be implanted with the CardioMEMS remote pulmonary arterial pressure device.

The male-to-female ratio in the present study was 4:1, reflecting the real-world situation of heart transplant in Spain and elsewhere.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

Artificial intelligence was not used in the preparation of the present study.

AUTHORS' CONTRIBUTIONS

All authors participated in this research, evaluated the results, and agree to their publication.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

David Couto-Mallón,[a,b,c,*] Daniel Enríquez-Vázquez,[a,b,c] Ramón Calviño-Santos,[a,b,c] Carlos Velasco-García de Sierra,[b,d] José Manuel Rodríguez-Vázquez,[a,b,c] and María G. Crespo-Leiro[a,b,c]

[a]*Servicio de Cardiología, Complexo Hospitalario Universitario de A Coruña, A Coruña, Spain*
[b]*Instituto de Investigación Biomédica de A Coruña (INIBIC), A Coruña, Spain*
[c]*Centro de Investigación Biomédica en Red de Enfermedades Cardiovasculares (CIBERCV), Spain*
[d]*Servicio de Cirugía Cardiaca, Complexo Hospitalario Universitario de A Coruña, A Coruña, Spain*

[*] Corresponding author.
E-mail address: couto.mallon.david@gmail.com (D. Couto-Mallón).

Available online 19 February 2024

REFERENCES

1. Guazzi M, Naeije R. Pulmonary hypertension in heart failure. *Pathophysiology pathobiology and emerging clinical perspectives J Am Coll Cardiol.* 2017;69:1718–1734.
2. Crespo-Leiro MG, Metra M, Lund LH, et al. Advanced Heart Failure: a position treatment of the European Society of Cardiology. *Eur J Heart Fail.* 2018;20:1505–1535.
3. Abraham VT, Adamson PB, Bourge RC, et al. Wireless pulmonary artery haemodynamic monitoring in chronic heart failure: a randomised controlled trial. *Lancet.* 2011;377:658–666.
4. Brugts JJ, Radhoe SP, Clephas PRD, et al. Remote haemodynamic monitoring of pulmonary artery pressures in patients with chronic heart failure (MONITOR-HF): a randomized clinical trial. *Lancet.* 2023;401:2113–2123.
5. Angermann CE, Assmus B, Anker SD, et al. Pulmonary artery pressure-guided therapy in ambulatory patients with symptomatic heart failure: the CardioMEMS European Monitoring Study for Heart Failure (MEMS-HF). *Eur J Heart Fail.* 2020;22:1891–1901.
6. Velleca A, Shullo MA, Dhital K, et al. The International Society for Heart and Lung Transplantation (ISHLT) guidelines for the care of heart transplant recipients. *J Heart Lung Transplant.* 2023;42:e1–e141.

https://doi.org/10.1016/j.recesp.2023.12.014

Initial experience with a circulatory support program in massive pulmonary thromboembolism

Experiencia inicial de un programa de soporte circulatorio en tromboembolia pulmonar masiva

To the Editor,

Acute pulmonary embolism (PE) is the third leading cause of cardiovascular mortality. In Spain, it has an annual incidence of 154 cases per 100 000 inhabitants.[1] The mortality rate for massive PE (cardiogenic shock, systolic blood pressure < 90 mmHg, and organ hypoperfusion) can be as high as 60%. Catheter-directed therapy is an alternative to systemic fibrinolysis in refractory cases or patients with a high risk of bleeding.

A recent study of catheter-directed therapy in patients with high-risk PE reported a success rate of 80% and a complication rate of less than 5%.[2] Extracorporeal cardiopulmonary resuscitation (CPR) consists of the rapid deployment of venoarterial extracorporeal membrane oxygenation (VA-ECMO) to provide circulatory support when conventional CPR fails to achieve sustained return of spontaneous circulation. Clinical practice guidelines recommend considering VA-ECMO as rescue therapy for selected patients. In patients with massive PE who develop refractory cardiogenic shock or experience cardiorespiratory arrest, VA-ECMO can be used to maintain appropriate hemodynamics and organ perfusion, serving as a bridge to stabilization or reperfusion.

We describe our initial experience with percutaneous mechanical thrombectomy and VA-ECMO. Cannulation was performed by a specialist cardiovascular technologist and an ECMO-experienced intensivist in the catheterization laboratory using arterial return cannulas (17-19 Fr) and venous drainage cannulas (21-25 Fr) (BioMedicus NextGen; Medtronic, United States). The Novalung ECMO circuit (Fresenius, United States) was primed. Vascular access was achieved percutaneously under ultrasound guidance with fluoroscopic confirmation using a unilateral or bilateral femorofemoral approach. In all cases, a 6-Fr distal perfusion cannula was placed in the superficial femoral artery. After initiation of VA-ECMO (flow rate of 3-4 L/min), thrombectomy was performed via the femoral vein contralateral to the venous drainage cannula. A 24-Fr Gore DrySeal Flex introducer sheath (Gore Medical, United States) and the FlowTriever 24 Curve system (Inari Medical, United States) were used to maximize aspiration. ECMO support was interrupted momentarily during the removal of the 24-Fr introducer sheath to prevent air from entering the system. Although the ECMO system is designed to eliminate this risk, a large volume of air entering the system could disrupt the flow of blood through the centrifugal pump, compromising life support. Vascular closure was achieved using compression and figure-of-8 sutures. The patients were transferred to the coronary care unit on completion of the thrombectomy.

In 2023, we performed 4 mechanical thrombectomies with VA-ECMO: 2 in patients with cardiorespiratory arrest and 2 in patients with refractory cardiogenic shock in whom fibrinolysis had been ineffective. The cases were diagnosed by transthoracic echocardiography and confirmed by angiography after initiation of ECMO. Support was started within 4 hours of diagnosis in all cases. All patients received norepinephrine at a dosage of > 1 μg/kg/min. The mean patient age was 51 years (table 1). The median

Table 1
Patient characteristics and clinical outcomes

Characteristics	Patient 1	Patient 2	Patient 3	Patient 4
Demographic characteristics				
Sex	Female	Female	Male	Female
Age, y	51	46	69	39
Initial resuscitation				
Clinical situation	Cardiogenic shock	Asystole	PEA	Cardiogenic shock
Previous cardiorespiratory arrest	Yes	Yes	Yes	No
Location	ICU	Out of hospital	Cath lab	ICU
Time from diagnosis to ECMO, min	220	70	30	120
Low-flow time, min	—	70	15	—
Fibrinolysis	Yes	No	No	Yes
ECMO flow rate during thrombectomy, L/min	3	3	3.5	4
Bleeding	Yes	Yes	Yes	Yes
Packed red blood cell units, No.	7	7	7	9
Location	Decannulation	Gastrointestinal bleeding	Pericardial effusion	Distal perfusion cannula
Pre-ECMO data				
pH	7.22	< 6.9	6.9	7.17
Lactate, mmol/L	16	21	9	18
[0,1-5]Times				
Time from diagnosis to ECMO, h	5.5	4	1	4.75
Time from fibrinolysis to ECMO, h	1	—	—	3.5
Time from ECMO initiation to death, d	—	1	22	—
Complications within 48 h of PE	Kidney failure, respiratory failure, repeat PE	Kidney failure, death	Pericardial effusion	Kidney failure
Duration				
Time on ECMO, h	38	27	50	80
Length of ICU stay, d	9	2	10	9
Length of hospital stay, d	17	—	—	22
Survival				
Weaned off ECMO	Yes	No	Yes	Yes
In-hospital survival	Yes	No	No	Yes
CPC	1	Death	—	1
Cause of death	Still alive	Intestinal ischemia	Septic shock	Still alive

Cath lab, catheterization laboratory; CPC, Cerebral Performance Category; ECMO, extracorporeal membrane oxygenation; ICU, intensive care unit; PE, pulmonary embolism; PEA, pulseless electrical activity.

time on ECMO was 44 hours. Perfusion was restored in the main pulmonary arteries after the procedure as thrombectomy was successful in all cases (figure 1A,B). The ECMO blood flow rate was not reduced during aspiration. Apart from the patients' dependence on the life support system, the venous cannula was positioned at the entrance of the vena cava (figure 1B, arrow, double dagger) and the aspiration device in the pulmonary arteries (figure 1B, arrow, dagger). The decision not to adjust the flow rate did not affect the success of the procedure (figure 1B,C) or cause air to enter the ECMO circuit. Three of the 4 patients were successfully weaned off VA-ECMO. The fourth patient died during support. She experienced flow problems, probably due to a loss of pulsatility, and developed intestinal ischemia. Two of the patients had a favorable neurological outcome (Cerebral Performance Category 1 to 2). The in-hospital survival rate was 50%. The most common complication was access site bleeding. All the patients required blood transfusion and 1 of them experienced major bleeding. Decannulation was performed by the vascular surgery team.

In a recent review of data from the Extracorporeal Life Support Organization, extracorporeal CPR was found to be an independent predictor of in-hospital mortality (OR = 3.67; 95% CI, 1.46-9.2) in a group of 821 patients with PE who underwent ECMO (88% with VA support and 28% with extracorporeal CPR).[3] The use of reperfusion therapies has been linked to a decrease in ECMO duration and an increased likelihood of successful weaning. The American Heart Association recommends early initiation of VA-ECMO in patients with massive PE and refractory shock when fibrinolysis is ineffective, as these patients have a high risk of cardiorespiratory arrest before or during thrombectomy.[4] All 4 patients in the present series developed severe biventricular dysfunction and experienced intermittent loss of pulsatility during thrombectomy. VA-ECMO was therefore essential for preventing a likely irreversible cardiorespiratory arrest.[5] Hobohm et al.[6] recently reported that embolectomy and VA-ECMO were used only in a minority of patients but were associated with a lower likelihood of in-hospital mortality (OR = 0.5; 95% CI, 0.41-0.61).

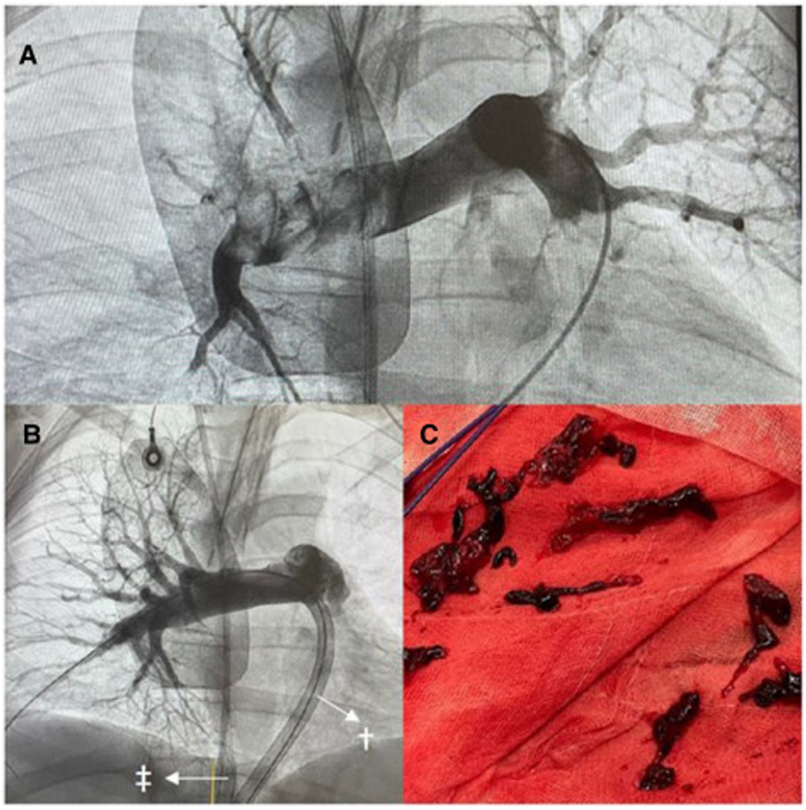

Figure 1. Mechanical thrombectomy using the FlowTriever 24 Curve system (Inari Medical, United States). A. Initial pulmonary angiogram. B. Result after aspiration. C. Aspirated thrombotic material. †FlowTriever cannula. ‡Venous cannula for 25-Fr ECMO.

In conclusion, early VA-ECMO support in patients with massive PE who develop refractory cardiogenic shock or experience cardiorespiratory arrest is a feasible and effective strategy for maintaining adequate hemodynamics, and within this setting, mechanical thromboaspiration is considered safe and effective.

FUNDING

None

ETHICAL CONSIDERATIONS

This study was conducted in accordance with international clinical research recommendations (World Medical Association Declaration of Helsinki). Informed consent was not deemed necessary as the procedures were emergency interventions. Verbal consent, however, was obtained from the patients' relatives. All possible sex and gender biases were taken into account when writing this article.

USE OF ARTIFICIAL INTELLIGENCE

Artificial intelligence was not used for this article.

AUTHORS' CONTRIBUTIONS

All the authors had access to the data and contributed to preparing this manuscript. R. García del Moral drafted the article and J. Caballero-Borrego revised it. All the authors contributed to the conceptualization of the study, data curation, formal analysis, research, methodology, validation, and revision.

CONFLICTS OF INTEREST

None.

Raimundo García Del Moral,[a] Juan Caballero-Borrego,[b,c,*] Fernando Sabatel-Pérez,[b] José Damián Herrera Mingorance,[d] Álvaro Cabrera Peña,[e] and Manuel Colmenero[a,c]

[a]*Servicio de Medicina Intensiva, Hospital Universitario Clínico San Cecilio, Granada, Spain*
[b]*Unidad de Hemodinámica, Servicio de Cardiología, Hospital Universitario Clínico San Cecilio, Granada, Spain*
[c]*Instituto de Investigación Biosanitaria ibs.GRANADA, Granada, Spain*
[d]*Servicio de Angiología y Cirugía Vascular, Hospital Universitario Clínico San Cecilio, Granada, Spain*
[e]*Servicio de Radiología Intervencionista, Hospital Universitario Clínico San Cecilio, Granada, Spain*

* Corresponding author.
E-mail address: caballero.borrego@gmail.com
(J. Caballero-Borrego).
𝕏 @de_clinico

Available online 28 February 2024

REFERENCES

1. Salinas P, Vázquez-Álvarez ME, Jurado-Román A, Leal S, Huanca M. Experiencia inicial de trombectomía con FlowTriever en embolia aguda de pulmón. *REC Interv Cardiol.* 2023;5:142–150.
2. Salinas P, Vázquez-Álvarez ME, Salvatella N, et al. Catheter-directed therapy for acute pulmonary embolism: results of a multicenter national registry. *Rev Esp Cardiol.* 2024;77:138–147.
3. Sakuraya M, Hifumi T, Inoue A, Sakamoto T, Kuroda Y; SAVE-J II Study Group. Neurological outcomes and reperfusion strategies in out-of-hospital cardiac arrest patients due to pulmonary embolism who underwent venoarterial extracorporeal membrane oxygenation: A post-hoc analysis of a multicenter retrospective cohort study. *Resuscitation.* 2023;191:109926.
4. Goldberg JB, Giri J, Kobayashi T, et al. Surgical Management and Mechanical Circulatory Support in High-Risk Pulmonary Embolisms: Historical Context Current Status, and Future Directions: A Scientific Statement From the American Heart Association. *Circulation.* 2023;147:e628–e647.
5. Goldberg JB, Spevack DM, Ahsan S, et al. Survival and Right Ventricular Function After Surgical Management of Acute Pulmonary Embolism. *J Am Coll Cardiol.* 2020;76:903–911.
6. Hobohm L, Sagoschen I, Habertheuer A, et al. Clinical use and outcome of extracorporeal membrane oxygenation in patients with pulmonary embolism. *Resuscitation.* 2022;170:285–292.

https://doi.org/10.1016/j.recesp.2023.12.015

Results of a population screening program for hereditary transthyretin amyloidosis

Resultados de un programa de cribado poblacional de amiloidosis hereditaria por transtirretina

To the Editor,

Hereditary transthyretin amyloidosis (ATTRv) is a systemic disease with an autosomal dominant inheritance pattern, and more than 100 pathogenic variants have been described. The prevalence of ATTRv varies widely among regions, and the disease is endemic in certain geographical areas due to founder effects. For instance, the p.Val50Met variant is endemic in Povoa de Varzim (Portugal), Västerbotten (Sweden), and Mallorca (Spain).[1] The p.Glu109Lys variant is the third most frequent mutation in Spain and is defined by early age of onset, mixed cardiac and neurologic involvement, and an overall poor prognosis. A recent study detected a founder effect of the variant believed to have originated in south-east Spain.[2,3]

ATTRv is an optimal disease for undertaking screening efforts due to its significant impact on health, the long latent period of the disease, and the availability of noninvasive screening tests and effective disease-modifying therapies.[1,4] Based on these characteristics, we sought to examine the feasibility of implementing a screening program in the town of origin of the p.Glu109Lys variant.

For this purpose, a prospective study was designed to offer genetic screening for the transthyretin (*TTR)* gene to inhabitants of Villacarrillo at risk of ATTRv. Inclusion criteria were age 40 to 70 years and the presence of at least 1 of the following clinical red flags for ATTRv: a diagnosis of heart failure not explained by ischemic cardiomyopathy or valvular heart disease; left ventricular hypertrophy (≥ 12 mm) on echocardiography; pacemaker implantation due to conduction disturbances; signs/symptoms of peripheral neuropathy defined by the presence of paresthesia, sensory loss or neuropathic pain in the absence of other neurological disease; carpal tunnel syndrome; and lumbar spinal stenosis. Patients with a previous *TTR* genetic study or with any conditions that disqualified them from taking an informed decision on genetic testing were excluded. Identification of candidates was manually performed by remote review of the electronic medical records of Villacarrillo primary care center (PCC). Patients fulfilling the inclusion criteria were contacted by the PCC staff by telephone or during routine visits to invite them to participate. Patients willing to participate signed an informed consent form, received genetic counseling, and provided a saliva sample for genetic testing of the *TTR* gene. Genetic results were provided to participants by the PCC medical staff.

All inhabitants registered at Villacarrillo PCC in February 2022 were included (10 233 persons). The clinical records of the 4536 individuals aged 40-70 years old were analyzed. After a medical records review, 294 inhabitants were identified as possible candidates but 6 were excluded due to previous *TTR* gene testing (n = 4) or were disqualified due to their inability to make an informed decision (n = 2). The final study cohort included 288 patients (6.4% of screened participants). The mean age was 59.1 ± 7.5 years and 164 (56.9%) were female. Among clinical red flags, carpal tunnel syndrome was the most frequent (n = 133, 46.2%), followed by left ventricular hypertrophy (n = 61, 21.2%) and lumbar spinal stenosis (n = 44, 15.3%). Thirty patients (10.4%) had ≥ 2 red flags. A total of 256 individuals (88.9%) underwent genetic testing, while 22 participants (7.6%) refused to participate and 10 (3.5%) were not included because they could not be reached (n = 6, 2.1%) or because they died before contact (n = 4, 1.4%). An exploratory analysis found that patients not living in the main town of the municipality had an increased probability of rejecting screening (OR, 9.24; 95%CI, 3.64-23.5, $P < .001$). Genetic testing was successfully performed in all patients with no incidents but none of the patient were identified as carrying the p.Glu109Lys variant or any other pathogenic variant (figure 1).

To the best of our knowledge, this is the first study to perform a population screening program targeting a hereditary cardiac disease within a specific region in Spain. Our findings demonstrate that this approach is feasible and has a high acceptance rate among potential participants. We propose that 2 factors contributed to the high rate of acceptance. First, the involvement of local medical staff in patient outreach, which may have engendered trust. Second, the use of saliva kits instead of blood collection methods, which facilitated participation. In addition, our results also suggest that proximity plays an important role in acceptance. Our work also shows that ATTR red flags are very common in the general population, as they were present in 6% of participants aged 40 to 70 years. This finding suggests that future projects designed to screen for ATTR in the general population may benefit from a more targeted approach focusing on more specific red flags or a combination of common red flags to increase specificity and cost-effectiveness.

Population genetic screening programs are expected to grow exponentially in the coming years due to cheaper access to genetic studies. Overall, pilot programs are focusing on newborns, and although they include a myriad of diseases, inherited cardiac diseases have not usually been included.[5] Population genetic screening for ATTR has been proposed, particularly in countries with a high prevalence of the black population, as the pathogenic p.Val142Ile variant affects 3% to 4% of black individuals in the US.[6] These programs might be based on automatic big data retrieval from electronic health records designed to detect specific red flags.

In summary, despite the negative result of our screening project, our experience provides valuable insights about the feasibility of genetic screening programs and the possible barriers to their implementation in real life scenarios.