# Sürekli RRT ve ECMO

# Çözüm mü? Risk mi?

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**Yoğun Bakım BD**

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**Risk Index for Postoperative Acute Kidney Injury After Valvular Surgery Using Cardiopulmonary Bypass**

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Ann Thorac Surg 2017;104:868–76

**Sürekli renal replasman tedavisi**

- Hemodinamik stabilite
- Sıvı balansı
- Vazoaktif ilaç dozlarının azalması
- İnflamatuar mediyatör temizliği
- İmmun fonksiyonun iyileşmesi
- Organ fonksiyonlarının iyileşmesi
- Renal fonksiyonun iyileşmesi

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**Risk factors for failure of continuous veno-venous hemodialysis in the treatment of acute renal failure following cardiac surgery**

DOI: 10.1177/0267659110377818

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- Tek cerrah
- 2005-2008 yılları
- 1712 operasyon
- 52 olgu ARY **(%3.04)**

**Table 3.** Operation type and associated LVEF

| Operation type | N | LVEF< 35% | | |
|---|---|---|---|---|
| | | Total | Success group | Failure group |
| Valve only | 14 | 4 | 1 | 3 |
| CABG only | 15 | 6 | 4 | 2 |
| CABG +valve | 16 | 5 | 3 | 2 |
| Aortic surgery | 7 | 1 | 0 | 1 |

Mortalite: %30.8

**Table 1.** Comparison of pre-operative data between the two groups

| Variable | Success group (n=36) | Failure group (n=16) | p |
|---|---|---|---|
| Age (year) | 65±12 | 66±13 | 0.7880 |
| Gender (male / female) | 23/13 | 10/6 | 1.0000 |
| Recent smoking | 14 (38.9%) | 8 (50.0%) | 0.5482 |
| Diabetes | 19 (52.8%) | 10 (62.5%) | 0.5600 |
| Hypertension | 25 (69.4%) | 12 (75.0%) | 0.7522 |
| Recent MI | 12 (33.3%) | 7 (43.8%) | 0.5405 |
| LVEF (%) | 46±9 | 40±7 | 0.0220 |
| LVEF below 35% | 8 (22.2%) | 8 (50.0%) | 0.0578 |
| LVEDD (mm) | 57±15 | 64±14 | 0.1195 |
| Pre-operative inotropic support | 7 (19.4%) | 6 (37.5%) | 0.1843 |
| Pre-operative IABP support | 1 (2.8%) | 1 (6.3%) | 0.5249 |
| Baseline BUN (mmol/L) | 6.7±1.4 | 6.8±1.5 | 0.8170 |
| Baseline creatinine (mg/dl) | 0.9±0.3 | 1.0±0.3 | 0.2726 |
| EuroSCORE | 7.2±3.1 | 7.6±2.9 | 0.6635 |

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**Table 4.** Comparison of post-operative data between the two groups

| Variable | Success group (n=36) | Failure group (n=16) | p |
|---|---|---|---|
| Hypotension | 27 (75.0%) | 13 (81.3%) | 0.7331 |
| Inotrope score before dialysis | 12.1±3.1 | 14.5±4.6 | 0.0318 |
| LCOS | 20 (55.6%) | 14 (87.5%) | 0.0306 |
| IABP requirement | 4 (11.1%) | 3 (18.8%) | 0.6619 |
| Re-exploration for bleeding | 3 (8.3%) | 3 (18.8%) | 0.3565 |
| Hypoxemia | 25 (69.4%) | 13 (81.3%) | 0.5060 |
| Respiratory failure | 19 (52.8%) | 11 (68.8%) | 0.3676 |
| MODS | 26 (72.2%) | 16 (100%) | 0.0218 |
| Pre-dialysis CVP (mmHg) | 10.9±3.5 | 13.4±4.0 | 0.0272 |
| Pre-dialysis PCWP (mmHg) | 14.1±4.0 | 16.8±4.8 | 0.0397 |
| Peak BUN (mmol/L) before dialysis | 26.3±7.4 | 31.2±9.8 | 0.0520 |
| Peak creatinine (mg/dl) before dialysis | 3.2±1.1 | 4.0±1.5 | 0.0357 |
| Pre-dialysis potassium (mmol/L) | 5.1±1.1 | 5.3±1.2 | 0.5588 |
| Pre-dialysis Lac(mmol/L) | 6.9±1.5 | 8.1±2.2 | 0.0259 |
| Duration of oliguria until dialysis (h) | 11.6±2.5 | 22.1±6.9 | < 0.0001 |
| MODS score before dialysis | 8.2 ± 2.7 | 10.5 ± 3.3 | 0.0109 |
| APACHE III score before dialysis | 78.9±11.2 | 86.6±13.8 | 0.0382 |

Akut renal yetmezlik

+

- Düşük kardiyak debi
- Ciddi volüm yüklenmesi
- Elektrolit bozukluğu
- Asit-baz bozukluğu

↓

Uygun RRT – zaman

↓

Geri dönüşüm ???

| | | | | | |
|---|---|---|---|---|---|
| Pre-dialysis Lac(mmol/L) | 6.9±1.5 | 8.1±2.2 | 0.0259 | Preoperatif LVEF | OR=0.635 (CI 0.358-0.852) p=0.0137 |
| Duration of oliguria until dialysis (h) | 11.6±2.5 | 22.1±6.9 | < 0.0001 | Oligüri - diyaliz süresi | OR=2.442 (CI 1.563-5.768) p=0.0025 |
| MODS score before dialysis | 8.2 ± 2.7 | 10.5 ± 3.3 | 0.0109 | | |
| APACHE III score before dialysis | 78.9±11.2 | 86.6±13.8 | 0.0382 | | |

Diyaliz öncesi MODS
APACHE III
Mortalite

Kardiyak – renal – solunum – hepatik - serebral fonksiyon bozukluğu

RRT erken başlandığında prognoz iyi
Preop LV fonksiyonu önemli

**Table 5.** Number of impaired organs in the two groups

| Number of impaired organs | Patients | | | Mortality |
|---|---|---|---|---|
| | Total | Success group | Failure group | |
| 1 | 3 | 3 | 0 | 0 |
| 2 | 24 | 22 | 2 | 8.3% |
| 3 | 14 | 10 | 4 | 28.6% |
| 4 | 6 | 1 | 5 | 83.3% |
| >4 | 5 | 0 | 5 | 100% |

**Mortality prediction in patients with acute kidney injury requiring renal replacement therapy after cardiac surgery**

*Inga Skarupskienė[1], Dalia Adukauskienė[2], Jurgita Kuzminskienė[2], Laima Rimkutė[2], Vilma Balčiuvienė[2,3], Edita Žiginskienė[2], Vytautas Kuzminskis[2], Agnė Adukauskaitė[2], Daiva Pentiokinienė[2], Inga Arūnė Bumblytė[2]*

MEDICINA 53 (2017) 217–223

5 yıl, tek merkez
KRY Ø
ARY → RRT

**Table 1 – Clinical characteristics of study patients (n = 111) with dialysis-dependent acute kidney injury after cardiac surgery.**

| Factors | All (n = 111) | Survivors (n = 26) | Non-survivors (n = 85) | P |
|---|---|---|---|---|
| CPB time, min | 156.72 ± 9.29 | 171.00 ± 27.41 | 151.82 ± 9.86 | 0.371 |
| APACHE II score | 24.77 ± 6.16 | 22.19 ± 1.11 | 25.56 ± 0.66 | 0.014 |
| SOFA score | 14.59 ± 0.44 | 11.27 ± 0.981 | 15.38 ± 0.49 | 0.0001 |
| Liano score | 0.628 ± 0.17 | 0.556 ± 0.341 | 0.650 ± 0.194 | 0.02 |
| Oliguria, n (%) | 65 (58.6) | 13 (50.0) | 52 (61.2) | 0.311 |
| Serum creatinine before RRT, μmol/L | 400.37 ± 14.49 | 449.77 ± 31.83 | 385.26 ± 15.97 | 0.059 |
| Blood urea before RRT, mmol/L | 27.91 ± 1.35 | 26.88 ± 2.49 | 28.22 ± 1.58 | 0.676 |
| Serum potassium before RRT, mmol/L | 5.31 ± 0.09 | 5.17 ± 0.15 | 5.34 ± 0.10 | 0.421 |
| RRT modality, n (%) | | | | |
| IHD | 49 (44.1) | 17 (65.4) | 32 (37.6) | 0.240 |
| CVVH or CVVHDF | 43 (38.7) | 5 (19.2) | 38 (44.7) | 0.601 |
| IHD + CVVH or CVVHDF | 19 (17.2) | 4 (15.4) | 15 (17.7) | 0.165 |
| Other outcomes | | | | |
| Length of hospital stay, days | 35.5 ± 3.24 | 65.69 ± 7.93 | 26.26 ± 2.80 | 0.0001 |

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MEDICINA 53 (2017) 217–223

**Table 2 – Associations of variables and mortality of patients with dialysis-dependent acute kidney injury after cardiac surgery in the model of multivariable logistic regression analysis.**

| Variable | | Coefficient estimate | Odds ratio (95% CI) | P |
|---|---|---|---|---|
| Glasgow coma points | < 14 | 0.547 | 3.304 (1.130–9.662) | 0.0029 |
| Mean arterial blood pressure | < 63.5 mmHg | 0.642 | 3.872 (1.01–13.616) | 0.035 |
| Postoperative platelet count | < 115x10⁹/L | 0.554 | 3.731 (1.259–11.054) | 0.018 |
| Preoperative serum creatinine | > 1.23 mg/dL | 0.531 | 0.347 (0.123–0.982) | 0.046 |

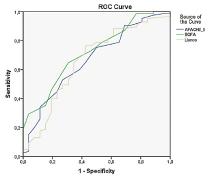


**Table 3 – AUC values for severity scores (APACHE II, SOFA, Liano).**

| | SOFA | APACHE II | Liano |
|---|---|---|---|
| Area under curve (AUC) | 0.719 | 0.668 | 0.661 |
| Standard error | 0.062 | 0.060 | 0.064 |
| 95% CI | 0.598–0.841 | 0.550–0.785 | 0.535–0.787 |

**Mortalite %76.5**
Kapak: %7.1
CABG:%40.0 Aort op: %18.8
CABG+kapak:%15.3 Diğer:%18.8

RRT başlama zamanındaki SOFA skoru, kardiyak cerrahi sonrası 30 günlük mortalitede önemli

**Effects of continuous renal replacement therapy on serum cytokines, neutrophil gelatinase-associated lipocalin, and prognosis in patients with severe acute kidney injury after cardiac surgery**

**Heng-jin Wang[1,2,*], Pei Wang[3,*], Nan Li[1,*], Cheng Wan[1], Chun-ming Jiang[1], Jing-song He[1], Dong-jin Wang[1], Miao Zhang[1] and Ling-yun Sun[1]**

**Oncotarget, 2017, Vol. 8, (No. 6), pp: 10628-10636**

153 hasta AKI, sürekli RRT *yaşam = organ yetmezliği 2-3 → %84
64 hasta eksitus, **mortalite %41.8** ≥ 4 → %16.1

**Table 2: Changes in HR, MAP, and OI in the survival (A) and non-survival (B) groups before and after CRRT (mean ± standard deviation)**

| | MODS score | | APACHE II score | | HR (/min) | | MAP (mm Hg) | | OI | |
|---|---|---|---|---|---|---|---|---|---|---|
| Groups | A | B | A | B | A | B | A | B | A | B |
| Before CRRT | 6.7 ± 2.3[#] | 13.1 ± 3.7 | 16.9 ± 4.8[#] | 26.7 ± 9.9 | 98.2 ± 16.7 | 106.1 ± 23.0 | 73.9 ± 12.1[#] | 64.8 ± 11.3 | 221.4 ± 47.9[#] | 169.7 ± 53.9 |
| (pre-CRRT) | | | | | | | | | | |
| CRRT 24h | 3.9 ± 1.7* | 12.8 ± 4.1 | 9.8 ± 3.1* | 25.0 ± 10.8 | 86.9 ± 19.8* | 97.3 ± 16.9 | 78.1 ± 6.8* | 66.9 ± 10.1* | 279.3 ± 78.6* | 203.1 ± 70.2* |

**Table 3: Comparison of clinical data of Group A (survival) and B (non-survival) (mean ± standard deviation)**

| | Sex (male/female, n) | Age (years) | CPB Time (min) | Time of CRRT away from the AKI (hours) | Time of CRRT away from urine <0.5 mL·kg⁻¹·h⁻¹ (hours) |
|---|---|---|---|---|---|
| Group A | 61/28 | 55.03 ± 10.47 | 125.89 ± 38.47 | 12.81 ± 13.76 | 13.74 ± 6.19 |
| Group B | 43/21 | 53.39 ± 11.56 | 142.38 ± 50.29 | 33.98 ± 31.84 | 35.83 ± 32.71 |
| *t* | 0.401 | 0.265 | -1.037 | -2.316 | -2.503 |
| *P* | 0.697 | 0.803 | 0.294 | 0.041 | 0.032 |

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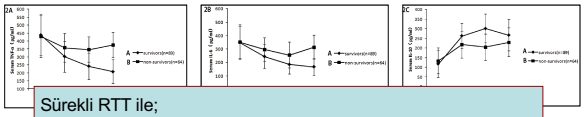

Sürekli RTT ile;

- Yaşayanların %74.9'unda böbrek fonksiyonları normale döner
- İnflamatuar mediyatörlerin azalması ile organ hasarı azalır
- Prognoz iyileşir
- Zamanında RRT önemlidir
- En uygun zaman **??**

## Kardiyojenik Şok & VA- ECMO

- İskemik kardiyomiyopati
- Postpartum kardiyomiyopati
- Viral miyokardit
- Postkardiyak cerrahi
- Pulmoner emboli

→ Kardiyak yetmezlik

**Düşük kardiyak output sendromu (LCOS)**

- CI < 2 L/dk/m2
- SAB < 90 mmHg
- Periferik hipoperfüzyon bulguları
- Artmış laktat düzeyi (hipovolemi yok)

## Veno-arterial extracorporeal membrane oxygenation for adult cardiovascular failure

Curr Opin Crit Care 2014, 20:484–492

**Table 1.** Common conditions associated with acute cardiovascular failure in which veno-arterial extracorporeal membrane oxygenation support is reported

| Causes | References | Expected outcomes | Comments |
|---|---|---|---|
| AMI | [11**,12–17] | 30–60% survival | Likely to vary according to |
| | | | • Time to revascularization |
| | | | • Proximal versus distal/diffuse coronary artery disease |
| | | | • Underlying chronic heart disease |
| | | | • Occurrence of cardiac arrest prior to ECMO |
| | | | • Occurrence of structural complications (VSD/MR/myocardial rupture) |
| Myocarditis | [14,18,19] | >65% survival | Diagnostic group associated with the best survival |
| Cardiomyopathy | [11**,14,20] | 20–60% survival | Acute decompensated heart failure with severe chronic cardiomyopathy. VA ECMO is a bridge to long-term durable VAD and transplantation |
| Pulmonary embolism | [21] | 40–70% survival | Many case reports of successful VA ECMO. Often reversible but outcome depends on occurrence of cardiac arrest prior to ECMO |
| Septic shock/myocardial depression | [22**,23*] | 10–70% survival | Highly variable outcomes reported. Heterogeneous population. Confounding effects of excessive catecholamine toxicity |
| Post cardiotomy | [14,24] | 20–40% survival | Difficult group. Often heterogeneous with AMI cases included. High rates of bleeding expected |
| Cardiac failure following heart and lung transplantation | [14,25,26] | 40–75% survival | Acute right ventricular failure most commonly seen with preoperative pulmonary artery hypertension. Left ventricular failure also occurs |

**Early and late outcomes of 517 consecutive adult patients treated with extracorporeal membrane oxygenation for refractory postcardiotomy cardiogenic shock**

Arshawn Julian Rastan, MD, PhD, Andreas Dege, MD, Matthias Mohr, MD, Nicolas Doll, MD, PhD, Volkmar Falk, MD, PhD, Thomas Walther, MD, PhD, and Friedrich Wilhelm Mohr, MD, PhD

J Thorac Cardiovasc Surg 2010;139:302-311

Perioperatif ECMO ?

Bilimsel kanıtlar !

Karar * zor → morbidite ↑ (iskemi, kanama vs)

* bireysel (cerrah - olgu)

Yüksek riskli cerrahi & Kardiyak yetmezlik olasılığı (+)

⇒ ECMO?

**Düşük riskli hasta & Beklenmeyen kardiyak yetmezlik**

**⇒ ECMO?**

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[J Thorac Cardiovasc Surg 2010;139:302-311]

1996-2008 yılları, 40.538 hasta, 517 hasta **PCS → ECMO (%1.28)**
En sık ECMO endikasyonu: Kardiyopulmoner bypass'dan ayrılamama
%41.9 → Cerrahi sırasında - hemen sonra
%58.1 → Cerrahi sonrası (30 dk)

**TABLE 1. Patient demographic data and preoperative clinical status with respect to hospital outcomes**

| Characteristic | All (n = 517) | Hospital survivors (n = 128) | Nonsurvivors (n = 389) | Hospital survival (%) | In-hospital mortality OR | 95% CI | P value |
|---|---|---|---|---|---|---|---|
| Extracardiac characteristics | | | | | | | |
| Age (y, mean ± SD) | 63.5 ± 11.2 | 60.4 ± 12.3 | 64.0 ± 10.7 | | | | .002 |
| >70 y (%) | 29.8% | 22.6% | 32.2% | 18.7% | 1.62 | 1.01–2.69 | .049 |
| Sex (% female) | 28.5% | 27.0% | 29.0% | 23.5% | 1.11 | 0.69–1.78 | .671 |
| BMI >30 (%) | 21.8% | 14.8% | 24.1% | 16.8% | 1.83 | 1.04–3.75 | .037 |
| Diabetes (%) | 32.5% | 19.1% | 36.0% | 14.7% | 2.47 | 1.48–4.13 | .001 |
| Hyperlipidemia (%) | 47.4% | 52.2% | 45.8% | 27.4% | 0.78 | 0.51–1.18 | .238 |
| Arterial hypertension (%) | 70.3% | 69.6% | 70.6% | 24.6% | 1.05 | 0.66–1.66 | .832 |
| COPD (%) | 13.0% | 9.6% | 14.1% | 18.3% | 1.55 | 0.78–3.09 | .214 |
| Smoker (%) | 27.5% | 37.4% | 24.2% | 33.9% | 0.54 | 0.34–0.84 | .006 |
| Renal insufficiency (%) | 15.6% | 9.2% | 17.6% | 14.3% | 2.11 | 1.04–4.29 | .038 |
| Preop neurologic impairment (%) | 7.8% | 4.3% | 8.9% | 13.9% | 2.15 | 0.82–5.67 | .121 |
| Peripheral vascular disease (%) | 23.5% | 17.4% | 25.6% | 18.3% | 1.63 | 0.95–2.80 | .075 |

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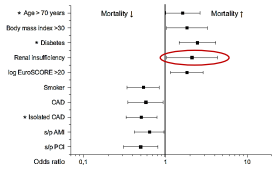
[J Thorac Cardiovasc Surg 2010;139:302-311]

ECMO weaning: %63.5
ECMO weaning – yaşam ≥ 24 saat: %56.4
**Hastane mortalitesi: %75.2**
Başlıca ölüm nedeni kardiyak:%79.9




Triküspit regürjitasyon (≥2)
Akut tip 2 aort diseksiyonu
Aort+mitral kapak hastalığı
} Mortalite eğilimi ↑

Acil operasyon
Preoperatif AMI
ECMO öncesi aktif
mekanik resüsitasyon
} Mortaliteye etkisi yok

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**ECMO sonuçları orantılı**

- ECMO öncesi PCS şiddeti
- ECMO desteği sırasında dolaşım ve metabolik iyileşme

**Mortalite yüksek**

- Laktat > 10 mmol/L (hemen ECMO sonrası) (%83.0, OR:2.65, p < 0.001)
- Dirençli laktat yüksekliği (> 10 mmol/L)
  - * 24 st → %93.6, OR:8.2, p < 0.001
  - * 48 st → %97.6, OR:22.5, p < 0.001
- Karaciğer hasarı (OR:3.25, p < 0.001)
- **ARY** (OR:4.27, p < 0.001)

Clinical Outcomes of Adult Patients Who Receive Extracorporeal Membrane Oxygenation for Postcardiotomy Cardiogenic Shock: A Systematic Review and Meta-Analysis

Liangshan Wang, MD, Hong Wang, MD, Xiaotong Hou, MD[1]

Journal of Cardiothoracic and Vascular Anesthesia

20 çalışma, 2877 olgu

**Mortalite: %66** (%45.2-75.3)
**Taburcu: %34**

Table 1
Description of Included Studies

| Author (Year) | Study Period | Study Design | Country | Number of Patients | Duration of ECMO (d) | Mode of ECMO | In-Hospital Mortality (%) | Surgical Procedures |
|---|---|---|---|---|---|---|---|---|
| Muehrcke[9] (1996) | 1992-1994 | Retrospective | USA | 23 | 2.4 ± 1.5 | VA | 69.6 | CABG, VP, AS, HT |
| Magovern[19] (1999) | 1991-1997 | Retrospective | USA | 55 | 1.8 ± 0.1 | VA | 63.6 | CABG, VP, AS |
| Ko[11] (2002) | 1994-2000 | Retrospective | Taiwan | 76 | 4.1 ± 1.4 | VA | 73.7 | CABG, VP, HT |
| Doll[12] (2004) | 1997-2002 | Retrospective | Germany | 219 | 2.8 ± 2.2 | VA | 75.3 | CABG, VP, other |
| Zhang[13] (2006) | 1996-2004 | Retrospective | Germany | 32 | 2.7 ± 1.7 | VA | 68.7 | CABG, VP, other |
| Bakhtiary[14] (2008) | 2003-2006 | Retrospective | Germany | 45 | 6.4 ± 4.5 | VA | 71.1 | CABG, VP, other |
| Formica[15] (2008) | 2000-2006 | Retrospective | Italy | 18 | 7.1 ± 6.3 | VA | 72.2 | CABG, other |
| Wang[16] (2009) | 2004-2008 | Retrospective | China | 62 | 2.5 ± 1.5 | VA | 45.2 | CABG, VP, AS, HT |
| Hsu[17] (2010) | 2002-2006 | Retrospective | Taiwan | 51 | 7.5 ± 6.7 | VA | 66.7 | CABG, VP, HT, other |
| Rastan[10] (2010) | 1996-2008 | Retrospective | Germany | 517 | 3.3 ± 2.9 | VA | 75.2 | CABG, VP, other |
| Mikus[18] (2013) | 2007-2011 | Retrospective | Italy | 14 | 5.0 (median) | VA | 57.2 | CABG, VP, other |
| Slottosch[20] (2013) | 2006-2010 | Retrospective | Germany | 77 | 3.3 ± 2.4 | VA | 70.0 | CABG, VP, HT, other |
| Unosawa[21] (2013) | 1992-2007 | Retrospective | Japan | 47 | 2.6 ± 2.5 | VA | 70.2 | CABG, VP, AS, other |
| Wang[22] (2013) | 2004-2011 | Retrospective | China | 87 | 2.5 ± 1.5 | VA | 51.0 | VP |
| Wu[23] (2013) | 2003-2011 | Retrospective | Taiwan | 16 | 4.0 (median) | VA | 68.0 | CABG |
| Santarpino[24] (2015) | NR | Retrospective | Multiple countries | 20 | 4.5 ± 4.1 | VA | 60.0 | CABG |
| Chang[25] (2016) | 2002-2012 | Retrospective | Taiwan | 1077 | 2.3 ± 0.9 | NR | 64.6 | CABG |
| Biancari[26] (2017) | 2005-2016 | Retrospective | Multiple countries | 148 | 6.4 ± 5.6 | VA | 64.2 | CABG |
| Lin[27] (2017) | 2008-2015 | Retrospective | Taiwan | 20 | NR | VA | 65.0 | AS |
| Xie[28] (2017) | 2011-2015 | Retrospective | China | 273 | S 4.0, D 5.0 (median) | VA | 56.4 | CABG, VP, AS, other |

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Liangshan Wang, MD, Hong Wang, MD, Xiaotong Hou, MD[†]

Journal of Cardiothoracic and Vascular Anesthesia

Table 2
Risk Factors for In-Hospital Death

| Author (Year) | Risk Factors for In-Hospital Death |
|---|---|
| Muehrcke[29] (1996) | Female, left ventricular dilation |
| Ko[11] (2002) | Dialysis for acute renal failure |
| Zhang[13] (2006) | CK-MB relative index 48 h after ECMO initiation |
| Wang[16] (2009) | A peak lactate level > 12 mmol/L before ECMO initiation |
| Hsu[17] (2010) | Low serum albumin level, low platelet count, low oxygen pressure of the venous tube of the ECMO, and poor cardiac systolic function |
| Rastan[18] (2010) | Age > 70 y, diabetes, preoperative renal insufficiency, obesity, logistic EuroSCORE > 20%, surgical lactate > 4 mmol/L |
| Slottosch[20] (2013) | Greater lactate levels after 24 h of ECMO therapy, a longer duration of ECMO support, and the presence of any ECMO-related or gastrointestinal complications |
| Unosawa[21] (2013) | Incomplete sternum closure, more than 48 h of support |
| Wang[23] (2013) | Age > 65 y, postoperative renal replacement treatment, a peak lactate level > 12 mmol/L, receiving ECMO for > 60 h |
| Wu[25] (2013) | Age > 60 y, profound anoxic encephalopathy |
| Chang[27] (2016) | Duration of ECMO > 3 d |
| Biancari[26] (2017) | Creatinine clearance, pulmonary disease, pre-ECMO blood lactate |
| Xie[28] (2017) | Age > 65 y, neurologic complications, lower extremity ischemia, left ventricular ejection fraction < 35%, multiorgan function failure |

## Clinical Outcomes of Adult Patients Who Receive Extracorporeal Membrane Oxygenation for Postcardiotomy Cardiogenic Shock: A Systematic Review and Meta-Analysis

Liangshan Wang, MD, Hong Wang, MD, Xiaotong Hou, MD[†]

Journal of Cardiothoracic and Vascular Anesthesia

Table 4
Meta-Analysis for All Outcomes and Publication Bias

| Outcomes | Proportion 95% CI | $I^2$ (%) | Egger's p |
|---|---|---|---|
| Survival rate to hospital discharge | 0.34 (0.30-0.38) | 71.8 | 0.93 |
| 1-y survival rate | 0.24 (0.19-0.30) | 75.6 | |
| Midterm survival rate | 0.18 (0.11-0.27) | 77.3 | |
| Leg ischemia | 0.14 (0.10-0.20) | 74.8 | 0.45 |
| Redo surgery | 0.50 (0.32-0.68) | 96.6 | 0.17 |
| Renal failure | 0.52 (0.42-0.66) | 87.1 | 0.65 |
| Neurologic complication | 0.16 (0.13-0.20) | 60.5 | 0.37 |
| Infection | 0.31 (0.22-0.41) | 78.9 | |

**Mortalite ile ilişkili**
Yaş > 65
DM
Preop. böbrek yetmezliği
Obezite
Akciğer hastalığı
Pre-ECMO kan laktat düzeyi

ECMO ile tedavi edilen olgularda kısa ve orta (3-5 yıl) süreli yaşam oranı düşük.
ECMO komplikasyonları yüksek.

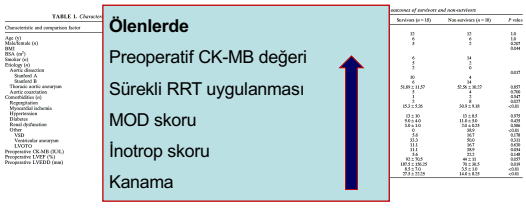
## Veno-Arterial Extracorporeal Membrane Oxygenation Support in Patients Undergoing Aortic Surgery

*†Zhaopeng Zhong, *Chunjing Jiang, *Feng Yang, *Xing Hao, *Jialin Xing, *Hong Wang, and *†Xiaotong Hou

*Artificial Organs* 2017, 41(12):1113–1120

2009-2016 yıl, 5637 aort cerrahisi
36 hasta VA ECMO (**%0.64**)
24 hasta → ECMO sonlandırıldı
18 hasta → Taburcu

Mortalite: %50



**Ölenlerde**
Preoperatif CK-MB değeri
Sürekli RRT uygulanması
MOD skoru
İnotrop skoru
Kanama

## Veno-Arterial Extracorporeal Membrane Oxygenation Support in Patients Undergoing Aortic Surgery

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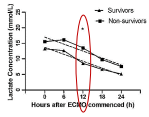



TABLE 3. *Logistic regression model to identify factors associated with in-hospital mortality*

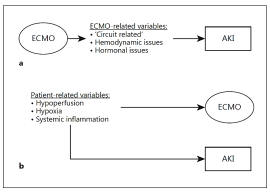
| Variable | Survivors ($n = 18$) | Non-survivors ($n = 18$) | OR | *P* value | 95% CI |
|---|---|---|---|---|---|
| Retrograde-flow cannulation (*n*) | 6 | 14 | 2.49 | 0.019 | 1.16–5.32 |
| Peak lactate level ≥ 20 mmol/L (*n*) | 3 | 9 | 5.0 | 0.041 | 1.07–23.46 |
| Preoperative CK-MB level ≥ 100 IU/L (*n*) | 2 | 8 | 6.40 | 0.036 | 1.12–36.44 |
| Combined aortic arch replacement (*n*) | 8 | 13 | 3.25 | 0.096 | 0.81–13.0 |
| Postoperative CRRT (*n*) | 2 | 7 | 5.09 | 0.068 | 0.89–29.27 |
| Inotropi score ≥ 25 (*n*) | 4 | 11 | 3.14 | 0.100 | 0.80–12.29 |

Aort cerrahisi sonrası gelişen kardiyojenik şokta VA-ECMO kabul edilen bir tedavidir.
Yüksek laktat düzeyleri ve pre-operatif CK-MB düzeyleri hastane içi mortaliyeti olumsuz etkiler.

## Extracorporeal Membrane Oxygenation and the Kidney

Gianluca Villa[a, b] Nevin Katz[c] Claudio Ronco[b]

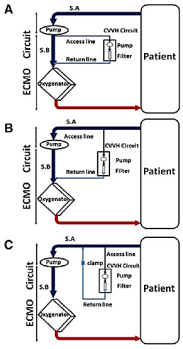
Cardiorenal Med 2016;6:50–60




## CRRT Connected to ECMO: Managing High Pressures

Christian de Tymowski,* Pascal Augustin,* Hamza Houissa,* Nicolas Allou,* Philippe Montravers,* Alienor Delzongle,* Quentin Pellenc,† and Mathieu Desmard*

*ASAIO Journal* 2017; 63:48–52




## Impact of connecting continuous renal replacement therapy to the extracorporeal membrane oxygenation circuit

Christian de Tymowski[a,b,c,*], Mathieu Desmard[a], Brice Lortat-Jacob[a], Quentin Pellenc[c], Soleiman Alkhoder[d], Arezki Alouache[a], Benedicte Fritz[a], Philippe Montravers[a,b,f,†], Pascal Augustin[a,†]

Anaesth Crit Care Pain Med xxx (2018) xxx–xxx

Ocak 2014-mart 2015, prospektif

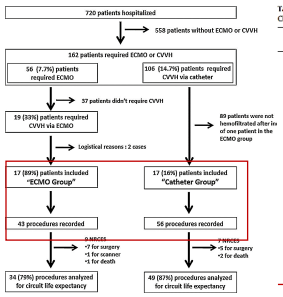



**Table 1**
Clinical characteristics according to connection to vascular access (ECMO or DC).

| Patient characteristics | ECMO (n = 17) | DC (n = 17) | *P* |
|---|---|---|---|
| *Age (year)* | 60 [49–65] | 64 [60–68] | 0.29 |
| *Gender male, n (%)* | 14 (82%) | 13 (77%) | 1 |
| *Weight (kg)* | 76 [67–85] | 78 [71–91] | 0.56 |
| *Chronic kidney disease, n (%)* | 3 (18%) | 5 (29%) | 0.68 |
| *Underlying disease* | | | |
| Cardiac surgery, n (%) | 5 (29%) | 4 (24%) | 0.7 |
| Vascular surgery, n (%) | 4 (24%) | 4 (24%) | 1 |
| Lung transplantation, n (%) | 5 (31%) | 1 (6%) | 0.8 |
| Pneumoniae n (%) | 2 (12%) | 2 (12%) | 1 |
| Peritonitis, n (%) | 1 (6%) | 3 (36) | 0.6 |
| Pancreatitis, n (%) | 0 (0%) | 2 (12%) | 0.48 |
| Gastro-intestinal bleeding, n (%) | 0 (0%) | 1 (6%) | 1 |
| *SOFA score at admission* | 12 [10–13] | 10 [9–12] | 0.18 |
| *SAPS II score at admission* | 56 [49–70] | 54 [53–58] | 0.8 |
| *Cardiogenic shock, n (%)* | 7 (41%) | 3 (18) | 0.26 |
| *Septic shock, n (%)* | 5 (29%) | 9 (53%) | 0.3 |
| *Haemorrhagic shock, n (%)* | 3 (18%) | 3 (18%) | 1 |
| *Laboratory characteristics at first RRT session* | | | |
| Creatinine (µmol/L) | 174 [136–233] | 232 [184–277] | 0.08 |
| BUN (mmol/L) | 18 [10–28] | 14.5 [13–19] | 0.33 |
| Lactate (mmol/L) | 3.1 [2–11] | 2.8 [1.2–5] | 0.23 |
| Haematocrit before session (%) | 23 [21.5–26] | 25.5 [23–32] | 0.004 |
| *Length of stay in ICU (days)* | 23 [13–45] | 21 [9–36] | 0.66 |
| *Mortality in ICU, n (%)* | 12 (71%) | 7 (41%) | 0.08 |

Impact of connecting continuous renal replacement therapy to the extracorporeal membrane oxygenation circuit

Christian de Tymowski[a,b,c,*], Mathieu Desmard[a], Brice Lortat-Jacob[a], Quentin Pellenc[c], Soleiman Alkhoder[d], Arezki Alouache[a], Benedicte Fritz[a], Philippe Montravers[a,b,f,†], Pascal Augustin[a,†]

Anaesth Crit Care Pain Med xxx (2018) xxx–xxx

Ocak 2014-mart 2015, prospektif

**ECMO ile sürekli RRT**

Kan akımı ↑

İstenen atık ↓

Etkin atık volmü ↓

Heparin dozu ↓

Devrede pıhtı ↓

Etkin RRT ↑

Transfüzyon gereksinimi ↑

ECMO'dan RRT uygulanabilir

RRT devresi kullanım süresi

uzar → Maliyet azalır

İş yükü azalır

Ayrı iv kanülasyon gerekmez

| | | | |
|---|---|---|---|
| | | 4.1 [3.6–6.11] | 0.001 |
| | | 74 [61–83] | 0.82 |
| | | 3 (1–4) | 0.43 |
| 5 (12) | | 1 (2) | 0.001 |
| 1 (2) | | 0 | 0.22 |
| 7 (16) | | 11 (20) | 0.8 |
| 18 (42) | | 8 (14) | 0.005 |
| 9 (20) | | 8 (14) | 0.38 |
| 3 (7) | | 0 | 0.078 |

Inadequate inflow pressure, n (%)
Inadequate outflow pressure, n (%)
Effective CVVH, n (%)
NCRES, n (%)
Negative TMP, n (%)

**Risk paylaşımı !**

## Sürekli RRT

- Hemodinamik tolerasyon iyi
- Erken dönemde volüm kontrolü yetersiz
- İlerleyen dönemde etkin volüm kontrolü
- İmmun fonksiyonda iyileşme
- Renal fonksiyonda iyileşme

Risk - yarar dengesi (?)

Doğru (ERKEN) zaman

## ECMO

- Hızlı dolaşım desteği
- Tüm hastalara uygun bir tedavi
- Tüm klinik durumlarda uygulanabilir
- VAD'ye göre ucuz
- Kalp + akciğer fonksiyonlarını destekler

Antikoagülan kullanımı
Kan transfüzyonu gereksinimi
Sistemik inflamatuar yanıtta artış

## RRT - ECMO

- Hasta özellikleri
- Tecrübe
- Cerrahi beklenti - alan
- Risk - yarar dengesi
- Doğru zaman (organ hasarı !)

**Teşekkürler.....**