Original Article

Characteristics and Outcome for Very Elderly Patients (≥ 80 years) Admitted to a Respiratory Care Center in Taiwan

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S U M M A R Y

Background: The aim of the study was to assess the characteristics of and outcomes for very elderly patients (≥ 80 years) with prolonged mechanical ventilation (PMV) under the mandatory integrated delivery system (IDS) in Taiwan.

Method: This was a retrospective observational study conducted in a step-down respiratory care center (RCC) among adult patients aged > 45 years on prolonged mechanical ventilation (≥ 21 days) between January 2006 and December 2008.

Results: A total of 288 patients (63 aged 45–65 years, 115 aged 66–79 years, and 110 aged ≥ 80 years) were included in the study. There were more female patients in the oldest group (p < 0.01). A cardiovascular disorder as the main reason for ventilator dependence was associated with increasing age (p < 0.01). A longer RCC stay in the oldest compared to the youngest group was noted (30 vs 25 days, p = 0.02). Some 126 patients (43.8%) were weaned; there was a trend for successful weaning in relation to age group (p = 0.04). However, RCC mortality was not associated with age (p = 0.44). For weaned patients, those in the oldest group had higher mortality in long-term follow-up (p = 0.03). For patients with weaning failure, age had no influence on long-term weaning outcome or mortality rate (p = 0.56 and 0.69, respectively).

Conclusion: The oldest PMV patients (≥ 80 years) had lower weaning probability and a poorer outcome even if they were weaned from the ventilator in the RCC. For patients with weaning failure, age had no impact on weaning outcome and long-term survival rate after they were transferred to a step-down care facility.

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1. Introduction

The intensive care unit (ICU) is designed to accommodate critically ill patients. It is estimated that approximately 36% of patients admitted to the ICU develop respiratory distress and temporary ventilatory support is required1,2. Most patients survive several acute episodes, but approximately 5–20% become dependent on prolonged mechanical ventilation (PMV). In Taiwan, a health insurance integrated delivery system (IDS) has been developed to accommodate PMV patients, as previously described3. All patients admitted to the ICU should be reported to the National Health Insurance Bureau (NHIB) within 5 days of the initiation of mechanical ventilation (MV). Once the overall condition of a patient has improved but MV is still necessary, the patient should be transferred to a step-down respiratory care center (RCC) within 21 days under IDS regulations. The NHIB provides continued treatment in an RCC for a maximum of 42 days. If MV is still required at that point, the patient should be transferred to an extended care facility such as a respiratory care ward or for home ventilator use unless their condition has otherwise deteriorated. In a previous study, we found that elderly patients (average 73.9 years) accounted for a large proportion of our PMV patients. According to government data, 10.4% of the total population (2.39 million people) in Taiwan was older than 65 years in 20084. Among these, 1.03 million (6% of the total population) were older than 75 years. Those who are older than 65 years are expected to account for 14.4% of the total population by 2018. According to previous studies, very elderly patients constitute approximately 8.9–9.6% of ICU admissions5,6. As the older generation ratio increases in total population, the number of elderly patients who receive critical care services is expected to increase substantially in the future. Age has

* All contributing authors declare no conflict of interest.

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been considered an important factor in hospital mortality\(^7\). Although MV has been standard practice in Taiwan for years, there are few data available on outcomes and characteristics for elderly and very elderly patients\(^9\). The aim of this retrospective study was to investigate the characteristics and outcomes for very elderly PMV patients under current health insurance regulations in Taiwan.

2. **Method**

Mackay Memorial Hospital, Tamsui branch, is a tertiary referral center in northern Taipei with 1033 beds. There are four adult ICUs, including two medical ICU, one surgical ICU and one neurological ICU. A 21-bed respiratory care center (RCC) was first established in

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**Fig. 1.** Flow chart of exclusion and outcomes in patients admitted to the RCC according to age groups. AAD = advised against discharge; RCC = respiratory care center; RCW = respiratory care ward; TB = tuberculosis.
October 2000 to accommodate patients from all four adult ICUs. According to government regulations, bed numbers were reduced to 14 beds. The medical records of consecutive PMV patients admitted to the RCC from January 2006 to December 2008 were reviewed. Criteria for admission to this unit included age > 17 years, MV used for more than 14 days, arterial oxygenation > 60 mmHg with the fraction of inspired oxygen (FiO2) < 0.4, and positive end-expiratory pressure < 10 cmH2O. Patients with shock, acute myocardial infarction, massive gastrointestinal bleeding, acute renal failure with instability during hemodialysis, severe hepatic failure or additional planned surgery are not accepted in this unit. If patients are diagnosed with contagious tuberculosis, they are transferred to a special isolation ward for quarantine. Age, sex, history of MV dependence, MV duration, underlying diseases, and Apache II score were analyzed on RCC admission. Successful weaning was defined as complete MV independence for more than 120 hours. Patients who required nocturnal ventilation were considered to have weaning failure. Patients were classified according to the diseases for which they required PMV as opposed to the reasons for initiation of ventilatory support in the first place. Invasive MV (Puritan-Bennett 7200, Nellcor Puritan Bennett, Pleasanton, California, USA) and continuous cardiovascular monitoring were standard for every patient admitted. Weaning outcome was assessed by chart review. After patients left the unit, we followed them by telephone contact and review of outpatient records.

### 3. Statistical analysis

Outcome groups were compared using χ² tests for categorical data. All continuous data are expressed as mean ± standard deviation and were analyzed using one-way analysis of variance. A p value of < 0.05 was considered to be statistically significant. The Kaplan-Meier method was used to estimate the cumulative probability of survival as a function of the number of months after RCC discharge. The significance of differences was assessed using a log-rank test. All data were analyzed using Prism 5 for Windows (Graphpad, La Jolla, CA, USA).

### 4. Results

During the study period, 367 patients were admitted to the RCC. Of these, 79 patients were excluded, including 18 patients of < 45 years, six patients with tuberculosis (transferred for quarantine immediately after diagnosis), 16 patients who left against medical advice as soon as they were admitted, 37 who refused treatment, such as cancer patients who wanted hospice care or whose family refused further treatment (e.g., amputation), and two patients with a degenerative neuromuscular disorder. Thus, 288 patients were available for the study. Among these, 63 patients were aged 45–65 years, 115 were aged 66–79 years, and 110 were ≥ 80 years (Fig. 1).

The mean age of the study patients was 74.5 (± 40.3) years, with an Apache II score of 20.8 (± 4.3) and a Charlson co-morbidity score of 4.9 (± 2.0). The average MV duration was 201.1 (± 61.1) days before transfer to the RCC. There was no significant difference in ICU duration, Apache II score, Charlson co-morbidity score or albumin level before RCC admission between the age groups (Table 1). However, there were more female patients in the oldest group (p < 0.01). In addition, cardiovascular disorders in PMV patients were associated with increasing age (p < 0.01).

RCC stay was significantly longer for the oldest compared to the younger groups (Table 2; 30 vs 28 and 25 days, p = 0.02). In total, 126 patients (43.8%) were successfully weaned. Of these, 41 (37.3%) were ≥ 80 years, 49 (42.6%) were 66–79 years, and 36 (51.7%) were 45–65 years (Table 2). Age was significantly associated with successful weaning (p = 0.04). There was no significant association between age and stay length for weaned patients (p = 0.30) or mortality in the RCC (p = 0.27; Fig. 1).

During follow-up up to December 2009, higher mortality was noted in the oldest group of weaned patients (p < 0.01; Fig. 2). For the 105 patients with weaning failure, only four were successfully weaned during the follow-up period. Of these, three patients were in the oldest group and one was aged 66–79 years (p = 0.56; Table 2). Most patients with failure (46 aged ≥ 80 years, 40 aged 66–79 years, and 10 aged 45–65 years) expired during 1-year follow-up (p = 0.69).

### 5. Discussion

It has been estimated that decreasing mortality and infertility will lead to a 2% increase in the relative proportion of elderly people

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**Table 1**

<table>
<thead>
<tr>
<th>Age group</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>45–65 y</td>
<td>66–79 y</td>
</tr>
<tr>
<td>n</td>
<td>63</td>
</tr>
<tr>
<td>Female/male</td>
<td>23/40</td>
</tr>
<tr>
<td>Average age (y)</td>
<td>56.6 ± 4.8</td>
</tr>
<tr>
<td>Average MV duration before RCC (d)</td>
<td>22.3 ± 9.9</td>
</tr>
<tr>
<td>Admission diagnosis</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>COPD</td>
<td>5</td>
</tr>
<tr>
<td>Neuromuscular disorder</td>
<td>32</td>
</tr>
<tr>
<td>Uremia</td>
<td>6</td>
</tr>
<tr>
<td>Cancer</td>
<td>7</td>
</tr>
<tr>
<td>CAD/CHF</td>
<td>5</td>
</tr>
<tr>
<td>Others</td>
<td>8</td>
</tr>
<tr>
<td>Apache II score</td>
<td>20.7 ± 6.1</td>
</tr>
<tr>
<td>Charlson score</td>
<td>4.8 ± 2.5</td>
</tr>
<tr>
<td>Albumin level</td>
<td>2.7 ± 0.8</td>
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</tbody>
</table>

**Table 2**

<table>
<thead>
<tr>
<th>Age group</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>45–65 y</td>
<td>66–79 y</td>
</tr>
<tr>
<td>Average RCC LOS for all patients (d)</td>
<td>25 ± 15</td>
</tr>
<tr>
<td>RCC LOS for weaned patients (d)</td>
<td>19 ± 12</td>
</tr>
<tr>
<td>Weaning outcome in RCC</td>
<td>36/63</td>
</tr>
<tr>
<td>Weaning outcome in RCW</td>
<td>0/11</td>
</tr>
</tbody>
</table>

LOS = length of stay; RCC = respiratory care center; RCW = respiratory care ward.
among the global population. In Taiwan, people older than 65 years are expected to account for 14.4% of the total population by 2018. An increase in the geriatric population means that more elderly people will become critically ill and potentially require critical care resources for life-threatening diseases. Today, approximately 9% of patients admitted to ICUs are elderly. If the need for intensive care remains unchanged, the demand for ICU beds is expected to increase by 19% by the year 2020 due to the change in age distribution for the Finnish population. In the present study, more than 70% of our admitted patients were aged > 65 years and nearly 37% were ≥ 80 years. In a survey by Scheinhorn et al., the average age of PMV patients was 71.4 years in the USA. Polverino et al. reported that the average age of PMV patients was > 70 years in Italy. We found similar results for our patient group, for whom the average age was 74 years. The proportion of female patients admitted to our unit increased with patient age. This is compatible with national population data for Taiwan. The average male life span is 75.6 years and the female life span is 82.3 years. For our patients, a change in the female/male ratio is evident between 66 and 79 years. In the study by Polverino et al., patients had spent nearly 30 days in the ICU before transfer to the RCC. In comparison, our patients had a slightly shorter ICU stay but had higher comorbidities than in the Italian study. This might be because more of our ICUs are for neurosurgical cases. Otherwise, the incidence of chronic illness such as cardiovascular and respiratory disorders increases with age. Previous studies have shown that among patients older than 65 years, the most common etiology for acute respiratory failure on emergency room presentation was congestive heart failure, followed by respiratory disorders. In our previous study, congestive heart failure was the commonest co-morbidity among the oldest patients. As the main reasons for acute respiratory failure in older patients, it is natural to expect that more PMV patients will suffer from cardiovascular or respiratory diseases. Scheinhorn et al. reported that cardiovascular and respiratory disorders are the main entry diagnosis for PMV in the USA. This is in accordance with our study results. Among patients < 65 years of age, neurological disorders were the major cause of MV dependence. With increasing age, cardiovascular disorders were the main reason for ventilator dependence.

Several studies have mentioned age as an important factor for outcome in the ICU. Ely et al. reported a median MV duration of 4.2 days for patients aged ≥ 75 years and 6.4 days for patients aged < 75 years in the ICU. Elderly patients also have a higher mortality rate in both the ICU and hospital in general. Despite the lack of differences in length of ICU stay, Apache score, Charlson comorbidity score and albumin levels on RCC admission, differences in outcome were observed between the age groups after their RCC stay. Elderly patients, especially those ≥ 80 years, had a higher failure rate for weaning. This could be reflected in their relatively prolonged stay in the RCC. In studies by Su et al. and Wu et al., there was a trend for difficult weaning in elderly patients in Taiwan. In addition, Yang et al. found that age was a predictor for weaning in the RCC. However, their patients were younger than in our study and that by Wu et al., which might explain the difference. In this study, we found that age was associated with poor prognosis for weaning.

Several studies have mentioned a decrease in physical functioning in elderly people. For example, Maruyama observed that left ventricular volume correlated negatively with age. Frazier et al. showed that if there were no significant changes in cardiac output, stroke volume or heart rate, there would be difficulty in discontinuing MV. Chatila et al. also pointed out that increases in the rate-product index and hypoxemia were likely to occur during weaning. Hypoxic events and poor physical responses would have a very negative effect on very elderly patients and might be a major factor in weaning difficulties.

In our study, the oldest weaned patients had a higher mortality rate during long-term follow-up. Using a cutoff age of 65 years, Aboussonou et al. found that 53% of those < 65 years were alive compared to only 27.5% of individuals aged ≥ 65 years during long-term follow-up. Stoller et al. reported that most patients discharged after PMV expired within 2 years. Younger age is significantly associated with greater long-term survival, and the risk of mortality increases 1.3-fold with every 10-year increase in age. Hui et al. reported that 67.1% of weaned patients were readmitted within 3 months of discharge and that the most common cause of readmission was airway infection. Patients with cardiac and pulmonary disease as causes of respiratory failure had higher readmission probability. This might explain why our oldest weaned patients had a worse outcome compared to younger patients. In our oldest patients, cardiovascular disorders were a major factor in respiratory failure. At such an old age, poor cardiovascular and respiratory functions are expected compared to younger people, which might explain the poor long-term outcome. In our previous study, most patients with weaning failure expired within 6 months of discharge and the 1-year weaning rate was 5%. This might be the reason for the lack of significant differences in survival rate and weaning outcome during long-term follow-up.

Our study has several limitations. First, it was a retrospective observational study carried out in a single hospital. Second, a significant number of patients had neurologic defects. Under such circumstances, many families tend to favor hospice care after long-term care because of old age, poor quality of life and cognitive disorders. However, our study still indicates that age influences the outcome for PMV patients, regardless of weaning outcome, during long-term follow-up.

In conclusion, the oldest PMV patients had the worst outcome in terms of weaning. Moreover, even if they were weaned from MV, these patients had a poor outcome during long-term follow-up. However, there was no outcome difference between patients with weaning success and those with weaning failure during long-term follow-up.

References