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Evaluation of the RESP Score and Demographic Information in order to Predict Survival of ECMO Patients at a Community Hospital



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Introduction

Extracorporeal Membrane Oxygenation (ECMO) is the use of mechanical devices to temporarily support heart or lung function during cardiopulmonary failure, leading to organ recovery or replacement. Venovenous ECMO is commonly used in patients with acute respiratory distress syndrome (ARDS) in which blood is withdrawn from and returned through the venous system. The patient's blood is oxygenated and carbon dioxide is excreted via a membrane outside the body. ECMO is initiated in patients with ARDS when positive-pressure ventilation cannot maintain adequate gas exchange to support life.

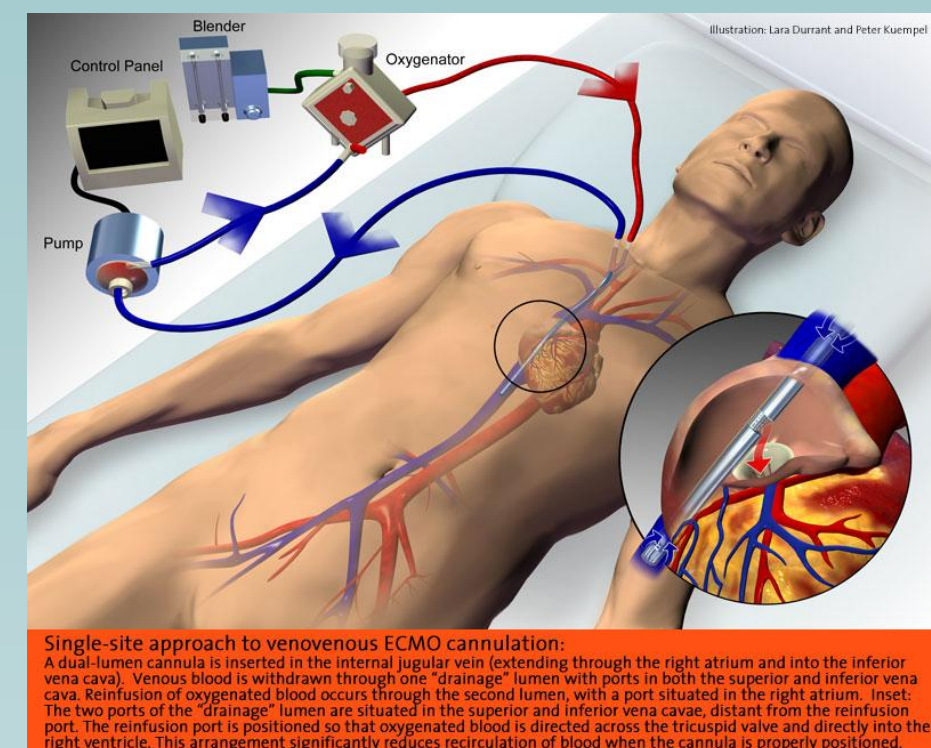


Figure 1. Retrieved June 14, 2014 from NYP: <http://nyp.org/services/carf/what-is-ecmo.html>

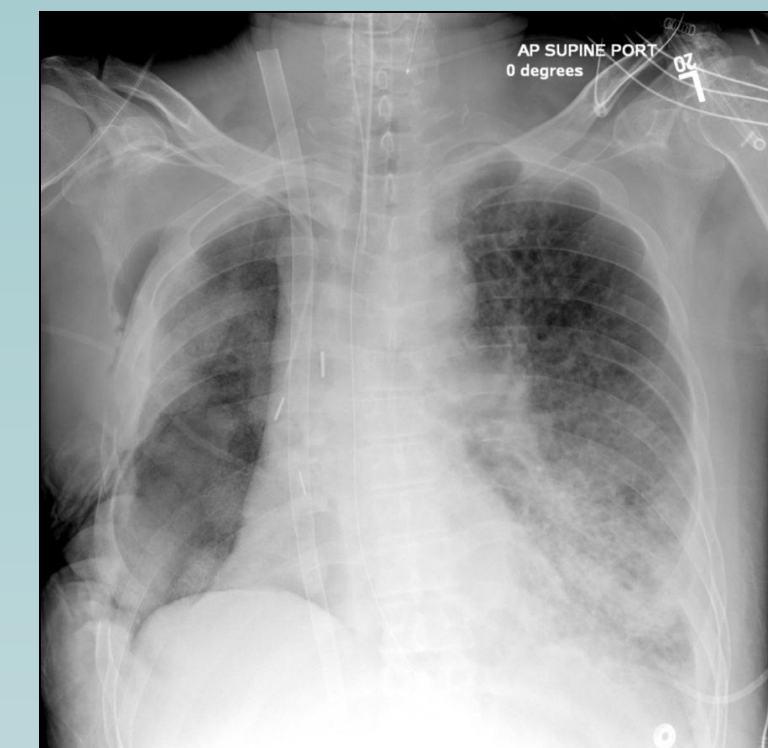


Figure 2. X-Ray of a patient with ARDS and the dual-lumen catheter inserted

ECMO has been shown to increase survival rates for patients with ARDS. Lehigh Valley Health Network, a community scholastic hospital, began using ECMO in 2013 and has seen great success. By using the Respiratory Extracorporeal Membrane Oxygenation Survival Prediction (RESP) score, clinicians can better target patients who will benefit from ECMO as well as patients who need more resources and attention. The objective of this project was to show that ECMO at a community hospital is possible and very successful.

The RESP Score

The Australian and New Zealand Intensive Care Research Centre developed a method using pre-ECMO variables of 2,355 patients from the Extracorporeal Life Support Organizations (ELSO) international registry. It assesses 12 pre-ECMO variables to determine a final score predicting survival for patients receiving ECMO for respiratory failure. The score can range anywhere from -22 to 15. The lower the score, the sicker the patient was before ECMO and the lower chance of survival is assumed.

| Parameter | Score |
|--|-----------|
| Age, yr | |
| 18 to 49 | 0 |
| 50 to 59 | -2 |
| ≥ 60 | -3 |
| Immunocompromised status | -2 |
| Mechanical Ventilation prior to initiation of ECMO | |
| < 48 hours | 3 |
| 48 hours to 7 days | 1 |
| > 7 days | 0 |
| Acute Respiratory Diagnosis Group | |
| Viral Pneumonia | 3 |
| Bacterial Pneumonia | 3 |
| Asthma | 11 |
| Trauma and burn | 3 |
| Aspiration Pneumonitis | 5 |
| Other Acute Respiratory Diagnoses | 1 |
| Nonrespiratory and chronic respiratory diagnoses | 0 |
| Central Nervous System Dysfunction | -7 |
| Acute Associated (nonpulmonary) Infection | -3 |
| Neuromuscular Blockade Agents before ECMO | 1 |
| Nitric Oxide used before ECMO | -1 |
| Bicarbonate infusion before ECMO | -2 |
| Cardiac Arrest before ECMO | -2 |
| PaCO ₂ , mmHg | |
| < 75 | 0 |
| ≥ 75 | -1 |
| Peak Inspiratory Pressure, cm H ₂ O | |
| < 42 | 0 |
| ≥ 42 | -1 |
| Total Score | -22 to 15 |

Figure 3. The RESP Score at ECMO Initiation
Schmidt, et al. (2014) Predicting Survival after Extracorporeal Membrane Oxygenation for Severe Acute Respiratory Failure, [chart]. Retrieved June 22, 2014 from American Journal of Respiratory and Critical Care Medicine.

Methods

All 42 VV ECMO patients' data at LVHN was analyzed for demographic information and for the pre-ECMO variables instituted by the RESP score. The RESP score was then calculated for each patient based on the 12 parameters. The survival rates were then analyzed by overall score, age, gender, and BMI. The patients were also subcategorized into groups focusing on those who were diagnosed with H1N1 influenza, were administered a paralytic, those who were not administered a paralytic, those who developed a cardiac arrest, and those who were placed on high frequency percussive ventilation (VDR). In these groups, the average RESP score was calculated as well as the survival percentage in order to show a connection and highlight the importance of the RESP score.

Results

Figure 2. Pre-ECMO RESP Score Information for LVHN Patients

| | All Patients (n=40) | Alive (n=27) | Expired (n=13) |
|---|---------------------|--------------|----------------|
| Acute Respiratory Failure Diagnoses | | | |
| Bacterial Pneumonia | 27 | 19 | 8 |
| Aspiration Pneumonitis | 10 | 7 | 3 |
| Other Acute Respiratory Diagnoses*** | 4 | 2 | 1 |
| Other | 1 | 0 | 1 |
| Immunocompromised*** | 6 | 3 | 2 |
| Acute Associated Nonpulmonary Infection | 5 | 2 | 3 |
| Neuromuscular Blockage Agents before ECMO*** | 34 | 25 | 9 |
| Nitric Oxide Infusion before ECMO ** | 24 | 17 | 7 |
| Bicarbonate Infusion before ECMO*** | 21 | 11 | 9 |
| Cardiac Arrest before ECMO | 8 | 3 | 5 |
| PaCO ₂ , mmHg | | | |
| < 75*** | 37 | 25 | 11 |
| ≥ 75 | 5 | 3 | 2 |
| Peak Inspiratory Pressure, cmH ₂ O * | | | |
| < 42 | 39 | 26 | 12 |
| ≥ 42 | 3 | 2 | 1 |

* Patient Info Missing (1 patient)
** Flolan also included
***Patient currently still on ECMO so status is unavailable

Figure 3. Demographic Characteristics of Critically Ill Patients on ECMO

| | No. of Patients (%) |
|------------------------|---------------------|
| Age, mean in years | 51.6 |
| 18-49 | 17 (42.5) |
| 50-59 | 12 (30) |
| 60+ | 11 (27.5) |
| Females | 22 (55) |
| Avg RESP Score | 1.86 |
| Males | 18 (45) |
| Avg RESP Score | 1.78 |
| Overall Avg RESP Score | 1.83 |
| Overall Avg BMI | 32.4 |

Figure 4. Survival based on Gender

| Gender | Total # | % Survival | Avg RESP Score | Avg Age | Avg BMI |
|---------|---------|------------|----------------|---------|---------|
| Females | 23* | 59% | 1.48 | 49.4 | 33.3 |
| Males | 19 | 78.9% | 1.89 | 52.2 | 31.2 |

* One patient is still on ECMO so status is unknown

Figure 5. Survival based on BMI

| BMI | Total # | % Survival | Avg RESP Score | Avg Age |
|---------------|---------|------------|----------------|---------|
| < 30 | 19 | 68.4% | 1.68 | 48 |
| 30-40 | 15 | 80% | 1.93 | 52.2 |
| > 40* | 7 | 33% | 1.29 | 54.14 |
| obesity(>30)* | 22 | 66.7% | 1.95 | 52.8 |

*One patient is still on ECMO so status is unknown
One patient's BMI is unknown

Figure 6. VDR (High Frequency Percussive Ventilation) Statistics

| | Total # | % Survival | Avg RESP Score | Avg Age | Avg BMI |
|-----------|---------|------------|----------------|---------|---------|
| VDR | 21 | 70% | 1.95 | 48 | 34.35 |
| Female* | 12 | 72.7% | 2.25 | 47.5 | 36.7 |
| Male | 9 | 62.5% | 1.56 | 48.8 | 31.3 |
| < 30 BMI | 7 | 85.7% | 2.14 | 44.3 | - |
| > 30 BMI* | 12 | 58.3% | 1.86 | 49.9 | - |
| No VDR | 21 | 66.7% | 1.33 | 53.3 | 31.06 |
| Female | 11 | 45.5% | 0.64 | 51.5 | 31 |
| Male | 10 | 90% | 2.4 | 55.2 | 31.1 |
| < 30 BMI | 12 | 58.3% | 1.33 | 50.2 | - |
| > 30 BMI | 8 | 75% | 1.5 | 57.9 | - |

*One patient is still on ECMO so status is unknown

Conclusion

Table 7. Survival by Risk Class for LVHN and for the RESP Article

| RESP Score | % Patients at LVHN | LVHN Survival % | % Patients in RESP Article | RESP Article Survival % |
|------------|--------------------|-----------------|----------------------------|-------------------------|
| ≥ 6 | 4.8% | 100% | 7% | 92% |
| 3 to 5 | 38.1% | 94% | 24% | 76% |
| -1 to 2 | 47.6% | 50% | 44% | 57% |
| -5 to 2 | 9.5% | 33% | 19% | 33% |
| ≤ -6 | 0% | N/A | 6% | 18% |

Schmidt, et al. (2014) Predicting Survival after Extracorporeal Membrane Oxygenation for Severe Acute Respiratory Failure, [chart]. Retrieved June 22, 2014 from American Journal of Respiratory and Critical Care Medicine.

LVHN had a survival rate of 68.3% which was higher than the Extracorporeal Life Support Organization rate of 57%. When the survival percentages were broken down by RESP scores, LVHN surpassed the RESP article's percentage in the first two categories, was slightly lower in the -1 to 2 category, and matched the RESP article's rate for the -5 to 2 category. We believe our successes to be due to three things: 24 hour attending physician supervision, a fully trained clinical staff in ECMO management, and an arsenal of rescue modes of ventilation.

A major limitation of this study was due to the small population of Venovenous ECMO patients. With its recent institution at Lehigh Valley Health Network, only 42 patients have undergone this life saving measure. Even though we have great statistics so far, much is to be learned and verified. An ECMO database for Lehigh Valley Health Network was created for future data and analysis.

The first informative research study on VV ECMO patients at LVHN was performed showing great success for a community hospital. We hope our data and knowledge will influence other community hospitals to begin to initiate ECMO. I hope this study and evaluation of the RESP score will initiate the use of the RESP score at the bedside of a patient rather than calculating it retrospectively in order to prevent errors and slight discrepancies.

Thank You

I would like to thank my mentors Kenneth Miller and Dr. Matthew McCambridge for their time and support. Throughout this program I was able to have many clinical experiences. I shadowed in the bronchoscopy lab, the AICU, Pediatrics, Medical Physics, Radiation Oncology, MICU/SICU, and the Cath Lab. Thank you Lehigh Valley Hospital for this experience.

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