

Scientific letters

Ventricular Support With Extracorporeal Membrane Oxygenation: Beyond Cardiogenic Shock Treatment**Asistencia ventricular con oxigenador extracorpóreo de membrana: más allá del tratamiento del shock cardiogénico****To the Editor,**

Extracorporeal membrane oxygenation (ECMO) systems are circulatory support devices that provide effective hemodynamic support in patients with cardiogenic shock with left ventricular dysfunction.^{1,2} There are, however, other less well known options for their use, such as right ventricular failure with cardiogenic shock,³ hemodynamic support during high-risk percutaneous coronary intervention (PCI),⁴ and life-threatening electrical storm.⁵

Between October 2013 and December 2014, the CARDIOHELP™ system (MAQUET Cardiopulmonary AG; Germany) was used to perform 10 venoarterial and 3 venovenous ECMO procedures in patients at the University Hospital of Salamanca (Spain). We describe the baseline characteristics, indications, implantation approach, ECMO duration, management, and progress of 5 ECMO patients whose indications were other than cardiogenic shock (Table).

Extracorporeal membrane oxygenation was administered for hemodynamic support during high-risk PCI in 4 patients and during a life-threatening electrical storm in 1 patient. All patients were discussed by a heart team comprising cardiologists and cardiac surgeons. Heart surgery was initially ruled out in all patients. Three patients were scheduled for intervention; however, because of patient 3's clinical status, the procedural approach was agreed in the catheterization laboratory. Interventional cardiologists and cardiac surgeons jointly performed cannulation and a perfusionist operated the CARDIOHELP™ system. During all procedures, ECMO support was maintained at a flow of 2.5/L min to 3.0 L/min with an activated clotting time between 180 seconds and 250 seconds. With the exception of patient 2, all patients required invasive mechanical ventilation. Intra-aortic balloon counterpulsation was used in 2 patients (patients 3 and 5) to detect signs and symptoms of heart failure without shock.

Extracorporeal membrane oxygenation was administered in patient 1 to provide support during a PCI procedure, which was considered high risk based on severe left ventricular dysfunction, 3-vessel disease with total occlusion of 2 vessels, liver disease, severe sleep apnea-hypopnea syndrome, and severe peripheral vascular disease. Given the latter condition, a hybrid method was used to administer ECMO. In the operating room, surgical access was obtained through the right axillary artery and percutaneous access through the right femoral vein. The patient was transferred to the cardiac catheterization laboratory and ECMO was removed without complications in the operating room after conclusion of the PCI procedure. The patient's progress was favorable.

In patient 2, ECMO was also used to provide support during a PCI procedure, which was considered high risk based on Killip class III acute myocardial infarction, left main coronary artery and 3-vessel disease, severe left ventricular dysfunction, and kidney failure. Extracorporeal membrane oxygenation was administered through peripheral access in the cardiac catheterization laboratory. Similar to the procedure used in patient 4, a Prostar XL

(Perclose, Abbott Vascular Devices) device was used to achieve hemostasis prior to ECMO arterial cannula insertion. The patient's progress was favorable.

Patient 3 received urgent ECMO. This patient had acute anterior myocardial infarction treated with primary angioplasty with a stent in the proximal left anterior descending artery. During a second revascularization procedure of the proximal right coronary artery, the patient showed severe iatrogenic dissection of the proximal left anterior descending artery, TIMI (Thrombolysis In Myocardial Infarction) 0 flow, hemodynamic instability, and acute pulmonary edema, requiring endotracheal intubation and intraaortic balloon pump implantation. Given the patient's hemodynamic instability, ECMO was administered percutaneously in the cardiac catheterization laboratory and the right coronary artery was revascularized without complications. Extracorporeal membrane oxygenation was surgically removed on the third day due to improvements in the patient's hemodynamic status. One week later, the patient died from complications of hospital-acquired pneumonia.

Patient 4 had aortic stenosis, severe mitral regurgitation, 2-vessel coronary disease, severe left ventricular dysfunction, and heart failure. Aortic valvuloplasty supported by ECMO was performed as a bridge to cardiac surgery. Extracorporeal membrane oxygenation was administered through peripheral access in the cardiac catheterization laboratory. One month later, the patient underwent further intervention. Based on improved left ventricular dysfunction and the absence of heart failure, aortic and mitral valve replacement and double coronary artery bypass grafting were performed with good outcome.

Extracorporeal membrane oxygenation was administered in patient 5 following an electrical storm with hemodynamic instability that did not respond to conventional management. Extracorporeal membrane oxygenation was administered percutaneously in the cardiac catheterization laboratory and the superficial femoral artery was cannulated to perfuse the distal limb and prevent ischemic complications. Following the method described in *Revista Española de Cardiología*,⁶ the patient was transferred 224 km under ECMO support to a heart transplant center, where he remained in the emergency department for 10 days until dying from an intracranial hemorrhage.

With the exception of cardiogenic shock,^{1,2} experience with ECMO as hemodynamic support in adults has not been published in Spain. We present the potential usefulness of percutaneous implantation of ECMO support in high-risk PCI, and even in immediate life-threatening electrical storm, although studies with more patients are needed. Extracorporeal membrane oxygenation provides hemodynamic support and decreases the risk associated with percutaneous procedures in patients with multiple comorbidities. It has even allowed us to move a patient with electrical storm and hemodynamic instability over a considerable distance to a heart transplant center. In our opinion, ECMO could provide an alternative means of hemodynamic support beyond the setting of cardiogenic shock, and in cardiology services where PCI or highly complex electrophysiological studies are performed.

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Table

Baseline Characteristics, Indication, Implantation Route, Management, and Outcome of Patients Provided with Ventricular Support via Venoarterial Extracorporeal Membrane Oxygenation

Patient	Sex	Age, y	Indication	Disease	LVEF, %	Implant setting	Cannula; arterial access	Cannula; venous access	ECMO duration	Setting and withdrawal method	90-day survival, 90-day LVEF, and cause of death	SYNTAX score
1	M	55	High-risk PCI	LMCA stenosis and 3-vessel disease (CTO in 2 vessels)	22	OR	21; axillary surgery	23; percutaneous transfemoral	7 h	OR; direct arterial suture. Venous compression, single stitch	Yes; LVEF 35%	55
2	M	65	High-risk PCI	LMCA stenosis and 3-vessel disease	30	CCL	17; percutaneous transfemoral	21; percutaneous transfemoral	2 h	CCL; Prostar XL arterial. Venous compression, single stitch	Yes; LVEF 40%	32
3	W	53	High-risk PCI	2-vessel disease	38	CCL	17; percutaneous transfemoral	21; percutaneous transfemoral	3 d	OR; direct arterial suture. Venous compression, single stitch	No; sepsis	17.5
4	W	73	High-risk PCI	Severe aortic stenosis (AVA, 0.4 cm ² /m ²), severe mitral regurgitation, 2-vessel disease	28	CCL	17; percutaneous transfemoral	23; percutaneous transfemoral	2 h	CCL; Prostar XL arterial. Venous compression, single stitch	Yes; LVEF 35%	19
5	M	55	Electrical storm	Dilated cardiomyopathy	25	CCL	17; percutaneous transfemoral	23; percutaneous transfemoral	12 d	Not withdrawn	No; died under ECMO in emergency department (cerebral hemorrhage)	—

AVA, aortic valve area; CCL, cardiac catheterization laboratory; CTO, chronic total occlusion; ECMO, extracorporeal membrane oxygenation; LMCA, left main coronary artery; LVEF, left ventricular ejection fraction; M, man; OR, operating room; PCI, percutaneous coronary intervention; W, woman.

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REFERENCES

1. Ariza-Solé A, Sánchez-Salado JC, Lorente-Tordera V, González-Costello J, Miralles-Cassina A, Cequier-Fillat A. Asistencia ventricular con membrana de

- oxigenación extracorpórea: una nueva alternativa al rescate del shock cardiogénico refractario. *Rev Esp Cardiol.* 2013;66:501–3.
2. Díez-Villanueva P, Sousa I, Núñez A, Díez F, Elízaga J, Fernández-Avilés F. Tratamiento precoz del shock cardiogénico refractario mediante implante percutáneo de ECMO venoarterial en el laboratorio de hemodinámica. *Rev Esp Cardiol.* 2014;67:1059–61.
3. Belohlavek J, Rohn V, Jansa P, Tosovsky J, Kunstir J, Semrad M, et al. Veno-arterial ECMO in severe acute right ventricular failure with pulmonary obstructive hemodynamic pattern. *J Invasive Cardiol.* 2010;22:365–9.
4. Jones HA, Kalisetti DR, Gaba M, McCormick DJ, Goldberg S. Left ventricular assist for high-risk percutaneous coronary intervention. *J Invasive Cardiol.* 2012;24:544–50.
5. Fux T, Svenarud P, Grinnemo KH, Albåge A, Bredin F, Van der Linden J, et al. Extracorporeal membrane oxygenation as a rescue of intractable ventricular fibrillation and bridge to heart transplantation. *Eur J Heart Fail.* 2010;12:301–4.
6. Dalmau MJ, Beiras-Fernández A, Keller H, Bingold T, Moritz A, Stock U. Experiencia inicial de un programa de transporte interhospitalario con ECMO para pacientes con insuficiencia cardíaca aguda y/o insuficiencia respiratoria grave. *Rev Esp Cardiol.* 2014;67:329–30.

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Use of Antihypertensive Drugs in Spain: National Trends From 2000 to 2012[☆]



Uso de medicamentos antihipertensivos en España: tendencias nacionales en el periodo 2000-2012

To the Editor,

Hypertension is a major global public health problem, mainly because of its contribution to the risk of cardiovascular events.^{1,2} Epidemiological studies^{2,3} have reported that hypertension control in Spain continues to be suboptimal and that, on occasions, targets (arterial blood pressure < 140/90 mmHg) are met in less than half of the hypertensive individuals under treatment.² A number of previous studies⁴ have called attention to important changes in the patterns of use of antihypertensive drugs in recent decades.

Following the methodology described by the Observatory for the Use of Medicines of the Spanish Agency of Medicine and Medical Devices,⁵ we examined the pattern of antihypertensive drug use in Spain from 2000 to 2012. We selected the treatment subgroups of the Anatomical Therapeutic Chemical Classification (ATC): antihypertensive agents (C02), diuretics (C03), beta-blockers (C07), calcium channel blockers (C08), and drugs that act on the renin-angiotensin system (C09), such as angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, and direct renin inhibitors (aliskiren). The analytical measure was the number of defined daily doses (DDD) dispensed per 1000 inhabitants per day (DID).⁵ We used the consumption data provided by the Directorate-General of the Basic Service Portfolio of the Spanish Health and Pharmacy System, whose database compiles prescriptions for the medications covered by the Spanish Health System.

The patterns of use of antihypertensive drugs in Spain are shown in the Table (according to treatment subgroup and active ingredient). The use of antihypertensive medications in Spain increased from 2000 to 2012, and those most widely consumed were angiotensin receptor blockers and angiotensin-converting enzyme inhibitors. More specifically, the total used of antihyper-

tensive drugs was 165.5 DID in the year 2000 and 299.0 DID in 2012. By group, angiotensin receptor blockers (18.2 DID and 93.8 DID in 2000 and 2012, respectively), angiotensin-converting enzyme inhibitors (62.2 DID and 86.4 DID, respectively), diuretics (32.8 DID and 44.8 DID, respectively), and calcium channel blockers (33.4 DID and 38.8 DID) were the most widely used antihypertensive drugs. Enalapril (42.7 DID), amlodipine (20.7 DID), furosemide (16.4 DID), ramipril (15.1 DID), valsartan (14.3 DID), and candesartan (12.5 DID) were the most widely used active ingredients in 2012.

The upward trends in use had been observed in an earlier study performed in Spain for the period from 1995 to 2001.⁵ In the present report, the series was extended to cover 2000 to 2012, revealing continued growth, with an increase of 80.7%. This continued growth occurred even though there have been no important changes in the marketing of new antihypertensive medications with respect to the existing groups. It is important to mention the introduction of aliskiren in 2008, of imidapril in 2004, of olmesartan in 2004, and of eplerenone in 2005. The consumption of antihypertensive drugs has increased all over Europe,⁶ and the growth in Spain is similar to the European average. Germany in central Europe, Finland among the Nordic countries, and Italy in the Mediterranean area were the countries with the widest use in absolute terms. The consumption of antihypertensive drugs in Spain is higher than in other countries such as France and Portugal, and lower than in the United Kingdom and the central European and Nordic countries, with the exception of Luxemburg and Iceland.⁶

Whether the increase in the intensity of antihypertensive therapy in Spain has contributed to improving blood pressure control is, at best, controversial. Although the results of the various studies may appear to disagree, the evidence suggests that, despite the increase in the consumption of antihypertensive drugs, blood pressure control in Spain continues to be inadequate. The growth observed could be related to the increase in the prevalence of treated hypertension and population aging.^{1,2} One of the limitations of this study is that it does not enable us to determine whether the reason for the increment in medication use is the increase in the number of hypertensive patients being treated (including mild forms), the increase in the duration of the treatments, or both. In addition, estimation of drug use was based on the DDD, which is a unit of measure that does not necessarily coincide with the dose actually used in clinical practice. Moreover, true consumption of these drugs could be higher than that

[☆] The opinions expressed in this report are the responsibility of the authors and, thus, do not necessarily reflect the point of view of the organisms in which they work.