# Medicine®

# The effect of tracheostomy delay time on outcome of patients with prolonged mechanical ventilation
## A STROBE-compliant retrospective cohort study

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## Abstract

The tracheostomy timing for patients with prolonged mechanical ventilation (PMV) was usually delayed in our country. Both physician decision time and tracheostomy delay time (time from physician's suggestion of tracheostomy to procedure day) affect tracheostomy timing. The effect of tracheostomy delay time on outcome has not yet been evaluated before.

Patients older than 18 years who underwent tracheostomy for PMV were retrospectively collected. The outcomes between different timing of tracheostomy (early: ≤14 days; late: >14 days of intubation) were compared. We also analyzed the effect of physician decision time, tracheostomy delay time, and procedure type on clinical outcomes.

A total of 134 patients were included. There were 57 subjects in the early tracheostomy group and 77 in the late group. The early group had significantly shorter mechanical ventilation duration, shorter intensive care unit stays, and shorter hospital stays than late group. There was no difference in weaning rate, ventilator-associated pneumonia, and in-hospital mortality. The physician decision time ($8.1 \pm 3.4$ vs $18.2 \pm 8.1$ days, $P < .001$) and tracheostomy delay time ($2.1 \pm 1.9$ vs $6.1 \pm 6.8$ days, $P < .001$) were shorter in the early group than in the late group. The tracheostomy delay time [odds ratio (OR) = 0.908, 95% confidence interval (CI) = 0.832–0.991, $P = .031$) and procedure type (percutaneous dilatation, OR = 2.489, 95% CI = 1.057–5.864, $P = .037$) affected successful weaning. Platelet count of $>150 \times 10^3/\mu L$ (OR = 0.217, 95% CI = 0.051–0.933, $P = .043$) and procedure type (percutaneous dilatation, OR = 0.252, 95% CI = 0.069–0.912, $P = .036$) were associated with in-hospital mortality.

Shorter tracheostomy delay time is associated with higher weaning success. Percutaneous dilatation tracheostomy is associated with both higher weaning success and lower in-hospital mortality.

**Abbreviations:** APACHE II = Acute Physiology and Chronic Health Evaluation II, BUN = blood urea nitrogen, CI = confidence interval, GCS = Glasgow coma scale, ICU = intensive care unit, LOS = length of stay, MV = mechanical ventilation, NHI = National Health Insurance, OR = odds ratio, PMV = prolonged mechanical ventilation, PSV = pressure support ventilation, RCC = respiratory care center, RCT = randomized controlled trial, SD = standard deviation, VAP = ventilator-associated pneumonia.

**Keywords:** early tracheostomy, percutaneous dilatation tracheostomy, prolonged mechanical ventilation, respiratory failure, tracheostomy timing

## 1. Introduction

Tracheostomy is the most commonly performed surgical procedure in intensive care unit (ICU). The most important

indication for tracheostomy is prolonged mechanical ventilation (PMV). The benefits of tracheostomy over endotracheal tube are definitive for patients with PMV, including more airway security, better patient comfort, better oral hygiene, less need for sedation, and faster weaning of mechanical ventilation (MV).[1,2]

Initially, the tracheostomy timing was considered as intubation for >21 days.[1] However, the concept of early tracheostomy also emerged in the past 30 years. Observational studies have shown better clinical outcomes in patients with early tracheostomy, although the definitions of early tracheostomy are variable (from within 3 days to within 21 days).[3] A recent meta-analysis of randomized controlled trials (RCTs), however, failed to show significant outcome benefits for early tracheostomy within 10 days of intubation (most of which were within 7 days).[4] Therefore, the optimal timing for tracheostomy remained controversial, and recent literature suggested that MV patient should be observed for at least 10 days to make a decision for tracheostomy[2,5]

Moreover, the tracheostomy timing was not only determined by the physician decision time but also affected by the tracheostomy delay time, mainly the hesitation time of the patient and family. The influence of physician decision time and tracheostomy delay time on clinical outcomes has not yet been evaluated in previous literature.

Performing tracheostomy in critically ill patients in Taiwan is often delayed, with the mean time to tracheostomy from 18.5 to 36.7 days.[6,7] Therefore, we chose the definition of early tracheostomy as within 14 days after intubation and late tracheostomy as after 14 days. This definition is consistent with the most recent clinical review and is also practical in Taiwan.[2] Our study aimed to compare clinical outcomes between different tracheostomy timings and to analyze the influence of physician decision time, tracheostomy delay time, and procedure type on outcome in patients with PMV.

## 2. Methods

### 2.1. Study design and population

This retrospective cohort study was conducted in a 1414-bed tertiary medical center in southern Taiwan. Our hospital contains 81 beds in ICU and 16 beds in the respiratory care center (RCC). From April 2014 to April 2015, medical or surgical patients with PMV who were transferred to the RCC due to difficult weaning were included. The RCC is a specialized weaning unit for patients with difficult weaning and is designed to improve the turnover rate of ICU. Patients eligible for RCC admission included those with PMV or expected to have PMV, those with a stable condition, and those who met the criteria for weaning. Exclusion criteria were patients younger than 18 years, patients who did not undergo tracheostomy throughout hospitalization, patients with nasal intubation, patients who had tracheostomy before this episode of hospitalization, and patients with major trauma or brain injury in whom tracheostomy was done for airway protection. This study was approved by the Institutional Review Board of Kaohsiung Veterans General Hospital (VGHKS15-CT9-10) and informed consent was not required.

### 2.2. Data collection and definition

The clinical information was recorded from medical charts. The following data were collected: age, sex, patient source (medical or surgical ICU), Acute Physiology and Chronic Health Evaluation II (APACHE II) score, Glasgow coma scale (GCS) score, initial cause of MV, comorbidities including obstructive lung disease (asthma and chronic obstructive pulmonary disease), coronary artery disease, heart failure, stroke, diabetes, cirrhosis, chronic kidney disease, hemodialysis, and cancer. The following laboratory data were collected within 3 days of RCC admission: hemoglobin, platelet count, blood urea nitrogen (BUN), creatinine, and albumin.

The early tracheostomy was defined as tracheostomy performed within 14 days of endotracheal tube intubation, and late tracheostomy was defined as tracheostomy performed after 14 days of intubation. The tracheostomy timing was collected and further divided into the physician decision time and tracheostomy delay time. The physician decision time was defined as time from intubation to the physician's suggestion of tracheostomy. The tracheostomy delay time was defined as the time from the physician's suggestion of tracheostomy to the day of the procedure. Because tracheostomy procedures were performed within 1 day of the patient's/family's decision at our hospital, the tracheostomy delay time was mainly determined by the patient's and family's hesitation time. The procedure type (surgical tracheostomy or percutaneous dilation) was collected. Percutaneous dilatation was performed using a single-step dilator (Ciaglia Blue Rhino technique). The ICU length of stay (LOS) before RCC admission, hospital duration, MV duration, and in-

hospital mortality were also collected. The weaning success was defined as liberation from MV for >5 days. Ventilator-associated pneumonia (VAP) was defined as pneumonia occurring 48 hours after initiation of MV.

Patients with the following features were considered to be weaning candidates: improving underlying disease which causes respiratory failure, $FIO_2 \leq 40\%$, positive end-expiratory pressure $\leq 8$ cm $H_2O$, stable hemodynamics without vasopressor, and adequate spontaneous breathing capacity.[7] Pressure support ventilation (PSV) was used as the weaning mode in our hospital. When the patient could tolerate a PSV of 10 cm $H_2O$ overnight, a T-piece trial was initiated to evaluate the readiness for extubation. The reintubation criteria included altered consciousness, unstable vital signs, and oxygen saturation <90% with respiratory distress and use of accessory muscles. The decision for performing the tracheostomy was made by the patient's primary physician.

### 2.3. Statistical analysis

Continuous variables were expressed as mean ± standard deviation (SD) and were compared using independent $t$ tests. Categorical variables are expressed as number (percentage) and were compared with the chi-square test or Fisher exact test, as appropriate. Binary logistic regression was used to identify the factors related to successful weaning and mortality. Factors with a $P$ value <.1 in the univariate analysis were entered into the multivariate analysis. SPSS (Version 20.0; IBM Corp, Armonk, NY) was used for statistical analysis. A 2-tailed $P$ value <.05 was considered statistically significant.

## 3. Results

Between April 2014 and April 2015, a total of 292 adult patients with PMV who were transferred to the RCC were screened. Ninety-seven cases were excluded due to successful extubation. Twenty-two cases were excluded due to tracheostomy performed during a previous hospitalization or to protect the airway (eg, following major trauma and brain injury). Thirty-nine cases that refused tracheostomy were also excluded. The remaining 134 tracheostomy patients with PMV were enrolled in this study (Fig. 1).
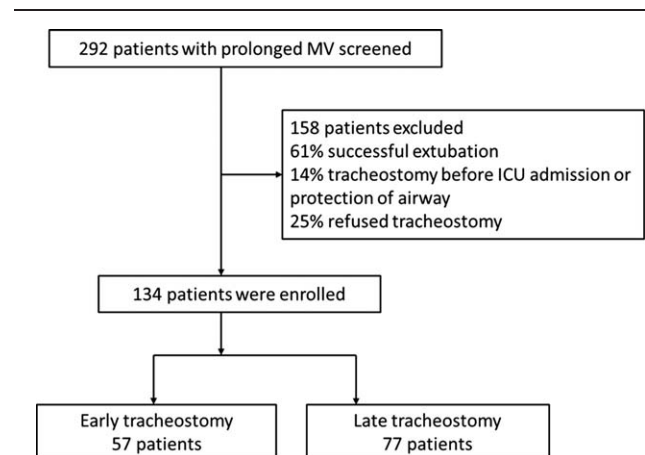


**Figure 1.** Flowchart of enrollment and outcomes. ICU = intensive care unit, MV = mechanical ventilation.

**Table 1**

**Baseline features of tracheostomy patients (N=134).**

| Characteristics | Total, n=134 | Tracheostomy group | | P |
| --- | --- | --- | --- | --- |
| | | Early, n=57 | Late, n=77 | |
| Age, y | 69.4±16 | 70.8±15.3 | 68.4±16.5 | .397 |
| Sex (male/female) | 96/38 | 43/14 | 53/24 | .401 |
| APACHE II score | 21.2±7.3 | 20.4±8.1 | 21.7±6.7 | .316 |
| GCS score | 9.3±2.1 | 9.3±2.3 | 9.4±1.9 | .836 |
| ICU LOS before RCC, day | 19.1±10.1 | 16.6±8.5 | 21±10.8 | .009* |
| Timing of tracheostomy, day | 18.3±10.2 | 10.2±3 | 24.3±9.5 | <.001* |
|    Physician decision time | 13.9±8.2 | 8.1±3.4 | 18.2±8.1 | <.001* |
|    Tracheostomy delay time | 4.4±5.7 | 2.1±1.9 | 6.1±6.8 | <.001* |
| Tracheostomy before RCC admission, n (%) | 108 (80.6) | 52 (91.2) | 56 (72.7) | .007* |
| Procedure type, n (%) | | | | |
|    Surgical | 40 (29.9) | 11 (19.3) | 29 (37.7) | .022* |
|    Percutaneous dilatation | 94 (70.1) | 46 (80.7) | 48 (62.3) | |
| Type of ICU, n (%) | | | | |
|    Medical ICU | 76 (56.7) | 29 (50.9) | 47 (61) | .241 |
|    Surgical ICU | 58 (43.3) | 28 (49.1) | 30 (39) | |
| Initial cause of MV, n (%) | | | | |
|    Pulmonary disease | 83 (61.9) | 35 (61.4) | 48 (62.3) | .877 |
|    Sepsis | 10 (7.5) | 5 (8.8) | 5 (6.5) | |
|    Circulatory disease | 10 (7.5) | 4 (7) | 6 (7.8) | |
|    Neurologic disease | 29 (21.6) | 13 (22.8) | 16 (20.8) | |
|    Acute kidney injury | 2 (1.5) | 0 (0) | 2 (2.6) | |
| Obstructive lung disease,[†] n (%) | 15 (11.2) | 8 (14) | 7 (9.1) | .369 |
| Coronary artery disease, n (%) | 33 (24.6) | 10 (17.5) | 23 (29.9) | .102 |
| Heart failure, n (%) | 33 (24.6) | 13 (22.8) | 20 (26) | .647 |
| Stroke, n (%) | 26 (19.4) | 12 (21.1) | 14 (18.2) | .678 |
| Diabetes, n (%) | 59 (44) | 28 (49.1) | 31 (40.3) | .307 |
| Cirrhosis, n (%) | 8 (6) | 3 (5.3) | 5 (6.5) | .766 |
| Chronic kidney disease, n (%) | 39 (29.1) | 15 (26.3) | 24 (31.2) | .541 |
| Hemodialysis, n (%) | 24 (17.9) | 7 (12.3) | 17 (22.1) | .144 |
| Cancer, n (%) | 20 (14.9) | 9 (15.8) | 11 (14.3) | .809 |
| Hemoglobin, g/dL | 10±1.4 | 10.2±1.6 | 9.9±1.3 | .287 |
| Platelet, $10^3/\mu L$ | 276.8±135.2 | 267.3±128.8 | 283.8±140.1 | .488 |
| BUN, mg/dL | 40.6±35.8 | 37.8±29 | 42.7±40.1 | .418 |
| Creatinine, mg/dL | 2.1±2.3 | 1.9±1.8 | 2.3±2.6 | .295 |
| Albumin, g/dL | 2.66±0.48 | 2.54±0.41 | 2.75±0.52 | .009* |

Continuous data are expressed as mean ± SD, and categorical data are expressed as number (%).

APACHE II = Acute Physiology and Chronic Health Evaluation II, BUN = blood urea nitrogen, COPD = chronic obstructive pulmonary disease, GCS = Glasgow Coma Scale, ICU = intensive care unit, LOS = length of stay, MV = mechanical ventilation, SD = standard deviation.

* $P < .05$.

† Obstructive lung disease includes 3 patients with asthma and 12 patients with COPD. One asthma and 7 COPD patients were in early group, whereas 2 asthma and 5 COPD patients were in late group.

The baseline clinical features are summarized in Table 1. The mean age was 69.4±16 years. Ninety-six (71.6%) patients were men. The APACHE II score was 21.2±7.3, and GCS was 9.3±2.1. Twenty (14.9%) patients had a history of cancer and 24 (17.9%) patients received hemodialysis. Seventy-six (56.7%) patients were transferred from medical ICU. Pulmonary disease was the most common cause of respiratory failure (n = 83, 61.9%). The mean timing of tracheostomy was 18.3±10.2 days. There were 57 patients in the early tracheostomy group (≤14 days, 42.5%), and 77 patients in the late tracheostomy group (>14 days, 57.5%). The baseline clinical features between the early and late tracheostomy groups showed significant differences in tracheostomy timing (10.2±3 vs 24.3±9.5 days, $P < .001$), physician decision time (8.1±3.4 vs 18.2±8.1 days, $P < .001$), tracheostomy delay time (2.1±1.9 vs 6.1±6.8 days, $P < .001$), tracheostomy before RCC admission (91.2% vs 72.7%, $P = .007$), ICU LOS before RCC (16.6±8.5 vs 21± 10.8 days, $P = .009$), procedure type (percutaneous dilatation, 80.7% vs 62.3%, $P = .022$), and albumin levels (2.54±0.41 vs

2.75±0.52 g/dL, $P = .009$). There was no significant difference in APACHE II score, initial cause of MV, and comorbidities between 2 groups.

The clinical outcomes are summarized in Table 2. Compared to the late tracheostomy group, the early tracheostomy group had significantly shorter hospital stay (51±21.7 vs 65.6±23.8 days, $P < .001$) and MV duration (35.2±21.4 vs 46.6±18.8 days, $P = .001$). There was no significant difference in successful weaning, in-hospital mortality, ICU readmission rate, and VAP between the 2 groups. For all patients, successful MV weaning rate was 61.9%, in-hospital mortality was 11.9%, ICU readmission rate was 7.5%, and VAP rate was 39.6%.

Table 3 demonstrates the relationship between clinical factors and successful MV weaning for the entire patient population. In univariate logistic regression analysis, significant factors were tracheostomy delay time, procedure type, platelet count of $\geq 150 \times 10^3/\mu L$, BUN levels, and albumin levels. In multivariate logistic regression analysis, tracheostomy delay time (odds ratio OR = .908, 95% confidence interval CI = 0.832–0.991, $P = .031$)

**Outcomes of tracheostomy for the patients with mechanical ventilation (N=134).**

| | | Tracheostomy group | | |
|---|---|---|---|---|
| Parameters | Total, n=134 | Early, n=57 | Late, n=77 | P |
| Successful weaning, n (%) | 83 (61.9) | 36 (63.2) | 47 (61) | .803 |
| In-hospital mortality, n (%) | 16 (11.9) | 8 (14) | 8 (10.4) | .520 |
| ICU re-admission rate, n (%) | 10 (7.5) | 3 (5.3) | 7 (9.1) | .516 |
| Hospital LOS, day | 59.4±24 | 51±21.7 | 65.6±23.8 | <.001* |
| MV duration, day | 41.7±20.7 | 35.2±21.4 | 46.6±18.8 | .001* |
| VAP, n (%) | 53 (39.6) | 24 (42.1) | 29 (37.7) | .603 |

Continuous data are expressed as mean ± SD, and categorical data are expressed as number (%).
ICU = intensive care unit, LOS = length of stay, MV = mechanical ventilation, RCC = respiratory care center, SD = standard deviation, VAP = ventilator-associated pneumonia.
* $P < .05$.

and procedure type (percutaneous dilatation, OR=2.489, 95% CI=1.057–5.864, P=.037) were significantly associated with successful MV weaning. Age (OR=0.980, 95% CI=0.958–1.002, P=.075) and albumin levels (OR=2.166, 95% CI=0.895–5.244, P=.087) showed a borderline significant association with weaning.

Table 4 demonstrates the relationship between clinical factors and in-hospital mortality. In univariate logistic regression analysis, significant factors associated with in-hospital mortality were platelet count $\geq 150 \times 10^3/\mu L$, BUN levels, albumin levels, and MV duration. In the multivariate logistic regression analysis, platelet count $\geq 150 \times 10^3/\mu L$ (OR=0.221, 95% CI=0.051–0.955, P=.043) and procedure type (percutaneous dilatation, OR=0.252, 95% CI=0.069–0.912, P=.036) was significantly associated with mortality.

## 4. Discussion

Our study showed that early tracheostomy within 14 days was associated with significantly shorter MV duration, shorter ICU and hospital LOS, but did not have beneficial effects on weaning rate, in-hospital mortality, and VAP. The physician decision time was not associated with outcome difference. However, the tracheostomy delay time represents approximately 25% of tracheostomy timing. A longer delay time to tracheostomy after the physician's decision was significantly associated with a decreased weaning rate. Percutaneous dilatation was also

significantly associated with better weaning rate and decreased in-hospital mortality.

The benefits of early tracheostomy mostly come from retrospective observational studies. Moreover, the definitions of "early" timing were quite variable, ranging from within 21 days to within 3 days.[3] Tracheostomy within 10 days has been well investigated by up to 15 RCTs, and most of these studies had early tracheostomy within 7 days.[5] However, the most recent systemic review of RCT failed to demonstrate the outcome benefits, including mortality, VAP, MV duration, and ICU duration.[4] Therefore, recent consensus suggests that physicians should wait for at least 10 days to confirm that there is an ongoing need of MV and then make the decision of performing tracheostomy.[2,5]

The real-world problem for early tracheostomy is that physicians are unable to predict the need for PMV accurately when the timing is too early.[2] In the largest RCT of early tracheostomy, the TracMan study in 2013, 92% of patients in the early group (within 4 days) underwent tracheostomy, but only 46% of the patients in the late group (after 10 days) underwent tracheostomy. Many of the patients in the late group were liberated from MV and some were dead.[8] Therefore, approximately 50% of cases of tracheostomy in the early group in the TracMan study can be considered as prediction error, which resulted in unnecessary procedures and additional complications.[8] In the second largest RCT published on 2010, patients in the early group (6–8 days) also underwent 22% more tracheostomy than patients in the late group (13–15 days).[9]

**Factors associated with successful mechanical ventilation weaning.**

| | Univariate | | Multivariate | |
|---|---|---|---|---|
| Factors | OR (95% CI) | P | OR (95% CI) | P |
| Age, y | 0.979 (0.957–1.002) | .072 | 0.980 (0.958–1.002) | .075 |
| Timing of tracheostomy, day | 0.972 (0.939–1.006) | .106 | | |
|   Physician decision time | 0.993 (0.952–1.036) | .750 | | |
|   Tracheostomy delay time | 0.913 (0.842–0.989) | .026* | 0.908 (0.832–0.991) | .031* |
| Hemodialysis | 0.447 (0.183–1.092) | .077 | 0.838 (0.281–2.499) | .751 |
| Procedure type | | | | |
|   Surgical | Reference | .026* | Reference | .037* |
|   Percutaneous dilatation | 2.358 (1.106–5.027) | | 2.489 (1.057–5.864) | |
| Hemoglobin, g/dL | 1.319 (0.994–1.750) | .055 | 0.948 (0.748–1.202) | .660 |
| Platelet $\geq 150 \times 10^3/\mu L$ | 3.111 (1.233–7.851) | .016* | 2.136 (0.729–6.257) | .167 |
| BUN, mg/dL | 0.986 (0.976–0.997) | .009* | 0.991 (0.979–1.004) | .172 |
| Albumin, g/dL | 3.154 (1.386–7.180) | .006* | 2.166 (0.895–5.244) | .087 |

BUN = blood urea nitrogen, CI = confidence interval, OR = odds ratio.
* $P < .05$.

**Table 4**

**Factors associated with in-hospital mortality.**

| Factors | Univariate | | Multivariate | |
|---|---|---|---|---|
| | OR (95% CI) | P | OR (95% CI) | P |
| Return to ICU | 3.659 (0.842–15.907) | .084 | 3.076 (0.563–16.816) | .195 |
| Procedure type | | | | |
|   Surgical | Reference | .068 | Reference | .036* |
|   Percutaneous dilatation | 0.372 (0.129–1.075) | | 0.252 (0.069–0.912) | |
| Platelet $\geq 150 \times 10^3/\mu L$ | 0.202 (0.066–0.618) | .005* | 0.221 (0.051–0.955) | .043* |
| BUN, mg/dL | 1.013 (1.000–1.025) | .041* | 1.007 (0.994–1.020) | .284 |
| Albumin, g/dL | 0.216 (0.060–0.779) | .019* | 0.630 (0.284–1.397) | .256 |
| MV duration | 1.024 (1.001–1.047) | .044* | 1.014 (0.989–1.040) | .287 |

* $P < .05$.
BUN = blood urea nitrogen; CI = confidence interval; ICU = intensive care unit; MV = mechanical ventilation; OR = odds ratio.

Therefore, an accurate PMV prediction is unlikely to be made within 10 days of MV. It should be more ideal to make a tracheostomy decision between 10 and 14 days of MV, to reduce PMV prediction error and unnecessary procedure.

On the contrary, in selective groups of patients with higher PMV risk or impaired ability to protect airway, earlier tracheostomy within 10 days may be beneficial.[2] These include patients with acute respiratory distress syndrome, chronic obstructive pulmonary disease, failed primary extubation, trauma, brain injury, spinal cord injury, and those requiring airway protection.[2,10–12] However, evidence from RCT supporting the benefits of earlier tracheostomy for the above subgroups was lacking.[2] The most recent RCT evaluating the trauma patients failed to demonstrate the outcome benefits in early (within 7 days) than late tracheostomy (after 28 days).[13]

Tseng et al[14] ever evaluated the outcome benefits of tracheostomy before RCC admission in Taiwan. Their study result showed that pre-RCC tracheostomy group has significant higher weaning rate (73.5% vs 62.8%, P < .01) and shorter hospital stay (57.4 vs 61 days, P < .01) compared to control group. But the in-hospital mortality and MV duration were similar between 2 groups.[14] Another similar study conducted by Huang et al showed that pre-RCC tracheostomy group has significant lower in-hospital mortality (24% vs 36%, P = .049) and lower VAP (10% vs 20%, P = .03) compared to control group. But the weaning rate and MV duration were similar between 2 groups.[15] However, the control groups in the above 2 studies include not only the intubated patients receive tracheostomy after RCC admission, but also include those who did not receive tracheostomy throughout the course of hospitalization (tracheostomy rate in control groups: 39% and 19.7% only).[14,15] Therefore, the better outcomes associated with pre-RCC tracheostomy in these 2 studies cannot be totally attributed to early tracheostomy. Tracheostomy per se also has definitive outcome benefit when compared to prolonged endotracheal intubation.[1] What's more, these 2 studies did not present the data of tracheostomy timing in each patient group. Therefore, the timing difference between early and late tracheostomy is difficult to evaluate in these 2 studies.

We also evaluate the rate of pre-RCC admission tracheostomy in our study. The overall rate of pre-RCC tracheostomy is 80.6%, with 91.2% in early group and 72.7% in late group (P = .007). However, this result excludes intubated patients without receiving tracheostomy. If we include the RCC patients without receiving tracheostomy, the overall rate of pre-RCC tracheostomy would be 40%, which is comparable to previous 2 studies (50.6% and 32.9%, respectively).[14,15]

To our knowledge, the physician decision time and tracheostomy delay time, which reflect the real-world condition in clinical practice, were never evaluated in the previous literature. In our study, both physician decision time and tracheostomy delay time showed significant difference between the early and late groups. However, the tracheostomy delay time, rather than physician decision time, significantly affects successful weaning. Our study showed a significant delay in tracheostomy procedure after the physician's suggestion (mean, 4.4 days). In our traditional culture, people prefer to maintain an intact body and tend to refuse or postpone a tracheostomy. Therefore, methods to improve people's understanding and acceptance for tracheostomy are important. The intervention with shared decision making and patient decision aids of tracheostomy should be effective to shorten the tracheostomy delay time and tracheostomy timing.

Our study also found that percutaneous dilatation tracheostomy was associated with significant better weaning success and lower mortality, when compared to surgical tracheostomy. Current literature also suggests that percutaneous dilatation is the procedure of choice for a tracheostomy due to the following reasons: reduced procedure time and medical cost, no need of patient transfer, and free from anesthesia risk.[2] In our hospital, the percutaneous dilatation tracheostomy was performed by experienced general surgeon at bedside. For patient with higher disease severity, surgical tracheostomy may not be a better choice, because transferal and general anesthesia for severe patient produce additional risk. Percutaneous dilatation tracheostomy also helps shorten tracheostomy timing by decreasing the waiting time for operating room and general anesthesia. This may explain the higher percentage of percutaneous dilatation tracheostomy in early group than late group. In addition, the National Health Insurance (NHI) payment policy in Taiwan also encourage early performance of percutaneous dilatation tracheostomy. The NHI only pays for patients receiving percutaneous dilatation tracheostomy in ICU. For those patients receive this procedure in RCC, additional self-payment of 6400 NT dollars is required. By contrast, the NHI pays for surgical tracheostomy both inside and outside the ICU. Therefore, some patients in RCC may choose surgical tracheostomy due to economical reason.

The value of early tracheostomy is the decrease in MV duration and LOS in the ICU and hospital, which may reduce considerable medical cost and improve ICU turnover. It was suggested that early tracheostomy contributed to only a small mortality benefit [tracheostomy within 10 vs >10 days (1-year mortality, 46.5% vs 49.8%, P = .032)], according to a previous large retrospective cohort.[16] Therefore, the similar mortality can be expected in our

small short-term study. On the contrary, patients with PMV are approaching a condition of chronic critical illness, with 1-year mortality as high as 50%. Therefore, long-term prognosis, disability, and heavy care burden should also be evaluated for individual patients with PMV before making a tracheostomy decision.[5,17]

Our study has several limitations. This is a retrospective cohort study, with a relatively small number of patients and short-term mortality. Therefore, the power to detect mortality difference may be inadequate. The analysis of long-term outcome, long-term disability, and chronic care was also lacking. However, our study has several strengths. This is the first study evaluating the effect of physician decision time and tracheostomy delay time on tracheostomy outcomes, and we found that tracheostomy delay time can affect weaning outcome. We use a more restrictive definition of successful weaning (liberation from MV > 5 days), which make our weaning outcome more reliable.

In conclusion, early tracheostomy is still a reasonable goal for its benefit on MV duration and ICU stay, which can reduce medical cost and enhance ICU turnover. In our study, tracheostomy timing is usually delayed. A significant portion of tracheostomy timing for patients with PMV was affected by patients' and family's hesitation. The tracheostomy delay time, but not physician decision time, can affect the weaning outcome. Future investigation on shared decision-making and patient decision aids to improve the tracheostomy delay is necessary.

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