Conversion from venovenous to venoarterial extracorporeal membrane oxygenation

Falk L.[1,2], Hultman J.[1,2], Fletcher-Sandersjöö A.[3,4], Broman LM.[1,2]

[1]ECMO Centre Karolinska, Karolinska University Hospital, Stockholm, Sweden, [2]Department of Physiology and Pharmacology, Karolinska Institutet, Stockholm, Sweden, [3]Department of Clinical Neuroscience, Stockholm, Sweden, [4]Department of Neurosurgery, Karolinska University Hospital, Stockholm

| Background

Already in 1984 Klein(1) described the necessity to convert neonatal patients from veno-venous extracorporeal membrane oxygenation (VV) ECMO) to veno-arterial (VA) ECMO in the case of circulatory failure. Even though conversion is not well described in the literature it seems to be an empirical and accepted form of treating failing circulation in the pediatric and neonatal population as described in several articles (1-2). Concerning the adult population, evidence is scarce. There are a couple of studies mentioning conversion but they remain elusive in to why conversion was considered or performed (3-4). VV ECMO may be used in refractory severe respiratory failure unresponsive to conventional critical care. However, arising heart failure may limit tissue oxygen delivery. To offer adequate support these patients may need conversion to VA ECMO. The aim of this study was to characterise the patients that undergo conversion from VV o VA ECMO at our unit. Our hypothesis from own experience as well as other ECMO centres', is that conversion takes place when circulation fails from a cardiac or vasoplegic cause, or from dysfunction or failure of the right ventricle (RV). We aimed to review conversions, a group with limited pre-existing data.

| Methods

Patients from the age of 18 years that were treated at ECMO Centre Karolinska between 2005 and 2015, excluding ECPR-patients and patients partially treated at a different hospital, were included. Mann Whitney U test, Chi-square and Fisher's exact test were used accordingly. The statistical significance level was set to $p<0.05$.

| Results

Of 274 included patients, 176 were initially treated with VV ECMO. Sixty (34%) of these patients showed signs of cardiac failure, and thirty-nine (22%) were converted to VA ECMO. Survival from VA ECMO was 64%, and from VV 82% ($p<0.001$). Survival for the converted cohort was 41% ($p<0.01$). There was no difference in admission SAPS-3 score between the converted and non-converted VV patients. The RESP score was lower for the group that was later converted (-3 vs. 2, $p<0.0001$). At the time of conversion the SAVE score for the conversions was -6 (VA -4, $p=0.11$). The SOFA score followed the same trend increasing from 11 at admission to 15 at the time of conversion ($p<0.00001$).

| Conclusion

VV ECMO patients may deteriorate in cardiac function and require VA conversion. In our study these may be predicted by the RESP score at admission. We found that patients who were converted from VV to VA ECMO had a lower survival compared to patients who were put on VA from the onset of ECMO treatment. Daily clinical and echocardiographic assessment may help identifying patients in need of conversion thereby leading to earlier intervention.

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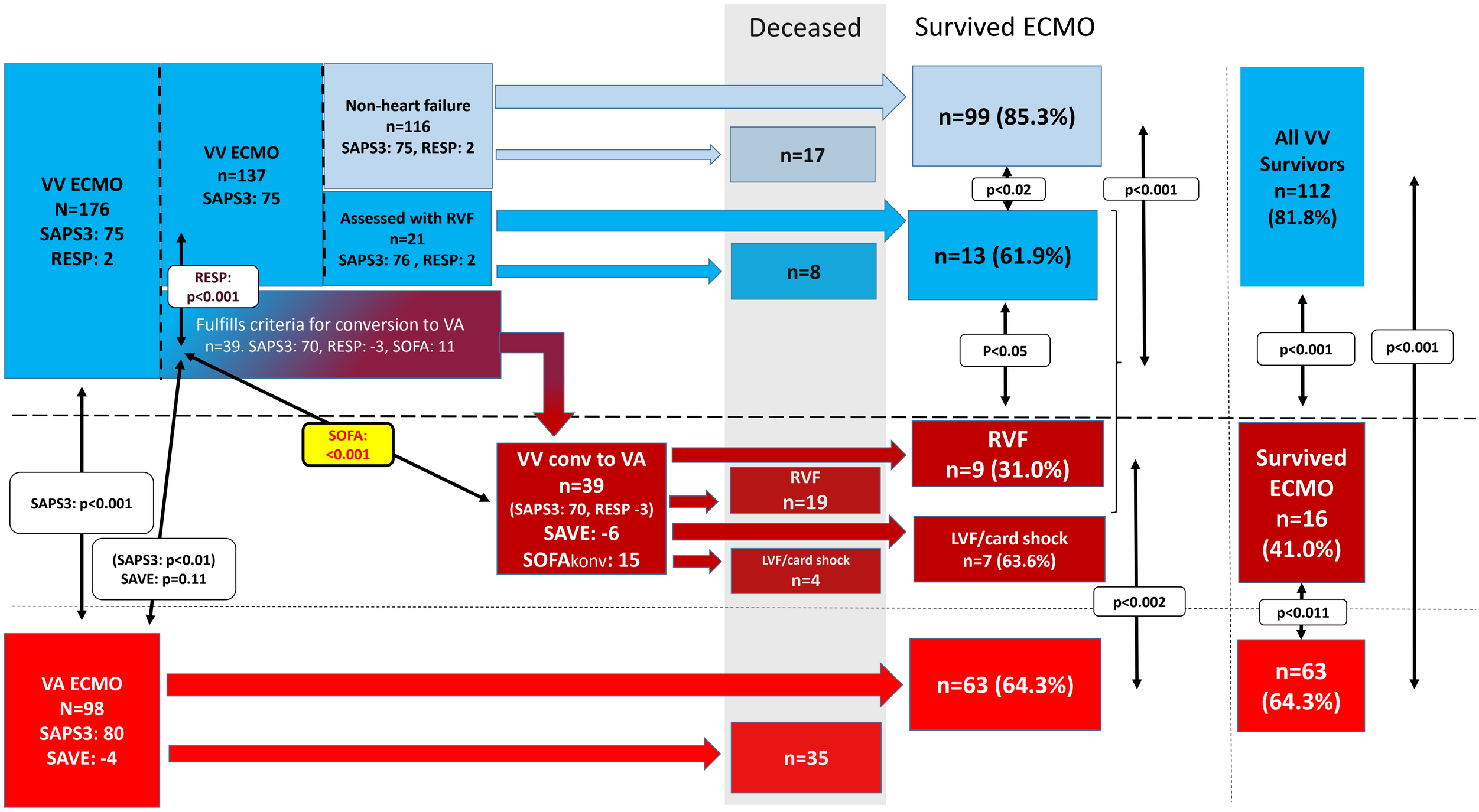
2) Anderson H, Snedecor S, Otsu T, Bartlett R. Multicenter Comparison of Conventional Venoarterial Access Versus Venovenous Double-Lumen Catheter Access in Newborn Infants Undergoing Extracorporeal Membrane Oxygenation. *Journal of Pediatric Surgery.* 1993;28(4):530-535.
3) Bachetta M, Javidfar J, Sonett J, Kim H, Zwischenberger J, Wang D. Ease of Conversion from Venovenous Extracorporeal Membrane Oxygenation to Cardiopulmonary Bypass and Venoarterial Extracorporeal Membrane Oxygenation with a Bicaval Dual Lumen Catheter. *ASAIO J.* 2011;57(4):283-285.
4) Cordell-Smith JA, Roberts N, Peek GJ, Firmin RK. Traumatic lung injury treated by extracorporeal membrane oxygenation (ECMO). *Injury.* 2005;37(1):29-32.

Fig. 1: Flow chart for admissions of venovenous (VV) and venoarterial (VA) respiratory extracorporeal membrane oxygenation (ECMO) commencements. A limited number of VV patients experienced deterioration of cardiac function and were converted to VA ECMO.



Abbreviations: SAPS3=Simplified Acute Physiology Score (rev 3) ; RESP=Respiratory Extracorporeal Membrane Oxygenation Survival Prediction; SAVE=Survival After Veno-arerial ECMO; SOFA= Sequential Organ Failure Assessment score; ARF= Acute respiratory failure; RVF=Right ventricular failure; LVF=Left ventricular failure