, noting how it provided a more supportive, comforting, and familiar environment for both their child and their family. One of the main benefits mentioned was relief from the constant interruptions that are common in hospital settings. Beyond the medical aspect, care partners expressed how emotional and rewarding it was to bring their child home, where they could experience a sense of stability and connection.

> *They had told us that we would be there for a minimum of 6 months. And I said I'm not staying in hospital with this machine that's plugged into the wall.*

> *He was using CPAP when in hospital for a while, and then eventually they tried the heated high-flow and it seemed to really work well for him, so we ended up going home with the heated high-flow.*

> *Without it [home-based HHHFT], we wouldn't have even been able to go home when we did.*

Some participants shared the developmental progress they observed in their children after using home-based HHHFT, attributing these improvements to better sleep and a more comfortable home environment. They mentioned that their infants were able to reach milestones more easily and were more awake and engaged during the day. Such increased alertness was particularly beneficial for children who needed to complete exercises prescribed by their occupational therapists. As well, the improved sleep contributed to better mood and daytime alertness; many participants noticed that their children appeared happier overall.

> *Once he had the Airvo [home-based HHHFT device], his alertness during the time that he was awake was a lot better, and he was much more active.*

> *She was so far behind on milestones … And it's because she's been restricted to [the hospital] her whole life. When we were home, we were able to work on keeping her caught up.*

When we left the hospital, he couldn't hold his head up ... He couldn't do anything like he can now ... he's like a totally different kid now.

We could do a little bit more physical activity, which he needs due to his occupational physiotherapy.

She was so much happier … She could be on the floor. She could be on her swing. She could do everything a normal baby would do.

Participants emphasized that home-based HHHFT was a highly effective tool for managing their child's symptoms at home, substantially reducing the need for frequent hospital visits and specialist appointments. Many care partners noted that the device helped maintain their child's respiratory stability, even during times of illness, such as when their child had the flu or a cold. For care partners, fewer hospital and specialist visits brought a sense of relief and control, knowing they could manage their child's symptoms effectively at home.

It has saved us lots of trips back and forth, gas and time and money to go to the ear, nose, and throat specialist.

MyAirvo [home-based HHHFT device] allows for humidity to be given; it allows for secretions to keep moving while also administering the oxygen, which is really important because it keeps your child out of the hospital.

It has saved us lots of trips to the hospital when she was plugged in, couldn't breathe properly.

They have a 24/7 emergency number that we can call if we have any questions, concerns … The frequency of our having to call that number has decreased.

The improved symptom management substantially alleviated the burden on care partners. Care partners found they were able to manage other responsibilities such as household errands. Parents were also able to devote more time to caring for their other children. This sense of balance helped reduce their feelings of overwhelm.

I think it made it easier for us – in particular when he was napping. I didn't have to hold him all the time.

I'm actually able to leave him watching his cartoons and I'm still in the room, but I can do stuff like fold my laundry.

It allowed me to spend a bit more time with my firstborn son.

Furthermore, care partners reported experiencing better sleep because they no longer had to constantly wake up during the night to address their child's symptoms.

She sleeps for longer without those alarms going off at night, so it's giving me more sleep.

I can easily remove the secretions, and she stays asleep … It's giving me a big sense of relief, peace of mind, and more sleep.

Barriers to Accessing Home-Based HHHFT

The high initial cost of home-based HHHFT was a major access barrier for families. Participants shared the financial strain of caring for a child with complex medical needs, including out-of-pocket expenses and being a single-income household.

Where should we put the money? In an Airvo [home-based HHHFT device], or in a van that we can mobilize him?

[Home-based HHHFT] was a huge hit on our budget. We had to dip into savings, borrowed from family. When you're doing that, that means you're rock-bottom as it is.

Do you know how that feels when you can't afford something, but your child absolutely needs it?

It's like his supplies every month. I think I spend $1,000 a month just for him to have the Airvo machine [home-based HHHFT device] at home.

Participants whose insurance covered home-based HHHFT described the cumbersome process, including having to make up-front payments and seek reimbursement, as well as providing additional documentation.

The letter from the insurance company said it wasn't guaranteed … so the [medical supply] company said no, we would rather just deal with you. You pay us first and seek reimbursement.

It's not easy to access things through insurance … We needed to provide an extra letter through complex care.

A couple participants who rented the home-based HHHFT device mentioned that the monthly rental cost was not a financial burden because their insurance covered part of the expense. However, they highlighted that the ongoing costs of replacement parts and other consumables were a substantial financial strain.

It was $280 a month … We were getting almost $200 covered from our insurance. The rental just covered the tubing and stuff, not the nose prongs, for example, and we still have to pay for the distilled water.

We just paid $300 a month for the rental. The supplies were a lot more expensive.

In one instance, the participant mentioned that their care team was unaware that renting could be an alternative to purchasing home-based HHHFT.

Originally, we were told that we couldn't rent one – we had to buy one. But another RT [respiratory therapist] told us where to call to rent one, and that was the golden ticket.

Discussion

Direct engagement with participants allowed for a deeper understanding of patient values and preferences, as well as the various factors that influence decision-making about treatment options. This approach also provided valuable insights into the impact of home-based HHHFT, particularly from parents of children for whom alternative treatments were unsuitable. For example, some children were unable to tolerate the use of masks, and others experienced issues with insufficient humidification, both of which made home-based HHHFT a more favourable choice. However, our study did have limitations. Our sample size was relatively small, and this may have affected the generalizability of the findings. As well, we had no representation from the adult population.

Conclusions

All participants we interviewed saw home-based HHHFT as highly favourable. They emphasized its substantial positive effects on managing respiratory symptoms, enhancing their child's overall quality of life and reducing the number of hospital and specialist visits. For many, home-based HHHFT proved to be an essential treatment option for their child, especially when alternative therapies were not suitable or effective. However, participants also pointed out that the treatment came with important barriers – particularly the initial and ongoing costs, which could pose challenges for families. Participants stressed that equitable access to home-based HHHFT should be a priority in its implementation.

Conclusions of the Health Technology Assessment

We did not find any studies that specifically evaluated the effectiveness of home-based HHHFT versus hospital-based HHHFT for the treatment of respiratory conditions in adults or children, or that compared home-based HHHFT with other home-based oxygen therapies or no treatment for the treatment of obstructive sleep apnea in children. However, we did identify studies conducted in hospital settings or in populations receiving alternative treatments at home that demonstrated clinical benefits of HHHFT, including improved oxygenation, reduced respiratory rates, decreased severity of obstructive sleep apnea, and fewer acute exacerbations of chronic obstructive pulmonary disease. As well, HHHFT is used widely in Ontario hospitals, is generally considered to be clinically effective, and is standard care in such settings.

Our economic evidence review did not identify any cost-effectiveness studies that were directly applicable to our research questions. As a result, the cost-effectiveness of home-based HHHFT is unknown. We estimate that publicly funding home-based HHHFT in Ontario for children with obstructive sleep apnea would lead to cost savings of $185,981 over the next 5 years. Savings were due to an estimated 99 fewer inpatient visits and 127 fewer outpatient visits. We estimate that publicly funding home-based HHHFT in Ontario for adults and children with other respiratory conditions would cost an additional $2.5 million over the next 5 years. We estimate that publicly funding home-based HHHFT would result in 653 inpatient days avoided. Due to data limitations, these budget impact estimates are highly uncertain.

All participants we interviewed viewed home-based HHHFT very positively. They highlighted its substantial benefits in managing respiratory symptoms, improving their child's overall quality of life and reducing the number of hospital and specialist visits. For many, home-based HHHFT was an essential treatment option, especially when other therapies were ineffective or unsuitable. However, participants noted that a key challenge to accessing home-based HHHFT was the initial and ongoing costs.

Abbreviations

BiPAP: bilevel positive airway pressure

COPD: chronic obstructive pulmonary disease

CPAP: continuous positive airway pressure

DNI: do not intubate

DNR: do not resuscitate

FiO_2: fraction of inspired oxygen

GRADE: Grading of Recommendations Assessment, Development, and Evaluation

HHHFT: heated humidified high flow therapy

ICER: incremental cost-effectiveness ratio

ILD: interstitial lung disease

IPF: idiopathic pulmonary fibrosis

LTOT: long-term oxygen therapy

NHS: National Health Service

NICE: National Institute for Health and Care Excellence

OSA: obstructive sleep apnea

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-analyses

QALY: quality-adjusted life-year

RCT: randomized controlled trial

SAIL: Saskatchewan Aids to Independent Living

Glossary

Budget impact analysis: A budget impact analysis estimates the financial impact of adopting a new health care intervention on the current budget (i.e., the affordability of the new intervention). It is based on predictions of how changes in the intervention mix will impact the level of health care spending for a specific population. Budget impact analyses are typically conducted for a short-term period (e.g., 5 years). The budget impact, sometimes referred to as the net budget impact, is the estimated cost difference between the current scenario (i.e., the anticipated amount of spending for a specific population without using the new intervention) and the new scenario (i.e., the anticipated amount of spending for a specific population following the introduction of the new intervention).

Cost-effective: A health care intervention is considered cost-effective when it provides additional benefits, compared with relevant alternatives, at an additional cost that is acceptable to a decision-maker based on the maximum willingness-to-pay value.

Cost–utility analysis: A cost–utility analysis is a type of economic evaluation used to compare the benefits of two or more health care interventions with their costs. The benefits are measured using quality-adjusted life-years, which capture both the quality and quantity of life. In a cost–utility analysis, the main outcome measure is the incremental cost per quality-adjusted life-year gained.

EQ-5D: The EQ-5D is a generic health-related quality-of-life classification system widely used in clinical studies. In economic evaluations, it is used as an indirect method of obtaining health state preferences (i.e., utility values). The EQ-5D questionnaire consists of five questions relating to different domains of quality of life: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. For each domain, there are three response options: no problems, some problems, or severe problems. A newer instrument, the EQ-5D-5L, includes five response options for each domain. A scoring table is used to convert EQ-5D scores to utility values.

Equity: Unlike the notion of equality, equity is not about treating everyone the same way.[55] It denotes fairness and justice in process and in results. Equitable outcomes often require differential treatment and resource redistribution to achieve a level playing field among all individuals and communities. This requires recognizing and addressing barriers to opportunities for all to thrive in our society.

Health-related quality of life: Health-related quality of life is a measure of the impact of a health care intervention on a person's health. It includes the dimensions of physiology, function, social life, cognition, emotions, sleep and rest, energy and vitality, health perception, and general life satisfaction.

Health state: A health state is a particular status of health (e.g., sick, well, dead). A health state is associated with some amount of benefit and may be associated with specific costs. Benefit is captured through individual or societal preferences for the time spent in each health state and is expressed in quality-adjusted weights called utility values. In a Markov model, a finite number of mutually exclusive health states are used to represent discrete states of health.

Incremental cost-effectiveness ratio (ICER): The incremental cost-effectiveness ratio (ICER) is a summary measure that indicates, for a given health care intervention, how much more a health care consumer must pay to get an additional unit of benefit relative to an alternative intervention. It is obtained by dividing the incremental cost by the incremental effectiveness. Incremental cost-

effectiveness ratios are typically presented as the cost per life-year gained or the cost per quality-adjusted life-year gained.

Markov model: A Markov model is a type of decision-analytic model used in economic evaluations to estimate the costs and health outcomes (e.g., quality-adjusted life-years gained) associated with using a particular health care intervention. Markov models are useful for clinical problems that involve events of interest that may recur over time (e.g., stroke). A Markov model consists of mutually exclusive, exhaustive health states. Patients remain in a given health state for a certain period of time before moving to another health state based on transition probabilities. The health states and events modelled may be associated with specific costs and health outcomes.

Quality-adjusted life-year (QALY): The quality-adjusted life-year (QALY) is a generic health outcome measure commonly used in cost–utility analyses to reflect the quantity and quality of life-years lived. The life-years lived are adjusted for quality of life using individual or societal preferences (i.e., utility values) for being in a particular health state. One year of perfect health is represented by 1 quality-adjusted life-year.

Reference case: The reference case is a preferred set of methods and principles that provide the guidelines for economic evaluations. Its purpose is to standardize the approach of conducting and reporting economic evaluations, so that results can be compared across studies.

Scenario analysis: A scenario analysis is used to explore uncertainty in the results of an economic evaluation. It is done by observing the potential impact of different scenarios on the cost-effectiveness of a health care intervention. Scenario analyses involve varying structural assumptions from the reference case.

Time horizon: In economic evaluations, the time horizon is the time frame over which costs and benefits are examined and calculated. The relevant time horizon is chosen based on the nature of the disease and health care intervention being assessed, as well as the purpose of the analysis. For instance, a lifetime horizon would be chosen to capture the long-term health and cost consequences over a patient's lifetime.

Uptake rate: In instances where two technologies are being compared, the uptake rate is the rate at which a new technology is adopted. When a new technology is adopted, it may be used in addition to an existing technology, or it may replace an existing technology.

Utility: A utility is a value that represents a person's preference for various health states. Typically, utility values are anchored at 0 (death) and 1 (perfect health). In some scoring systems, a negative utility value indicates a state of health valued as being worse than death. Utility values can be aggregated over time to derive quality-adjusted life-years, a common outcome measure in economic evaluations.

Willingness-to-pay value: A willingness-to-pay value is the monetary value a health care consumer is willing to pay for added health benefits. When conducting a cost–utility analysis, the willingness-to-pay value represents the cost a consumer is willing to pay for an additional quality-adjusted life-year. If the incremental cost-effectiveness ratio is less than the willingness-to-pay value, the health care intervention of interest is considered cost-effective. If the incremental cost-effectiveness ratio is more than the willingness-to-pay value, the intervention is considered not to be cost-effective.

Appendices

Appendix 1: Literature Search Strategies

Clinical Evidence Search

Database:
EBM Reviews - Cochrane Central Register of Controlled Trials <August 2024>
EBM Reviews - Cochrane Database of Systematic Reviews <2005 to September 5, 2024>
EBM Reviews - NHS Economic Evaluation Database <1st Quarter 2016>
Ovid MEDLINE(R) ALL <1946 to September 10, 2024>

#	Query	Results from 11 Sep 2024
1	exp Community Health Services/	360,821
2	Home Nursing/	9,009
3	(home or home care or house* or (communit* adj3 care) or domiciliar*).ti,ab,kf.	630,539
4	(Hospice* or palliat* or "end of life" or convalescen*).ti,ab,kf.	158,349
5	(((senior or "old age" or elder* or aged or retirement) adj3 (care or home)) or "long term care").ti,ab,kf.	56,461
6	or/1-5	1,095,490
7	Oxygen Inhalation Therapy/	18,116
8	Oxygen/	190,284
9	or/7-8	203,230
10	Cannula/	2,555
11	Tracheostomy/	9,434
12	10 or 11	11,965
13	9 and 12	1,444
14	(("high flow" or highflow or "high frequency" or humid*) adj3 (can?ul* or prong*)).ti,ab,kf.	4,344
15	(("high flow" or highflow or "high frequency") adj3 (nasal* or transnasal* or intranasal*)).ti,ab,kf.	6,098
16	(("high flow" or highflow or "high frequency" or humid*) adj3 oxygen*).ti,ab,kf.	5,002
17	(transnasal adj3 (insufflation* or humid*)).ti,ab,kf.	218
18	(TNI or HHFCO or HHFT or HFNC or HFNT or HFNO or HHHFNC or HFNP or HFT).ti,ab,kf.	5,790
19	or/13-18	11,799
20	6 and 19	500
21	(("high flow" or highflow or "high frequency") adj3 (tracheostom* or tracheotom*)).ti,ab,kf.	36
22	(myairvo* or my airvo* or optiflow*).ti,ab,kf.	251
23	or/20-22	767
24	exp Animals/ not Humans/	5,260,902
25	23 not 24	763
26	Case Reports/ or Comment.pt. or Editorial.pt. or (Letter not (Letter and Randomized Controlled Trial)).pt. or Congress.pt.	4,555,155
27	25 not 26	662
28	limit 27 to english language [Limit not valid in CDSR; records were retained]	638

29	28 use medall,coch,cleed	314
30	((Letter not (Letter and Randomized Controlled Trial)) or Conference proceeding or Editorial or Comment or Trial registry record).pt.	3,074,504
31	28 not 30	377
32	31 use cctr	63
33	29 or 32	377
34	33 use medall	314
35	33 use cctr	63
36	remove duplicates from 33	328
37	36 use medall	312
38	36 use cctr	16

Economic Evidence Search

Database:
EBM Reviews - Cochrane Central Register of Controlled Trials <August 2024>
EBM Reviews - Cochrane Database of Systematic Reviews <2005 to September 5, 2024>
EBM Reviews - NHS Economic Evaluation Database <1st Quarter 2016>
Ovid MEDLINE(R) ALL <1946 to September 17, 2024>

#	Query	Results from 18 Sep 2024
1	exp Community Health Services/	361,049
2	Home Nursing/	9,009
3	(home or home care or house* or (communit* adj3 care) or domiciliar*).ti,ab,kf.	631,207
4	(Hospice* or palliat* or "end of life" or convalescen*).ti,ab,kf.	158,532
5	(((senior or "old age" or elder* or aged or retirement) adj3 (care or home)) or "long term care").ti,ab,kf.	56,513
6	or/1-5	1,096,528
7	Oxygen Inhalation Therapy/	18,126
8	Oxygen/	190,331
9	or/7-8	203,284
10	Cannula/	2,554
11	Tracheostomy/	9,435
12	10 or 11	11,965
13	9 and 12	1,445
14	(("high flow" or highflow or "high frequency" or humid*) adj3 (can?ul* or prong*)).ti,ab,kf.	4,349
15	(("high flow" or highflow or "high frequency") adj3 (nasal* or transnasal* or intranasal*)).ti,ab,kf.	6,105
16	(("high flow" or highflow or "high frequency" or humid*) adj3 oxygen*).ti,ab,kf.	5,005
17	(transnasal adj3 (insufflation* or humid*)).ti,ab,kf.	218
18	(TNI or HHFCO or HHFT or HFNC or HFNT or HFNO or HHHFNC or HFNP or HFT).ti,ab,kf.	5,797
19	or/13-18	11,813
20	6 and 19	501
21	(("high flow" or highflow or "high frequency") adj3 (tracheostom* or tracheotom*)).ti,ab,kf.	37
22	(myairvo* or my airvo* or optiflow*).ti,ab,kf.	251
23	or/20-22	769

24 exp Animals/ not Humans/ 5,263,503
25 23 not 24 765
26 Case Reports/ or Comment.pt. or Editorial.pt. or (Letter not (Letter and Randomized Controlled Trial)).pt. or Congress.pt. 4,560,359
27 25 not 26 662
28 limit 27 to english language [Limit not valid in CDSR; records were retained] 638
29 28 use medall,coch,cleed 314
30 ((Letter not (Letter and Randomized Controlled Trial)) or Conference proceeding or Editorial or Comment or Trial registry record).pt. 3,077,579
31 28 not 30 377
32 31 use cctr 63
33 29 or 32 377
34 33 use coch,cleed 0
35 economics/ 27,610
36 economics, medical/ or economics, pharmaceutical/ or exp economics, hospital/ or economics, nursing/ or economics, dental/ 46,269
37 economics.fs. 477,059
38 (econom* or price or prices or pricing or priced or discount* or expenditure* or budget* or pharmacoeconomic* or pharmaco-economic*).ti,ab,kf. 662,159
39 exp "costs and cost analysis"/ 304,514
40 (cost or costs or costing or costly).ti. 167,408
41 cost effective*.ti,ab,kf. 236,713
42 (cost* adj2 (util* or efficacy* or benefit* or minimi* or analy* or saving* or estimate* or allocation or control or sharing or instrument* or technolog* or increment*)).ab,kf. 146,045
43 models, economic/ 13,112
44 markov chains/ or monte carlo method/ 49,843
45 (decision adj1 (tree* or analy* or model*)).ti,ab,kf. 32,916
46 (markov or markow or monte carlo).ti,ab,kf. 92,213
47 quality-adjusted life years/ 22,447
48 (QOLY or QOLYs or HRQOL or HRQOLs or QALY or QALYs or QALE or QALEs).ti,ab,kf. 54,307
49 ((adjusted adj1 (quality or life)) or (willing* adj2 pay) or sensitivity analys*s).ti,ab,kf. 101,341
50 or/35-49 1,511,145
51 33 and 50 35
52 51 use medall 27
53 51 use cctr 8
54 51 use coch 0
55 51 use cleed 0
56 remove duplicates from 51 28

Grey Literature Search

Performed on: October 1–7, 2024

Websites searched: Alberta Health Evidence Reviews, BC Health Technology Assessments, Canada's Drug Agency (CDA), Institut national d'excellence en santé et en services sociaux (INESSS), Institute of Health Economics (IHE), University Of Calgary Health Technology Assessment Unit, Ontario Health

Technology Assessment Committee (OHTAC), McGill University Health Centre Health Technology Assessment Unit, Centre Hospitalier de l'Universite de Quebec-Universite Laval, Contextualized Health Research Synthesis Program of Newfoundland (CHRSP), Health Canada Medical Device Database, International HTA Database (INAHTA), Agency for Healthcare Research and Quality (AHRQ) Evidence-based Practice Centers, Centers for Medicare & Medicaid Services Technology Assessments, Veterans Affairs Health Services Research and Development, Institute for Clinical and Economic Review, Oregon Health Authority Health Evidence Review Commission, Washington State Health Care Authority Health Technology Reviews, National Institute for Health and Care Excellence (NICE), National Health Service England (NHS), Healthcare Improvement Scotland, Health Technology Wales, Ireland Health Information and Quality Authority Health Technology Assessments, Adelaide Health Technology Assessment, Australian Government Medical Services Advisory Committee, Monash Health Centre for Clinical Effectiveness, The Sax Institute, Australian Government Department of Health and Aged Care, Australian Safety and Efficacy Register of New Interventional Procedures - Surgical (ASERNIP-S), Pharmac, Italian National Agency for Regional Health Services (Aegnas), Belgian Health Care Knowledge Centre, Ludwig Boltzmann Institute for Health Technology Assessment (Austria), The Regional Health Technology Assessment Centre (HTA-centrum), Swedish Agency for Health Technology Assessment and Assessment of Social Services, Norwegian Institute of Public Health - Health Technology Assessments, The Danish Health Technology Council, Ministry of Health Malaysia - Health Technology Assessment Section, Tuft's Cost-Effectiveness Analysis Registry, Sick Kids PEDE Database, PROSPERO, EUnetHTA, clinicaltrials.gov

Keywords used: home; house; community care; long term care; domiciliary; "high flow"; "high frequency"; humid*; cannula; prong; nasal; intranasal; transnasal; transnasal insufflation; oxygen; TNI; HHFCO; HHFT; HFNC; HFNO; HHHFNC; HFNP; HFT; tracheostomy; tracheotomy; myairvo; myairvo2; my airvo; optiflow; débit élevé; haute fréquence; humidifié; canule; l'oxygène; trachéotomie; trachéostomie

Clinical results (included in PRISMA): 3

Economic results (included in PRISMA): 3

Ongoing HTAs (PROSPERO/EUnetHTA): 29

Ongoing clinical trials: 22

Appendix 2: Selected Excluded Studies – Clinical Evidence

For transparency, we provide a list of studies that readers might have expected to see but that did not meet the inclusion criteria, along with the primary reason for exclusion.

Citation	Primary reason for exclusion
Ammadeo A, Khirani S, Frapin A, Teng T, Griffon L, Fauroux B. High-flow nasal cannula for children not compliant with continuous positive airway pressure. Sleep Med. 2019;63:24-8.	Wrong study design (no comparator)
Crimi C, Nolasco S, Campisi R, Nigro M, Impellizeri P, Cortegiani A, et al. J Clin Med. 2022;11(24): 7323.	Wrong comparator
Dolidon S, Dupuis J, Valencia LM, Salaun, M, Thiberville L, Muir J, et al. Characteristics and outcome of patients set up on high-flow oxygen therapy at home. Ther Adv Respir Dis. 2019;13:1-8.	Wrong study design
Ehrlich S, Golan Tripto I, Lavie M, Cahal M, Shonfeld T, Prais D, et al. High flow nasal cannula therapy in the pediatric home setting. Pediatr Pulmonol. 2023;58(3):941-8.	Wrong study design
Fishman H, Al-Shamli N, Sunkonkit K, Maguire B, Selvadurai S, Baker A, et al. Heated humidified high flow nasal cannula therapy in children with obstructive sleep apnea: a randomized cross-over trial. Sleep Med. 2023;107:81-8.	Wrong setting (therapy done in the hospital, not home)
Ignatiuk D, Schaer B, McGinley B. High flow nasal cannula treatment for obstructive sleep apnea in infants and young children. Pediatr Pulmonol. 2020;55(10):2791-8.	Wrong study design (no comparator)
Nagata K, Kikuchi T, Horie T, Shiraki A, Kitajima T, Kadowaki T, et al. Domiciliary high-flow nasal cannula oxygen therapy for patients with stable hypercapnic chronic obstructive pulmonary disease: a multicenter randomized crossover trial. Ann Am Thorac Soc. 2018;15(4):432-9.	Wrong comparator
Pitre T, Abbasi S, Su J, Mah J, Zeraatkar D. Home high flow nasal cannula for chronic hypercapnic respiratory failure in COPD: a systematic review and meta-analysis. Respir Med. 2023;219:107420.	Wrong comparator
Rea H, McAuley S, Jayaram L, Garrett J, Hockey H, Storey L, et al. The clinical utility of long-term humidification therapy in chronic airway disease. Respir Med. 2010;104(4):525-33.	Wrong comparator
Ruangsomboon O, Dorongthom T, Chakorn T, Monsomboon A, Praphruetkit N, Limsuwat C, et al. High-flow nasal cannula versus conventional oxygen therapy in relieving dyspnea in emergency palliative patients with do-not-intubate status: a randomized crossover study. Ann Emerg Med. 2020;75(5):615-26.	Wrong setting
Stripoli T, Spadaro S, Di Mussi R, Volta CA, Trerotoli P, De Carlo F, et al. High-flow oxygen therapy in tracheostomized patients at high risk of weaning failure. Ann Intens Care. 2019;9(1):4.	Wrong setting
Storgaard LH, Hockey H-U, Laursen BS, Weinreich UM. Long-term effects of oxygen-enriched high-flow nasal cannula treatment in COPD patients with chronic hypoxemic respiratory failure. Int J Chron Obstruct Pulmon Dis. 2018;13:1195-205.	Wromg comparator
Wilson ME, Mittal A, Dobler CC, Curtis JR, Majzoub AM, Soleimani J, et al. High-flow nasal cannula oxygen in patients with acute respiratory failure and do-not-intubate or do-not-resuscitate orders: a systematic review. J Hosp Med. 2020;15(2):101-6.	Wrong setting
Yang H, Huang D, Luo J, Liang Z, Li J. The use of high-flow nasal cannula in patients with chronic obstructive pulmonary disease under exacerbation and stable phases: a systematic review and meta-analysis. Heart Lung. 2023;60:116-26.	Wrong comparator

Appendix 3: Selected Excluded Studies – Economic Evidence

For transparency, we provide a list of studies that readers might have expected to see but that did not meet the inclusion criteria, along with the primary reason for exclusion.

Citation	Primary reason for exclusion
Eaton Turner E, Jenks M. Cost-effectiveness analysis of the use of high-flow oxygen through nasal cannula in intensive care units in NHS England. Expert Rev Pharmacoecon Outcomes Res. 2018;18(3):331-7.	Intervention (inpatient use of HHHFT)
Huang L, Manley BJ, Arnolda GRB, Owen LS, Wright IMR, Foster JP, et al. Cost-effectiveness of nasal high flow versus CPAP for newborn infants in special-care nurseries. Pediatrics. 2021;148(2).	Intervention (inpatient use of HHHFT)
Fernandez-Alvarez JR, Gandhi RS, Amess P, Mahoney L, Watkins R, Rabe H. Heated humidified high-flow nasal cannula versus low-flow nasal cannula as weaning mode from nasal CPAP in infants ≤28 weeks of gestation. Eur J Pediatr. 2014;173(1):93-8.	Intervention (inpatient use of HHHFT)

Abbreviation: HHHFT, heated humidified high-flow therapy.

Appendix 4: Results of Applicability Checklists for Studies Included in the Economic Literature Review

Table A1: Assessment of the Applicability of Studies Evaluating the Cost-Effectiveness of Home-Based HHHFT

Author, year, country	Is the study population appropriate for the review question?	Are the interventions appropriate for the review question?	Is the system in which the study was conducted sufficiently like the current Ontario context?	Is the perspective of the costs appropriate for the review question (e.g., Canadian public payer)?	Is the perspective of the outcomes appropriate for the review question?	Are all future costs and outcomes discounted appropriately (as per current CDA guidelines)?	Are QALYs derived using CDA's preferred methods, or is an appropriate social care–related equivalent used as an outcome? (If not, describe rationale and outcomes used in line with the analytical perspective taken)	Overall judgment[a]
Milne et al, 2014,[31] New Zealand	Partially; relevant to adult research question	Yes	Partially	Partially	Yes	NA, 1-year time horizon	Yes	Partially applicable
Dolidon et al, 2019,[24] France	Partially; relevant to adult research question	Yes	Partially	Partially	NA, budget impact analysis	No	NA, cost-consequence	Partially applicable
Sørensen et al, 2021,[30] Denmark	Partially; relevant to adult research question	Yes	Partially	Partially	Yes	NA, 1-year time horizon	Yes	Partially applicable
Milne et al, 2022,[28] New Zealand	Partially; relevant to adult research question	Yes	Partially	Partially	NA, budget impact analysis	NA, budget impact analysis	NA, budget impact analysis	Partially applicable
Groessl et al, 2023,[29] United States	Partially; relevant to adult research question	Yes	No	No	Yes	Yes	Yes	Partially applicable

Note: Response options for all items were "yes," "partially," "no," "unclear," and "NA" (not applicable).

Abbreviations: CDA, Canada's Drug Agency; HHHFT, heated humidified high-flow therapy; NA, not applicable; QALY, quality-adjusted life-year.

[a] Overall judgment may be "directly applicable," "partially applicable," or "not applicable."

Appendix 5: Budget Impact Analysis Inputs

Pediatric Population

We sourced the pediatric population to resemble the uptake of home-based heated humidified high-flow therapy (HHHFT) in Saskatchewan, where home-based HHHFT is publicly funded for pediatric patients. We sourced the number of home-based HHHFT devices provided under the Saskatchewan Aids to Independent Living (SAIL) program from 2019 to 2023 (Saskatchewan Ministry of Health, September 11, 2024, email communication). Given the reported 5-year lifespan of the device (based on Groessl et al[29]), we assumed that each device provided by the SAIL program would correspond to a new patient. We divided the number of patients by the Saskatchewan population aged 0 to 17 (sourced from Statistics Canada[56]) to obtain the number of home-based HHHFT devices provided per 100,000 people aged less than 18 years. The rate per 100,000 people was consistent from 2019 to 2023, and we took an average for those 5 years to estimate a rate of 1.11 devices provided per 100,000 people aged less than 18 years. We then matched this rate with population projections from the Ontario Ministry of Finance for people aged less than 18 years.[57] Experts indicated an expected growth rate in the number of pediatric cases of 10% per year. We assumed that 80% to 85% of HHHFT prescriptions would be for sleep disordered breathing, and 15% to 20% would be for other chronic respiratory conditions, such as tracheostomies. We selected the midpoint of these 2 ranges for our reference case and used extreme values in scenario analyses. The estimated population is provided in Table A2.

Table A2: Pediatric Population Estimate

Population	Year 1	Year 2	Year 3	Year 4	Year 5	Source
Projected Ontario population aged < 18 years	2,884,226	2,918,640	2,954,710	2,994,407	3,037,678	Ontario Ministry of Finance[57]
Estimated pediatric population using home-based HHHFT (1.11 device per 100,000 people) and assuming a 10% growth rate (expert opinion)	32	35	40	44	49	Calculated based on data from the Saskatchewan SAIL program[10]
Sleep disordered breathing (80%–85%)	27	29	33	37	40	Calculated[a]
Other chronic respiratory conditions (15%–20%)	6	6	7	8	9	Calculated[b]

Abbreviations: HHHFT, heated humidified high-flow therapy; SAIL, Saskatchewan Aids to Independent Living.
[a] Calculated using the midpoint percentage for sleep disordered breathing (82.5%).
[b] Calculated using the midpoint of other respiratory conditions (17.5%).

Adult Population

We sourced the adult population to resemble the uptake of home-based HHHFT in the Norfolk and Waveney Integrated Care System in the United Kingdom. In that region, approximately 10 to 12 patients per year receive home-based HHHFT (Norfolk and Waveney Integrated Care Board, freedom of information response, October 30, 2024). We sourced an age range of 56 to 74 years for adults receiving home-based HHHFT from Dolidon et al.[24] Using UK population estimates, we estimated that of the 1.1 million people covered by the Norfolk and Waveney Integrated Care System, 272,184 would be aged 56 to 74.[33,58] Using these 2 inputs, we estimated an incidence for home-based HHHFT use of 4.04 per 100,000 people aged 56 to 74. We then sourced estimates of the number of people in Ontario

aged 56 to 74 years from Ontario Ministry of Finance population projections.[57] We used these values to estimate the number of adult patients receiving home-based HHHFT. We assumed that 80% of people would receive home-based HHHFT via tracheostomy. The estimated population is provided in Table A3.

Table A3: Adult Population Estimate

Population	Year 1	Year 2	Year 3	Year 4	Year 5	Source
Projected Ontario population aged 56 to 74 years	3,505,722	3,536,015	3,563,238	3,580,042	3,587,556	Ontario Ministry of Finance[57]
Average incidence of home-based HHHFT in the Norfolk and Waveney Integrated Care System per 100,000 individuals aged 56 to 74 years	4.04	4.04	4.04	4.04	4.04	Norfolk and Waveney Integrated Care Board
Estimated adult population for home-based HHHFT	142	143	144	145	145	Calculated
Tracheostomy (80%)	114	114	115	116	116	Assumption
Other chronic respiratory conditions (20%)	28	29	29	29	29	Assumption

Abbreviation: HHHFT, heated humidified high-flow therapy.

Device Acquisition and Consumables Costs

We sourced device acquisition and consumables costs for home-based HHHFT from a manufacturer (Fisher & Paykel Healthcare Inc., email communication, October 10, 2024). The device acquisition cost was $2,400, and consumables costs were $800 per year. Consumables included a water chamber, a heater tube, an interface, and a filter.

In the loan funding model, we assumed a device acquisition cost of $578.31 per year for the Ministry of Health. We calculated this by dividing device acquisition costs by the expected 5-year device lifespan and device utilization rate sourced from Groessl et al[29] ($578.31 = [$2,400/5]/0.83). We assumed a consumables cost of $800 per year for the Ministry of Health.

In the 75% public funding model, we assumed a device acquisition cost of $1,800 for the Ministry of Health and $600 for patient out-of-pocket costs. We assumed a cost for consumables of $600 per year for the Ministry of Health and $200 for patient out-of-pocket costs.

In the 100% public funding model, we assumed a device acquisition cost of $2,400 for the Ministry of Health and a consumables cost of $800 per year.

Resource Utilization, Pediatric Obstructive Sleep Apnea

We sourced the number of outpatient and inpatient visits from Radhakrishnan et al[35] for pediatric patients who are nonadherent (to continuous positive airway pressure [CPAP] or home-based HHHFT) and for those who are adherent to home-based HHHFT. The authors conducted a retrospective analysis of resource utilization for people prescribed CPAP for pediatric obstructive sleep apnea (OSA) at an Ontario children's hospital. The authors reported 1.13 outpatient visits and 0.76 inpatient visits the year before a CPAP prescription; they reported 0.86 outpatient visits and 0.55 inpatient visits the year after a CPAP prescription. To account for adherence to treatment, we assumed that 37% of the study population was adherent, and that the number of outpatient and inpatient visits before and after a

prescription of CPAP would be the same for those who were nonadherent. With these assumptions, we then calculated the number of outpatient or inpatient visits for those who are adherent or nonadherent:

- Outpatient visits after CPAP prescription = outpatient visits nonadherent × (1 − CPAP adherent) + outpatient visits adherent × CPAP adherent
- Outpatient visits adherent = (outpatient visits after CPAP prescription − outpatient visits nonadherent × [1 − CPAP adherent])/CPAP adherent
- Outpatient visits adherent was 0.4: (0.86 − 1.13 × [1 − 0.37])/0.37

A similar calculation for inpatient visits resulted in 0.19 visits = (0.55 − 0.76 × [1 − 0.37])/0.37.

We were highly uncertain about this model parameter, and we conducted scenario analyses that varied the reduction in resource utilization as a result of adherence to treatment for pediatric OSA.

Duration of Treatment, Pediatric OSA

We sourced the duration of treatment for pediatric OSA from Castro-Codesal et al.[36] The authors conducted a retrospective analysis of pediatric patients who were starting long-term invasive ventilation (CPAP, bilevel positive airway pressure [BiPAP], and automatic positive airway pressure [autoPAP]) in Alberta from 2005 to 2018. We used published, deidentified data to estimate the proportion of children who would continue to receive treatment for pediatric OSA: 456 children were prescribed noninvasive ventilation, and the median follow-up was 3.27 years (interquartile range 1.61 to 5.2 years). The maximum follow-up was 10.12 years. We estimated the percentage of children who continued to receive treatment at the start of years 1, 2, 3, 4, and 5 using a Kaplan–Meier estimator. The results were 100% at the start of year 1, 87% at the start of year 2, 72.2% at the start of year 3, 49.2% at the start of year 4, and 41.7% at the start of year 5.

Inpatient and Outpatient Costs, Pediatric OSA

We sourced outpatient visit costs by querying the National Ambulatory Care Reporting System using IntelliHealth Ontario for the average total cost of ambulatory visits with a Main Problem Diagnosis code of G47.30 sleep apnea, obstructed. This resulted in a total cost estimate of $1,338.58 in 2023 CAD. We adjusted to 2024 CAD using the Consumer Price Index (CPI) for an estimate of $1,384.80 CAD.[34] Based on claims data, we assumed that the following Ontario Health Insurance Plan (OHIP) fee codes would also be claimed during the outpatient visit:

- H103: Multiple systems assessment (Monday to Friday, daytime), 37% of visits
- H123: Multiple systems assessment (nights), 18% of visits
- H133: Multiple systems assessment (evenings), 32% of visits
- H123: Multiple systems assessment (nights), 18% of visits
- H153: Multiple systems assessment (Saturdays, Sundays, and holidays, daytime and evenings), 13% of visits

We queried the Discharge Abstract Database using IntelliHealth Ontario for the average inpatient costs for people aged less than 19 years who had an inpatient stay with a Most Responsible Diagnosis code of G47.30 sleep apnea, obstructed. This resulted in an estimated inpatient cost of $5,863.27 in 2023 CAD.

We adjusted for inflation using the CPI for an estimate of $6,065.71 CAD. We assumed that people would have a 2-day inpatient stay and would incur the following OHIP physician fee codes:

- C265: Consultation, pediatrics, and E082: Admission assessment (add 30%)
- C122: Day following the hospital admission assessment

Home Monitoring for Home-Based HHHFT

We assumed that pediatric and adult patients receiving home-based HHHFT would incur OHIP physician fees related to home monitoring – specifically code G101: Home/self-care ventilation – per week. Based on administrative data, we assumed that during the year, 40 such claims would be incurred.

Proportion of Adults for Whom HHHFT Facilitated Earlier Discharge

We sourced the proportion of adult patients for whom home-based HHHFT would facilitate an earlier discharge from Dolidon et al.[24] The authors reported that the median fraction of inspired oxygen (FiO_2) for people discharged home with home-based HHHFT via nasal cannula was 63%. The authors indicated that for these people, discharge would not have been feasible on low-flow long-term oxygen therapy. They reported that 31 out of 43 people who received home-based HHHFT via a nasal cannula were discharged home. We assumed that 72% (31/43) of the population receiving home-based HHHFT via nasal cannula would have had an earlier discharge as a result of access to home-based HHHFT.

It is unclear whether home-based HHHFT would facilitate earlier discharge for those receiving HHHFT via a tracheostomy. Dolidon et al[24] reported the median, mean, and interquartile range for FiO_2 for those receiving HHHFT via a nasal cannula and via a tracheostomy. We fit beta distributions for both subgroups to match the reported statistics. We then assumed that the overlap in distributions for HHHFT via nasal cannula and via tracheostomy could be attributed to the fact that those who received HHHFT via tracheostomy would have had an earlier discharge as a result of access to the technology.

The results of this analysis resulted in a beta distribution for the FiO_2 of HHHFT via nasal cannula (parameters alpha = 3.217 and beta = 2.018) and a beta distribution for the FiO_2 of HHHFT via tracheostomy (parameters alpha = 6.705 and beta = 19.164). The distributions overlapped by 6%, and we assumed that 6% of those receiving home-based HHHFT via tracheostomy would have an earlier discharge as a result of access to home-based HHHFT.

During expert consultation for this health technology assessment, we received a wide range of responses to the question of whether access to home-based HHHFT would facilitate earlier discharge for adults. For this reason, we conducted scenario analyses that varied both model parameters, including a scenario in which home-based HHHFT did not facilitate earlier discharge.

Proportion of Pediatric Patients for Whom HHHFT Facilitated Earlier Discharge

For pediatric patients, we were unable to source a published estimate of the proportion of pediatric patients who would experience an earlier discharge as a result of access to home-based HHHFT. Expert consultation and the experience of using home-based HHHFT in Saskatchewan indicated that there are pediatric patients for whom home-based HHHFT would facilitate an earlier discharge.[59]

Given the lack of pediatric data, we assumed that values for pediatric patients would be similar to those for adults, above. We also conducted a wide range of scenario analyses varying the proportion of patients for whom access to home-based HHHFT would facilitate earlier discharge.

Inpatient Days Avoided Due to Earlier Discharge

We were unable to source an estimate for the number of inpatient days avoided in adults as a result of access to home-based HHHFT. We assumed that home-based HHHFT would be associated with a 6-day reduction in length of stay, but this model parameter was highly uncertain. Given the substantial uncertainty, we conducted scenario analyses varying the reduction from 0 to 30 days.

We were unable to source the number of reduced inpatient days related to initiation of home-based HHHFT in pediatric patients. We assumed that the value would be comparable to the adult parameter (i.e., 6 days).

Probability of Continuing Home-Based HHHFT Treatment

We sourced the probability of continuing home-based HHHFT treatment for adults from Dolidon et al.[24] The authors reported survivorship after initiation of home-based HHHFT for people receiving home-based HHHFT via nasal cannula and via tracheostomy. We assumed that home-based HHHFT in adults would lead to survivorship similar to that reported by Dolidon et al.[24] The values reported are outlined in Table A4.

Table A4: Survivorship With Home-Based HHHFT, Adults

Year	Home-based HHHFT via nasal cannula	Home-based HHHFT via tracheostomy	Merged values[a]
Year 1	100%	100%	100%
Year 2	25%	66%	57.8%
Year 3	22%	57%	50%
Year 4	12%	56%	47.2%
Year 5	12%	56%	47.2%

Abbreviation: HHHFT, heated humidified high-flow therapy.
[a] Assuming that 80% of the population would receive home-based HHHFT via tracheostomy.
Source: Dolidon et al.[24]

We sourced the probability of continuing home-based HHHFT treatment for pediatric patients from Castro-Codesal et al.[36] We used published deidentified data to estimate the proportion of children who were receiving treatment for conditions other than pediatric OSA and found 105 cases with a median follow-up of 3.1 years (maximum 9 years; interquartile range 1.8 to 5.1 years). We were able to estimate the percentage of patients continuing to receive treatment at the start of years 1, 2, 3, 4, and 5 using a Kaplan–Meier estimator. The results were as follows: 100% at the start of year 1, 87.5% at the start of year 2, 76.1% at the start of year 3, 41.8% at the start of year 4, and 35.4% at the start of year 5.

Inpatient Costs Per Day (Other Chronic Respiratory Conditions)

We sourced pediatric inpatient costs by querying the Discharge Abstract Database using IntelliHealth Ontario[38] for inpatient admissions at pediatric hospitals with the following Most Responsible Diagnosis codes:

- J988: Other specified respiratory disorders
- J961: Chronic respiratory failure
- J980: Diseases of bronchus
- E849 and E840: Cystic fibrosis
- I278: Other specified pulmonary heart
- Z515: Palliative care

This resulted in an average total cost divided by length of stay of $2,693.93 in 2023 CAD. We adjusted for inflation using the Consumer Price Index for an estimate of $2,786.94 in 2024 CAD.[34] We assumed that an earlier discharge would be associated with fewer OHIP physician fee code claims of C122: Day following hospital admission assessment.

We sourced adult patients costs by querying the National Rehabilitation Reporting System using IntelliHealth Ontario[41] for the average per-day cost of an inpatient admission at an Ontario rehabilitation centre with the following Most Responsible Diagnosis codes:

- J449: Chronic obstructive pulmonary disease
- J941: Chronic respiratory failure

This resulted in an estimated total cost divided by length of stay of $882.25 in 2023 CAD. We adjusted for inflation using the Consumer Price Index for an estimated per-day cost of $912.71.[34] We also assumed that reductions in inpatient admissions would result in fewer OHIP physician fee code claims for W132: Subsequent health visit.

Appendix 6: Additional Budget Impact Analysis Results

Table A5: Detailed Resource Utilization, Pediatric OSA

Scenario	Year 1	Year 2	Year 3	Year 4	Year 5	Total[a]
Current scenario						
Nonadherent (not accessing home-based HHHFT)						
Inpatient admissions	14.8	29.4	43.9	56.1	68.5	212.8
Outpatient visits	22.0	43.7	65.3	83.4	101.9	316.4
Nonadherent (home-based HHHFT)						
Inpatient admissions	1.9	3.7	5.6	7.1	8.7	27.0
Outpatient visits	2.8	5.5	8.3	10.6	12.9	40.1
Adherent (home-based HHHFT)						
Inpatient admissions	0.8	1.5	2.3	2.9	3.5	11.0
Outpatient visits	1.6	3.2	4.8	6.1	7.5	23.1
New scenario						
Nonadherent (not accessing home-based HHHFT)						
Inpatient admissions	0	0	0	0	0	0
Outpatient visits	0	0	0	0	0	0
Nonadherent (home-based HHHFT)						
Inpatient admissions	7.5	14.9	22.2	28.4	34.7	107.8
Outpatient visits	11.2	22.2	33.1	42.3	51.6	160.3
Adherent (home-based HHHFT)						
Inpatient admissions	3.1	6.1	9.1	11.6	14.2	44.0
Outpatient visits	6.4	12.8	19.1	24.4	29.8	92.6

Abbreviations: HHHFT, heated humidified high-flow therapy; OSA, obstructive sleep apnea.
[a] Results may appear inexact due to rounding.

Table A6: Detailed Resource Utilization, Adult and Pediatric (Other Chronic Respiratory Conditions)

Scenario	Year 1	Year 2	Year 3	Year 4	Year 5	Total[a]
Current scenario						
Adult hospital days avoided						
Those not accessing home-based HHHFT	0	0	0	0	0	0
Those accessing home-based HHHFT via private insurance	40.9	41.2	41.5	41.8	41.8	207.3
Those accessing home-based HHHFT via public funding	0	0	0	0	0	0
Pediatric hospital days avoided						
Those not accessing home-based HHHFT	0	0	0	0	0	0
Those accessing home-based HHHFT via private insurance	1.7	1.7	2.0	2.3	2.6	10.4
Those accessing home-based HHHFT via public funding	0	0	0	0	0	0
New scenario						
Adult hospital days avoided						
Those not accessing home-based HHHFT	0	0	0	0	0	0
Those accessing home-based HHHFT via private insurance	0	0	0	0	0	0
Those accessing home-based HHHFT via public funding	163.7	164.9	166.0	167.2	167.2	829.1
Pediatric hospital days avoided						
Those not accessing home-based HHHFT	0	0	0	0	0	0
Those accessing home-based HHHFT via private insurance	0	0	0	0	0	0
Those accessing home-based HHHFT via public funding	6.9	6.9	8.1	9.2	10.4	41.5

Abbreviation: HHHFT, heated humidified high-flow therapy.
[a] Results may appear inexact due to rounding.

Table A7: Budget Impact and Total Costs, Pediatric OSA, 75% and 100% Funding Models[a,b]

Scenario	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Current scenario						
Inpatient and outpatient costs						
Hospital costs	$142,536	$282,989	$422,138	$539,664	$659,263	$2,046,591
Physician fees	$6,536	$12,977	$19,358	$24,747	$30,231	$93,849
Home monitoring costs	$8,723	$14,435	$20,224	$25,066	$30,114	$98,562
Total cost, current scenario	$157,795	$310,401	$461,720	$589,478	$719,609	$2,239,002
New scenario						
Inpatient and outpatient costs						
Hospital costs	$88,514	$175,734	$262,144	$335,127	$409,397	$1,270,916
Physician fees	$4,039	$8,019	$11,962	$15,292	$18,681	$57,992
Home monitoring costs	$34,892	$57,739	$80,897	$100,265	$120,456	$394,249
75% funding model						
Device acquisition costs	$46,800	$52,200	$59,400	$64,800	$72,000	$295,200
Device consumables costs	$15,600	$25,815	$36,169	$44,828	$53,855	$176,266
Total cost, 75% funding model	$189,845	$319,506	$450,572	$560,311	$674,389	$2,194,623
100% funding model						
Device acquisition costs	$62,400	$69,600	$79,200	$86,400	$96,000	$393,600
Device consumables costs	$20,800	$34,420	$48,225	$59,770	$71,807	$235,022
Total cost, 100% funding model	$210,645	$345,511	$482,428	$596,854	$716,341	$2,351,778
Budget impact[c]						
Inpatient and outpatient costs						
Hospital costs	−$54,022	−$107,255	−$159,994	−$204,537	−$249,866	−$775,675
Physician fees	−$2,497	−$4,958	−$7,396	−$9,455	−$11,551	−$35,858
Home monitoring costs	$26,169	$43,304	$60,673	$75,198	$90,342	$295,687
75% funding model						
Device acquisition costs	$46,800	$52,200	$59,400	$64,800	$72,000	$295,200
Device consumables costs	$15,600	$25,815	$36,169	$44,828	$53,855	$176,266
Budget impact, 75% funding model	$32,049	$9,105	−$11,148	−$29,166	−$45,220	−$44,379
100% funding model						
Device acquisition costs	$62,400	$69,600	$79,200	$86,400	$96,000	$393,600
Device consumables costs	$20,800	$34,420	$48,225	$59,770	$71,807	$235,022
Budget impact, 100% funding model	$52,849	$35,110	$20,708	$7,376	−$3,268	$112,776

Abbreviation: OSA, obstructive sleep apnea.

[a] In 2024 Canadian dollars.

[b] Negative costs indicate savings.

[c] New scenario − current scenario.

Table A8: Budget Impact and Total Costs, Adult and Pediatric (Other Chronic Respiratory Conditions), 75% and 100% Funding Models[a,b]

Scenario	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Current scenario						
Reduced inpatient costs						
Hospital costs	−$42,183	−$42,446	−$43,513	−$44,579	−$45,383	−$218,103
Physician fees	−$1,502	−$1,512	−$1,539	−$1,566	−$1,584	−$7,703
Home monitoring costs	$49,654	$79,165	$105,223	$129,857	$154,413	$518,311
Total cost	$5,969	$35,207	$60,171	$83,711	$107,447	$292,506
New scenario						
Reduced inpatient costs						
Hospital costs	−$168,732	−$169,784	−$174,050	−$178,316	−$181,530	−$872,412
Physician fees	−$6,007	−$6,046	−$6,156	−$6,266	−$6,336	−$30,810
Home monitoring costs	$198,616	$316,658	$420,891	$519,426	$617,653	$2,073,245
75% funding model						
Device acquisition costs	$266,400	$268,200	$271,800	$275,400	$277,200	$1,359,000
Device consumables costs	$88,800	$141,576	$188,178	$232,232	$276,149	$926,935
Total cost, 75% funding model	$379,078	$550,604	$700,663	$842,477	$983,135	$3,455,957
100% funding model						
Device acquisition costs	$355,200	$357,600	$362,400	$367,200	$369,600	$1,812,000
Device consumables costs	$118,400	$188,768	$250,904	$309,643	$368,198	$1,235,914
Total cost, 100% funding model	$497,478	$687,196	$853,989	$1,011,688	$1,167,585	$4,217,936
Budget impact[c]						
Reduced inpatient costs						
Hospital costs	−$126,549	−$127,338	−$130,538	−$133,737	−$136,148	−$654,309
Physician fees	−$4,505	−$4,535	−$4,617	−$4,699	−$4,752	−$23,108
Home monitoring costs	$148,962	$237,494	$315,669	$389,570	$463,240	$1,554,934
75% funding model						
Device acquisition costs	$266,400	$268,200	$271,800	$275,400	$277,200	$1,359,000
Device consumables costs	$88,800	$141,576	$188,178	$232,232	$276,149	$926,935
Budget impact, 75% funding model	$373,108	$515,397	$640,492	$758,766	$875,689	$3,163,452
100% funding model						
Device acquisition costs	$355,200	$357,600	$362,400	$367,200	$369,600	$1,812,000
Device consumables costs	$118,400	$188,768	$250,904	$309,643	$368,198	$1,235,914
Budget impact, 100% funding model	$491,508	$651,989	$793,818	$927,976	$1,060,138	$3,925,430

[a] In 2024 Canadian dollars.

[b] Negative costs indicate savings.

[c] New scenario − current scenario.

Table A9: Per-Person Resource Utilization and Costs, Pediatric OSA

Scenario	Year 1	Year 2	Year 3	Year 4	Year 5
Current scenario					
Inpatient visits	0.67	0.58	0.48	0.33	0.28
Outpatient visits	1.02	0.88	0.73	0.50	0.42
HHHFT use, private payer	25.0%	13.5%	11.2%	7.6%	6.5%
HHHFT use, public payer	0%	0%	0%	0%	0%
Home monitoring costs	$335.50	$180.97	$150.18	$102.34	$86.74
Inpatient costs	$4,273.54	$3,717.98	$3,085.49	$2,102.58	$1,782.07
Outpatient costs	$964.37	$839.00	$696.28	$474.47	$402.14
Device acquisition costs, out of pocket	$600.00	$0.00	$0.00	$0.00	$0.00
Device consumables costs, out of pocket	$200.00	$107.88	$89.53	$61.01	$51.71
New scenario					
Inpatient visits	0.41	0.35	0.29	0.20	0.17
Outpatient visits	0.68	0.59	0.49	0.33	0.28
HHHFT use, out of pocket	0%	0%	0%	0%	0%
HHHFT use, public payer	100%	54%	45%	31%	26%
Home monitoring costs	$1,342.00	$723.87	$600.73	$409.36	$346.96
Inpatient costs	$2,587.09	$2,250.77	$1,867.88	$1,272.85	$1,078.82
Outpatient costs	$583.81	$507.91	$421.51	$287.23	$243.45
Device acquisition costs, out of pocket	$600.00	$0.00	$0.00	$0.00	$0.00
Device consumables costs, out of pocket	$200.00	$107.88	$89.53	$61.01	$51.71
Device acquisition costs, public payer	$1,800.00	$0.00	$0.00	$0.00	$0.00
Device consumables costs, public payer	$600.00	$323.64	$268.58	$183.02	$155.12

Abbreviations: HHHFT, heated humidified high-flow therapy; OSA, obstructive sleep apnea.

Table A10: Per-Person Resource Utilization and Costs, Adult and Pediatric (Other Chronic Respiratory Conditions)

Scenario	Year 1	Year 2	Year 3	Year 4	Year 5
Current scenario					
Hospital days avoided	0.29	0.00	0.00	0.00	0.00
HHHFT use, out of pocket	25.0%	14.7%	12.7%	11.7%	11.7%
HHHFT use, public payer	0%	0%	0%	0%	0%
Home monitoring costs	$335.50	$197.13	$170.23	$157.62	$156.75
Inpatient costs avoided	−$295.17	$0.00	$0.00	$0.00	$0.00
Device acquisition costs, out of pocket	$600.00	$0.00	$0.00	$0.00	$0.00
Device consumables costs, out of pocket	$200.00	$117.51	$101.48	$93.96	$93.44
New scenario					
Hospital days avoided	1.153	0	0	0	0
HHHFT use, out of pocket	0%	0%	0%	0%	0%
HHHFT use, public payer	100.0%	58.8%	50.7%	47.0%	46.7%
Home monitoring costs	$1,342.00	$788.52	$680.90	$630.49	$627.00
Inpatient costs avoided	−$1,181	$0.00	$0.00	$0.00	$0.00
Device acquisition costs, out of pocket	$600.00	$0.00	$0.00	$0.00	$0.00
Device consumables costs, out of pocket	$1,800.00	$0.00	$0.00	$0.00	$0.00
Device acquisition costs, public payer	$200.00	$117.51	$101.48	$93.96	$93.44
Device consumables costs, public payer	$600.00	$352.54	$304.43	$281.89	$280.33

Abbreviation: HHHFT, heated humidified high-flow therapy.

Table A11: Detailed Budget Impact Results, Pediatric OSA[a,b]

Budget impact	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Nonadherent						
Inpatient and outpatient costs						
Hospital costs	−$74,653	−$148,215	−$221,093	−$282,647	−$345,287	−$1,071,894
Physician fees	−$3,426	−$6,803	−$10,148	−$12,973	−$15,848	−$49,198
Home monitoring costs	$9,944	$11,092	$12,622	$13,769	$15,299	$62,725
Device acquisition costs	$5,714	$6,373	$7,252	$7,911	$8,790	$36,040
Device consumables costs	$7,904	$8,816	$10,032	$10,944	$12,160	$49,856
Budget impact	−$54,517	−$128,737	−$201,335	−$262,996	−$324,885	−$972,471
Adherent[c]						
Inpatient and outpatient costs						
Hospital costs	$20,630	$40,959	$61,099	$78,110	$95,420	$296,220
Physician fees	$929	$1,845	$2,752	$3,518	$4,297	$13,340
Home monitoring costs	$16,225	$32,212	$48,052	$61,430	$75,043	$232,962
Device acquisition costs	$9,322	$10,398	$11,832	$12,908	$14,342	$58,803
Device consumables costs	$12,896	$25,604	$38,193	$48,826	$59,647	$185,166
Budget impact	$60,003	$111,018	$161,928	$204,791	$248,750	$786,490

Abbreviation: OSA, obstructive sleep apnea.

[a] In 2024 Canadian dollars.

[b] Negative costs indicate savings.

[c] The increased budget impact for those who are adherent is a result of 2 factors: 1) a decrease in the number of nonadherent people and an increase in adherent people; and 2) a change in relative resource utilization between those who are adherent and those who are nonadherent.

Table A12: Detailed Budget Impact Results, Adult and Pediatric (Other Chronic Respiratory Conditions)[a,b]

Budget impact	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Pediatric patients						
Reduced inpatient costs						
Hospital costs	−$14,462	−$14,462	−$16,872	−$19,282	−$21,692	−$86,769
Physician fees	−$317	−$317	−$370	−$423	−$476	−$1,904
Home monitoring costs	$6,039	$10,955	$16,080	$20,430	$25,080	$78,583
Device acquisition costs	$3,470	$3,470	$4,048	$4,627	$5,205	$20,819
Device consumables costs	$4,800	$8,707	$12,781	$16,238	$19,934	$62,461
Budget impact	−$470	$8,353	$15,667	$21,590	$28,051	$73,191
Adult patients						
Reduced inpatient costs						
Hospital costs	−$112,087	−$112,877	−$113,666	−$114,455	−$114,455	−$567,540
Physician fees	−$4,188	−$4,217	−$4,247	−$4,276	−$4,276	−$21,204
Home monitoring costs	$142,923	$226,539	$299,589	$369,140	$438,160	$1,476,350
Device acquisition costs	$82,120	$82,699	$83,277	$83,855	$83,855	$415,807
Device consumables costs	$113,600	$180,061	$238,123	$293,405	$348,264	$1,173,453
Budget impact	$222,369	$372,205	$503,076	$627,669	$751,548	$2,476,866

[a] In 2024 Canadian dollars.
[b] Negative costs indicate savings.

Table A13: Out-of-Pocket Expenditures for Home-Based HHHFT[a]

Out-of-pocket expenditures	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Current scenario						
Device acquisition costs	$135,600	$141,600	$150,000	$156,600	$164,400	$748,200
Device consumables costs	$45,200	$73,007	$98,895	$122,238	$145,905	$485,245
Total	$180,800	$214,607	$248,895	$278,838	$310,305	$1,233,445
New scenario, 75% coverage						
Device acquisition costs	$104,400	$106,800	$110,400	$113,400	$116,400	$551,400
Device consumables costs	$34,800	$55,797	$74,782	$92,353	$110,001	$367,734
Total	$139,200	$162,597	$185,182	$205,753	$226,401	$919,134
New scenario, loan coverage						
Device acquisition costs	$0	$0	$0	$0	$0	$0
Device consumables costs	$0	$0	$0	$0	$0	$0
Total	$0	$0	$0	$0	$0	$0

Abbreviation: HHHFT, heated humidified high-flow therapy.
[a] In 2024 Canadian dollars.

Table A14: Scenario Analysis, Detailed Results[a]

Scenario	Total budget impact, pediatric OSA	Total budget impact, adult and pediatric (other chronic respiratory conditions)
Reference case	-$185,981	$2.55 million
Pediatric population size +25%	-$232,825	$2.56 million
Pediatric population size +50%	-$283,121	$2.58 million
Pediatric population size +75%	-$328,247	$2.60 million
Pediatric population size −25%	-$141,350	$2.53 million
Pediatric population size −50%	-$94,716	$2.51 million
Pediatric population size −75%	-$46,844	$2.49 million
Percent of population with pediatric OSA (80%–85%) +10%	-$205,589	$2.51 million
Percent of population with pediatric OSA (80%–85%) −10%	-$169,502	$2.58 million
Adult population size +25%	-$185,981	$3.17 million
Adult population size +50%	-$185,981	$3.79 million
Adult population size +75%	-$185,981	$4.40 million
Adult population size −25%	-$185,981	$1.93 million
Adult population size −50%	-$185,981	$1.31 million
Adult population size −75%	-$185,981	$0.69 million
Uptake reaches 100% in year 2	-$144,447	$2.17 million
Uptake reaches 100% in year 3	-$104,577	$1.82 million
Uptake reaches 100% in year 4	-$67,840	$1.52 million
Uptake reaches 100% in year 5	-$36,969	$1.26 million
Adherence to home-based HHHFT, pediatric OSA +25%	-$330,253	$2.55 million
Adherence to home-based HHHFT, pediatric OSA −25%	-$41,708	$2.55 million
Reduction in outpatient visits, pediatric OSA +25%	-$231,469	$2.55 million
Reduction in outpatient visits, pediatric OSA −25%	-$140,493	$2.55 million
Reduction in inpatient visits, pediatric OSA +25%	-$343,376	$2.55 million
Reduction in inpatient visits, pediatric OSA −25%	-$28,585	$2.55 million
Proportion of patients continuing treatment for pediatric OSA +25%	-$209,658	$2.55 million
Proportion of patients continuing treatment for pediatric OSA −25%	-$162,303	$2.55 million
Outpatient facility costs +25%	-$202,426	$2.55 million
Outpatient facility costs −25%	-$125,654	$2.55 million
Inpatient facility costs +25%	-$337,354	$2.55 million
Inpatient facility costs −25%	-$36,729	$2.55 million
Home-based HHHFT monitoring costs +25%	-$112,059	$2.94 million
Home-based HHHFT monitoring costs +50%	-$38,137	$3.32 million
Home-based HHHFT monitoring costs −25%	-$259,902	$2.16 million
Home-based HHHFT monitoring costs −50%	-$333,824	$1.77 million
HHHFT device costs +25%	-$162,270	$2.66 million
HHHFT device costs −25%	-$209,691	$2.44 million
HHHFT consumables costs +25%	-$127,225	$2.86 million
HHHFT consumables costs −25%	-$244,736	$2.24 million

Scenario	Total budget impact, pediatric OSA	Total budget impact, adult and pediatric (other chronic respiratory conditions)
Proportion of adults for whom home-based HHHFT resulted in earlier discharge		
0	-$185,981	$3.14 million
0.2	-$185,981	$2.52 million
0.4	-$185,981	$1.91 million
0.6	-$185,981	$1.30 million
0.8	-$185,981	$0.69 million
1	-$185,981	$0.07 million
Proportion of pediatric patients for whom home-based HHHFT resulted in earlier discharge		
0	-$185,981	$2.64 million
0.2	-$185,981	$2.54 million
0.4	-$185,981	$2.45 million
0.6	-$185,981	$2.35 million
0.8	-$185,981	$2.26 million
1	-$185,981	$2.16 million
Inpatient days avoided for adults whose earlier discharge was facilitated by home-based HHHFT		
0 days	-$185,981	$3.14 million
3.3 days	-$185,981	$2.81 million
6.7 days	-$185,981	$2.48 million
10 days	-$185,981	$2.15 million
13.3 days	-$185,981	$1.83 million
16.7 days	-$185,981	$1.50 million
20 days	-$185,981	$1.17 million
23.3 days	-$185,981	$0.85 million
26.7 days	-$185,981	$0.52 million
30 days	-$185,981	$0.19 million
Inpatient days avoided for pediatric patients whose earlier discharge was facilitated by HHHFT		
0 days	-$185,981	$2.64 million
3.3 days	-$185,981	$2.59 million
6.7 days	-$185,981	$2.54 million
10 days	-$185,981	$2.49 million
13.3 days	-$185,981	$2.44 million
16.7 days	-$185,981	$2.38 million
20 days	-$185,981	$2.33 million
23.3 days	-$185,981	$2.28 million
26.7 days	-$185,981	$2.23 million
30 days	-$185,981	$2.18 million
Proportion of adults continuing to receive home-based HHHFT +25%	-$185,981	$2.21 million
Proportion of adults continuing to receive home-based HHHFT −25%	-$185,981	$2.57 million
Proportion of pediatric patients continuing to receive home-based HHHFT +25%	-$185,981	$2.55 million
Proportion of pediatric patients continuing to receive home-based HHHFT −25%	-$185,981	$2.55 million

Abbreviations: HHHFT, heated humidified high-flow therapy; OSA, obstructive sleep apnea.

[a] In 2024 Canadian dollars.

Table A15: Exploratory Analysis Results

Average number of inpatient days avoided (adult and pediatric, other chronic respiratory conditions)	5-year budget impact[a]
0.5	$2.93 million
1	$2.64 million
1.5	$2.34 million
2	$2.05 million
2.5	$1.75 million
3	$1.46 million
3.5	$1.16 million
4	$0.87 million
4.5	$0.57 million
5	$0.28 million
5.5	−$0.02 million
6	−$0.31 million
6.5	−$0.61 million
7	−$0.90 million
7.5	−$1.20 million
8	−$1.49 million
8.5	−$1.79 million
9	−$2.08 million
9.5	−$2.38 million
10	−$2.67 million
10.5	−$2.97 million
11	−$3.26 million
11.5	−$3.56 million
12	−$3.85 million
12.5	−$4.15 million
13	−$4.44 million
13.5	−$4.74 million
14	−$5.03 million
14.5	−$5.33 million
15	−$5.62 million
15.5	−$5.92 million
16	−$6.21 million
16.5	−$6.51 million
17	−$6.80 million
17.5	−$7.10 million
18	−$7.39 million
18.5	−$7.69 million
19	−$7.98 million
19.5	−$8.28 million

Average number of inpatient days avoided (adult and pediatric, other chronic respiratory conditions)	5-year budget impact[a]
20	−$8.57 million
20.5	−$8.87 million
21	−$9.16 million
21.5	−$9.46 million
22	−$9.75 million
22.5	−$10.05 million
23	−$10.34 million
23.5	−$10.64 million
24	−$10.93 million
24.5	−$11.23 million
25	−$11.52 million
25.5	−$11.82 million
26	−$12.11 million
26.5	−$12.41 million
27	−$12.70 million
27.5	−$13.00 million
28	−$13.29 million
28.5	−$13.59 million
29	−$13.88 million
29.5	−$14.18 million
30	−$14.47 million

[a] In 2024 Canadian dollars.

Appendix 7: Letter of Information

Ontario Health is conducting a review of **Humidified High Flow Therapy (HHFT) at Home.** The purpose is to better understand whether this intervention should be publicly funded in Ontario.

An important part of this review involves gathering perspectives of patients and care partners of those who have direct experience or could benefit from Humidified High Flow Therapy (HHFT) at Home.

What Do You Need From Me

- Willingness to share your story
- 30-40 minutes of your time for a phone interview
- Permission to audio- (not video-) record the interview

What Your Participation Involves

If you agree to share your experiences, you will be asked to have an interview with Ontario Health (OH) staff. Ontario Health staff will contact interested participants by collecting contact information (i.e., email address and/or phone number) to set up an interview. The interview will last about 30-40 minutes. It will be held over the telephone. With your permission, the interview will be audiotaped. The interviewer will ask you questions about your or your loved one's condition and your perspectives about your diagnosis and treatment options in Ontario. Participation is voluntary. You may refuse to participate, refuse to answer any questions, or withdraw before or at any point during your interview. Withdrawal will in no way affect the care you receive.

Confidentiality

All information you share will be kept confidential and your privacy will be protected except as required by law. The results of this review will be published; however no identifying information will be released or published. Any records containing information from your interview will be stored securely until a year after the project completion. After a year post completion, the records will be destroyed. If you are sending us personal information by email, please be aware that electronic communication is not always secure and can be vulnerable to interception.

Ontario Health is designated an "institution" by the *Freedom of Information and Protection of Privacy Act* (FIPPA) and is collecting your personal information pursuant to FIPPA and the *Connecting Care Act, 2019* to support the Health Technology Assessment Program. If you have any questions regarding Ontario Health's collection and use of personal information for the purposes of this program, please contact Team Lead, Jigna Mistry noted below.

Risks to Participation

There are no known physical risks to participating. Some participants may experience discomfort or anxiety after speaking about their experience.

If you are interested, please contact us.

Appendix 8: Interview Guide

Pediatrics

Introduction

Explain Ontario Health purpose, HTA process, and purpose of interview (Respond to any initial questions or inquiries)

Lived Experience

- What condition does your child have that requires the use of myAirvo?
  - Does you child have a tracheostomy?
- What was the impact of this condition on your child's day to day life?
- What is the impact on the care partners day to day life?

Intervention

- How long has your child you been using the myAirvo device at home?
- What training did you have to use the myAirvo device at home?
- What is the day-to-day maintenance of the myAirvo device?
  - Comfort level
- How often does your child use the myAirvo?
- Did you face any barriers to accessing the myAirvo device?
  - Cost: out of pocket, insurance, others
  - Geography
  - Awareness
  - Other barriers

Impact of myAirvo

- Did myAirvo have an impact on the condition and/or symptoms?
  - avoidance of tracheostomy
  - reduced hospital stay
- Sleep quality, daytime alertness, appetite
- Did myAirvo have an impact on your caregiving responsibilities?
- Any equity/ethical concerns? (theoretically)

Adults

Introduction

Explain Ontario Health purpose, HTA process, and purpose of interview (Respond to any initial questions or inquiries)

Lived Experience

- What condition do you have that requires the use of myAirvo at home?
  - Do you have a tracheostomy?
- What is the impact of your condition on your day to day life?
- What is the impact on the care partners day to day life?

Intervention

- How long have you been using the myAirvo device at home?
- What training did you have to use the myAirvo device at home?
- What is day-to-day maintenance of the myAirvo device?
  - Comfort level
- How often are you using myAirvo?
- Did you face any barriers to accessing the myAirvo device?
  - Cost: out of pocket, insurance, others
  - Geography
  - Awareness
  - Other barriers

Impact of myAirvo

- Did myAirvo have an impact on the condition and/or symptoms?
  - avoidance of tracheostomy
  - reduced hospital stay
- Sleep quality, daytime alertness, appetite
- Did myAirvo have an impact care partner responsibilities?
- Any equity/ethical concerns? (theoretically)

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About Us

We are an agency created by the Government of Ontario to connect, coordinate, and modernize our province's health care system. We work with partners, providers, and patients to make the health system more efficient so everyone in Ontario has an opportunity for better health and well-being.

Equity, Inclusion, Diversity and Anti-Racism

Ontario Health is committed to advancing equity, inclusion and diversity and addressing racism in the health care system. As part of this work, Ontario Health has developed an Equity, Inclusion, Diversity and Anti-Racism Framework, which builds on existing legislated commitments and relationships and recognizes the need for an intersectional approach.

Unlike the notion of equality, equity is not about sameness of treatment. It denotes fairness and justice in process and in results. Equitable outcomes often require differential treatment and resource redistribution to achieve a level playing field among all individuals and communities. This requires recognizing and addressing barriers to opportunities for all to thrive in our society.

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