



## Review article

# The viability of transplanting organs from donors who underwent cardiopulmonary resuscitation: A systematic review<sup>☆</sup>



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## ABSTRACT

**Aims:** To identify reports of patients who underwent cardiopulmonary resuscitation (CPR) prior to solid organ donation and compare recipient and organ function outcomes to those that did not undergo CPR. Donation after restoration of circulation then progressing to death and those donating with on-going CPR who would have otherwise have termination of efforts were both included.

**Methods:** Systematic review. Clinical studies comparing the outcome of patients and organs retrieved from donors who underwent CPR with those that did not require CPR. Full-text articles were searched on Embase, MEDLINE, Cochrane Database of Systematic Reviews and the Cochrane Register of Controlled Trials.

**Results:** Twenty-two observational studies were included. There were 12,206 adult and 2552 paediatric organ transplantation identified. Comparing donation after restoration of circulation there was no difference in immediate, one year, and five-year graft function. Donation with on-going CPR was associated with reduced immediate graft function for both renal and hepatic transplantation, however long term function was not different.

**Conclusions:** CPR does not appear to adversely affect graft function. Patients who have restored circulation after resuscitation and subsequently progress to death should be evaluated for organ donation. Those with on-going CPR should be considered for hepatic and renal transplantation but there may be worse initial graft function.

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## Introduction

Currently there are 121,508 patients awaiting organ transplantation in the United States.<sup>1</sup> While in 2013 there were 86,000 patients on the transplant waiting list in Europe, and about 6000 of these will die waiting.<sup>2</sup> Efforts have been made to remove barriers to organ donation, such as media campaigns highlighting the benefits of donating.<sup>3</sup> Any way to expand the number of potential donors will increase the available organs, but this must be done cautiously. Transplanting substandard organs would clearly not be a viable solution.

Cardiac arrest is a relatively common reason for admission to critical care units that can result in irrecoverable brain injury up to and including brainstem death. Other organs may be more robust

and could be viable for transplantation. Given the period of warm ischaemia post cardiopulmonary resuscitation (CPR) donors are often treated with caution.<sup>4</sup> These donors are potentially a significant source of organs. In a single centre in Belgium it was reported that up to 31% of their donors were post cardiac arrest.<sup>5</sup>

A systematic review in 2010,<sup>6</sup> suggested that renal, liver, heart and intestinal transplants from donors who were brain dead due to cardiac arrest had no significant difference in function compared to those who were brain dead for other reasons. Only four studies were able to be included and there was marked heterogeneity between them.

This systematic review was conducted as part of the 2015 International Liaison Committee on Resuscitation (ILCOR) Consensus on Science and Treatment Recommendation (CoSTR) process.<sup>7,8</sup> The ILCOR Advanced Life Support Task Force held an international consultation and this subject was ranked as still being of significant interest and requiring further systematic review since the 2010 CoSTR.<sup>9</sup> We aim to identify reports of patients who underwent CPR prior to solid organ donation and compare recipient and organ function outcomes. This included both those patients who donated

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**Table 1**  
Summary of terms used.

Terminology	Definition
Cardiopulmonary resuscitation received (CPR+)	Patient has had CPR at some stage before organ donation
No Cardiopulmonary resuscitation (CPR–)	Patient has never had CPR before organ donation
Uncontrolled donation after circulatory death (DCD)	Maastricht II donation. Return of spontaneous circulation never occurred after CPR. Donor declared dead and further interventions, including mechanical compressions and extracorporeal circulation for potential organ donation. By definition these donors are CPR+
Controlled DCD	Maastricht III Donation. Occurred after circulatory death in patients after controlled withdrawal of treatment in patients with a circulation. These patients could be CPR+ with a return of spontaneous circulation, or CPR–
Donation after brainstem death (DBD)	Donation occurs after formal diagnosis of brain stem death. These patients could be CPR+ with a return of spontaneous circulation, or CPR–

organs after successful CPR and later died on intensive care, and those who had unsuccessful CPR. These will be compared to those who underwent donation, but had not received any CPR before they died.

## Method

This systematic review followed the process described by ILCOR for its 2015 CoSTR process.<sup>10</sup> Worksheet evaluation experts reviewed the search strategy and its findings. The method was informed and validated against the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist<sup>11</sup> and the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) working group approach.<sup>12</sup> The Assessing the Methodological Quality of Systematic Reviews score (AMSTAR) was 10 out of 11.<sup>13</sup>

The terms used to define different organ donation processes can be confusing. The terms used in this article are defined in [Table 1](#).

### PICO question

The ILCOR Advanced Life Support Task Force agreed the following question after a period of public consultation using the PICO format (Patient/population, Intervention, Comparator, Outcome)<sup>14</sup>: in adult and paediatric organ transplantation (P), does organ retrieval from a donor who has had CPR (I), as opposed to those that did not require CPR (C), affect outcome in terms of immediate, one year and five year graft function (O).

### Inclusion criteria

#### Types of studies

Any clinical study that included comparison between CPR+ and CPR– donors, DBD, controlled and uncontrolled DCD were considered for inclusion. Only studies published in full-text form in an indexed journal, with full method and outcome data were included. No restrictions were placed on language, publication date, publication status or sample size.

**Table 2**  
ILCOR quality assessment of cohort studies.<sup>10</sup>

Factors being assessed	
Were comparison groups clearly defined?	
Were outcomes measured in the same (preferably blinded), objective way in both groups?	
Were known confounders identified and appropriately controlled for?	
Was follow-up of patients sufficiently long and complete (e.g. >80%)	
Number of factors present	Quality level
4	Good
3	Fair
2	Poor
1	Insufficient

### Types of patients

Adults and children.

### Types of organs

All organ donation was considered. Tissue donation, such as corneas, were not considered.

### Exclusion criteria

#### Types of studies

Reviews, case reports and series of less than four, and studies just in abstract form were excluded.

#### Types of patients

Organs retrieved from those that were brain dead before cardiac arrest, i.e. cardiac arrest in brain dead donors.

### Information sources and search strategy

Electronic searches of the Cochrane Database of Systematic Reviews and the Cochrane Register of Controlled Trials, and EMBASE and MEDLINE databases. Studies were identified through these searches and by backwards chaining using the references of selected articles. The searches were undertaken on June 27, 2014 for completion of the ILCOR process and updated on February 20, 2016. Automatic alert was setup on MEDLINE to identify new publications released during the study selection, data extraction and analysis. Full search criteria in Supplementary material.

### Study selection and data extraction

Eligibility assessment was performed independently in a blinded fashion by two authors (CC and SW). Disagreements were resolved by consensus but with a view to inclusion if doubt existed.

The following information was extracted from each study: design and type of organ transplanted, status of donors: DBD, uncontrolled or controlled DCD, types of outcome measure, and age of recipients.

### Quality assessment

Study quality was assessed according to the ILCOR recommended methods as per in the International Consensus on Resuscitation Science 2015<sup>10</sup> and according to the criteria in [Table 2](#). Studies of insufficient quality were excluded from further analysis

### Outcome measures

The main outcome measure was immediate graft function, which was taken as up to 30 days post transplantation as it

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