Donation aFter Circulatory Death

2024

Intensive Care Society of Ireland

Intensive Care Society of Ireland: Donation after Circulatory Death Guidelines	
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Introduction

The Guide to Professional Conduct and Ethics for Registered Medical Practitioners (9th edition 2024) specifically refers to the doctor's responsibilities where organ donation is concerned:

> "You should involve patients (and/or persons with decision-making authority in relation to the patient) in decision-making about their end-of-life care, respecting their will, preference any Advance Healthcare Directive and decision-making capacity. This may include discussions on potential organ donation, where appropriate." (1)

End of life care in general, and DCD in particular are areas where ethical challenges occur. A comprehensive discussion of ethics and law in the context of DCD is presented within the British Transplant Society guideline "Transplantation from donors after circulatory death" (2) . The steps described within these guidelines are comparable to the above and other international guidelines (2, 3, 4, 5, 6).

The Irish Human Tissue Act, dealing with the areas of Transplantation, Post-Mortem, Anatomical Examination and Public Display, was signed into law on the 28th February 2024 by President Michael D Higgins. Areas pertinent to organ donation and transplantation including the processes of authorisation, consent and assent for organ retrieval. Permission for organ donation is written in the vast majority of cases. In exceptional circumstances, verbal permission will suffice where witnesses will attest to its validity. This documentation and the requirement for witnessing are codified within the Act. The legal standing of advance directives and their precedence is also included in the Act.

For the purpose of these guidelines the term "next of kin" rather than "family" is used to represent the many qualifying relationships of trust or professional duty. Such relationships include, but are not confined to, designated family member, designated decision makers, decision making representative, designated healthcare representative or finally, an attorney within the legal framework of the enduring power of attorney. Appropriate advice should be sought where clarification is required. Within these guidelines, the term "next of kin" may be interchanged with others where legally appropriate.

The Act stipulates a less prescriptive approach to the diagnosis of death: death must be diagnosed in accordance with "accepted medical standards". Specific mention is made of the maintenance of cardiopulmonary function in patients whose death may have been diagnosed by neurological criteria, while pertinent to brainstem death, it is also relevant to Maastricht Category 4 patients outlined within the body of this guideline. Equally in deceased persons, there is mention of the steps which may be taken for the purpose of preserving the organs and tissues where subsequent transplantation is likely to be a possibility. Explicit instructions are prescribed for organs removed, but later considered unsuitable for transplantation. This may encompass retention of the organs, the return of the organs to the patient, or the

respectful disposal, cremation, or burial of these organs. The laws governing coronial investigations are addressed. Care and respect for the body of the deceased are implicit in all medical practice. The Human Tissue Act codifies much of this practice.

The following guideline is the culmination of a process of engagement within the Intensive Care Society of Ireland, the Medical Council, the HSE Division of Nursing and Midwifery within the HSE, the Coroners Society, and Organ Donation and Transplant Ireland (ODTI). The expected levels of support from each representative group are contingent upon an approach being undertaken within the context of an agreed guideline, together with audit and performance monitoring and the institution of appropriate governance arrangements.

Section 2: Donation after Circulatory Death: Principles and Practice

Donation after Circulatory Death (DCD) occurs when a patient donates organs following the determination of death by cardio-respiratory criteria. As of 2019, 28 European countries have an active DCD programme accounting for 20% of organs transplanted in the EU in that year (7). In the USA, DCD accounted for 30% of deceased donations in 2021 (8).

Organs donated after circulatory death suffer a period of hypoperfusion known as the Warm Ischaemic Time (WIT). This period is characterised by a low flow state followed by circulatory arrest. Hypoperfusion is thought to be most damaging where the systolic blood pressure is less than 50mmHg or where the SpO_2 decreases to less than 70% for greater than 2 minutes. These parameters describe the onset of the "functional warm ischaemic time" (fWIT) (Appendix A).

As a result of WIT, DCD organs may be more prone to early graft dysfunction, increased reintervention rates and inferior outcomes when compared with DBD organs.

In an attempt to minimise the impact of warm ischemia on transplanted organ outcomes, maximum time-periods are set by transplant teams from withdrawal of life-sustaining therapies (WLST) or from the onset of fWIT.

Whether teams use the time from WLST until the organ is reperfused after death has occurred (i.e., the "Withdrawal to Perfusion time"), or the time from onset of fWIT until the organ is reperfused is variable (**Figure 1**). If the time to cardiac arrest exceeds that deemed acceptable by the transplant team, the process of DCD may be stood down. This is reported in up to 25% of DCD attempts in the USA and 40% of DCD attempts in the UK (8, 9). The WIT ends with cold perfusion or the establishment of a regional perfusion technique.

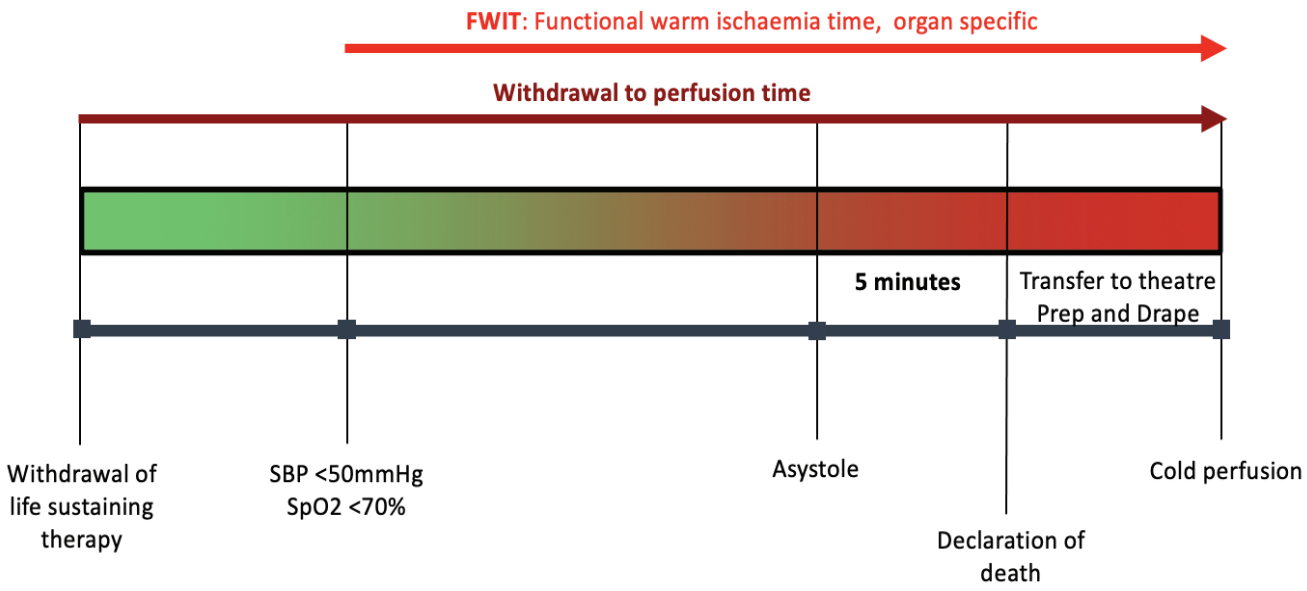

FIGURE 1: Timeline of DCD, including fWIT and Withdrawal to Perfusion time

There is evidence to suggest that in some cases DCD organs may compare unfavourably when compared to organs donated after brain death (DBD), likely due to the impact of WIT. DCD livers are predisposed to vascular stenosis, ischaemic cholangiopathy and increased healthcare costs in comparison to hepatic grafts from DBD donor patients (10). The incidence of delayed graft function in kidneys is significant and as a consequence patients remain longer in hospital (11).

Even allowing for warm ischaemic injury, outcomes from lung transplantation following DCD are encouraging; equal primary graft dysfunction, acute rejection rates and mortality rates are reported from the USA and Europe (12, 13). These results are borne out in a systematic review from 17 studies from Europe, the USA and Australia. Despite these results, airway anastomotic complications were twice as likely to occur in DCD lungs (DCD 8-29% vs DBD 4-14%) (14).

While cardiac transplantation also, has been successful from DCD donors, either in-situ or ex-situ perfusion is an essential prerequisite to implantation. Studies of simultaneous pancreas-kidney transplants have demonstrated almost equal outcomes to DBD pancreas-kidney transplant. However, given the limited tolerance of warm ischaemia, it is likely that many more pancreas transplants could be performed if the maximum warm ischaemic time could be extended (15, 16).

Acknowledging the depth of motivation and reflection that typically underpins familial choices around DCD, we would advocate extending the current "withdrawal to perfusion" time-limits. This would increase the chances of these wishes being realised, consistent with the gift of donation of the donor and donor families.

Techniques such as normothermic regional perfusion (NRP) have the potential to extend acceptable withdrawal to perfusion time-limits. The use of NRP is evidence-based and supported by individuals and expert groups in numerous reviews and consensus statements. The importance and contribution of perfusion repair is supported an international group of experts from the fields of intensive care, neurology, surgery, ethics, law and organ donation (17):

> *"The value of perfusion repair for increasing the success of organ transplantation is established by this consensus statement to recommend that a protocol of cDCDD utilise either in-situ or ex-situ perfusion consistent with the practice of each country conducting cDCDD"*

NRP is discussed further in Appendix B.

The Maastricht Classification

Potential donors after circulatory death may be divided into 5 categories, originally described in Maastricht in 1995 and updated in 2013 (18) **(Table 1).** These categories define whether the permanence implicit in the declaration of death is based on:

a) Whether CPR was deemed inappropriate: a "*will not* resuscitate" situation (Category III)

or

b) Because CPR efforts were unsuccessful: a "*cannot resuscitate"* situation (Categories I, II & IV)

'Controlled' DCD refers to organ donation from donors who have died in hospital following the withdrawal of life-sustaining treatment.

'Uncontrolled' DCD refers to organ donation after failed efforts to resuscitate an individual experiencing an out-of-hospital or unexpected in-hospital cardiac arrest.

The terms "controlled" and "uncontrolled" reflect the applicable time constraints for authorisation or consent and the logistics of organising retrieval teams and theatre (4). All organs in the Republic of Ireland donated from DCD donors are currently in Maastricht category III or IV.

Maastricht Category III:

These patients die following the elective withdrawal of life-sustaining therapies. The vast majority of these patients have devastating non-recoverable neurological injury, typically secondary to traumatic brain injury, intracranial haemorrhage or hypoxic ischaemic encephalopathy.

Rarely organ donation may occur following the withdrawal of life-sustaining therapies in patients who have not sustained severe neurological injury. Examples may include the withdrawal of cardiovascular supports in extra-corporeal life support or the withdrawal of respiratory support in high spinal injuries or neuromuscular disorders.

Maastricht Category IV:

These patients may already have a diagnosis of BSD. Others are likely to fulfil criteria for BSD, but completion of the tests may not be possible due to cardio-respiratory instability or the presence of a high spinal injury. Four-vessel cerebral angiography equally, may prove impossible due to hypotension. DCD may be the only feasible way for these patients to donate organs.

The modified Maastricht Classification for DCD: Paris 2013 (18)				
Category	**Clinical Scenario**	**Location**	**Circulatory Death (uDCD or cDCD)**	**Warm Ischaemic Time**
Ia	Cardiac arrest, unwitnessed	Out of hospital	Uncontrolled	Approximate calculation
Ib	Cardiac arrest, unwitnessed	In-hospital	Uncontrolled	Approximate calculation
IIa	Cardiac arrest, witnessed	Out of hospital	Uncontrolled	Approximate calculation
IIb	Cardiac arrest, witnessed	In-hospital	Uncontrolled	Approximate calculation
III	**Withdrawal of life-sustaining therapies**	**In-hospital**	**Controlled**	**Known Exactly**
IV	**Cardiac arrest during or after criteria for BSD satisfied**	**In-hospital**	**Controlled & Uncontrolled**	**Known Exactly**

Controlled (cDCD): Permanent and irreversible circulatory death determined on the basis that patient *will not* be resuscitated - Do Not Attempt Resuscitation order in place.

Uncontrolled (uDCD): Permanent and irreversible circulatory death determined on the basis that the patient *cannot* be resuscitated - failed resuscitation.

Maastricht Category V: Legislation in 18 jurisdictions allows organ donation after Medical Assistance in Dying (MAiD), Organ donation after Euthanasia (ODE) or organ donation after Voluntary Assisted Dying (VAD)**(19)**

TABLE 1: The modified Maastricht Classification for DCD

Section 3: The Identification of Potential Organ Donors after Circulatory Death

The goal for healthcare professionals in organ donation is to honour the wishes of the donor patient. DCD will only be considered where it is clearly understood that this would have been the wishes of the patient. Securing the best outcome from their altruistic gift to others must be achieved in the context of optimal and ethical end-of-life-care.

Care of the dying patient is of paramount importance and measures to maintain the comfort and dignity of the patient must not be compromised for organ donation. Within the risk-benefit analysis of any intervention, the risks of discomfort to the donor who remains alive must be balanced with the benefits to optimise their success as a donor. An impact assessment of specific interventions for potential organ recipients is also important to consider. No interventions that could possibly cause pain or distress to the patient before death are acceptable. Blood sampling (to facilitate viral screening and crossmatching) and heparin administration are permissible, and where applicable, authorisation for regional perfusion should be sought. The risk-benefit profile of each intervention must be specifically detailed within the authorisation documentation. (Appendix C) (12,17-23).

Withdrawal of life-sustaining care and DCD

The possibility of DCD arises only when it has been determined that maintaining life-sustaining treatment is not providing benefit to a patient and that such treatment should therefore be withdrawn. The decision to withdraw such therapies is usually made by the primary consultant physician or surgeon in conjunction with the intensive care consultant, with due respect to the patient's autonomy and wishes as interpreted and expressed by their next of kin.

Factors in patient selection for DCD

Once a decision has been made to withdraw life-sustaining care, consideration must be given to features which may influence eligibility for DCD.

Predicting time of death

Patients considered for DCD must be dependent upon ventilation or vasopressors to the extent that they are likely to die within 90 minutes of withdrawal. Estimating time from WLST to cardiac arrest can be difficult. Certain patient features including aetiology of neurological injury (if applicable) and high levels of ventilatory and circulatory support can be used to help predict time to cardiac arrest. Several decision-making tools and scores have also been developed to aid clinicians in patient selection for DCD, which are discussed in **Appendix D.**

Tolerable WIT

Maximal tolerable WIT limits vary with the organ(s) involved and are influenced by the age and physical fitness of the donor. When assessing patient suitability for DCD, the clinician must be cognisant that the upper limits of tolerable WIT are patient specific and are generally set by the transplant surgeons.
The exact point where the timer is started may vary, from WLST, to fWIT, to points in-between. In the case of cardiac donation, the timer begins when the SBP decreases below 90mmhg (figure 1, table 2). The timer stops with reperfusion of the organs with either cold perfusate or with oxygenated blood as in a regional perfusion technique.

In practice, these times may be significantly shorter or longer than outlined below and are at the discretion of the transplant team.

	Australian Government Organ and Tissue Authority (6)	British Transplant Society (2)
	Tolerable WIT in minutes	**Tolerable WIT in minutes**
Kidney	60 (from SBP <50mmHg)	180 (from WLST, may be extended with NRP)
Liver	30 (from WLST)	30 (from SBP <50mmHg)
Lung	90 (from SBP <50mmHg)	30 (from SBP <50mmHg) 120 (from WLST)
Heart	30 (from SBP <90mmHg)	Not specified
Pancreas	60 (from SBP <50mmHg)	60 (from SBP<50 mmHg, "ideal donor" criterion is 30 minutes)
Islets		30 (from <50mmHg, extended criteria up to 60 minutes)

TABLE 2: Suggested maximum tolerable WIT from international guidelines

Redirection of care towards palliative measures in the ICU

In all patients deemed potential candidates for DCD, the opinion of a second intensive care consultant that life-sustaining therapies are medically inappropriate is required. Ideally, medical opinions should be personally written or typed into the medical record. Where this in not possible, it should be documented clearly by their surrogate, a clinician who will attest to its validity.

(1) Devastating neurological injury

This is the underlying diagnosis in the vast majority of cases. The opinion of a consultant neurologist, consultant stroke physician or consultant neurosurgeon that life-sustaining therapies are medically inappropriate should be documented before proceeding to DCD.

(1a) **Devastating Hypoxic Brain Injury, Intracranial Haemorrhage or Traumatic Brain Injury**.

These injuries are characterised by definitive structural evidence of injury on CT or MRI. In these situations, the neurological opinion, whether stroke physician, neurology or neurosurgery does not necessarily require an on-site in-person review. However, it must be the opinion of a consultant, based on the clinical history and appropriate radiological plus or minus electrophysiological investigations.

(1b) **No CT or MRI evidence of devastating neurological injury**

Where there is consideration given to WLST without clear radiological evidence, the personal review and ***on-site*** opinion of a consultant neurologist is mandated. This consultant opinion must be attained before progression towards DCD. Typically, these patients will have an irreversible severe encephalopathy caused by an underlying neurodegenerative disorder, metabolic condition, or toxic injury.

(2)Patients without devastating neurological Injury

DCD is occasionally considered in patients without a devastating neurological injury. Death may result from the elective withdrawal of mechanical ventilation in patients with end-stage respiratory failure, high spinal injuries or neuromuscular disorders, or the elective withdrawal of cardiovascular supports such as the discontinuation of extra-corporeal membrane oxygenation (ECMO).

In these situations, there should be agreement by two ICU Consultants together with a Consultant Surgeon or Consultant Physician that further life-sustaining therapies are medically inappropriate before DCD is undertaken.

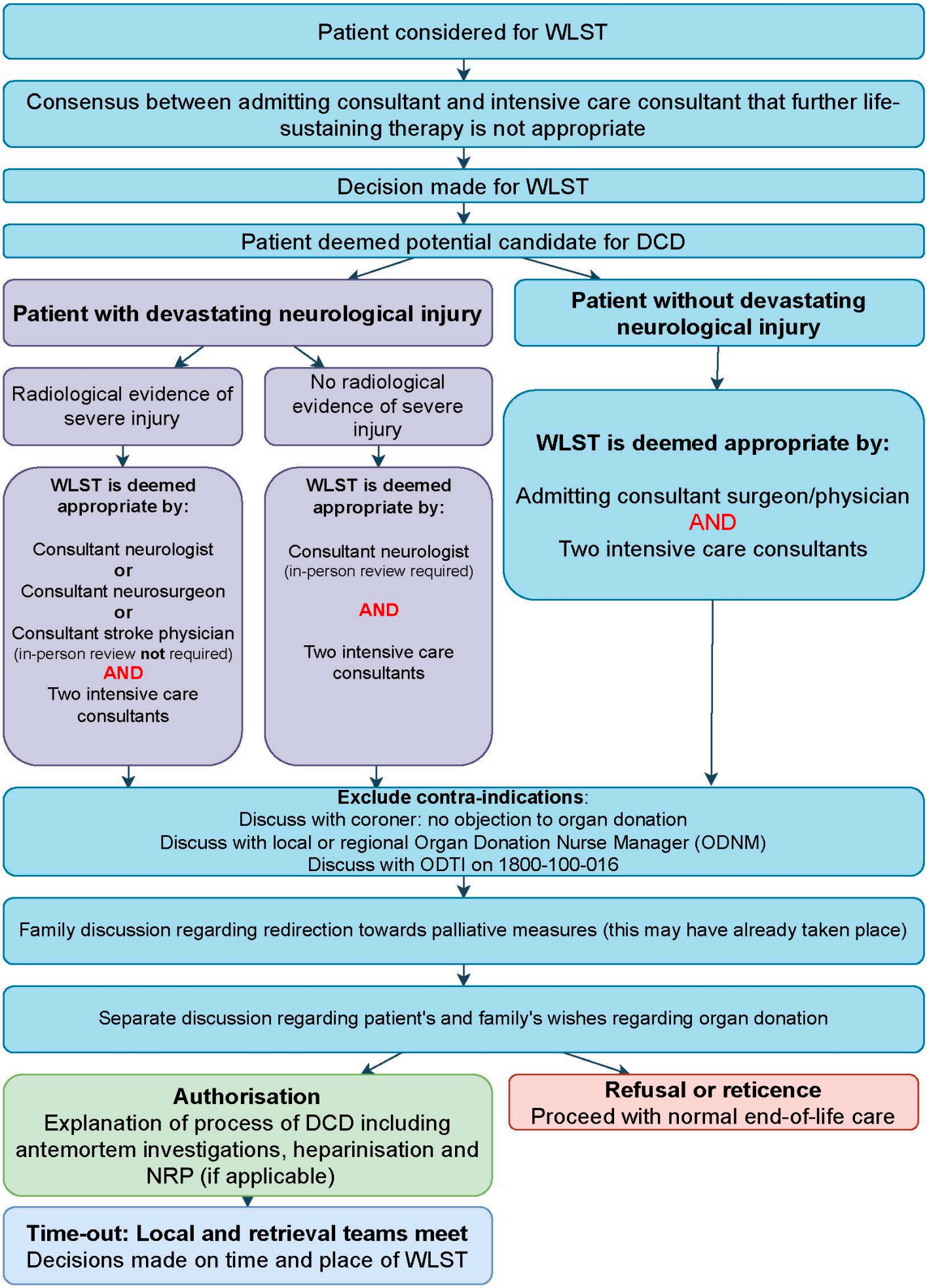

FIGURE 2: Additional consultant input prior to WLST in patients considered for DCD

Section 4 Communication with the next of kin and Authorisation-Consent

The topic of organ donation should be visited only ***after*** a decision has been made to redirect therapies to palliative measures. All healthcare professionals involved should agree that organ donation could be an appropriate end-of-life care pathway before a patient's next of kin is approached in situations where DCD is a potential outcome.

Where this agreement exists, it is appropriate to explore with the patient's next of kin whether the patient had expressed any views about organ or tissue donation, and if donation is likely to be a possibility(20).

Where the next of kin raises the question of organ donation either before a decision to redirect therapies to end-of-life care has been reached or before brain death has occurred, the intensivist should:

> "ensure the family understands that the intensivist will revisit the issue of organ and tissue donation without being further prompted should it become appropriate in the future" (21).

Authorisation, Consent and Assent: supporting the best knowledge of the patient's wishes

As part of the authorisation process, the following should be specifically discussed:

- A detailed description of the process of WLST, including plans for extubation, and measures to ensure patient comfort and dignity
- Pre-mortem blood sampling and systemic heparinisation (discussed further in Appendix C)
- Which organs are likely to be retrieved
- Subsequent care of the deceased
- The possibility of a stand-down, in which case organ donation will not be possible. The tools described in Appendix D may be helpful in predicting the likelihood of such an outcome which can help to inform discussions with the patient's next of kin
- Where a regional perfusion technique is being considered, this should be discussed
- Assurances should be given to the next of kin that they may change their minds at any time
- Most patients considered for DCD will be notifiable to the coroner, this should be communicated to the patient's next of kin
- Details will be provided regarding instances in which organs, initially intended for transplantation, are deemed unsuitable. This could involve retaining and utilizing the organs for research, returning them to the patient, or ensuring their respectful disposal through cremation or burial.

Section 5: The Process of DCD:

Over-Riding Principles

These Guidelines apply only to patients who may be classified as Maastricht categories III or IV. DCD should only be undertaken when there is consensus among all clinicians and among all the next of kin.

Time-Out Process

Prior to the WLST a Time-Out should take place. The essential participants include the Intensive Care consultant or consultant Anaesthesiologist, ICU and theatre nursing staff, the National Organ Procurement Services (NOPS) donor coordinator, the organ donation nurse manager (ODNM) if available and the transplant retrieval teams. Close liaison between the teams will ensure that all expectations are met, and all potential outcomes are discussed before withdrawal of life-sustaining therapies.

Premortem Interventions

The patient should be fully anticoagulated, the standard unfractionated heparin dose being 300 IU kg^{-1}. The patient may remain in the ICU or be transferred to an appropriate area with privacy for the next of kin and others who may wish to be present where WLST can occur. The administration of unfractionated heparin has figured prominently in the discussions around DCD and is reviewed in Appendix C.

Withdrawal of Life-Sustaining Therapies (WLST)

Mechanical ventilation and vasoactive supports should be discontinued. Sedative infusions should not be weaned. Additional sedative, analgesic or anti-sialagogue medications may be administered as appropriate to optimise patient comfort.

Some clinicians recommend the gradual reduction of ventilatory support before terminal extubation to allow time to control tachypnoea through the titration of medications. Many advocate terminal extubation as the chosen method of airway management and argue that palliative goals are best achieved by appropriate pre-emptive sedation (rather than reactively treating tachypnoea) and by reducing technology wherever possible. Survivors of critical illness recall endotracheal tubes and suctioning as being significant sources of discomfort thus reinforcing the argument for removal of artificial airways (22).

The patient's vital signs should be monitored and recorded from when life-sustaining therapies are withdrawn to the time of death. If death does not occur within the predetermined period set in agreement with the transplanting surgeons, then it is reasonable to stand-down (Appendix D).

Determination of death

This will be in accordance with the criteria defined by Academy of Medical Royal Colleges Criteria (2008) (23):

a) Death is certified after five minutes of asystole on a continuous ECG display.

or

b) Five minutes absence of pulsatile flow using direct intra-arterial pressure monitoring.

Should there be a resumption of breathing, a change in neurological status, or return of a pulse or arterial waveform during this five-minute period of observation, then the period of observation must be restarted after this activity disappears.

After five minutes of asystole on ECG or pulselessness on arterial blood pressure, the patient may then be examined for absent pupillary reactions, corneal reflexes and absent response to supraorbital pressure.

Death may be diagnosed if these criteria are satisfied.

Following the Diagnosis of Death

The patient may be transferred to the operating theatre. The exact time of death should be documented and formally communicated to those present. The written consent for organ donation and the patient's identity should be checked, the patient prepped and draped and the organ donation operation may commence.

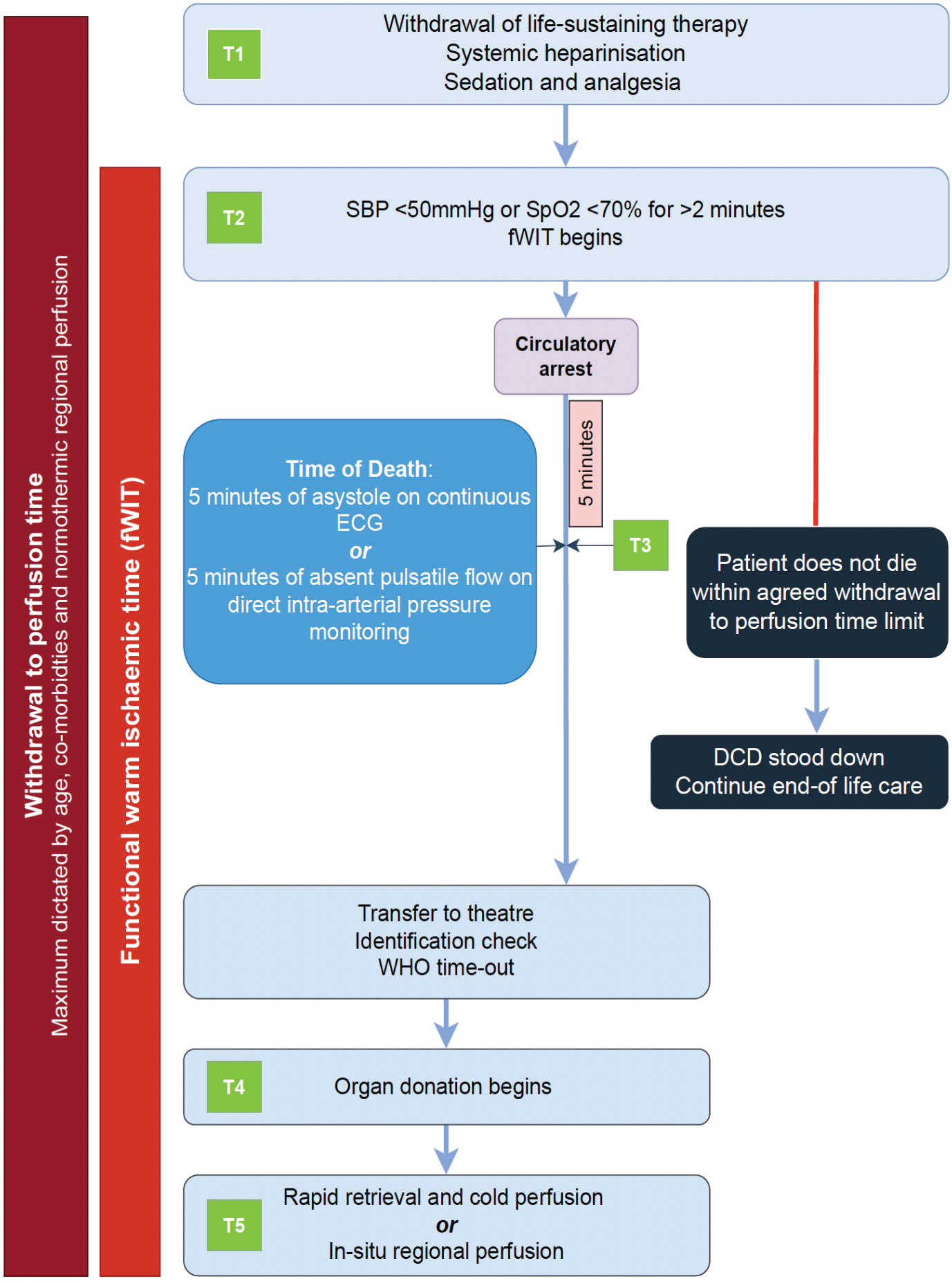

FIGURE 3: The Process of DCD

Care of the body of the deceased patient

The remains of the deceased patient are cared for in accordance with normal practice. The patient's next of kin may wish to spend time with the deceased before the remains are taken to the mortuary. Formal identification with the Gardai is necessary where a post-mortem is required by the Coroner. This may occur after the organ donation operation has been completed or later in the mortuary.

Section 6: Education, Audit and Clinical Governance

While DCD is not new, most medical and nursing staff may not be familiar with the processes involved. It is an important end-of-life care pathway when criteria for brainstem death are not fulfilled. It will be sustained within any hospital by the development of a locally agreed policy, education, after-event reviews and audit.

Participation in an organ donor awareness program is a mandatory course prior to completion of specialist training in Intensive Care Medicine (the Irish Donor Awareness course runs annually).

Organ Donation Nurse Managers (ODNMs) are in place across the HSE health regions. They play a pivotal role in many aspects of the DCD process and the care of donor patients and their families. ODNMs have led and continue to lead initiatives in the areas of education, process development, and staff support throughout the country.

Similarly, individual Donor Coordinators within the National Organ Procurement Service place a strong emphasis on staff support and education. They provide a vital resource for medical and nursing staff education and offer onsite clinical support as needed 24 hours a day, 365 days a year.

The ODTI provides support for all educational and training activities relating to organ donation and transplantation, whether in the context of staff participation, funding or the organisation and logistics of such activities. The ODTI and transplanting hospitals organise and run several "Transplantation link" meetings throughout the year.

The ODTI has been delegated the regulatory functions assigned to the HSE within the statutory instrument (SI) 325 (2012) i.e. the Quality and Safety of Human Organs intended for transplantation 2012. The ODTI remains the responsible body providing audit and quality assurance within the Republic of Ireland.

Appendix A

EDQM Glossary of Acronyms, Abbreviations & Definitions (24)		
Acronym	**Title**	**Definition**
WLST	Withdrawal of life- sustaining therapies	Changing goals of therapy to comfort and palliative measures. Reflects discontinuation of life sustaining therapy: stopping mechanical ventilation, inotropes, dialysis, cardiovascular mechanical supports such as ECMO, VADs, IABP.
WIT	Warm Ischaemic Time, including: a) Withdrawal time/agonal period b) Primary WIT/asystolic warm time c) Withdrawal to perfusion time, donor WIT, total WIT	**Synonyms**: Donor WIT, Total WIT, withdrawal to perfusion time **a) Agonal period/withdrawal time**: WLST to circulatory arrest **b) Primary WIT/Asystolic warm time:** Circulatory arrest to in-situ perfusion of organs **c) Donor WIT/total WIT/Withdrawal to perfusion time:** WLST to in-situ perfusion of organs (agonal period + asystolic warm time)
fWIT	Functional warm ischaemic time	The time between the first episode of significant hypoperfusion and in situ cold perfusion or NRP **Begins**: Systolic BP <50mmhg or SpO2 <70% for >2 minutes **Ends**: In-situ perfusion of organs
DGF	Delayed graft function Renal	The need for dialysis in the 7 days after transplantation.
EAD	Early Allograft Dysfunction Hepatic (Olthoff criteria)	One of: (a) AST or ALT > 2000 units (within 7 days) (b) Bilirubin > 171 micromoles/L (day 7) (c) INR > 1.6 (day 7)
ITBL/IC	Ischaemic type biliary lesions Ischaemic cholangiopathy	Progressive ischemic biliary injury: bile duct stenosis or necrosis, bile leakage, biloma, bile duct fibrosis. Incidence in DCD 16-29%. Most occur within 1 year of transplant.
RR/SRR	Rapid Retrieval Super Rapid Retrieval	Describes standard procedure of organ retrieval, laparotomy and cannulation of vessels for immediate cold perfusion
A-NRP	Abdominal normothermic regional perfusion	**Synonyms:** • **nECMO:** normothermic (regional) ECMO • **ANOR:** Abdominal Normothermic Oxygenation & Recirculation • **EISOR:** Extracorporeal Interval Support for Organ Retrieval
TA-NRP	Thoraco-Abdominal NRP	A partial circulation which excludes the cerebral circulation only through ligation and division of carotid and subclavian arteries

TABLE 3: EDQM Glossary of Acronyms, Abbreviations & Definitions

Appendix B: Normothermic Regional Perfusion (NRP):

In the context of DCD, NRP is an enhanced therapy, delivered post-mortem, which ameliorates the effects of ischaemia on donated organs (figures 1 & 3). Regional Perfusion may be limited to the abdominal organs: A-NRP, or to both thoracic and abdominal organs: TA-NRP.

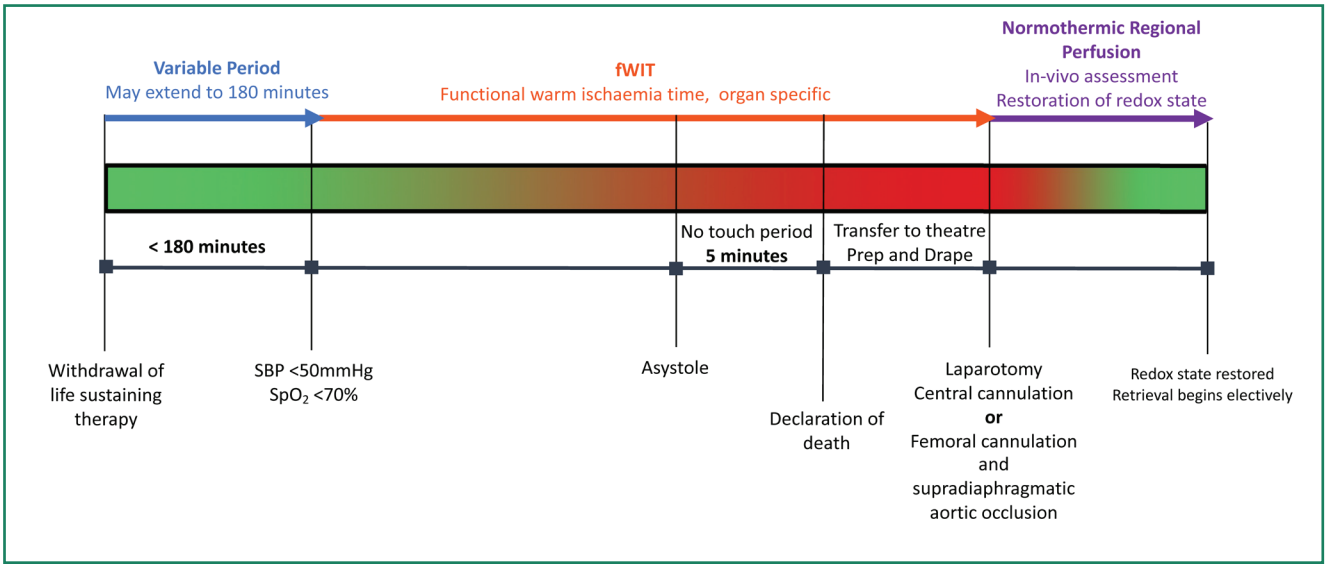

FIGURE 4: DCD incorporating the Process of In-situ Perfusion NRP

NRP has the potential to increase the time-period from WLST until organ donation begins by several hours without detrimental effects on donor organ outcomes. If the timer starts with the onset of fWIT, and NRP is used, then it is likely that less stand-downs will occur. The number of organs retrieved are also higher per patient than with standard DCD (3.3 vs 2.6) (25).

While on NRP, macroscopic appearances and trends in biochemical parameters provide reassurance of post-transplant function. It has been shown that a period of *in situ* perfusion after warm ischaemia allows replenishment of ATP stores. In addition, it is likely that there is an ischaemic preconditioning effect once the circulation is restored, allowing better tolerance of subsequent periods of cold ischaemia. In the absence of other contraindications, it is recommended that if the two-hour ALT is under 500 iu/L and there is a glucose rise at the start of NRP, the liver should be considered suitable for transplant (2).

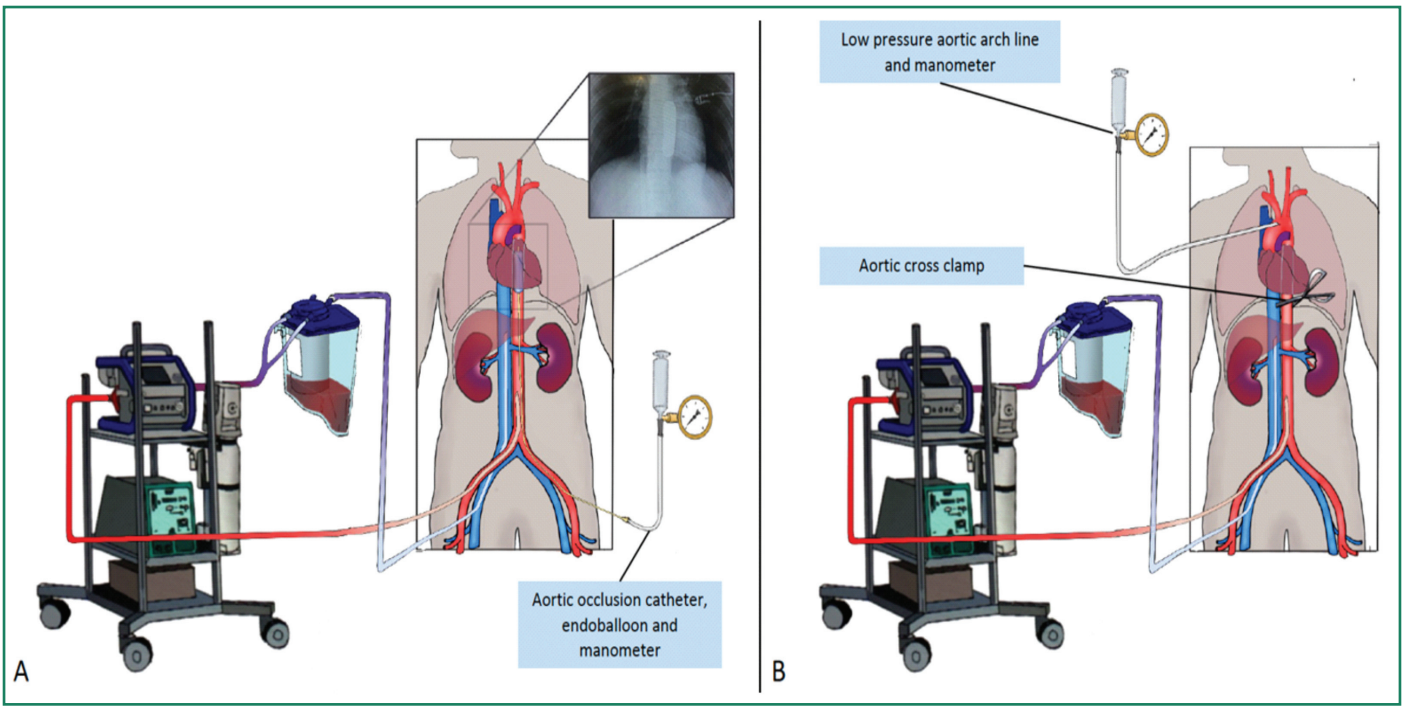

FIGURE 5: Circulatory path for A-NRP, with low-pressure points in proximal aorta.
A: Endovascular aortic occlusion balloon and low-pressure aortic point via wiring lumen of catheter
B: External aortic occlusion with cross clam and low-pressure aortic point via arch cannula

In France, Italy and Norway, A-NRP has become the standard procurement procedure for DCD donors mandated by the health authorities. It is the preferred routine in several regions in the UK and Spain. The function and outcomes after kidney and liver transplantation using A-NRP appear superior to DCD without A-NRP when comparing data to large cohorts described elsewhere (26) (Table 4).

Renal Transplant (27)	Matched groups NRP n=700 RR n=770	Hepatic Transplant (28)	NRP – DCD N= 152	SRR – DCD N=218
Delayed graft function	OR 1.97 (CI: 1.4-2.7)	**Biliary complications**	8%	31%
Creatinine 1 year	132 vs 160 µmol	**Ischemic biliary lesions**	2%	13%
Graft loss	OR 1.77 (CI: 1.01 – 3.2)	**Graft loss**	12%	24%

TABLE 4: Outcomes after kidney and liver transplant from DCD donors with and without NRP. SRR: super rapid retrieval, RR: rapid retrieval

APPENDIX C: Antemortem and Postmortem Interventions

There should be no medical interventions before WLST that are likely to cause discomfort, harm or place that patient at risk of adverse events. Specific examples of such interventions include the administration of phentolamine or thrombolytic agents or antemortem femoral cannulation. Blood testing for tissue typing is considered appropriate.

No procedure is permissible after the diagnosis of death that has the potential to restore cerebral circulation. Where re-intubation is required where the lungs are being retrieved; the lungs should not be re-inflated until after isolation of the cerebral circulation (usually by aortic or bilateral carotid arterial cross-clamp).

Antemortem Heparin

Systemic heparinisation may incur a risk of bleeding and thus harm to the patient, however the administration of antemortem heparin in DCD must be considered in context. A medication which provides no direct benefit to the donor patient may be considered "not in their best interests". However, "best interests" may extend beyond the patient's medical needs:

> "*best interests must also include their social, emotional, cultural and religious interests, so if a patient wished to donate their organs, it would be in their best interests to ensure that the organs are transplanted in the best possible condition*" (29)

THE UK Donation Ethics Committee called for further work to determine if the use of ante-mortem heparin should be revisited. It states that there is no ethical barrier, provided an individualised assessment of risk is completed for each potential donor patient. The arguments against the use of antemortem were legal in nature. In the UK antemortem Heparin is administered to Maastricht category IV donor patients only (2).

The Australian Organ Donation and Tissue Authority and the Australia and New Zealand intensive care society (ANZICS) support antemortem interventions to maintain organ viability providing there is no legal impediment, and state that they support:

> *"Administering heparin (e.g. 25,000 units [or 300 u/kg]) to prevent small-vessel thrombosis —[however] if there is any concern than heparin may foreshorten the patient's life, the heparin can be given when the patient is apnoeic."* (21)

In 2013, the American Thoracic Society, the International Society for Heart and Lung Transplantation and the Society of Critical Care Medicine deemed administration of antemortem heparin ethically acceptable once the risks and potential benefits to the recipient patient were disclosed to the donor families (3).

The American Association of Thoracic Surgery 2023 Expert consensus document states (in relation to adult cardiac transplantation) that in DCD:

> *"Administration of intravenous heparin at the point of the WLST is the current standard of care. There are no reported cases of heparin administered at this time hastening death" (30)*

The use of antemortem heparin decreases the incidence of primary non-function of liver grafts and the rate of vascular thrombosis in pancreatic grafts (31, 32) . The beneficial effects of antemortem heparin in other organs are less clear but may include improved machine perfusion indices and less glomerular microthrombi in renal transplant and less pulmonary thrombi in lung transplantation.

In summary, the administration of heparin may be contentious. Although there is no medical benefit to the donor patient, best interests beyond their current medical needs must also be considered. The final decision on heparinisation should be based on the clinician's assessment of whether the clear benefits of heparin will outweigh the risks, however small, to the potential organ donor patient. Whatever decision is made, it must be communicated during the time-out process.

Appendix D: Support Tools for Estimating the Time of Death

A number of factors are known to predict the likelihood of death after WLST, but none are definitive. Independent predictors that have been shown on multivariate analysis to correlate with shorter time from WLST to death include (33):

- Aetiology of neurological injury: Patients with neurological injury due to traumatic brain injury die more quickly than patients who have suffered intracranial haemorrhage. The longest period from WLST to death is seen in patients with hypoxic ischaemic encephalopathy.
- Reduced Glasgow Coma Scale
- Hypoxia and increased FiO_2 requirement
- Acidosis at the time of WLST
- Impaired respiratory drive
- Inotropic support

Several scoring systems also exist to assist in decision making. It is important to note that the temporary withdrawal of mechanical ventilation as required by the Wisconsin and UNOS DCD support tools is within the category of unacceptable antemortem interventions and cannot be recommended. Partial scores may be calculated without ventilator disconnection.

The DCD N Score:

The DCD-N score uses four clinical variables to create a predictive score for cardiac death in patients with a neurocritical pathology (34). One point is allocated to an absent corneal reflex, an extensor or absent motor response and an oxygenation index of > 3.0. and two points to an absent cough reflex (maximum score = 5) (**Table 3**).

TABLE 3: The DCD N Score with probabilities of death within 60 min according to the combinations of predictive variables

Absent corneal reflex	Absent cough reflex	Extensor or absent motor response	Oxygenation index >3·0	Score	Probability of death in 60 minutes
No	No	No	No	0	0·08
No	No	No	Yes	1	0·16
Yes	No	No	No	1	0·18
No	No	Yes	No	1	0·20
No	Yes	No	No	2	0·26
Yes	No	No	Yes	2	0·34
No	No	Yes	Yes	2	0·37
Yes	No	Yes	No	2	0·40
No	Yes	No	Yes	3	0·45
Yes	Yes	No	No	3	0·48
No	Yes	Yes	No	3	0·51
Yes	No	Yes	Yes	3	0·61
Yes	Yes	No	Yes	4	0·68
No	Yes	Yes	Yes	4	0·71
Yes	Yes	Yes	No	4	0·74
Yes	Yes	Yes	Yes	5	0.87

The Wisconsin DCD Evaluation Tool

This tool requires temporary patient disconnection from the ventilator for a period of up to ten minutes to calculate a full score, which is then used to estimate probability of death within 60 minutes from the WLST (**Table 4**). These results were not externally validated in a general ICU population and consequently this tool should only be used in neurological critical care (35).

TABLE 4: The University of Wisconsin DCD Tool and estimated expiration likelihood within 60 minutes

Criteria	Assigned Points	Score
Spontaneous respiration after 10 mins		
Rate >12	1	
Rate <12	3	
TV >200ml	1	
TV <200ml	3	
NIF <20	3	
NIF >20	1	
No spontaneous respiration	9	
Vasopressors/Inotropes		
No vasopressors/inotropes	1	
Single vasopressor/inotrope	2	
Multiple vasopressors/inotropes	3	
Patient Age		
0-30	1	
31-50	2	
51+	3	
Intubation		
Endotracheal tube	3	
Tracheostomy	1	
Oxygenation after 10 minutes		
SpO2 >90%	1	
SpO2 80-89%	2	
SpO2 <80%	3	
Final Score		

UW Score	Probability of death in <60 min (%)
7	4
8	6
9	19
10	16
11	24
12	34
13	47
14	59
15	71
16	80
17	87
18	92
19	94
20	97
21	98

TV: tidal volume **NIF**: Negative inspiratory force. The amount of effort a person makes with each inspiration in cm H_2O. A minimum NIF is considered to be -20 cm H2O.

The UNOS Criteria

This tool also relies on a disconnection of the patient from the ventilator to determine spontaneous respiratory drive and oxygenation. It may be used in patients in whom advanced extracorporeal life support is in use. Patients with two or more criteria in any section may be considered as a potential DCD donor (**Table 5**). Patients who had zero, one, two or three criteria had a probability of dying within 60 minutes of 29%, 52%, 65% and 82% respectively (36).

TABLE 5: The UNOS Criteria

Respiratory drive	Pressure Cost of Oxygenation	Invasive cardiovascular support	Vasopressor or Inotropic support	Intra-aortic ballon pump (IABP) & Cardiac Index (CI)
Apnoea RR < 8 RR >30 during trial off ventilation	PEEP ≥ 10 & S_aO_2 ≤ 92% F_iO_2 ≥ 0.5 & S_aO_2 ≤ 92%	Left ventricular assist device Right ventricular assist device Veno-arterial ECMO Pacemaker with unassisted rhythm < 30	High dose vasopressors: Noradrenaline Adrenaline Phenylephrine ≥ 0.2mcgs/kg/min Dopamine ≥ 15 mcgs/ kg/min	IABP 1:1 Dobutamine > 10mcgs/ kg/min and CI < 2.2 l min^{-1} IABP 1:1 & CI < 1.5 l min-1

Appendix E: Proforma Observation Sheet for DCD

Donation after Circulatory Death

To be completed by doctor caring for patient during WLST

Addressograph

Diagnosis:

Admitting Consultant:
Diagnosis and prognosis consistent with WLST and DCD:

ICU Consultant Opinions:
Diagnosis and prognosis consistent with WLST and DCD:

Neurological opinion (where applicable):
Diagnosis and prognosis consistent with WLST and DCD:

Case Discussed with Coroner:

Authorisation from Next of Kin:

Authorisation for Antemortem interventions:	Yes	No
• Bloods for Crossmatch &Viral screens		
• Heparin 300 IU kg^{-1}		
In-situ regional perfusion discussion		

Timeout procedure with teams:

Consultant responsible for care during withdrawal period:

ICU Staff nurse responsible for care during withdrawal period:

	Ventilation settings prior to WLST Sedative Infusions
T1	***Withdrawal of Life Sustaining therapies*** Date Time Location Heparinisation 300 IU kg^{-1}

Medications Administered before and after WLST

Time	***Medication***	***Dose***

T2	fWIT begins SBP <50mmhg and/or SpO_2 < 70% for 2 minutes

Criteria for diagnosis of Cardiorespiratory Death
Determined: After 5 minutes Asystole on ECG **OR** After 5 minutes of pulselessness on Arterial line

• Pulseless - flat arterial waveform trace	Y/N
• Absent Heart sounds	Y/N
• Apnoeic	Y/N
• Pupils fixed with no reaction	Y/N
• Absent response to supra-orbital pressure	Y/N
• Absent Corneal reflexes.	Y/N

T3	Time of Death
Time Out, Transfer to theatre	
T4	Organ donor operation Begins
T5	Cold perfusion fluid begins WIT ends (Cold Ischaemic time begins) Normothermic Regional Perfusion

Signature of Clinician: IMC No: Date:

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