Long-Term Survival and Medical Costs of Patients with Prolonged Mechanical Ventilation and Tracheostomy: A Nationwide Cohort Study

Hui-Hsuan Lai 1, Pei-Ying Tseng 2,3,†, Chen-Yu Wang 4,5,‡ and Jong-Yi Wang 6,*,‡

Abstract: Few large-scale studies have focused on tracheostomy in patients with prolonged mechanical ventilation. This retrospective population-based study extracted data from the longitudinal National Health Insurance Research Database in Taiwan to compare long-term mortality between patients on prolonged mechanical ventilation with and without tracheostomy and their related medical expenditures. Data on newly developed respiratory failure in patients on ventilator support were extracted from 1 January 2002 to 31 December 2008. Of 10,705 patients included, 1372 underwent tracheostomy (n = 563) or translaryngeal intubation (n = 779). Overall survival of the patients with tracheostomy was followed for 5 years. Average survival was 4.98 years for the patients with tracheostomy and 5.48 years for the patients with translaryngeal intubation (not significant). Sex, age, premium-based monthly salary difference, occupation, urbanization level, chronic obstructive pulmonary disease, chronic heart failure, chronic renal disease, and cerebrovascular diseases were significantly associated with mortality for endotracheal intubation. Male sex, chronic heart failure, chronic renal disease, age ≥ 45 years, and low income were associated with significantly higher mortality. Although total medical expenditures were higher for the patients with tracheostomy, annual medical expenditures were not significantly different. There were no differences in long-term mortality between the two groups.

Keywords: tracheotomy; mechanical ventilator; mortality; survival analysis; medical expense

1. Introduction

Prolonged translaryngeal endotracheal intubation increases the risk of laryngeal injury, sinusitis, and ventilator-associated pneumonia [1–3]. Hence, tracheostomy is preferred to translaryngeal endotracheal intubation, because it provides better oral hygiene, improved patient comfort (Table 1), returned speech, and airway security during weaning [4–6]. However, the optimal timing for tracheostomy remains a clinical dilemma, with inconclusive results in the literature due to the heterogeneity of critically ill patients [7].

Prolonged mechanical ventilation (PMV) is defined as a period of ≥ 6 h/day on mechanical ventilation for 21 days, and it has been suggested that early tracheostomy after 2 weeks of ventilator dependency could be considered, based on patient comfort [7–10]. A retrospective study showed that the weaning rate from a ventilator was 56.3% [11], with old age [12], chronic obstructive pulmonary disease (COPD) [13], poor heart function [14],
high APACHE II score [15], and lower Glasgow Coma Scale score [16] causing difficulty in weaning. Thus, physicians and family inevitably face a difficult decision regarding the timing of tracheostomy for patients with PMV.

Reportedly, early tracheostomy does not decrease hospital [17] or 30-day mortality [18]. Moreover, there were no differences in 1-year mortality between early tracheostomy, late tracheostomy, and translaryngeal endotracheal intubation [19]. In a cohort study in Germany, the survival rate of ventilated patients discharged from hospital was 67.6% within 3 months, 49.4% within 1 year, and 38.1% within 3 years [13]. Pilcher et al. also showed that the 3-year survival rate of patients with tracheostomy who were successfully weaned from the ventilator was 47% [20]. In the US, the number of ventilated patients who received a tracheostomy increased from 16.7 to 34.3 per 100,000 adults from 1993 to 2002, and only 10% of the patients were successfully discharged to home, with the need for long-term care after discharge increasing from 40.1% to 71.9% [21]. Long-term care of patients with PMV is associated with increased medical expenditures. Although the long-term outcomes of patients with PMV have been discussed in the literature, few large-scale studies have focused on patients with PMV and tracheostomies. Indeed, some patients and their families remain hesitant to undergo tracheostomy due to insufficient information regarding the long-term outcome of patients with tracheostomy. The aim of this retrospective population-based study was to use data extracted from the longitudinal National Health Insurance Research Database in Taiwan to compare long-term mortality between patients on PMV with and without tracheostomy and their related medical expenditures.

Table 1. Comparison of patient characteristics between tracheostomy and translaryngeal intubation.

| Style          | Neck operation wound                      | Oral route                                    |
|----------------|------------------------------------------|----------------------------------------------|
| Quality of life| Improved oral comfort                    | Inability to close the mouth                  |
|                | Maintained ability to eat and talk by     | Difficulty in oral cleaning                   |
|                | mouth after training                      | Damaged facial skin                           |
|                |                                         | Inability to speak and communicate            |
| Complications  | Hemorrhage                                | Oral ulcer                                   |
|                | Loss of airway                            | Granuloma in the throat                       |
|                | Wound infection                           | Damaged vocal cords                          |

2. Materials and Methods

2.1. Data Source and Study Sample

This retrospective population-based study employed data extracted from 1 million randomly sampled beneficiaries recorded in the NHIRD from 2001 to 2013. The NHIRD, maintained by the National Health Research Institute of Taiwan, contains all original medical claims of all enrollees in the universal NHI program. The diagnostic codes used in this database are in the form of the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM). The overall survival of the patients with tracheostomy was assessed over a 5-year observation period. Information regarding newly developed respiratory failure of ventilator support patients based on the ICD-9-CM codes (96.70, period of ventilation unspecified; 96.71, ventilated for <96 h; 96.72, ventilated for >96 h) was extracted from the NHIRD from 1 January 2002 to 31 December 2008. In total, 10,705 patients were included in the study, of which 1372 patients underwent tracheostomy (n = 563) or translaryngeal intubation (n = 779) within the study period.

2.2. Variables

Basic demographic data, including age, sex, socioeconomic status, premium-based monthly salary, and insured occupation, were collected. Urbanization level was measured by using a 7-point scale, with levels 1 and 7 indicating the highest and lowest urbanization levels, respectively. The health status, including pneumonia, COPD, congestive heart
failure (CHF), chronic renal disease, neurovascular disease, and neuromuscular disease, was noted.

2.3. Outcome Measurement

The outcome measurements included mortality and medical costs. Mortality was dichotomous and categorically defined in the study.

2.4. Statistical Analysis

Descriptive analysis was performed to calculate the mean, standard difference frequency, percentage, and variable distribution. The chi-square test was used to compare categorical variables. Logistic regression was used to estimate the odds ratios and 95% confidence intervals (CIs) for successful weaning from a ventilator or tracheostomy. The Cox proportional hazard model was used to compare survival in the patients with tracheostomy and translaryngeal intubation after adjusting for potential confounders. The general linear model was used to calculate the difference in medical expenditures between patients with tracheostomy and translaryngeal intubation. All tests were performed in the SAS statistical software package (version 9.4; SAS Institute Inc., Cary, NC, USA), and p-values of <0.05 were taken to be indicative of statistical significance.

3. Results

Altogether, we examined 1342 patients, among which 563 underwent tracheostomy, with 142 deaths, and 779 underwent translaryngeal intubation (using endotracheal tube), with 204 deaths. The total death toll was 346 (25.78%). The average survival was 4.98 years for patients with tracheostomy and 5.48 years for patients with translaryngeal intubation (Table 2), with no difference in mortality between the groups (Table 3). Sex, age, premium-based monthly salary difference, occupation, urbanization levels, COPD, CHF, chronic renal disease (CRD), and cerebrovascular diseases were statistically significant in the mortality of patients with endotracheal tubes (Table 3). In the Cox regression model, male sex (hazard ratio (HR): 1.29, 95% CI: 1.03–1.63), CHF (HR: 1.29, 95% CI: 1.02–1.63), and CRD (HR: 1.54, 95% CI: 1.10–2.14) were associated with higher mortality. Age >45 years was associated with higher mortality than age ≤45 years. Urbanization levels lower than the highest level were associated with lower mortality (Table 4). Although the total medical expenditure was higher for patients with tracheostomy than for laryngeal patients with endotracheal tubes, this was not the case for annual medical expenditures (Table 5). In the Kaplan–Meier survival curve, as shown in Figure 1 for the corrected survival curve of people using different breathing circuits, the observation time was >4 years, and patients with endotracheal tubes had a higher mortality risk than those with tracheal tubes.

Table 2. Descriptive analysis of survival in patients with tracheostomy and translaryngeal intubation (n = 1342).

| Variables            | Total (n, %) | Mortality (n, %) | Average Survival (Year ± SD) |
|----------------------|-------------|------------------|-----------------------------|
| PMV                  | 1342 (100%) | 346 (25.78%)     | 5.27 ± 2.36                 |
| Translaryngeal intubation | 779 (58.95%) | 204 (26.19%)     | 5.48 ± 2.42                 |
| Tracheostomy         | 563 (41.04%)| 142 (25.22%)     | 4.98 ± 2.25                 |
Table 3. Univariate analysis of patients with PMV characteristics.

| Variables | Total (N) | Survived (n) | Mortality (n) | $\chi^2$ | p-Value |
|-----------|-----------|--------------|---------------|---------|---------|
| All       | 1342      | 996 74.22    | 346 25.78     | 0.159   | 0.690   |
| Patients with PMV | 779    | 575 73.81    | 204 26.19     | 10.102  | <0.01   |
| Translaryngeal intubation | 563    | 421 74.78    | 142 25.22     | 10.102  | <0.01   |
| Tracheostomy | 527    | 416 78.94    | 111 21.06     | 10.102  | <0.01   |
| Sex        | 815       | 580 71.17    | 235 28.83     | 92.081  | <0.001  |
| Female     | 527       | 416 78.94    | 111 21.06     | 10.102  | <0.01   |
| Male       | 815       | 580 71.17    | 235 28.83     | 92.081  | <0.001  |
| Age (years) |         |              |               |         |         |
| <45        | 285       | 260 91.23    | 25 8.77       | 51.228  | <0.001  |
| 45–54      | 160       | 130 81.25    | 30 18.75      | 51.228  | <0.001  |
| 55–64      | 167       | 128 76.65    | 39 23.35      | 51.228  | <0.001  |
| 65–74      | 327       | 237 72.48    | 90 27.52      | 51.228  | <0.001  |
| 75–84      | 324       | 193 59.57    | 131 40.43     | 51.228  | <0.001  |
| ≥85        | 79        | 48 60.76     | 31 39.24      | 51.228  | <0.001  |
| Premium-based monthly salary (NTD) |         |              |               |         |         |
| ≤20,008    | 436       | 275 63.07    | 161 36.93     | 51.228  | <0.001  |
| ≥20,009    | 255       | 221 86.67    | 34 13.33      | 51.228  | <0.001  |
| Occupation |          |              |               |         |         |
| First category (private employee and government) | 53       | 46 86.79     | 7 13.21      | 26.362  | <0.001  |
| Second category (labor union member) | 56       | 51 91.07     | 5 8.93       | 26.362  | <0.001  |
| Third category (farmer and fisherman) | 169      | 141 83.43    | 28 16.57     | 26.362  | <0.001  |
| Fourth and fifth categories (soldier and social) | 89       | 59 66.29     | 30 33.71     | 26.362  | <0.001  |
| Sixth category (veteran and religious group) | 975      | 699 71.69    | 276 28.31    | 30.1064 | <0.001  |
| Urbanization level |         |              |               |         |         |
| Level 1    | 320       | 213 66.56    | 107 33.44     | 30.1064 | <0.001  |
| Level 2    | 389       | 274 70.44    | 115 29.56     | 30.1064 | <0.001  |
| Level 3    | 248       | 190 76.61    | 58 23.39      | 30.1064 | <0.001  |
| Level 4    | 202       | 167 82.67    | 35 17.33      | 30.1064 | <0.001  |
| Level 5    | 41        | 37 90.24     | 4 9.76       | 30.1064 | <0.001  |
| Level 6    | 85        | 70 82.35     | 15 17.65      | 30.1064 | <0.001  |
| Level 7    | 57        | 45 78.95     | 12 21.05      | 30.1064 | <0.001  |
| Pneumonia  | 641       | 483 75.35    | 158 24.65     | 0.824   | 0.3641  |
| Yes        | 701       | 513 73.18    | 188 26.82     | 0.824   | 0.3641  |
| COPD       | 864       | 674 78.01    | 190 21.99     | 18.225  | <0.001  |
| Yes        | 478       | 322 67.36    | 156 32.64     | 18.225  | <0.001  |
| Congestive heart failure |         |              |               |         |         |
| No         | 823       | 651 79.1     | 172 20.9      | 26.520  | <0.001  |
| Yes        | 519       | 345 66.47    | 174 33.53     | 26.520  | <0.001  |
| Chronic renal disease |        |              |               |         |         |
| No         | 1,227     | 925 75.39    | 302 24.61     | 10.235  | <0.01   |
| Yes        | 115       | 71 61.74     | 44 38.26      | 10.235  | <0.01   |
| Cerebrovascular disease |       |              |               |         |         |
| No         | 803       | 621 77.33    | 182 22.67     | 10.154  | <0.01   |
| Yes        | 539       | 375 69.57    | 164 30.43     | 10.154  | <0.01   |
| Neuromuscular disease |       |              |               |         |         |
| No         | 1,265     | 941 74.39    | 324 25.61     | 0.332   | 0.5644  |
| Yes        | 77        | 55 71.43     | 22 28.57      | 0.332   | 0.5644  |
Table 4. Cox regression model of survival analysis in patients with PMV.

| Variables                              | Unadjusted HR | 95% CI  | p-Value | Adjusted HR | 95% CI  | p-Value |
|----------------------------------------|---------------|---------|---------|-------------|---------|---------|
| Patients with PMV                      | 1             |         |         | 1           |         |         |
| Translaryngeal intubation              | 0.97          | 0.78   | –       | 1.20        | 0.749   | 0.90    | 0.72    | –       | 1.13    | 0.380   |
| Tracheostomy                           |               |         |         |             |         |         |
| Sex                                    | 1.36          | 1.08   | –       | 1.70        | <0.05   | 1.29    | 1.03    | –       | 1.63    | <0.05   |
| Age                                    |               |         |         |             |         |         |
| <45 y/o (Reference)                    | 2.32          | 1.36   | –       | 3.94        | <0.01   | 2.26    | 1.32    | –       | 3.88    | <0.01   |
| 45–54 y/o                              | 2.87          | 1.74   | –       | 4.74        | <0.001  | 2.76    | 1.64    | –       | 4.64    | <0.001  |
| 55–64 y/o                              | 3.55          | 2.28   | –       | 5.54        | <0.001  | 3.15    | 1.97    | –       | 5.05    | <0.001  |
| 65–74 y/o                              | 6.55          | 4.26   | –       | 10.06       | <0.001  | 5.03    | 3.13    | –       | 8.08    | <0.001  |
| ≥85 y/o                                | 7.29          | 4.29   | –       | 12.37       | <0.001  | 6.27    | 3.54    | –       | 11.11   | <0.001  |
| Premium-based monthly salary (NTD)     |               |         |         |             |         |         |
| <20,008 Dollars (Reference)            | 0.56          | 0.45   | –       | 0.70        | <0.001  | 0.70    | 0.55    | –       | 0.90    | <0.01   |
| ≥20,009                                | 0.33          | 0.23   | –       | 0.48        | <0.001  | 0.21    | 0.05    | –       | 0.81    | <0.05   |
| Occupation                             |               |         |         |             |         |         |
| First category (private employee and government) (Reference) | 0.65          | 0.21   | –       | 2.06        | 0.467   | 1.11    | 0.23    | –       | 5.25    | 0.896   |
| Second category (labor union member)    | 1.26          | 0.55   | –       | 2.88        | 0.586   | 1.86    | 0.49    | –       | 6.98    | 0.359   |
| Third category (farmer and fisherman)   | 2.47          | 1.09   | –       | 5.63        | <0.05   | 1.02    | 0.42    | –       | 2.48    | 0.973   |
| Fourth and fifth categories (soldier and social) | 2.18          | 1.03   | –       | 4.61        | <0.05   | 0.72    | 0.31    | –       | 1.68    | 0.450   |
| Sixth categories (veteran and religious groups) |           |         |         |             |         |         |
| Urbanization level                     |               |         |         |             |         |         |
| Level 1 (Reference)                    | 1             |         |         |             |         |         |
| Level 2                                | 0.88          | 0.68   | –       | 1.14        | 0.335   | 0.75    | 0.57    | –       | 0.98    | <0.05   |
| Level 3                                | 0.66          | 0.48   | –       | 0.91        | <0.05   | 0.56    | 0.41    | –       | 0.78    | <0.001  |
| Level 4                                | 0.46          | 0.32   | –       | 0.68        | <0.001  | 0.42    | 0.28    | –       | 0.63    | <0.001  |
| Level 5                                | 0.28          | 0.10   | –       | 0.75        | <0.05   | 0.25    | 0.09    | –       | 0.68    | <0.01   |
| Level 6                                | 0.50          | 0.29   | –       | 0.85        | <0.05   | 0.40    | 0.23    | –       | 0.71    | <0.01   |
| Level 7                                | 0.62          | 0.34   | –       | 1.13        | 0.120   | 0.49    | 0.27    | –       | 0.92    | <0.05   |
| Pneumonia                              |               |         |         |             |         |         |
| No (Reference)                         | 1             |         |         |             |         |         |
| Yes                                    | 1.29          | 1.04   | –       | 1.59        | <0.05   | 1.02    | 0.81    | –       | 1.28    | 0.898   |
| COPD                                   |               |         |         |             |         |         |
| No (Reference)                         | 1             |         |         |             |         |         |
| Yes                                    | 1.86          | 1.50   | –       | 2.30        | <0.0001 | 1.27    | 1.00    | –       | 1.61    | 0.052   |
| Congestive heart failure               |               |         |         |             |         |         |
| No (Reference)                         | 1             |         |         |             |         |         |
| Yes                                    | 2.02          | 1.63   | –       | 2.49        | <0.0001 | 1.29    | 1.02    | –       | 1.63    | <0.05   |
| Chronic renal disease                  |               |         |         |             |         |         |
| No (Reference)                         | 1             |         |         |             |         |         |
| Yes                                    | 1.95          | 1.42   | –       | 2.68        | <0.001  | 1.54    | 1.10    | –       | 2.14    | <0.05   |
| Cerebrovascular disease                |               |         |         |             |         |         |
| No (Reference)                         | 1             |         |         |             |         |         |
| Yes                                    | 1.57          | 1.27   | –       | 1.94        | <0.001  | 1.19    | 0.95    | –       | 1.49    | 0.133   |
| Neuromuscular disease                  |               |         |         |             |         |         |
| No (Reference)                         | 1             |         |         |             |         |         |
| Yes                                    | 1.20          | 0.78   | –       | 1.85        | 0.404   | 1.21    | 0.78    | –       | 1.88    | 0.393   |
Table 5. Linear regression model of medical costs in patients with PMV.

| Variables                          | Total Medical Cost | Annual Medical Cost | p-Value | p-Value |
|------------------------------------|--------------------|--------------------|---------|---------|
|                                    | Unadjusted | p-Value | Adjusted | Average Value of Smallest Square | Coefficients | Adjusted | Average Value of Smallest Square | Coefficients |
| Patients with PMV                 |            |         |          |                                |              |          |                                |              |
| Translaryngeal intubation (Reference) | 1,663,197.09 | <0.001 | 2,759,195.31 | 1,095,998 | <0.001 | 1581 | 0.995 | 2,177,477.92 | 1,219,391.83 |
| Tracheostomy                       | 2,116,280.54 |          | 2,306,111.86 | 189,831 | 0.241 | 266,942 | 0.250 | 2,301,919.93 | 2,004,949.82 |
| Female (Reference)                | 215,556 | 0.189 | 2,307,712.55 |          |        | 1,729,964.34 | 1,773,750.38 | <0.001 | 1,773,750.38 | 1,773,750.38 |
| Male                               | 47,102 | 0.911 | 2,642,481.77 | −48,459 | 0.908 | 2,640,012 | <0.001 | 1,773,750.38 | 2,680,525 |
| Urbanization level                 | −162,251 | 0.649 | 2,238,771.07 | −122,630 | 0.731 | 71,043 | 0.806 | 1,807,407.71 | 94,273 |
| Level 2 (Reference)               | −584,933 | <0.05 | 1,917,074.72 | −739,716 | 0.126 | 167,666 | 0.908 | 1,787,265.82 | 10,965 |
| Level 3                            | −119,316 | 0.630 | 2,275,082.95 | −158,941 | 0.516 | −13,395 | 0.969 | 1,824,237.79 | 77,443 |
| Level 4                            | 299,320 | 0.175 | 2,349,253.48 | 244,769 | 0.257 | 59,010 | 0.850 | 4,410,489.13 | 43,786 |
| Pneumonia                          | 516,672 | <0.01 | 2,047,683.86 | 327,025 | <0.05 | 141,574 | 0.533 | 2,238,768.41 | 2,068,101.34 |
| No (Reference)                    | 235,296 | 0.160 | 2,279,014.26 | 135,636 | 0.458 | −89,303 | 0.706 | 2,146,556.23 | 170,667 |
| Yes                                | 1,433,378.14 |          | 135,636 | 0.458 |          | −89,303 | 0.706 | 2,146,556.23 | 13,757 |
| Congestive heart failure           | 392,577 | <0.05 | 1,952,943.31 | 516,506 | <0.01 | −72,350 | 0.756 | 2,188,786.19 | 70,703 |
| No (Reference)                    | 1,952,943.31 |          | 516,506 | <0.01 |          | −72,350 | 0.756 | 2,188,786.19 | 70,703 |
| Yes                                | 1,952,943.31 |          | 516,506 | <0.01 |          | −72,350 | 0.756 | 2,188,786.19 | 70,703 |
| Chronic renal disease              | 39,173 | 0.891 | 2,193,369.16 | 35,654 | 0.901 | −45,400 | 0.911 | 2,134,248.28 | 38,373 |
| No (Reference)                    | 2,193,369.16 |          | 35,654 | 0.901 |          | −45,400 | 0.911 | 2,134,248.28 | 38,373 |
| Yes                                | 2,193,369.16 |          | 35,654 | 0.901 |          | −45,400 | 0.911 | 2,134,248.28 | 38,373 |
| Cerebrovascular disease            | 219,130 | 0.180 | 2,214,315.27 | −623,8 | 0.971 | −125,437 | 0.887 | 2,186,823.15 | 66,777 |
| No (Reference)                    | 2,214,315.27 |          | −623,8 | 0.971 |          | −125,437 | 0.887 | 2,186,823.15 | 66,777 |
| Yes                                | 2,214,315.27 |          | −623,8 | 0.971 |          | −125,437 | 0.887 | 2,186,823.15 | 66,777 |
| Neuromuscular disease              | 789,420 | <0.05 | 1,957,674.33 | 507,044 | 0.135 | 25,825 | 0.958 | 2,181,317.54 | 55,765 |
| No (Reference)                    | 1,957,674.33 |          | 507,044 | 0.135 |          | 25,825 | 0.958 | 2,181,317.54 | 55,765 |
| Yes                                | 1,957,674.33 |          | 507,044 | 0.135 |          | 25,825 | 0.958 | 2,181,317.54 | 55,765 |
4. Discussion

As found in previous studies, old age was a risk factor for mortality [22–25], with 40% mortality in patients >75 years old. Additionally, the mortality rate was significantly higher in lower-income patients. According to the definition of the attachment population of the Ministry of Justice and Health Insurance Bureau in Taiwan, the attachment population comprises non-occupational adults or spouses, most of whom are >65 years old or <20 years old. Higher socioeconomic patients may have more resources to promote health and a decreased risk of exposure to disease-related risk factors. However, the attachment population does not accurately reflect the family economic status. Hence, this existing bias failed to explain whether the attachment population mortality rate was lower than the low-income population rate.

In our study, there were no differences between ventilator-dependent patients undergoing tracheostomy and those with a laryngeal endotracheal tube. However, age >45 years and male sex were associated with higher mortality. Old age is an established risk factor for the long-term outcome in intensive care unit survival and patients with PMV [26,27]. In Taiwan, males tend to have higher rates of mortality, smoking, and drinking, as well as a higher body mass index than females [28,29]. Due to this unhealthy lifestyle, perhaps it is not surprising that males have a higher mortality rate.

Furthermore, CHF and CRD in patients with PMV were associated with a higher mortality rate. Patients with COPD were not only difficult to wean from the ventilator [14,30] but COPD was also recognized as an independent risk factor for the long-term mortality of ventilator-dependent patients [31,32]. In the literature, COPD and pneumonia were two common reasons for ventilator dependency [14,15] in patients with high-risk pneumonia having short- and long-term mortality [33,34]. COPD is an important risk factor accounting for the long-term mortality of patients with pneumonia in the literature [35–37]. However, COPD and pneumonia were not found to be significantly associated with higher mortality in our study. COPD in this study was defined according to the ICD-9-CM codes rather than spirometry or medication results [38], so there was a risk of misclassification, which is a limitation of this study.

In a population-based study, acute kidney injury with dialysis increased the long-term mortality of patients with PMV [39], whereas another population-based study showed that end-stage renal disease did not increase the long-term mortality of patients who had been ventilated, but this study did not consider patients with PMV [40]. A cohort study by
Lai et al. showed that hemodialysis was associated with higher mortality in patients with PMV [25], similar to the present study findings. Few studies have assessed the relationship between CHF and the long-term outcome of patients with PMV. A retrospective study in Taiwan showed that patients with PMV and heart failure had a lower weaning rate and a higher mortality rate [11]. However, more large-scale prospective studies are required to confirm the role of CHF in patients with PMV.

The benefits of the timing of tracheostomy remain controversial. Early tracheostomy may shorten the duration of ventilator usage [17,41–43] but has not been found to influence mortality [17]. Young et al. reported that the early tracheostomy group did not have a decreased 30-day mortality rate [18], and Siempos et al. found that there was no difference in the 1-year mortality rates between patients with and without tracheostomy [19]. Previous studies have focused on short-term mortality or 1-year mortality, whereas the present study assessed 5-year mortality and found no difference in the long-term mortality rates between patients with translaryngeal intubation and tracheostomy, indicating that the tracheostomy procedure is safe and does not influence long-term mortality.

Patients with PMV medical costs accounted for 20.6% of the medical expenditures of the top-ten chronic illnesses requiring hospitalization in Taiwan [44]. The mean survival time was 4.98 years after tracheostomy and 5.48 years for patients with translaryngeal intubation. Additionally, there was no significant difference in the annual medical expenditures between patients with PMV and tracheostomy and translaryngeal intubation. In addition to the timing of tracheostomy, these results provide scientific evidence that physicians, patients, families, and authorities can review to assess the value of undergoing a tracheostomy in patients with PMV.

In the present study, there was no significant difference in the total cost or annual medical cost of patients with COPD, whereas a previous matched cohort study found that malnutrition status had higher medical costs in non-ventilated patients with COPD [45]. We did not extract nutritional status data in the current study, so malnutrition status should be considered to be a potential risk factor for increased medical costs in ventilated patients with COPD and evaluated in a future study.

Limitations

There were some study limitations that should be considered. First, this was a retrospective databank study, with little information collected prospectively. Second, all diagnosis and comorbidity data were retrieved from the ICD-9 code, so misclassification or diagnosis due to reimbursement purposes in some hospitals was possible.

5. Conclusions

This study showed that male sex, old age, and comorbidities, including CHF and CRD, were risk factors associated with higher mortality in patients with PMV. The decision to perform a tracheostomy did not influence long-term survival or annual medical costs of patients with PMV, emphasizing that individual treatment plans should be designed to reduce mortality and medical expenditures.

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