Variability in Home Mechanical Ventilation Prescription

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Abstract

Introduction: Few studies have analyzed the prevalence and accessibility of home mechanical ventilation (HMV). The aim of this study was to characterize the prevalence of HMV and variability in prescriptions from administrative data.

Methods: Prescribing rates of HMV in the 37 healthcare sectors of the Catalan Health Service were compared from billing data from 2008 to 2011. Crude accumulated activity rates (per 100,000 population) were calculated using systematic component of variation (SCV) and empirical Bayes (EB) methods. Standardized activity ratios (SAR) were described using a map of healthcare sectors.

Results: A crude rate of 23 HMV prescriptions per 100,000 population was observed. Rates increase with age and have increased by 39%. Statistics measuring variation not due to chance show a high variation in women (SCV=0.20 and EB=0.30) and in men (SCV=0.21 and EB=0.40), and were constant over time. In a multilevel Poisson model, hospitals with a respiratory medicine unit were associated with a greater number of cases (beta=0.68, P<0.0001).

Conclusions: High variability in prescribing HMV can be explained, in part, by the attitude of professionals toward treatment and accessibility to specialist centers with a respiratory medicine unit. Analysis of administrative data and variability mapping help identify unexplained variations and, in the absence of systematic records, are a feasible way of tracking treatment.

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Variabilidad en la prescripción de la ventilación mecánica a domicilio

Resumen

Introducción: Hay pocos estudios que hayan analizado la prevalencia y la accesibilidad a la ventilación mecánica a domicilio (VMD). El objetivo del presente estudio es describir la prevalencia de la VMD y estudiar la variabilidad a partir de datos administrativos.

Métodos: Se compararon las tasas de VMD en las 37 áreas de salud a partir de los datos de facturación del Servicio Catalán de la Salud, durante el período 2008–2011. Se calcularon las tasas brutas de actividad acumulada (por 100,000 habitantes) utilizando el componente sistemático de variación (CSV) y empírico Bayes (EB). Las razones de actividad estandarizada (REA) se describieron mediante un mapa de sectores de salud.

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**Resultados:** La tasa bruta VMD fue de 23 usuarios/100.000 habitantes. Las tasas aumentan con la edad y han crecido un 39%. Los estadísticos que miden la variación no debida al azar muestran una variación elevada en mujeres (CSV = 0.20 y EB = 0.30) y en hombres (CSV = 0.21 y EB = 0.40), y constante a lo largo del tiempo. En un modelo de Poisson multinivel la existencia de un hospital con servicio de neumología se asoció con un mayor número de casos (β = 0.68; p < 0.0001).

**Conclusiones:** La variabilidad elevada de la VMD puede explicarse, en parte, por la actitud de los profesionales hacia el tratamiento y la accesibilidad a centros que disponen de especialista de neumología. El análisis de los datos administrativos y la confección de mapas de variabilidad permiten identificar variaciones no explicadas y, en ausencia de registros sistemáticos, es una manera factible de realizar el seguimiento de un tratamiento.

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**Introducción**

La ventilación mecánica domiciliaria (VMD) fue introducida debido a la necesidad de tratar a los supervivientes de la poliomielitis que no solamente requerían tratamiento de larga estancia que permitiera la supervivencia,

La VMD ha sido introducida, en la mayoría de los hospitales en el mundo, en los últimos 20 años. Durante este periodo, se han descrito múltiples indicadores de la VMD, incluyendo la variabilidad intercentro y la variabilidad dentro de cada centro. Los análisis de estos datos indican que la VMD es un factor importante en la calidad del tratamiento y la eficiencia de los servicios de VMD.

**Métodos**

Para el análisis de los datos, se utilizó el software STATISTICA versión 11.2 y R, versión 3.00.0. Se realizaron análisis descriptivos y estadísticos, incluyendo pruebas de normalidad y homogeneidad de varianzas. Los resultados se presentan en forma de gráficos y tablas, y se discuten con base en la literatura previa.

**Resultados**

Un total de 240.760 pacientes que recibieron algún tipo de tratamiento respiratorio fueron identificados en el sistema público durante el periodo entre 2008 y 2011. De estos, 75.8% utilizó dispositivos de soporte respiratorio, y 17.3% recibieron diferentes formas de tratamiento para la ventilación mecánica no invasiva (VNI). Las tasas de hospitalización se calcularon en 2.5% en la población general, y 4.2% en pacientes con neumopatía crónica. Estos resultados sugieren la importancia de la vigilancia y el control de la VMD en el sistema público.

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**Bibliografía**


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**Agradecimientos**

Agradecemos a las consultoras y los profesionales del área de la salud que participaron en la revisión de los datos. Esta colaboración es fundamental para el éxito de este estudio.
Table 1

<table>
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<tr>
<th>Statistic</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;40</td>
<td>40–64</td>
</tr>
<tr>
<td>n</td>
<td>272</td>
<td>1016</td>
</tr>
<tr>
<td>Crude rate x 100 000</td>
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<td>21.26</td>
</tr>
<tr>
<td>VR_{0.95}</td>
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<td>5.43</td>
</tr>
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</table>

\( VR_{0.95} \): ratio between the 95th and the 5th percentile of the standardized rate.
Crude rate x 100 000: crude cumulative incidence between 2008 and 2011.

**Fig. 1.** Evolution of the number and crude rate of home mechanical ventilation in men and women between 2008 and 2011.

During the period studied, 6867 patients received HMV, giving a crude rate of 23 users per 100 000 population between 2008 and 2011. Table 1 shows the number of men and women with HMV by age group, reference population, and crude rates. Between 2008 and 2011, there was an average of 1 patient on HMV per 4352 women and per 4361 men. By age groups, the crude rates increased with age to 1 user per 1194 women and 1297 men in the patient group aged over 74 years. The rates of HMV increased by 39% over the study period (Fig. 1). Table 1 also shows the distribution of the standardized HMV rates by health sector. In the over-40 years group, the HMV rate in the 95th percentile was 5 times higher than the rate in the 5th percentile in women, and 14 times higher in men. By age groups, this inter-sectorial variation increased by between 6 and 40 times in both sexes.

**Fig. 2.** Dot plot showing standardized home mechanical ventilation rates by sector and age group (2008–2011).

**Fig. 3.** Shows the standardized HMV rates on a map. The darker the color of the sector, the higher the standardized HMV rate.

Table 2 shows the distribution of the standardized HMV rate ratios and indirectly standardized rates by age groups and sex. In sectors with a standardized ratio in the 95th percentile, a 76% higher standardized HMV rate can be observed in men with respect to the standardized rate of the sectors as a whole; in women it is 51% higher. Meanwhile, both the systematic coefficient of variation (SCV) and the empirical Bayes (EB) rate variation not due to chance, show high variation in women (SCV=0.20 and EB=0.30) and men (SCV=0.21 and EB=0.40) for HMV. The trend in statistics measuring variations not due to chance shows a consistently high year-on-year variation, taking values of between EB=0.25 and EB=0.39 in the same period.

**Fig. 4.** Shows a funnel chart where each point represents a sector: the blue line at 1 represents the average rate of all the sectors; and the dotted blue lines on either side of 1 represent the 99.9% confidence interval of this average. The orange dots are sectors with no statistically significant differences with respect to the average of all sectors, the green dots are sectors with lower standardized rates with respect to the average, and the red dots are those with higher standardized rates with respect to the average. Some sectors can be observed above and below the area defined by the confidence interval, corresponding to overuse or underuse of HMV with respect to the average of all the sectors, respectively.

The high variation identified between sectors could be explained by different factors related with supply and demand for the service. In a multilevel Poisson model, both sectors (variance sectors 0.38) and clusters (variance clusters 0.15) explained some of the variability. These data suggest that, disregarding the effect of sex and age, intra-sectorial and intra-cluster variability was less than inter-sectorial and inter-cluster variability, respectively. Moreover, in this same model, the presence of a hospital with a Respiratory Medicine department was associated with a higher number of cases (beta=0.68; \( P<.0001 \)).

**Discussion**

The aim of this study was to analyze variability in the prescription of HMV based on administrative data available in public services of hospital records. Variability in clinical practice, in terms of both diagnosis and treatment, occurs in all care settings. Newhouse and Garber14 drew attention to the variability in post-hospital discharge healthcare services (long-term care hospitals, skilled nursing facilities or home health services). Studies showing variability in the prescription of HMV in Europe have been published for over 20 years.15 The Euvovent Survey found that HMV variability occurred both in the number of prescriptions and the profile of patients for whom this treatment was prescribed, neither of which was related with the characteristics of the healthcare system or the economic situation in each country.16 The national Swedish HMV register also highlighted variability in prescription within the country itself, despite a similar level of healthcare coverage.17

The number and profile of patients could be related to the number of prescribing centers and their characteristics (presence of a
respiratory medicine specialist). Although HMV is not technically complex, decision-making and resolving complications require the types of skills that justify concentrating prescription in only a few centers. In Denmark, there are only 2 centers that prescribe HMV; in this country prevalence is low, and the therapy is usually indicated in younger patients with neuromuscular diseases.\textsuperscript{18}

Another factor that may explain the variability is the absence of objective evidence-based criteria for starting HMV, especially in obese or COPD patients. The findings of a recent study on the variability of HMV in Australia and New Zealand suggest that, in addition to variability in prevalence, HMV is more likely to be started in obese patients in New Zealand than in Australia.\textsuperscript{19} On the other hand, the wide variety of diagnoses or patients potentially in need of HMV could also explain the variations observed. In the final analysis, therefore, the attitude of physicians to ventilation might well be one of the most important factors behind variability, although this is hard to demonstrate.\textsuperscript{20}

In England,\textsuperscript{21} evidence of variability and difficulty of access to treatment led to calls for the creation of a register, and for indications to be standardized by means of, for example, clinical practice guidelines. However, although registers can be very useful for analyzing long-term trends, they are often of little use in promptly identifying specific problems if they are not regularly updated and the patient’s overall stability is not accurately reported. In addition, in some neuromuscular diseases such as amyotrophic lateral sclerosis, lung function data have prognostic value but very little predictive value.

The greatest limitation of this study is the lack of access to diagnoses. The use of administrative data, for reasons of confidentiality, only allows access to the type of treatment subsidized by the public health system, the patient’s age and town of residence. Register-based analysis would improve data mining, but a register is not easy to construct, and is expensive and difficult to maintain. Moreover, obtaining information from the prescribing center (which would give more detailed information on diagnosis and the technical characteristics of the treatment) might not necessarily give an idea of the population impact (a center may prescribe ventilation to patients from various geographical sectors). In Catalonia, the population insured by CatSalut (with different levels of coverage) represents practically the entire population. Patients with double medical coverage (public and private) seen in private centers are currently not included in public information systems.

![Fig. 3. Map of standardized home mechanical ventilation rates in patients aged over 40 years (2008–2011).](image)

### Table 2

<table>
<thead>
<tr>
<th>Statistic</th>
<th>&lt;40</th>
<th>40–64</th>
<th>65–74</th>
<th>&gt;74</th>
<th>&lt;40</th>
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<th>65–74</th>
<th>&gt;74</th>
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<td>0.00</td>
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<tr>
<td>SCV</td>
<td>0.44</td>
<td>0.07</td>
<td>0.28</td>
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<td>0.65</td>
<td>0.12</td>
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</tr>
<tr>
<td>EB</td>
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<td>0.09</td>
<td>0.42</td>
<td>0.90</td>
<td>0.40</td>
<td>0.22</td>
<td>0.92</td>
<td>0.88</td>
</tr>
</tbody>
</table>

EB: empirical Bayes; SAR<sub>x</sub>: value in the x percentile of the standardized rate ratio; SCV: systematic component of variation.
Therefore, in terms of rates, the numerator (number of cases) may be higher, but the denominator (population at risk) would remain the same, which could suggest a slight underestimation.

Nevertheless, simple but easily accessible information, such as that discussed here, allows treatment to be followed-up practically online, without the need for a specific register.

Thus, despite the aforementioned limitations, the data analyzed reveal some key points. First, there is large variability in the prescription of HMV that cannot be explained by administrative or economic difficulties in accessing services. Despite the existence of few prescribing centers, and the fact that these are in contact with each other and often exchange experiences, large variability persists. There are no data to suggest that this variability is due to recent changes in criteria for prescribing ventilation, such as indication in COPD or OHS patients. In the study by Farré et al.,23 which reported findings from the 4 hospitals that attended most patients with HMV in the Barcelona metropolitan area, large variations between prescribing centers had already been observed almost 10 years ago.

The number of specialists available in a particular area could cause variability in prescription, and this has been observed in other respiratory therapies, such as home oxygen therapy. However, this phenomenon does not explain the variations within the Barcelona metropolitan area, where access is easy and a large number of specialists available. Besides, context should always be taken into account when performing data analysis. Hospitals did not begin to prescribe HMV simultaneously. Prior to 1990, only 1 center in Catalonia systematically prescribed HMV,24 and until 1995, it was prescribed routinely in only 5–6 hospitals.

The large variability in criteria for prescribing HMV in older patients is notable. This contrasts with studies that show the benefits of HMV in patients aged over 75 years. Farrero et al.25 showed that ventilation in patients aged over 75 years improved gas exchange and that, after the initial adaptation phase, median survival was 6 years.

Finally, supply companies can influence the variability of HMV prescription. Given the characteristics of the funding system, with very stringent limits on increases in prescriptions, it is unlikely that these companies have a direct effect on such prescriptions. However, the range of services or type of apparatus offered could have a bearing on prescription numbers. Either way, technical service should always be included as a variable in the analysis of variability in HMV prescription.

Sunwoo et al.26 highlighted the complexity of evaluating HMV-related technology, both due to the increase in the number of users and the difficulties involved in standardizing the services they receive. The type of analysis proposed, based on available data (essentially billing-related) may be a good complement to clinical experience and cross-sectional studies that give an overall view of the problem, and reveal variations in a relatively simple, inexpensive way.

**Conflict of Interests**

The authors declare that they have no conflict of interests.

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References