WORKSHEET for Evidence-Based Review of Science for Emergency Cardiac Care

**Clinical question.**

“Does the use of organs from patients with brain death after cardiac arrest (pre-hospital or in-hospital) (I), as opposed to the use of organs from patients with brain-death not due to cardiac arrest (C), improve outcomes (O) in adult and paediatric organ recipients (P), (e.g., Transplant success).

Is this question addressing an intervention/therapy, prognosis or diagnosis?

This question addresses a diagnosis and an intervention and therapy: Intervention/therapy.

State if this is a proposed new topic or revision of existing worksheet: New topic.

**Conflict of interest specific to this question**

Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet?

I received an unrestricted grant from the publicly funded Biomedicine Agency in 2005, which manages organ donor data in France.

**Search strategy (including electronic databases searched).**

Searched Medline (mostly Pubmed), Ovid, Cochrane databases (reviews and trials), AHA EndNote 7 Master library and references from previous articles and review articles

- **Search Pubmed**
  - #1 Search "heart arrest" [MeSH Terms] 25783 hits
  - #2 Search "organ procurement"[MeSH Terms] 10832 hits
  - #3 Search "brain death"[MeSH Terms] 6132 hits
  - #4 Search (#1) AND (#2) 212 hits
  - Or #5 Search ((#1) AND (#2)) AND (#3) 80 hits

- **Search Ovid:**
  - #1 cardiac arrest.mp. [mp=title, abstract, full text, caption text] 24077 hits
  - #2 organ procurement.mp. [mp=title, abstract, full text, caption text] 3528 hits
  - #3 brain death.mp. [mp=title, abstract, full text, caption text] 4568 hits
  - #4 1 and 3 and 2 187 hits

**Criteria of inclusion and exclusion criteria**

Criteria of inclusion: Organ donation after brain death caused by cardiac arrest

Criteria of exclusion: Non-heart-beating donation, cardiac death.

**Number of articles/sources meeting criteria for further review:**

- **One case report:**


- **One report of pre-procurement factors:**


- **8 articles (non-randomised, concurrent controls):**


Matsumoto C, al Utilization of donors who have suffered cardiopulmonary arrest and resuscitation in intestinal transplantation. Transplantation 2008 86: 941-946.
# Summary of evidence

## Evidence Supporting Clinical Question

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- A = Return of spontaneous circulation
- B = Survival of event
- C = Survival to hospital discharge
- D = Intact neurological survival
- E = Other endpoint
- *Italics = Animal studies*
### Evidence Neutral to Clinical question

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**Italics = Animal studies**

### Evidence Opposing Clinical Question

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**Italics = Animal studies**
Brain death was uncommon in published cohorts of patients with successfully resuscitated cardiac arrest. The prevalence has varied widely, from 8% to 16%, probably because of case-mix differences, underdiagnosis, and underreporting. For the individual patient, the main benefit from CPR is survival with full neurological recovery. However, the societal benefits from brain death followed by organ donation should not be underestimated, as they consist in saving the lives of patients on organ-transplant waiting lists. Extending the criteria for organ donation may increase the number of available organs, thereby contributing to lessen the current shortage of organs. Even early in the era of organ transplantation, less-than-ideal donors were accepted in situations of particularly severe organ shortage, particularly in emergencies and for rare recipient subgroups. The question “Does the use of organs from patients with brain death after cardiac arrest (pre-hospital or in-hospital) (I), as opposed to the use of organs from patients with brain-death not due to cardiac arrest (C), improve outcomes (O) in adult and paediatric organ recipients (P), (e.g., Transplant success)” is ambiguous; what is a transplant success? First, hemodynamic instability of these render the organ procurement more frequent with a rate a high rate failure, secondarily graft success can be appreciated on ICU or hospital discharge but after longer period of time. Most ICU physicians would expect the quality of organs from successfully resuscitated patients to be compromised by previous exposure to cardiac arrest. For instance, cardiac arrest was deemed detrimental by many transplant teams in a study of pancreas donors (Vinkers et al. 2008). However, another possibility is that resuscitated cardiac arrest constitutes beneficial preconditioning to ischemia. Choosing the outcome that best reflects transplant success is problematic, as many factors are involved in addition to organ quality, such as the quality of organ-procurement procedures. Hospital discharge can be used, but the best endpoint may be transplant survival rates after 1 year or, preferably, several years. The few studies that specifically address this issue all suggest that long-term survival of transplants from brain-dead donors after cardiac arrest may be similar to that of transplants from patients with other causes of brain death.

A potential protective effect of ischemia-reperfusion related to cardiac arrest – or preconditioning – on short-term outcomes after liver transplantation has been suggested. One study showed smaller liver enzyme increases in recipients of organs from cardiac-arrest patients than from other patients (Totsuka, 2000). In another study (Wilson, 2003), no differences were found in clinical or laboratory variables at hospital discharge, or in liver biopsy results (hepatocyte swelling, apoptosis, necrosis, and hemorrhage) in a subgroup of patients. The study variables were evaluated during the ICU stay or at hospital discharge at the latest in both studies, neither of which obtained data on long-term transplant survival. Furthermore the occurrence of cardiac arrest before or after brain death was not specified.

Long-term (1-5 years) heart transplant survival was not different in recipients of cardiac-arrest donor hearts (n=38) after careful selection and in other recipients (n=566) (Ali at al, 2007). Similarly, long-term survival rates of kidney and liver transplants (Adrie et al, 2008) from out-of-hospital cardiac-arrest patients and non-cardiac-arrest patients were similar (29 vs. 79 and 14 vs. 43, respectively, NS). A very recent study (Matsumoto et al, 2008) showed that cardiac arrest should not prevent the donation of intestine for transplantation; thus, 1-year survival was similar in the 12 recipients (n=12) of intestine from cardiac arrest donors and in the 55 other recipients (75% vs. 83%, respectively; NS). Finally, one study evaluated heart function after heart transplantation in children from birth to 17 years of age and found no difference between recipients of hearts from successfully resuscitated cardiac arrest donors compared to donors without cardiac arrest (n= 72 vs. 68, respectively) (De Begona JA,1993).

In adult, brain dead patients after cardiac arrest often more frequently due to asystolie and are younger at least compared to brain dead after other causes (Ali et al, 2007, Adrie et al, 2008)

Larger studies are needed to obtain better information on the quality of organs from cardiac-arrest donors and to be able to perform better adjusted analyzes after univariate analysis to avoid bias related to difference between patient bran dead after cardiac arrest
from those brain dead from other causes. Furthermore, the absence of a universally accepted reference standard for measuring transplant quality is an obstacle to comparisons of outcomes in recipients of organs from cardiac-arrest donors and in other transplant recipients. Organ donation remains to be evaluated from brain dead patient after in-hospital cardiac arrest. Most of all, we lack data on the outcome of organ obtained from children.

Acknowledgements: None
Citation List


No abstract.

The authors retrospectively evaluated the quality of kidneys obtained from cardiac-arrest donors (n=56) and from other donors (n=204) in one center. They focused on acute renal failure during the first seven post-transplantation days, defined as a need for hemodialysis and/or as serum creatinine elevation. Oddly enough, prolonged hypotension (not defined) before organ procurement was common in both cardiac-arrest donors (56/56) and other donors (n=148/204). Interestingly, acute renal failure in the first seven days was significantly less common in the recipients of kidneys from cardiac-arrest donors (6/30) than in recipients of kidneys from other donors (p<0.05). This study does not give any information about the long-term outcome (beyond 7 days) of the kidneys or about the outcomes of other organs from the study donors.

Level LOE2. Supporting clinical question. Poor evidence. There is no information on long-term transplant survival, and acute renal failure was poorly defined (serum creatinine elevation with no threshold or any other stringent criteria).


No abstract.

A very short letter in which the authors report the retrospective finding that 80 of 176 brain-dead patients admitted to their unit as potential donors actually donated organs. Hemodynamic instability was more common in patients with brain death due to cardiac arrest compared to other causes and was a more common source of failed donation (15.9%). This manuscript only highlight that these patients are more hemodynamically unstable and failure to organ procurement more common in these patients. This paper just highlight what we meant by "transplant success" in the ambiguous question. If there is no organ procurement; there is no transplant success and highlight that these patients are more unstable and have a higher rate of failure related to technical reason (multiple organ failure).

Excluded. This is a very short report (half a page), and many descriptive variables are missing. There is no information about the outcome of transplanted organs.


No abstract.

Just one case report of organ procurement after a successfully resuscitated cardiac arrest related to primary myocardial infarction. The heart (without palpable atheroma in the coronary arteries) was found suitable for transplantation, as well as the kidneys. In the authors' institution, livers were not accepted after cardiac arrest at that time (1995). The heart recipient did well for seven weeks then died from bacterial meningitis, and one kidney recipient died from myocardial infarction on day 7 without recovering good kidney function. The second kidney recipient had good graft function three years after transplantation (1997). As neither of the deaths was directly related to transplant function, the authors concluded that multiorgan retrieval was possible after prolonged cardiac arrest. This is only a short case report and two of three organ recipients died soon after transplantation (from causes not directly related to transplant function).

Excluded: Neutral to clinical question. Poor evidence.


The authors evaluated the role of a "brief" cardiac arrest during the ICU stay in donors included prospectively between May 1997 and July 1998 on the outcome of liver transplants. Among the donors, 144 had no cardiac arrest and 37 experienced "brief" cardiac arrest with cardiopulmonary resuscitation for 27.5 min (Interquartile range, 4-90 min). Of note, 21 cardiac-arrest donors experienced anoxia (probably related to a previous cardiac arrest), compared to none of the other donors. Short-term graft survival was not affected by the "brief" cardiac arrest, and no differences were found for ICU or hospital stay durations. Furthermore, mean peak aspartate transaminase and alanine transaminase concentrations in the recipients of livers from cardiac-arrest donors were lower than in the other recipients, suggesting that ischemic preconditioning induced by a brief cardiac arrest might be protective. No information is available on the long-term outcome after hospital discharge. Furthermore, it is not clear whether or not cardiac arrest occurred before or after the diagnosis of brain death.

Level LOE2 Supporting clinical question. Poor evidence. There is no information on long-term transplant survival.

Of 135 patients with at least one episode of cardiac arrest (occurring at the time of hospitalization), 131 were individually matched to 131 non-cardiac-arrest controls on age (± 5 years), gender, and year of organ recovery (± 1 year). No other information was obtained about the controls. Hemodynamic stability was similar in both groups, but thoracic organ procurement was significantly lower in the cardiac-arrest donors (35% vs. 53%, p<0.01). Procurement of three or more abdominal organs from cardiac-arrest donors was similar to that from control donors (77% vs. 87%, NS). Although significantly fewer livers were transplanted from cardiac-arrest donors (69% vs. 85%, p<0.01), post-transplantation transplant function and injury parameters such as liver enzymes were similar between the two groups. Histological findings (hepatocyte swelling, apoptosis, necrosis, and hemorrhage) in postperfusion liver allograft biopsies were not significantly different between donors with cardiac arrest (n=37) and other donors (n=39). Cardiac arrest did not seem associated with the protective preconditioning to ischemia suggested by previous studies in humans and pigs. It is not clear whether or not cardiac arrest occurred before or after the diagnosis of brain death. Actually the authors acknowledge that most of the cardiac arrest was a single episode occurring at the time of hospitalization.

Excluded because it was not clear if the cardiac arrest occurred after or before brain death.


A cohort of 140 infants and children (birth to age 17 years) who received heart transplants between November 1985 and November 1995 was studied retrospectively. In 72 patients, the hearts were from donors who did not receive CPR. In the remaining 68 patients, the donors had CPR for a mean of 18.8 ± 08 minutes (up to 60 minutes). Mean donor age was 755 ± 1049 days in the group without CPR and 372 ± 679 days in the group with CPR. Mean recipient age was 704 ± 1444 days in the group whose donors had no CPR and 174 ± 475 days in the group whose donors had CPR. Transplant function was studied using M-mode echocardiography for up to 2 years after transplantation. No differences were found for graft survival transplant function, or early post-operative use of inotropic or vasopressor support. These findings suggest that hearts from selected CPR donors perform as well as those from other donors. Many clinical variables from both donors and recipients are missing. Most importantly, the term "brain death" is not mentioned in the manuscript. However, given the study dates, it is probably safe to assume that the donors met brain-death criteria and that few or no donors died from cardiac death (Maastricht III).

LOD 5. This is the only study in children, but the term "brain death" is not mentioned in the manuscript. Furthermore, it is not specified if cardiac arrest occurred before or after diagnosis of brain death. However cardiac arrest occurred mainly after primary anoxia in children.


Thirty-eight patients received hearts from multiorgan donors who were resuscitated after cardiac arrest and 566 patients received hearts from control donors without cardiac arrest. Median follow-up was 61 months (IQR, 15-166). Patient survival rates after 1 year were 94.2% and 83.6% in the arrest and non-arrest groups; 5-year survival rates were 79.8% and 74.5%, respectively (p=0.35). Donor cardiac arrest was not an adverse predictor of mortality by multivariate analysis (adjusted odds ratio, 0.86; 95%CI, 0.60-1.25, p=0.42). Interestingly, postoperative needs for intra-aortic-balloon pump were similar in both groups, and a ventricular-assist device was required in none of the arrest donors compared to 9 (1.6%) of the other donors. Thus, with careful case selection, there was no evidence that survival after cardiac transplantation was worse following a period of cardiac arrest in the donor. The authors conclude that hearts from cardiac arrest patients should not be excluded from being considered for transplantation.


This prospective study had the dual objective of determining whether early predictors of brain death existed in a patient cohort and of assessing long-term outcomes of the transplants (mainly liver and kidney) in the recipients. Of 246 consecutive patients admitted after out-of-hospital cardiac arrest, 40 (16%) experienced brain death. No early predictors were identified. Interestingly long-term (1 and 5 years) survival rates of livers and kidneys, as assessed using Kaplan-Meier analysis and the log-rank test, were not significantly different between cardiac-arrest donors (29 kidneys and 14 livers) and other donors (79 and 43, respectively) from a previous database (mainly patients with stroke and head trauma). The numbers of other donated organs were too small to be properly adjusted. The size of the two organ cohorts was too small for meaningful adjustments (only the age difference for the kidneys could be taken into account).


No abstract available.

A donor quality score was developed to help recognize donors whose pancreases are likely to be accepted by most transplant teams. All 3180 consecutively reported pancreas donors for the 3.5-year study period were studied. This score does not provide information on transplant or recipient outcomes. However, an interesting finding is that CPR <5 min and >5 min was assigned 2 and 3 points, respectively, compared to 0 points in the absence of CPR. This fact indicates that cardiac arrest is widely believed to decrease donor organ quality, in the absence of scientific evidence to support this belief.
Excluded. However this paper indicates that most of the ICU physicians believe that cardiac arrest is detrimental and may be a very good reason not to performed organ procurement indicates that most transplant teams believe that cardiac arrest is detrimental but they do not give any data supporting this hypothesis.


Intestinal ischemia is believed to be very severe during cardiac arrest, as splanchnic vasoconstriction occurs to preserve coronary and cerebral blood flow. This is a retrospective study of short-term and 1-year outcomes after transplantation of isolated intestine, liver and small intestine, multiple organs, and multiple organs without the liver. In 12 donors, brain-death occurred after cardiac arrest, and in 55 donors brain death was due to other causes. Clinical and laboratory parameters at hospital discharge were similar in the two groups of recipients, as was 1-year post-transplantation survival (75% vs. 83%, NS).

Level LOE2. Neutral to clinical question. Fair evidence. Long-term outcome available but small number of recipients and heterogeneity of the transplant procedures (many different complex intestinal surgeries with or without liver transplantation).