Home Mechanical Ventilation: Results of A National Program In Adults (2008 to 2017), Ministry of Health, Chile

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Abstract

Background: Home mechanical ventilation (HMV) is a viable and effective strategy for patients with chronic respiratory failure (CRF) of different causes. The Chilean Ministry of Health started in 2006 a program for HMV in Children and in 2008 it began a program for HMV in adults. All belonged to the state health insurance.

Methods: Prospective cohort of adult patients with CRF in 10 regions of Chile admitted to the national HMV program, their demographic, clinical and functional characteristics, mode of admission, time in the program and survival.

Results: A total of 1,105 patients were included. Median age was 59 years (44-58, IQR1-IQR3). Women were 58.1%. The body mass index was 34.9 (26-46) kg/m², and 942 (85.4%) belonged to low-income socioeconomic groups. The baseline score on the Severe Respiratory Insuficiency questionnaire (SRI) was 47 (35-62.1) points, 98.5% lived in urban areas, 76.2% initiated HMV in the stable chronic mode, 23.8% in the acute mode and 99 patients were transferred from the children's program. There were 1047 patients on noninvasive ventilation and 58 on invasive ventilation through tracheostomy. Baseline PaCO₂ was 58.2 (52-65) mmHg. Device usage time was 7.3 h/d (5.8-8.8), the time in HMV was 21.6 (12.2-49.5) months. The diagnostic groups were COPD, 35%; obesity hypoventilation syndrome (OHS), 23.9%; neuromuscular disease (NMD) 16.3%; non-cystic fibrosis bronchiectasis or tuberculosis (non-CF BC or TBC) 8.3%; Scoliosis, 5.9%; and Amyotrophic Lateral Sclerosis (ALS) 5.24%. The lowest 1- and 3-year survival rates were observed in the ALS group, i.e., 67% and 26%, respectively, and the lowest 9-year survival was observed in the non-CF BC or TB and COPD, 27% and 30.9%, respectively. The best survival rates at 9 years were 57.7%, 57.2% and 50.9% for patients with OHS, Scoliosis and NMD, respectively.

Conclusion: The most common diagnoses were COPD and OHS. Patients were hypercapnic and had poor quality of life at program admission. The best survival was observed in patients with OHS, Scoliosis and NMD.

Background

Home mechanical ventilation (HMV) is a viable and effective treatment strategy for patients with chronic respiratory failure (CRF). HMV has been used since the 1980s, and in recent decades, its use has increased for a wide range of diseases, including neuromuscular diseases (1), restrictive thoracic diseases, obesity hypoventilation syndrome (OHS) (2) and advanced chronic obstructive pulmonary disease (COPD) (3). HMV seeks to correct hypoventilation, relieve symptoms, decrease hospitalizations, and improve quality of life and survival (4,5). The prevalence of HMV reported in Europe 20 years ago was 6.6 per 100,000 inhabitants (6), but currently, it has increased due to obesity and COPD. The study carried out by ANTADIR in France describes recent changes in the causes of CRF and mentions that OHS is an important indication for the use of HMV (7). A Canadian study reported that COPD and OHS are the most frequent diagnoses for admission into an HMV program among 4670 patients (8). In a region of Switzerland, Cantero et al. described how over two decades, the prevalence of COPD and OHS has increased as a cause of initiation of HMV, reporting a prevalence of 37.9 per 100,000 inhabitants (9). In Chile, there are no reports of the prevalence of HMV use, but the prevalence is known of diseases that increase the risk of CRF, such as obesity (34.4%) and smoking (33.3%) (10). The Chilean health system is mixed, with public health insurance covering 78% of the country’s population, private health insurance covering 14.4% and the armed forces covering 3% (11). In 2006, the Ministry of Health of Chile (Ministerio de Salud de Chile – MINSAL) initiated a program of invasive and noninvasive ventilation in children under 20 years of age covered by public health insurance (12). In 2008, MINSAL initiated a non-invasive home ventilation program for adults older than 20 years with CRF for multiple causes (AVNIA program, for its acronym in Spanish), and in 2004, invasive mechanical ventilation through tracheostomy was included in the program (13).

The MINSAL proposed the following goals: a) Transfer to the home of patients with CRF the technology and trained personnel for periodic home supervision, focusing on family and self-care; b) Reduce the mean number of days of hospitalization per year and vacate intensive care unit beds to allow the admission of patients with acute diseases; c) Improve quality of life by favoring social reintegration.

Patients And Methods

Study design and patients

Description of a prospective cohort of adult patients with CRF consecutively admitted to the national HMV program, their demographic, clinical and functional characteristics according to diagnostic groups, modes of admission, length of stay in the program, causes of discharge and survival.

All patients of both sexes and over 20 years of age with CRF admitted between May 1, 2008, and December 31, 2017, to the public HMV program from public hospitals and primary care clinics in 10 regions of Chile were included in the study. The two modes of admission were: acute hospitalized patient (immediately after discharge from hospitalization for exacerbation) or stable chronic patient (electively from outpatient monitoring). In both cases, the patient was evaluated by the program doctor who approved or refused admission according to the technical norm (13).
Diagnostic groups and inclusion criteria

For indication for HMV, the results of the Consensus Conference of 1999 were applied with respect to the indications for initiation of noninvasive mechanical ventilation (14). Patients were considered to have COPD when they presented with persistent airflow limitation with an FEV₁/FVC ratio <70% after the use of bronchodilators and with PaCO₂ level >55 mmHg in stable condition and with >30 days after the last exacerbation or with PaCO₂ >50 mmHg and clinical or echocardiographic signs of chronic cor pulmonale. These criteria were the same as those applied to patients grouped as presenting with sequelae of non-cystic fibrosis bronchiectasis or tuberculosis (non-CF BC or TB). Patients with OHS were defined by the presence of a body mass index (BMI) >30 kg/m², daytime hypercapnia >45 mmHg breathing room air, absence of other pulmonary or restrictive thoracic disease and restrictive or normal spirometry. Patients with restrictive thoracic diseases (scoliosis, thoracoplasties) and patients with neuromuscular diseases, including patients with traumatic cervical injury, started HMV due to the presence of daytime symptoms of hypoventilation with PaCO₂ >45 mmHg.

The pathologies were ultimately grouped as follows: COPD, OHS, non-CF BC or TB, ALS, non-ALS neuromuscular diseases (NMD), Scoliosis and other diagnoses.

Exclusion criteria

The program exclusion criteria were absence of a family support network, home lacking minimum required conditions (lack of electricity or plumbing), active smoking and drug addiction.

Data collected

The following were recorded prospectively: sex, age, BMI, spirometry, baseline daytime arterial gases (room air or oxygen supply in dependent patients), rural or urban residence, region of the country, section of the public health insurance (state health insurance classifies its insured according to their income level, the lower the income, the more coverage the state insurance provides), family APGAR (Assessed adult satisfaction with social support from the family, a score of 7 to 10 suggests a highly functional family) (15,16), baseline score on the Severe Respiratory Insufficiency (SRI) questionnaire, mode of admission (acute hospitalized patient, chronic stable patient and transferred from the children's program), use of home oxygen, interface (noninvasive or tracheostomy), spontaneous (S), spontaneous/timed (S/T), hybrid (average volume assured pressure support (AVAPS) and intelligent volume-assured pressure support (iVAPS) or other ventilation modes (pressure control, volume control, synchronous intermittent mandatory ventilation) and ventilator parameters,

From the time of admission to the program, the patient was followed up by the doctor assigned to the base hospital at one month, at three months, and every six months until year 4, after which the follow up was annual if the patients remained stable. Patients were regularly visited at their home 1 to 3 times a week by a kinesiologist and once a month by a nurse. The causes for discharge from the program were grouped as follows: poor adherence; disciplinary cause (non attendendance at medical check-ups, repeated absences at home when trying to visit him or her); voluntary withdrawal; transfer to another program; and improvement and exit from the program.

The baseline and follow-up data were entered into the online database designed by MINSAL for all respiratory programs, including those for home ventilation of children and adults (respiratorio.minsal.cl.). The survival analysis was conducted until August 1, 2018. The study was approved by the ethics committee of North Metropolitan Health Service of Santiago (Servicio de Salud Metropolitano Norte de Santiago), informed consent was obtained, and the study was conducted in accordance with the Declaration of Helsinki.

Lung function

Baseline spirometry was performed using a beta-2 bronchodilator (4 puffs of salbutamol), and the post-bronchodilator data were recorded. Turbine spirometers and predictive values according to Knudson (1983) were used (17).

Quality of life

Quality of life was evaluated with the SRI questionnaire (18), originally developed in Germany and translated into Spanish and validated in Spain for patients with home non-invasive ventilation (19). The version validated for Chile is being published, and preliminary data from a sample of 248 patients were found to be as valid and reliable as the original version.

Statistical analysis

The quantitative variables were expressed as the mean and standard deviation (SD) for those with a normal distribution and as the median and interquartile range (IQR1, IQR3) for those with a non-normal distribution. Categorical variables were expressed as absolute and relative frequencies. Differences were estimated with Anova test for numerical variables and with chi² test for categorical variables. Kaplan-Meier curves were used for the survival analysis with a closing date of August 1, 2018. The data were entered and analyzed using program STATA 14.2 IC (StataCorp LLC, USA).
Results

Patients' demographic and functional characteristics

In the described period, 1,105 patients were consecutively admitted, and the median age (IQR) was 59 (44-58) years; 58.1% were women, 762 (68.9%) lived in Santiago (metropolitan region) and 343 (31.1%) lived in other regions of the country. The BMI was 34.9 (26-46) kg/m². Socioeconomic groups A and B (personal monthly income below 450 USD) accounted for 85.4% of the patients covered by public health insurance (Table 1).

A total of 98.5% of the patients lived in urban areas, 76.2% (842 patients) started HMV in the chronic stable mode and 23.8% (263 patients) in the acute mode. The baseline SRI score was 47 (35-62.1) points. The family APGAR was 10 (8-10) points. A total of 99 patients were transferred from the children's program to the adult program (when they turned 20 years old).

The diagnostic groups were COPD 388 patients (35%); OHS 264 (23.9%), NMD 180 (16.3%); non-CF BC or TB 92 (8.3%), Scoliosis 65 (5.9%); ALS 58 (5.24%) and other diagnoses with 58 (5.24%) (Table 1). The baseline PaCO₂ of the overall sample was 58.2 (52-65) mmHg (Table 1).

Home mechanical ventilation characteristics

A total of 1,047 (94.8%) patients were ventilated noninvasively, and 58 (5.24%) were ventilated invasively (Table 2). The most used ventilatory mode was S/T in 86.8%. The baseline IPAP was 16 (14-18) cmH₂O. Patients were ventilated for 7.3 (5.8-8.8) hours per day (Table 2). The ALS group had the highest percentage of patients ventilated through tracheostomy, 29.3%, and in this same group, 44.7% of the patients used HMV for more than 16 hours a day (Table 3).

Baseline characteristics according to diagnostic group and time in the program

The COPD patients had a mean age of 65.6 (± 10) years and in the NMD group was 31.5 (± 15.1) years. The BMI of the patients with OHS was 47.3 (± 9.6) kg/m², and NMD patients was 22.5 (± 6.8) kg/m² (Table 3). Patients with Scoliosis had an FVC (% theoretical) of 36.1% (± 15), an FEV₁ of 34% (± 13), and a baseline PaCO₂ of 61.9 (± 12.8) mmHg.

The mean length of stay in the program was 21.6 (12.2-49.5) months. The Scoliosis group stayed in the program for 46.1 (±33.3) months, and the ALS group stayed for 14.8 (± 10.4) months.

Causes of discharge and survival in the program

As of December 31, 2017, 1,105 patients had been admitted to the HMV program. The condition of the patients as of August 1, 2018, was: 675 were active in the program (61.1%), 329 were deceased (29.8%) and 101 patients (9.6%) had left the program. The reasons for leaving the program were poor adherence in 52 patients (49.5%), no information in 23 (21.9%), disciplinary cause in 4 (3.8%), voluntary withdrawal in 3 (2.86%), and improvement and discharge from the program in 23 (22.7%). The latter group included patients undergoing bariatric surgery, with successful lung transplantation and those who started using continuous positive airway pressure (CPAP).

In regard to survival, patients with ALS were different from the other diagnostic groups because they showed lower 1- and 3-year survival of 67% and 26%, respectively (Figure 1).

The groups with the lowest 5-year survival were other diagnoses with 42%, COPD with 52% and non-CF BC or TB with 58%. The lowest 9-year survival was observed in the non-CF BC or TB and COPD groups, with 27% and 30.9%, respectively.

The longest 5-year survival was observed in the OHS, SCOLIOSIS and NMD groups with 81.2%, 77.4% and 71.4%, respectively, and these three groups maintained the highest survival at 9 years, with 57.7%, 57.2% and 50.9%, respectively.

A mean of 110 patients were admitted per year. In 2014 and 2017, there were a higher number of admissions, with 155 and 297 patients, respectively (figure 2, figure 3).

Discussion

We prospectively collected information on a cohort of adult patients who were beneficiaries of the public health insurance scheme and who were admitted to the HMV program with well-defined inclusion and exclusion criteria. The most frequent diagnoses observed in the cohort were COPD with 35%, OHS with 23.9% and NMD with 16.3%, these results are explained for the last three national health surveys in Chile (20), where the prevalence of smoking (daily or occasional) in 2003, 2010 and 2017 was 43.5%, 39.8% and 33.3%, respectively. In turn, the 2004 PLATINO survey established a prevalence of COPD in Chile of 16.9% in individuals over 40 years of age (21). In the same Chilean health surveys, the prevalence of obesity in 2003, 2010 and 2017 was 23.2%, 28.4% and 34.4%, respectively, and the expected number of mega-obese individuals (BMI >40)
increased from 148,000 people in 2003 to 415,000 in 2017 (20). We analyzed eight similar works published in the last 18 years, (table 4) From Janssens et al, in 2003 (22) to Cantero in 2020 (9), it is observed that OHS represents between 15.7% to 34% in those cohorts, except Windisch's work in 2003, in Australia and New Zealand, the most common indication for HMV was OHS in 31% cases of cases and NMD in 30% of cases (23). The prevalence of overweight and obesity reported in Australia was 63.4%, and in Tasmania, that of obesity was 32.3% (24). In Sweden, an analysis of 1526 patients with HMV between 1995 and 2006 showed that the most frequent diagnoses were OHS with 28%, COPD with 16%, non-ALS NMD with 15% and ALS with 11% (25).

The frequency of COPD varies between 6.3% up to 34.5% y 39% (7,18,9), similar to that of our cohort which was 35%. The median age in Chilean program people was 59 years, similar to the published reports, however Melloni (7) and Cantero (9) reported a median age that exceeds 70 years (table 4).

Schwartz et al (26) and Laub and Midgren (25) describe baseline PaCO2, 52.5 and 53.6 mmHg respectively, prior to the onset of HMV, in our cohort was 58.2 mmHg, possibly representing the admission of patients with more severe disease or suboptimal therapeutic control. In addition, in our program 72.6% of patients started HMV in a stable chronic condition, similar to what is reported by Povitz et al (8) and Laub and Midgren (25); while the Cantero cohort only 55% patients started HMV in this condition (table 4).

A explanation for more ALS patients entering HMV programs over the past two decades relates to the increased availability of flow-cycled and pressure-limited equipment with alarm systems that are cheaper and easier to implement at patients’ homes, there is also an increasing group of physicians and physiotherapists who are experts in this type of support which has allowed a growing number of patients to use this therapy at home.

In the series analyzed (table 4) the percentage of patients invasively ventilated through tracheostomy (TIV) varies between 3.1% and 12.4% (25,23,8,26) whereas in our cohort it was only 5.24%, this difference may be a consequence of the fact that in the Canadian program the most frequent diagnosis was NMD (30.4%) while the English cohort reported that it had 21.6% of patients with a diagnosis of ALS (26).

The HMV Chilean program includes socioeconomically vulnerable patients with a low monthly income and low educational level (27) but receive this home benefit at no cost, financed by the national public health insurance scheme. The baseline overall SRI score was 47 (35-62.1) points and expresses the severe limitation and alteration of the perception of quality of life of patients. Valko et al. reported an overall SRI score of 57.7 (± 14) (28), which is higher than ours. In our cohort, the APGAR family dysfunction score, which evaluates the functionality of the family group, was 10, and indicates important family support to the patient for the management of their disease (15,16).

The admission of patients with CRF to our program could be considered late compared to other countries as suggested by the PaCO2 levels, but we respect the indications of the 1999 consensus. Another reason that explains this is that among the criteria for admission to the Chilean national program, it is established that “the patient must have had been hospitalized for decompensation with CRF in the last 12 months”. This condition was necessary at the time of the creation of the program to reduce the number and duration of hospitalizations of the most severe patients, but now we must review the admission criteria and modify them so that patients are admitted to the program early.

In 2020, Schwarz et al. analyzed the time elapsed from admission to death of 1,210 patients on HMV in England and described that patients with ALS had the lowest mean survival, of 7 (3-14) months, whereas patients with OHS on HMV had the longest survival, 33 (13-75) months, and the mean survival of the overall cohort was 19.5 (6-55) months; in addition, 150 patients (12.4%) were ventilated through tracheostomy (26). The Swedish group describes that of its 1526 patients, only 6% were ventilated through tracheostomy and that the worst survival was observed in patients with ALS, with 20% survival at 2 years and 5% at 5 years (25). In the Chilean program, the mean time in HMV of patients with OHS was 42.3 (± 32.4) months, while in patients with ALS, it was 14.8 (± 10.4) months.

**Program weaknesses and strengths**

Baseline functional data at program admission, such as maximum inspiratory pressure (MIP), lung volumes and capacities, carbon monoxide diffusing capacity (DLCO) and polygraphs, were not available for all patients because some hospitals where the patients were evaluated did not have the equipment acquire these data. The measurement of DLCO and lung volumes and capacities has been described as having prognostic value, especially in COPD patients (29).

The SRI questionnaire was completed by all patients who had the ability to provide reliable information. At the beginning of the program, we did not have the validated Chilean version of the SRI questionnaire. The present cohort only represents the adult beneficiaries of the Chilean public health system, and it does not consider adults with private health insurance in need of HMV, whose number we do not know.

The strengths of this study include the fact that the HMV program was started gradually, first in the metropolitan region, which includes the capital of Chile, Santiago de Chile (6.1 million inhabitants); 3 years later, it was expanded to different regions of the country, and 6 years later, patients who needed invasive ventilation were included. Additionally, there has been low turnover in the technical team responsible, which includes medical
doctors, physiotherapists and nurses as well as professionals in the hospitals located in different regions of the country. This differs from other countries in which care is often provided by private health care companies or community providers (30).

Conclusion

The most frequent diagnoses in our cohort were COPD, OHS and NMD. Patients with a low quality of life score at admission were more hypercapnic than those in similar series from other countries. The patients were socioeconomically vulnerable, were distributed throughout the country, adapted very well to the use of HMV, and had a time of stay in the program similar to that of other series. The HMV program offers continuity of home ventilatory support for individuals transferred from the children’s national program. The best survival was observed in patients with OHS, Scoliosis and NMD, and the number of patients who were discharged from the HMV program due to resolution of their underlying disease was small.

Abbreviations

ALS, Amyotrophic lateral sclerosis; APGAR, screening for family dysfunction; BMI, body mass index; COPD, chronic obstructive pulmonary disease; CRF, chronic respiratory failure; DLCO, diffusion capacity of lung for carbon monoxide; EPAP, expiratory positive airway pressure; HMV, home mechanical ventilation; IPAP, inspiratory positive airway pressure; IQR, interquartile range; NMD, neuromuscular disease; OHS, obesity hypoventilation syndrome; PaCO$_2$, carbon dioxide arterial pressure; non-CF BC or TB, non-cystic fibrosis bronchiectasis or tuberculosis.

Declarations

Acknowledgments

Not applicable

Authors’ Contributions

CM, MAT, CR and NV designed the study. CM, MAT, MA, and KC collected data. CM, MAT, CR and NV analyzed and interpreted the data. CM, MAT and CR contributed to the writing of the manuscript. CM, MAT; CA, MA, PR, AV, SZ, MT and JV, were in charge of the evaluation, admission, direct clinical monitoring of patients and input of data on the MINSAL online database throughout the development of the program.

CO and OC contributed to data acquisition from flow generating equipment, memory oximeters and polygraphs.

All authors approved the final version of the manuscript, especially regarding the veracity and integrity of each of the phases of this work.

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Availability of date and materials

All data generated or analyzed during this study are included in this published article

The datasets generated and /or analyzed during the current study are not publicly available due to the ethical standards established by the law of duties and rights of patients Nº 20584 promulgated in 2012 by the Chilean State, but are available from the corresponding author on reasonable request.

[HMV Chile DATABASES WITHOUT PATIENTS NAMES.xlsx].

Ethics approval and consent to participate

The study was approved by the research ethics committee of the North Metropolitan Health Service Santiago, Chile, (Nº 018/2021). Participation was voluntary and informed written consent was obtained from all participants or their legal representatives. All procedures performed involving human participants were in accordance with the ethical standards established by the law of duties and rights of patients Nº 20584 promulgated in 2012 by the Chilean State and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Consent for publication

Not applicable.
Competing interests

The authors declare that they have no conflict of interest

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Tables

Table 1. Baseline demographic and clinical characteristics of HMV patients in Chile (n = 1,105)
| Characteristics          | n (%)     | Mean (IQR)       |
|--------------------------|-----------|------------------|
| Female                   | 572 (51.8) |                 |
| Male                     | 233 (48.2) |                 |
| Median age               | 59 (44-68) |                 |
| BMI (n=536)              | 34.9 (26-46)|                |
| Residence                |           |                 |
| Urban (%)                | 1008 (98.5)|                 |
| Rural (%)                | 17 (1.5)   |                 |

| Public health insurance (according to monthly income in 2020) |
|---------------------------------------------------------------|
| Group A and D (≤ 450 USD)                                     |
| Group C (450 and ≥ 667 USD)                                   |
| Group D (667 USD)                                             |
| Family APGAR (n=655)                                         |
| Baseline overall SRI score                                   |
| Comorbidities                                                 |
| Arterial hypertension                                        |
| Diabetes                                                     |

| Initiation of ventilation                                     |
|---------------------------------------------------------------|
| Acute                                                         |
| Chronic                                                      |
| Transferred from the children’s program                      |
| Patients with ≤ 90 days in the program                       |
| Patients with > 90 days in the program                       |

| Diagnosis causing hypoventilation (Groups)                   |
|---------------------------------------------------------------|
| 1) COPD                                                      |
| 2) OHS                                                       |
| 3) NMD                                                       |
| 4) non-CF BC or TB                                           |
| 5) SCOLIOSIS                                                |
| 6) ALS                                                      |
| 7) OTHER DIAGNOSES                                          |

| Lung function (Spirometric) (n = 623)                        |
|---------------------------------------------------------------|
| FVC (L)                                                      |
| FEV₁ (L)                                                     |
| FEV₁/FVC (%)                                                 |
| Arterial blood gas                                          |
| PaO₂ (mmHg)                                                  |
| PaCO₂ (mmHg)                                                 |
| HCO₃⁻ (mmol/L)                                               |

**Abbreviations:** HMV, home mechanical ventilation; BMI, body mass index; URBAN, area with > 10,000 people; APGAR, screening for family dysfunction, 7 to 10 suggests a highly functional family; SRI, severe respiratory insufficiency score; COPD, chronic obstructive pulmonary disease; OHS, obesity hypoventilation syndrome; NMD, neuromuscular disease; non-CF BC or TB, non-cystic fibrosis bronchiectasis or tuberculosis; ALS, amyotrophic lateral sclerosis; OTHER DIAGNOSES, cystic fibrosis, pulmonary fibrosis, phrenic paralysis, posttransplant bronchiolitis.
Table 2. Baseline ventilatory characteristics of HMV patients (n = 1,105)

| O₂ supplementation needed (LTOT) | n (%) | 688 (62.4) |
|----------------------------------|-------|------------|
| **Interface**                    |       |            |
| Noninvasive                      | n (%) | 1047 (94.8) |
| Invasive (tracheostomy)          | n (%) | 58 (5.2) |
| **Time in home mechanical ventilation (months)** | median [IQR] | 21.6 (12.2-49.5) |
| **Ventilatory modes (n = 706 patients)** |       |            |
| Spontaneous/timed (S/T)         | n (%) | 613 (86.8) |
| Spontaneous (S)                 | n (%) | 34 (4.8) |
| Hybrid (AVAPS or iVAPS)         | n (%) | 46 (6.5) |
| Other modes                     | n (%) | 13 (1.8) |
| **Compliance (hours/day)**      | median [IQR] | 7.3 (5.8-8.8) |
| **Ventilator settings (n = 706 patients)** |       |            |
| IPAP (cmH₂O)                    | median [IQR] | 16 (14-18) |
| EPAP (cmH₂O)                    | median [IQR] | 6 (6-8) |
| Maximum IPAP (cmH₂O) (only hybrid mode) | median [IQR] | 18 (16-22) |
| Backup respiratory rate         | median [IQR] | 15 (14-16) |

**Abbreviations:** HMV, home mechanical ventilation; LTOT, long time oxygen therapy; AVAPS, average volume assured pressure support; iVAPS, intelligent volume-assured pressure support; OTHER MODES, controlled assist mode, synchronous intermittent mandatory ventilation, pressure control and volume control; IPAP = inspiratory positive airway pressure; EPAP, expiratory positive airway pressure.

Table 3. Baseline variables and time spent in the program of active, dead, and discharged patients as of August 1, 2018, according to diagnostic groups (n = 1,105).
Abbreviations: COPD, chronic obstructive pulmonary disease; OHS, obesity hypoventilation syndrome; NMD, neuromuscular disease; non-CF BC or TB, non-cystic fibrosis bronchiectasis or tuberculosis; ALS, amyotrophic lateral sclerosis; OTHER DIAGNOSES, cystic fibrosis, pulmonary fibrosis, phrenic paralysis, posttransplant bronchiolitis; BMI, body mass index; NIV, noninvasive ventilation; TIV, tracheostomy invasive ventilation; HMV, home mechanical ventilation; IPAP = inspiratory positive airway pressure; EPAP, expiratory positive airway pressure.

Comparison: differences were estimated with Anova test for numerical variables and with chi2 test for categorical variables and they were significant with a p value of <0.001, except for bicarbonate in arterial blood, with p value = 0.008.

Table 4. Published studies about HMV and the frequency of the different diagnostic groups.
| Author | Janssens JP\textsuperscript{22} | Windisch\textsuperscript{18} | Midgren\textsuperscript{25} | Gamer\textsuperscript{23} | Povitz\textsuperscript{8} | Melloni\textsuperscript{7} | Schwartz\textsuperscript{26} | Cantero\textsuperscript{9} |
|--------|------------------|-----------------|-------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Year   | 2003             | 2003            | 2007              | 2013            | 2017            | 2018            | 2020            | 2020            |
| Reference | 22           | 18              | 25                | 23              | 8               | 7               | 26              | 9               |
| Area/Country | Area      | Area            | Country           | Country         | Area            | Country         | Area            | Area            |
| Type of study | cohorte   | cohorte         | cohorte           | survey          | cohorte         | survey          | cohorte         | cohorte         |
| Patients (n) | 211         | 226             | 1,526             | 2,725           | 4,670           | 4,522           | 1,210           | 489             |
| Age (years) | 63           | 57.3            | 58.6              | 57.5            | 58.5            | 70.3            | 65.1            | 71              |
| PaCO2 (mmHg) | >45         | >50             | 53.6              | ...             | ...             | >45             | 52.5            | >50             |
| TIV(%) | excluded        | excluded        | 6                 | 3.1             | 7.7             | ...             | 12.4            | excluded        |
| NMD (%) | 10             | 19              | 15                | 30              | 30.4            | 18              | 13              |                 |
| COPD (%) | 27           | 34.5            | 16                | 8               | 18.8            | 6.3             | 24.5            | 39              |
| OHS (%) | 34             | 5.3             | 28                | 31              | 15.9            | 15.7            | 16.7            | 26              |
| ALS (%) | 3              | 27              | 11                | 8.4             | 7.5             | 1.2             | 21.6            | 3               |
| Acute onset of ventilation (%) | ...          | ...             | 26.6             | ...             | 23              | ...             | ...             | 45              |
| Follow-up time (years) | 7            | 3.25            | 10                | 4               | 12              | 15              | 10              | 3.3             |

**Abbreviations:** HMV, Home Mechanical Ventilation; TIV, Tracheostomy invasive ventilation; NMD, Neuromuscular disease; OHS, Obesity hypoventilation syndrome; ALS, Amyotrophic lateral sclerosis.

**Figures**

**Figure 1**

Survival time in years according to diagnostic groups.
Figure 2

Annual flow of patients in the AVNIA-AVIA home mechanical ventilation programs in 2008 to 2017, Chile (n = 1,105).

Figure 3

Yearly count of the cumulative population of patients treated by HMV during the study period (2008 to 2017), by diagnostic category.