



Cardiopulmonary resuscitation does not affect donation in uncontrolled donation after circulatory death procedures

Alonso A Mateos Rodriguez^{a,b,*} , Fernando Neria Serrano^b, Jose Maria Navalpotro Pascual^a, Maria Jose Polonio Anguas^c, Cristina de la Torre Toyos^c, Carlos Rubio Chacón^a

^a Medical Emergencies Service of Madrid, SUMMA112, Spain

^b Faculty of Medicine, Universidad Francisco de Vitoria, Spain

^c Regional transplant coordination office, Autonomous Community of Madrid, Spain

ARTICLE INFO

Keywords:

Emergency medical services
Donation
Uncontrolled donors after cardiac death
Cardiac arrest

ABSTRACT

Introduction: The uncontrolled donation after circulatory death process is started upon cardiac arrest (CA). Although the initial objective of all emergency services is to recover a pulse after said CA, if this is not possible there is a possibility of initiating uncontrolled donation after circulatory death procedures. The aim of this study is to evaluate the actions implemented to resolve CA and how they may affect subsequent donation.

Materials and methods: A double-perspective observational study to study the association between the actions carried out to revert CA and the efficacy of donors in uncontrolled asystole. Data were collected between 2018 and November 2023. Patients who experienced an out-of-hospital CA with no response to advanced cardiopulmonary resuscitation, and who complied with all inclusion criteria and none of the exclusion criteria, were included. The following information was collected: age, sex, initial heart rate, adrenalin, amiodarone, serum therapy, inotropics, bicarbonate, magnesium sulfate, rapid intubation sequence, fibrinolysis, acetylsalicylic acid, atropine, number of defibrillations, use of an automatic defibrillator and discharges thereof, transitory recovery of pulse and initial heart rate. The statistical analysis was carried out using the R software package (ver. 4.1). An effective donor was defined as one from whom at least one organ was extracted and transplanted, and a non-effective donor as one from whom no organs were transplanted.

Results: A total of 69 patients, with a mean age of 49 years (43–52), the majority of whom were male (88.4 %), were collected. A total of 43 of these patients were non-effective donors and 26 were effective, with a statistically significant difference being found in terms of younger age (51 vs 46; $p = 0.020$). In the case of non-effective donors, eight adrenalin doses were administered compared with seven for the effective donor group, with the difference being statistically significant ($p = 0.012$). Fibrinolysis was used in eight cases (11.8 %), with two of these being non-effective donors and six effective; this difference was also statistically significant ($p = 0.044$). The remaining variables did not differ significantly.

Conclusion: On the basis of our series, only a lower use of adrenaline and the use of fibrinolytic agents appear to result in an effective donation if a pulse cannot be recovered. The other variables do not affect the efficacy of donation after uncontrolled circulatory death.

Introduction

Uncontrolled donation after circulatory death (UDCD) has become an alternative for increasing the availability of organs for transplant [1]. The increasing demand for organs, together with a shortage of available donors, has led to the development and implementation of UDCD [2]. The scientific societies that support cardiopulmonary resuscitation

recognise and encourage the possibility of converting patients who have not had their cardiac arrest reverted into possible donors [3].

The process initiated in UDCD is out-of-hospital cardiac arrest (CA) refractory to treatment. However, the actions established to revert this CA may affect the effectiveness or not of the subsequent organ donation. Previous studies have suggested that capnography may be an important variable to be considered when assessing this type of donor [4]. In

* Corresponding author.

E-mail address: aamateosr@gmail.com (A.A.M. Rodriguez).

<https://doi.org/10.1016/j.tpr.2025.100185>

Received 25 August 2025; Accepted 19 November 2025

Available online 20 November 2025

2451-9596/© 2025 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

contrast, other aspects of CA treatment and their relationship to the viability of the possible donor, have received little attention. Although it is the case that the objective of an emergency team is to recover a spontaneous pulse, the actions performed on a CA patient may affect the subsequent viability of organs for donation. Studies have been published regarding the influence of drugs, defibrillation and ventilatory models on the resolution of CA, but it is still not known whether [5], and how, they may affect a possible subsequent donation [6].

This article reviews the actions performed during the treatment of out-of-hospital CA and how they may affect the subsequent efficacy or not of the donor.

Materials and methods

A double-perspective observational study to study the association between the actions carried out to revert CA and the efficacy of donors in uncontrolled asystole. Data were collected retrospectively between January 2018 and November 2023.

Patients who experienced an out-of-hospital CA with no response to advanced cardiopulmonary resuscitation and who were selected as potential UDCDs were selected. The inclusion criteria were: patients aged between 16 and 60 years, with a pattern of asystole, advanced life support prior to 15 min, CPR for at least 20 min and who arrived at the hospital prior to 120 min. The exclusion criteria were: exsanguination due to thoracic and/or abdominal lesions, suspected neoplasm, infection or use of intravenous drugs, and thoracic perimeter incompatible with the use of a thoracic compression device.

The following information was collected: age, sex, initial heart rate, adrenaline, amiodarone, serum therapy, inotropics, bicarbonate, magnesium sulfate, rapid intubation sequence, fibrinolysis, acetylsalicylic acid, atropine, number of defibrillations, use of an automatic defibrillator and discharges thereof, transitory recovery of pulse and initial heart rate. Data were collected from the corresponding medical records via the Horus system, an IT platform used by the Madrid Health Service.

Quantitative variables were expressed as median [interquartile range] or as the mean and standard deviation (SD) and qualitative variables were expressed as absolute (n) and relative frequencies (%). The relationship between the qualitative variables and capnometry levels was evaluated using the Wilcoxon test. Results were considered to be statistically significant at a p-value of 0.05. The statistical analysis was carried out using the R software package (ver. 4.1).

An effective donor was defined as one from whom at least one organ was extracted and transplanted, and a non-effective donor as one from whom no organs were transplanted.

The study was approved by the Research Ethics Committee at the Universidad Francisco de Vitoria.

Results

A total of 69 patients, with a mean age of 49 years (43–52), the majority of whom were male (88.4 %), were collected. A total of 43 of these patients were non-effective donors and 26 were effective, with the difference being statistically significant ($p = 0.02$; Table 1)

Adrenalin was used in all CA patients. In the case of non-effective donors, a mean of eight (6.5–9.5) adrenalin doses were administered compared with seven (6–8) for the effective donor group, with the

Table 1
Distribution of the study population by age and sex.

	Overall, N = 69	Non-effective, N = 43	Effective, N = 26	p-value
AGE	49 (43–52)	51 (46–56)	46.5 (41.3–51.5)	0.020
SEX				>0.999
Male	61 (88.4 %)	38 (88.4 %)	23 (88.5 %)	
Female	8 (11.6 %)	5 (11.6 %)	3 (11.5 %)	

difference being statistically significant ($p = 0.012$). Fibrinolysis was used in eight cases, two amongst the non-effective donors (4.7 %) and six of the effective donors (24 % of this group), with this difference also being statistically significant ($P = 0.044$; Table 2).

Inotropic drugs were used in two cases (2.9 %), bicarbonate in 18 cases (26.5 %), magnesium sulfate in two cases (2.9 %), a rapid intubation sequence on seven occasions (10.3 %), acetylsalicylic acid in three cases (4.4 %) and atropine in three cases (4.4 %). There were no statistically significant differences between effective and non-effective donors for any of these variables.

A mean of 500 ml saline 0.9 % (0–700) was perfused for the non-effective donors group compared with 275 ml for the effective donors group (0–1000; $p = 0.531$).

As regards the use of electrical therapy, the automatic defibrillator was used in 10 cases and discharges were performed in five patients, with no significant differences being found between the two groups. A mean of 1.8 defibrillations were performed with the manual defibrillator for the non-effective donors group (SD 3.1) compared with 2.7 (SD 4.1) for the effective donors group ($p = 0.220$).

11 patients experienced transitory pulse recovery, with four of these being in the non-effective donors group (9.3 %) and seven (26.9 %) in the effective donors group ($p = 0.087$).

The majority of patients presented ventricular fibrillation as the first rhythm observed upon arrival of the emergency team (27 cases, 39.1 %), followed by asystole (21 cases, 30.4 %). No statistically significant relationships have been found between the first rhythm observed and the effectiveness of the donor ($p = 0.324$).

Discussion

The influence of drugs and electrical therapy at the cardiac arrest site has been studied for many years [7,8], as has the influence thereof on organ perfusion at the reanimation site [9]. However, although the primary objective of cardiopulmonary resuscitation must always be the recovery of a spontaneous pulse, it should also be remembered that if this recovery is not achieved, the patient can be transferred to facilitate organ donation³. As such, an understanding of the likely influence of

Table 2
Analysis of the variables for effective donors.

	Overall, N = 69	Non-effective, N = 43	Effective, N = 26	p-value
EPINEPHRINE (N)	8 (6–9)	8 (6.5–9.5)	7 (6–8)	0.012
AMIODARONE (N)	0 (0–0)	0 (0–0)	0 (0–1)	0.120
SALINE (ml)	400 (0–750)	500 (0–700)	275 (0–1000)	0.531
IONOTROPES	2 (2.9 %)	2 (4.7 %)	0 (0 %)	0.528
BICARBONATE	18 (26.5 %)	14 (32.6 %)	4 (16 %)	0.136
MAGNESIUM SULFATE	2 (2.9 %)	0 (0 %)	2 (8 %)	0.132
RIS	7 (10.3 %)	4 (9.3 %)	3 (12 %)	0.702
FIBRINOLYTIC AGENT	8 (11.8 %)	2 (4.7 %)	6 (24 %)	0.044
ASA	3 (4.4 %)	2 (4.7 %)	1 (4 %)	>0.999
ATROPINE	3 (4.4 %)	2 (4.7 %)	1 (4 %)	>0.999
DF	2.1 (3.5)	1.8 (3.1)	2.7 (4.1)	0.220
AED USED	10 (14.5 %)	6 (14 %)	4 (15.4 %)	>0.999
AED DISCHARGES	5 (7.2 %)	2 (4.7 %)	3 (11.5 %)	0.358
TRANSITORY PULSE RECOVERY	11 (15.9 %)	4 (9.3 %)	7 (26.9 %)	0.087
FIRST RHYTHM				0.324
Asystole	21 (30.4 %)	16 (37.2 %)	5 (19.2 %)	
PEA	17 (24.6 %)	11 (25.6 %)	6 (23.1 %)	
PVT	4 (5.8 %)	2 (4.7 %)	2 (7.7 %)	
VF	27 (39.1 %)	14 (32.6 %)	13 (50 %)	

such drugs on the possibility of donation may be of interest.

According to our series of data, a lower use of adrenaline and the use of fibrinolytic agents may affect the effectiveness of donation. However, the limited difference in the values for adrenaline suggests that this difference may be random. In contrast, a higher use of fibrinolytic agents was found in the case of effective donors. In this regard, fibrinolytic agents are not recommended in cardiopulmonary resuscitation guidelines⁶ as they have not been shown to increase the recovery of a spontaneous pulse [10]. However, fibrinolytic agents and heparin are common treatments in the cases of donors in uncontrolled asystole and this may explain the greater effectiveness in cases where donation is proposed.

Patients in our series who presented a transitory pulse recovery also failed to result in a higher number of effective donations. Previous studies have shown that a transitory pulse recovery is related to better neurological outcomes in these patients [11,12].

None of the other variables collected in our study was found to affect the effectiveness of donation. The out-of-hospital care variables shown to affect donation to some degree in previous studies include cardiac compression [13] and transfer time [14], both of which form part of the warm ischaemia time that is of such importance in all donation processes.

Consequently, it appears that none of the actions implemented in the event of CA to recover a spontaneous pulse affect the effectiveness of donation in uncontrolled donation after circulatory death procedures.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Alonso mateos rodriguez reports was provided by Oficina Regional de Coordinación de Trasplantes. Alonso Mateos reports a relationship with Community of Madrid Health Service that includes: employment. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have

appeared to influence the work reported in this paper.

References

- [1] E. Coll, E. Miñambres, A. Sánchez-Fructuoso, C. Fondevila, J.L. Campo-Cañaveral de la Cruz, B. Domínguez-Gil, Uncontrolled donation after circulatory death: a unique opportunity, *Transplantation* 104 (2020) 1542–1552.
- [2] R. Matesanz, B. Domínguez-Gil, E. Coll, Donación en asistolia no controlada: necesidad, oportunidad y reto, *Med. Intensiva* (2013) 221–223.
- [3] Laurie J. Morrison, et al., Organ donation after out-of-hospital cardiac arrest: a scientific statement from the International Liaison Committee on Resuscitation, *Resuscitation* 190 (2023) 109864.
- [4] Carlos Rubio Chacón, Alonso Mateos Rodríguez, Fernando Neria Serrano, Francisco Del Río Gallegos, Amado Andrés Belmonte, Influence of donor capnometry on renal graft evolution in uncontrolled donation after circulatory death, *Resuscitation* 89 (2023) 109863.
- [5] J. Soar, et al., European Resuscitation Council Guidelines 2021: adult advanced life support, *Resuscitation* (2021).
- [6] C. Rubio-Chacón, A. Mateos-Rodríguez, F. Neria-Serrano, F. Del Río-Gallegos, A. Andrés-Belmonte, Reply to pre hospital interventions and organ donation in out of hospital cardiac arrest, *Resuscitation* 183 (2023) 110030.
- [7] Jerry P. Nolan, et al., Advanced life support drugs: do they really work? *Curr. Opin. Crit. Care* 8 (2002) 212–218.
- [8] Max Harry Weil, Shijie Sun, Clinical review: devices and drugs for cardiopulmonary resuscitation—opportunities and restraints, *Critical Care* 9 (2004) 287.
- [9] H.R. Holmes, et al., Influence of adrenergic drugs upon vital organ perfusion during CPR, *Crit. Care Med.* 8 (1980) 137–140.
- [10] Daniel M. Fatovich, Geoffrey J. Dobb, Richard A. Clugston, A pilot randomised trial of thrombolysis in cardiac arrest (The TICA trial), *Resuscitation* 61 (2004) 309–313.
- [11] V. Antonaglia, C. Pegani, G.D. Caggegi, A. Patsoura, V. Xu, M. Zambon, G. Sanson, Impact of transitory ROSC events on neurological outcome in patients with out-of-hospital cardiac arrest, *J Clin Med* 8 (7) (2019) 926.
- [12] H. Lian, A. Xia, X. Qin, S. Tian, X. Kang, L. Zhang, J. Zhang, Association between duration of return of spontaneous circulation and outcomes after out-of-hospital cardiac arrest, *Emerg. Critic. Care Med.* 2 (4) (2022) 191–196.
- [13] Mateos Rodríguez, Alonso Antonio, Amado Andrés Belmonte, Francisco Del Río Gallegos, Elisabeth Coll, Factors influencing the evolution of grafts from donors after out-of-hospital cardiac death, *Emergencias* 29 (2017) 167–172.
- [14] A.S. Fructuoso, M.R. Del Barrio, M. Prats, J. Torrente, M. Illescas, P. Mateos, A. Barrientos, Donation of organs after circulatory death. Results from Hospital Clínico San Carlos, *Nefrología* 18 (1998) 47–52.