Atrial Fibrillation on Intensive Care Unit Admission Independently Increases the Risk of Weaning Failure in Non-heart Failure Mechanically Ventilated Patients in a Medical Intensive Care Unit

A Retrospective Case–Control Study

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Abstract: Atrial fibrillation (AF) is one of the most frequent arrhythmias in clinical practice. Previous studies have reported the influence of AF on patients with heart failure (HF). The effect of AF on the non-HF critically ill patients in a medical intensive care unit (ICU) remains largely unclear. The study aimed to investigate the impact of AF presenting on ICU admission on the weaning outcome of non-HF mechanically ventilated patients in a medical ICU.

A retrospective observational case–control study was conducted over a 1-year period in a medical ICU at Taipei Veterans General Hospital, a tertiary medical center in north Taiwan. Non-HF mechanically ventilated patients who were successful in their spontaneous breathing trial and underwent ventilator discontinuation were enrolled. The primary outcome measure was the ventilator status after the first episode of ventilator discontinuation.

A total of 285 non-HF patients enrolled were divided into AF (n = 62) and non-AF (n = 223) groups. Compared with the non-AF patients, the AF patients were significantly associated with old age (P = 0.002), a higher rate of acute respiratory distress syndrome causing respiratory failure (P = 0.015), a higher percentage of sepsis before liberation from mechanical ventilation (MV) (P = 0.004), and a higher serum level of blood urea nitrogen on the day of liberation from MV (P = 0.003). Multivariate logistic regression analysis demonstrated that AF independently increased the risk of weaning failure [adjusted odds ratio (AOR), 3.268; 95% confidence interval (CI), 1.254–8.517; P = 0.015]. Furthermore, the AF patients were found to be independently associated with a high rate of ventilator dependence (log rank test, P = 0.026), prolonged total ventilator use (AOR, 1.979; 95% CI, 1.032–3.794; P = 0.040), increased length of ICU stay (AOR, 2.256; 95% CI, 1.049–4.849; P = 0.037), increased length of hospital stay (AOR, 2.921; 95% CI, 1.363–6.260; P = 0.006), and increased ICU mortality (AOR, 4.143; 95% CI, 1.381–12.424; P = 0.011).

AF on ICU admission is an independent risk factor for weaning failure and significantly associated with poor hospital outcome in non-HF mechanically ventilated patients in a medical ICU.

INTRODUCTION

Atrial fibrillation (AF) is recognized as one of the most frequent arrhythmias in clinical practice.1–4 The prevalence of AF ranges from 6% to 26% in noncardiac adult medical ICUs.5–8 In critically ill patients, AF is associated with increased mortality and a prolonged ICU stay, and increased hospital stay.6,9–11 Numerous studies reporting the influence of AF on short- and long-term patient outcomes have been conducted in surgical and mixed ICUs where postoperative and/or heart failure (HF) patients are enrolled.12–18 Few studies focus on the non-HF critically ill patient of medical ICUs and investigate the impact of AF on the clinical outcome in this
The weaning outcome in critically ill patients receiving mechanical ventilation (MV) is frequently studied and potentially influenced by AF. The irregular rhythm and chaotic atrial activity associated with AF can cause various potentially deleterious hemodynamic consequences that may exert a negative influence on the weaning process of mechanically ventilated patients.2 In patients with exacerbated chronic respiratory failure, Marcelino et al recently reported that patients presenting with AF on ICU admission require a significantly long length of MV. However, the influence of AF on ventilator outcomes, including successful weaning of ventilator, ventilator days, and ventilator dependence, in a medical ICU has not yet been investigated and remains unknown.

In the present study, we conducted an observational retrospective case-control study to investigate the influence of AF on the weaning outcome in non-HF mechanically ventilated patients in a medical ICU. We hypothesized that AF on ICU admission may have an adverse effect on the weaning outcome and increase the burden of respiratory critical care in this patient group.

**METHODS**

**Design of the Study**

A retrospective observational case–control study was conducted in a 35-bed medical ICU of Taipei Veterans General Hospital, a tertiary medical center in Taiwan. The study was approved by the Institutional Ethical Review Board of Taipei Veterans General Hospital (approval number: VGHTPE-IRB No. 2015-02-006AC), and informed consent was waived for this retrospective study. Patients who were admitted to the ICU for intensive critical care and ventilator weaning during the study period between January 2011 and December 2011 were reviewed. Non-HF mechanically ventilated patients who were successful in their spontaneous breathing trial (SBT) and underwent ventilator discontinuation were enrolled. Patients were excluded from the study if they were receiving noninvasive positive pressure ventilation (NIPPV) on ICU admission, they had a diagnosis of HF on ICU admission, they had a history of cardiac surgery, they had a history of arrhythmia except AF, there was newly diagnosed HF during the hospitalization, AF was terminated within 7 days of onset or there was a new onset of AF during the ICU stay, the occurrence of AF was due to medication and/or electrolyte imbalance, and this was a repeat ICU admission. To evaluate the effect of AF on the weaning outcome, patients with factors known to influence the weaning process and SBT were also excluded. The enrolled patients were divided into the AF and non-AF groups (Figure 1).

**Subjects and Measurements**

The departmental log of the ICU was used to identify the patients. The medical charts of all consecutive appropriate patients admitted to the ICU during the study period were carefully reviewed and recorded. The following information was collected, namely age, sex, Acute Physiology and Chronic Health Evaluation (APACHE) II score on ICU admission,20 body mass index, the cause(s) of respiratory failure, comorbidities, the patient’s laboratory data on ICU admission, the patient’s laboratory data on the day of liberation from MV, any ICU events, the weaning parameters on the day of readiness for weaning (RFW), the length of ICU stay and the length of hospital stay. The weaning outcome, ICU mortality, and hospital mortality were also recorded. If the patient enrolled had several episodes of attempted weaning from MV, only the first episode was analyzed. The primary outcome measure was the status of ventilator status after the first episode of ventilator discontinuation.

**Weaning Protocol**

When the patients were weaned from the disease(s) causing respiratory failure, they were assessed as to whether they met the following criteria: adequate cough ability and/or an acceptable conscious state, adequate oxygenation: PaO2 ≥60 mm Hg and FIO2 ≤40% with PEEP ≤8 cmH2O or PaO2/FIO2 >150 mmHg, afibrile (BT <38°C), a stable cardiovascular status: HR ≤140/min, SBP 90–160 mm Hg with no or minimal vasopressors, a stable metabolic status with acceptable electrolyte levels, no significant respiratory acidosis, and an adequate mental state with spontaneous breathing ability. Subsequently, the patient’s rapid shallow breathing index (RSBI, respiratory rate/tidal volume ratio, breaths per liter per minute) was checked. At least 2 physicians were used to confirm the criteria for weaning every day. After the RSBI of patients was less than 105 breaths per liter per minute, the patients were considered suitable for RFW. These patients then received a T-piece or pressure support ventilation of 5 cmH2O with PEEP of 5 cmH2O for 60 minutes as SBT. Data regarding their arterial blood gas before SBT within 24 hours and immediately after SBT were recorded. The heart rate of the study patients was also recorded before and immediately after SBT. For those patients who could tolerate SBT without any symptoms or signs of respiratory distress, we performed extubation or discontinuation of MV. We did not routinely use NIPPV after weaning from MV.

**Definitions**

AF was diagnosed based on electrocardiogram characteristics including: absence of distinct repeating P waves, irregular RR intervals (when atrioventricular conduction is present), and irregular atrial activity.2 In this study, we enrolled patients with AF for more than 7 days (chronic AF) instead of paroxysmal AF and new-onset AF. HF was confirmed by a cardiologist and the diagnosis was based on the patient’s clinical symptoms/signs, echocardiogram, or cardiac nuclear medicine examination.21 Acute respiratory distress syndrome (ARDS) was defined according to the Berlin definition.22 Acute kidney injury was defined according to the glomerular filtration rate criteria of the “Risk of renal dysfunction, Injury to the kidney, Failure of kidney function, Loss of kidney function, and End-stage kidney disease” (RIFLE) classification.2,23 The criteria for a diagnosis of respiratory distress during SBT were as follows: a respiratory rate of more than 35 breaths per minute, accessory muscle use or paradoxical movement, a persistent saturation of less than 88% on a pulse oximeter, a systolic or diastolic blood pressure that increased by 10%, and a heart rate of more than 130 beats per minute. Weaning failure was defined as the need for reintubation or reconnecting tracheotomized patients to the ventilator within 72 hours after weaning from MV, or receiving NIPPV within 72 hours after weaning from MV.

**Statistical Analysis**

All data are expressed as the mean ± standard deviation (SD) or as a percentage (%). For numerical variables, we used the Mann–Whitney U test for nonnormally distributed variables and the independent t test for normally distributed variables.
Categorical variables were compared using the Chi-square test or Fisher exact test. Additionally, multivariate logistic regression analyses were used to calculate the crude odds ratios (OR) and adjusted odds ratio (AOR) of each dependent variable for the AF patients, with non-AF patients as the reference group. A multivariate logistic regression model was used via the enter technique, and the variables used during the univariate analysis were total ventilator days, length of ICU stay, length of hospital stay, weaning failure, ICU mortality, and hospital mortality. We also analyzed the ventilator dependence of the study patients by the Kaplan–Meier method and the log-rank test. These statistical analyses were carried out using SPSS, version 19.0 (SPSS, Inc., Chicago, IL). The results were considered significant at \( P < 0.05 \) and all \( P \) values were 2-sided.

**RESULTS**

**Demographic Characteristics of the Study Patients**

During this 1-year study period, 508 consecutive patients were admitted to the ICU and reviewed. A total of 223 patients were excluded according to the exclusion criteria, and 285 non-HF patients who received MV support on ICU admission and underwent ventilator discontinuation were enrolled in this study (Figure 1). The overall rate of weaning failure in these study patients was 25.3%, and the ICU and hospital mortalities were 19.3% and 29.8%, respectively. The mean age and APACHE II on ICU admission of the study patients were 77.4 (±14.5) years and 18.1 (±4.9), respectively. The most common comorbidities were hypertension (54%), stroke (40%), and diabetes mellitus (DM) (30%). The mean length of total ventilator use, the length of ICU stay, and length of hospital stay were 22.7 (±20.2), 26.2 (±17.3), and 54.8 (±46.2) days, respectively.

**Clinical Characteristics of the Study Patients With and Without AF on ICU Admission**

The study patients were divided into AF (n = 62) and non-AF (n = 223) groups according to the occurrence of AF on ICU admission. Compared with the non-AF patients, the AF patients were significantly associated with an older age (82.3 ± 8.3 years)
AF on ICU Admission Was Independently Associated With a Poor Hospital Outcome

The effect of AF on ICU admission among non-HF patients with MV was further analyzed by multivariate logistic regression and the ORs and AORs for patient outcomes are shown in Table 3. Compared with the non-AF patients, AF on ICU admission was independently associated with the risk of poor patient outcomes, including prolonged total ventilator days (AOR, 1.979; 95% confidence interval (CI), 1.032–3.794; \(P = 0.040\)), increased ICU stay (AOR, 2.256; 95% CI, 1.049–4.849; \(P = 0.037\)), increased hospital stay (AOR, 2.921; 95% CI, 1.363–6.260; \(P = 0.006\)), increased ICU mortality (AOR, 4.143; 95% CI, 1.381–12.424; \(P = 0.011\)), and increased weaning failure (AOR, 3.268; 95% CI, 1.254–8.517; \(P = 0.015\)) (Figure 3).

TABLE 1. Baseline Characteristics of the Study Patients With and Without AF on ICU Admission

| Variables                                      | AF (n = 62) | Non-AF (n = 223) | \(P\)     |
|------------------------------------------------|------------|-----------------|----------|
| Age                                           | 82.3 ± 8.3 | 76.0 ± 15.5     | 0.002    |
| Body mass index                               | 21.4 ± 4.4 | 21.3 ± 4.7      | 0.551    |
| Male/female                                   | 46/20      | 172/65          | 0.630    |
| Smoking                                       | 26 (41.9)  | 92 (41.3)       | 0.442    |
| APACHE II on ICU admission                    | 18.6 ± 4.2 | 18.0 ± 5.1      | 0.257    |
| Comorbidity                                   |            |                 |          |
| Hypertension                                  | 33 (53.2)  | 122 (54.7)      | 0.836    |
| Stroke                                        | 25 (40.3)  | 90 (40.4)       | 0.996    |
| Diabetes mellitus                             | 18 (29)    | 69 (30.9)       | 0.773    |
| Coronary artery disease/unstable angina       | 14 (22.6)  | 38 (17)         | 0.318    |
| Gastrointestinal bleeding                     | 7 (11.3)   | 24 (10.8)       | 0.906    |
| Malignancy                                    | 7 (11.3)   | 36 (16.1)       | 0.345    |
| Chronic kidney disease                        | 6 (9.7)    | 29 (13)         | 0.672    |
| Hemodialysis                                  | 1 (1.6)    | 10 (4.5)        | 0.299    |
| Reasons for ventilator support                |            |                 |          |
| Pneumonia                                     | 28 (45.2)  | 78 (35)         | 0.142    |
| Sepsis                                        | 10 (16.1)  | 43 (19.3)       | 0.572    |
| AECOPD                                        | 8 (12.9)   | 41 (18.4)       | 0.312    |
| Acute respiratory distress syndrome           | 9 (14.5)   | 12 (5.4)        | 0.015    |
| Sudden cardiac arrest                         | 2 (3.2)    | 11 (4.9)        | 0.569    |
| Neurology                                     | 2 (3.2)    | 25 (11.2)       | 0.058    |
| others                                        | 8 (12.9)   | 29 (13)         | 0.983    |
| Laboratory data on ICU admission              |            |                 |          |
| Hemoglobin, g/dl                              | 10.4 ± 2.0 | 10.8 ± 2.4      | 0.187    |
| Blood urea nitrogen, mg/dl                    | 44.9 ± 41.8| 39.2 ± 33.1     | 0.345    |
| Serum creatinine, mg/dl                       | 1.9 ± 1.5  | 1.9 ± 2.0       | 0.307    |

Data were reported as mean ± SD or number (percentage).
AF = atrial fibrillation, AECOPD = acute exacerbation of chronic obstructive pulmonary disease, APACHE = Acute Physiology and Chronic Health Evaluation, ICU = intensive care unit

DISCUSSION

AF, one of the most frequent arrhythmias in clinical practice, is known to adversely affect various hospital outcomes in critically ill patients.\(^5\)\(^–\)\(^11\)\(^,\)\(^24\)\(^–\)\(^27\) This study focused on the non-HF mechanically ventilated patients of medical ICU and found that AF on ICU admission was independently associated with prolonged total ventilator use, increased length of ICU stay,

| Variables                                      | AF (n = 62) | Non-AF (n = 223) | \(P\)     |
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| Body mass index                               | 21.4 ± 4.4 | 21.3 ± 4.7      | 0.551    |
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| Smoking                                       | 26 (41.9)  | 92 (41.3)       | 0.442    |
| APACHE II on ICU admission                    | 18.6 ± 4.2 | 18.0 ± 5.1      | 0.257    |
| Comorbidity                                   |            |                 |          |
| Hypertension                                  | 33 (53.2)  | 122 (54.7)      | 0.836    |
| Stroke                                        | 25 (40.3)  | 90 (40.4)       | 0.996    |
| Diabetes mellitus                             | 18 (29)    | 69 (30.9)       | 0.773    |
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| Reasons for ventilator support                |            |                 |          |
| Pneumonia                                     | 28 (45.2)  | 78 (35)         | 0.142    |
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| Laboratory data on ICU admission              |            |                 |          |
| Hemoglobin, g/dl                              | 10.4 ± 2.0 | 10.8 ± 2.4      | 0.187    |
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| Serum creatinine, mg/dl                       | 1.9 ± 1.5  | 1.9 ± 2.0       | 0.307    |
increased length of hospital stay, and increased ICU mortality, as compared with non-AF patients. Importantly, AF on ICU admission independently increased the risk of weaning failure and significantly contributed to a higher rate of ventilator dependence as compared with those patients without AF on ICU admission.

Clinically, the factors commonly associated with the development of AF include both cardiac and noncardiac conditions. The cardiac factors associated with AF development are HF, structural heart disease, ischemic heart disease, and hypertension.28,29 Recently, D’Ascia et al28 enrolled 58 non-AF patients who received cardiac resynchronization therapy for nonischemic idiopathic dilated cardiomyopathy and severe HF, and they reported that device implantation nonresponders had an increased risk of new-onset AF development. According to this result, the authors concluded that structural atrial remodeling, left ventricular systolic function, and the degree of mitral regurgitation can simultaneously contribute to the development of atrial arrhythmia.28,29 Therefore, electrical remodeling and structural remodeling are among the most important pathological mechanisms for AF development.28–31

The noncardiac factors associated with the development of AF include old age, DM, chronic kidney disease (CKD), sepsis and chronic obstructive pulmonary disease.30–34 An advanced age is a well-known risk factor for AF development among critically ill patients with HF, trauma, long-term hemodialysis, and sepsis.9–11,14,17,18 Cardiac aging and the molecular mechanism of mitochondrial oxidative stress in promoting AF have been well investigated by Xie et al.35 The prevalence of AF increases with age, and this age-dependent increase in oxidative stress can promote the development of AF.35 In our non-HF mechanically ventilated patients, we confirmed that old age was still associated with AF development. In addition, we found that AF patients had a higher percentage of respiratory failure due to ARDS than non-AF patients. To the best of our knowledge, no previous study has reported ARDS as a risk factor for the AF development. We assumed that ARDS-related systemic inflammation participates in the pathogenesis of AF and contributes to the development of dysrhythmia. Our findings were consistent with a previous observation that suggested severe sepsis increases the risk of developing newly diagnosed AF.11 These findings indicated that AF may be a consequence of a severe systemic inflammation response in patients with ARDS and severe sepsis. However, other potentially predisposing factors for the development of AF, which include DM, CKD, coronary artery disease, and ischemic heart disease, did not show a statistical difference between the AF and non-AF groups in our study. This finding may be explained by the fact that we excluded HF patients and reduced the effect of these factors on AF development.

Cardiac ischemia and left ventricular dysfunction have been reported as predictors of weaning failure,36–42 but whether cardiac dysrhythmia influences weaning outcome remains unclear. Only one study reported that AF is associated with a prolonged duration of MV in patients with exacerbated chronic respiratory failure.19 The effect of AF alone on the weaning outcome in non-HF critically ill patients remains uncertain. Our study is the first to report that AF on ICU admission independently increased the risk of weaning failure by threefold in non-HF mechanically ventilated patients in a medical ICU. In addition, no significant difference in baseline heart rate before SBT was observed between the AF and non-AF groups.

### TABLE 2. Clinical Characteristics and Patient Outcomes in the Study Patients With and Without AF on ICU Admission

| ICU events before liberation from MV          | AF (n = 62) | Non-AF (n = 223) | P       |
|-----------------------------------------------|------------|-----------------|---------|
| Acute kidney injury                           | 14 (22.6%) | 32 (14.3)       | 0.119   |
| Recent myocardial infarction                  | 3 (4.8)    | 6 (2.7)         | 0.392   |
| Sepsis                                        | 34 (54.8%) | 77 (34.5)       | 0.004   |
| Pneumonia                                     | 30 (48.4%) | 82 (36.8)       | 0.098   |
| Gastrointestinal bleeding                     | 14 (23)    | 37 (16.6)       | 0.252   |

- **On the day of liberation from MV**
  - Artificial airway via tracheostomy tube: 5 (1.8%) vs. 23 (8.1%), P = 0.599
  - Hemoglobin, g/dl: 10.7 ± 1.3 vs. 11.1 ± 1.8, P = 0.161
  - Blood urea nitrogen, mg/dl: 69.8 ± 49.0 vs. 52.7 ± 41.9, P = 0.003
  - Creatinine, mg/dl: 1.3 ± 0.8 vs. 1.4 ± 1.4, P = 0.230
  - Serum sodium, mmol/L: 138.2 ± 6.2 vs. 137.3 ± 4.7, P = 0.646
  - PF ratio before SBT, mm Hg: 355.3 ± 89.1 vs. 397.7 ± 193.2, P = 0.231
  - PF ratio after SBT, mm Hg: 429.7 ± 181.2 vs. 411.7 ± 168.1, P = 0.551
  - Heart rate before SBT, beat/min: 82.2 ± 12.8 vs. 83.9 ± 15.9, P = 0.422
  - Heart rate after SBT, beat/min: 88.0 ± 12.9 vs. 89.5 ± 15.4, P = 0.526
  - MV day before RFW, d: 19.2 ± 13.2 vs. 18.4 ± 32.2, P = 0.040
  - Total ventilator day, d: 24.9 ± 21.4 vs. 22.1 ± 19.9, P = 0.080
  - ICU stay, d: 24.7 ± 16.0 vs. 20.7 ± 15.4, P = 0.020
  - Hospital stay, d: 65.6 ± 47.4 vs. 51.8 ± 45.7, P = 0.004
  - Weaning failure from MV: 23 (37.1%) vs. 49 (22.0%), P = 0.020
  - ICU mortality: 19 (30.6) vs. 36 (16.1), P = 0.010
  - Hospital mortality: 26 (41.9) vs. 59 (26.5), P = 0.020

Data were reported as mean ± SD or number (percentage).

AF = atrial fibrillation, ICU = intensive care unit, MV = mechanical ventilation, PF = Pao2/Fio2 index, SBT = spontaneous breathing trial.
Moreover, there was no significant difference in the occurrence of tachycardia after SBT across both groups. A previous study determined the cardiac origin of weaning failure and identified diastolic dysfunction of the left ventricle with relaxation impairment as a predictor of weaning failure.\textsuperscript{41} Our findings indicated that AF-related irregular rhythm and chaotic atrial activity, but not relaxation impairment caused by a rapid ventricular response during weaning processes, played a dominant role that led to deleterious hemodynamic consequences when mechanically ventilated AF patients underwent weaning.\textsuperscript{3,14,41,43} Accordingly, AF-related dysrhythmia may affect weaning processes and contribute to weaning failure.

Previous studies have reported that AF worsens hospital outcomes in critically ill patients, including a higher rate of MV support, a longer length of ICU stay, a longer length of hospital stay, increased cardiovascular mortality, and increased noncardiovascular mortality.\textsuperscript{5–11,24–27} However, the influence of AF on hospital outcomes in mechanically ventilated ICU patients without HF remains largely unclear. In this patient population, we found that AF on ICU admission was significantly associated with increased morbidity because of its relation to more septicemia cases, as well as a high rate of renal dysfunction. Furthermore, AF on ICU admission was significantly associated with a range of hospital outcomes, including prolonged

**FIGURE 2.** Clinical outcomes based on the occurrence of AF on ICU admission among non-HF mechanically ventilated patients. MV = mechanical ventilation, RFW = readiness for weaning, ICU = intensive care unit, AF = atrial fibrillation.
ventilation use, increased ICU stay, increased hospital stay, and increased ICU mortality. Although the mechanism by which AF is associated with deterioration in hospital outcomes in critically ill patients is complex, there is growing evidence indicating that AF is an inflammatory disorder linked to an increased risk of AF-related complications. Therefore, we suggested that AF-related inflammation may have a critical influence on patient outcomes and may be potentially implicated in the development of sepsis and in renal function impairment. Intensivists should pay attention to mechanically ventilated patients with AF on ICU admission and be alerted to the AF-related respiratory care burden.

This study had several limitations. First, our investigation was a retrospective observational study, and the etiologies of

### TABLE 3. Multivariate Logistic Regression Analysis for Patient Outcomes in the Study Patients With and Without AF on ICU Admission

|                          | AF (n = 62) | Non-AF (n = 223) | P   |
|--------------------------|-------------|-----------------|-----|
| MV day before RFW        |             |                 |     |
| Crude OR, 95% CI         | 1.818 (0.935–3.536) | 1.0  | 0.078 |
| Adjusted OR, 95% CI      | 1.730 (0.853–3.507)  | 1.0  | 0.129 |
| Total ventilator days    |             |                 |     |
| Crude OR, 95% CI         | 2.080 (1.113–3.888)  | 1.0  | 0.022 |
| Adjusted OR, 95% CI      | 1.979 (1.032–3.794)  | 1.0  | 0.040 |
| ICU stay                 |             |                 |     |
| Crude OR, 95% CI         | 2.429 (1.167–5.056)  | 1.0  | 0.018 |
| Adjusted OR, 95% CI      | 2.256 (1.049–4.849)  | 1.0  | 0.037 |
| Hospital stay            |             |                 |     |
| Crude OR, 95% CI         | 2.653 (1.276–5.515)  | 1.0  | 0.009 |
| Adjusted OR, 95% CI      | 2.921 (1.363–6.260)  | 1.0  | 0.006 |
| Weaning failure from MV  |             |                 |     |
| Crude OR, 95% CI         | 2.094 (1.144–3.835)  | 1.0  | 0.015 |
| Adjusted OR, 95% CI      | 3.268 (1.254–8.517)  | 1.0  | 0.015 |
| ICU mortality            |             |                 |     |
| Crude OR, 95% CI         | 2.295 (1.202–4.384)  | 1.0  | 0.010 |
| Adjusted OR, 95% CI      | 4.143 (1.381–12.424) | 1.0  | 0.011 |
| Hospital mortality       |             |                 |     |
| Crude OR, 95% CI         | 2.008 (1.118–3.606)  | 1.0  | 0.018 |
| Adjusted OR, 95% CI      | 1.904 (0.878–4.126)  | 1.0  | 0.103 |

Data were reported as odds ratio (95% confident interval).
AF = atrial fibrillation, CI = confident interval, ICU = intensive care unit, MV = mechanical ventilation, OR = odds ratio, RFW = readiness for weaning.

FIGURE 3. Results of multivariate logistic regression analysis of the clinical outcomes among patients with AF on ICU admission. Patients without AF were used as the reference group. AOR = adjusted odds ratio, CI = confidence interval, ICU = intensive care unit, OR = odds ratio.

FIGURE 4. Kaplan–Meier curves illustrating the effect of AF on ICU admission on the risk of ventilator dependence among non-HF mechanically ventilated patients. HF = heart failure, AF = atrial fibrillation.
AF could not be evaluated thoroughly. The observational design precludes causal statements about the relationship between AF and hospital outcomes. Furthermore, the groups differed significantly in terms of age, incidence of sepsis, and ARDS; we could not determine whether AF “causes” long hospital stays, ICU stays, and an increase in mortality. Second, the diagnosis of HF was challenging and dependent on the patient’s history, their clinical symptoms and signs, the physical examination, and the findings of echocardiography. A previous study suggested that no standard value exists for the diagnosis of HF in the elderly and such subjects may have an atypical presentation. Third, only some of the patients received echocardiography. We could not confirm if the prevalence of diastolic dysfunction was higher among patients with AF and contributed to AF development. Fourth, we used electrocardiography as the standard for AF diagnosis. Holter examination and continuous monitoring offered by implanted devices were not used for AF diagnosis, and overall AF burden might not be assessed adequately. Finally, our research was carried out at Veterans General Hospital. Therefore, the average age of the study population is relatively old. The clinical features and effect of AF on younger patients still require further study.

In conclusion, we found that AF on ICU admission was an independent risk factor for weaning failure and also significantly associated with poor hospital outcomes of non-HF patients receiving MV in a medical ICU. Intensivists should be alerted regarding this issue in the respiratory care of critically ill patients.

ACKNOWLEDGMENTS

The authors thank all the health care workers of the RCUB at the Taipei Veterans General Hospital for their valuable contribution to the patient care. The authors are grateful to Dr. Ralph Kirby, Department of Life Sciences, National Yang-Ming University, and Dr. Hollie, Department of Enago, Crimson Interactive, Inc. (USA) for his help with language editing.

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