Circulation

ILCOR SCIENTIFIC STATEMENT

Organ Donation After Out-of-Hospital Cardiac Arrest: A Scientific Statement From the International Liaison Committee on Resuscitation

Laurie J. Morrison, MD, MSc, Chair; Claudio Sandroni, MD; Brian Grunau, MD, MHSc; Michael Parr, MBBS; Finlay Macneil, MBBS; Gavin D. Perkins, MD; Mayuki Aibiki, MD, PhD; Eileen Censullo, MBA, RRT; Steve Lin, MD, MSc; Robert W. Neumar, MD, PhD, FAHA; Steven C. Brooks, MD, MHSc, Vice Chair; on behalf of the International Liaison Committee on Resuscitation

AIM OF THE REVIEW: Improving rates of organ donation among patients with out-of-hospital cardiac arrest who do not survive is an opportunity to save countless lives. The objectives of this scientific statement were to do the following: define the opportunity for organ donation among patients with out-of-hospital cardiac arrest; identify challenges and opportunities associated with organ donation by patients with cardiac arrest; identify strategies, including a generic protocol for organ donation after cardiac arrest, to increase the rate and consistency of organ donation from this population; and provide rationale for including organ donation as a key clinical outcome for all future cardiac arrest clinical trials and registries.

METHODS: The scope of this International Liaison Committee on Resuscitation scientific statement was approved by the International Liaison Committee on Resuscitation board and the American Heart Association, posted on ILCOR.org for public comment, and then assigned by section to primary and secondary authors. A unique literature search was completed and updated for each section.

RESULTS: There are a number of defining pathways for patients with out-of-hospital cardiac arrest to become organ donors; however, modifications in the Maastricht classification system need to be made to correctly identify these donors and to report outcomes with consistency. Suggested modifications to the minimum data set for reporting cardiac arrests will increase reporting of organ donation as an important resuscitation outcome. There are a number of challenges with implementing uncontrolled donation after cardiac death protocols, and the greatest impediment is the lack of legislation in most countries to mandate organ donation as the default option. Extracorporeal cardiopulmonary resuscitation has the potential to increase organ donation rates, but more research is needed to derive neuroprognostication rules to guide clinical decision-making about when to stop extracorporeal cardiopulmonary resuscitation and to evaluate cost-effectiveness.

CONCLUSIONS: All health systems should develop, implement, and evaluate protocols designed to optimize organ donation opportunities for patients who have an out-of-hospital cardiac arrest and failed attempts at resuscitation.

Key Words: AHA Scientific Statements ■ heart arrest ■ tissue and organ procurement ■ resuscitation

There is a mismatch between the availability of organs for transplantation and demand.[1] In 2008, almost 60 000 patients were on the waiting list in the European Union for a kidney, liver, heart, or lung, whereas only 25 000 solid-organ transplantations were performed during that year. It was estimated in 2019 that 18 patients died each day while waiting for an organ in Europe.[2] In the United States, 105 800 adults and children were on the waiting list for organ transplantation on January 29, 2023, and every 10 minutes another person is added to the transplantation waiting list.[3]

Although donation from living donors can address some of this demand, contributions from deceased donors are crucial to meet demand. According to 2008

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LAY SUMMARY

Hundreds of thousands of people are on organ transplantation waiting lists around the world because there is a critical shortage of organ donors. One organ donor can provide life-changing vital organs for ≥7 people on the waiting list in optimal conditions. Many countries are participating in efforts to increase organ donation to address this problem.

Cardiac arrest occurs when the heart stops beating unexpectedly. Many patients with this condition do not survive. When this happens, there is an opportunity for cardiac arrest patients to become organ donors and provide the gift of life to others. Sometimes, this opportunity arises soon after cardiac arrest because, despite maximal efforts, the heart cannot be restarted. In other cases, emergency treatment is able to restart the heart, but patients never wake up because the brain was starved of oxygen for too long. Cardiac arrest patients in this situation may have an opportunity to become organ donors after they are declared brain dead, or it has become clear that recovery is not possible.

Numerous barriers and logistical challenges exist to setting up systems that support organ donation after cardiac arrest. This review aims to identify the best ways to help cardiac arrest patients become organ donors after all efforts to save them have been exhausted. The goal of our statement is to make organ donation more accessible for cardiac arrest patients and their families, and ultimately save lives through organ donation for people in need of organs.

data from the Global Observatory on Donation and Transplantation, produced by the World Health Organization (WHO)–Organización Nacional de Trasplantes collaboration from 104 countries representing 90% of the worldwide population, only 46% of kidney transplants originate from living donors and 14.6% of liver transplants originate from living donors. Donation from living donors is not possible for heart, lung, pancreas, or small bowel.

Out-of-hospital cardiac arrest (OHCA) is a time-sensitive, life-threatening emergency. North American and European estimates show the annual incidence of emergency medical services (EMS)–treated OHCA to be 50 to 74 per 100 000 population. With a global population of 7.3 billion, there are likely to be >4 million patients with sudden OHCA annually worldwide.[4]

When patients experience cardiac arrest and do not recover, there are opportunities for several other lives to be saved through organ donation.[5–7] Unfortunately, organ donation after sudden OHCA is uncommon. Data from a single-center study in the United Kingdom suggest that only 39% of patients who did not recover after OHCA were referred for organ donation. Of those who were referred, consent was obtained in only 68%, and 25% actually went on to donate an average of 1.9 organs per patient.[8]

Improving rates of organ donation among patients with OHCA who do not survive is an opportunity to save countless lives. The objectives of this scientific statement were to do the following:

- Define the opportunity for organ donation among patients with OHCA;
- Identify challenges and opportunities associated with organ donation by patients with cardiac arrest;
- Identify strategies, including a generic protocol for organ donation after cardiac arrest, to increase the rate and consistency of organ donation from this population; and
- Provide rationale for including organ donation as a key clinical outcome for all future cardiac arrest clinical trials and registries.

METHODOLOGY

This International Liaison Committee on Resuscitation (ILCOR) scientific statement was approved by the ILCOR board and the American Heart Association. The author group was proposed by the ILCOR board on the basis of ILCOR policy, which considers regional resuscitation council representation, country of origin, expertise, sex, and diversity in the nomination process. The proposed scope of each section was defined by the writing group and posted on ILCOR.org for public comment on October 26, 2018. Email notifications were sent by American Heart Association staff to potentially interested groups and webmasters of a number of international agencies (Supplemental Material). After 11 weeks of opportunity for public comment, there were 1030 visits to the site, 921 page openings, 14 comments by health care professionals, and 2 comments by the lay public (Supplemental Material). Several ILCOR member national resuscitation councils sent the link for public commenting to organizations within their jurisdiction that were deemed to have a stake in organ donation. Each section was assigned primary and secondary authors from the writing group. A unique literature search was completed for each section. Search strategies, search results, and article selection are described in the Supplemental Material. Each section is a narrative review with knowledge gaps, policy suggestions, future directions, and conclusions representing the opinion of the writing group.

DEFINING THE POTENTIAL FOR ORGAN DONATION AFTER CARDIAC ARREST

Defining Pathways for Patients With Cardiac Arrest to Become Organ Donors

The natural clinical pathway of a patient who has had a cardiac arrest through to discharge or death (with or without organ donation) is complex (Figure 1).

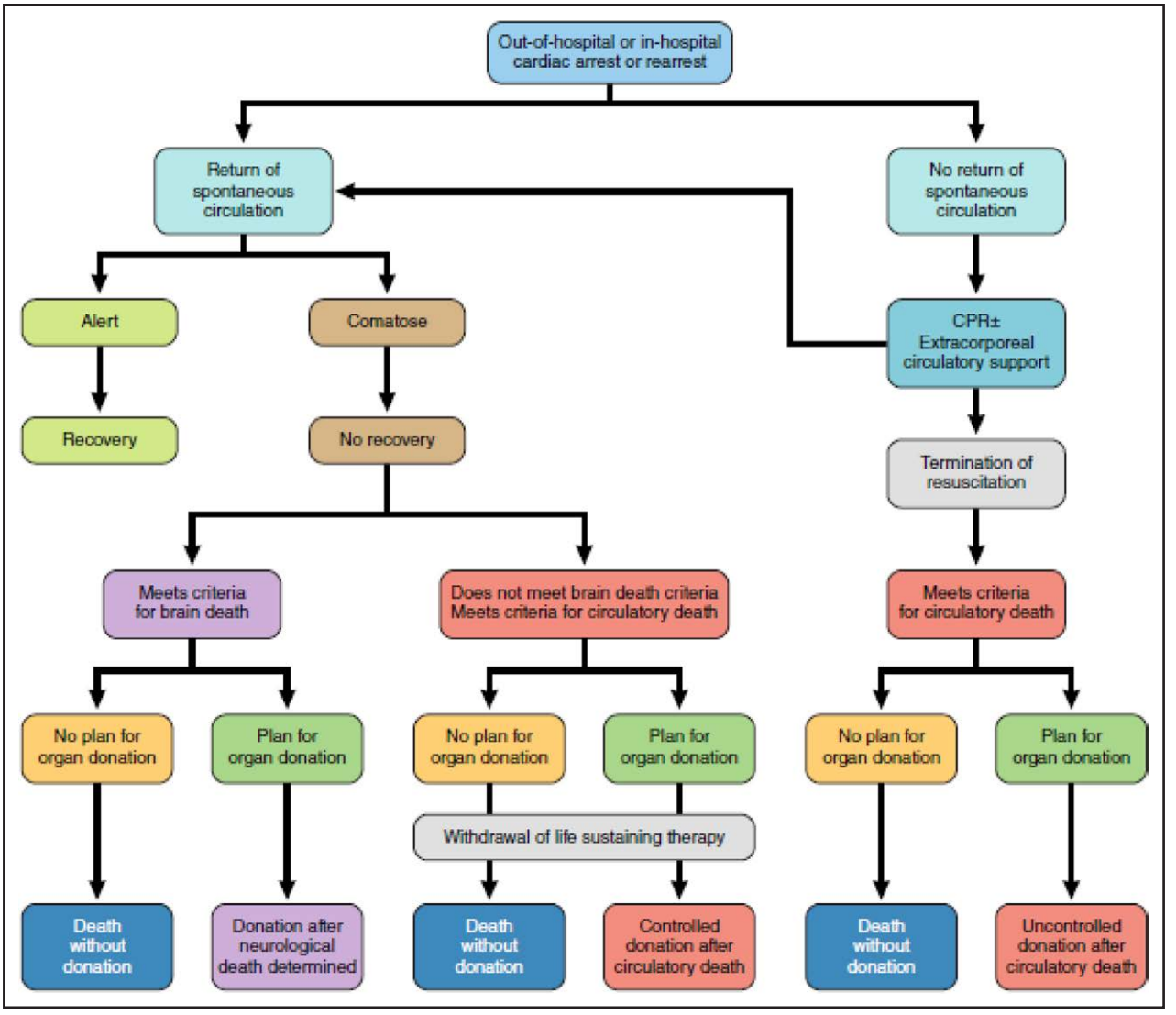

Figure 1. Clinical pathway for out-of-hospital cardiac arrest, in-hospital cardiac arrest, and rearrest.
CPR indicates cardiopulmonary resuscitation.

In the out-of-hospital setting, ≈50% of all patients with cardiac arrest are treated by EMS.[9] Of these, 45% are unwitnessed, and if resuscitation is unsuccessful, they are pronounced dead in the out-of-hospital setting. The other 55% are witnessed by bystanders. Many of these patients with OHCA, both witnessed and unwitnessed, are successfully resuscitated and transported to hospital.

These patients could evolve to have an expected circulatory death in the intensive care unit (ICU) after a failed recovery. Organ donation may occur only after resuscitation attempts have been abandoned and a patient has been declared dead. Death may be declared on the basis of neurological criteria (brain death) or cardiocirculatory criteria (circulatory death).[10,11] The WHO has developed critical pathways for organ donation in adults and children in an effort to address inconsistencies internationally and within countries (Figure 2). It is unclear whether organ donors after cardiac arrest are classified on the basis of their clinical pathway (Figure 1) and clinical and event characteristics such as witnessed status at time of initial arrest, location of arrest, course in hospital, where resuscitation was terminated or where death was declared, or some combination of these clinical and event characteristics. Reporting rates and outcomes of organ donation after cardiac arrest will depend on how donors after cardiac arrest are categorized and labeled within the organ donation critical pathway and nomenclature.

Defining Donation After Brain Death or Neurological Determination of Death

Donation after neurological determination of death (DNDD), or beating-heart donation, occurs when a patient donates organs after brain death has been declared.

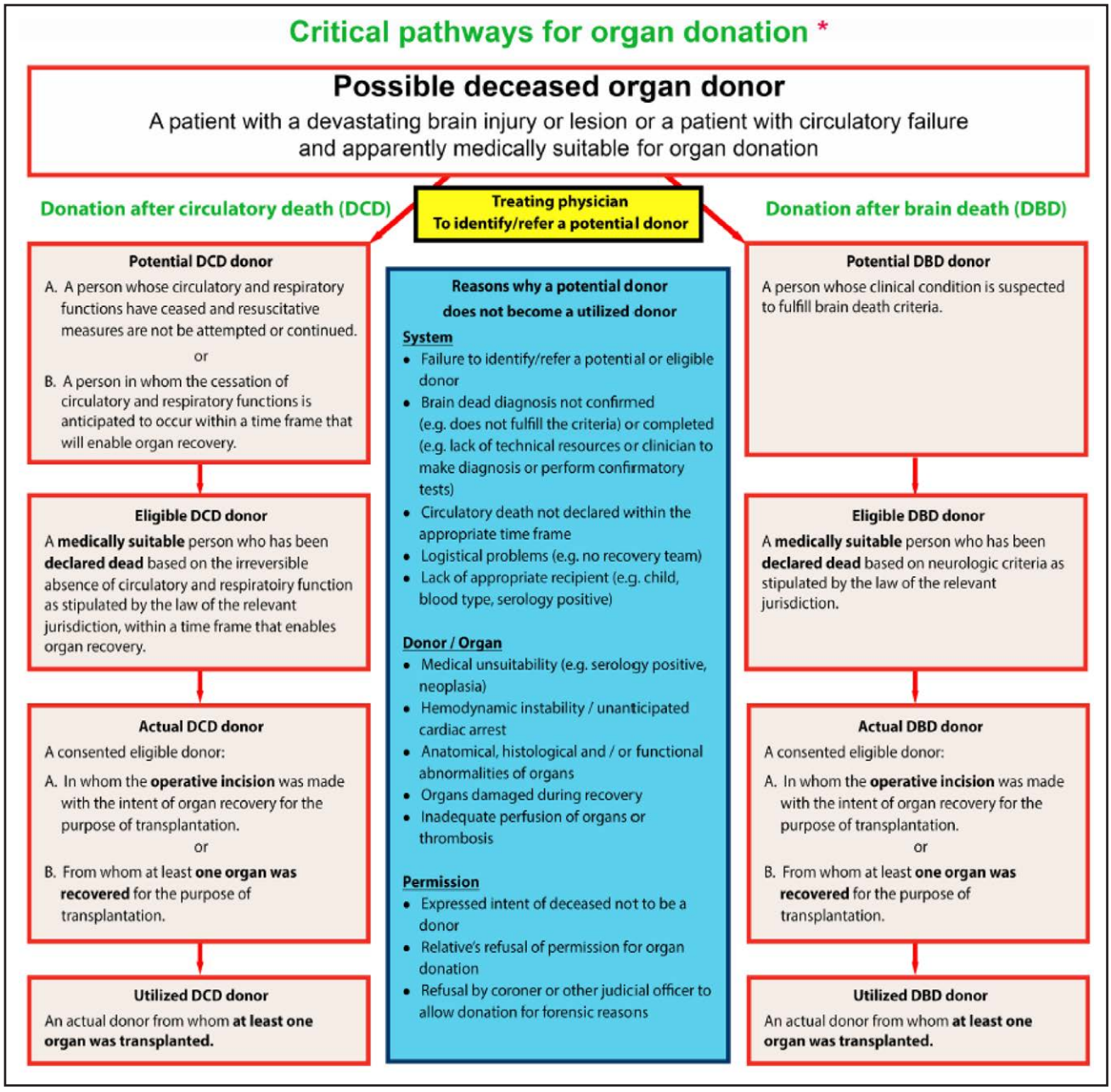

Figure 2. The World Health Organization critical pathways for organ donation.
*The "dead donor rule" must be respected; that is, patients may become donors only after death, and the recovery of organs must not cause a donor's death. DBD indicates donation after brain death; DCD, donation after circulatory death. Reproduced from Domínguez-Gil et al[10] with permission from John Wiley & Sons Inc. Copyright © 2011 European Society for Organ Transplantation.

Brain death is declared after the patient meets stringent criteria determined according to legislation and local standards. The WHO World Brain Death Project defines brain death as the diagnosis and confirmation of death based on the irreversible cessation of functioning of the entire brain, including brainstem, and provides minimum acceptable clinical standards for determination.[12] DNDD can occur with the patient's cardiovascular system intact and functioning. DNDD is the most common type of pathway for organ donation.

Defining Donation After Circulatory Death

Donation after circulatory death (DCD), or non–beating-heart donation, occurs when a patient donates organs after death is declared on the basis of cardiocirculatory criteria. Although practice varies in different countries, the diagnosis of cardiocirculatory death may occur after 5 to 10 minutes of continuously observed absence of pulse, blood pressure, or ventilation. DCD can be further categorized into controlled (cDCD) and uncontrolled (uDCD).

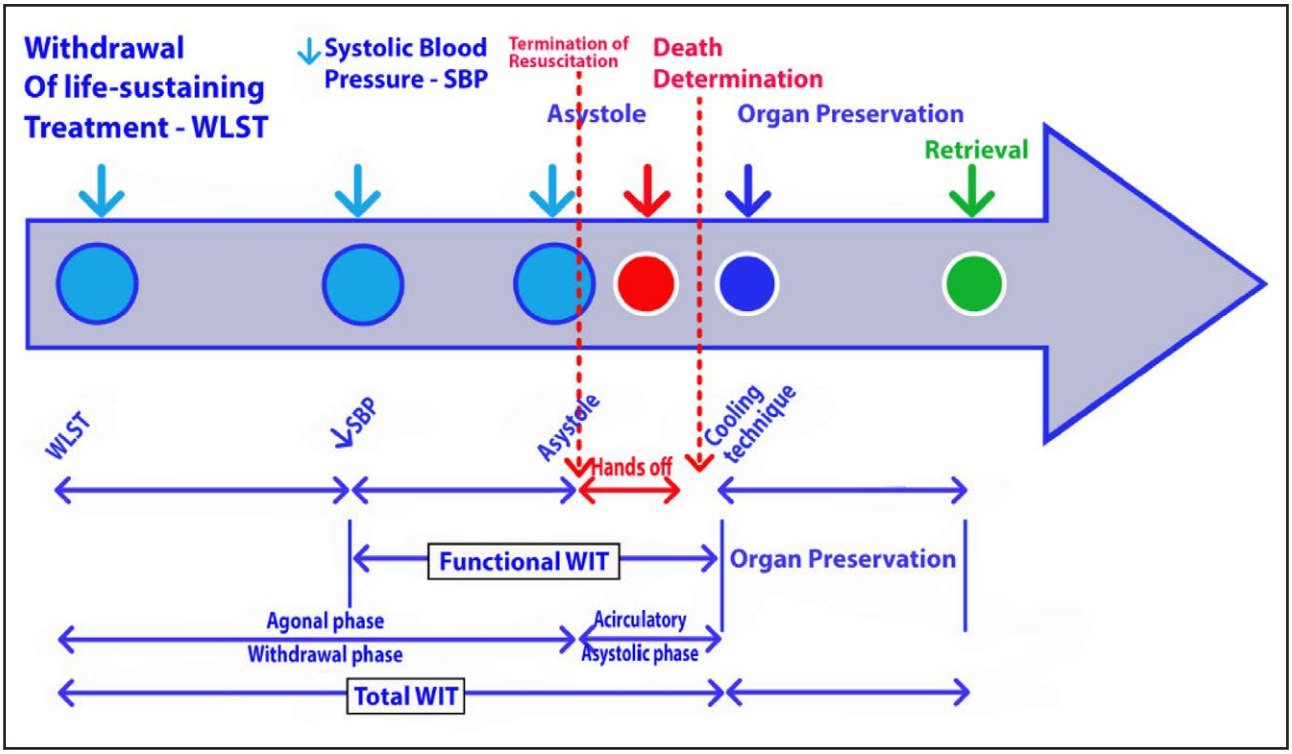

Figure 3. Controlled donation after determination of death process.
Functional warm ischemia time (WIT) starts when systolic blood pressure (SBP) is either ≤50 or ≤60 mm Hg by protocol. WLST indicates withdrawal of life-sustaining therapy. Modified from Thuong et al.[11] Copyright © 2016 Steunstichting ESOT. Published by John Wiley & Sons Ltd.

Defining cDCD

cDCD occurs in a controlled fashion with surgical team assembly before a planned withdrawal of life-sustaining therapy (WLST; eg, mechanical ventilation or extracorporeal circulation). Once criteria for cardiocirculatory death are met and death is determined, organ procurement proceeds (Figure 3).

Defining uDCD

uDCD occurs after an unexpected cardiac arrest. If resuscitative efforts fail for a patient in a region where uDCD is available and the patient is deemed eligible, the uDCD protocol is activated promptly to assemble a surgical team and to prepare for organ procurement. Organ preservation techniques are often implemented (eg, ongoing chest compressions, extracorporeal circulatory support, temperature control, medications) as consent is obtained and the patient is rapidly transported to the surgical team.

Globally, uDCD capability is rare compared with cDCD and DNDD because of the significant logistical challenges and the rapid transition from resuscitation to organ preservation required in these settings (Figure 4). Systems supporting uDCD require personnel and processes to be in place before the candidate patient is recognized so that warm ischemia time can be minimized and organ procurement can occur rapidly once the system is triggered. There are many barriers to uDCD related to logistical, ethical, jurisdictional, procedural, and resource issues.[13]

GLOBAL DCD RATES

Until the establishment of criteria for brain death in 1968, all organ donors were donors after circulatory death.[14] Although most donations worldwide now occur through the DNDD mechanism, DCD has become increasingly common in recent years.[15,16] In some countries, DNDD was not legal or accepted ethically, and thus, until recently, DCD represented the only source for organ donation.[1,17] There is renewed worldwide interest in DCD to increase the supply of organs and tissue for transplantation.[18]

Two studies reported a remarkable increase in the proportion of cDCD donors over time (Table 1).[16,19] However, with few exceptions, DCD still represents a minority of total donations in the world (Figure 5).

DCD is currently practiced in Australia, Canada, Colombia, Israel, Austria, Belgium, France, Italy, Spain, Portugal, Luxembourg, Switzerland, Ireland, the United Kingdom, Poland, Czech, Lithuania, Latvia, the Netherlands,

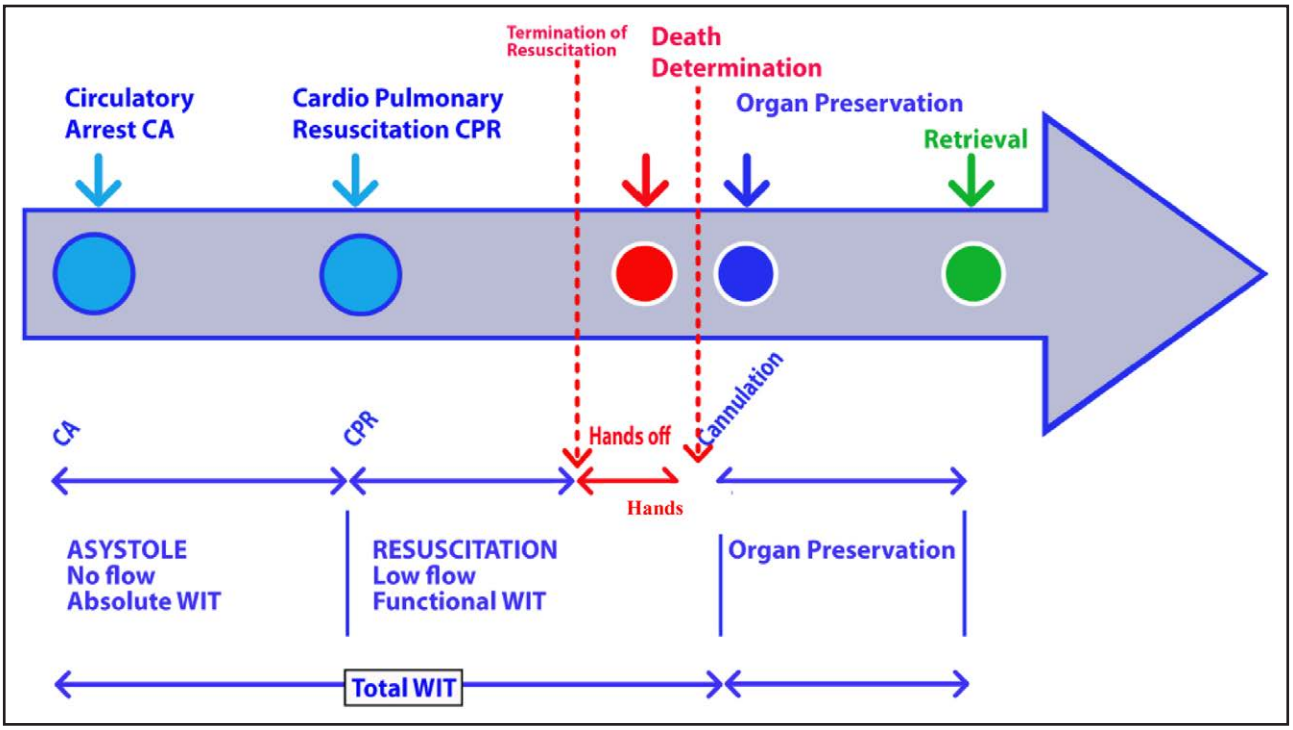

Figure 4. Uncontrolled donation after determination of death process.
CA indicates cardiac arrest; CPR, cardiopulmonary resuscitation; and WIT, warm ischemia time. Modified from Thuong et al.[11] Copyright © 2016 Steunstichting ESOT. Published by John Wiley & Sons Ltd.

Norway, Sweden, Japan, New Zealand, and the United States.[20] In most of these countries, the prevalent donor category is cDCD; however, a growing number (50% of European countries) include both cDCD and uDCD. China launched a pilot program for DCD in March 2011.[21] Russia launched a program for DCD after OHCA in 2017.[22] Algeria, Bolivia, Brazil, Hong Kong SARC, Lebanon, Pakistan, Saudi Arabia, Singapore, and South Korea have reported low rates of DCD donation activity since 2000.[1]

Finding high-quality data on DCD rates among patients who had cardiac arrest as their primary problem is complicated by the fact that data presented in the literature often do not explicitly cite whether the donor had a cardiac arrest and where in the clinical course was circulatory death declared. Often, these events are reported as generic DCD or just cDCD without any other details.

OPPORTUNITIES FOR ORGAN DONATION AFTER CARDIAC ARREST

The natural pathway of a patient who has had a cardiac arrest through to discharge or death can be complex (Figure 1). Patients with OHCA experience neurologically favorable survival in <8% of cases (range, 2%–20%).[23] In most developed countries with an emergency response system and medical directives that allow full resuscitation and pronouncement in the out-of-hospital setting, 50% of individuals with cardiac arrest are pronounced dead in the out-of-hospital setting. Of those transported, 50% live long enough to be admitted to the ICU, and ≈40% of this ICU cohort survive to discharge. Given the overall survival rate of ≈10%[23] across all registries, a large number of patients with cardiac arrest are potential organ donors. The majority succumb to a circulatory death with or without ever regaining

Table 1. Comparison Statistics of International Prevalence of DCD Over Time

Study	Country of origin	Organ(s)	Contemporary DCD fraction of all donors, %	Year(s)	Historical DCD fraction of all donors, %	Historical comparison year(s)
Hosgood and Nicholson,[16] 2013 (n=703)	United Kingdom	Kidney	40.1 (436/1088)	2011–2012	7.9 (61/777)	2002–2003
Israni et al,[19] 2018 (n=434)	United States	Solid organs	15.0 (1498/9979)	2016	6.7 (537/8023)	2006

DCD indicates donation after circulatory death.

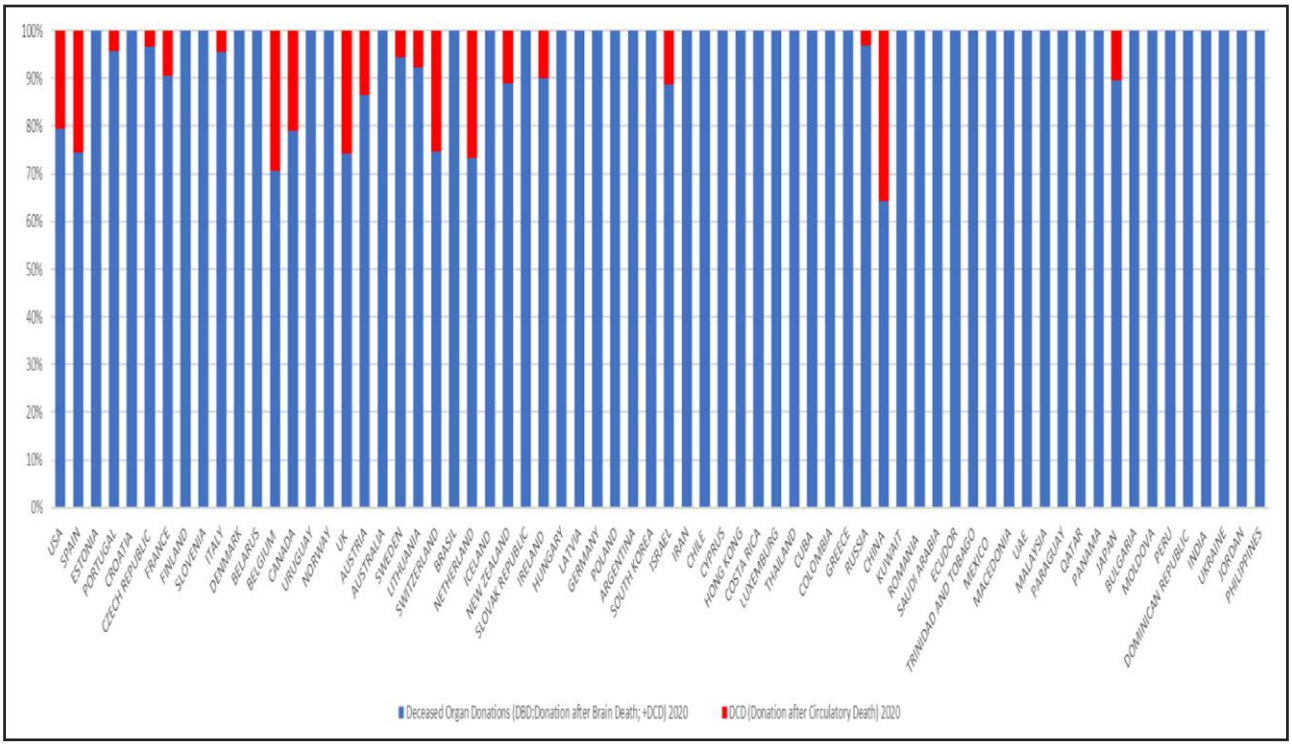

Figure 5. Donor rates after circulatory death as a proportion of all donors by country: 2020 data.
Created by Dr Mayuki Aibiki from data collected from International Registry in Organ Donation and Transplantation, Donation and Transplantation Institute, Barcelona, Spain.[24]

spontaneous circulation or regain circulation only to have life-sustaining therapy withdrawn secondary to extensive neurological injury and a poor prognosis.[25] Brain death determination after cardiac arrest is less frequent. Patients in whom the initial resuscitation is deemed futile are potential uDCD donors.

Patients who arrest in the intensive care setting can potentially donate through the uDCD (sudden rearrest and failed resuscitation), cDCD (expected arrest after WLST), or DNDD (confirmed brain death) pathway, depending on the circumstances of the arrest. There is variability in the mode of death between adult and pediatric cardiac arrest and between in-hospital cardiac arrest (IHCA) and OHCA. The mode of death in the ICU after OHCA is predominantly withdrawal of treatment precipitated by a poor neurological prognosis (potential cDCD or DNDD donor), whereas after IHCA, there is relatively equal chance that the mode of death is withdrawal for poor neurological prognosis (potential cDCD or DNDD donor) or for comorbidity (potential cDCD donor) or alternatively refractory hemodynamic shock (potential cDCD donor); Table 2.

In patients with brain death after cardiac arrest, the diagnosis of brain death is made at a mean of 3 to 6 days after return of spontaneous circulation, which is consistent with the fact that neuronal death occurring after global brain ischemia is typically delayed.[26,27] A comprehensive algorithm for brain death screening after arrest has been suggested[28] (Figure 6).

The overall prevalence of brain death among patients with cardiac arrest who died before hospital discharge is low. In a study of 162 patients who were comatose after resuscitation from cardiac arrest (131 OHCAs and 31 IHCAs) and were treated with targeted temperature management, hypoxic-ischemic brain injury was the most common cause of death (58 of 86 patients, 67%). Among these, 54 died after WLST for poor neurological prognosis, and 4 were diagnosed as brain-dead and became organ donors; the brain-dead rate was 12.6% (10.2%–15.2%).[29] In a systematic review of 26 studies including a total of 23388 adult patients resuscitated from cardiac arrest (mostly OHCA), brain death occurred in only 1830 (7.8%).[30]

Thus, given the clinical pathway of OHCA, the critical pathways for organ donation, the establishment of the determination of death requirements for circulatory and neurological death, and the low survival rates, there is tremendous unrealized potential for organ donation.[5,7] One major impediment to realizing this potential is the inability to accurately report current organ donation rates after OHCA. The current international classification system for organ donation is based on mode of death and location of death. Depending on their clinical course, patients who had a sudden or an expected OHCA can become donors in any of these categories. This means

Table 2. Mode of Death in the ICU After Cardiac Arrest

	Neurological reason for withdrawal of treatment, %	Comorbid withdrawal of treatment, %	Refractory hemodynamic shock, %	Respiratory failure, %	Sudden cardiac death, %
Adult IHCA					
Witten et al,[31] 2019	27	36	25	1	11
Adult OHCA					
Witten et al,[31] 2019*	73	4	17	3	4
Wittwer et al,[32] 2022	71	15	14		
Pediatric OHCA					
Du Pont-Thibodeau et al,[33] 2018	81†		10		9

ICU indicates intensive care unit; IHCA, in-hospital cardiac arrest; and OHCA, out-of-hospital cardiac arrest.
*The adult OHCA data add up to 101% per the original article; a request for clarity from the senior author was not answered.
†Brain death, 47%; withdrawal attributable to neurological prognosis, 34%.

that reporting outcomes after cardiac arrest is subject to categorical bias in how they were labeled.

DCD: THE MAASTRICHT CLASSIFICATION

The Maastricht classification was developed in 1995[34] to better delineate various clinical scenarios that could give rise to DCD. Over time, the original criteria have been subjected to suggested modifications to include new clinically relevant subcategories and to incorporate the practice of medically assisted death[11,35] (Tables 1S and 2S, Section 6.0 in the Supplemental Material).

Maastricht categories I and II describe uDCD. For patients with cardiac arrest, uDCD Maastricht I includes

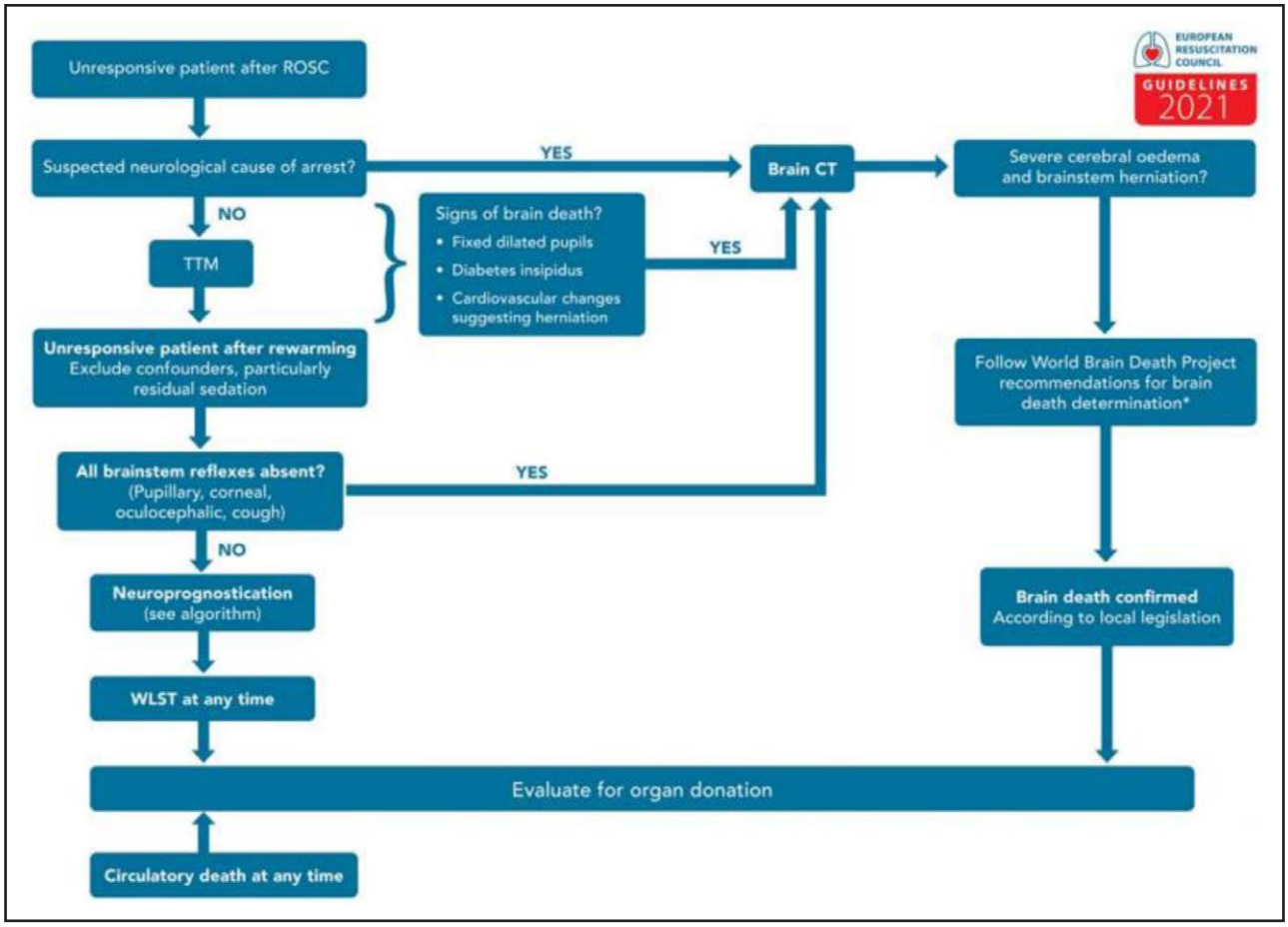

Figure 6. Clinical pathway to brain death determination and organ donation after cardiac arrest.[28]
*Includes a 24-hour observation period after rewarming to 36°C before clinical testing for brain death/death by neurological criteria.[12] CT indicates computed tomography; ROSC, return of spontaneous circulation; TTM, targeted temperature management; and WLST, withdrawal of life-sustaining therapy. Reproduced from Sandroni et al[30] with permission from the authors.

organ donation from patients for whom resuscitation is not attempted; uDCD Maastricht IA refers to an OHCA, and uDCD Maastricht IB refers to IHCA. uDCD Maastricht II describes organ donation from an individual with witnessed cardiac arrest for whom resuscitation was attempted; however, the criteria for termination of resuscitation (TOR) were met, and the patient was declared dead. Similar to uDCD Maastricht I, uDCD Maastricht IIA and IIB refer to OHCA and IHCA, respectively.

cDCD is defined by 3 Maastricht subcategories: III, IV, and V. Maastricht III describes the scenario in which organ donation occurs after further treatment is deemed to be futile, that is, devastating neurological injury or impairment for which the prognosis is poor but the patient does not meet brain death criteria and WLST occurs. Many patients in this category have had a devastating brain injury, through hypoxic ischemia or trauma, and are not expected to make a meaningful neurological recovery.[11] cDCD Maastricht IV describes the scenario in which organ donation is planned and occurs after the patient with OHCA or IHCA has met the brain death criteria; however, the patient had a second unexpected cardiocirculatory arrest before procurement of organs (Tables 1S and 2S, Section 6.0 in the Supplemental Material).

Proposed Modifications to the Maastricht Classification System

The current international classification system for organ donors excludes a large number of potential donors after cardiac arrest and may lead to inconsistent categorical classification in reporting in others. All contemporary Maastricht-based classification systems identified in this review omit the group of patients who experience an unwitnessed cardiac arrest but receive resuscitation attempts. This missing group represents a significant proportion of patients with OHCA (45% of all patients with OHCA).[36] We identify this group as a new subcategory for the Maastricht classification system in our proposal for modification (Table 3).

In addition, patients with both witnessed and unwitnessed cardiac arrest may achieve return of spontaneous circulation and survive long enough for admission to the ICU or may rearrest at any time while in hospital and become cDCD or DNDD donors. However, only witnessed arrests are included and classified in contemporary Maastricht categories for those who experience cardiac arrest in the out-of-hospital setting. This restrictive categorization ignores the potential for tissue donation and non–heart-beating lung donations from this population. It also means that it is expensive and daunting to put into place a system to identify potential donors from patients with cardiac arrest that is useful for only a select few eligible patients. Two pilot projects in Philadelphia and New York City demonstrated that few eligible patients with cardiac arrest were identified in the out-of-hospital setting as suitable for consideration for organ donation when the eligibility criteria were restrictive.[37]

It is also a concern that patients with OHCA who survive to hospital admission and then rearrest and become eligible for cDCD are coded in the current Maastricht classification system as having IHCA when in fact they have now had 2 cardiac arrests (1 OHCA and 1 IHCA) and thus may have a significantly longer period of combined ischemia and asphyxia. If they are all coded as having IHCA, it may significantly bias the assessment of organ outcomes after donation with this classification system. To report them separately would allow more precise delineation of these common clinical scenarios and provide more accurate insights into donation through these pathways. We propose a modification of the Maastricht classification that merges the 2012 and 2016 versions (Tables 1S and 2S, Section 6.0 in the Supplemental Material) while accounting for all clinically relevant subgroups of patients with cardiac arrest. This will facilitate a more comprehensive understanding of how patients who experience cardiac arrest may ultimately become organ donors, aid in knowledge translation efforts aimed at clinicians caring for these patients, and support future research efforts to track and quantify organ donation among all patients who had cardiac arrest (Figure 1 and Table 3).

PUBLISHED ORGAN DONOR RATES AFTER CARDIAC ARREST

Given the aforementioned limitations attributable to classification errors and misalignment between the critical pathway of organ donation and the clinical pathway of OHCA, it is not surprising that published data on observed versus potential donation rates after OHCA are sparse. Therefore, we have reported donor rates after sudden versus expected cardiac arrest and where we could find data, including data specific to donors after OHCA for all Maastricht categories.

Published Donor Rates After Neurological Determination of Death From Cardiac Arrest

Observational studies[38–40] and a systematic review[41] showed that patients brain-dead after resuscitation from cardiac arrest are suitable as organ donors, despite the severity of global hypoxic-ischemic injury leading to brain death. In 1 of these studies[38] of 246 patients resuscitated from OHCA, 40 (16%) developed brain death. Of these, 19 (48%) donated 52 organs (29 kidneys, 14 livers, 7 hearts, and 2 lungs). The overall rate of organ donation among brain-dead patients, reported in 9 of the 26 studies (1264 patients) included in a systematic review, was 41.8% (20.2%–51.0%).[30] An algorithm for brain death screening after cardiac arrest was proposed (Figure 6).

Table 3. ILCOR Proposed Modifications to the Maastricht Classification

Category	Definition	Location of event	Proposed modifications to the Maastricht classification system	Potential outcomes
uDCD Maastricht I	Unwitnessed cardiac arrest	OHCA or IHCA	IA: Unwitnessed cardiac arrest for which resuscitation was not attempted because the patient met the criteria for obvious death* or confirmed advance directive, and cardiocirculatory death is determined† IB: Unwitnessed cardiac arrest for which resuscitation was attempted and terminated because the patient met criteria for obvious death or had confirmed do-not-resuscitate advance directive documented, and cardiocirculatory death is determined† IC: Unwitnessed cardiac arrest for which resuscitation was attempted, exhausted, and terminated on the basis of clinical decision rules‡ or medical directive that defines futility, and cardiocirculatory death is determined†	IA: No ROSC–tissue donation IB: No ROSC–tissue donation IC: No ROSC–tissue, multiorgan through uDCD and nonperfusing lung donation
uDCD Maastricht II	Witnessed cardiac arrest	OHCA or IHCA	IIA: Witnessed cardiac arrest for which resuscitation was not attempted because the patient had a confirmed do-not-resuscitate advance directive documented, and cardiocirculatory death is determined† IIB: Witnessed cardiac arrest for which resuscitation was attempted and terminated because the patient had a confirmed do-not-resuscitate advance directive documented, and cardiocirculatory death is determined† IIC: Witnessed unexpected cardiac arrest in any setting and resuscitation was attempted and terminated on the basis of clinical decision rules‡ or medical directive that defines futility, and cardiocirculatory death is determined†	IIA: No ROSC–tissue donation IIB: No ROSC–tissue donation IIC: No ROSC–tissue, multiorgan donation through uDCD and nonperfusing lung donation
cDCD Maastricht III	Cardiac arrest after WLST	IHCA	IIIA: Circulation becomes not physiologically sustainable and considered futile, WLST occurs anywhere, and cardiac arrest occurs before the initiation of a planned organ procurement procedure IIIB: Resuscitated patient with cardiac arrest with ROSC and poor neurological prognosis after arrest who does not meet brain death criteria, circulation is sustainable, WLST occurs after consent or procurement team is ready, and cardiocirculatory death is determined† within an acceptable time interval§	IIIA: Tissue, multiorgan donation through uDCD and nonperfusing lung donation IIIB: Tissue, multiorgan donation through cDCD
uDCD Maastricht IV	Cardiac arrest after brain death determination but before planned organ procurement	IHCA	Unexpected cardiac arrest occurs after a diagnosis of brain death but before initiation of a planned organ procurement procedure, and cardiocirculatory death is determined†	Tissue, multiorgan donation through uDCD and nonperfusing lung donation
cDCD Maastricht V	Planned organ procurement to occur after medically assisted death	OHCA or IHCA	Cardiocirculatory death is determined† after medically assisted death	Tissue, multiorgan donation through cDCD and nonperfusing lung donation

cDCD indicates controlled donation after circulatory death; IHCA, in-hospital cardiac arrest; ILCOR, International Liaison Committee on Resuscitation; OHCA, out-of-hospital cardiac arrest; ROSC, return of spontaneous circulation; uDCD, uncontrolled donation after cardiocirculatory death; and WLST, withdrawal of life-sustaining therapy.

*"Obvious death" is defined by local legislation and may include text such as rigor mortis, transection, decapitation, lividity, and decomposition.

†The World Health Organization definition for determination of circulatory death is the absence of any circulatory function after a hands-off time interval of 2 to 5 minutes without any preceding resuscitation (cardiopulmonary resuscitation [CPR]) or 7 minutes when preceded by any resuscitation (CPR).[42]

‡A validated clinical decision rule exists for adult OHCA termination of resuscitation for which the cause is presumed to be cardiac or not obvious and the system of care is advanced or basic life support paramedics with online medical control in developed countries.[43–45] Published validated clinical decision rules do not exist to guide termination of resuscitation for pediatric cardiac arrests, adult IHCA of any origin, adult OHCA for which the cause is known (ie, trauma, drowning, drug overdose, inhalation asphyxia), or in EMS systems of care that configured differently from the population in which the clinical decision rule was validated. The default approach in these situations is local policy or a medical directive.[46]

§All patients may rearrest, and the location and timing of their rearrest and where resuscitation is terminated may eventually affect their classification as a donor. Maastricht III classification type IIIB is usually defined as circulatory death within 120 minutes of WLST. Usually 2 hours is the maximum time interval, and this time interval varies on the basis of type of organ and organ preservation and local implantation strategy.

Potential Donor Rates After Neurological Determination of Death From Cardiac Arrest

According to the latest report from CARES (Cardiac Arrest Registry to Enhance Survival), including data from 28 statewide registries and 45 additional communities in 14 states and covering a catchment area of 152 million people in the United States (46% of the total population), a total of 100 782 adults with nontraumatic OHCA were resuscitated by EMS in 2019. Of those patients, 28 173 (28%) survived to hospital admission, and 10 641 (10.6%) survived to discharge.[47]

According to a systematic review, an estimated 5.4% (n=1521) of those who survived to hospital admission may have developed brain death.[30] Using the 41.8% rate of organ donation observed in a systematic review,[30] we could expect that ≈636 patients in the CARES cohort could have donated organs in 2019. Applying this rate to the entire US population, we estimate a potential for 1383 organ donors annually through DNDD after OHCA.

Published Donor Rates After Circulatory Determination of Death (All Subcategories of DCD) After Cardiac Arrest

According to a survey conducted in 2011 by the European Committee on Organ Transplantation within the Council of Europe,[10] among the total 538 DCDs reported during 2008 in the Council of Europe, 137 (25.5%) were uDCD Maastricht I and II donors, and 401 (74.5%) were cDCD Maastricht III donors; no cDCD Maastricht IV donors were reported. The majority of uDCD Maastricht I and II donors are attributed to France and Spain.[15] Ninety percent of these donors experienced OHCA. uDCD Maastricht I and II organ donation programs started in the 1980s in Spain and the Netherlands and began in 2006 in France. In Spain, DCD was almost entirely uncontrolled until recent years. From 2001 to 2016, a total of 1430 uDCD Maastricht II donors (presumably OHCA) were reported, and their number has increased steadily from 17 in 2001 to 138 in 2012. Starting from that year, a growing number of controlled (cDCD Maastricht III) donors were registered. In 2015, for the first time, the yearly number of cDCD Maastricht III donors in Spain exceeded that of uDCD Maastricht II donors (210 versus 104, respectively).[48] In a retrospective analysis of 63 417 ICU admissions after cardiac arrest between 2004 and 2014 in British hospitals, a consistent increase in solid-organ donors among nonsurvivors was observed, especially for OHCA (from 3.1% to 10.1%).[49] The authors estimated that those admitted to an ICU after OHCA accounted for at least 25% of the deceased solid-organ donors in the United Kingdom.

According to the potential clinical course of cardiac arrest, donors after circulatory death from cardiac arrest could be classified as Maastricht I to IV. The rates of recruitment and the transplantation outcomes for the recipients may not be the same across all Maastricht categories.

Potential Donor Rates From Patients With Cardiac Arrest Through uDCD (Maastricht I and II)

It is important to keep in mind that all published potential donor rates using the current Maastricht classification ignore the large number of OHCAs that are unwitnessed (45% of all arrests)[36] and report only potential donor rates from OHCAs that are not resuscitated or witnessed arrests.

Potential donor rate estimates depend on inclusion criteria, implementation strategies, and limitations of the Maastricht classification. To illustrate this, we provide 2 national estimates for Maastricht IIA organ donors. In a retrospective analysis of the nationwide OHSCAR (Out-of-Hospital Spanish Cardiac Arrest Registry), data on deceased patients with OHCA in Spain for 13 months (October 1, 2013–October 31, 2014) were included. Inclusion criteria for uDCD Maastricht IIA were 16 to 60 years of age, witnessed OHCA, no return of spontaneous circulation, and time interval <15 minutes between OHCA occurrence and cardiopulmonary resuscitation (CPR) initiation (no-flow time). Of the 3544 reported patients with OHCAs in the registry, 181 (5.1%) fulfilled all the inclusion criteria and could have been considered for uDCD. An additional group of 154 patients fulfilled inclusion age and witnessed status criteria, but no-flow time was not recorded, which resulted in a loss of potential donors. Ultimately, the actual number of patients with OHCA who became uDCD Maastricht IIA donors was 141 (4%).[50] Reed and Lua[51] retrospectively screened all patients who had an OHCA in the Lothian region of Scotland between August 1, 2008, and September 30, 2009, to identify the patients who might have been potential uDCDs Maastricht IIA donors. Inclusion criteria were 16 to 60 years of age, witnessed arrest, paramedic arrival on scene in ≤15 minutes, death of the patient in the emergency department (ED) after unsuccessful resuscitation, downtime of <2 hours, registration of the patient on the organ donor registry, and patient arrival in the ED between 9 AM and 5 PM on weekdays. Among 564 patients with OHCA, only 4 (0.7%) would have been eligible. The difference between the 2 estimates may be attributed to opt-out (Spain) versus donor registration (Scotland) and an implementation restriction in Scotland that organ donation could be considered only if the OHCA occurred during weekday daytime hours.

Published Organ Donation Rates From Patients With Cardiac Arrest Through cDCD (Maastricht III and IV)

Three observational studies that follow from the United States and the United Kingdom suggest that it is possible to extrapolate from cardiac arrest data sets that are modified to collect organ donation variables to estimate the potential for organ donor rates after cardiac arrest. It serves to demonstrate that organ donation after cardiac arrest is feasible, but there are many missed opportunities to do so.[8,40,52]

A study on cDCD Maastricht IIIA and IIIB after cardiac arrest conducted in a regional cardiac arrest and transplantation center in the United States[52] reported that among 991 patients admitted between 2005 and 2011 (91% after OHCA), 560 did not survive to hospital discharge (57%). Of these, 530 (94.6%) were referred to the organ procurement organization, and 389 (73%; 259 OHCAs, 67%) were considered potential donors. Of those considered, 243 were not suitable, mainly because of comorbidities, and 71 families refused donation, leaving 75 (13%) with organs procured. The overall yield was 1.8 solid organs and 1.3 eyes per donor, and the majority were transplanted. In addition, tissue was procured from 38 patients.

Table 4. Modifications to the Utstein Template

Mandatory or core variables for organ donation after cardiac arrest		Optional variables for organ donation after cardiac arrest
Variable	**Responses**	
Organ donor	Yes/no	For each organ procured, report outcomes as: Sex of recipient Age of recipient Recipient survival at 1 y Graft survival at 1 y Primary nonfunction* Delayed graft function*
DNDD or DCD	Select either category	
If DCD	Select Maastricht level I–V according to Maastricht table	
No. of organs procured per donor	Insert number	
Organs procured	Select all that apply: Lung (1) only Lungs (2) only Heart only Kidney (1) only Kidneys (2) only Liver only Pancreas only Small bowel only Kidney and pancreas Kidney and liver Other combination–text field	
Tissue donor	Yes/no	

DCD indicates donation after cardiocirculatory death; and DNDD, donation after neurological determination of death.
*Reported at standard time frame customary for the organ of interest.

In a retrospective audit of 514 patients with OHCA admitted to a UK regional cardiac arrest center ICU, 273 died, of whom 106 (39%) were referred to a specialist nurse for organ donation, 58 (21%) had family consent to proceed, 39 (14%) were deemed eligible, and 25 (9%) successfully donated.[8] Of these, 9 (3%) were DNDD and 14 (5%) were cDCD; the mechanism of death was not specified for 2 of them. The study could not assess why 61% of patients were not referred to the specialist nurse for organ donation. A recent large UK study suggested that referral to the donation nurse specialist was the single most readily modifiable factor that could improve the consent rate beyond 67% in 2019.[53]

In another study,[40] of 100 patients resuscitated from OHCA and admitted to the ICU of the Leeds General Infirmary, 53 (53%) did not survive to hospital discharge. Among these patients, 13 (25%) had a second arrest in the ICU and were not considered for donation, 3 (6%) died outside the ICU, and 1 (2%) became a DNDD. The remaining 36 patients (68%) had treatment withdrawn, and 29 (55%) were referred to the organ donation program as potential cDCD Maastricht III donors. Among these, 14 (26%) were deemed medically suitable, and the family gave consent in 7 (13%). Of these 7 patients, 1 went on to donate (2% of the original 53 nonsurvivors).[40]

MODIFICATIONS TO THE UTSTEIN TEMPLATE

Extrapolation from existing cardiac arrest registries to estimate the potential of organ donation after cardiac arrest is currently not possible because the data related to organ donation are not routinely collected or classified in a way that is compatible with the Utstein reporting templates for cardiac arrest. Moreover, organ donation variables are not defined or mandated in the current Utstein reporting template for cardiac arrest.[54] Clinical trials and registries in cardiac arrest are based in part on this reporting template. Making changes to the template would increase capture of consistent data related to organ donation after cardiac arrest (Table 4). The UK PARAMEDIC2 randomized trial (Prehospital Assessment of the Role of Adrenaline: Measuring the Effectiveness of Drug Administration in Cardiac Arrest) comparing epinephrine with placebo in OHCA recently published reporting organ donation metrics, setting a precedent for future trials.[55]

OVERVIEW OF THE CHALLENGES AFFECTING REPORTING OF TRANSPLANTATION OUTCOMES AFTER CARDIAC ARREST

Transplantation outcomes such as graft viability after cardiac arrest are affected by misclassification errors, similar to donor rates. Therefore, we have reported transplantation outcomes after cardiac arrest by Maastricht category in the section that follows. When we could find data specific to OHCA, this is identified by Maastricht category. The modifications we are suggesting for the Maastricht classification and the Utstein template should address inconsistencies and gaps in reporting.

Organs Transplanted Per Donor for cDCD Maastricht III

The number of organs transplanted per donor is generally lower for cDCD Maastricht III compared with DNDD.

This observed difference is attributed to longer warm ischemia time intervals in cDCD donors. For example, during 2012 and 2013 in Belgium, the average was 3.4 organs per donor for DNDD compared with 2.6 organs per donor for cDCD Maastricht III.[56] This difference is not observed across all organs. For example, among a cohort of 8287 DNDD and 1684 cDCD Maastricht III donors, the number of organs transplanted per donor (all organs) was 3.29 and 1.93, respectively[19]; however, when only kidneys were compared, the organs transplanted per donor for kidneys was higher in cDCDs than in DNDDs (1.55 versus 1.43, respectively). We did not identify any estimates for organs transplanted per donor from cohorts of patients with cardiac arrest undergoing uDCD Maastricht III donation.

Outcomes for Kidneys Transplanted From Donors After Cardiac Arrest

Kidneys transplanted from uDCDs (Maastricht II) generally have higher rates of primary nonfunction and delayed graft function compared with those from DNDDs; medium- and long-term graft survival rates are comparable.[15,57–60] However, an ICU study of cardiac deaths comparing outcomes of 128 uDCD Maastricht II and 208 cDCD Maastricht III donors[61] suggested that outcome rates were also comparable. The incidences of primary nonfunction and delayed graft function were similar (22% versus 21% and 61% versus 56%, uncontrolled versus controlled, respectively; P=0.43) The estimated glomerular filtration rate after 1 year (40±16 mL/min per 1.73 m^2 versus 42±19 mL/min per 1.73 m^2 [P=0.55]) and the 10-year graft survival rates (50% versus 46%; [P=0.74]) were similar. We did not identify any estimates for transplanted kidney outcomes from uDCD Maastricht I donors or cDCD Maastricht IV donors after cardiac arrest.

Outcomes for Livers Transplanted From Donors After Cardiac Arrest

Results from well-established transplantation programs show that liver donation from uDCDs Maastricht II is possible, although outcomes are less favorable than for kidney transplantation. In a study from Fondevila et al[62] of 400 potential uDCD Maastricht IIA donors in Spain, 34 (9%) liver transplantations were performed, whereas 236 (59%) and 130 (32%) livers were turned down for absolute and relative contraindications, respectively. One-year recipient survival was 82% and graft survival was 70% with a median follow-up of 24 months. In a prospective case-control study of 60 adult liver recipients (20 from uDCD Maastricht II donors, 40 from DNDDs),[63] the rate of primary nonfunction was 10% (n=2) in uDCD Maastricht II recipients compared with 2.5% (n=1) in DNDD recipients (P=0.21), with graft loss in all of them. One-year cumulative patient survival was 85.5% for uDCD compared with 87.5% for DNDD (P=0.768). We did not identify any estimates for transplanted liver outcomes from uDCD Maastricht I donors or cDCD Maastricht III or IV donors after cardiac arrest.

Outcomes for Pancreas Transplanted From Donors After Cardiac Arrest

We did not identify any estimates for transplanted pancreas outcomes from uDCD Maastricht I donors or cDCD Maastricht III or IV donors after cardiac arrest.

Outcomes for Lungs Transplanted From Donors After Cardiac Arrest

Results of lung transplantation are still limited but encouraging. In a systematic review published in 2015[64] of 11 retrospective observational studies, no differences were found in 1-year mortality after lung transplantation between DCD (uDCD Maastricht II [2 studies] and cDCD Maastricht III [9 studies]) and DNDD cohorts in individual studies or in 6 of 11 studies that met the inclusion criteria for a meta-analysis (DCD [n=271] versus DNDD [n=2369]; relative risk, 0.88 [95% CI, 0.59–1.31]; P=0.52). In 5 studies, the risk of primary graft dysfunction was also not significantly different between the DCD and DNDD cohorts (relative risk, 1.09 [95% CI, 0.68–1.73]; P=0.7). Nine of the 11 studies reported only cDCD Maastricht III donors, and it was not possible to tease out the rates for donors after cardiac arrest. Of the remaining 2 studies, 1 included uDCD Maastricht IIA donors.[65] The study was conducted in Spain between 2002 and 2009 and included 29 patients with OHCA. The overall prevalence of primary graft dysfunction was 73% and hospital survival was 83%. In terms of overall survival, the 3-month survival rate was 78%, 1-year rate was 68%, 2-year rate was 57%, and 5-year rate was 51%. No comparison with a DNDD population was made. The first North American study of lung transplantations from uDCD Maastricht IIA donors referred from the ED or ICU was published in 2020. Of the 147 referrals, 44 were approached; of these, 16 organs were recovered. Of these, 5 were transplanted. Four of the 5 recipients were alive at a median of 269 days after transplantation, and 2 of 5 had primary graft dysfunction at 72 hours.[66] We did not identify any estimates for transplanted lung outcomes from uDCD Maastricht I donors or cDCD Maastricht IV donors after cardiac arrest.

REALIZING THE POTENTIAL THROUGH IMPLEMENTATION

Challenges With Deriving uDCD Protocols

Inclusion Criteria

Eligibility criteria for uDCD are not well established. The most commonly used are based on age, witnessed status, and duration of no flow (from collapse to start of

Table 5. Inclusion and Exclusion Criteria for uDCD

Inclusion
Lower age limit varies by nation for the age of consent
Upper age limit is 60 y
Any cardiac arrest for which cause of death is unlikely to be attributed to an obvious cause on the exclusion list according to the information at the time of decision making
No-flow time from emergency call or witnessed arrest to EMS-initiated CPR is <15 min
Transport time to hospital is <90 min from EMS-initiated CPR start time
Registered as an organ donor (where applicable)
Exclusion
Cause of arrest is trauma or sustained profound environmental hypothermia
Registered as opted out of organ donation (where applicable)
Any active hematological malignancy
Any cancer with evidence of spread outside affected organ within 3 y
History of melanoma or choriocarcinoma
Active infection (eg, tuberculosis, HIV disease, hepatitis, COVID-19)
Neurodegenerative disease associated with infectious agents (eg, prion disease)
Liver disease (cirrhosis and portal vein thrombosis)
Kidney disease
Prior transplant recipient

COVID-19 indicates coronavirus disease 2019; CPR, cardiopulmonary resuscitation; EMS, emergency medical services; and uDCD, uncontrolled donation after circulatory death.

CPR) or low flow (from start of CPR to time when CPR is stopped). Some causes of arrest such as trauma, intoxication, or sustained prolonged environmental hypothermia are excluded from DCD programs; however, some exceptions exist. Comorbidities such as malignancy, infection, or specific organ disease are contraindications for donation. In a survey conducted in 2016 by Domínguez-Gil et al,[15] the practice of uDCD among the European countries with the highest activity (Spain, France, and the Netherlands) was investigated. Results showed important differences in the selection and inclusion criteria for donors, as well as in the regulatory and legal framework of uDCD practice.[15] Last, in countries where an organ donor register exists, presence of the patient with cardiac arrest in the register may be a prerequisite. The Supplemental Material contains a summary table of published inclusion and exclusion criteria. There are numerous criteria listed and some common trends across all protocols, but validation studies comparing protocol criteria with a high likelihood of successful organ procurement and comparable organ outcomes are lacking.

We have derived a generic set of inclusion criteria based on published reports of uDCD programs for consideration when developing a local uDCD protocol (Table 5). These criteria are not directly supported by evidence; rather, this list reflects a summary of established programs reported in the literature. Future research is required to validate inclusion and exclusion criteria to ensure that the practice is considered when the probability of procuring viable organs for successful transplantation is reasonable.

Implementation Challenges With uDCD Programs

In addition to donor suitability, there are technical and organizational difficulties and ethical and legal constraints that may pose challenges to the implementation of a successful uDCD program. Few countries have published protocols in place to procure organs through uDCD.[15,67,68] There are several ethical and logistical issues associated with each step, which are managed differently across jurisdictions where programs exist.[69,70] In the next section, we present a generic uDCD protocol adapted from Ortega-Deballon et al[71] for patients after cardiac arrest to highlight key implementation issues for each step and how they are managed in jurisdictions around the world where uDCD is occurring (Figure 7).

BASIC PROTOCOL STEPS FOR UDCD MAASTRICHT I AND II

Step 1: Determining Conditions for Withholding Resuscitation or TOR in Refractory Cardiac Arrest

Consideration for uDCD can be made only after resuscitation efforts have been determined to be inappropriate or futile. EMS personnel are not required to initiate resuscitation when criteria for obvious death are met or a do-not-resuscitate directive for the patient is present. Criteria for obvious death include decapitation, transection, obvious decomposition, or the presence of rigor mortis. Patients with obvious death are not eligible for uDCD.

Among patients who have resuscitation attempted, some will experience refractory cardiac arrest. The process of deciding when to terminate resuscitation attempts on the basis of futility is variable across different jurisdictions. In some settings, TOR for adult patients with OHCA may be guided by the use of validated TOR clinical decision rules; however, these have been validated only in North American paramedic-based systems with online medical control.[43–45] In other settings, TOR is at the discretion of the treating clinician or online medical support, and the lack of consistency has been well documented.[72] When a program of organ donation after OHCA is being implemented, the transition from TOR to organ preservation is best if done in an evidence-based way rather than relying on discretion.

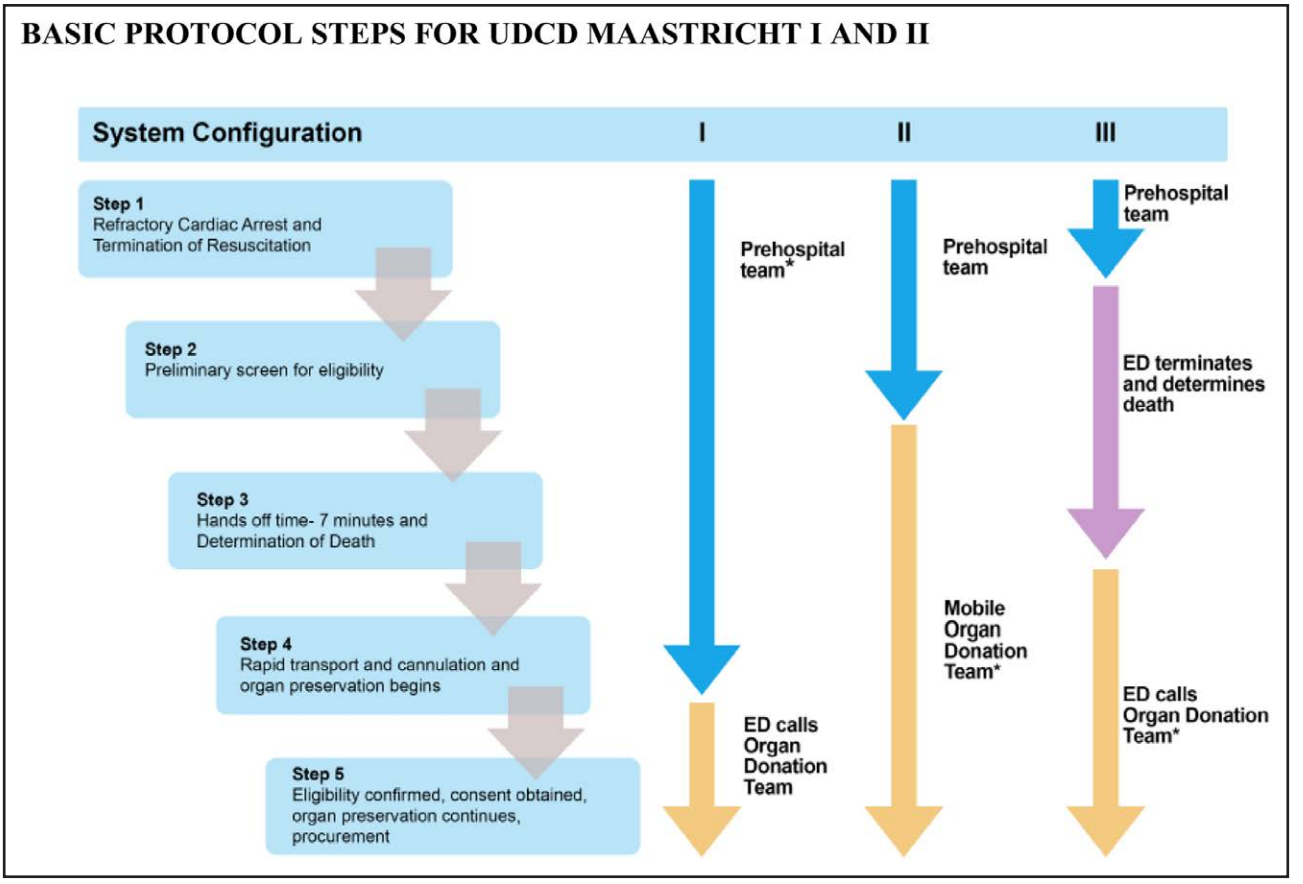

Figure 7. Basic protocol steps for uncontrolled DCD Maastricht I and II.
*With opt-out or organ donation registry accessible 24/7. DCD indicates donation after circulatory death; and ED, emergency department. Based on data from Ortega-Deballon et al.[71]

System Configurations to Achieve Steps 2 Through 4

For organ transplantation to be successful, the warm ischemia time between circulatory arrest and retrieval of the organs must be as short as possible. Thus, there is the potential for conflict between limiting resuscitative efforts prematurely and transitioning to a plan of organ donation to procure organs and potentially save the lives of others and further resuscitation, which may actually save the patient. These competing priorities present a potential conflict of interest between practitioners trying to preserve life and those hoping to preserve organs for procurement. This conflict is best addressed by using 2 separate teams to do these tasks, and the procurement team should be allowed to undertake any procedures only once the resuscitation team has determined death (preferably by using established standardized guidelines) and transferred care.[73,74] It is challenging to implement 2 separate teams in the prehospital setting.

System Configuration 1: Single Prehospital Team Providing Resuscitation and Transitioning to Organ Preservation

A body of literature from European systems guides this approach. A systematic review identified guidelines in Spain, France, and Italy operating within a system of opt-out consent for organ donation and opt-out registration whereby, in each protocol, next of kin were informed in the out-of-hospital setting and organ preservation was initiated en route to the hospital. These prehospital systems of care use the Franco-German approach to staffing ambulances: paramedics providing basic life support and physicians providing advanced life support. Thus, in these uDCD programs, prehospital determination of death is completed by an on-scene EMS physician, with implementation of organ preservation strategies and rapid transport to the hospital for organ procurement.[71]

In other jurisdictions where opt-out consent is not used, a single-team strategy could be deployed if dispatch linked the prehospital practitioners with a 24/7 on-call organ donation coordinator to check for documentation of organ donor predetermination, that is, registration in an organ donor registry as a donor or as a nondonor and compliance with local established criteria for organ donation, using information acquired in the prehospital setting. This would be a preliminary screen because the data collected in the prehospital setting may not be accurate. A secondary, more definitive screen could occur on arrival in the ED under the direction of the organ donation team. If the patient fulfills the preliminary

criteria for organ donation, the initiation of organ preservation measures could be considered on the basis of local protocols, availability of technology, and the specific organs being targeted for donation. This would require fulsome community engagement in donor registration.

Some centers are capable of facilitating nonperfusing lung transplantation, which requires only intubation and oxygenation of the potential donor with prone positioning and heparin administration. However, if the goal of the uDCD is perfusing organ transplantation, organ donors require immediate intubation, oxygenation, and reestablishment of perfusion. Perfusion for organ preservation may be achieved through resumption of manual or mechanical chest compression or through the use of prehospital extracorporeal membrane oxygenation (ECMO).

It is advisable for prehospital personnel to explicitly document TOR time, hands-off time, determination of death, and start time for organ preservation. Transport to a transplantation center as soon as possible and within 90 minutes from the start of CPR is preferable.

System Configuration 2: Single Prehospital Team Providing Resuscitation and Second Team Responding as the Mobile Organ Donation Team

There is limited evidence to guide a 2-team mobile organ donor approach in the prehospital setting. A New York City protocol was designed and implemented in 2011 to evaluate the feasibility of this 2-team approach. After the treating paramedics terminated resuscitation, they triggered the arrival of a dedicated organ preservation team within 2 minutes after the termination. Organ preservation was planned to begin as soon as affirmation from a person of authority was acquired. The organ preservation team was activated 9 times; none of the patients were actual preregistered organ donors, and only 4 met the screening criteria. No organs were procured, and the program was terminated.[68,75]

On the basis of this literature and expert opinion, those implementing this approach may want to consider a few key elements. As is the case with a single-team approach, jurisdictions with opt-out consent could act without delay, whereas in jurisdictions with a registry in place, the first team would require confirmation of predetermination and suitability before activation of the second team: the mobile organ donor unit. While waiting for the arrival of the second team, the patient remains in a nonperfusing state because resuscitation has ceased, and the treating paramedics would redirect their care to supporting the family, completing the necessary documentation, and cleaning the ambulance after the event. Transfer of treatment to the mobile organ donation team onsite could enable discussion with the family or substitute decision maker, confirm eligibility, and start organ preservation. This transition from the treating team to the organ donation team is challenging in the prehospital setting where resources are scarce and the interface with the family is emotionally charged.[73,74] The time to arrival of the mobile organ donation team and the ability to start organ preservation on site are critical elements of this strategy.

System Configuration 3: Continued Prehospital Resuscitation and Transfer to the ED for Decision-Making and Involvement of the Organ Donor Team

Experience and literature to guide this approach are limited. The Scottish prehospital protocol for uDCD included rapid transport to hospital with active resuscitation, deferring the decision to cease resuscitation efforts until the patient arrives at the hospital. The ED physician terminated resuscitation and confirmed death before deferring care to the organ preservation team. During the 18 months of the pilot, 4 patients met all of the inclusion criteria and were registered on the organ donation registry. However, no organs were retrieved because of issues with the organ retrieval team. During the same time interval, there were 18 cases not registered on the organ donation registry (but with families available in the ED to consent), and changes were made to their inclusion criteria after the pilot concluded. The first donor after OHCA was recruited 6 months later.[76] A feasibility study completed in Pittsburgh of patients who arrested in the ED demonstrated that it was possible to identify 6 eligible donors from a cohort of 50 patients dying in the ED after cardiac arrest; 4 organs were procured from 2 donors with a 2-team approach in the in-hospital setting.[37] Both of these programs have been discontinued. A study of 112 hospitals in the United States providing treatment to 9792 individuals with OHCA suggested that high-volume centers are more likely to refer and procure transplantable organs from patients with nonsurvivable OHCA.[77]

If a system of care is considering this implementation approach, there are some key steps to consider. Once the cardiac arrest team has terminated resuscitation on the basis of clinical decision rules or local practice, determination of death is the responsibility of the team leader, and the hands-off time interval may begin. Hospital policy should include how the team leader contacts and consults with the organ donor team to confirm potential eligibility and that the team leader defers to them to discuss donation with the family or substitute decision maker, to confirm eligibility, and to start organ preservation if indicated.

Step 3: Hands-Off Time

The WHO guidelines address the circulatory sequence in the dying process (Figure 1S, Section 7.0, Supplemental Material) and specifically define the hands-off time interval as 2 to 5 minutes for WLST or planned no resuscitation (advance directive) and 7 minutes in cases in which prior resuscitation included CPR. The reason the

hands-off period is longer in cases involving prior resuscitation is to accommodate the increased risk of autoresuscitation or spontaneously occurring cardiac activity after TOR. A systematic review of cardiac arrest donors reported that this did not occur after a 7-minute hands-off time interval.[78] A standardized time period embedded in the protocol between when CPR is terminated and death is confirmed before the handover of care to the organ retrieval team improved trust in the integrity of the decision to cease resuscitation and allowed the teams to be more comfortable with the decision to move to organ donation.[73] The usual clinical pathway with OHCA ends with the prehospital clinical team terminating resuscitation and determining death through a conversation with online medical control. In the prehospital setting, this would be the start of the hands-off time interval.

Step 3: Determination of Death

The WHO has published international guidelines for the determination of death, including simpler definitions for both brain death and cardiocirculatory death.[42] It is recommended that "brain death" be defined as cessation of neurological function and "cardiocirculatory death" be defined as cessation of circulatory function. The WHO definition for determination of death is the processes and tests required to diagnose death in accordance with established criteria (Figure 1S, Section 7.0, Supplemental Material).

Heart function is defined as effective contractions of the myocardium leading to anterograde flow of blood through the aorta and arterial system. The guidelines define the minimal acceptable standard for confirming cessation of circulation and breathing as the following:

1. Absent palpable pulse
2. Absent breath sounds
3. Absent heart sounds
4. Absent respiratory effort or chest wall motion
5. Loss of pulsatile arterial blood pressure by noninvasive measurement and loss of any pressure wave on arterial line (if available)
6. Coma and fixed dilated pupils
7. Electric asystole not required (pulseless electrical activity is acceptable)

Step 4: Starting Organ Preservation

Implementing organ preservation has to balance the potential conflict of interest between what is best for the patient and actions to preserve organs for the best outcome of the transplant recipient.[79] This can be addressed best by clear criteria for death, observation of the hands-off period, and ideally separation of the resuscitation activities from the organ preservation activities between different care practitioners. The system configurations proposed in Figure 7 provide options for when to begin organ preservation; however, each system of care is not without controversy or consequence. Starting organ preservation after TOR would be particularly difficult in the prehospital setting without a second team dedicated to organ procurement, that is, system configuration 2. Some authors have suggested that death determination and starting organ preservation should be completed on arrival in the ED, that is, system confirmation 3.[80] However, this approach would increase the number of transports or patients with irreversible cardiac arrests to the ED who would otherwise have been pronounced dead in the out-of-hospital setting. This may increase the current rates of transport accidents involving prehospital health care professionals and the public during high-acuity transports in urban settings and add to the clinical burden in the ED.

Implementing organ preservation involves addressing the ethics of preserving the organs in uDCD donors before obtaining consent from the next of kin. In Spain, national legislation presumes consent for organ donation. This is interpreted locally to permit the continuation of perfusion and airway interventions to preserve organs. In the United States, the Uniform Anatomical Gift Act is designed to encourage doctors, hospitals, and other actors to increase donation rates and to honor the wishes of the deceased person. The prevailing view of the act suggests that it is ethically permissible, if not obligatory, to preserve the deceased person's organs for a reasonable time while a responsible family member is being sought for consent. This obligation is also extended to cases in which the intentions of the deceased have not been recorded before death.[81] UK and Scottish legislation allows femoral perfusion cannulation before approaching the family for consent.[81] The use of a 2-step approach to consent would presume consent to provide organ preservation interventions, and then after transfer of care to the organ retrieval team, a formal consent for organ donation would be acquired before organ retrieval.[82,83]

Organ preservation interventions may include restarting manual or mechanical CPR, intubating and providing oxygen in the prone position to potential lung transplant donors, providing cannulation for ECMO, inserting occluding catheters to reduce brain perfusion, heparinizing or cannulating, and perfusing with hypothermic or normothermic preservation fluid. In Spain, the public accepts the prehospital continuation of CPR (manual, mechanical or extracorporeal CPR [eCPR], and mechanical ventilation) in combination with other organ preservation interventions and rapid transport for organ procurement.[84]

Clinically, there is the possibility of benefit or harm with organ-preserving interventions on a patient who is not yet brain-dead but for whom circulatory death has been confirmed and resuscitation has ceased. A recent study has revealed that 3 patients in a series of 48 had return of spontaneous circulation when a mechanical device

was used during transfer of potential uDCD donors from the community to the transplantation center, 1 of whom went on to make a good neurological recovery.[84] There is growing consensus that organ perfusion techniques that restore circulation should be started only when brain perfusion can be eliminated. Thus, perhaps in system configuration 1 in which only 1 team provides resuscitation and transport, an initial approach would be to pursue nonperfusing transfers in the prone position for consideration of tissue donation and nonperfusing lung donation. This may be an excellent option for communities and systems where uDCD requiring organ preservation is not feasible or allowable within existing legislation. It is a less controversial option because, after prehospital TOR, hands-off time interval, and determination of death, there is no need to restart CPR during transport to hospital.

Step 5: Consent and Jurisdictional Issues

In all 3 system configurations, the assumption is that consent is either by opt-out or organ donor registry accessibility 24/7, which enables organ donation in OHCA. The best method to improve the rates of organ donation is the widespread adoption of an opt-out system with implied consent to donation.[85,86] This may not be possible in some jurisdictions because of legal, cultural, or religious objections.

Consent issues related to organ donation in the United States were historically addressed by a set of legislative changes referred to as the "required request laws." Initially, request for organ donation was legislated to be the responsibility of health care professionals and mandatory reporting was required. Low rates of organ donation were attributed to health care professionals' reluctance.[87] This shifted to involvement of organ donation personnel directly to obtain consent in 1998.

In 1994, US legislation moved from first-person consent to donor designated or opt-in, which reinforces the principles espoused in the Uniform Anatomical Gift Act of 1968 and, more important, provides the legal authority for organ donor staff to initiate organ donation without family member consent in cases when the patient has made his or her intentions known and documented. However, this does not apply to the patient whose intentions are not known or are not documented, and family consent is required in the United States. Similar legislation supporting opt-in for organ donation is in place internationally.[88] However, the rates of registration as an organ donor vary from a low of 0.5% in Turkey[89] to a high of 80% in the Netherlands.[90] In the Netherlands, 58% of those who registered consented or had no objection to organ donation, 31% refused consent, and 11% deferred to family to make the decision.[90]

uDCD is identified as a significant potential source of donors in the OHCA population, which is directly enabled in countries where legislation supports organ donation by default as an opt-out program on a national level. Spain, Belgium (since 1986), Austria (since 1982), Singapore (kidneys since 1986, all since 2004), and Wales (since 2015) have had opt-out programs in place supporting the default of consent for organ donation unless registered otherwise. A systematic review published in 2009 identified 26 studies reporting outcomes after an opt-out program for organ donation was implemented.[91] Five of these studies reported before and after in a single country (Austria, Belgium, and Singapore), and 8 studies compared organ donation rates between countries with and those without opt-out legislation. The rates of all donors per 1 million increased from 4.6 to 27.2 in Austria within 5 years of implementation[92]; over a 3-year period, rates of kidney donation increased in Belgium from 18.9 to 41.3[93] and in Singapore from 4.7 to 31.3 per 1 million.[94] The legislation was just one of many changes that occurred to optimize organ donation in each of these countries; donor availability, improved infrastructure for transplantation, health care investment, and changes in public attitudes may have had a role.[91]

The UK organ donor registry moved to a default consent or opt-out approach for all citizens ≥18 years of age with new legislation on May 20, 2020. Individuals lacking capacity to understand and take the appropriate action and those living in the United Kingdom for <12 months or living in the United Kingdom not by choice are excluded.[95] The government of Nova Scotia, Canada, has passed a similar law, the first one of its kind in North America. It took effect January 18, 2021, for those who have lived in Nova Scotia for ≥12 months and who are ≥19 years of age.[96]

Step 5: Consent and Challenges to Obtaining Consent Before Organ Procurement

In jurisdictions where consent is required, some authors suggest that the hands-off period can be used to discuss the question of organ donation with the family and to obtain consent; however, this is possible only if family members have been located.[97] In uDCD, time is a critical factor in determining the ultimate success of organ procurement and transplantation. In most cases of uDCD, the event is unexpected and sudden, and the family is often overwhelmed with emotion.[98] The challenges of obtaining consent under these conditions, particularly in the chaotic prehospital setting, are significant. It is important to remember that, when deriving a protocol, the majority of families contacted after the possibility of organ preservation had passed stated that they would have approved organ donation if it had been offered, and many who refused organ donation regretted the decision later. Positive experiences by families asked to donate contribute to a reservoir of social trust and support for organ donation.[99] When requesting consent from family members in the absence of the donor's express consent or when confirming family acceptance for donors who

express a prior consent, it may be helpful to keep in mind that families are more likely to regret refusing to donate their loved one's organs and tissue rather than feeling remorseful about giving permission.[100,101] Among families who denied the request to donate their loved one's organs, 42% indicate that they would change their decisions given a second chance to consent to the donation.[101] A qualitative systematic review revealed just how complex the decision-making process is for family members with many issues contributing to the decision[102] (Figure 2S, Section 7.0, Supplemental Material).

With this level of complexity and the time pressures that exist in the uDCD situation, we need helpful strategies for how health care professionals can facilitate the donation decision by family members in distress. A qualitative study in 2006 of family members who consented compared with those who did not consent to organ donation confirmed that improving rates of obtaining consent for organ donation was attributed to a combination of key patient characteristics and essential implementation steps. These included (1) the involvement of organ donation staff in the request, (2) a younger patient with predetermined organ donation wishes, (3) a favorable inclination to organ donation in the family members, (4) a sensitive approach by the individual requesting consent, and (5) family perception that they were given enough time to weigh the request before making their decision.[103] The key message is that, under duress, it is possible to obtain consent for organ donation, but the approach is an important determinant of success. The published evidence suggests optimism, with 70% to 84% of families agreeing to their loved ones becoming donors after cardiac arrest,[73,104,105] and families had the same rate of consent to organ donation in DCD and DNDD.[105] All 3 strategies proposed in Figure 7 defer the discussion about consent to the in-hospital setting where trained organ donation staff would discuss with families in jurisdictions where consent was required to proceed.

DONATION AFTER CARDIAC DEATH IN SPECIAL CIRCUMSTANCES

Ethics, Equity, and Cultural Differences in Organ Donation and Distribution

There is a huge difference in the number of organ donors among different countries (Figure 5). Furthermore, there is a trend of higher values in donors per 1 million people in European countries and the United States, but the rate is much lower in Asian countries. The reasons why these differences exist have not been studied thoroughly and remain open to conjecture. Concerns vary from lack of consistency and evidence to support the decision to terminate resuscitation to the determination of cardiac or brain death by health care professionals. Lay concerns vary by religious belief, geographic or neighborhood effect on subjective norms, social economic status, and education. These concerns may culminate in fears of the unknown or misunderstanding and community-based impediments to organ donation.

All countries are experiencing a shortage of donor organs, and the implementation strategies proposed by this scientific statement may help to address the lack of equity in organ donation and distribution when legislative changes enable opt-out consent. The cultural and religious influences, if left unaddressed at the community level, will limit the acceptability of the proposed implementation strategies and the recommended legislative change. Current successful organ donation programs are attributed in part to engagement of patients and families, religious leaders and cultural champions, health care professionals, and organ donor experts with government and health care policymakers to address the knowledge gaps, correct misunderstandings, and engage in evolving public opinion.

Traumatic Arrest and Organ Donation

In DCD programs, trauma as a cause of arrest often represents a contraindication for DCD. However, in an Arizona trauma center study of 252 patients who required CPR for traumatic arrest either in the out-of-hospital setting or in the trauma center,[106] among 213 (84.5%) who died, 19 (8.9%) became organ donors. A total of 26 organs were procured from these patients, including 15 kidneys, 6 livers, 4 hearts, and 1 pancreas. Of those who failed to donate organs, 64.7% had a cardiac arrest after the donor network had been contacted but before their arrival. The second most common cause of missed donor (11.8%) was lack of consent or inability to find relatives.

Refractory OHCA Resuscitated With eCPR

eCPR may be used as a rescue treatment in patients with refractory cardiac arrest in settings where this is implementable.[46,107] These patients may become Maastricht III DCD or DNDD organ donors when eCPR is later suspended for futility, with the usual reason being severe and irreversible brain injury. The prevalence of brain death was significantly higher in patients resuscitated with eCPR compared with those resuscitated with conventional CPR (27.9% [19.7%–36.6%] versus 8.3% [6.5%–10.4%]; $P<0.0001$).[30] In a systematic review of eCPR practices and outcomes for OHCA,[108] including 20 studies and 833 patients, a total of 88 potential deceased donors among nonsurvivors from 8 studies were identified. Of these potential donors, 17 (19%) became actual donors (15 DNDD and 2 cDCD donors). Most donors were identified after the failure of patients to achieve neurological recovery while supported with eCPR.[30,109,110] Of these, in 1 study, 90% of organs transplanted from eCPR-treated patients with OHCA achieved good functional recovery.[109]

Intersection Between eCPR for Cardiac Arrest Resuscitation and ECMO for Organ Preservation in uDCD Programs

Whereas the primary goal of veno-arterial ECMO in the context of eCPR for resuscitation is patient survival, the same ECMO technology is used for organ preservation as part of the uDCD process. The components of these programs, using the same technology with different objectives, have substantial overlap. Eligibility criteria are similar, as well as required processes for prehospital candidacy assessment, emergency team mobilization, and ECMO initiation.[111] Some centers have integrated these 2 approaches, creating integrated eCPR/uDCD programs.[112,113] One such program, reported by Roncon-Albuquerque and colleagues[114] in Spain, described a system in which all individuals with refractory nonasystolic witnessed cardiac arrest from 18 to 65 years of age were transported to hospital. Patients were first assessed as ineligible for eCPR and then considered for uDCD. In this series, 71% (41 of 58) had OHCA, and 18 (31%) were treated with eCPR. Of the 18 eCPR-treated cases, 6 survived to hospital discharge with full neurological recovery, and from nonsurvivors, 1 liver and 2 kidneys were transplanted. Of the 40 cases assessed for uDCD, 44 kidneys were transplanted.

One French study combined eligibility for eCPR with ECMO for organ preservation after determination of death.[112] Among 27 patients with OHCA with prehospital criteria for eCPR transported to the hospital by helicopter with mechanical chest compressions, 13 were referred for organ donation. In those 13 patients, ECMO was started for regional perfusion and organ preservation purposes after the diagnosis of death. Of these 13 patients, 4 were excluded for medical reasons. In the remaining 9 patients, 18 kidneys were retrieved, of which 6 were successfully transplanted. Of the 14 patients in whom eCPR was started for resuscitation purposes, 1 survived to hospital discharge, whereas 1 became brain-dead and a solid-organ donor (liver and kidneys).

End-of-Life Care and Organ Donation in Patients Treated With eCPR After OHCA

No published guidelines or decision rules specifically address end-of-life care in patients treated with eCPR after OHCA. Data to guide early decisions of futility may include 3-hour lactate and lactate clearance,[115,116] gray-white matter ratio and cerebral edema on computed tomography performed after eCPR initiation,[116–118] and pupillary response after eCPR initiation.[117] One study of eCPR-treated patients (65% had OHCAs) who were rewarmed after targeted temperature management reported that patients without a pupillary light reflex, a corneal reflex, or a cough reflex and those with bilateral absence of N20 somatosensory evoked potentials were unlikely to survive.[109] However, these data are limited by small sample size and require validation.

Published studies reporting patients treated with eCPR after OHCA who became organ donors have reported using brain death criteria or neuroprognostication strategy rates that are similar to those used for comatose post–cardiac arrest survivors not requiring eCPR.[114] In the absence of brain death, it remains unclear whether prognosticators of poor neurological outcome derived from patients not receiving eCPR can be extrapolated reliably to patients receiving eCPR. The absence of validated early prognosticators or poor neurological outcome in patients treated with eCPR is a critical knowledge gap that limits the timely transition to organ donation when there is no possibility of good neurological outcome.

COST-EFFECTIVENESS OF DONATION AFTER OHCA

Organ DNDD is generally regarded as a cost-effective intervention.[119–121] Although initial costs of the intervention are high, the future cost-savings and improvement in survival and health-related quality of life among transplant recipients generate acceptable cost-effectiveness ratios.[122] Although DCD approaches can increase the organ donation pool, the costs of additional interventions (such as eCPR) potentially decrease organ suitability for transplantation and may adversely affect the cost-effectiveness profile compared with DNDD. We set out to evaluate the published literature on the cost-effectiveness of organ donation of controlled and uncontrolled organ donation after cardiac arrest, with and without the use of eCPR.

Cost-Effectiveness of Organ Donation After Conventional CPR

There are no published data on the cost-effectiveness of the uDCD approach to organ donation after conventional CPR. The reported data that follow for this cohort of patients include both DCD and uDCD combined. A single study has reported the cost-effectiveness of uDCD with ongoing eCPR and ECMO for organ preservation.

Love et al[123] examined the inclusion of organ donation as a successful outcome on the cost-effectiveness of treating traumatic cardiac arrest. Among 237 patients who had a traumatic cardiac arrest, at the scene, en route, or after admission, 5% were eligible for organ donation with a procurement rate of 2%. The cost of traumatic cardiac arrest per survivor was $1.8 million. If survival

or organ donation was included, then the cost fell to $538 000. The incremental cost-effectiveness ratio was $76 816 per additional life saved, including donation as an outcome.

Achana et al[55] examined incorporating the indirect economic effects associated with transplanted organs in a cost-effectiveness analysis of epinephrine in adults with OHCA in which the cause is not obvious but presumed to be cardiac, and patients were randomized to either epinephrine in standard doses or placebo. The trial randomized 8014 patients, of whom 224 were alive at 30 days. Of those who died in the field or did not survive to hospital discharge, there were 40 organ donors in the epinephrine group and 24 in the placebo group. The mean number of organs donated per donor was 3; the majority were kidney only (56%), liver only (24.1%), and kidney and pancreas together (6%). Including organ donation outcomes improved the cost-effectiveness estimates for the use of epinephrine compared with placebo from <1% to 90% at a €34 500 per quality-adjusted life-year cost-effectiveness threshold. With adoption of the proposed changes to the Utstein template, perhaps more trials in the future will include organ donation as an outcome measure and report cost-effectiveness.

Cost-Effectiveness of uDCD With Ongoing eCPR and ECMO for Organ Preservation

A single study reported the feasibility and outcomes of the Italian Programma Alba, which was set up to facilitate organ donation.[124] This study reported that 8 kidneys were collected from 4 patients who were declared deceased while receiving eCPR treatment. Four of these kidneys were successfully transplanted. The cost of this Italian program was reported as €247 000 over 12 months.

The cost-effectiveness of the recent introduction of ex situ machine perfusion to support organs after removal and to assess viability before transplantation has not been evaluated in post–cardiac arrest organ donation. The methods have the potential to cost-effectively increase the number of organs available for transplantation, to improve marginal organs before transplantation, and to reduce the transplantation of less viable organs.[125,126]

KNOWLEDGE GAPS AND FUTURE DIRECTIONS

There is a paucity of information pertaining directly to organ donation after cardiac arrest, and this may be attributed to various issues, some of which our list of priorities tries to address.

1. Legislation pertaining to organ donation in all jurisdictions should consider changing to a default consent or opt-out approach for all citizens ≥18 years of age.
2. The current DCD categories in the modified Maastricht classification[11,35] are not defined in a way that enables reporting and comparisons based on the type of donor across the clinical spectrum for unwitnessed and witnessed OHCA and IHCA. Modifications to the Maastricht classification system are proposed to consistently identify and report the following:
   - The type of donor after cardiac arrest according to the characteristics of the arrest, location, and clinical pathway
   - Reliable incidence and outcomes for donation after cardiac arrest
   - Reliable cost estimates based on the system of care: resuscitation, termination, consideration for organ donation and organ procurement, functional organ measures, survival, and quality-of-life measures of the recipient are required
3. Clinical registries, clinical trials, and quality indices in cardiac arrest and trauma should collect organ donation variables and outcomes.
   - The Utstein template[54] should be revised to include organ donation variables and outcomes as mandatory elements.
4. The published validated TOR rule[42–44] should be implemented more uniformly to support decisions on TOR and the transition to organ preservation in systems in which uDCD is feasible and prehospital systems of care are similar to the derivation EMS system (tiered paramedic response system with online medical control). TOR rules to support this decision in other populations (eg, outside of North America, pediatric, neonatal, in hospital, obvious cause cardiac arrest) should be developed.
5. The WHO standard for determination of death and hands-off time should be uniformly implemented in all protocols.[42]
6. The feasibility and acceptability of different implementation strategies for uDCD after OHCA should be explored through future implementation research directed at addressing and guiding the operational, ethical, economic, and clinical challenges identified to date. Implementation strategies should address the spectrum of organ donation on the basis of health system capacity and community support:
   - Tissue procurement
   - Nonperfused organ donation
   - Perfused organ donation
7. Algorithms and guidelines for the management of cardiac arrest consider organ donation as a routine component of post–cardiac arrest care and a

measurable outcome in future research and performance metrics for health care systems.

8. Resuscitation treatment strategies that include eCPR programs consider incorporating plans for the systematic evaluation and identification of potential organ donors, such that if and when patients have expected or unexpected deaths, organ donation can occur.
9. In the absence of brain death, no published guidelines or validated decision rules specifically address prognostication of poor neurological outcome in post–cardiac arrest patients treated with eCPR.
10. Published studies in which patients treated with eCPR after OHCA became organ donors have reported using brain death criteria or neuroprognostication strategies that are similar to those used for comatose post–cardiac arrest survivors not requiring eCPR. These strategies need to be validated prospectively in this population of patients with OHCA.

CONCLUSIONS

Sudden OHCA is an important public health issue that results in a tremendous loss of life despite optimal therapy. When resuscitation fails, organ donation provides an opportunity for patients experiencing cardiac arrest and their families to save the lives of others. With organ transplant waiting lists getting longer every day, it is our responsibility, as the resuscitation community, to optimize donation opportunities for our patients. The potential for organ donation after OHCA in communities around the world is substantial and underrecognized. Unfortunately, the published science is sparse and complicated by inconsistent and incomplete definitions that do not reflect all relevant clinical scenarios associated with OHCA. Changes to the Maastricht classification system are suggested to closely align with the clinical spectrum of OHCA and refined reporting based on type of donor. Changes to the Utstein template for OHCA reporting to include organ donation metrics as mandatory variables will contribute to more uniform reporting. These changes will support improved quality and relevance of future research on organ donation after OHCA. Future cardiac arrest care guidelines should include organ and tissue donation considerations on the basis of available local options. uDCD is identified as a significant potential source of organ donors in the OHCA population, but significant operational, ethical, and legal barriers exist across most jurisdictions. Evolution in technology and systems of care may create opportunities for this to be a more viable option in the future. Legislative changes to a default consent or opt-out approach for all adult citizens will increase donor availability and transplantation rates, and the increase in volume will contribute to improved transplantation infrastructure and cost-effective ratios. We support continued innovation in uDCD approaches addressing recognized barriers. All health systems should evaluate, develop, and implement protocols to optimize organ donation opportunities for patients who had OHCA and fail attempts at resuscitation.

ARTICLE INFORMATION

The American Heart Association, the European Resuscitation Council, and the International Liaison Committee on Resuscitation make every effort to avoid any actual or potential conflicts of interest that may arise as a result of an outside relationship or a personal, professional, or business interest of a member of the writing panel. Specifically, all members of the writing group are required to complete and submit a Disclosure Questionnaire showing all such relationships that might be perceived as real or potential conflicts of interest.

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Laurie J. Morrison	Department of Emergency Services, Sunnybrook Health Sciences Center, University of Toronto (Canada)	None	None	None	None	None	None	None
Mayuki Aibiki	Ehime University Hospital (Japan)	None	None	None	None	None	None	None
Steven C. Brooks	Queen's University, Kingston General Hospital (Canada)	Canadian Institutes of Health Research (operating grant to study the PulsePoint app)†; Ontario Ministry of Health (operating grant to study a community first responder program for cardiac arrest)†; Action First Aid (in-kind support of research through donation of AEDs)†	None	None	None	Rapid Response Revival†	Rapid Response Revival†	None
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Brian Grunau	University of British Columbia (Canada)	None	None	None	None	None	None	None
Steve Lin	St. Michael's Hospital Li Ka Shing Knowledge Institute, University of Toronto (Canada)	None	None	None	None	None	None	None
Finlay Macneil	ANZCOR (Australia)	None	None	None	None	Invocare*; Sonic Health*	None	None
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Michael Parr	Liverpool Hospital, University of New South Wales and Macquarie University Hospital, Macquarie University (Australia)	None	None	None	None	None	None	None
Gavin D. Perkins	Warwick Medical School and University Hospitals NHS Foundation Trust (United Kingdom)	None	None	None	None	None	None	None
Claudio Sandroni	Università Cattolica del Sacro Cuore (Italy)	None	None	None	None	None	None	None

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*Modest.

†Significant.

Reviewer Disclosures

Reviewer	Employment	Research grant	Other research support	Speakers' bureau/ honoraria	Expert witness	Ownership interest	Consultant/ advisory board	Other
Michael C. Kontos	Pauley Heart Center, Virginia Commonwealth University	None	None	None	None	None	None	None
Bryan McNally	Emory University School of Medicine	AHA (grant funding for CARES)†	None	None	None	None	None	None
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