Acute Respiratory Distress Syndrome With and Without Extracorporeal Membrane Oxygenation: A Score Matched Study

Hsiao-Chi Tsai, MD,* Chih-Hsiang Chang, MD,* Feng-Chun Tsai, MD, Pei-Chun Fan, MD, Kuo-Chang Juan, MD, Chan-Yu Lin, MD, Huang-Yu Yang, MD, Kuo-Chin Kao, MD, Ji-Tseng Fang, MD, Chih-Wei Yang, MD, Su-Wei Chang, PhD, and Yung-Chang Chen, MD

Kidney Research Center, Department of Nephrology, Division of Cardiovascular Surgery, and Department of Thoracic Medicine, Chang Gung Memorial Hospital, Taipei; and College of Medicine and Clinical Informatics and Medical Statistics Research Center, College of Medicine, Chang Gung University, Taoyuan, Taiwan

Background. **Acute respiratory distress syndrome (ARDS) is a life-threatening medical condition. Extracorporeal membrane oxygenation (ECMO) is a salvage therapy for patients with ARDS and refractory hypoxia. This study compared the characteristics and outcomes of ARDS patients who did or did not receive ECMO matched with Acute Physiology and Chronic Health Evaluation II (APACHE II) score and age.**

Methods. **This retrospective, case-control study enrolled patients with ARDS admitted to the intensive care unit of a tertiary referral hospital between January 2007 and December 2012. Overall, 216 patients with ARDS—81 receiving ECMO (ECMO group) and 135 not receiving ECMO (non-ECMO group)—were enrolled in this study. Patients were paired when the difference in their APACHE II scores was within 3 points and their age difference was 3 years. In total, 126 patients could not be matched and were thus excluded. Eventually, of the 90 patients with ARDS enrolled in this study, 45 ECMO group patients were matched with 45 non-ECMO group patients. The demographic data, reasons for intensive care unit admission, and laboratory variables were evaluated.**

Results. **The primary etiology of ARDS was infection (72.2%). The APACHE II score and age-matched group receiving ECMO therapy had higher inhospital survival rates. Moreover, the patients receiving ECMO therapy had significantly lower 6-month mortality rates than did the non-ECMO group.**

Conclusions. **Patients with ARDS who received ECMO treatment had higher inhospital survival rates than did those with a similar disease severity and at a similar age who did not receive ECMO.**

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Despite the extensive progress in intensive care, acute respiratory distress syndrome (ARDS) remains a major cause of death in the intensive care unit (ICU). The reported mortality rate of patients with ARDS ranges from 38.5% to 58% [1–3]. Although extracorporeal membrane oxygenation (ECMO) was first introduced in 1953 to facilitate systemic perfusion during open heart surgery, this technique was not introduced for the first time to rescue life-threatening hypoxemia until 1972 [4]. Thereafter, ECMO has been increasingly used in the past decades to treat ARDS. The Conventional Ventilatory Support Versus ECMO for Severe Adult Respiratory Failure (CESAR) trial revealed that ECMO-based management for patients with potentially reversible respiratory failure can considerably and cost effectively improve survival [5]. The advantage of ECMO was further corroborated during the H1N1 influenza pandemic in 2009 [6]. However, limited evidence regarding mortality in ARDS was available from large randomized clinical trials. In this study, ARDS patients were matched based on their Acute Physiology and Chronic Health Evaluation II (APACHE II) scores and age to determine the utility of ECMO in patients with a similar disease severity. The APACHE II assumes that mortality is affected by physiologic disturbances that occur early during the course of a disease [7]. In addition, we analyzed the discriminatory power and accuracy of the prognostic systems used on the day of ARDS diagnosis.

Material and Methods

Study Design

The Institutional Review Board of Chang Gung Memorial Hospital approved this study and waived the requirement for informed consent because there was no

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*Hsiao-Chi Tsai and Chih-Hsiang Chang contributed equally to this manuscript.

Address correspondence to Dr Chen, Department of Nephrology, Chang Gung Memorial Hospital, 199 Tung Hwa N Rd, Taipei 105, Taiwan; e-mail: cyc2356@adm.cgmh.org.tw.

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Table 1. Demographic Data and Clinical Characteristics of Patients With and Patients Without Extracorporeal Membrane Oxygenation

	Original Groups			Score-Matched Groups			
Demographics and Characteristics	All ECMO (n = 81)	All Non-ECMO (n = 135)	*p* Value	All Patients (n = 90)	ECMO (n = 45)	Without ECMO (n = 45)	*p* Value
Age, years	48 ± 2.2	57 ± 2.5	<0.001	56 ± 1.6	56 ± 2.4	56 ± 2.4	NS (0.995)
Male	56 (69)	92 (68)	NS (0.880)	66 (73)	32 (71)	34 (75)	NS (0.634)
ARDS to ECMO diagnosis, days	3 ± 2	…	…	…	3 ± 2	…	…
ECMO support duration, days	14 ± 2	…	…	…	14 ± 2	…	…
GCS	7 ± 1	12 ± 1	<0.001	9 ± 1	8 ± 1	11 ± 1	0.006
Temperature, °C	36 ± 1	37 ± 1	0.010	37 ± 1	36 ± 1	37 ± 0	NS (0.168)
Heart rate, beats/min	117 ± 3	131 ± 3	0.003	124 ± 4	118 ± 4	132 ± 6	0.012
MAP, mm Hg	75 ± 4	69 ± 2	<0.0001	73 ± 3	67 ± 3	79 ± 3	0.009
Urine output, mL/day	1,782 ± 164	1,471 ± 160	NS (0.105)	1,763 ± 167	2,005 ± 277	1,532 ± 187	NS (0.158)
SCr, mg/dL	2.5 ± 0.5	2.3 ± 0.2	NS (0.896)	2.3 ± 0.4	2.4 ± 0.4	2.3 ± 0.4	NS (0.837)
Sodium, mEq/L	140 ± 1	137 ± 1	0.007	139 ± 1	141 ± 1	137 ± 1	0.020
Total bilirubin, mg/dL	1.9 ± 0.5	3.3 ± 0.5	NS (0.053)	3.4 ± 0.7	2.9 ± 0.9	3.9 ± 1.0	NS (0.458)
Albumin, g/dL	2.5 ± 0.4	2.4 ± 0.1	NS (0.406)	2.5 ± 0.1	2.4 ± 0.8	1.9 ± 0.2	NS (0.320)
WBC count, $\times 10^3/\mu L$	14.3 ± 1.2	15.6 ± 1.6	NS (0.631)	15.2 ± 1.5	14.1 ± 1.3	16.4 ± 2.8	NS (0.456)
Hemoglobin, g/dL	11.2 ± 0.9	10.2 ± 0.2	NS (0.561)	10.7 ± 0.3	11.1 ± 0.4	10.2 ± 0.4	NS (0.072)
Platelets, $\times 10^3/\mu L$	157 ± 12.2	159 ± 11.4	NS (0.924)	154 ± 13	154 ± 16	152 ± 20	NS (0.940)
Blood pH	7.3 ± 0	7.3 ± 0	NS (0.060)	7.3 ± 0	7.3 ± 0	7.3 ± 0	NS (0.200)
PaO_2/FiO_2	117.4 ± 21.4	121.8 ± 5.9	0.004	109.3 ± 8.9	92.9 ± 13.3	123.5 ± 11.9	NS (0.089)
Tidal volume, mL	423 ± 15	420 ± 8.4	NS (0.822)	423 ± 14	411 ± 22	436 ± 16	NS (0.371)
Plateau pressure, cmH_2O	28 ± 1	28 ± 1	NS (0.535)	28 ± 1	28 ± 1	27 ± 1	NS (0.328)
PEEP, cmH_2O	11 ± 0	11 ± 0	NS (0.949)	11 ± 0	11 ± 1	11 ± 0	NS (0.365)
ECMO mode, VA/VV	19/62	…	…	…	8/37	…	…
RRT	33 (40.7)	37 (27.4)	0.043	26 (28.9)	18 (40.0)	8 (17.8)	0.020
APACHE II score	26 ± 0.7	23 ± 1.1	<0.001	25 ± 1.1	25 ± 1.1	25 ± 1.1	NS (1.000)
SOFA	12.4 ± 0.3	9.8 ± 0.4	<0.001	11.6 ± 0.7	11.9 ± 0.5	10.2 ± 0.8	NS (0.103)
RIFLE	1.2 ± 0.2	1.3 ± 0.3	NS (0.763)	1.1 ± 0.1	1.2 ± 0.2	1.0 ± 0.2	NS (0.474)
Severe COPD	9 (9.8)	6 (5.9)	NS (0.062)	7 (7.8)	4 (8.9)	3 (6.7)	NS (0.694)
Chronic dialysis	9 (9.8)	14 (10.4)	NS (0.139)	11 (12.2)	7 (15.6)	4 (8.9)	NS (0.334)
Hospital mortality	45 (55)	88 (65.1)	NS (0.139)	56 (62.2)	22 (48.9)	34 (75.6)	0.009

Values are mean ± SE or n (%), unless otherwise indicated.

APACHE = Acute Physiology and Chronic Health Evaluation; ARDS = acute respiratory distress syndrome; COPD = chronic obstructive pulmonary disease; ECMO = extracorporeal membrane oxygenation; GCS = Glasgow Coma Scale; MAP = mean arterial pressure; NS = not significant; PEEP = positive end-expiratory pressure; RIFLE = risk, injury, failure, loss of kidney function, and end-stage kidney disease; RRT = renal replacement therapy; SCr = serum creatinine; SE = standard error; SOFA = sequential organ failure assessment; VA = venoarterial; VV = venovenous; WBC = white blood cell.