A single-centre 7-year experience with weaning from mechanical ventilation

Anna Rojek-Jarmuła¹, Rainer Hombach¹, Danuta Gierek², Łukasz J. Krzych³, ⁴

¹Marienhaus Klinikum Eifel Weaning Intensivstation Neuerburg, Germany
²Department of Anaesthesiology and Intensive Care, Upper Silesian Medical Centre, Katowice, Poland
³Department of Cardiac Anaesthesia and Intensive Care, Silesian Centre for Heart Diseases, Zabrze, Poland
⁴Medical University of Silesia, Katowice, Poland

Abstract

Background: Weaning from mechanical ventilation is a growing and challenging issue in modern intensive care medicine. We aimed to describe a 7-year experience in weaning from mechanical ventilation of a single centre in Germany.

Methods: We retrospectively analysed data regarding 403 patients admitted between 2007 and 2013 with difficult or prolonged mechanical ventilation weaning.

Results: There were 261 men (64.8%) in the population. The median age was 72 (IQR 63; 77) years. The underlying reasons for ventilator dependence comprised: post-operative respiratory failure (56.3%), exacerbation of chronic obstructive pulmonary disease (14.4%) and pneumonia (7.4%). A tracheostomy was performed about 9 (IQR 7; 14) days after the last attempt of a spontaneous breathing trial, usually with the percutaneous method (89.3%). The median length of stay was 28 (IQR 20; 41) days. Sixty-five (16.1%) patients died. Among the survivors, complete ventilator independence was achieved in 316 (78.4%) subjects while 94 (29.7%) of subjects required a tracheal tube on discharge. The vast majority of patients were discharged to rehabilitation clinics (56.1%). All of the analysed parameters did not statistically significantly differ between consecutive years in the investigated period.

Conclusion: Our initial experience with weaning from mechanical ventilation are encouraging, repeatable in subsequent years of observation and consistent with the literature data. Assessing the predictors of successful mechanical ventilation weaning requires further research.

Key words: weaning; mechanical ventilation; chronic respiratory failure

Chronic respiratory failure is a growing problem in intensive care [1, 2]. Considering the increasingly aging and more severely affected profile of patients both qualified for surgical procedures and chronically those treated due to ailments in the departments of internal diseases, the percentage of such patients is expected to increase [2]. Due to advances in mechanical ventilation (its availability, methods, staff training, etc.) and an increasingly restrictive cost-related policy, departments dedicated to the weaning of chronically ventilated patients (who otherwise would be treated in standard ICUs) are being organized.

Although the admission criteria, definitions determining mechanical ventilator dependence and personnel are different in various centres, attempts are being made to standardise the care provided for this group of patients [3]. Such solutions have been functioning in the countries of North America [4, 5] and Western Europe [6–8] for about 15 years and are expected to be implemented in Poland in the nearest future.

Generally, the first few years of the functioning of the departments in question provide information which allows one to sum up treatment outcomes and to compare them with the literature data available [4–9]. Therefore, the aim of the study was to present the 7-year experience of a German mechanical ventilation weaning centre, which admits chronically ventilated patients.
METHODS

The study included consecutive patients admitted to the mechanical ventilation weaning station in Neuerburg in the years 2007−2013. This 9-bed station was opened in May 2007 and started to admit patients on 13.06.2007 with 424 patients having been admitted until 31.12.2013. As the data of 21 patients were incomplete, they were excluded from further analyses (6 — 2007, 4 — 2008, 3 — 2009, 6 — 2010, 2 — 2012). The patients were referred from ICUs (the ICU stay ranged from 1 to 6 weeks) with postoperative respiratory failure, exacerbations of respiratory failure in the course of chronic diseases (chronic obstructive pulmonary disease, asthma, pulmonary hypertension, pulmonary fibrosis, pneumoconiosis, etc.), neurological causes of respiratory insufficiency (central and peripheral), post-resuscitation disease, osteoarticular diseases, multiple organ trauma, and with neoplastic diseases after palliative procedures. The data were used with the consent of the head of the station. The approval of the Ethical Committee was not legally required. The indications for hospitalization in such stations are described in the updated guidelines of the German Respiratory Society [10]. The admission criteria include chronic respiratory failure requiring mechanical ventilation with anticipated severe or prolonged mechanical ventilation weaning, i.e. 2−3 attempts of unsuccessful extubation and/or < 7 days of prolonged mechanical ventilation and 3 or more extubation attempts and/or > 7 days of prolonged mechanical ventilation. The treatment and the procedures used are based on standards for definite disease entities (AWMF, Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften) [11].

Treatment is refunded by healthcare funds within the system of German Refined Diagnosis-Related Groups [12]. All the procedures are priced as in standard intensive care units while the costs of mechanical ventilation are covered separately (per hour of ventilation).

The basic parameters, involving demographic data, reasons for admission, early tracheostomy required (i.e. within 7 days of ventilation), duration of stay, place of discharge and efficacy of treatment, were statistically analysed using MedCalc v 14.8.1 software. Qualitative variables were presented as an absolute value and/or percentage whereas those which were quantitative were presented as median and interquartile range (IQR). Inter-year differences were evaluated using the χ2 or Kruskal-Wallis test. In the case of statistically significant differences for quantitative variables, a post-hoc analysis was performed. P < 0.05 was considered as statistically significant.

RESULTS

An analysis included 403 chronically ventilated patients hospitalised in the individual years were 9, 44, 75, 69, 74, 69 and 63. The study group consisted of 261 male (64.8%) and 142 female (35.2%) patients, with no differences in the consecutive years (Fig. 1) (P = 0.5). The mean age was 72 years (IQR 63; 77 years). No differences in the age of patients admitted during the consecutive years were found (Fig. 2) (P = 0.4).

The reasons for admission to the chronic ventilation centre are presented in Table 1. The causes of respiratory failure did not differ in the individual years (P = 0.2).

The median length of stay in the centre was 28 days (IQR 20; 41 days), with no differences in the individual years (Fig. 3) (P = 0.5). The longest stay was 153 days. As far as the largest group is concerned (with postoperative respiratory failure), the median time between surgery and admission was 25 days (IQR 17; 41 days) and was statistically significantly different in the successive years (P = 0.03). The patients from this group were found to be increasingly quickly transferred to the chronic ventilation centre (Fig. 4). From the perspective of 7 years, the patients admitted most commonly were those after cardiac (57.5%) and abdominal surgical procedures (16%), as well as neurosurgeries (9.8%).

A tracheostomy was performed in patients on about post-intubation day 9 (IQR 7; 14 days), with no differences observed in the analysed years (P = 0.3). The percutaneous method was applied most frequently (n = 360; 89.3% vs. surgical in 43 patients; 10.7%), with no inter-year differences (P = 0.7). Although a pre-admission tracheostomy was carried out in 368 patients (95.1%), it is noteworthy that none of the patients had a pre-admission tracheostomy in 2007, and only 2% in 2008 with the percentage of such patients increasing in the successive years (P = 0.01). An early tracheostomy was performed in 131 chronically ventilated patients.
individuals, and an increasing tendency in the percentage of patients admitted with early tracheostomy was observed in the individual years (Fig. 5) \( P < 0.01 \).

Among the patients admitted, 65 (16.1%) died during their hospital stay; no significant differences were noted in the individual years (Fig. 6) \( P = 0.8 \). The places the remaining patients (338, 83.9%) were transferred to are listed in Table 2. Most commonly, these were rehabilitation centres (56.1%), home (14.8%) and transferring departments (13.2%). The factor which markedly determined the type of place the patients were discharged to was age (Fig. 7) \( P < 0.001 \). Weaning from chronic ventilation was feasible in 316 (78.4%) discharged patients, including 94 discharged with a tracheostomy tube.

**DISCUSSION**

The objective of the study was to describe the patients admitted to the regional centre for chronic respiratory failure treatment over a period of 7 years and to assess the treatment outcomes. In general, our findings are consistent with the literature data, particularly as for treatment successes and hospital mortality [4–9]. The largest differences concern the percentage of hospitalized women — 35% in our study and about 50% in other reports [4–6, 8, 9], which most likely results from the differences in admission reasons — in our study, surgical patients were predominantly admitted (56.3%) whereas in other studies this concerned patients from medical ICUs. A comparison of ages confirms that, in the studies published earlier [4,
analyses involved younger patients, as compared to the most recent reports [5, 7].

Patients requiring prolonged ventilation are a financial and logistic burden for intensive care units, which is evidenced by the number of ventilation days before admission to the mechanical ventilation weaning station. This number in the study performed in 23 American centres was 34 days [13]; in other single centres — 56 [5] or 50 days [7]. Our findings

Figure 3. Length of stay and year of hospitalisation.
Explanations: the figure contains medians, interquartile range (box-whiskers) plus divergent and extreme observations (circles and squares)

Figure 4. Time between surgery and admission versus year of hospitalisation.
Explanations: the figure contains medians and interquartile range (box — whiskers) < divergent and extreme observations (circles and squares); P < 0.05 in post-hoc analyses concerned differences in 2009 vs. 2008, 2011 and 2012
are satisfactory as the median time between admission and transfer was only 25 days (IQR 17; 41 days). Moreover, it was demonstrated that a high index of successful mechanical ventilation weaning could be obtained with early and regular extubation attempts according to the pain — agitation — delirium (PAD) protocol [14]; when failed — with early institution of specialist treatment in weaning stations [15]. In patients receiving longer ventilation and sedation, the risk of respiratory, circulatory and infectious complications is higher, which translates into a poor prognosis [10, 15]. Moreover, the underlying conditions inducing respiratory failure are more difficult to be cured in such patients [8]. Considering the extent of the issue, the register of chronically ventilated patients being weaned (WeanNet) was prepared under the auspices of the German Society for Pneumology and Respiratory Medicine [16]. The project is coordinated by the Institut für Lungenforschung and to date encompasses 70 centres. Its objective is to widen the cooperation between centres, standardise treatment and improve the quality of care. The near future should reveal whether the initiative is effective enough to be applied in other countries.

### Table 2. Departments and places of discharge

<table>
<thead>
<tr>
<th>Place of discharge</th>
<th>Percentage of patients (n = 344)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rehabilitation</td>
<td>56.1</td>
</tr>
<tr>
<td>Home</td>
<td>14.8</td>
</tr>
<tr>
<td>Surgical</td>
<td>8.7</td>
</tr>
<tr>
<td>Geriatric</td>
<td>7.8</td>
</tr>
<tr>
<td>Nursing home</td>
<td>7</td>
</tr>
<tr>
<td>Internal diseases</td>
<td>4.7</td>
</tr>
<tr>
<td>Neurological</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Figure 5. Early tracheostomy and year of hospitalisation

Figure 6. Percentage of deaths and year of hospitalisation

Figure 7. Age of patients, discharge departments and places

Explanations: the figure contains medians and interquartile range (box—whiskers plus divergent observations (circles); P < 0.05 in post-hoc analyses concerned differences between the following departments: surgical vs. nursing home, geriatric; home vs. geriatric, internal diseases, rehabilitation; nursing home vs. surgical, internal diseases, rehabilitation; geriatric vs. surgical, home, internal diseases, rehabilitation; internal diseases vs. home, nursing home, geriatric; rehabilitation vs. home, nursing home, geriatric.
Our study is not free of limitations, which have to be considered during interpretation of results. The findings are preliminary and descriptive, despite the thorough characteristics of the study group and initial additional diseases. Furthermore, the long-term fate of patients was not analysed as such data are not easily available in Germany. Most interestingly, more detailed analyses should be carried out to search for the factors that can determine the success of treatment in mechanical ventilation weaning stations, as for weaning and probability of survival since numerous algorithms of increasingly better predictive capacities have been designed for many years [17–20].

CONCLUSIONS
Preliminary treatment outcomes are encouraging, repeatable over the period of 7 years and consistent with the literature data. In the majority of cases, weaning is feasible during one month of hospitalization. Further studies are required to assess the weaning predictors.

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References

Corresponding author:
Anna Rojek-Jarmała, MD
Marienhaus Klinikum Eifel St. Elisabeth Krankenhaus
Aloys-Schneider-Straße 37
54568 Gerolstein, Germany
e-mail: Anna.Rojek-Jarmała@marienhaus.de

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