# Does earlier cannulation with veno-venous extracorporeal membrane oxygenation (VV-ECMO) in adult patients with Acute respiratory distress syndrome (ARDS) decrease duration on artificial mechanical ventilation?

DeSales University


A Scholarly Project

Christine Hartner, MSN, RN

Committee Chair/Committee Members:

Jacqueline Ochsenreither, DNP, CRNP, PPCNP-BC, DeSales University, Department of Nursing and Health

Tracey Shivok-Jefferson, DNP, CRNP, FNP-C, DeSales University, Department of Nursing and Health

Kenneth Miller, MEd, MSRT, Lehigh Valley Health Network, Respiratory Department

Michael Weiss, MPH, DeSales University, Department of Nursing and Health

June 28, 2018

# INTRODUCTION

- ARDS is the most common, and lethal, single organ failure in intensive care units (Wu, Huang, Wu, Wang, & Lin, 2016)
- Despite modern therapies, mortality from ARDS remains high (Linden et al., 2000)
- Advanced therapies improve outcomes (Wallace et al., 2014)
- A more recent technology shown to improve outcomes in adult patients with ARDS is VV-ECMO (Aokage, Palmer, Ichiba, & Takeda, 2015)
- Use of VV-ECMO, as a treatment for lung disease, has increased since the 2009 H1N1 Influenza outbreak (Aokage et al., 2015)
- Due to advances in technology, VV-ECMO has become more widely used (Squiers, Lima, & DiMaio, 2016)

# Statement of the Problem

- Timing of initiating VV-ECMO for adult patients with ARDS remains controversial
- Prolonged artificial mechanical ventilation has been linked to higher mortality rates (Combes, Bacchetta, Brodie, Muller, & Pellegrino, 2012)
- Treatments vary for adult patients with ARDS due to lack of standard protocols (Haile & Schears, 2009)

# Inquiry question

- Does earlier cannulation with VV-ECMO in adult patients diagnosed with ARDS decrease duration of artificial mechanical ventilation?

# OBJECTIVE

- To determine if adult patients 30 to 65 years of age, who are diagnosed with ARDS and who are cannulated with VV-ECMO within 48 hours, require shorter duration on artificial mechanical ventilation (AMV) .

# Background and Significance

- 700,000 adult patients require AMV annually due to ARDS (Mitchell et al., 2010)
- Mortality rates in adult with ARDS approach (40-50%) (Mitchell et al., 2010)
- No published evidence-based clinical practice guidelines for use of VV-ECMO in adult patients with ARDS exist (Mitchell et al., 2010)

# Background and Significance

- ARDS remains a life-threatening illness for critically-ill patients (Wu et al., 2016)
- Early intervention in adult patients with ARDS is necessary to prevent further lung damage (Shekar, Davies, Mullany, Tiruvoipati, & Fraser, 2013)
- Lack of evidence remains for timing of initiation of VV-ECMO therapy in adult patients with ARDS
- Development of therapeutic protocols for VV-ECMO allows for standardized care and informed decisions regarding care of adult patients with ARDS (Wu et al., 2016)

# Review of the Literature: Summary

- Significance of mortality rates differ
- Many studies did not examine the significance of timing of VV-ECMO cannulation to the duration of AMV
- Few studies performed in the United States
- Most studies had limited participants and focused on influenza-associated ARDS
- Need for timely evaluation of VV-ECMO use in adult ARDS population (Fan et al., 2016)

# PROJECT DESIGN AND SETTING

- 49-month quantitative, retrospective, inpatient electronic medical record (EMR) review
- Conducted at a single, tertiary-care center in two intensive care units (ICU)
- Comparison was made between length of time on AMV in adult patients with ARDS who received VV-ECMO treatment up to and inclusive of 48 hours of admission and diagnosis, to those adult patients with ARDS who received VV-ECMO after 48 hours of admission and diagnosis

# POPULATION AND STUDY SAMPLE

- Two comparison groups
- Adult patients with ARDS who received VV-ECMO up to and inclusive of 48 hours of diagnosis and admission
- Adult patients with ARDS who received VV-ECMO after 48 hours of diagnosis and admission
- The power of the study was set at 0.80 for a moderate to large effect size. The desired confidence interval was 0.95 with a significance level of 0.05
- Recruitment would have stopped when 100 participants (50 in each group) were identified and met inclusion criteria

# Inclusion criteria

- Male and female adult patients
- 30 to 65 years of age
- Diagnosed with ARDS by Pulmonary Intensivist
- Admitted to one of two critical-care units (2K South or Open Heart)
- Received AMV
- Treated with VV-ECMO up to and inclusive of 48 hours and post 48 hours of diagnosis and admission

# Exclusion criteria

- Less than 30 years of age and greater than 65 years of age
- Did not have a diagnosis of ARDS
- Did not require AMV
- Did not get admitted to one of two critical-care units (2K South or Open Heart)
- Did not receive treatment with VV-ECMO for ARDS

# Sources of data

- Data was extracted from the EMR based on principle International Classification of Disease, ninth and tenth edition (ICD-9 and ICD-10) procedure codes:

  - 39.65, ICD-9 Extracorporeal Membrane Oxygenation
  - 5A15223, ICD-10 Extracorporeal Membrane Oxygenation

# Collection of data

- Access to the EMR was obtained after Institutional Review Board (IRB) review and approval of study by DeSales University IRB committee and study institution of record
- Data were collected from the EMR and logged using RedCap, a password-protected survey tool, which was utilized to collect de-identified data
- Data collected from the EMR included date of birth, gender, date of admission, diagnosis, date and time of VV-ECMO cannulation, date and time of VV-ECMO de-cannulation, date and time of AMV initiation, and date and time of AMV liberation
- Data collected from comparable participants were analyzed, evaluated, and interpreted

# Data analysis strategies

- Data were de-identified
- Data were run through SPSS software for statistical analysis
- Independent samples *t*-tests were performed to identify differences between length of days and length of hours on AMV between the two comparable groups
- Data were evaluated and interpreted for statistical significance and implications for practice

# TIMEFRAME

- Date range was January 1, 2014 through January 1, 2018

# Data Analysis and Results

**110 Total participants**

**58 participants included**

- 39 participants were cannulated for VV-ECMO up to and inclusive of 48 hours of admission and diagnosis with ARDS
- 19 participants were cannulated for VV-ECMO after 48 hours of admission and diagnosis with ARDS

**52 participants excluded**

- 49 participants were excluded due to age requirements
- Three participants were excluded due to non-diagnosis of ARDS

# COMPARISON OF DAYS ON ARTIFICIAL MECHANICAL VENTILATION

| | Group 1 (n = 39) | Group 2 (n = 19) | *p* |
|---|---|---|---|
| Days on AMV | 21 (13-36)* | 27 (15-33)* | .579 |

*Note.* The median length of days in Group 1 was 6 days less than the median length of days in Group 2, but was not statistically significant.

*Median (Interquartile Range)

# COMPARISON OF HOURS ON ARTIFICIAL MECHANICAL VENTILATION

| | Group 1 (n = 39) | Group 2 (n = 19) | *p* |
|---|---|---|---|
| Hours on AMV | Mean (SD) 573±340 | Mean (SD) 628±372 | .574* |

*Notes*. Hours on AMV were calculated from the time of intubation until liberation from AMV.

*Calculated using *t*-test for Equality of Means

# COMPARISON OF HOURS CANNULATED ON VV-ECMO

| | Group 1 (n = 39) | Group 2 (n = 19) | *p* |
|---|---|---|---|
| Hours on VV-ECMO | Mean (SD) 307±237 | Mean (SD) 287±160 | .733* |

*Notes*. Hours on VV-ECMO were calculated based on the time of VV-ECMO cannulation until time of VV-ECMO de-cannulation

*Calculated using *t*-test for Equality of Means

# Comparison of length of time on AMV and VV-ECMO

- There was a six-day difference in median days on AMV between Group 1 and Group 2 when comparing days on AMV
- There was a 55 hour difference in mean hours between Group 1 and Group 2 when comparing hours on AMV
- **There was no clinically significant variance between the two study groups related to length of time on AMV or VV-ECMO**

# Comparison of rescue therapies utilized

| Rescue Therapies | Group 1 (n = 39) | Group 2 (n = 19) | *p* |
|---|---|---|---|
| Utilized | 13 (33.3%) | 8 (42.2%) | .514* |
| Not Utilized | 26 (66.6%) | 11 (57.8%) | .514* |

*Note.* Rescue therapies included prone positioning, high frequency percussive ventilation (VDR), inhaled nitric oxide (iNO), and Flolan.

*Calculated using Pearson Chi-Square (2-sided)

# Comparison of Survival at Discharge

| Discharge Status | Group 1 | Group 2 | *p* |
|---|---|---|---|
| Survived | 31 (79.5%) | 12 (63.2%) | .213* |
| Expired | 8 (20.5%) | 7 (36.8%) | .213* |

*Note.* There was a higher percentage of participants who survived at discharge in Group 1 than in Group 2. This was not proven to be statistically significant.

*Calculated using Fisher's Exact (2-sided) Test

# Comparison of rescue therapies and survival

- There were more participants in Group 1 that received rescue therapies
- There was a lower mortality in Group 1 than in Group 2
- **There was no clinically significant variance between the two study groups comparing rescue therapies and survival**

# Study strengths

- Clearly defined inclusion and exclusion criteria reduces the possibility of investigative error
- Data were gathered by a single individual reducing data recording errors
- No risk for participants due to retrospective nature of study
- Limiting diagnosis of ARDS to a single medical group (Pulmonary Intensivist) allows for limited error in diagnosis of ARDS

# Study Strengths

- Due to the limited research available related to timing of VV-ECMO cannulation and its correlation to length of AMV in adult patients with ARDS, this scholarly project may add to the current body of knowledge assisting other centers in the development of treatment programs for adult patients with ARDS

# Study Limitations

- Lack of generalizability due to single investigative site
- Small sample size
- Inclusive of adult patients only with ARDS
- Treatment variations may exist such as AMV settings, VV-ECMO settings, rescue therapies utilized, and co-morbidities
- VV-ECMO program at site of study is in its infancy (< four years) performing +/- 70 ECMO cases per year


# Discussion and Recommendations

# Discussion

- Although not statistically significant, the decreased duration of AMV in participants cannulated up to and including 48 hours (21 days vs 27 days) may have provided participants:
  - Improved survivability
  - Decreased lung injury
  - Earlier discharge
  - Earlier mobilization
  - Ability to communicate sooner
  - Reduced complications
  - Decreased risk of pulmonary infection
  - Improved patient and family satisfaction
  - Decreased hospital costs

# Questions

christine.hartner@lvhn.org

Or

ch4735@desales.edu

# REFERENCES


- Aokage, T., Palmer, K., Ichiba, S., & Takeda, S. (2015). Extracorporeal membrane oxygenation for acute respiratory distress syndrome. *Journal of Intensive Care*, *3*. http://dx.doi.org/10.1186/s40560-015-0082-7
- Beiderlinden, M., Eikermann, M., Boes, T., Breitfeld, C., & Peters, J. (2006). Treatment of severe acute respiratory distress syndrome: Role of extracorporeal gas exchange. *Intensive Care Medicine*, *32*, 1627-1631. http://dx.doi.org/10/1007/s00134-006-0262-y
- Bosarge, P., Raff, L., McGwin, G., Carroll, S., Bellot, S., DiazGuzman, E., & Kerby, J. (2016). Early initiation of extracorporeal membrane oxygenation improves survival in adult trauma patients with severe adult respiratory distress syndrome. *Journal of Trauma Acute Care Surgery, 81*(2), 236-243. http://dx.doi.org/10.1097/TA.0000000000001069

# REFERENCES


- Combes, A., Bacchetta, M., Brodie, D., Muller, T., & Pellegrino, V. (2012). Extracorporeal membrane oxygenation for respiratory failure in adults. *Current Opinions in Critical Care*, *18*, 99-104. http://dx.doi.org/10.1097/MCC.0b013e32834ef412
- Fan, E., Gattinoni, L., Combes, A., Schmidt, M., Peek, G., Brodie, D., …Papazian, L. (2016). Venovenous extracorporeal membrance oxygenation for acute respiratory failure. *Intensive Care Medicine, 42*, 712-724. http://dx.doi.org/10.1007/s00134-016-4314-7
- Fletcher, K., Chapman, R., & Keene, S. (2018). An overview of medical ECMO for neonates. *Seminars in Perinatology, 42*, 68-79. https:dx.doi.org/10.1053/j.semperi.2017.12.002
- Haile, D., & Schears, G. (2009). Optimal Time for Initiating Extracorporeal Membrane Oxygenation. *Seminars in Cardiothoracic and Vascular Anesthesia*, *13*(3), 146-153. http://dx.doi.org/10.1177/1089253209347924

# REFERENCES


- Hanson, M. (2004). Using Data from Critical Care Nurses to Validate Swanson's Phenomenological Derived Middle Range Caring Theory. *The Journal of Theory Construction & Testing, 8*(1), 21-25.
- Linden, V., Palmer, K., Reinhard, J., Westman, R., Ehren, H., Granholm, T., & Frenckner, B. (2000). High survival in adult patients with acute respiratory distress syndrome treated by extracorporeal membrane oxygenation, minimal sedation, and pressure supported ventilation. *Intensive Care Medicine*, *26*, 1630-1637. http://dx.doi.org/10.1007/s001340000697
- Mitchell, M., Mikkelsen, M., Umscheid, C., Lee, I., Fuchs, B., & Halpern, S. (2010). A systematic review to inform institutional decisions about the use of extracorporeal membrane oxygenation during the H1N1 influenza pandemic. *Critical Care Medicine*, *36*(6), 1398-1404. http://dx.doi.org/10.1097/CCM.0b013e3181de45db

# REFERENCES


- Munshi, L., Telesnicki, T., Walkey, A., & Fan, E. (2014). Extracorporeal life support for acute respiratory failure: A systematic review and metaanalysis. *Annals of the American Thoracic Society, 11*(5), 802-810. http://dx.doi.org/10.1513/AnnalsATS.201401-0120C
- Noah, M., Peek, G., Finney, S., Griffiths, M., Harrison, D., Grieve, R., ... Rowan, K. (2011). Referral to an extracorporeal membrane oxygenation center and mortality among patients with severe 2009 influenza A (H1N1). *Journal of the American Medical Association, 306*(15), 1659-1668. http://dx.doi.org/10.1001/jama.2011.1471
- Shekar, K., Davies, A., Mullany, D., Tiruvoipati, R., & Fraser, J. (2013). To ventilate, oscillate, or cannulate? *Journal of Critical Care*, *28*(5), 655-662. Retrieved from www.jccjournal.org

# REFERENCES


- Squiers, J. J., Lima, B., & DiMaio, J. M. (2016). Contemporary extracorporeal membrane oxygenation therapy in adults: Fundamental principles and systematic review of the evidence. *The Journal of thoracic and cardiovascular surgery*, *152*(1), 20-32.
- Wallace, D. J., Angus, D. C., Seymour, C. W., Yealy, D. M., Carr, B. G., Kurland, K., ... Kahn, J. M. (2014). Geographic Access to High Capability Sever Acute Respiratory Failure Centers in the United States. *PLOS One*, *9*(4). http://dx.doi.org/10.1371/journal.pone/0094057
- Wu, M., Huang, C., Wu, T., Wang, C., & Lin, P. (2016). Venovenous Extracorporeal Membrane Oxygenation for Acute Respiratory Distress Syndrome in Adults. *Medicine*, *95*(8). http://dx.doi.org/10.1097/MD.0000000000002870