Original Article

Can Tracheostomy Improve Outcome and Lower Resource Utilization for Patients with Prolonged Mechanical Ventilation?

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Abstract

Background: It is not clear whether the benefits of tracheostomy remain the same in the population. This study aimed to better examine the effect of tracheostomy on clinical outcome among prolonged ventilator patients.
Methods: Data were from the medical claims data in Taiwan. A total of 3880 patients with ventilator use for more than 14 days between 2005 and 2009 were identified. Among them, 645 patients with tracheostomy conducted within 30 days of ventilator use were compared to 2715 patients without tracheostomy on death during hospitalization and study period, and successful weaning and medical utilization during hospitalization. Cox proportional hazards and linear regression models were used to examine the associations between tracheostomy and the main outcomes.
Results: The tracheostomy rate was 30%, and 55% of tracheostomies were performed within 30 days of mechanical ventilation. After adjustments, patients with tracheostomy were at a lower risk of death during hospitalization (hazard ratio [HR] =0.51; 95% confidence interval [*CI*] =0.43–0.61) and 5-year observation (HR = 0.73; 95% *CI* = 0.66–0.81), and a lower probability of successful weaning (HR = 0.88; 95% *CI* = 0.79–0.99). Higher medical use was also observed in patients with tracheostomy.
Conclusions: The beneficial effect for tracheostomy observed in our data was the reduction of death. However, patients with tracheostomy were less likely to wean and more likely to consume medical resources.

Key words: Mechanical Ventilation; Medical Utilization; Mortality; Tracheostomy; Weaning

Introduction

Health care improvement and technological advances have extended the average life expectancy. As a result, aging populations and accompanying comorbid conditions are becoming increasingly serious, leading to increases in the use of health care including ventilator usage.[1] In the United States, the number of patients using ventilators increased by 11% between 1996 and 2002, accounting for 12% of all medical expenditures in the hospitals.[2,3] In addition, patients with the prolonged mechanical ventilation (MV), defined as the daily use of ventilators for more than 6 h and for more than 21 consecutive days,[4] are also increasing. For example, prolonged MV patients in the United States have increased by more than 100,000 for each year. In the United Kingdom, 6.3% of ventilator users further develop into prolonged MV patients.[5,6] Prolonged MV has also linked to increased risks of ventilator-associated pneumonia, mortality, and higher medical costs, and, therefore, has become a vital global issue.[7,8]

To reduce the consequences of prolonged MV, evidence from numerous studies has indicated that early tracheostomy is recommended for prolonged MV patients in stable conditions.[9,10] The benefits include improving comfort, safety, and oral hygiene, as well as reducing the use of

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sedatives and hypnotics. The procedure also enables early ventilator weaning and reduces the risks of pneumonia and mortality. Consequently, health care costs are reduced, and patients' quality of life is also increased.[4,11-13] On the contrary, some studies found patients without tracheostomy had shorter MV durations,[14-16] suggesting that the evidence is inconsistent across studies.

In Taiwan, the National Health Insurance (NHI) program has insured more than 99% of 23 million people since its establishment in 1995. All expenses of ventilator usage are covered. However, the recent increase in the number of ventilator patients has imposed a huge medical burden. For example, prolonged MV has become the second greatest expense of hospitalization due to a catastrophic illness. Each patient consumes an average of approximately US$ 24,000 of medical expenses each year, which is equivalent to 30 times the average of the overall population.[17]

The majority of previous studies to examine the association between tracheostomy and outcomes in patients with ventilator use are conducted in hospitals with the limited study sample. In 2000, the Taiwanese Bureau of NHI entrusted the National Health Research Institutes (NHRI) with establishing the NHI Research Database (NHIRD). This database has accumulated the medical claims data of one million people residing in Taiwan since the implementation of NHI. The database is representative of the medical information in Taiwan and provides researchers with an alternative from the previous studies based on small-scale data. In this study, data from the NHIRD were analyzed to better examine whether tracheostomies influenced the mortality, ventilator weaning, and use of medical resources among ventilator patients.

Methods

Study sample

Data were sourced from the NHIRD, established by the NHRI. To protect privacy, the NHRI recompiled the medical claims data and made the data publicly available for researchers in Taiwan. Individual and hospital identifiers are unique to the research database and cannot be used to trace individual patients or health service providers. Based on the above, the present study is exempted from full review by the Institutional Review Board.

In this study, we used medical claims of a total of one million individuals from 2005 to 2009. The study sample comprised patients who were admitted to Intensive Care Unit (ICU) and used ventilators for the first time between 2005 and 2009. Claims data during hospitalization and death information during the study period were included for analyses. Total days of hospitalization included those for both intensive and nonintensive care, respectively. Evidence from previous studies indicates that the reductions in ventilator usage and hospitalization days are most significant for the tracheostomies conducted within 2–28 days after ventilator use.[11,18] Therefore, we included patients who were potentially required for tracheostomies (those using ventilators for more than 14 days during the hospitalization) and divided them into two groups: Patients who received tracheostomies within 30 days after ventilator use and patients who did not received tracheostomies [Figure 1]. Overall, the exclusion criteria included: (1) No any records of ICU admission or ventilator use during ICU admission, (2) having both records but they began prior to January 1, 2005, (3) ventilator use for <14 days (4) having both ventilator use for more than 14 days and tracheostomy surgery but the time for tracheostomy could not be verified, and (5) tracheostomy was performed after 30 days of ventilator use.

Other measures

Other characteristics were basic demography including gender, age, and health conditions including comorbid conditions and organ failures. Health conditions were considered because of their influence on the physician's decision of performing a tracheostomy. We used the Charlson comorbidity index modified by Deyo as the measure of comorbidity.[19,20] The score was calculated based on the severity of seventeen common conditions, with higher total scores indicating more numerous and severe comorbidities. Organ failure was defined as any dysfunction of seven systems: Respiratory, cardiovascular, kidneys, liver, nervous, blood, and metabolic.[21]

Outcome measures

The main outcome measures were mortality, successful weaning of MV, and utilization of medical care. The deaths during hospitalization and within the 5-year study period were analyzed separately. Death during hospitalization

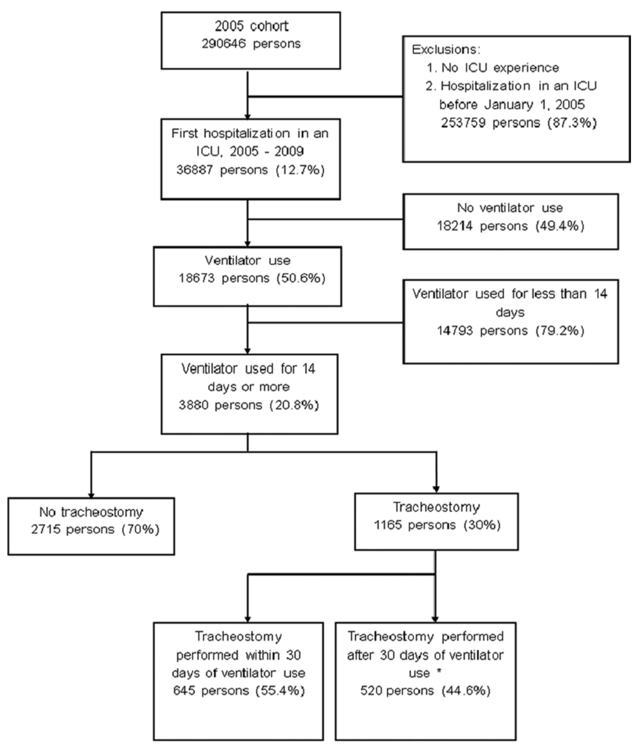

Figure 1: Sample selection process. *Including those who were unable to verify the time to perform tracheostomy.

refers to deaths that occurred during the hospitalization period or within 3 days of discharge. This study included patients deceased within 3 days after discharge because it is customary in Taiwan for family members to apply for a discharge and enable terminally ill patients to decease at their homes. Death within the 5-year study period refers to patients who died during or after hospitalization, all in the study period. The vital status in the database was verified by determining patients' enrollment or withdrawal from the NHI and the records for use in medical services.

Successful weaning was based on the definition in the NHI payment standards; that is, MV weaning for 5 or more consecutive days.[22] In the claims data, patients originally used ventilators but stopped use for 5 or more days during the hospital stays were classified as weaning successfully. At the analytic stage, MV status conversion was used to include those weaning successfully only. Those using MV continuously, stop using for <5 days, and being dead without successful weaning during hospitalization were not regarded as MV conversion.

Utilization of medical care involved observations on the number of days of MV use, ICU, and total hospitalization, and medical costs. The number of days of MV use was the cumulative number of days for ventilator use during hospitalization. Medical costs were the total costs calculated from the data including all deductible fees paid by the patients and reimbursement fees applied by the hospitals. Because the data did not include costs not covered by insurance, these costs were not in our calculations.

Statistical analysis

The basic analysis was conducted on two groups: A tracheostomy group and a nontracheostomy group. Mean, standard deviation, and *t*-test were used for continuous variables including age, comorbidity, organ failure, and measures of medical use. For categorical variables such as gender, frequency and percentage, Chi-square test was used to test the differences between the two groups. For the mortality analysis, the Kaplan–Meier was used to estimate survival function for each group during the hospitalization period and the 5-year study period. A log-rank test was employed to determine whether the survival curves exhibited significant statistical differences. The Cox proportional hazard model was further applied to investigate the relationship between tracheostomy during hospitalization and the 5-year study period and risk of death before and after adjusting for covariates including gender, age, comorbidity, and organ failures. A similar analysis was also conducted to examine the association between tracheostomy and weaning of MV during hospitalization. Finally, linear regression model was used to analyze the relationships between tracheostomies and hospital utilization including total number of days, days in the ICU, days not in the ICU, days of ventilator use, and total medical costs. Covariates adjusted in the model were nearly the same, but mortality during hospitalization was also considered because the proportions of death during hospitalization between two groups were different and should be adjusted.

To minimize the potential effect of treatment selection bias on our results, propensity score matching (PSM) was used to select the nontracheostomy group comparable with the tracheostomy group. The predicted value in the logistic regression model in which the tracheostomy status was the dependent variable and other measures employed in the study were independent variable was served as the score. Caliper matching method based on the score was further conducted with 1–2 matches between both groups. The comparison of basic characteristics between tracheostomy and post-PSM nontracheostomy groups was no-significant, indicating both groups after PSM were comparable [Table 1]. The same advanced analysis was conducted in the post-PSM sample, and the results were also presented to confirm the associations. SAS 9.3 statistical software program (SAS Institute Inc, USA) was adopted to conduct data processing and analysis. Statistical significance was set at $P < 0.05$.

Results

Patient characteristics

The research sample consisted of 3360 patients. Table 1 shows their basic characteristics. Patients who used ventilators for more than 14 days during hospitalization and had tracheostomies within 30 days consisted of 19.2% of the sample. Men were more likely to receive tracheostomies than women. The average age and numbers of organ failures for the tracheostomy group was less than those of the nontracheostomy group. However, the 2 groups showed no statistically significant differences regarding comorbidity.

Analysis of mortality during hospitalization and the 5-year study period

Table 2 shows a basic comparison of the main outcomes for both groups. The tracheostomy group exhibited lower mortality compared to the nontracheostomy group during hospitalization and 5-year period. Figure 2a and 2b respectively indicate the survival curves of the tracheostomy and nontracheostomy groups during the first 90 days follow-up and within the 5-year study period. The survival probability of the tracheostomy group was consistently higher than that of the nontracheostomy group in both short and long-term comparisons. The log-rank test confirmed that the differences of survival curves for both comparisons were statistically significant. Further analysis of the tracheostomies and risk of death during the hospitalization and the 5-year observational periods [Table 3] indicated that the risk of death in the tracheostomy group was lower than that of the nontracheostomy group, regardless of whether other characteristics were adjusted and the PSM method was applied.

Analysis of mechanical ventilation weaning during hospitalization

The results presented in Table 2 indicated that the tracheostomy group showed a higher rate of MV conversion or successful weaning during hospitalization. The Cox proportional hazard model was further used to examine the likelihood of MV conversion during hospitalization among

Table 1: Basic characteristics of the tracheostomy and nontracheostomy groups during hospitalization

Variables	Tracheostomy (*n* = 645)	Nontracheostomy (*n* = 2715)	Total (*n* = 3360)	X^2 or *t*	*P**
Gender, *n* (%)				3.21 (χ^2)	0.073
Male	407 (63.1)	1603 (59.0)	2010 (59.8)		
Female	238 (36.9)	1112 (41.0)	1350 (40.2)		
Age, years	68.7 ± 17.1	71.1 ± 17.7		3.08	0.002
<65 years, *n* (%)	216 (33.5)	707 (26.0)	923 (27.5)		
65–79 years, *n* (%)	235 (36.4)	972 (35.8)	1207 (35.9)		
≥80 years, *n* (%)	194 (30.1)	1036 (38.2)	1230 (36.6)		
Multiple organ failure	1.2 ± 0.5	1.4 ± 0.6		5.69	<0.001
Respiratory failure only, *n* (%)	513 (79.5)	1863 (68.6)	2376 (70.7)		
Respiratory failure and one organ failure, *n* (%)	113 (17.5)	725 (26.7)	838 (24.9)		
Respiratory failure and two or more organ failure, *n* (%)	19 (3.0)	127 (4.7)	146 (4.4)		
Charlson comorbidity index	1.4 ± 2.1	1.5 ± 2.2		1.18	0.239
0, *n* (%)	227 (35.2)	1021 (37.6)	1248 (37.2)		
1, *n* (%)	254 (39.4)	879 (32.4)	1133 (33.7)		
2, *n* (%)	55 (8.6)	281 (10.3)	336 (10.0)		
3, *n* (%)	49 (7.6)	255 (9.4)	304 (9.1)		
≥4, *n* (%)	60 (9.3)	279 (10.3)	339 (10.1)		

*Continuous variables were tested using a *t*-test. These variables included age, multiple organ failures, and the Charlson comorbidity index. The results were expressed using means ± SD. The Chi-square test was used to test the categorical variables (i.e., gender). $P<0.05$ indicate statistically significant differences. Although age, multiple organ failures, and the Charlson comorbidity index were continuous variables, they also showed categorical variable distributions. SD: Standard deviation.

Table 2: Comparison of main outcomes for the tracheostomy and nontracheostomy patients during hospitalization and the 5-year study period

Items	Tracheostomy (*n* = 645)	Nontracheostomy (*n* = 2715)	Total (*n* = 3360)	X^2 or *t*	*P**
During hospitalization					
Death, *n* (%)	151 (23.4)	1139 (42.0)	1290 (38.4)	75.0 (χ^2)	<0.001
MV status conversion†, *n* (%)	406 (63.0)	1581 (58.2)	1987 (59.1)	4.6 (χ^2)	0.032
Total hospital LOS‡, days	56.8 ± 51.1	49.6 ± 50.1		−3.2	0.001
ICU LOS, days	24.7 ± 17.7	25.5 ± 15.4		1.07	0.283
Non-ICU LOS, days	32.1 ± 44.1	24.1 ± 57.2		−4.05	<0.001
Total MV dependent days	36.1 ± 40.0	33.8 ± 45.4		−1.22	0.223
Total amount (NT)	634,390 ± 463,286	577,160 ± 404,776		−2.89	0.004
5-year follow-up					
Death, *n* (%)	401 (62.2)	1982 (73.0)	2383 (70.9)	29.12 (χ^2)	<0.001

*A *t*-test was used to test the continuous variables and compare the results of the tracheostomy and nontracheostomy groups. These variables were total hospital LOS, ICU LOS, non-ICU LOS, total MV-dependent days, and total amount. The results were expressed using means ± SD. The Chi-square test was used to test the categorical variables, which were mortality and MV status conversion. $P<0.05$ indicate statistically significant differences. †MV status conversion: As defined by the BNHI, ventilator weaning is recognized as discontinuing ventilator use for at least 5 continuous days, and the MV status was converted from yes to no in our study; ‡Total hospital LOS: Total number of days of intensive care and nonintensive care hospitalization. Total MV dependent days: Total number of days of ventilator use during hospitalization. Total amount: Based on the NHIRD, the sum of patients' co-payment amounts (PART_AMT) and hospitals' application amounts (APPL_AMT) during hospitalization. MV: Mechanical ventilator; LOS: Length of stay; ICU: Intensive Care Unit; NT: New Taiwan Dollars; SD: Standard deviation; BNHI: Bureau of National Health Insurance.

the tracheostomy and nontracheostomy groups [Table 4]. However, after controlling for other potential confounding factors, the difference of weaning for the both groups only reached borderline significance in both pre-PSM and post-PSM samples, indicating that the weaning rate was relatively lower for the tracheostomy group, but the difference was not very significant.

Analysis of medical utilization during hospitalization

The results in Table 2 indicate that the tracheostomy group accounted for greater total costs and total days (mainly non-ICU days) during hospitalization compared to the nontracheostomy group. Although the tracheostomy group possessed a greater number of days of relying on ventilators days, this difference did not reach statistical significance. Table 5 shows a linear regression analysis of the adjusted associations among tracheostomy and the total number of days of hospitalization including both ICU and non-ICU days, days of MV use, and total medical costs. Similarly, tracheostomy patients exhibited higher totals of hospitalization days, non-ICU days, and total medical costs than the nontracheostomy patients did. On the other hand, the tracheostomy group spent fewer days in ICUs

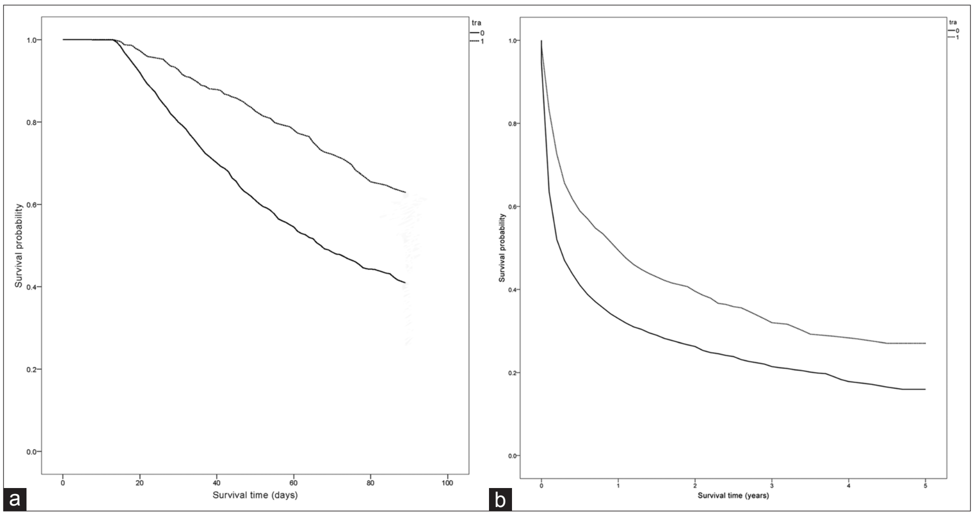

Figure 2: Survival curves of the tracheostomy and non-tracheostomy groups within 90 days of hospitalization (a), and within the 5-year follow-up period (b) *P* values using log-rank tests were <0.0001 for both graphs.

Table 3: Crude and adjusted risk of death for the tracheostomy and nontracheostomy groups during hospitalization and the 5-year follow-up period

Items	During hospitalization			5-year follow-up		
	Death, *n* (%)	CHR (95% *CI*)	AHR (95% *CI*)	Death, *n* (%)	CHR (95% *CI*)	AHR (95% *CI*)
Original data	Total (*n* = 1290)			Total (*n* = 2383)		
Tracheostomy						
Yes	151 (23.4)	0.47 (0.39–0.55)‡	0.51 (0.43–0.61)‡	401 (62.2)	0.74 (0.66–0.82)‡	0.73 (0.66–0.81)‡
No	1139 (42.0)	1	1	1982 (73.0)	1	1
Gender						
Male	793 (39.5)	1.08 (0.97–1.20)	1.11 (0.99–1.24)	1458 (72.5)	1.14 (1.05–1.24)†	1.16 (1.07–1.26)‡
Female	497 (36.8)	1	1	925 (68.5)	1	1
Age		1.01 (1.01–1.01)‡,§	1.01 (1.01–1.01)‡,‖		1.01 (1.00–1.01)‡,¶	1.01 (1.00–1.01)‡,**
Multiple organ failure		1.71 (1.58–1.85)‡	1.68 (1.55–1.82)‡		0.96 (0.90–1.03)	0.94 (0.89–1.01)
Charlson comorbidity index		1.11 (1.09–1.13)‡	1.11 (1.09–1.13)‡		1.02 (1.00–1.04)*	1.02 (1.00–1.03)
PSM data	Total (*n* = 641)			Total (*n* = 1303)		
Tracheostomy						
Yes	151 (23.4)		0.53 (0.44–0.63)‡	401 (62.2)		0.73 (0.65–0.82)‡
No	490 (38.0)		1	902 (69.9)		1

**P*<0.05; †*P*<0.01; ‡*P*<0.001. §95% *CI*: 1.007–1.014; ‖95% *CI*: 1.006–1.013; ¶95% *CI*: 1.002–1.007; **95% *CI*: 1.002–1.007. 95% *CI*: 95% confidence interval; CHR and AHR: Crude and adjusted hazard ratios; PSM: Propensity score matching.

than the nontracheostomy group, but this difference was not statistically significant. Similar results were also observed in the post-PSM samples.

Discussion

The results of this study indicate that for both the hospitalization and 5-year study periods, patients who received tracheostomies within 30 days of MV use exhibited a lower risk of death than those who did not. However, tracheostomy did not facilitate patients weaning from ventilators. As a result, the tracheostomy patients consumed greater medical resources, including longer days of hospitalization and higher medical costs.

Numerous studies have investigated the relationships among tracheostomy, death, ventilator weaning, and resource consumption. For example, one cohort study indicated that the survival rate during ICU stay for patients who received tracheostomies was higher than that of those who did not.[23] Some studies have also indicated that earlier tracheostomies result in a correspondingly lower number of days in ICUs, total days of hospitalization, and health care costs.[11,12,24] One study also found that higher chance of ventilator weaning was observed for patients who received earlier tracheostomies.[25] The results of higher survival for both the short and longer period of time in patients with tracheostomy found in our study were basically in agreement with those in previous studies. However, our findings of longer survival time but less chance of weaning, and higher medical utilization as a consequence for patients with tracheostomy, are not quite consistent with those in other studies.

Table 4: Crude and adjusted probability of MV weaning for the tracheostomy and nontracheostomy groups during hospitalization

Items	MV status conversion, *n* (%)	CHR (95% *CI*)	AHR (95% *CI*)
Original data	Total (*n* = 1987)		
Tracheostomy			
Yes	406 (62.9)	0.94 (0.84–1.05)	0.88 (0.79–0.99)*
No	1581 (58.2)	1	1
Gender			
Male	1207 (60.0)	1.10 (1.00–1.20)*	1.10 (1.01–1.20)*
Female	780 (57.8)	1	1
Age		0.99 (0.99–1.00)‡,§	0.99 (0.99–1.00)‡,‖
Multiple organ failure		0.68 (0.62–0.74)‡	0.68 (0.62–0.74)‡
Charlson comorbidity index		0.97 (0.94–0.99)†	0.97 (0.94–0.99)†
PSM data	Total (*n* = 1193)		
Tracheostomy			
Yes	406 (63.0)		0.86 (0.76–0.97)*
No	787 (61.0)		1

*P<0.05; †P<0.01; ‡P<0.001; §95% *CI*: 0.991–0.995; ‖95% *CI*: 0.991–0.99. 95% *CI*: 95% confidence interval; CHR and AHR: Crude and adjusted hazard ratios; PSM: Propensity score matching; MV: Mechanical ventilator.

Table 5: Comparison of the tracheostomy and nontracheostomy groups for total days of hospitalization, number of ICU and non-ICU days, number of MV days, and total medical costs, coefficient (95% *CI*)

Items	Total hospital LOS	LOS		Total MV dependent days	Total amount
		ICU LOS	Non-ICU LOS		
Original data					
Intercept	40.44‡ (31.96–48.91)	31.27‡ (28.59–33.96)	9.16* (1.31–17.02)	13.97‡ (23.33–45.73)	731,432‡ (662,367–800,497)
Tracheostomy	**6.48† (2.16–10.80)**	**−0.59 (−1.95–0.78)**	**7.06‡ (3.06–11.07)**	**3.38 (−0.45–7.21)**	**64,675‡ (29,474–99,876)**
Age	−0.04 (−0.13–0.06)	−0.11‡ (−0.14–0.08)	0.08 (−0.01–0.16)	0.10* (0.01–0.18)	−4426.81‡ (−5211.34–3642.30)
Gender	−2.05 (−5.48–1.38)	−0.60 (−1.69–0.49)	−1.45 (−4.63–1.73)	−3.12* (−6.18–0.08)	−2678.21 (−30,667–253,11)
Multiple organ failure	10.97‡ (7.92–14.03)	1.62† (0.65–2.59)	9.35‡ (6.52–12.19)	10.63‡ (7.92–13.34)	92,680‡ (67,779–117,581)
Charlson comorbidity index	2.24‡ (1.45–3.03)	−0.04 (−0.29–0.21)	2.28‡ (1.55–3.01)	1.26‡ (0.56–1.96)	17,373‡ (10,939–23,808)
Mortality	−12.39‡ (−16.05–8.74)	1.47* (0.31–2.63)	−13.86‡ (−17.25–10.47)	−3.56* (−6.80–0.32)	22,203 (−7594.11–51,999)
PSM data					
Intercept	48.38‡ (45.66–51.11)	24.75‡ (23.92–25.58)	23.63‡ (21.12–26.14)	32.77‡ (30.37–35.16)	560,137‡ (538,421–581,853)
Tracheostomy	**8.41‡ (3.69–13.14)**	**−0.07 (−1.51–1.36)**	**8.49‡ (4.14–12.82)**	**3.23 (−0.91–7.38)**	**74,253‡ (36,640–111,867)**

*P<0.05; †P<0.01; ‡P<0.001. The figures in bold indicate the coefficients and 95% *CI* of tracheostomy in the linear regression models. MV: Mechanical ventilator; LOS: Length of stay; ICU: Intensive Care Unit; 95% *CI*: 95% confidence interval; PSM: Propensity score matching.

According to our data, the proportion of tracheostomy for prolonged MV patients is only 30%, and only around half of the surgery was conducted before 30 days of MV use, suggesting that the clinical recommendation for tracheostomy is not followed for most prolonged MV cases. The low proportion could be mainly attributable to the negative attitude in most Taiwanese people including patients' family members toward to performing the tracheostomy. Traditional Chinese people are affected by one of the Confucius's sayings; our body is inherited from our parents and cannot be damaged. Therefore, physician's persuasion plays a major role for patients and their family members to accept tracheostomy. To achieve a most beneficial effect on tracheostomy, tracheostomy is usually considered only for those with a high likelihood of MV dependency and survival that was subjectively judged by the physician in Taiwan.[26] Our result did reveal that tracheostomy group had a fewer number of organ failures and were younger (as can be seen in the basic characteristics). After adjustment of those variables, our data still demonstrate the higher survival and lower weaning rate. In addition, in contrast to most studies our analysis did not demonstrate that the tracheostomy patients are more likely to wean from the ventilator. There might be some possible explanations for it. First, the timing of tracheostomy was relatively late; nearly all patients received tracheostomy after 14 days of the ventilator in our data. A recent systematic review based on a meta-analysis of studies regarding the timing of tracheostomy in adult patients undergoing artificial ventilation found that early tracheostomy (tracheostomy within 7 days of MV) shortens the duration of artificial ventilation as compared to late or no tracheostomy.[9] Furthermore, early percutaneous dilatational tracheostomy within 48 h after intubation significantly reduce the day of ventilator compared to delayed tracheostomy at days 14–16.[10] Second, although tracheostomy is a permanent artificial airway that facilitates sputum removal and oral hygiene and further help the weaning from ventilator and discharge from ICU, the major determinants of weaning are patients' condition and physical reserve, especially in a long-term prospective. Third, the physician usually takes into the consideration of the likelihood of weaning in a short-term prospective, and patients who are likely to wean in a short period of time will not be persuaded to receive tracheostomy. As a consequence, tracheostomy are performed for patients who are relatively unable to wean and able to survive for a longer period of time. Although the tracheostomy extends the life for MV-dependent patients, their quality of life is generally poor. This raises a question of whether it is worth undergoing tracheostomy at a later stage for these MV-dependent patients who are less likely to wean, survive longer but with poor quality of life, and consume more medical resources. This is a dilemma currently existing in Taiwan and merits further discussions from different aspects.

The advantage of this study was that the analyzed insurance database was representative of Taiwan. The sample size was large and results were generalizable to the whole population. In addition, the majority of previous studies have followed patient survival for a shorter period of only one or 2 years.[8,27] We followed the patients up to 5 years and observed both short- and long-term mortality. The main limitation of this study was that it was a study based on the claims data rather than the first-hand hospital data. Since the data provide information limited for claiming purpose, some information such as the laboratory and physiological data representing the clinical condition are not available. For example, the Acute Physiology and Chronic Health Evaluation II (APACHE II) data that are commonly used to evaluate the severity of critically ill patients are not in our data. Still, the Carlson index in conjunction with age and gender is a risk adjustment method for use in the absence of ICU-based acuity scores although the prediction power is lower than APACHE.[28,29] As in a natural observational environment, the decision to tracheostomy was not randomized and apt to selection bias as mentioned previously. However, the effect on survival persisted after statistical adjustment. Also, information for other potential confounding factors such as the indicators from clinical examination and assessment were also unable to include in our analysis. Therefore, residual confounding could not be ruled out in our study.

In conclusion, in contrast to previous studies conducted in one or several hospitals, our results from the claims data with a large and representative sample also found that patients with tracheostomy had lower risk of death, but differently were less likely to wean and consume more medical resources.

Acknowledgments

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Conflicts of interest

There are no conflicts of interest.

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