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## 5 Nationwide Potential for Uncontrolled Donations after Cardiac Death in the Era of Extracorporeal Cardiopulmonary Resuscitation

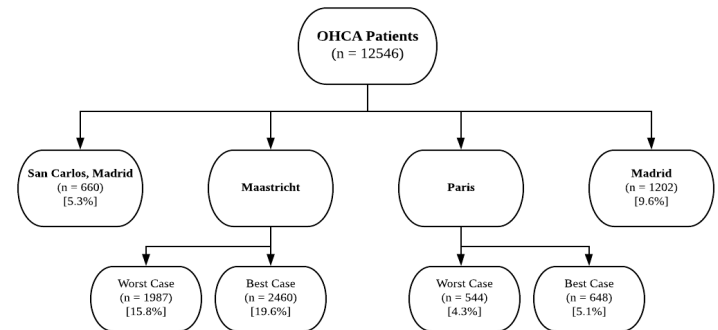
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**Objective:** One organ donor can save 10 or more lives. Despite legislating an opt-out programme in Singapore, rates of organ donation and transplant are still low. This study explored the potential national numbers for uncontrolled donations after cardiac death (uDCD) amongst out-of-hospital cardiac arrest (OHCA) patients in Singapore. In addition, we also attempted to explore the influence of extracorporeal cardiopulmonary resuscitation (ECPR) on uDCD, and the possible negative effects on potential survivors.

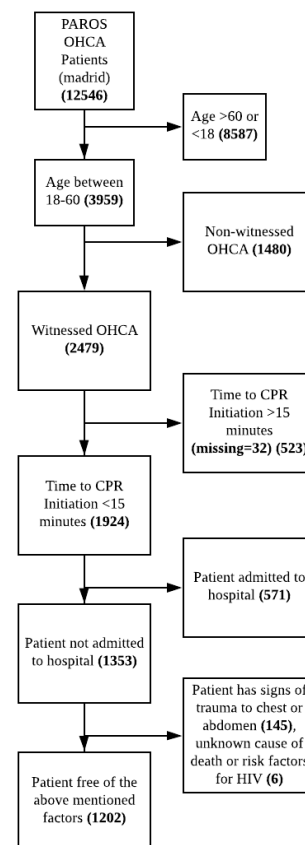
**Design and Method:** We analysed OHCA cases from 2010–2016 in the Pan-Asian Resuscitation Outcomes Study. Four established criteria for identifying individuals eligible for uDCD (Madrid, Maastricht, Paris, and San Carlos Madrid) were retrospectively applied onto the population. Within these four groups we applied a condensed ECPR eligibility criteria, and thereafter applied an estimated ECPR survival rate, extrapolating for possible survivors if ECPR had been applied, assuming a neurologically-intact survival rate of 12.3% (derived from literature reviews).

**Results:** A total of 12,546 cases qualified for analysis. The four criteria produced four groups eligible for uDCD: Madrid (n = 1202, 9.6%); Maastricht (range (n) = 1987–2460, 15.8–19.6%); Paris (range (n) = 544–648, 4.3–5.1%); and San Carlos Madrid (n = 660, 5.3%). Within these groups, a subset would have been eligible for ECPR: Madrid (n = 208); Maastricht (n = 266); Paris (n = 102); and San Carlos Madrid (n = 152). From these, the potential numbers of neurologically-intact survivors were as follows: Madrid (n = 26, 2.1%); Maastricht (n = 33, 1.3–1.6%); Paris (n = 13, 1.9–2.3%); and San Carlos Madrid (n = 19, 2.8%).

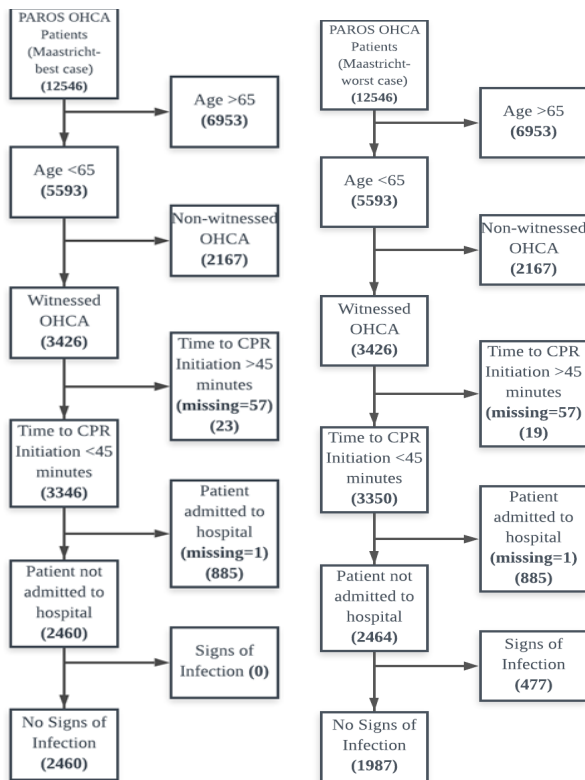
**Conclusion:** The potential exists to increase the organ donor pool in Singapore by shifting from current criteria of neurological death to cardiac death. A small proportion of these patients qualified for ECPR. However, sizeable numbers of cases were suggested for organ donation despite the possibility of eventually attaining neurologically-favourable recovery through ECPR.



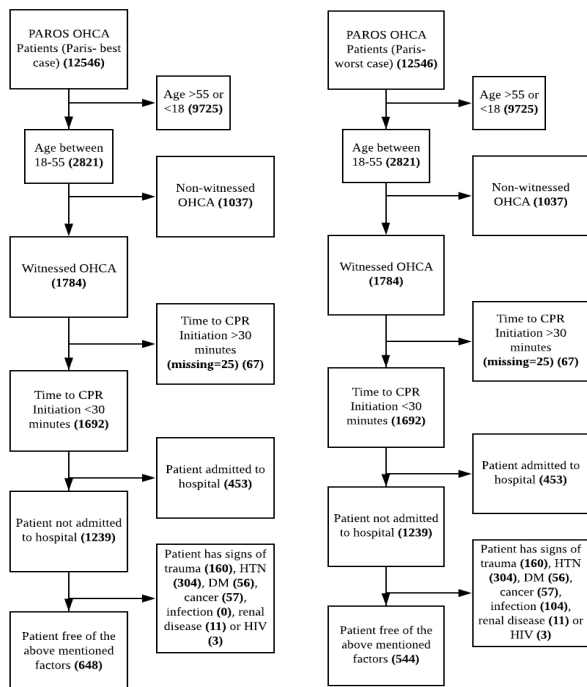
**Figure 1.** Compiled potential uDCD organ donor numbers. uDCD, uncontrolled donations after cardiac death; OHCA, out-of-hospital cardiac arrest.



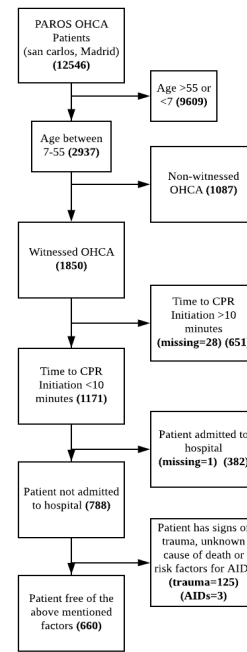
**Figure 2.1.** Application of Madrid criteria. PAROS, Pan-Asian Resuscitation Outcomes Study; OHCA, out-of-hospital cardiac arrest; HIV, human immunodeficiency virus.



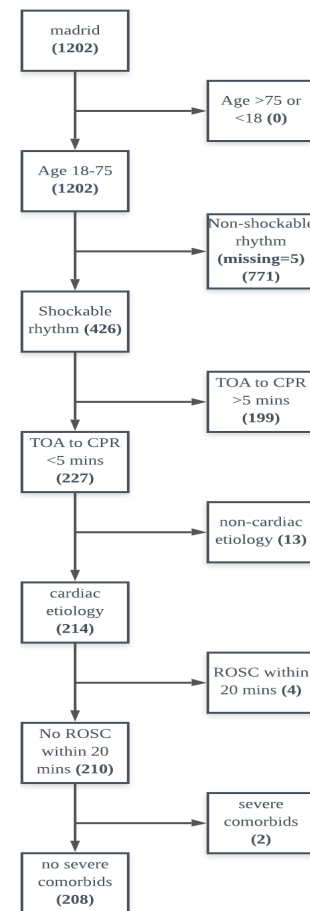
**Figure 2.1.** Application of Maastricht criteria. PAROS, Pan-Asian Resuscitation Outcomes Study; OHCA, out-of-hospital cardiac arrest.



**Figure 2.1.** Application of Paris criteria. PAROS, Pan-Asian Resuscitation Outcomes Study; OHCA, out-of-hospital cardiac arrest.



**Figure 2.1.** Application of San Carlos Madrid criteria.



**Figure 3.1.** Application of condensed ECPR criteria (Madrid).

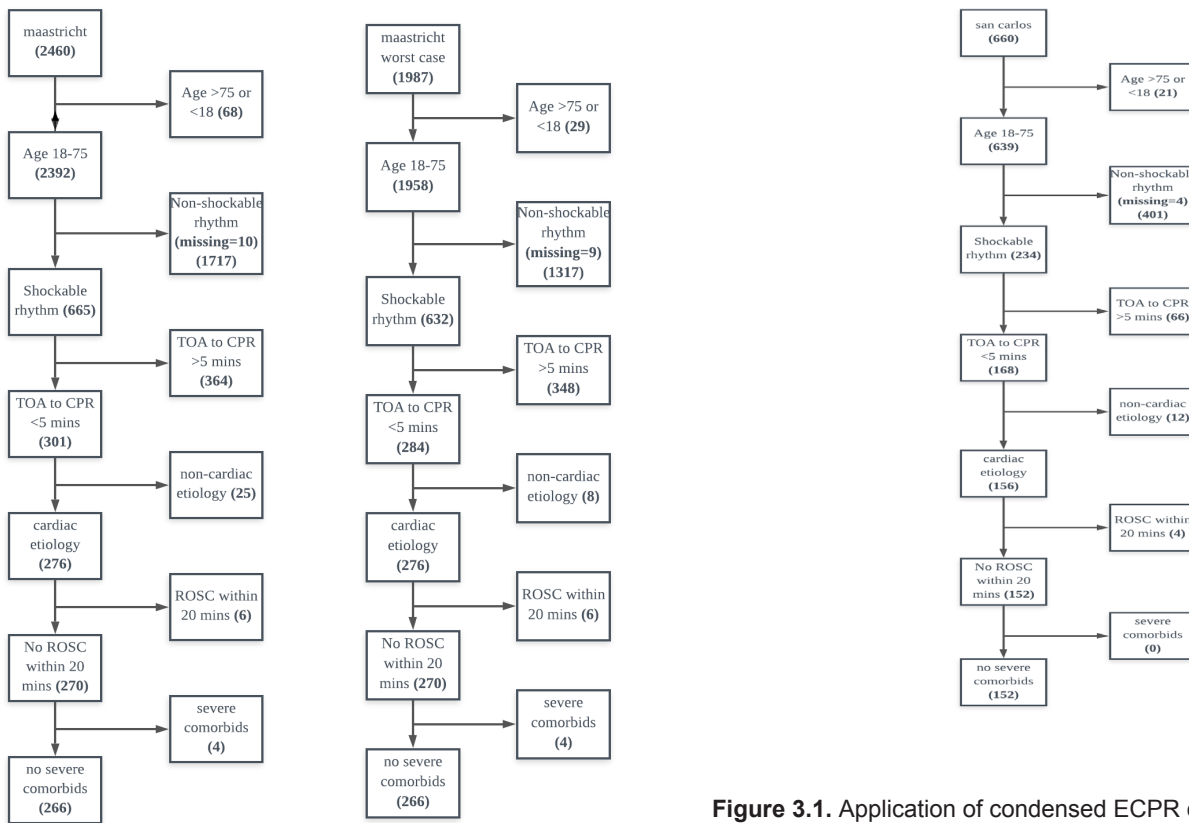


Figure 3.1. Application of condensed ECPR criteria (Maastricht).

Figure 3.1. Application of condensed ECPR criteria (San Carlos, Madrid).

Table 4.1. Number of possible survivors among eligible organ donors.

	Madrid	San Carlos	Maastricht	Maastricht WC	Paris	Paris WC
Total	1202	660	2460	1987	648	544
Number of patients eligible for ECPR	208	152	266	266	102	102
(%)	17.3	23.0	10.8	13.4	15.7	18.8
Number of survivors	25.6	18.7	32.7	32.7	12.5	12.5
(%)	2.1	2.8	1.3	1.6	1.9	2.3

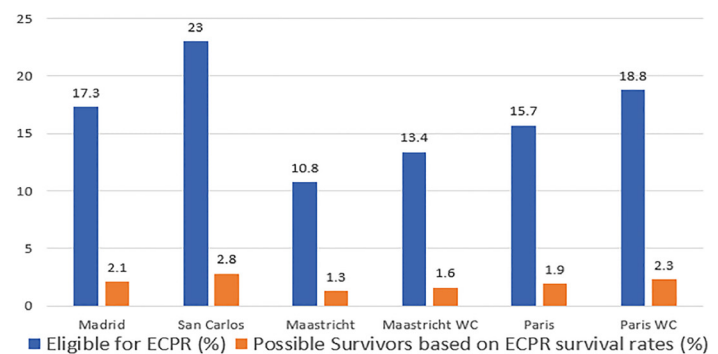


Figure 4.2. Percentage of possible survivors among eligible organ donors. ECPR, extracorporeal cardiopulmonary resuscitation.



ECPR, extracorporeal cardiopulmonary resuscitation; ROSC, return of spontaneous circulation.

Figure 3.1. Application of condensed ECPR criteria (Paris).